DENMARK'S NATIONAL INVENTORY REPORT 2010

Emission Inventories 1990-2008 – Submitted under the United Nations Framework Convention on Climate Change and the Kyoto Protocol

NERI Technical Report no. 784 2010

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Data sheet

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Abstract: This report is Denmark's National Inventory Report 2010. The report contains information on Denmark's emission inventories for all years' from 1990 to 2008 for CO_2, CH_4, N_2O, HFCs, PFCs and SF_6, NO_x, CO, NMVOC, SO_2.

Keywords: Emission inventory; UNFCCC; Kyoto Protocol; Greenhouse gases; IPCC; CO_2; CH_4; N_2O; HFCs; PFCs; SF_6.

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Contents

Executive summary

ES.1. Background information on greenhouse gas inventories and climate change

Reporting

This report is Denmark's National Inventory Report (NIR) 2010 for submission to the United Nations Framework Convention on Climate change and the Kyoto Protocol, due April 15, 2010. The report has been updated since the emission inventories were updated and resubmitted to UNFCCC within the six weeks limit from April 15, 2010, i.e. May 27, 2010. The report contains detailed information about Denmark's inventories for all years from 1990 to 2008. The structure of the report is in accordance with the UNFCCC guidelines on reporting and review. The main difference between Denmark's NIR 2010 report to the European Commission, due March 15, 2010, and this report to UNFCCC is reporting of territories. The NIR 2010 to the EU Commission was for Denmark, while this NIR 2010 to UNFCCC is for Denmark, Greenland and the Faroe Islands. The suggested outline provided by the UNFCCC secretariat has been followed to include the necessary information under the Kyoto Protocol. The report includes detailed and complete information on the inventories for all years from year 1990 to the year 2008, in order to ensure transparency.

The annual emission inventories for the years from 1990 to 2008 are reported in the Common Reporting Format (CRF). Within this submission separate CRF's are available for Denmark (EU), Greenland, the Faroe Islands, for Denmark and Greenland (KP) as well as for Denmark, Greenland and the Faroe Islands (UN Climate Convention). The CRF spreadsheets contain data on emissions, activity data and implied emission factors for each year. Emission trends are given for each greenhouse gas and for total greenhouse gas emissions in CO_2 equivalents.

The issues addressed in this report are: Trends in greenhouse gas emissions, description of each emission category of the CRF, uncertainty estimates, explanations on recalculations, planned improvements and procedure for quality assurance and control.

This report itself does not contain the full set of CRF tables. Only the trend tables, Tables 10.1-5 of the CRF format for Denmark, are included, refer to Annex 8. The full set of CRF tables is available at the EIONET, Central Data Repository, kept by the European Environmental Agency:
http://cdr.eionet.europa.eu/dk/Air_Emission_Inventories

Please note that figures in Annex 8 are in the Danish notation, which is "," (comma) for decimal sign and "." (full stop) to divide thousands. In the report (except where tables are taken from the CRF as "pictures" as in Annex 9) English notation is used: "." (full stop) for decimal sign and mostly space for division of thousands. The English notation for division of thousand as "," (comma) is mostly not used due to the risk of being misinterpreted by Danish readers.

Institutions responsible

On behalf of the Ministry of the Environment and the Ministry of Climate and Energy NERI is responsible for the calculation and reporting of the Danish national emission inventory to EU and the UNFCCC (United Nations Framework Convention on Climate Change) and UNECE CLRTAP (Convention on Long Range Transboundary Air Pollution) conventions. Hence, the National Environmental Research Institute (NERI), University of Aarhus, prepares and publishes the annual submission for Denmark to the EU and UNFCCC of the National Inventory Report and the GHG inventories in the Common Reporting Format, in accordance with the UNFCCC guidelines. Further, NERI is responsible for reporting the national inventory for the Kingdom of Denmark to the UNFCCC. NERI is also the body designated with overall responsibility for the national inventory under the Kyoto Protocol for Greenland and Denmark. Furthermore, NERI participates when reporting issues are discussed in the regime of UNFCCC and EU (Monitoring Mechanism).

The work concerning the annual greenhouse gas emission inventory is carried out in cooperation with Danish ministries, research institutes, organisations and companies. The Government of Greenland is responsible for finalising and transferring the inventory for Greenland to NERI. The Faroe Islands Environmental Agency is responsible for finalising and transferring the inventory for the Faroe Islands to NERI.

Greenhouse gases

The greenhouse gases reported are those under the UN Climate Convention:

- Carbon dioxide CO_2
- Methane CH_4
- Nitrous Oxide N_2O
- Hydrofluorocarbons HFCs
- Perfluorocarbons PFCs
- Sulphur hexafluoride SF_6

The global warming potential (GWP) for various greenhouse gases has been defined as the warming effect over a given time of a given weight of a specific substance relative to the same weight of CO_2. The purpose of this measure is to be able to compare and integrate the effects of the individual greenhouse gases on the global climate. Typical lifetimes in the atmosphere of greenhouse gases are very different, e.g. approximately 12 and 120 years for CH_4 and N_2O, respectively. So the time perspective clearly plays a decisive role. The lifetime chosen is typically 100 years. The effect of the various greenhouse gases can then be converted into the equivalent quantity of CO_2, i.e. the quantity of CO_2 giving the same effect in absorbing solar radiation. According to the IPCC and their Second Assessment Report, which UNFCCC has decided to use as reference, the global warming potentials for a 100-year time horizon are:

- CO_2: 1
- Methane (CH_4): 21
- Nitrous oxide (N_2O): 310

Based on weight and a 100-year period, CH_4 is thus 21 times more powerful a greenhouse gas than CO_2 and N_2O is 310 times more powerful than CO_2. Some of the other greenhouse gases (hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride) have considerably higher global warming potentials. For example, sulphur hexafluoride has a global warming potential of 23 900. The values for global warming potential used in this report are those prescribed by UNFCCC. The indirect greenhouse gases reported are Nitrogenoxide (NO_x), Carbonmonooxide (CO), Non-Methane Volatile Organic Compound (NMVOC) and Sulphurdioxid (SO_2). Since no GWP is assigned these gases they do not contribute to GHG emissions in CO_2-equivalents.

ES.2. Summary of national emission and removal trends

Summary ES.2.-4. is the inventory for Denmark only. The inventories for Greenland, Denmark and Greenland and the Faroe islands are described in Annex 9, 10 and 11, respectively.

ES.2.1 Greenhouse gas emissions inventory

The greenhouse gas emissions are estimated according to the IPCC guidelines and guidance and are aggregated into seven main sectors. According to decisions made under the UNFCCC and the Kyoto protocol the greenhouse gas emissions are estimated according to IPCC 1996 guidelines and IPCC 2000 good practice guidance. The greenhouse gases include CO_2, CH_4, N_2O, HFCs, PFCs and SF_6. Figure ES.1 shows the estimated total greenhouse gas emissions in CO_2 equivalents from 1990 to 2008. The emissions are not corrected for electricity trade or temperature variations. CO_2 is the most important greenhouse gas contributing in 2008 to national total emission in CO_2 equiv. excluding LULUCF (Land Use and Land Use Change and Forestry) with 79.5 %, followed by N_2O with 10.5 %, CH_4 8.6 % and F-gases (HFCs, PFCs and SF_6) with 1.4 %. Seen over the time span from 1990 to 2008 these contributions (in percentages) have been increasing for CO_2 and F-gases, almost constant for CH_4 and decreasing for N_2O. Stationary combustion plants, transport and agriculture represent the largest emission categories, followed by Industrial processes, Waste and Solvents, see Figure ES.1. The net CO_2 emission for the LULUCF sector in 2008 is 2.2 % of the total emission in CO_2 equivalents (including LULUCF). The National total greenhouse gas emission in CO_2 equivalents excluding LULUCF has decreased by 7.4 % from 1990 to 2008 and decreased 4.0 % including LULUCF. Comments on the overall trends on the individual greenhouse gases etc. seen in Figure ES.1 are given in the sections below.

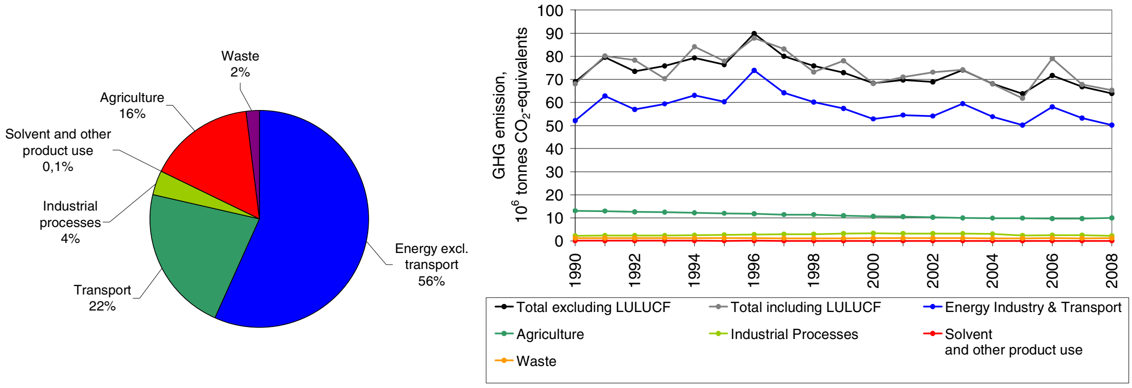


Figure ES.1 Greenhouse gas emissions in CO_2 equivalents distributed on main sectors (excl. LULUCF) for 2008 and time-series for 1990 to 2008, where data for CO_2 excludes LULUCF.

ES.2.2 KP-LULUCF activities

Net removals from Afforestation Reforestation Deforestation (ARD) activities in 2008 were 33.9 Gg CO_2 eqv., hereof 0.4 Gg CO_2 eqv. owe to N_2O emissions from disturbance of soils. Net emissions from FM activity were 293.2 Gg CO_2 eqv. (Table ES.1) hereof 8.6 Gg CO_2 eqv. owe to N_2O emissions from drainage of soils.

For Cropland Management (CM) the net emissions in 2008 were 863.5 Gg CO_2 eqv. compared to a net emission in 1990 of 3 471.8 Gg CO_2 eqv.

For Grassland Management (GM) the net emission in 2008 was 81.7 Gg CO_2 eqv. compared to a net emission in 1990 of 95.7 Gg CO_2 eqv.

Table ES.1 Emissions and removals in 2008 for activities relating to Article 3.3 and Article 3.4

	Net CO_2 emissions/removals	CH_4	N_2O	Net CO_2 equivalent emissions/removals
		(Gg)		
A. Article 3.3 activities				**-33.92**
A.1. Afforestation and Reforestation	-69.81	NA	IE,NA	-69.81
A.1.1. Units of land not harvested since the beginning of the commitment period	-69.81	NA	IE,NA	-69.81
A.1.2. Units of land harvested since the beginning of the commitment period	IE,NA	NA	IE,NA	IE,NA
A.2. Deforestation	35.48	NA	0.00	35.89
B. Article 3.4 activities				**1,238.45**
B.1. Forest Management	281.02	NA	0.04	293.24
B.2. Cropland Management	863.52	NO	NO,NR	863.52
B.3. Grazing Land Management	81.69	NO	NO	81.69
B.4. Revegetation	NA	NA	NA	NA

ES.3. Overview of source and sink category emission estimates and trends

ES.3.1 Greenhouse gas emissions inventory

Energy

The largest source of the emission of CO_2 is the energy sector, which includes the combustion of fossil fuels such as oil, coal and natural gas. Energy excluding transport contributes in 2008 with 57 % of the national total CO_2 emissions (excl. LULUCF). The transport sector accounts for approximately 22 %. The CO_2 emission from the energy sector including transport decreased by approximately 6 % from 2007 to 2008. The relatively large fluctuations in the emission time-series from 1990 to 2008 are due to inter-country electricity trade. Thus, high emissions in 1991, 1994, 1996, 2003 and 2006 reflect electricity export and the low emissions in 1990 and 2005 were due to import of electricity in these years. The low emission in 2008 is due to a decrease in the energy demand due to the economic recession. The minor increasing emission of CH_4 is due to increasing use of gas engines in the decentralised cogeneration plants. The deregulation of the electricity market has made production of electricity in gas engines less favourable, therefore the fuel consumption has decreased and hence the CH_4 emission has decreased. The CO_2 emission from the transport sector has increased by 31 % since 1990, mainly due to increasing road traffic.

Industrial processes

The emissions from industrial processes, i.e. emissions from processes other than fuel combustion, amount to 3.5 % of total emissions in CO_2-equivalents (excl. LULUCF). The main categories are cement production, refrigeration, foam blowing and calcination of limestone. The CO_2 emission from cement production – which is the largest source contributing with about 2.1 % of the national total – increased by 31 % from 1990 to 2008. The second largest source has been N_2O from the production of nitric acid. However, the production of nitric acid/fertiliser ceased in 2004 and therefore the emission of N_2O also ceased.

The emission of HFCs, PFCs and SF_6 has increased by 176 % from 1995 until 2008, largely due to the increasing emission of HFCs. The use of HFCs, and especially HFC-134a, has increased several fold so HFCs have become the dominant F-gases, contributing 67 % to the F-gas total in 1995, rising to 95 % in 2008. HFC-134a is mainly used as a refrigerant. However, the use of HFC-134a is now stabilising. This is due to Danish legislation, which in 2007, banned new HFC-based refrigerant stationary systems. However, in contrast to this trend is the increasing use of air conditioning systems in mobile systems.

Solvents

The use of solvents in industries and households contribute 0.1 % of the total greenhouse gas emissions in CO_2-equivalents. There is a 52 % decrease in CO_2 emissions from 1990 to 2008. N_2O comprises in 2007 30 % of the total CO_2-equivalent emissions for solvent use.

Agriculture

The agricultural sector contributes with 15.6 % of the total greenhouse gas emission in CO_2-equivalents (excl LULUCF) and is one of the most important sectors regarding the emissions of N_2O and CH_4. In 2008 the contributions to the total emissions of N_2O and CH_4 were 91 % and 70 %, respectively. The main reason for the decrease of 31 % in the emission of N_2O from 1990 to 2008 is a legislative demand for an improved utilisation of nitrogen in manure. This result in less nitrogen excreted pr livestock unit produced and a considerable reduction in the use of fertilisers. From 1990 to 2008, the emission of CH_4 from enteric fermentation has decreased due to decreasing numbers of cattle. However, the emission from manure management has increased due to changes in stable management systems towards an increase in slurry-based systems. Altogether, the emission of CH_4 for the agricultural sector has decreased by 6 % from 1990 to 2008.

Land Use and Land Use Change and Forestry (LULUCF)

The LULUCF sector alters between being a net sink and a net source of GHG. In 2008 LULUCF was a net source with 2.2 % of the total GHG emission including LULUCF. In 2007 LULUCF was a net source equivalent to 1.3 % of the total GHG emission (including LULUCF). In 2008 Forest Land, Cropland, Grassland and Settlements was net sources contributing with 442.15 Gg CO_2-eqv., 836.92 Gg CO_2-eqv., 140.45 Gg CO_2-eqv. and 51.77 Gg CO_2-eqv., respectively. In the same year Wetlands was a net sink contributing with 7.15 Gg CO_2-eqv. The emission from Croplands is mainly due to emissions from organic soils. Since 1990 there has been a decrease in the total C-stock in soil. Despite the global warming it seems that this decrease has stabilized so that it is possible to maintain the current C stock level in soil.

Waste

The waste sector contributes in 2008 with 1.9 % of the national total. The trend of emission from 1990 to 2008 is decreasing by 2.4 %. The sector is dominated by CH_4 emission from solid waste disposal contributing 85.0 % to the sector total in 2008. This emission has decreased by 2.5 % from 1990 to 2008. This decrease is due to the increasing incineration of waste for power and heat production. Since all incinerated waste is used for power and heat production, the emissions are included in the 1A IPCC category.

The CH_4 and N_2O emissions from wastewater handling contribute to the sectoral total with 3.8 and 8.4 %, respectively. For the wastewater handling the CH_4 emissions has an increasing trend while N_2O are at the same level as in 1990. Waste incineration without energy recovery contributes in 2008 with 2.6 % to the sectoral total; the trend of these emissions is slightly increasing from 1990 to 2008.

ES.3.2 KP-LULUCF activities

In 2008 the activities under Article 3.3 was a net sink of 34 Gg CO_2-eqv. and the activities under Article 3.4 was a net source of 1238 Gg CO_2-eqv. A short overview of KP-LULUCF is given in Chapter ES.2.2 and a more detailed description is given in Chapter 11.

ES.4. Other information

ES.4.1 Quality assurance and quality control

A plan for Quality Assurance (QA) and Quality Control (QC) in greenhouse gas emission inventories is included in the report. The plan is in accordance with the guidelines provided by the UNFCCC (Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories and Guidelines for National Systems). ISO 9000 standards are also used as an important input for the plan.

The plan comprises a framework for documenting and reporting emissions in a way that emphasis transparency, consistency, comparability, completeness and accuracy. To fulfil these high criteria, the data structure describes the pathway, from the collection of raw data to data compilation and modelling and finally reporting.

As part of the Quality Assurance (QA) activities, emission inventory sector reports are being prepared and sent for review to national experts, not involved in the inventory development. To date, the reviews have been completed for the stationary combustion plants sector, the transport sector and the agricultural sector. In order to evaluate the Danish emission inventories, a project where emission levels and emission factors are compared with those in other countries has been conducted.

ES.4.2. Completeness

The Danish greenhouse gas emission inventories include all sources identified by the revised IPPC guidelines except the following:

Agriculture: The CH_4 conversion factor in relation to the enteric fermentation for poultry and fur farming is not estimated. There is no default value recommended by the IPCC. However, this emission is seen as non-significant compared with the total emission from enteric fermentation.

Please see annex 5 for more information.

ES.4.3. Recalculations and improvements

The main improvements of the inventories are:

General

The documentation for the emission inventory has been significantly expanded to include all elements of a regular NIR. A full CRF for Greenland and the Faroe Islands and the appropriate aggregations hereof with the CRF for Denmark has been worket out. Additionally many sectors that have not previously been estimated are included for the first time. For a thorough documentation of the emission inventory for Greenland please refer to Annex 9.

At the request of the ERT a tier 1 uncertainty estimate has been made for the aggregated submission of Denmark and Greenland. A trend discussion and a key category analysis have also been performed. Please refer to Annex 10 for more information.

Energy

Stationary Combustion

Update of fuel rates according to the latest energy statistics. The update included the years 1980-2007. The most changes were for the years 2006 and 2007.

The split of the CO_2 emission factor for municipal waste between biomass and fossil fuel have been recalculated. This has led to an increased fossil CO_2 emission from waste incineration for the whole time-series.

Improved emission factors for decentralised CHP plants referring to a Danish emission measurement program (Nielsen et al. 2010) have been implemented. This has affected emissions of CH_4 and N_2O from several plant types.

Mobile sources

Road transport

The total mileage per vehicle category from 2005-2008 have been updated based on the traffic index development (derived from traffic counts on selected roads) from the Danish Road Directorate. In addition new data prepared by Department of Transport, Technical University of Denmark (DTU Transport) for the Danish Infrastructure Commission has given information of the total mileage driven by foreign trucks on Danish roads. This mileage contribution has been added to the total mileage for Danish trucks on Danish roads, for trucks > 16 tonnes of gross vehicle weight. The data from DTU Transport was estimated for 2005, and by using appropriate assumptions the mileage have been backcasted to 1985 and forecasted to 2008.

For passenger cars the new division of total mileage into gasoline and diesel made by the Danish Road Directorate is regarded as very broad. Hence in the subsequent model calculations, the fuel and emission results for diesel passenger cars are adjusted with the overall sales/calculated fuel ratio, being applied to the estimates for the other diesel vehicle categories as well. This is a change compared to previous year's inventory submissions for which the diesel passenger car results remain unadjusted.

Military

Emission factors derived from the new road transport simulations have caused some emission changes from 1985-2007. The minimum and maximum emission differences (min %, max %) for the different emission components are: CH_4 (0 %, 4 %) and N_2O (0 %, 2 %).

Aviation

En error for 2007 has been corrected. Erroneously, the flights between Denmark and Greenland/Faroe Islands were treated as international flights. As a result of this correction the fuel consumption and emissions change substantially. The fuel consumption and CO_2 emission increases are 51%, whereas CH_4 and N_2O emissions increase by 22 % and 26 %, respectively.

Very small emission changes between 0 % and 2 % occur for the years 2001-2006, due to inclusion of new representative aircraft types.

Fugitive emissions

Emissions from distribution of town gas have been included in the emission inventory for the years 1985-2008. The input data are sparse as more of the distribution companies have been closed down. Only in the cities of Copenhagen and Aalborg town gas is still being distributed. Another two distribution companies are included in the inventory. Those were closed in 2004 and 2006, respectively. To complete the time-series interpolation and extrapolation has been used on basis of the available data. The uncertainties are expected to be large both regarding the distribution for years without data, the distribution loss and the gas composition.

The emission factors for flaring in refineries have been updated. The emission factors for NMVOC and CH_4 are based on new information on the fuel gas composition from one of the two Danish refineries. The same emission factors are adopted for the second Danish refinery. Emission factors from the EMEP/EEA guidebook (2009) are used to calculate emissions of NO_x, CO and N_2O. CO_2 emission factors are based on data from the ETS reports for 2006-2008 and the calorific values for fuel gas for one refinery. For SO_2 the TIER 1 emission factors for stationary combustion from the EMEP/EEA guidebook (2009) are used.

Industry

The emission of CO_2 from production of cement has been revised for the years 1998-2005 based on new information from the company.

For yellow bricks and expanded clay products the CO_2 emission has been adapted from the company reports to EU-ETS as the emission factors calculated previously and used until 2005 were found not to be in line with the actual emission.

In the category "2F4 Aerosols/Metered Dose Inhalers" metered dose inhalers have been included for 2008 and the emissions has also been recalculated for 1998 - 2007.

Solvents

An improved and more detailed source allocation method has been implemented, which enables emission calculation on SNAP sub-category level.

Agriculture

A new method – a Tier 2/CS methodology - for the calculation of CH_4 from manure management has been implemented by using national values of manure conditions. The consequences of the recalculations shows increases in the years 1990 - 2007 from 16 % to 1 % given in CO_2-equivalents with a falling tendency.

Calculations of nitrogen loss from manure have been adjusted to TAN therefore recalculations have been made. Furthermore an error in the database calculations of N_2O has been corrected. These changes decrease the emission of N_2O from manure management in the years 1990-2005 up to 4 % in CO_2-equivalents, and increase emission in 2006 by 1 % and in 2007 decrease emission by 14 %.

New data for the number of animals and the distribution on stable types have been implemented. As recommended by the expert review team (ERT) the amount of feed and N ab animal for heifers have been interpolated in the years 2005-2006 to even out high differences. Also for dairy cattle, piglets and slaughter pigs the amount of feed has been interpolated for the amounts of cattle in 2006 and piglets and slaughter pigs in 1991-1993. Three new categories of animals are included, deer, pheasants and ostriches. New data for the use of sewage sludge as fertilizers for the years 2002, 2005 and 2007 have been implemented.

Field burning of agricultural wastes have been included and it effects the total emission by less than 1 % for all compounds.

LULUCF

A full matrice for Land Use Change has been implemented for all years.

Based on mapped forest area in 1990 and in 2005 a recalculation of carbon stored in both forest remaining forest and in afforestation since 1990 have been performed. The forest areas in 1990 as well as in 2005 have been mapped to be larger than previously estimated for the times. The recalculation of carbon stock in 1990 and in 2000 used age distribution as reported in census 1990 and in 2000 as an expression of the total forest land allocation to species and ages. Based on the actual measurements of carbon storage in different species and age classes with the current National Forest Inventory (NFI), the total standing carbon stock was calculated. For each of the years 1990 - 2000 calculated a standing carbon stock as a moving average, corrected for the deforestation which was detected. Wind throws and the effects of these are included in the overall estimation of changes in carbon stock.

For Cropland and Grassland the amount of living biomass has now been included for to estimate the change in C when land use change occurs. These were previously not estimated (NE). As a consequence a recalculation has been made for all years.

Previously the annual estimate from soils was based on a five-year average to avoid very large inter-annual fluctuations in the inventory. The ERT has recommended Denmark to use the estimated real annual emission in the inventory. This has been included. This leads to much higher variability between years due to differences in crop yield and climatic conditions.

Previous were also imported peat included in the Danish inventory. From this submission is only CO_2 emissions from Danish peat included. Previous were avoided CH_4 emission from the drainage of land where peat extraction takes place included. This has been removed from the inventory based on a recommendation from the ERT.

A recalculation has been made due to new area data on the established wetlands has been obtained. Furthermore the availability of the remote sensing data has made it possible to locate the exact position in relation to permanent wetlands.

Waste

The DOC content of Plastics has been changed from 85 to 0 %. This was an error in the previous model formulation. This change lowered the time-series of emissions from 9.5 (1990) to 13.1 % (2002) as compared to the 2009 submission.

The content of CH_4 in the gas emitted has been changed from 45 to 50 % to better reflect the GPG values. This change increased the time-series of emissions from 11.2 (1990) to 13.4 % (1998) as compared to the 2009 submission.

The half year time has been changes from 10 to 14 years according to the default value in the GPG. This change lowered the time-series of emissions from 15.0 (1990) to 4.2 % (2007) as compared to the 2009 submission.

The model formulation has been changed to reflect the accepted fact that emission from waste deposited starts after some time delay. The model now starts to estimate emissions from waste deposited January 1, the year after the waste was deposited. This change lowered the time-series of emissions from 11.9 (1990) to 6.4 % (2007) as compared to the 2009 submission.

The methane emission from wastewater treatment has been significantly reduced as a result of improved documentation of the biogas production, and i.e. methane recovery, in Denmark obtained by access to the Danish Sludge Database.

As recommended by the ERT, a first attempt for the derivation of a national N_2O emission factor for waste water treatment has been performed.

Emissions from incineration of corpses and carcasses and emissions from accidental fires are included in the inventory for the first time.

Total changes

For the national total CO_2 equivalent emissions without LULUCF the general impact of the improvements and recalculations performed is small and the changes for the whole time-series are between -0.20 % (1990) and +0.86 % (2006). Therefore, the implications of the recalculations on the level and on the trend, 1990-2007, of this national total are small, refer to Chapter 10, Table 10.1.

For the national total CO_2 equivalent emissions with LULUCF, the general impact of the recalculations is larger due to recalculations in the LULUCF sector. The changes vary between –6.3 % (1993) and +12.2 % (2006).

Sammenfatning

S.1. Baggrund for opgørelse af drivhusgasemissioner og klimaændringer

Rapporteringen

Denne rapport er Danmarks årlige rapport – den såkaldte Nationale Inventory Report (NIR) for 2010. Rapporten beskriver drivhusgasopgørelsen som blev fremsendt til FN's konvention om klimaændringer (UNFCCC) og Kyotoprotokollen den 15. april 2010. Rapporten er opdateret i forbindelse med at drivhusgasopgørelsen er rettet, og genfremsendt til FN inden for 6-ugers fristen i forhold til 15. april 2010. Rapporten indeholder detaljerede informationer om Danmarks drivhusgasudslip for alle år fra 1990 til 2008. Rapportens struktur er i overensstemmelse med UNFCCC's retningslinjer for rapportering og review. Hovedforskellen mellem Danmarks NIR 2010 som blev fremsendt til EU-Kommissionen til den 15. marts 2010, og denne rapport til UNFCCC vedrører det territorium rapporteringen omfatter. NIR 2010 til EU-Kommissionen var for Danmark, mens NIR 2010 til UNFCCC er for Danmark, Grønland og Færøerne. For at sikre at opgørelserne er sammenhængende og gennemskuelige indeholder rapporten detaljerede oplysninger om opgørelsesmetoder og baggrundsdata for alle årene fra 1990 og til 2008.

Denne emissionsopgørelse for årene 1990 til 2008, er som tidligere årlige opgørelser, rapporteret i formatet Common Reporting Format (CRF) som Klimakonventionen foreskriver anvendt. Emissionsopgørelsen i CRF foreligger med denne rapportering således at der er seperate CRF for Danmark (EU), Grønland, Færøerne, for Danmark og Grønland (KP) samt for Danmark, Grønland og Færøerne (Klimakonventionen). CRF-tabellerne indeholder oplysninger om emissioner, aktivitetsdata og emissionsfaktorer for hvert år, emissionsudvikling for de enkelte drivhusgasser samt den totale drivhusgasemission i CO_2-ækvivalenter.

Følgende emner er beskrevet i rapporten: Udviklingen i drivhusgasemissionerne, metoder mv. som anvendes til opgørelserne i de emissionskategorier som findes i CRF-formatet, usikkerheder, rekalkulationer, planlagte forbedringer og procedure for kvalitetssikring og – kontrol.

Denne rapport indeholder ikke det fulde sæt af CRF-tabeller. Kun trendtabellerne fra CRF for Danmark, som viser udviklingen for de rapporterede direkte drivhusgasser - CO_2, CH_4 og N_2O - for 1990-2008 (tabellerne 10.1-5 fra CRF formatet) er medtaget, se Annex 8. Det fulde sæt af CRF tabeller er tilgængelige på EIONET, som er det Europæiske Miljøagenturs rapporterings-internetsite:
http://cdr.eionet.europa.eu/dk/Air_Emission_Inventories

Med hensyn til gengivelsen af tal i rapporten og i CRF-formatet, gøres opmærksom på at Annex 8 er med dansk notation: "," (komma) for decimaladskillelse og "." (punktum) til adskillelse af tusinder. I rapporten (undtagen i de få tilfælde hvor tabeller er indsat som "billede" fra CRF, som Annex 9) er den engelske notation brugt: "." (punktum) for decimaltegn og for det meste mellemrum for adskillelse af tusinder. Den engelske notation for adskillelse af tusinder med "," (komma) er for det meste ikke brugt på grund af risikoen for fejltagelser for danske læsere.

Ansvarlige institutioner
Danmarks Miljøundersøgelser (DMU) ved Aarhus Universitet er på vegne af Miljøministeriet samt Klima- og Energiministeriet ansvarlig for udregning og afrapportering af den nationale emissionsopgørelse til EU og til UNFCCC (FN's konvention om klimaændringer) såvel som til UNECE-konventionen om langtransporteret grænseoverskridende luftforurening. Som følge heraf er DMU ansvarlig for udførelse og publisering af opgørelserne af drivhusgasemissioner og den årlige rapportering til EU og UNFCCC for Danmark. DMU er den centrale institution for Danmarks nationale system til drivhusgasopgørelser under Kyotoprotokollen. Ydermere er DMU ansvarlig for rapportering af drivhusgasemissionsopgørelser til Klimakonventionen for Kongeriget Danmark (Færøerne, Grønland og Danmark), samt Danmarks og Grønlands samlede rapportering til Kyotoprotokollen. DMU deltager desuden i arbejdet i regi af Klimakonventionen og Kyotoprotokollen, hvor retningslinjer for rapportering diskuteres og vedtages og i EU's moniteringsmekanisme for opgørelse af drivhusgasser, hvor retningslinjer for rapportering til EU reguleres.

Arbejdet med de årlige opgørelser udføres i samarbejde med andre danske ministerier, forskningsinstitutioner, organisationer og private virksomheder. Grønlands Klima- og Infrastrukturstyrelse er ansvarlig for levering af opgørelser for Grønland til DMU. Færøernes miljømyndighed (Umhvørvisstovan) er ansvarlig for de Færøske opgørelser.

Drivhusgasser
Til Klimakonventionen rapporteres følgende drivhusgasser:

- Kuldioxid CO_2
- Metan CH_4
- Lattergas N_2O
- Hydrofluorcarboner HFC'er
- Perfluorcarboner PFC'er
- Svovlhexafluorid SF_6

Det globale opvarmningspotentiale, på engelsk Global Warming Potential (GWP), udtrykker klimapåvirkningen over en nærmere angivet tid af en vægtenhed af en given drivhusgas relativt til samme vægtenhed af CO_2. Drivhusgasser har forskellige karakteristiske levetider i atmosfæren, således for CH_4 ca. 12 år og for N_2O ca. 120 år. Derfor spiller tidshorisonten en afgørende rolle for størrelsen af GWP. Typisk vælges 100 år. Herefter kan effekten af de forskellige drivhusgasser omregnes til en ækvivalent mængde CO_2, dvs. til den mængde CO_2 der vil give samme klimapåvirkning. Til rapporteringen til Klimakonventionen er vedtaget at anvende GWP-værdier for en 100-årig tidshorisont, som ifølge IPCC's anden vurderingsrapport er:

- Kuldioxid, CO_2: 1
- Metan, CH_4: 21
- Lattergas, N_2O: 310

Regnet efter vægt og over en 100-årig periode er metan således ca. 21 og lattergas ca. 310 gange så effektive drivhusgasser som kuldioxid. For andre drivhusgasser der indgår i rapporteringen, de såkaldte F-gasser (HFC, PFC, SF_6) findes væsentlig højere GWP-værdier. Under Klimakonventionen er der ligeledes vedtaget GWP-værdier for disse baseret på IPCC's anbefalinger. Således har f.eks. SF_6 en GWP-værdi på 23 900. I denne rapport anvendes de GWP-værdier, som UNFCCC har vedtaget.

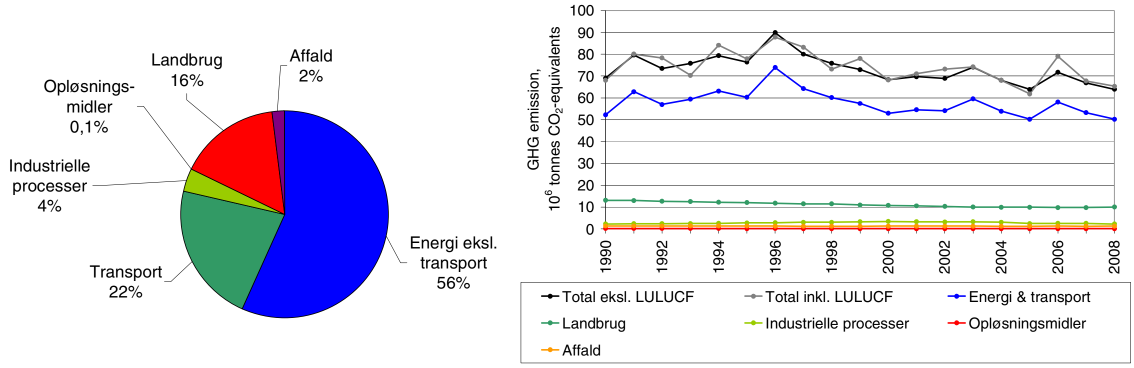
Endvidere rapporteres de indirekte drivhusgasser Nitrogenoxide (NO_x), Carbonmonooxide (CO), Non-Methane Volatile Organic Compound (NMVOC) og Sulphurdioxid (SO_2). Da der ikke tilskrives disse gasser GWP-værdier, medregnes disse ikke I drivhusgasemissioner i CO_2-ækvivalenter.

S.2. Udviklingen i drivhusgasemissioner og optag

Sammenfatning S.2.-4. omhandler alene opgørelsen for Danmark. Opgørelsen for Grønland, Danmark og Grønland samt for Færøerne beskrives i Annex 9-11.

S.2.1 Drivhusgas emissionsopgørelse

De danske opgørelser af drivhusgasemissioner følger metoderne som beskrevet i IPCC's retningslinjer. I den forbindelse skal nævnes at det under Klimakonventionen og Kyotoprotokollen er vedtaget at IPCC's 1996 retningslinjer og IPCC's 2000 anvisninger skal anvendes. Opgørelserne er opdelt i seks overordnede sektorer, 1. energi, 2. industrielle processer, 3. opløsningsmidler, 4. landbrug, 5. arealanvendelse for skove og jorder (Land Use Land Use Change and Forestry: LULUCF) og 6. affald. Drivhusgasserne omfatter CO_2, CH_4, N_2O og F-gasserne: HFC'er, PFC'er og SF_6. I Figur S.1 ses de estimerede drivhusgasemissioner for Danmark i CO_2-ækvivalenter for perioden 1990 til 2008. Figuren viser Danmarks totale udledning med og uden LULUCF-sektoren (Land Use and Land Use Change and Forestry). Til venstre i S.1 ses det relative bidrag til Danmarks totale udledning (uden LULUCF) i 2008 for sektorerne 1. – 4. og 6. For sektor 1. energi er vejtrafik vist særskilt. Sektor 5. LULUCF indgår ikke i denne figur da sektoren omfatter kilder der bidrager med både optag og udledninger.



Figur S.1 Danske drivhusgasemissioner. Bidrag til total emission fra hovedsektorer for 2008 og tidsserier i CO_2-ækvivalenter for 1990-2008, hvor data for CO_2 er uden LULUCF.

I overensstemmelse med retningslinjerne for opgørelserne er emissionerne ikke korrigerede for handel med elektricitet med andre lande og temperatursvingninger fra år til år. CO_2 er den vigtigste drivhusgas og bidrager i 2008 med 79,5 % af den nationale totale udledning, efterfulgt af N_2O med 10,5 % og CH_4 med 8,6 %, mens HFC'er, PFC'er og SF_6 kun udgør 1,4 % af de totale emissioner. Set over perioden 1990-2008 så har disse procenter været stigende for CO_2 og F-gasser, nær konstant for CH_4 og faldende for N_2O. Netto-CO_2-udledningen fra LULUCF er i 2008 2,2 % af den nationale totale emission inklusiv LULUCF. Med hensyn til sektorerne (figur S.1) så bidrager energi ekskl. vejtransport (hovedsageligt stationære forbrændingsanlæg), transport og landbrug mest med i 2008 henholdsvis 56,6, 22,0 og 15,7 % af den nationale udledning eksklusiv LULUCF. De nationale totale drivhusgasemissioner i CO_2-ækvivalenter er faldet med 7,4 % fra 1990 til 2008, hvis nettobidraget fra skovenes og jordernes udledninger og optag af CO_2 (LULUCF) ikke indregnes, og faldet med 4,0 % hvis de indregnes.

S.2.2 KP-LULUCF aktiviteter

Det samlede optag af drivhusgasser i skov omfattet af Kyotoprotokollens artikel 3.3 udgør 33,9 Gg CO_2-ækv. i 2008, heraf stammer 0,4 Gg CO_2-ækv. fra jorde i forbindelse med skovrydning. Netto emissionen fra skov plantet før 1990 under Kyotoprotokollens artikel 3.4 udgør 293,2 Gg CO_2-ækv. i 2008, heraf 12,2 Gg CO_2-ækv. i form af N_2O fra dræning af jorde (tabel S.1). Nettoemissionen fra landbrugsarealer under artikel 3.4 udgør 863,5 Gg CO_2-ækv. i 2008. Til sammenligning var netto emissionen fra samme kilde 3.471,8 Gg CO_2-æqv. i 1990.

Det samlede emission fra permanente græsarealer under artikel 3.4 udgør 81,7 Gg CO_2-ækv. i 2008. I 1990 var den tilsvarende emission på 95,7 Gg CO_2-ækv.

Tabel S.1 Emissioner og optag i 2008 for aktiviteter under Kyotoprotokollens artikel 3.3 og 3.4

	Netto CO_2 emission/optag	CH_4	N_2O	Netto CO_2 ækvivalent emission/optag
			(Gg)	
A. Aktiviteter under artikel 3.3				**-33,92**
A.1. Skovrejsning	-69,81	NA	IE,NA	-69,81
A.1.1. Arealer der ikke er afskovet siden starten af 2008	-69,81	NA	IE,NA	-69,81
A.1.2. Arealer der er afskovet siden starten af 2008	IE,NA	NA	IE,NA	IE,NA
A.2. Skovrydning	35,48	NA	0,00	35,89
B. Aktiviteter under artikel 3.4				**1.238,45**
B.1. Forvaltning af skov plantet før 1990	281,02	NA	0,04	293,24
B.2. Forvaltning af landbrugsarealer	863,52	NO	NO,NR	863,52
B.3. Forvaltning af permanente græsarealer	81,69	NO	NO	81,69
B.4. Gentilplantning	NA	NA	NA	NA

S.3. Oversigt over drivhusgasemissioner og optag fra sektorer

S.3.1 Drivhusgas emissionsopgørelse

1. Energi

Energisektoren inklusiv transport bidrager i 2008 med 78,7 % af den danske totale emission (excl. LULUCF). Når transportens bidrag ikke regnes med bidrager energisektoren med 57 % af den nationale udledning eksklusiv LULUCF. Udledningen af CO_2 stammer altovervejende fra forbrænding af kul, olie, benzin og naturgas på kraftværker, i beboelsesejendomme, industri og vejtransport. Kraft- og fjernvarmeværker samt udvinding af olie og gas bidrager med 46 % af de totale CO_2 emissioner, omkring 27 % stammer fra transportsektoren. CO_2-emissionen fra energisektorerne faldt med omkring 6 % fra 2007 til 2008. De relative store udsving i emissionerne fra år til år skyldes handel med elektricitet med andre lande, herunder særligt de nordiske. De høje emissioner i 1991, 1994, 1996, 2003 og 2006 er et resultat af stor eksport af elektricitet, mens de lave emissioner i 1990 og 2005 skyldes import af elektricitet. Udledningen af CH_4 fra energiproduktion har været stigende på grund af øget anvendelse af gasmotorer, som har en stor CH_4-emission i forhold til andre forbrændingsteknologier. Anvendelsen af gasmotorer er dog blevet mindre siden liberaliseringen af elmarkedet, hvilket har ført til lavere CH_4-emissioner fra energisektoren. Transportsektorens CO_2-emissioner er steget med ca. 31 % siden 1990 hovedsagelig på grund af voksende vejtrafik.

2. Industrielle processer

Emissionen fra industrielle processer – hvilket vil sige andre processer end forbrændingsprocesser – udgør i 2008 3,5 % af de totale danske drivhusgasemissioner. De vigtigste kilder er cementproduktion, kølesystemer, opskumning af plast og kalcinering af kalksten. CO_2-emissionen fra cementproduktion - som er den største kilde - bidrager med 2,1 % af den totale emission i 2008 og stigningen fra 1990 til 2008 er 31 %. Den anden største kilde har tidligere været N_2O fra produktion af salpetersyre. Produktionen af salpetersyre stoppede i midten af 2004, hvilket betyder, at N_2O-emissionen er nul for denne kilde fra 2005.

Emissionen af HFC'er, PFC'er og SF_6 er i perioden fra 1995 og til 2008 steget med 176 %, hovedsageligt på grund af stigende emissioner af HFC'er. Anvendelsen af HFC'er, og specielt HFC-134a, er steget kraftigt, hvilket har betydet, at andelen af HFC'er af den samlede F-gas emission steg fra 67 % i 1995 og til 95 % i 2008. HFC'er anvendes primært inden for køleindustrien. Anvendelsen er dog nu stagnerende, som et resultat af dansk lovgivning, der forbyder anvendelsen af nye HFC-baserede stationære kølesystemer fra 2007. I modsætning til denne udvikling ses et stigende brug af airconditionsystemer i køretøjer.

3. Opløsningsmidler og relaterede produkter

Forbrug af opløsningsmidler i industrier og husholdninger bidrager i 2008 med 0,1 % af totalmængden af emitterede drivhusgasser i CO_2-ækvivalenter. Der er en reduktion på 32 % i total CO_2 emissionerne i perioden 1990 til 2008. Bidraget fra N_2O-forbruget til de totale CO_2-ækvivalent emissioner for solventer er 30 %.

4. Landbrug

Landbrugssektoren bidrager i 2008 med 15,6 % til den totale drivhusgasemission i CO_2-ækvivalenter og er den vigtigste sektor hvad angår emissioner af N_2O og CH_4. I 2008 var landbrugets bidrag til de totale emissioner af N_2O og CH_4 henholdsvis 91 % og 70 %. Fra 1990 til 2008 ses et fald på 31 % i N_2O-emissionen fra landbrug. Dette skyldes mindre brug af kvælstofhandelsgødning og bedre udnyttelse af kvælstof i husdyrgødningen, hvilket resulterer i mindre emissioner pr. produceret dyreenhed. Emissioner af CH_4 fra husdyrenes fordøjelsessystem er faldet fra 1990 til 2008 grundet et faldende antal kvæg. På den anden side har en stigende andel af gyllebaserede staldsystemer bevirket at emissionerne fra husdyrgødning er steget. I alt er CH_4-emissionerne fra landbrugssektoren faldet med 6 % fra 1990 til 2008.

5. Arealanvendelse skove og jorder (LULUCF)

LULUCF-sektoren skifter mellem at udgøre et netto optag og en netto udledning. I 2008 udgør LULUCF en nettokilde svarende til 2,2 % af den samlede drivhusgas udledning, inklusiv LULUCF. I 2007 udgjorde LULUCF et nettokilde svarende til 1,3 % af den samlede drivhusgas udledning inklusiv LULUCF. I 2008 optræder arealer med skov, dyrkede jorder, græsning og bebyggelse med optag på hhv. 442,15 Gg CO_2-ækv., 836,92 Gg CO_2-ækv, 140,45 Gg CO_2-ækv og 51,77 Gg CO_2-ækv. I samme år optræder Wetlands som kilde med en emission på 7,15 Gg CO_2-ækv. Emisssionen fra Croplands stammer hovedsageligt fra organiske jorder. Siden 1990 har der været et fald i den totale mængde kulstof (C) der er lagret i jorder. På trods af den globale opvarmning tyder det på at dette fald er stabiliseret så det er muligt at bevare det nuværende kulstofniveau i jorder.

6. Affald

Affaldssektoren udgør i 2008 1,9 % af den danske total-emission. Lossepladser er den tredjestørste kilde til CH_4-emissioner og dominerer sektor-bidraget med 85,0 %. Emissionen er faldet med 2,4 % fra 1990 til 2008. Faldet skyldes faldende affaldsmængder til deponering og stigende anvendelse af affald til produktion af elektricitet og varme. Da al affaldsforbrænding bruges til produktion af elektricitet og varme, er emissionerne herfra inkluderet i IPCC-kategorien 1A.

Emissioner af CH_4 og N_2O fra spildevandsanlæg udgør i 2008 henholdsvis 3,8 % og 8,4 % af sektorens samlede drivhusgasudledning. CH_4 fra spildevandsanlæg er stigende fra 1990 til 2008 på grund af en stigning i mængden af industrielt spildevand, mens N_2O er i samme niveau som i 1990.

Afbrænding af affald uden energiudnyttelse udgør i 2008 2,6 % til affaldssektorernes bidrag. Tendensen i disse emissioner er en stigning i perioden 1990 – 2008.

S.3.2 KP-LULUCF aktiviteter

I 2008 udgjorde aktiviteterne under Kyotoprotokollens artikel 3.3 et netto optag på 33,9 Gg CO_2-ækv. mens aktiviteterne under artikel 3.4 udgjorde en netto emission på 1 238,5 Gg CO_2-ækv. En kort oversigt over KP-LULUCF findes i kapitel S.2.2 mens en mere detaljeret redegørelse findes i kapitel 11.

S.4. Andre informationer

S.4.1 Kvalitetssikring og - kontrol

Rapporten indeholder en plan for kvalitetssikring og -kontrol af emissionsopgørelserne. Kvalitetsplanen bygger på IPCC's retningslinjer og ISO 9000 standarderne. Planen skaber rammer for dokumentation og rapportering af emissionerne, så opgørelserne er gennemskuelige, konsistente, sammenlignelige, komplette og nøjagtige. For at opfylde disse kriterier, understøtter datastrukturen arbejdsgangen fra indsamling af data til sammenstilling, modellering og til sidst rapportering af data.

Som en del af kvalitetssikringen, udarbejdes der for emissionskilderne rapporter, der detaljeret beskriver og dokumenterer anvendte data og beregningsmetoder. Disse rapporter evalueres af personer uden for DMU, der har høj faglig ekspertise indenfor det pågældende område, men som ikke direkte er involveret i arbejdet med opgørelserne. Indtil nu er rapporter for stationære forbrændingsanlæg, transport og landbrug blevet evalueret. Desuden er der gennemført et projekt, hvor de danske opgørelsesmetoder, emissionsfaktorer og usikkerheder sammenlignes med andre landes, for yderligere at verificere rigtigheden af opgørelserne.

S. 4.2. Fuldstændighed i forhold til IPCCs retningslinjer for kilder og gasser

De danske opgørelser af drivhusgasemissioner indeholder alle de kilder der er beskrevet i IPCC's retningsliner undtagen:

Landbrug: Metankonverteringsfaktoren for emissioner fra kyllingers og pelsdyrs fordøjelsessystemer er ikke bestemt, og der findes ingen IPCC standardemissionsfaktor. Emissionerne fra disse dyrs fordøjelsessystemer anses dog for at være ubetydelige i forhold til de totale emissioner fra fordøjelsessystemer.

I annex 5 er der flere informationer om fuldstændigheden af den danske drivhusgasopgørelse.

S. 4.3. Rekalkulationer og forbedringer

De vigtigste forbedringer af opgørelserne er:

Generelt

Opgørelserne for Grønland og Færøerne er udformet i det fulde CRF-format. Behørige aggregeringer af den danske opgørelse i CRF, og den grønlandske og færøske CRF er udført. Dokumentationen for den grønlandske emissionsopgørelse er blevet væsentligt udvidet, så den nu indeholder alle elementer af en fuld NIR. Der er desuden i 2010 afleveringen inkluderet emissionsestimater for en række sektorer, som ikke tidligere har været estimeret for Grønland. Den fulde dokumentation af den grønlandske drivhusgasopgørelse er inkluderet i Annex 9.

I respons til reviewet af emissionsopgørelsen er der udført en tier 1 usikkerhedsanalyse af de samlede emissioner for Danmark og Grønland. En diskussion af udviklingen i emissioner og en analyse af de væsentligste kilder er også inkluderet. For flere oplysninger henvises der til Annex 10.

Energi

Stationær forbrænding

For stationær forbrænding er emissionsopgørelserne blevet opdateret i henhold til den seneste officielle energistatistik publiceret af Energistyrelsen. Opdateringen omfatter årene 1990-2007. De fleste ændringer berører årene 2006 og 2007.

Opdelingen af CO_2 emissionsfaktoren for affald mellem biomasse og fossilt brændsel er blevet genberegnet. Dette har medført en stigning af CO_2 fra den fossile del af affaldet for hele tidsserien.

Forbedrede emissionsfaktorer for decentrale kraft-varmeværker med reference til et dansk emissionsmålings program er blevet implementeret. Dette har påvirket emissionerne af CH_4 og N_2O fra flere anlægstyper.

Mobile kilder

Vejtransport

Det totale antal kørte kilometer per køretøjskategori er opdateret for årene 2005-2008 baseret på udvikling i trafikindeks (baseret på trafiktællinger på udvalgte vejstrækninger). Desuden har nye data udarbejdet af Institut for Transport, Danmarks Tekniske Universitet (DTU Transport) for Infrastrukturkommissionen bidraget med informationer om det totale trafikarbejde for udenlandske lastbiler på danske veje. Bidraget fra dette trafikarbejde er adderet til det totale trafikarbejde for danske lastbiler på danske veje, for lastbiler med en bruttovægt > 16 ton. Data fra DTU Transport, der er estimeret for 2005, er vha. relevante antagelser ekstrapoleret tilbage til 1985 og fremskrevet til 2008.

For passagerbiler er Vejdirektoratets opdeling af kørte kilometer fordelt på benzin og diesel, blevet justeret på grundlag af viden fra andre kategorier af dieselbiler.

Militær

Emissionsfaktorer baseret på nye simuleringer for vejtransport har betydet ændringer af emissionerne for årene 1985-2007. Minimum og maksimum forskelle for de beregnede emissioner (min%, max%) er for CH_4 (0 %, 4 %) og for N_2O (0 %, 2 %).

Luftfart

En fejl for 2007 er blevet rettet. Flyvninger mellem Danmark og Grønland/Færøerne er fejlagtigt blevet behandlet som internationale flyvninger. Korrektionen har betydet, at både brændselsforbrug og emissioner er ændret markant. Brændselsforbruget og CO_2 emissionen er steget med 51 % mens CH_4 og N_2O emissionen er steget med hhv. 22 % og 26 %.

Inddragelse af nye repræsentative flytyper har betydet små ændringer af emissionerne for årene 2001-2006 på 0 % til 2 %.

Flygtige emissioner

Emissioner fra distribution af bygas er inkluderet i opgørelsen for årene 1985-2008. Der er kun sparsomme mængder data til rådighed, da flere distributionsselskaber er lukket. I dag distribueres der kun bygas i Ålborg og København, mens to tidligere selskaber er lukket. i hhv. 2004 og 2006. Ud fra interpolation og ekstrapolation baseret på de tilgængelige data er der beregnet data for den manglende del af tidsserien. Usikkerhederne er forventeligt store både for data vedr. distribuerede mængder, ledningstab og gassammensætning.

Emissionsfaktorerne for flaring på raffinaderier er opdateret. Nye emissionsfaktorerne for NMVOC og CH_4 er baseret på nye informationer fra ét af de to danske raffinaderier. De samme faktorer er anvendt for der andet raffinaderi, da der ikke er tilsvarende data tilgængelige for dette. Emissionsfaktorer fra EMEP/EEA guidebogen (2009) er anvendt til beregning af NO_x, CO og N_2O. CO_2-emissionsfaktorerne er baseret på data fra CO_2-kvoteindberetninger for 2006-2008 samt brændværdier for fule gas for det ene raffinaderi. SO_2 emissionerne er beregnet ud fra TIER 1 emissionsfaktorer for stationær forbrænding fra EMEP/EEA guidebogen (2009).

Industri

CO_2 emissionen fra cementproduktion er blevet revideret for årene 1998-2005 baseret på nye oplysninger fra producenten.

For gule tegl og ekspanderede lerprodukter er CO_2 emissionsfaktoren tilpasset fra producenternes rapporter til CO_2-kvoteindberetningerne, da de tidligere estimerede emissionsfaktorer, der er anvendt frem til 2005, har vist sig ikke at afspejle den aktuelle emissions.

I kategorien 2F4 Aerosols/Metered Dose Inhalers er inhalatorer inkluderet for 2008 og emissionen for denne kategori er genberegnet for årene 1998-2007

Opløsningsmidler

Der er implementeret en forbedret og mere detaljeret metode til allokering af kilder, der har gjort det muligt at estimere emissionerne på detaljeret SNAP niveau.

Landbrug

Der er inddraget en ny metode – Tier 2/CS – til beregning af CH_4 fra håndtering af husdyrgødning baseret på nationale værdier for husdyrgødning. Genberegningen har medført et fald for årene 1990-2007 i størrelsesordenen 1 % til 16 % udtrykt i CO_2-ækvivalenter. Genberegningen er størst for de første år i tidsserien med en faldende trend.

Beregning af kvælstoftab fra husdyrgødning er korrigeret til TAN, og der er derfor lavet genberegning. Desuden er der rettet en fejl i databasen til beregning af N_2O. Disse ændringer har tilsammen reduceret emissionen af N_2O fra husdyrgødning for årene 1990-2005 med op til 4 %, øget emissionen i 2006 med 1 % og reduceret emissionen i 2007 med 14 %.

Nye data for antal dyr og fordeling af staldtyper er inddraget i opgørelsen. Som det er anbefalet af ERT er mængden af foder og N ab dyr for kvier blevet interpoleret for årenen 2005-2006 for at udligne store forskelle. Fodermængder for malkekøer, smågrise og slagtesviner også interpoleret for årene 2006 for malkekøer og 1991-1993 for smågrise og slagtesvin. Der er tilføjet tre nye dyrekategorier: rådyr, fasaner og strudse. Desuden er der inddraget nye data for mængden af slam spredt på marker for årene 2002, 2005 og 2007.

Afbrænding af halmrester på marker er inkluderet i opgørelsen. Emissionen herfra udgør mindre end 1 % af den totale emission for alle komponenter.

Arealanvendelse (LULUCF)

Der er indført en fuld arealanvendelsematrice for alle årene.

På baggrund af kortlægninger af skovarealet i 1990 og 2005 er der lavet en genberegning af kulstoflagring for skov etableret før 1990 og skov plantet efter 1990. Skovarealet i 1990 og 2005 er kortlagt til at udgøre et større areal end tidligere antaget for disse år. Genberegningen af lagret kulstof i 1990 og i 2000 anvendte aldersfordeling som rapporteret i skovstatistikken for 1990 og 2000 som et udtryk for den totale allokering af skovarealet på arter og alder. Ud fra aktuelle målinger af kulstofindholdet i forskellige arter og aldersklasser i den seneste nationale skov statistik (NFI) er den samlede stående mængde kulstof beregnet. For hvert af årene 1990-2000 er mængden af kulstof lagret i stående biomasse beregnet som et løbende gennemsnit, korrigeret for den skovrydning der er konstateret. Stormfald og effekten heraf er inkluderet i det samlede estimat af ændringer i den lagrede kulstofmængde.

For første gang er mængden af levende biomasse for landbrugsarealer og græsningsarealer inkluderet i opgørelsen. Det har medført genberegninger for alle år.

Tidligere er estimatet for jorder baseret på gennemsnittet for fem år for at undgå store fluktuationer mellem årene i opgørelsen. ERT har anbefalet

Danmark at anvende den beregnede emission for hvert enkelt år, hvilket er blevet inkluderet i opgørelsen. Dette har medført langt større forskelle mellem årene pga. forskelle i udbytter og klimatiske forhold.

Tidligere var importeret tørv inkluderet i den danske opgørelse. Fra denne rapportering er der kun inddraget CO_2 emissioner fra dansk tørv. I tidligere rapporteringer er undgåede emissioner af CH_4 fra dræning af arealer med tørvehøst blevet rapporteret. Dette er udeladt fra opgørelsen baseret på anbefalinger fra ERT.

Der er lavet genberegning på baggrund af nye data for etablerede vådområder. Desuden har adgang til satelitdata gjort det muligt at fastlægge positionen af vådområder i relation til permanente vådområder.

Affald

Andelen af nedbrydeligt organisk kulstof (DOC) i plastik er ændret fra 85 % til 0 %. Dette var en fejl i den tidligere model beregning. Ændringen har medført et fald i tidsserien af CH_4-emissioner fra 9,5 % (1990) til 13,1 % (2002) sammenlignet med 2009-rapporteringen.

Indholdet af CH_4 i den udledte gas er ændret fra 45 % til 50 % for bedre at afspejle værdierne i Good Pratice Guidance (GPG). Denne ændring har medført en stigning af emissioner fra 11,2 % (1990) til 13,4 % (1998) sammenlignet med 2009-rapporteringen.

Halveringstiden er ændret fra 10 til 14 år i overensstemmelse med værdierne i GPG. Denne ændring har medført et fald i tidsserien af emissioner fra 15,0 % (1990) til 4,2 % (2007) sammenlignet med 2009-rapporteringen.

Beregningsmodellen er ændret så den afspejler det faktum at emissioner fra deponering af affald starter med en forsinkelse. Modellen estimerer nu emissioner fra 1. januar året efter at affaldet er blevet deponeret. Denne ændring har medført et fald i tidsserien af emissioner fra 11,9 % (1990) til 6,4 % (2007) sammenlignet med 2009-rapporteringen.

CH_4 emissionen fra behandling af spildevand er reduceret markant, baseret på forbedret dokumentation af biogas produktion – dvs. metan genindvinding – i Danmark gennem adgang til den danske slam database.

Som anbefalet af ERT er der lavet en første udgave af en model til bestemmelse af en national N_2O emissionsfaktor for behandling af spildevand.

Emission fra forbrænding af lig og kadavere samt emissioner fra brande er inkluderet som en ny kilde i opgørelserne.

Totale ændringer

Ændringer i de danske totale drivhusgasemissioner (i CO_2-ækvivalenter), uden medtagning af emissioner og optag fra jorde og skov, som følge af forbedringer og rekalkulationer, er små i forhold til sidste års rapportering. Ændringerne for hele tidsserien 1990 til 2007 ligger mellem -0,20 % (1990) og +0,86 % (2006).

Ændringer i de danske totale drivhusgasemissioner (i CO_2-ækvivalenter) er noget større, når emissioner og optag fra jorde og skov (LULUCF) medtages. Det skyldes den væsentlige ændring i datagrundlaget for opgørelsen af LULUCF, som er blevet implementeret i dette års opgørelse. Ændringerne i forhold til sidste rapportering er for hele tidsserien 1990 til 2007 mellem –5,87 % (1993) og +12,60 % (2006).

1 Introduction

1.1 Background information on greenhouse gas inventories and climate change

1.1.1 Annual report

This report is Denmark's National Inventory Report (NIR) 2010 for submission to the United Nations Framework Convention on Climate change and the Kyoto Protocol (KP), due April 15, 2010. The report has been updated since the emission inventories were updated and resubmitted to UNFCCC within the six weeks limit from April 15, 2010, i.e. May 27, 2010. The report contains detailed information about Denmark's inventories for all years from 1990 to 2008. The structure of the report is in accordance with the UNFCCC guidelines on reporting and review. The main difference between Denmark's NIR 2010 report to the European Commission, due March 15, 2010, and this report to UNFCCC is reporting of territories. The NIR 2010 to the EU Commission was for Denmark, while this NIR 2010 to UNFCCC is for Denmark, Greenland and the Faroe Islands. The suggested outline provided by the UNFCCC secretariat has been followed to include the necessary information under the Kyoto Protocol. The report includes detailed and complete information on the inventories for all years from year 1990 to the year 2008, in order to ensure transparency.

The issues addressed in this report are trends in greenhouse gas emissions, a description of each IPCC category, uncertainty estimates, recalculations, planned improvements and procedures for quality assurance and control.

The annual emission inventories for the years from 1990 to 2008, are reported in the Common Reporting Format (CRF) as requested in the reporting guidelines. With this submission separate CRF's are available for Denmark (EU), Greenland, the Faroe Islands, for Denmark and Greenland (KP) as well as for Denmark, Greenland and the Faroe islands (UN Climate Convention). The CRF-spreadsheets contain data on emissions, activity data and implied emission factors for each year. Emission trends are given for each greenhouse gas and for the total greenhouse gas emissions in CO_2 equivalents.

According to the instrument of ratification, the Danish government has ratified the UNFCCC on behalf of Denmark, Greenland and the Faroe Islands. The Danish government has ratified the Kyoto Protocol on behalf of Denmark and Greenland. The information in this report relates to Denmark only.

This report is available to the public on the National Environmental Research Institutes homepage.
http://www.dmu.dk/International/Publications/ (search for "National Inventory Report 2010")

This report itself does not contain the full set of CRF Tables. Only the trend tables, Tables 10.1-5 of the CRF format, are included, refer Annex 8. The full set of CRF tables is available at the EIONET, Central Data Repository, kept by the European Environmental Agency: http://cdr.eionet.europa.eu/dk/Air_Emission_Inventories/Submission_UNFCCC

1.1.2 Greenhouse gases

The greenhouse gases reported under the Climate Convention are:

- Carbon dioxide CO_2
- Methane CH_4
- Nitrous Oxide N_2O
- Hydrofluorocarbons HFCs
- Perfluorocarbons PFCs
- Sulphur hexafluoride SF_6

The main greenhouse gas responsible for the anthropogenic influence on the heat balance is CO_2. The atmospheric concentration of CO_2 has increased from a pre-industrial value of about 280 ppm to 379 ppm in 2005 (an increase of about 35 %), and exceeds now the natural range of 180-300 ppm over the last 650 000 years as determined by ice cores (IPCC, Fourth Assessment Report, 2007). The main cause for the increase in CO_2 is the use of fossil fuels, but changing land use, including forest clearance, has also been a significant factor. The greenhouse gases CH_4 and N_2O are very much linked to agricultural production; CH_4 has increased from a pre-industrial atmospheric concentration of about 715 ppb to 1774 ppb in 2005 (an increase of about 140 %) and N_2O has increased from a pre-industrial atmospheric concentration of about 270 ppb to 319 ppb in 2005 (an increase of about 18 %) (IPCC, Fourth Assessment Report, 2007). Changes in the concentrations of greenhouse gases are not related in simple terms to the effect on the heat balance, however. The various gases absorb radiation at different wavelengths and with different efficiency. This must be considered in assessing the effects of changes in the concentrations of various gases. Furthermore, the lifetime of the gases in the atmosphere needs to be taken into account – the longer they remain in the atmosphere, the greater the overall effect. The global warming potential (GWP) for various gases has been defined as the warming effect over a given time of a given weight of a specific substance relative to the same weight of CO_2. The purpose of this measure is to be able to compare and integrate the effects of individual substances on the global climate. Typical lifetimes in the atmosphere of substances are very different, e.g. 12 and 120 years approximately for CH_4 and N_2O, respectively. So the time perspective clearly plays a decisive role. The lifetime chosen is typically 100 years. The effect of the various greenhouse gases can, then, be converted into the equivalent quantity of CO_2, i.e. the quantity of CO_2 giving the same effect in absorbing solar radiation. According to the IPCC and their Second Assessment Report, which UNFCCC has decided to use as reference for reporting for inventory years throughout the commitment period 2008-2012, the global warming potentials for a 100-year time horizon are:

- CO_2: 1
- Methane (CH_4): 21
- Nitrous oxide (N_2O): 310

Based on weight and a 100-year period, methane is thus 21 times more powerful a greenhouse gas than CO_2, and N_2O is 310 times more powerful. Some of the other greenhouse gases (hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride) have considerably higher global warming potential values. For example, sulphur hexafluoride has a global warming potential of 23 900.

The indirect greenhouse gases reported are nitrogenoxide (NO_x), carbonmonooxide (CO), Non-Methane Volatile Organic Compounds (NMVOC) and sulphurdioxid (SO_2). Since no GWP is assigned these gases they do not contribute to GHG emissions in CO_2-equivalents.

1.1.3 The Climate Convention and the Kyoto Protocol

At the United Nations Conference on Environment and Development in Rio de Janeiro in June 1992, more than 150 countries signed the UNFCCC (the Climate Convention). On the 21st of December 1993, the Climate Convention was ratified by a sufficient number of countries, including Denmark, for it to enter into force on the 21st of March 1994. One of the provisions of the treaty was to stabilise the greenhouse gas emissions from the industrialised nations by the end of 2000. At the first conference under the UN Climate Convention in March 1995, it was decided that the stabilisation goal was inadequate. At the third conference in December 1997 in Kyoto in Japan, a legally binding agreement was reached committing the industrialised countries to reduce the six greenhouse gases by 5.2 % by 2008-2012 compared with the base year and 1990 levels. For the 1990 levels and the base year and the F-gases, the nations can choose freely between 1990 and 1995 as the base year. On May 16, 2002, the Danish parliament voted for the Danish ratification of the Kyoto Protocol. Denmark (including Greenland and excluding the Faroe Islands) is, thus, under a legal commitment to meet the requirements of the Kyoto Protocol, when it came into force on the 16th of February 2005. Denmark (including Greenland) is committed to reduce greenhouse gases with 8 %. The European Union is under the KP committed to reduce emissions of greenhouse gases by 8 %. However, within the EU member states have made a political agreement – the Burden Sharing Agreement – on the contributions to be made by each state to the overall EU reduction level of 8 %.

Under the Burden Sharing Agreement, Denmark (excluding Greenland and the Faroe Islands) must reduce emissions by an average of 21 % in the period 2008-2012 compared with the base year emission level.

In accordance with the Kyoto Protocol, Denmark's base year emissions include the emissions of CO_2, CH_4 and N_2O in 1990 in CO_2-equivalents and Denmark has chosen the emissions of HFCs, PFCs and SF_6 in 1995 in CO_2-equivalents for the base year.

1.1.4 The role of the European Union

The European Union (EU) is a party to the UNFCCC and the Kyoto Protocol. Therefore, the EU has to submit similar datasets and reports for the collective 15 EU Member States under the burden sharing. The EU imposes some additional guidelines and obligations to these EU Member

States through Decision No. 280/2004/EC concerning a mechanism for monitoring community greenhouse gas emissions and for implementing the Kyoto Protocol (EU monitoring mechanism).

1.1.5 Background information on supplementary information required under KP article 7.1

For the LULUCF activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol Denmark has chosen annual accounting. Article 3.3 covers direct, human induced afforestation (A), reforestation (R) and deforestation (D) activities, and accounting of these activities is mandatory. Under Article 3.4 Denmark has elected the activities Forest Management (FM), Cropland Management (CM) and Grazing Land Management (GM) for optional accounting of the first Commitment Period (CP). Net removals from FM activity can be used to compensate net emissions from activities under Article 3.3., and through the issuance of removal units (RMUs) up to a cap value. Denmark's cap value for the CP is 916 667 tonnes CO_2 equivalents.

1.2 A description of the institutional arrangement for inventory preparation

On behalf of the Ministry of the Environment and the Ministry of Climate and Energy NERI is responsible for the calculation and reporting of the Danish national emission inventory to EU and the UNFCCC (United Nations Framework Convention on Climate Change) and UNECE CLRTAP (Convention on Long Range Transboundary Air Pollution) conventions. Hence, the National Environmental Research Institute (NERI), University of Aarhus, prepares and publishes the annual submission for Denmark to the EU and UNFCCC of the National Inventory Report and the GHG inventories in the Common Reporting Format, in accordance with the UNFCCC guidelines. Further, NERI is responsible for reporting the national inventory for the Kingdom of Denmark to the UNFCCC. NERI is also the body designated with overall responsibility for the national inventory under the Kyoto Protocol for Greenland and Denmark.

The work concerning the annual greenhouse gas emission inventory is carried out in cooperation with Danish ministries, research institutes, organisations and companies. The Government of Greenland is responsible for finalising and transferring the inventory for Greenland to NERI. The Faroe Islands Environmental Agency is responsible for finalising and transferring the inventory for The Faroe Islands to NERI.

There are now data agreements in place with both Greenland and the Faroe Islands ensuring the data delivery.

NERI has been and is engaged in work in connection to the meetings of the Conference of Parties (COP) to the UNFCCC and the meetings of the parties (COP/MOP) to the Kyoto protocol and its subsidiary bodies, where the reporting rules are negotiated and settled. Furthermore, NERI participates in the EU Monitoring Mechanism, Working Group 1 (WG1), where the guidelines, methodologies etc. on inventories to be prepared by the EU Member States are regulated.

The main experts responsible for the sectoral inventories and the corresponding chapters and annexes in this report are:

Project leader		Ole-Kenneth Nielsen (okn@dmu.dk)

Sector	Sub-sector	Expert name
Energy	Stationary combustion:	Malene Nielsen, Ole-Kenneth Nielsen
	Transport and other mobile sources	Morten Winther
	Fugitive emissions:	Marlene Plejdrup
Industrial processes		Leif Hoffmann, Erik Lyck
Solvent and other product use		Patrik Fauser
Agriculture		Mette Hjorth Mikkelsen, Rikke Albrektsen & Steen Gyldenkærne
LULUCF		Vivian Kvist Johannsen, Lars Vesterdal & Steen Gyldenkærne
Waste	Solid waste disposal	Erik Lyck
	Waste water handling	Marianne Thomsen
	Waste incineration	Katja Hjelgaard
Greenland		Lene Baunbæk
Faroe Islands		Maria Gunnleivsdóttir Hansen

The work concerning the annual greenhouse emission inventory is carried out in cooperation with other Danish ministries, research institutes, organisations and companies:

Danish Energy Authority, the Ministry of Climate and Energy: Annual energy statistics in a format suitable for the emission inventory work and fuel-use data for the large combustion plants.

Danish Environmental Protection Agency, The Ministry of the Environment: Database on waste and emissions of the F-gases.

Statistics Denmark, The Ministry of Economic and Business Affairs: Statistical yearbook, sales statistics for manufacturing industries and agricultural statistics.

Faculty of Agricultural Sciences, Aarhus University: Data on use of mineral fertiliser, feeding stuff consumption and nitrogen turnover in animals.

The Road Directorate, the Ministry of Transport and Energy: Number of vehicles grouped in categories corresponding to the EU classification, mileage (urban, rural, highway), trip speed (urban, rural, highway).

Danish Centre for Forest, Landscape and Planning, University of Copenhagen: Background data for Forestry and CO_2 uptake by forest. Responsible for preparing estimates of emissions/removals for reporting under KP article 3.3 and for reporting FM under article 3.4.

Civil Aviation Agency of Denmark, the Ministry of Transport and Energy: City-pair flight data (aircraft type and origin and destination airports) for all flights leaving major Danish airports.

Danish Railways, the Ministry of Transport and Energy: Fuel-related emission factors for diesel locomotives.

Danish companies: Audited green accounts and direct information gathered from producers and agency enterprises.

Formerly, the provision of data was on a voluntary basis, but more formal agreements are now prepared.

Additionally NERI receives data from Greenland and the Faroe Islands in order to report for the Kingdom of Denmark:

Statistics Greenland: Complete CRF tables for Greenland and documentation for the inventory process.

The Faroe Islands Environmental Agency: Complete CRF tables for the Faroe Islands and documentation for the inventory process.

1.3 Brief description of the process of inventory preparation. Data collection and processing, data storage and archiving

The background data (activity data and emission factors) for estimation of the Danish emission inventories is collected and stored in central databases located at NERI. The databases are in Access format and handled with software developed by the European Environmental Agency and NERI. As input to the databases, various sub-models are used to estimate and aggregate the background data in order to fit the format and level in the central databases. The methodologies and data sources used for the different sectors are described in Chapter 1.4 and Chapters 3 to 9. As part of the QA/QC plan (Chapter 1.6), the data structure for data processing support the pathway from collection of raw data to data compilation, modelling and final reporting.

For each submission, databases and additional tools and submodels are frozen together with the resulting CRF-reporting format. This material is placed on central institutional servers, which are subject to routine backup services. Material which has been backed up is archived safely. A further documentation and archiving system is the official journal for NERI. In this journal system, correspondence, both in-going and out-going, is registered, which in this case involves the registration of submissions and communication on inventories with the UNFCCC Secretariat, the European Commission, review teams, etc.

Figure 1.1 shows a schematic overview of the process of inventory preparation. The figure illustrates the process of inventory preparation from the first step of collecting external data to the last step, where the reporting schemes are generated for the UNFCCC and EU (in the CRF format (Common Reporting Format)) and to the United Nations Economic Commission for Europe/Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (UNECE/EMEP) (in the NFR format (Nomenclature For Reporting)). For data handling, the software tool is CollectER (Pulles et al., 1999) and for reporting the software tool is the CRF reporter tool developed by the UNFCCC Secretariat together with additional tools developed by NERI. Data files and programme files used in the inventory preparation process are listed in Table 1.1.

Table 1.1 List of current data structure; data files and programme files in use

QA/QC Level	Name	Application type	Path	Type	Input sources
4 store	CFR Submissions (UNFCCC and EU)	External report	I:\ROSPROJ\LUFT_EMI\Inventory\AllYears\8_All Sectors\Level_4a_Storage\	MS Excel, xml	CRF Reporter
3 process	CRF Reporter	Management tool	Working path: local machine Archive path: I:\ROSPROJ\LUFT_EMI\Inventory\AllYears\8_All Sectors\Level_3b_Processes	(exe + mdb)	manual input and Importer2CRF
3 process	Importer2CRF	Help tool	I:\ROSPROJ\LUFT_EMI\Inventory\AllYears\8_All Sectors\Level_3b_Processes	MS Access	CRF Reporter, CollectEr2CRFand excel files
3 process	CollectER2CRF	Help tool	I:\ROSPROJ\LUFT_EMI\Inventory\AllYears\8_All Sectors\Level_3b_Processes	MS Access	NERIRep
2 process 3 store	NERIRep	Help tool	Working path: I:\ROSPROJ\LUFT_EMI\DMURep	MS Access	CollectER databases; dk1972.mdb..dkxxxx.mdb
2 process	CollectER	Management tool	Working path: local machine Archive path: I:\ROSPROJ\LUFT_EMI\Inventory\AllYears\8_All Sectors\Level_2b_Processes	(exe +mdb)	manual input
2 store	dk1972.mdb.dkxxxx .mdb	Datastore	I:\ROSPROJ\LUFT_EMI\Inventory\AllYears\8_All Sectors\Level_2a_Storage	MS Access	CollectER

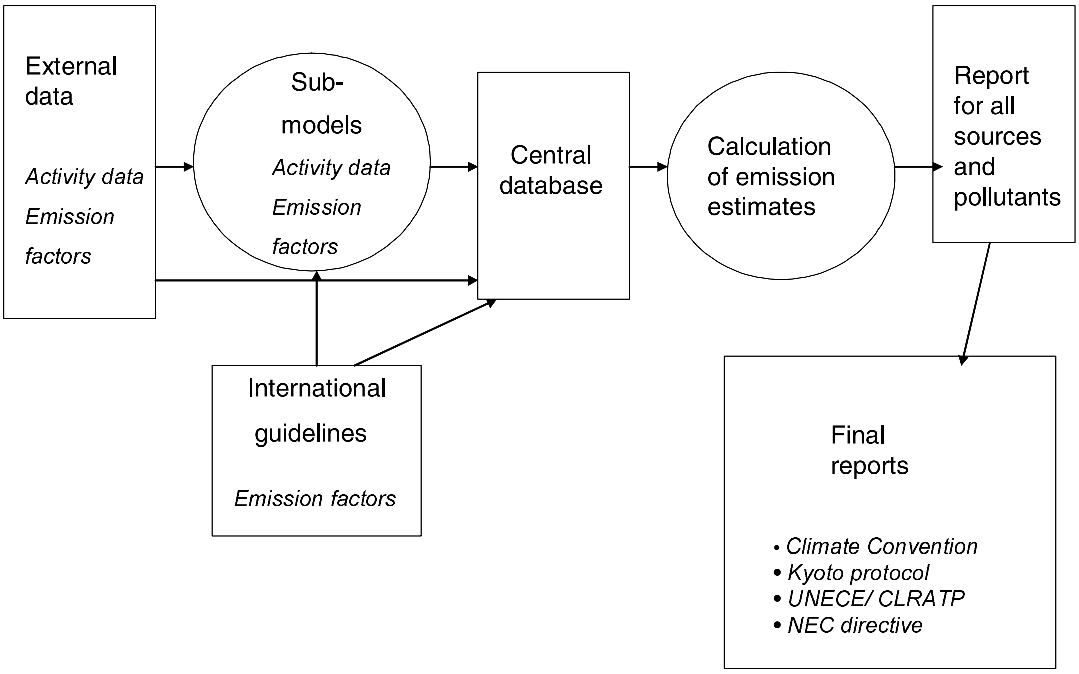


Figure 1.1 Schematic diagram of the process of inventory preparation.

1.4 Brief general description of methodologies and data sources used

Denmark's air emission inventories are based on the Revised 1996 Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories (IPCC, 1997), the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000), the Good Practice Guidance for Land Use, Land-Use Change and Forestry (IPCC, 2003) and the CORINAIR methodology. CORINAIR (COoRdination of INformation on AIR emissions) is a European air emission inventory programme for national sector-wise emission estimations, harmonised with the IPCC guidelines. To ensure estimates are as timely, consistent, transparent, accurate and comparable as possible, the inventory programme has developed calculation methodologies for most subsectors and software for storage and further data processing (EMEP-/CORINAIR, 2004).

A thorough description of the CORINAIR inventory programme used for Danish emission estimations is given in Illerup et al. (2000). The CORINAIR calculation principle is to calculate the emissions as activities multiplied by emission factors. Activities are numbers referring to a specific process generating emissions, while an emission factor is the mass of emissions pr unit activity. Information on activities to carry out the CORINAIR inventory is largely based on official statistics. The most consistent emission factors have been used, either as national values or default factors proposed by international guidelines.

A list of all subsectors at the most detailed level is given in Illerup et al. (2000) together with a translation between CORINAIR and IPCC codes for sector classifications.

1.4.1 Stationary Combustion Plants

Stationary combustion plants are part of the CRF emission sources *1A1 Energy Industries*, *1A2 Manufacturing Industries* and *1A4 Other sectors*.

The Danish emission inventory for stationary combustion plants is based on the CORINAIR system described in the Emission Inventory Guidebook (EMEP/CORINAIR, 2004). The inventory is based on activity rates from the Danish energy statistics and on emission factors for different fuels, plants and sectors.

The Danish Energy Authority aggregates fuel consumption rates in the official Danish energy statistics to SNAP categories.

For each of the fuel and SNAP categories (sector and e.g. type of plant), a set of general emission factors has been determined. Some emission factors refer to the EMEP/CORINAIR guidebook and some are country-specific and refer to Danish legislation, Danish research reports or calculations based on emission data from a considerable number of plants.

Some of the large plants, such as e.g. power plants and municipal waste incineration plants are registered individually as large point sources and emission data from the actual plants are used. This enables use of plant specific emission factors that refer to emission measurements stated in annual environmental reports, etc. At present, the emission factors for CH_4 and N_2O are, however, not plant-specific, whereas emission factors for SO_2 and NO_X often are. For CO_2 it was for the first time possible to use data reported under the EU-ETS in the emission inventory for 2006. Therefore it was possible to derive some plant specific CO_2 emission factors for coal and residual oil fired power plants.

The CO_2 from incineration of the plastic part of municipal waste is included in the Danish inventory.

In addition to the detailed emission calculation in the national approach, CO_2 emission from fuel combustion is aggregated using the reference approach. In 2008, the CO_2 emission inventory based on the reference approach and the national approach, respectively, differ by -0.51 %.

Please refer to Chapter 3.2 and Annex 3A for further information on the emission inventory for stationary combustion plants.

1.4.2 Transport

The emissions from transport, referring to SNAP category 07 (road transport) and the sub-categories in 08 (other mobile sources), are made up in the IPCC categories: 1A3b (road transport), 1A2f (Industry-other), 1A3a (Civil aviation), 1A3c (Railways), 1A3d (Navigation), 1A4c (Agriculture/forestry/fisheries), 1A4b (Residential) and 1A5 (Other).

An internal NERI model with a structure similar to the European COPERT III emission model (Ntziachristos, 2000) is used to calculate the Danish annual emissions for road traffic. For most vehicle categories, updated fuel use and emission data from the new COPERT IV version is incorporated in the NERI model. The emissions are calculated for operationally hot engines, during cold start and fuel evaporation. The model also includes the emission effect of catalyst wear. Input data for vehicle stock and mileage is obtained from the Danish Road Directorate, and is grouped according to average fuel consumption and emission behaviour. For each group the emissions are estimated by combining vehicle and annual mileage numbers with hot emission factors, cold:hot ratios and evaporation factors (Tier 2 approach).

For air traffic, the 2001-2008 estimates are made on a city-pair level, using flight data from the Danish Civil Aviation Agency (CAA-DK) and LTO and distance-related emission factors from the CORINAIR guidelines (Tier 2 approach). For previous years the background data consists of LTO/aircraft type statistics from Copenhagen Airport and total LTO numbers from CAA-DK. With appropriate assumptions, consistent time-series of emissions are produced back to 1990, which also include the findings from a Danish city-pair emission inventory in 1998.

Off-road working machines and equipment are grouped in the following sectors: inland waterways, agriculture, forestry, industry, and household and gardening. In general, the emissions are calculated by combining information on the number of different machine types and their respective load factors, engine sizes, annual working hours and emission factors (Tier 2 approach).

For the most important ferry routes in Denmark (a sub-part of Navigation (1A3d)) detailed calculations are made by combining annual number of return trips, sailing time, engine size, load factor and emission factors (Tier 2 approach).

The most thorough recalculations have changed the fuel consumption input data for road transport, national sea transport, fisheries, agriculture, residential and military. CH_4 and N_2O emission factor changes are made for road transport and military. The recalculations influence the emission estimates of CO_2, CH_4 and N_2O for the sectors Road transport (1A3b), Agriculture/forestry/fisheries (1A4c), Navigation (1A3d), Residential (1A4b) and Military (Other: 1A5).

Please refer to Chapter 3.3 and Annex 3B for further information on emissions from transport.

1.4.3 Fugitive Emissions from Fuels

Emissions from offshore activities are estimated using the methodology described in the Emission Inventory Guidebook (EMEP/CORINAIR, 2004). The sources include emissions from the extraction of oil and gas, on-shore oil tanks, and onshore and offshore loading of ships. The emission factors are based on the figures given in the guidebook, except for the onshore oil tanks where national values are used.

The VOC emissions from petroleum refinery processes cover non-combustion emissions from feedstock handling/storage, petroleum products processing, product storage/handling and flaring. SO_2 is also emitted from the non-combustion processes and includes emissions from processing the products and from sulphur recovery plants. The emission calculations are based on information from the Danish refineries and the energy statistics.

Inventories of the CH_4 emission from gas transmission and distribution is based on annual environmental reports from the Danish gas transmission company, Energinet.dk (former Gastra) and on a Danish inventory for the years 1999-2007, reported by the Danish gas sector (transmission and distribution companies).

Please refer to Chapter 3.5 for further information on fugitive emissions from fuels.

1.4.4 Industrial Processes

Energy consumption associated with industrial processes and the emissions thereof are included in the Energy sector of the inventory. This is due to the overall use of energy balance statistics for the inventory.

There is only one producer of cement in Denmark, Aalborg Portland Ltd. The activity data for the production of cement and the emission factor are obtained from the company as accounted for and published in the "Green Accounts" (In Danish: “Grønne regnskaber”) worked out by the company according to obligations under Danish law. These accounts are subject to audit. The emission factor is produced as a result of a weighting of the emission factors from the production of low alkali cement, rapid cement, basis cement and white cement.

The reference for the activity data for production of lime, hydrated lime, expanded clay products and bricks are the production statistics from the manufacturing industries, published by Statistics Denmark.

Limestone is used for the refining of sugar as well as for wet flue gas cleaning at power plants and waste incineration plants. The reference for the activity data is Statistics Denmark for sugar, Energinet.dk for gypsum from power plants combined with specific information on consumption of $CaCO_3$ at specific power plants and National Waste Statistics for gypsum from waste incineration. The emission factors are based on stoichiometric relations between consumption of $CaCO_3$ and gypsum generation as well as consumption of lime for sugar refining and precipitation with CO_2.

The reference for the activity data for asphalt roofing is Statistics Denmark for consumption of roofing materials, combined with technical specifications for roofing materials produced in Denmark. The emission factors are default factors.

For road paving with asphalt the reference for the activity data is Statistics Denmark for consumption of asphalt and cut-back asphalt. The emission factors are default factors for consumption of asphalt and an estimated emission factor for cut-back asphalt based on the statistics on the emission of NMVOC compiled by the industrial organisations in question.

The reference for activity data for the production of glass and glass wool are obtained from the producers published in their environmental reports. Emission factors are based on stoichiometric relations between raw materials and CO_2 emissions.

The production of lime and yellow bricks gives rise to CO_2 emissions. The emission factors are based on stoichiometric relations, assumption on $CaCO_3$ content in clay as well as a default emission factor for expanded clay products.

There has been one producer of nitric acid in Denmark. To date, the data in the inventory relies on information from the producer. The producer reports emissions of NO_x and NH_3 as measured emissions and emissions of N_2O for 2003 as estimated emissions. The emission of N_2O in 2005 and forward is not occurring as the nitric acid production was closed down in the middle of 2004.

There is one producer of catalysts in Denmark. The data in the inventory relies on information published by the producer in environmental reports.

There is one steelwork in Denmark. The activity data as well as data on consumption of raw materials (coke) has been published by the producer in environmental reports. Emission factors are based on stoichiometric relations between raw materials and CO_2 emission.

The inventory on the F-gases (HFCs, PFCs and SF_6) is based on work carried out by the Danish Consultant Company "Planmiljø". Their yearly report (DEPA, 2010) documents the inventory data up to the year 2008. The methodology is implemented for the whole time-series 1990-2008, but full information on activities only exists since 1995.

Please refer to Chapter 4 for further information on industrial processes.

1.4.5 Solvents

CRF Table 3.A-D. Sectorial background data for solvents and other product use

The approach for calculating the emissions of Non-Methane Volatile Organic Carbon (NMVOC) from industrial and household use in Denmark focuses on single chemicals rather than activities. This leads to a clearer picture of the influence from each specific chemical, which enables a more detailed differentiation on products and the influence of product use on emissions. The procedure is to quantify the use of the chemicals and estimate the fraction of the chemicals that is emitted as a consequence of use.

The detailed approach in EMEP/CORINAIR (2004) is used. Here all relevant consumption data on all relevant solvents must be inventoried or at least those together representing more than 90 % of the total NMVOC emission. Simple mass balances for calculating the use and emissions of chemicals are set up 1) use = production + import – export, 2) emission = use * emission factor. Production, import and export figures are extracted from Statistics Denmark, from which a list of 427 single chemicals, a few groups and products is generated. For each of these, a "use" amount in tonnes pr yr (from 1995 to 2008) is calculated. It is found that 40 different NMVOCs comprise over 95 % of the total use and it is these 40 chemicals that are investigated further. The "use" amounts are distributed across industrial activities according to the Nordic SPIN (Substances in Preparations in Nordic Countries) database, where information on industrial use categories and products is available in a NACE coding system. The chemicals are also related to specific products. Emission factors are obtained from regulators or the industry.

Outputs from the inventory are: a list where the 40 most predominant NMVOCs are ranked according to emissions to air; specification of emissions from industrial sectors and from households - contribution from each chemical to emissions from industrial sectors and households; tidal (annual) trend in NMVOC emissions, expressed as total NMVOC and single chemical, and specified in industrial sectors and households.

This emission inventory includes N_2O emissions from the use of anaesthesia for 2005-2008. Five companies sell N_2O in Denmark and only one company produces N_2O. Due to confidentiality no data on produced amount are available and thus the emissions related to N_2O production are unknown. An emission factor of one is assumed for all use, which equals the sold amount to the emitted amount.

Please refer to Chapter 5 for further information on the emission inventory for solvent and other product use.

1.4.6 Agriculture

CRF Table 4.A-F. Sectorial background data for agriculture

The emissions are given in CRF: Table 4 Sectoral Report for Agriculture and Table 4.A, 4.B(a), 4.B(b), 4.D and 4.F Sectoral Background Data for Agriculture. The calculation of emissions from the agricultural sector is based on methods described in the IPCC Guidelines (IPCC, 1996) and the Good Practice Guidance (IPCC, 2000). Activity data for livestock is on a one-year average basis from the agriculture statistics published by Statistics Denmark (2007). Data concerning the land use and crop yield is also from the agricultural statistics. Data concerning the feed consumption and nitrogen excretion is based on information from the Faculty of Agricultural Science, University of Aarhus. The CH_4 Implied Emission Factors for Enteric Fermentation and Manure Management are based on a Tier 2/CS approach for all animal categories. All livestock categories in the Danish emission inventory are based on an average of certain subgroups separated by differences in animal breed, age and weight class. The emissions from enteric fermentation for poultry and fur farming are not estimated. There is no default value recommended in the IPCC guidelines (Table A-4 in Good Practice Guidance).

Emission of N_2O is closely related to the nitrogen balance. Thus, quite a lot of the activity data is related to the Danish calculations for ammonia emission (Hutchings et al.; 2001, Mikkelsen et al., 2006). National standards are used to estimate the amount of ammonia emission. When estimating the N_2O emission the IPCC standard value is used for all emission sources. The emission of CO_2 from Agricultural Soils is included in the LULUCF sector.

A model-based system is applied for the calculation of the emissions in Denmark. This model (IAD – Inventory Agriculture Data) is used to estimate emission from both greenhouse gases and ammonia. A more detailed description is published in Mikkelsen et al. (2006). The emission from the agricultural sector is mainly related to livestock production. IAD works on a detailed level and includes around 38 livestock categories, and each category is subdivided according to stable type and manure type. The emission is calculated from each subcategory and the emission is aggregated in accordance with the livestock category given in the CRF.

To ensure data quality, both data used as activity data and background data used to estimate the emission factor are collected, and discussed in cooperation with specialists and researchers in different institutes and research sections. Thus, the emission inventory will be evaluated continuously according to the latest knowledge. Furthermore, time-series both of emission factors and emissions in relation to the CRF categories are prepared. Any considerable variations in the time-series are explained.

The uncertainties for assessment of emissions from enteric fermentation, manure management, agricultural soils and field burning of agricultural residue have been estimated based on a Tier 1 and Tier 2 approach. The most significant uncertainties are related to the emissions of CH_4 and N_2O from manure management.

A more detailed description of the methodology for the agricultural sector is given in Chapter 6 and Annex 3D.

1.4.7 Forestry, Land Use and Land Use Change

A complete Land Use Change matrix based on satellite imaging of the whole Danish land area has been performed into the six major area classes. This has improved the coverage and the quality of the inventory substantially.

In the forest inventory major changes has been made since the 2009 submission. Previously estimates were based on the National Forest Census. Now a National Forest Inventory (NFI) has replaced the Census and all applicable pools are reported. This type of forest inventory is very similar to inventories used in other countries, e.g. Sweden or Norway. Please see Chapter 7 for further details.

CO_2 emissions from Cropland and Grassland are based on census data from Statistics Denmark as regards size of area and crop yield combined with GIS-analysis on land use. Now all applicable pools are reported for Cropland and Grassland. The emission from mineral soils for both cropland and grassland is estimated with a three-pooled dynamical soil C model (C-TOOL). C-TOOL was initialised in 1980. The model is run for each county in Denmark. Emissions from organic soils are based on IPCC Tier 1b. The area with organic soils is based on soil maps combined with field-specific crop data. National models have been developed for the horticultural area based on area statistics from Statistic Denmark. Sinks in hedgerows are based on a national developed model. The area with hedgerows is based on hedgerows established with financial support from the Danish Government. Emissions from liming are based on annual sales data collected by the Danish Agricultural Advisory Centre, combined with the acid neutralisation capacity for each lot produced. The acid neutralisation capacity is estimated by the Danish Plant Directorate.

For Wetlands emissions are reported from peat extraction areas. Natural wetlands are not reported. A comprehensive programme for restoration of wetlands is taking place in Denmark. "Land" converted to Wetlands is therefore reported.

For the purpose of having estimates for the KP accounting "Land" converted to Settlements is reported but not Settlements remaining Settlements.

No estimates are made for Other Land remaining Other Land and no conversion of land to Other Land is made. For the purpose of having estimates for the KP accounting estimates for living biomass are provided for land converted from Other Land to Other Land Use.

1.4.8 Waste

For 6.A Solid Waste Disposal on Land, only managed waste disposal is of importance and registered. The data used for the amounts of municipal solid waste deposited at solid waste disposal sites is according to the official registration performed by the Danish Environmental Protection Agency (DEPA). CH_4 emissions from solid waste disposal sites are calculated with a model suited to Danish waste composition data. The model is based on the IPCC Tier 2 approach using a First Order Decay approach. The model is used for the whole time-series, but the model has been revised as a result of the review on the 2009 submission. Several studies to analyse the sensitivity of the model have been undertaken. These studies and the model are described in Chapter 8.2.

For 6.B Waste Water Handling, country-specific methodologies for calculating the emissions of CH_4 and N_2O at wastewater treatment plants (WWTPs) were prepared and implemented first time for the 2005 submissions. There have been smaller methodological revisions in the submissions in 2006 (Illerup et al., 2006). In the 2007 submission no revisions were introduced. In the 2008 and 2009 submissions only minor revisions occurred. For this submission revisions have been introduced, where the calculation of the gross methane emissions from the degradable organic matter is unchanged, while the approach for estimating the recovered methane has been revised. Further, the methodology on N_2O emissions has been revised.

The methodology developed for this submission for estimating emission of methane from wastewater handling follows the IPCC Guidelines (IPCC, 1997) and IPCC Good Practice Guidance (IPCC, 2000), refer to Chapter 8.3.

The methods are based on data from the Danish Water Quality Parameter Database, DEPA reports, Danish Energy statistics and several national and international studies.

Regarding 6.C Waste Incineration all municipal and industrial waste incinerated is used for energy and heat production. This production is included in the energy statistics, hence emissions are included in the CRF under fuel combustion activities (CRF sector 1A), and more specifically waste incineration takes place in CRF sectors 1A1a, 1A2f and 1A4a. For the 2010 submission reporting in this category covers incineration of corpses and carcasses, and accidental fires. The activity data are obtained from the National Association of Danish Crematoria, the three facilities incinerating carcasses and the Danish Emergency Management Agency.

In CRF category 6.D Other small emissions due to gasification of waste are included for the years 1994-2005. In 2006 onwards these emissions do not occur.

Please refer to Chapter 8 and Annex 3F for further information on emission inventories for waste.

1.4.9 KP-LULUCF

Regarding the possibility of including in the first commitment period emissions and removals associated with land use, land-use change and forestry activities under Article 3.4 of the Kyoto Protocol, Denmark has decided to include emissions and removals from Forest Management (FM), Cropland Management (CM) and Grazing land Management (GM).

The national system has identified land areas associated with the activities under Article 3.4 of the Kyoto Protocol in accordance with definitions, modalities, rules and guidelines relating to land use, land-use change and forestry activities under the protocol by satellite monitoring, use of EU Land Parcel Information System (LPIS), detailed crop information data on field level, soil mapping and sample plots from the national forest inventory (NFI). All land converted from other activities into Cropland and Grassland is accounted for. No land has been allowed to leave elected areas under art. 3.4.

The forest definition adopted in the NFI is identical to the FAO definition (TBFRA, 2000). It includes "wooded areas larger than 0.5 ha, that are able to form a forest with a height of at least 5 m and crown cover of at least 10 %". The minimum width is 20 m. For afforestation the carbon stock change in the period 1990 - 2008 is based both on the area of afforestation, the information on species composition from the Forest Census 2000 and from the NFI. In the afforestation a steady increase in carbon stock is found. The estimates for the carbon pools in the afforestation are similar to previous estimates, with a slight increase due to the new knowledge on species composition and average carbon stock in those areas based on the NFI data. Carbon stock change caused by deforestation is estimated based on the deforested area and the mean values of carbon stock in the total forest area. This is due to the fact that no specific knowledge is available on the carbon pools of the deforested areas.

For Cropland and Grassland the same methodology is used in the Convention reporting as used in the KP reporting. As shown in the Cropland sector there is a very high variability in the emissions from agricultural soils due to the actual harvest yield and the actual climatic conditions. To reduce the inter-annual variability in the accounting under the Kyoto-protocol the recommended five-year average is used for the base year, IPCC, 2004, Section 4.2.3.7 p 4.23. The averaging is only used for the subdivision "Agricultural cropland" and "Liming" and not for the minor sources such as perennial wooden plants and hedges which shows very little variability. For the first year in the commitment period the actual emission as reported under the Climate Convention is used. This approach will be followed in the coming years. As a result the total accounting in the first commitment period will include five years, equal to the number of years in the base year.

Please see Chapter 11 for further details.

1.5 Brief description of key categories

The key category analysis described in this section covers only Denmark. The aggregation used for the analysis is not directly suited for emissions from Greenland. If Greenlandic emissions were included in the analysis they would not affect the overall results of the key category analysis. For a key category analysis covering Greenland refer to Annex 9 and for Denmark and Greenland refer to Annex 10.

1.5.1 Key category analysis excluding LULUCF

A key category analysis (KCA) for year 1990 and 2008 has been carried out in accordance with the IPCC Good Practice Guidance. The present KCA differs from the previous KCA in the 2009 submission due to the inclusion of new categories. Besides these changes the analysis, as regards the basic categorisation, has been kept unchanged since previous analysis. The categorisation used results in a total of 113 categories. In the level KCA for the inventory for 1990, 23 key categories were identified. For the KCA for 2008, 24 categories are identified as key categories due to level and 25 due to trend. 20 categories are key for both trend and level. The energy sector and CO_2 emissions from stationary combustion contributes to those 24 key categories with 13 key sources, of which CO_2 from coal combustion in the analysis contributes most with 25.1 % of the national total (this contribution and the percentage contributions in the following are results from the level KCA based on the absolute values of the emissions; this contribution as percentages may differ somewhat from the percentage used in the sectoral chapters). The category, CO_2 emissions road transportation, is also a key source and the second highest contributor, with 20.3 %. CO_2 from natural gas is the third largest contributor with 15.3 %. The industrial sector contributes with 2 level and trend key sources: CO_2 from cement production (contributes 1.8 %) and HFC and PFC emissions from refrigeration and air (1.2 %). In the agricultural sector, there are 8 trend and level key categories, of which 2 are among the 5 highest contributors to the national total. These two categories are CH_4 from enteric fermentation and indirect N_2O emissions from leaching and run-off., contributing 4.4 and 3.1 %, respectively, to the national total in 2008. The waste sector includes one level key category, which is CH_4 from solid waste disposal on land, contributing 1.7 % to the national total. The categorisation used, results, etc. are included in Annex 1.

1.5.2 Key category analysis including LULUCF

A key category analysis (KCA) for year 2008 has been carried out in accordance with the IPCC Good Practice Guidance. The categorisation used results in a total of 133 categories. For the KCA for 2008, 30 categories are identified as key categories due to level. The energy sector and CO_2 emissions from stationary combustion contributes to those 30 key categories with 15 key categories, of which CO_2 from coal combustion in the analysis contributes most with 24.0 % of the national total (this contribution and the percentage contributions in the following are results from the level KCA based on the absolute values of the emissions; this contribution as percentages may differ somewhat from the percentage used in the sectoral chapters). The category, CO_2 emissions road transportation, is also a key category and the second highest contributor, with 19.4 %. CO_2 from natural gas is the third largest contributor with 14.6 %. The industrial sector contributes with 2 key categories: CO_2 from cement production (contributes 1.7 %) and HFC and PFC emissions from refrigeration and air (1.1 %). In the agricultural sector, there are 9 key categories, of which 2 are among the 5 highest contributors to the national total. These two categories are CH_4 from enteric fermentation and indirect N_2O emissions from leaching and run-off., contributing 4.2 and 3.0 %, respectively, to the national total in 2008. The waste sector includes one key category, which is CH_4 from solid waste disposal on land, contributing 1.7 % to the national total. LULUCF contributes with four key categories with the top two being cropland remaining cropland – organic soils and cropland remaining cropland – mineral soils.

The categorisation used, results, etc. are included in Annex 1. Since in Sections 1.5.1-.2 above summary of the Level tier 1 analysis for 2008 only is given, further reference is given to Annex 1.

1.5.3 KP-LULUCF

See Chapter 11.9.1 for discussion on the key category analysis of KP-LULUCF.

1.6 Information on QA/QC plan including verification and treatment of confidential issues where relevant

1.6.1 Introduction

This section outlines the Quality Control (QC) and Quality Assurance (QA) plan for greenhouse gas emission inventories performed by the Danish National Environmental Research Institute (Sørensen et al., 2005). The plan is in accordance with the guidelines provided by the UNFCCC (IPCC, 1997), and the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000). The ISO 9000 standards are also used as important input for the plan.

The QA/QC plan also covers Greenland. NERI receives the data corresponding to data processing level 3 and data storage level 4 and the data undergoes the same QA/QC procedure as the Danish data. The QA/QC specific to the Greenlandic emission inventory is described in Annex 9.

1.6.2 Concepts of quality work

The quality planning is based on the following definitions as outlined by the ISO 9000 standards as well as the Good Practice Guidance (IPCC, 2000):

- Quality management (*QM*) Coordinates activity to direct and control with regard to quality.
- Quality Planning (*QP*) Defines quality objectives including specification of necessary operational processes and resources to fulfil the quality objectives.
- Quality Control (*QC*) Fulfils quality requirements.
- Quality Assurance (*QA*) Provides confidence that quality requirements will be fulfilled.
- Quality Improvement (*QI*) Increases the ability to fulfil quality requirements.

The activities are considered inter-related in this report as shown in Figure 1.2.

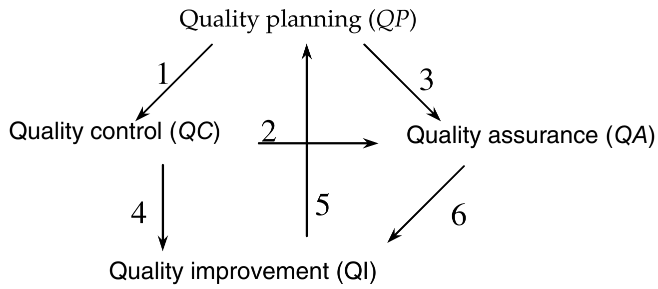


Figure 1.2 Interrelation between the activities with regard to quality. The arrows are explained in the text below this figure.

1: The *QP* sets up the objectives and, from these, measurable properties valid for the *QC*.

2: The *QC* investigates the measurable properties that are communicated to *QA* for assessment in order to ensure sufficient quality.

3. The *QP* identifies and defines measurable indicators for the fulfilment of the quality objectives. This yields the basis for the *QA* and has to be supported by the input coming from the *QC*.

4: The result from *QC* highlights the degree of fulfilment for every quality objective. It is thus a good basis for suggestions for improvements to the inventory to meet the quality objectives.

5: Suggested improvements in the quality may induce changes in the quality objectives and their measurability.

6: The evaluation carried out by external authorities is important input when improvements in quality are being considered.

1.6.3 Definition of quality

A solid definition of quality is essential. Without such a solid definition, the fulfilment of the objectives will never be clear and the process of quality control and assurance can easily turn out to be a fuzzy and unpleasant experience for the people involved. On the contrary, in case of a solid definition and thus a clear goal, it will be possible the make a valid statement of "good quality" and thus form constructive conditions and motivate the inventory work positively. A clear definition of quality has not been given in the UNFCCCC guidelines. In the Good Practice Guidance, Chapter 8.2, however, it is mentioned that:

"Quality control requirements, improved accuracy and reduced uncertainty need to be balanced against requirements for timeliness and cost effectiveness." The statement of balancing requirements and costs is not a solid basis for QC as long as this balancing is not well defined.

The resulting standard of the inventory is defined as being composed of accuracy and regulatory usefulness. The goal is to maximise the standard of the inventory and the following statement defines the quality objective:

The quality objective is only inadequately fulfilled if it is possible to make an inventory of higher standard without exceeding the frame of resources.

1.6.4 Definition of Critical Control Points (*CCP*)

A Critical Control Point (*CCP*) is defined in this submission as an element or an action which needs to be taken into account in order to fulfil the quality objectives. Every *CCP* has to be necessary for the objectives and the *CCP* list needs to be extended if other factors, not defined by the *CCP* list, are needed in order to reach at least one of the quality objectives.

The objectives for the *QM*, as formulated by IPCC (2000), are to improve elements of transparency, consistency, comparability, completeness and confidence. In the UNFCCC guidelines (IPCC, 1997), the element "confidence" is replaced by "accuracy" and in this plan "accuracy" is used.

The objectives for the *QM* are used as *CCP*s, including the elements mentioned above. The following explanation is given by UNFCCC guidelines (IPCC, 1997) for each *CCP*:

Transparency means that the assumptions and methodologies used for an inventory should be clearly explained to facilitate replication and assessment of the inventory by users of the reported information. The transparency of the inventories is fundamental to the success of the process for communication and consideration.

Consistency means that an inventory should be internally consistent in all its elements with inventories of other years. An inventory is consistent if the same methodologies are used for the base and for all subsequent years and if consistent datasets are used to estimate emissions or removals from source or sinks. Under certain circumstances, an inventory using different methodologies for different years can be considered to be consistent if it has been recalculated in a transparent manner in accordance with the Intergovernmental Panel on Climate Change (IPCC) guidelines and good practice guidance.

Comparability means that estimates of emission and removals reported by Annex I Parties in inventories should be comparable among Annex I parties. For this purpose, Annex I Parties should use the methodologies and formats agreed upon by the COP for estimating and reporting inventories. The allocation of different source/sink categories should follow the split of *Revised 1996 IPCC Guidelines for national Greenhouse Gas Inventories* (IPCC, 1997) at the level of its summary and sectoral tables.

Completeness means that an inventory covers all sources and sinks, as well as all gases, included in the IPCC guidelines as well as other existing relevant source/sink categories, which are specific to individual Annex I Parties and, therefore, may not be included in the IPCC guidelines. Completeness also means full geographic coverage of sources and sinks of an Annex I Party.

Accuracy is a relative measure of the exactness of an emission or removal estimate. Estimates should be accurate and should systematically neither over nor underestimate emissions or removals. Uncertainties on estimates should be reduced if possible. Appropriate methodologies should be used in accordance with the *IPCC good practice guidance*, to promote data accuracy in inventories.

The robustness against unexpected disturbance of the inventory work has to be high in order to secure high quality, which is not covered by the *CCP*s above. The correctness of the inventory is formulated as an independent objective. This is so because the correctness of the inventory is a condition for all other objectives to be effective. A large part of the Tier 1 procedure given by the Good Practice Guidance (IPCC, 2000) is actually checks for miscalculations and, thus, supports the objective of correctness. Correctness, as defined here, is not similar to accuracy, because the correctness takes into account miscalculations, while accuracy relates to minimizing the always present data-value uncertainty.

Robustness implies arrangement of inventory work as regards e.g. inventory experts and data sources in order to minimize the consequences of any unexpected disturbance due to external and internal conditions. A change in an external condition could be interruption of access to an external data source and an internal change could be a sudden reduction in qualified staff, where a skilled person suddenly leaves the inventory work.

Correctness has to be secured in order to avoid uncontrollable occurrence of uncertainty directly due to errors in the calculations.

The different *CCP*s are not independent and represent different degrees of generality. E.g. deviation from *comparability* may be accepted if a high degree of *transparency* is applied. Furthermore, there may even be a conflict between the different *CCP*s. E.g. new knowledge may suggest improvements in calculation methods for better *completeness*, but the same improvements may to some degree violate the *consistency* and *comparability* criteria with regard to earlier years' inventories and the reporting from other nations. It is, therefore, a multi-criteria problem of optimisation to apply the set of *CCP*s in the aim for good quality.

1.6.5 Process-oriented QC

The strategy is based on a process-oriented principle (ISO 9000 series) and the first step is, thus, to set up a system for the process of the inventory work. The product specification for the inventory is a dataset of emission figures and the process, thereby, equates with the data flow in the preparation of the inventory.

The data flow needs to support the QC/QA in order to facilitate a cost-effective procedure. The flow of data has to take place in a transparent way by making the transformation of data detectable. It should be easy to find the original background data for any calculation and to trace the sequence of calculations from the raw data to the final emission result. Computer programming for automated calculations and checking will enhance the accuracy and minimize the number of miscalculations and flaws in input value settings. Especially manual typing of numbers needs to be minimized. This assumes, however, that the quality of the programming has been verified to ensure the correctness of the automated calculations. Automated value control is also one of the important means to secure accuracy. Realistic uncertainty estimates are necessary for securing accuracy, but they can be difficult to produce due to the uncertainty related to the uncertainty estimates themselves. It is, therefore, important to include the uncertainty calculation procedures into the data structure as far as possible. The QC/QA needs to be supported as far as possible by the data structure; otherwise the procedures can easily become troublesome and subject to frustration.

Both data processing and data storage form the data structure. The data processing is carried out using mathematical operations or models. The models may be complicated where they concern human activity or be simple summations of lower aggregated data. The data storage includes databases and file systems of data that are either calculated using the data processing at the lower level, using input to new processing steps or even using both output and input in the data structure. The measure for quality is basically different for processing and storage, so these need to be kept separate in a well-designed quality manual. A graphical display of the data flow is seen in Figure 1.3 and explained in the following.

The data storage takes place for the following types of data:

***External Data*:** a single numerical value of a parameter coming from an external source. These data govern the calculation of *Emission calculation input.*

***Emission calculation input*:** Data for input to the final emission calculation in terms of data for release source strength and activity. The data is directly applicable for use in the standardized forms for calculation. These data are calculated using external data or represent a direct use of *External Data* when they are directly applicable for *Emission Calculations*.

***Emission Data*:** Estimated emissions based on the *emission calculation input.*

***Emission Reporting*:** Reporting of emission data in requested formats and aggregation level.

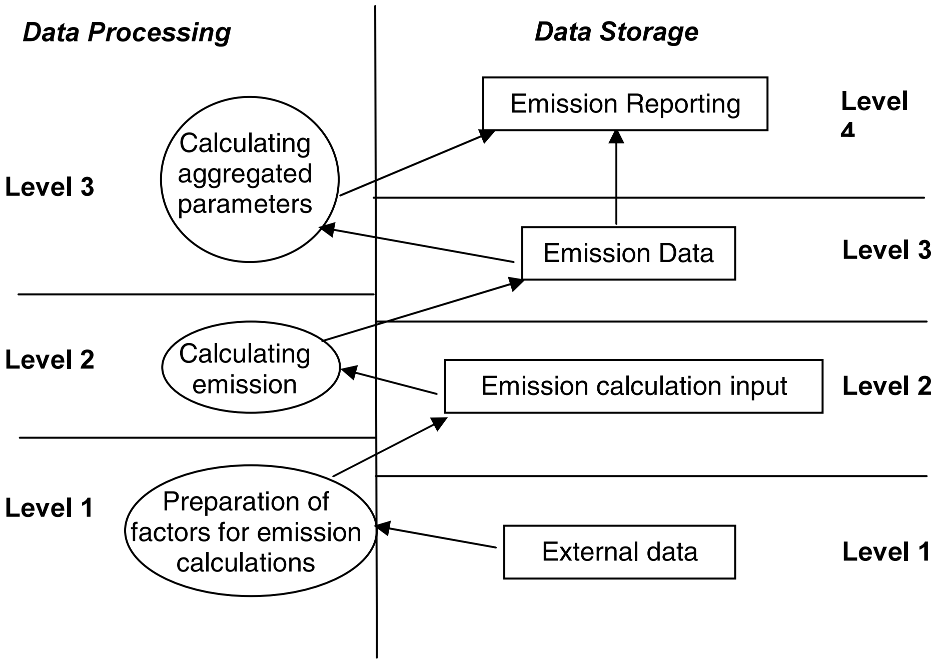


Figure 1.3 The general data structure for the emission inventory.

Key levels are defined in the data structure as:

Data storage Level 1, External data

Collection of external data for calculation of emission factors and activity data. The activity data are collected from different sectors and statistical surveys, typically reported on a yearly basis. The data consist of raw data, having an identical format to the data received and gathered from external sources. Level 1 data acts as a base-set, on which all subsequent calculations are based. If alterations in calculation procedures are made, they are based on the same dataset. When new data are introduced they can be implemented in accordance with the QA/QC structure of the inventory.

Data storage Level 2, Data directly usable for the inventory

This level represents data that have been prepared and compiled in a form that is directly applicable for calculation of emissions. The compiled data are structured in a database for internal use as a link between more or less raw data and data that are ready for reporting. The data are compiled in a way that elucidates the different approaches in emission assessment: (1) directly on measured emission rates, especially for larger point sources, (2) based on activities and emission factors, where the value setting of these factors are stored at this level.

Data storage Level 3, Emission data

The emission calculations are reported by the most detailed figures and divided in sectors. The unit at this level is typically mass pr yr for the country. For sources included in the SNAP system, the SNAP level 3 is relevant. Internal reporting is performed at this level to feed the external communication of results.

Data storage Level 4, Final reports for all subcategories

The complete emission inventory is reported to UNFCCC at this level by summing up the results from every subcategory.

Data processing Level 1 Compilation of external data

Preparation of input data for the emission inventory based on the external data sources. Some external data may be used directly as input to the data processing at level 2, while other data needs to be interpreted using more or less complicated models, which takes place at this level. The interpretation of activity data is to be seen in connection with availability of emission factors and vice versa. These models are compiled and processed as an integrated part of the inventory preparation.

Data processing Level 2 Calculation of inventory figures

The emission for every subcategory is calculated, including the uncertainty for all sectors and activities. The summation of all contributions from sub-sources makes up the inventory.

Data processing Level 3 Calculation aggregated parameters

Some aggregated parameters need to be reported as part of the final reporting. This does not involve complicated calculations but important figures, e.g. implied emission factors at a higher aggregated level to be compared in time-series and with other countries.

1.6.6 Definition of Point of Measurements (*PM*)

The *CCP*s have to be based on clear measurable factors, otherwise the *QP* will end up being just a loose declaration of intent. Thus, in the following, a series of *Points for Measuring* (*PM*) is identified as building blocks for a solid *QC*. Table 8.1 in Good Practice Guidance is a listing of such *PM*s. However, the listing in Table 1.1 below is an extended and modified listing, in comparison to Table 8.1. in the Good Practice Guidance supporting all the *CCP*s. The *PM*s will be routinely checked in the QC reporting and, when external reviews take place, the reviewers will be asked to assess the fulfilment of the *PM*s using a checklist system. The list of *PM*s is continually evaluated and modified to offer the best possible support for the *CCP*s. The actual list used is seen in Table 1.2.

Table 1.2 The list of *PM*s as used.

Level	CCP	Id	Description
Data Storage level 1	1. Accuracy	DS.1.1.1	General level of uncertainty for every dataset including the reasoning for the specific values
		DS.1.1.2	Quantification of the uncertainty level of every single data value, including the reasoning for the specific values.
	2. Comparability	DS1.2.1	Comparability of the data values with similar data from other countries, which are comparable with Denmark, and evaluation of the discrepancy.
	3.Completeness	DS.1.3.1	Documentation showing that all possible national data sources are included, by setting down the reasoning behind the selection of datasets.
	4.Consistency	DS.1.4.1	The origin of external data has to be preserved whenever possible without explicit arguments (referring to other PMs)
	6.Robustness	DS.1.6.1	Explicit agreements between the external institution holding the data and NERI about the conditions of delivery
		DS.1.6.2	At least two employees must have a detailed insight into the gathering of every external dataset.
	7.Transparency	DS.1.7.1	Summary of each dataset including the reasoning behind the selection of the specific dataset
		DS.1.7.2	The archiving of datasets needs to be easily accessible for any person in the emission inventory
		DS.1.7.3	References for citation for any external dataset have to be available for any single number in any dataset.
		DS.1.7.4	Listing of external contacts for every dataset
Data Processing level 1	1. Accuracy	DP.1.1.1	Uncertainty assessment for every data source as input to Data Storage level 2 in relation to type of variability. (Distribution as: normal, log normal or other type of variability)
		DP.1.1.2	Uncertainty assessment for every data source as input to Data Storage level 2 in relation to scale of variability (size of variation intervals)
		DP.1.1.3	Evaluation of the methodological approach using international guidelines
		DP.1.1.4	Verification of calculation results using guideline values
	2.Comparability	DP.1.2.1	The inventory calculation has to follow the international guidelines suggested by UNFCCC and IPCC.
	3.Completeness	DP.1.3.1	Assessment of the most important quantitative knowledge which is lacking.
		DP.1.3.2	Assessment of the most important cases where access is lacking with regard to critical data sources that could improve quantitative knowledge.
	4.Consistency	DP.1.4.1	In order to keep consistency at a high level, an explicit description of the activities needs to accompany any change in the calculation procedure
		DP.1.4.2	Identification of parameters (e.g. activity data, constants) that are common to multiple source categories and confirmation that there is consistency in the values used for these parameters in the emission calculations
	5.Correctness	DP.1.5.1	Shows at least once, by independent calculation, the correctness of every data manipulation
		DP.1.5.2	Verification of calculation results using time-series
		DP.1.5.3	Verification of calculation results using other measures
		DP.1.5.4	Show one-to-one correctness between external data sources and the databases at Data Storage level 2

Continued

Level	CCP	Id	Description
	6.Robustness	DP.1.6.1	Any calculation must be anchored to two responsible persons who can replace each other in the technical issue of performing the calculations.
	7.Transparency	DP.1.7.1	The calculation principle and equations used must be described
		DP.1.7.2	The theoretical reasoning for all methods must be described
		DP.1.7.3	Explicit listing of assumptions behind all methods
		DP.1.7.4	Clear reference to dataset at Data Storage level 1
		DP.1.7.5	A manual log to collect information about recalculations
Data Storage level 2	2.Comparability	DS.2.2.1	Comparison with other countries that are closely related to Denmark and explanation of the largest discrepancies
	5.Correctness	DS.2.5.1	Documentation of a correct connection between all data types at level 2 to data at level 1
		DS.2.5.2	Check if a correct data import to level 2 has been made
	6.Robustness	DS.2.6.1	All persons in the inventory work must be able to handle and understand all data at level 2.
	7.Transparency	DS.2.7.1	The time trend for every single parameter must be graphically available and easy to map
		DS.2.7.2	A clear Id must be given in the dataset having reference to level 1.
Data Processing level 2	1. Accuracy	DP.2.1.1	Documentation of the methodological approach for the uncertainty analysis
		DP.2.1.2	Quantification of uncertainty
	2.Comparability	DP.2.2.1	The inventory calculation has to follow the international guidelines suggested by UNFCCC and IPCC
	6.Robustness	DP.2.6.1	Any calculation at level 4 must be anchored to two responsible persons who can replace each other in the technical issue of performing the calculations.
	7.Transparency	DP.2.7.1	Reporting of the calculation principle and equations used
		DP.2.7.2	Reporting of the theoretical reasoning for all methods
		DP.2.7.3	Reporting of assumptions behind all methods
		DP.2.7.4	The reasoning for the choice of methodology for uncertainty analysis needs to be written explicitly.
Data Storage level 3	1. Accuracy	DS.3.1.1	Quantification of uncertainty
	5.Correctness	DS.3.5.1	Comparison with inventories of the previous years on the level of the categories of the CRF as well as on SNAP source categories. Any major changes are checked, verified, etc.
		DS.3.5.2	Total emissions, when aggregated to CRF source categories, are compared with totals based on SNAP source categories (control of data transfer).
		DS.3.5.3	Checking of time-series of the CRF and SNAP source categories as they are found in the Corinair databases. Considerable trends and changes are checked and explained.
	7.Transparency	DS.3.7.1	Documentation of a correct connection between all data types at DS3 to data at level DS2

Continued

Level	CCP	Id	Description
Data Processing level 3	7.Transparency	DP.3.7.1	In the calculation sheets, there must be clear Id to Data Storage level 3 data
Data Storage level 4	1. Accuracy	DS.4.1.1	Questionnaire to external experts: The performance of the PMs that relate to accuracy.
	2.Comparability	DS.4.2.1	Description of similarities and differences in relation to other countries' inventories for the methodological approach.
	3.Completeness	DS.4.3.1	Questionnaire to external experts: The performance of the PMs that relate to completeness.
		DS.4.3.2	National and international verification including explanation of the discrepancies.
	4.Consistency	DS.4.4.1	The inventory reporting must follow the international guidelines suggested by UNFCCC and IPCC.
	7.Transparency	DS.4.7.1	External review for evaluation of the communication performance.

1.6.7 Plan for the quality work

The IPCC uses the concept of a tiered approach, i.e. a stepwise approach, where complexity, advancement and comprehensiveness increase. Generally, more detailed and advanced methods are recommended in order to give guidance to countries which have more detailed datasets and more capacity, as well as to countries with less available data and manpower. The tiered approach helps to focus attention on the areas of the inventories that are relatively weak, rather than investing effort in irrelevant areas. Furthermore, the IPCC guidelines recommend using higher tier methods for key categories in particular. Therefore, the identification of key categories is crucial for planning quality work. However, there exist several issues regarding the listing of priority categories: (1) The contribution to the total emission figure (key source listing); (2) The contribution to the total uncertainty; (3) Most critical categories in relation to implementation of new methodologies and thus highest risk for miscalculations. All the points listed are necessary for different aspects of producing high quality work. These listings will be used to secure implementation of the full quality scheme for the most relevant categories. Verification in relation to other countries has been undertaken for priority categories.

1.6.8 Implementation of the QA/QC plan

The PMs listed in Table 1.2 are described for each sector in the QA/QC sections of Chapters 3-8, where a status with regard to implementation is also given. Some of the PMs are the same for all sectors and a common description for these PMs is given in Section 1.6.10, below. The focus has been on level 1 for both data storage and data processing as this is the most labour-intensive part. The quality system will be evaluated and adjusted continuously.

1.6.9 Archiving of data and documentations

The QA/QC work is supported by an inventory file system, where all data, models and QA/QC procedures and checks are stored as files in folders (Figure 1.4).

Figure 1.4 Schematic diagram of the folder structure in the inventory file system.

The inventory file system consists of the following levels: year, sector and the level for the process of the inventory work, as illustrated in Figure 1.4. The first level in the file system is year, which here means the inventory year and not the calendar year. The sector level contains the PMs relevant for the individual sectors i.e. the first levels (DS1 and DP1) (except the PMs described in Section 1.6.10), while the rest of the PMs (DS2-4 and DP2-3), are common for all sectors.

All data, models and other QA/QC related files are stored in the inventory file system and are accessible for all staff involved in the inventory work.

1.6.10 Common QA/QC PMs

The following PMs are common for all the sectors:

Data storage Level 1

Data Storage level 1	6. Robustness	DS.1.6.2	At least two employees must have a detailed insight into the gathering of every external dataset.

For all sectors: energy, industrial processes, solvent and other product use, agriculture, LULUCF and waste, two persons have detailed insight in data gathering and processing. A strong effort is continuously made to ensure the robustness of the inventory process.

Data Storage level 1	7. Transparency	DS.1.7.2	The archiving of datasets needs to be easy accessible for any person involved in the emission inventory.

All data, models and other QA/QC related files are stored in the inventory file system and are accessible for all inventory staff members. Refer to Section 1.6.9.

Data processing Level 1

Data Processing level 1	4. Consistency	DP.1.4.2	Identification of parameters (e.g. activity data, constants) that are common to multiple source categories and confirmation that there is consistency in the values used for these parameters in the emission calculations.

This PM is supported by the inventory file system where it is possible to compare and harmonise parameters that are common to multiple source categories.

Data Processing level 1	6.Robustness	DP.1.6.1	Any calculation must be anchored to two responsible persons who can replace each other in the technical issue of performing the calculations.

All data, models and other QA/QC related files are stored in the inventory file system and are accessible for all inventory staff members. Refer to Section 1.6.9.

Data storage Level 2

Data Storage level 2	2.Comparability	DS.2.2.1	Comparison with other countries that are closely related to Denmark and explanation of the largest discrepancies.

Systematic inter-country comparison has only been made on data storage level 4. Refer to DS 4.3.2.

Data Storage level 2	6.Robustness	DS.2.6.1	All persons in the inventory work must be able to handle and understand all data at level 2.

This PM is fulfilled for all sectors. The PM is supported by the inventory file system. Refer to Section 1.6.9.

Data Storage level 2	7.Transparency	DS.2.7.1	The time trend for every single parameter must be graphically available and easy to map.

Programs exist to make time-series for all parameters. A tool for graphically showing time-series has not yet been developed.

Data Storage level 2	7.Transparency	DS.2.7.2	A clear Id must be given in the dataset having reference to level 1.

An overview of all external data is given in DS 1.4.1 including ID numbers for all external datasets. Many references already exist in the databases (level 2) which point to the original source of data, but ID numbers have to be implemented and extended to all data in the databases.

Data Processing Level 2

Data Processing level 2	1. Accuracy	DP.2.1.1	Documentation of the methodological approach for the uncertainty analysis

Refer to chapter 1.7.

Data Processing level 2	1. Accuracy	DP.2.1.2	Quantification of uncertainty

Refer to chapter 1.7 and the QA/QC sections in the sectoral chapters (Chapter 3-8).

Data Processing level 2	2.Comparability	DP.2.2.1	The inventory calculation has to follow the international guidelines suggested by UNFCCC and IPCC.

The emission calculations follow the international guidelines.

Data Processing level 2	6.Robustness	DS.2.6.1	All persons in the inventory work must be able to handle and understand all data at level 2.

At present the emission calculations are carried out using applications developed at NERI. The software development and programme runs are anchored to two inventory staff members.

Data Processing level 2	7.Transparency	DP.2.7.1	Reporting of the calculation principle and equations used.

Due to the uniform treatment of input data in the calculation routines used by the NERI software programmes, a central documentation of calculation principles, equations, theoretical reasoning and assumptions must be given, treating all national emission sources. This documentation still remains to be made, but is planned to be carried out in the future.

Data Processing level 2	7.Transparency	DP.2.7.2	Reporting of the theoretical reasoning for all methods

Due to the uniform treatment of input data in the calculation routines used by the NERI software programmes, a central documentation of calculation principles, equations, theoretical reasoning and assumptions must be given, treating all national emission sources. This documentation still remains to be made, but is planned to be carried out in the future.

Data Processing level 2	7.Transparency	DP.2.7.3	Reporting of assumptions behind all methods

Due to the uniform treatment of input data in the calculation routines used by the NERI software programmes, a central documentation of calculation principles, equations, theoretical reasoning and assumptions must be given, treating all national emission sources. This documentation still remains to be made, but is planned to be carried out in the future.

Data Processing level 2	7.Transparency	DP.2.7.4	The reasoning for the choice of methodology for uncertainty analysis needs to written explicitly.

Refer to chapter 1.7 and the QA/QC sections in the sectoral chapters.

Data storage Level 3

Data Storage level 3	1. Accuracy	DS.3.1.1	Quantification of uncertainty

Refer to chapter 1.7 and the QA/QC sections in the sector chapters.

Data Storage level 3	5.Correctness	DS.3.5.1	Comparison with inventories of the previous years on the level of the categories of the CRF as well as on SNAP source categories. Any major changes are checked, verified, etc.

Time-series is prepared and checked, any major change is closely examined with the purpose of verifying and explaining changes from earlier inventories.

Data Storage level 3	5.Correctness	DS.3.5.2	Total emissions when aggregated to CRF source categories are compared with totals based on SNAP source categories (control of data transfer).

Total emission, when aggregated to IPCC and LRTAP reporting tables, is compared with totals based on SNAP source categories (control of data transfer).

Data Storage level 3	5.Correctness	DS.3.5.3	Checking of time-series of the CRF and SNAP source categories as they are found in the Corinair databases. Considerable trends and changes are checked and explained.

Time-series are prepared and checked, any major change is closely examined with the purpose of verifying and explaining fluctuations.

Data Storage level 3	7.Transparency	DS.3.7.1	Documentation of a correct connection between all data types at DS3 to data at level DS2

A central documentation will be provided, treating all national emission sources.

Data Processing Level 3

Data Processing level 3	7.Transparency	DP.3.7.1	In the calculation sheets, there must be clear Id to Data Storage level 3 data.

A central documentation will be provided, treating all national emission sources.

Data Storage Level 4

Data Storage level 4	1. Accuracy	DS.4.1.1	Questionnaire to external experts: The performance of the PMs that relates to accuracy

This PM is checked when the sectoral reports are reviewed by external experts.

Data Storage level 4	2.Comparability	DS.4.2.1	Description of similarities and differences in relation to other countries' inventories for the methodological approach

For each key source category, a comparison has been made between Denmark and the EU-15 countries. This is performed by comparing emission density indicators, defined as emission intensity value divided by a chosen indicator. The indicators are identical to the ones identified in the Norwegian verification inventory (Holtskog et al., 2000). The correlation between emissions and an independent indicator does not necessarily imply cause and effect, but in cases where the indicator is directly associated with the emission intensity value, such as for the energy sector, the emission density indicator is a measure of the implied emission factor and a direct comparison can be made. A qualitative verification of implied emission factors can, furthermore, be made when a measured or theoretical value of the CO_2 content in the respective fuel type (or other relevant parameter) is available. For the energy sector, all countries are, in principle, comparable and inter-country deviations arise from variations in fuel purities and fuel combustion efficiencies. A comparison of national emission density indicators, analogous to the implied emission factors, will give valuable information on the quality and efficiency of the national energy sectors.

Furthermore, the inter-country comparison of emission density indicators and comparison of theoretical values gives a methodological verification of the derivation of emission intensity values, and of the correlation between emission intensity values and activity values.

When emissions are compared with non-dependent parameters, similarities with regard to geography, climate, industry structure and level of economic development may be necessary for obtaining comparable emission density indicators (Fauser et al., 2007).

Data Storage level 4	3.Completeness	DS.4.3.1	Questionnaire to external experts: The performance of the PMs that relate to completeness

This PM is checked when the sectoral reports are reviewed by external experts. Please see the sectoral chapters for information on the review of sectoral reports.

Data Storage level 4	3.Completeness	DS.4.3.2	National and international validation including explanation of the discrepancies.

Refer to DS 4.2.1

Data Storage level 4	4.Consistency	DS.4.4.1	The inventory reporting must follow the international guidelines suggested by UNFCCC and IPCC.

The inventory reporting is in accordance with the UNFCCC guidelines on reporting and review (UNFCCC, 2002). The present report includes detailed and complete information on the inventories for all years from the base year to the year of the current annual inventory submission, in order to ensure the transparency of the inventory. The annual emission inventory for Denmark is reported in the Common Reporting Format (CRF) as requested in the reporting guidelines. The CRF-spreadsheets contain data on emissions, activity data and implied emission factors for each year. Emission trends are given for each greenhouse gas and for total greenhouse gas emissions in CO_2 equivalents. The complete sets of CRF-files are available on the NERI homepage (www.dmu.dk).

Data Storage level 4	7.Transparency	DS.4.7.1	External review for evaluation of the communication performance

The transparency of the CRF reporting is reviewed by experts when UNFCCC performs annual review of the Danish GHG inventory.

1.7 General uncertainty evaluation, including data on the overall uncertainty for the inventory totals

The uncertainty estimates are based on the Tier 1 methodology in the IPCC Good Practice Guidance (GPG) (IPCC, 2000). Uncertainty estimates for the following sectors are included in the current year: stationary combustion plants, mobile combustion, fugitive emissions from fuels, industry, solid waste and wastewater treatment, CO_2 from solvents, agriculture and LULUCF. The sources included in the uncertainty estimate cover 100 % of the total net Danish greenhouse gas emissions and removals. N_2O from product use (CRF sector 3D) and CO_2 from use of lubricants (CRF sector 2G) have been included for the first time.

The uncertainties for the activity rates and emission factors are shown in Table 1.4. The tier 1 uncertainty estimation has been expanded in the 2010 submission, so several sectors have been subdivided improving the uncertainty estimation.

The estimated uncertainties for total GHG and for CO_2, CH_4, N_2O and F-gases are shown in Table 1.3. The base year for F-gases is 1995 and for all other sources the base year is 1990. The total Danish net GHG emission is estimated with an uncertainty of ±4.1 % and the trend in net GHG emission since 1990 has been estimated to be -4.4 % ± 2.4 %-age points. The GHG uncertainty estimates do not take into account the uncertainty of the GWP factors.

The uncertainty on CH_4 emission from solid waste disposal, N_2O emission from leaching and run-off and CH_4 emission from manure management are the largest sources of uncertainty for the Danish GHG inventory.

The uncertainty of the GHG emission from combustion (sector 1A) is 2.5 % and the trend uncertainty is -4.0 % ±2.1 %-age points.

Table 1.3 Uncertainties 1990-2008.

	Uncertainty [%]	Trend [%]	Uncertainty in trend [%-age points]
GHG	4.1	-4.4	± 2.4
CO_2	2.2	0.3	± 2.1
CH_4	30	1.0	± 9.2
N_2O	25	-36	± 7
F-gases	49	+176	± 67

Table 1.4 Uncertainty rates for each emission source.

IPCC Source category	Gas	Base year emission	Year t emission	Activity data uncertainty	Emission factor uncertainty
		Gg CO_2 eq	Gg CO_2 eq	%	%
Stationary Combustion, Coal	CO_2	24 077	16 050	1	1
Stationary Combustion, BKB	CO_2	11	0	3	5
Stationary Combustion, Coke	CO_2	138	112	2	5
Stationary Combustion, Petroleum coke	CO_2	410	755	2	5
Stationary Combustion, Plastic waste	CO_2	394	1343	5	25
Stationary Combustion, Residual oil	CO_2	2505	1359	2	2
Stationary Combustion, Gas oil	CO_2	4547	1544	3	5
Stationary Combustion, Kerosene	CO_2	366	9	3	5
Stationary Combustion, Natural gas	CO_2	4320	9764	2	1
Stationary Combustion, LPG	CO_2	169	96	3	5
Stationary Combustion, Refinery gas	CO_2	806	841	1	5
1A1+1A2+1A4, Biomass	CH_4	83	187	16	100
Biogas fuelled engines, Biomass	CH_4	2	21	3	10
1A1+1A2+1A4, Natural gas	CH_4	8	15	2	100
Natural gas fuelled engines, Natural gas	CH_4	5	185	1	5
1A1+1A2+1A4, Liquid fuels	CH_4	7	4	2	100
1A1+1A2+1A4, Municipal waste	CH_4	2	1	5	100
1A1+1A2+1A4, Solid fuels	CH_4	15	8	1	100
1A1 + 1A2 + 1A4, Biomass	N_2O	39	81	16	400
1A1 + 1A2 + 1A4, Gaseous fuels	N_2O	28	61	2	300
1A1 + 1A2 + 1A4, Liquid fuels	N_2O	76	46	2	400
1A1 + 1A2 + 1A4, Municipal waste	N_2O	18	19	5	200
1A1 + 1A2 + 1A4, Solid fuels	N_2O	80	49	2	1000
Transport, Road transport	CO_2	9275	12948	2	5
Transport, Military	CO_2	119	108	2	5
Transport, Railways	CO_2	297	237	2	5
Transport, Navigation (small boats)	CO_2	48	101	41	5
Transport, Navigation (large vessels)	CO_2	666	353	11	5
Transport, Fisheries	CO_2	591	449	2	5
Transport, Agriculture	CO_2	1272	1230	24	5
Transport, Forestry	CO_2	36	17	30	5
Transport, Industry (mobile)	CO_2	842	1119	41	5
Transport, Residential	CO_2	113	239	35	5
Transport, Civil aviation	CO_2	243	164	10	5
Transport, Road transport	CH_4	55	22	2	40
Transport, Military	CH_4	0	0	2	100
Transport, Railways	CH_4	0	0	2	100
Transport, Navigation (small boats)	CH_4	0	1	41	100
Transport, Navigation (large vessels)	CH_4	0	0	11	100
Transport, Fisheries	CH_4	0	0	2	100
Transport, Agriculture	CH_4	2	2	24	100
Transport, Forestry	CH_4	0	0	30	100
Transport, Industry (mobile)	CH_4	1	1	41	100
Transport, Residential	CH_4	3	5	35	100
Transport, Civil aviation	CH_4	0	0	10	100
Transport, Road transport	N_2O	97	126	2	50
Transport, Military	N_2O	1	1	2	1000
Transport, Railways	N_2O	3	2	2	1000
Transport, Navigation (small boats)	N_2O	0	1	41	1000
Transport, Navigation (large vessels)	N_2O	13	7	11	1000
Transport, Fisheries	N_2O	11	9	2	1000

Continued IPCC Source category	Gas	Base year emission	Year t emission	Activity data uncertainty	Emission factor uncertainty
		Gg CO_2 eq	Gg CO_2 eq	%	%
Transport, Agriculture	N_2O	15	16	24	1000
Transport, Forestry	N_2O	0	0	30	1000
Transport, Industry (mobile)	N_2O	11	15	41	1000
Transport, Residential	N_2O	1	1	35	1000
Transport, Civil aviation	N_2O	3	3	10	1000
1.B.2. Flaring in refinery	CO_2	23	28	11	5
1.B.2. Flaring off-shore	CO_2	276	348	8	5
1.B.2. Flaring in refinery	CH_4	1	0	11	15
1.B.2. Flaring off-shore	CH_4	0	1	8	5
1.B.2. Refinery processes	CH_4	1	46	1	125
1.B.2. Land based activities	CH_4	17	37	2	40
1.B.2. Off-shore activities	CH_4	15	39	2	30
1.B.2. Transmission of natural gas	CH_4	4	3	15	5
1.B.2. Distribution of natural gas	CH_4	5	4	25	10
1.B.2. Flaring in refinery	N_2O	0	0	11	500
1.B.2. Flaring off-shore	N_2O	1	1	8	500
2A1 Cement production	CO_2	882	1155	1	2
2A2 Lime production	CO_2	116	66	5	5
2A3 Limestone and dolomite use	CO_2	14	39	5	5
2A5 Asphalt roofing	CO_2	0	0	5	25
2A6 Road paving with asphalt	CO_2	2	2	5	25
2A7 Glass and Glass wool	CO_2	55	60	5	2
2B5 Catalysts/Fertilizers, Pesticides and Sulphuric acid	CO_2	1	2	5	5
2C1 Iron and steel production	CO_2	28	0	5	5
2D2 Food and Drink	CO_2	4	3	5	5
2G Lubricants	CO_2	50	34	2	5
2B2 Nitric acid production	N_2O	1043	0	2	25
2F Consumption of HFC	HFC	218	853	10	50
2F Consumption of PFC	PFC	1	13	10	50
2F Consumption of SF6	SF6	107	32	10	50
3A Paint application	CO_2	26	9	10	15
3B Degreasing and dry cleaning	CO_2	0	0	10	15
3C Chemical products, manufacturing and processing	CO_2	23	15	10	15
3D5 Other	CO_2	86	41	10	20
3D1 Other - Use of N2O for Anaesthesia	N_2O	0	27	5	5
4A Enteric Fermentation	CH_4	3261	2819	10	8
4B Manure Management	CH_4	869	1050	10	100
4F Field burning af agricultural residues	CH_4	2	2	10	50
4.B Manure Management	N_2O	668	505	10	100
4.D1.1 Syntehetic Fertilizer	N_2O	2395	1318	3	50
4.D1.2 Animal waste applied to soils	N_2O	1050	1124	10	50
4.D1.3 N-fixing crops	N_2O	269	213	20	50
4.D1.4 Crop Residue	N_2O	361	305	20	50
4.D1.5 Cultivation of histosols	N_2O	117	117	20	50
4.D.2 Grassing animals	N_2O	314	214	20	25
4.D3 Atmospheric deposition	N_2O	441	286	10	50
4.D3 Leaching	N_2O	3334	1993	20	50
4.D1.6 Sewage sludge and Industrial waste used as fertiliser	N_2O	28	78	20	50
4.F Field Burning of Agricultural Residues	N_2O	1	1	10	50
5.A.1 Broadleaves	CO_2	-649	199	15	10
5.A.1 Conifers	CO_2	-254	239	15	10
5.A.2 Broadleaves	CO_2	3	-3	15	15

Continued					
5.A.2 Conifers	CO_2	5	-5	15	15
5A Drainage of soils	N_2O	16	12	30	75
5.B Living biomass	CO_2	-53	48	10	20
5.B Mineral soils	CO_2	-2021	-511	10	20
5.B Organic soils	CO_2	1056	1070	10	50
5.B Disturbance, Land converted to cropland	N_2O	3	0	50	75
5.C Living biomass	CO_2	183	59	10	20
5.C Organic soils	CO_2	93	81	10	50
5.D Re-established wetlands	CO_2	0	-12	10	50
5.D Land for peat extraction	CO_2	86	5	10	50
5.D Land for peat extraction	N_2O	0	0	10	100
5.E Living biomass	CO_2	80	52	10	50
5 Liming	CO_2	565	229	5	50
6 A. Solid Waste Disposal on Land	CH_4	1111	1057	10	118
6 B. Wastewater Handling	CH_4	30	47	44	78
5 B. Wastewater Handling - Direct	N_2O	24	70	37	98
6 B. Wastewater Handling - Indirect	N_2O	82	35	59	39
6.C Accidental fires, buildings	CO_2	15	18	10	500
6.C Accidental fires, vehicles	CO_2	6	11	10	500
6.C Incineration of corpses	CH_4	0	0	1	300
6.C Incineration of carcasses	CH_4	0	0	50	300
6.C Accidental fires, buildings	CH_4	2	3	10	500
6.C Accidental fires, vehicles	CH_4	0	0	10	500
6.C Incineration of corpses	N_2O	0	0	1	1000
6.C Incineration of carcasses	N_2O	0	0	50	1000

1.7.1 Tier 2 uncertainties

On the recommendation of recent ERT's Denmark has undertaken a tier 2 uncertainty analysis. For the 2010 submission the tier 2 uncertainty analysis has been carried out at the sectoral level. A tier 2 uncertainty analysis for the inventory as a whole will be included in the 2011 submission. Please see the sectoral chapters for the results of the tier 2 uncertainty analysis. Below is a description on the theoretical basis for the tier 2 uncertainty calculations.

When to use Tier 2

When the activity data and emission factors cannot fulfil the criteria for using the error propagation equations in Tier 1 an alternative stochastic simulation, i.e. Monte Carlo method, can be employed. The Monte Carlo method constitutes Tier 2 and Approach 2 in IPCC (2000 and 2006) and is suitable for estimating uncertainty in emission rates, from uncertainties in activity data and emission factors, when:

- Uncertainties are large
- Their distribution are non-normal
- The algorithms are complex function and not only simple multiplication of activity data with emission factors
- Correlations occur between some of the activity data sets, emission factors, or both.

Uncertainties found in inventory source categories can vary widely from a few percent to orders of magnitude. When using a normal distribution for a parameter with large uncertainty there is a risk of having a certain probability for negative values, which is not possible in reality. Furthermore large uncertainty gives a certain probability of having extremely large values, i.e. values orders of magnitude larger than the mean value. Extreme values are an often occurring quality for the distribution of realistic activity data and emission factors. A logarithmic plot of such a data set will transform a skewed distribution probability function (a) into a bell-shaped log-normal distribution function (b), cf. Figure 1.5. The latter can be defined by a mean value, α, and standard deviation, σ, respectively. The log-normal distribution is selected as standard in the first version of the Tier 2 and Approach 2 uncertainty assessment for year 2009.

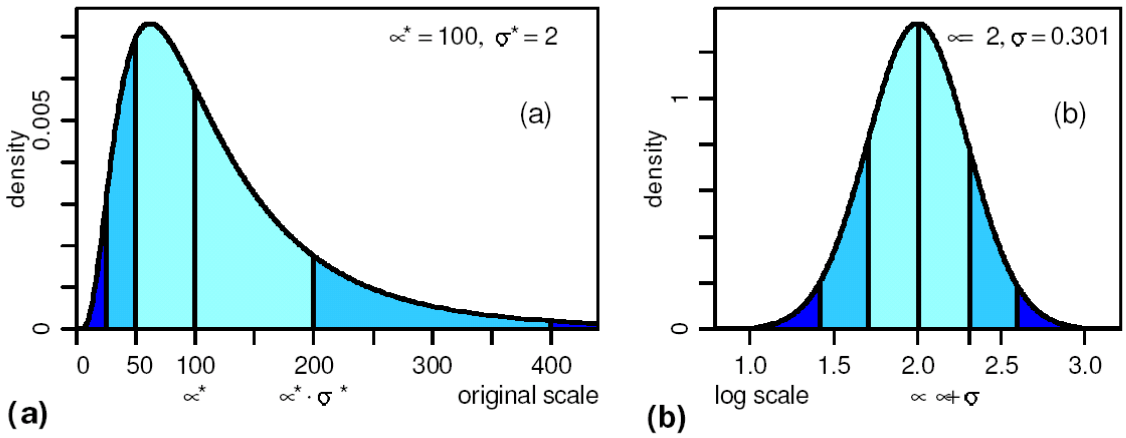


Figure 1.5 Log-normal distribution ($\log_{10}$), both on original (a) and log scale (b). The median (α^*) is 100 and the multiple standard deviation (σ^*) is 2. The resulting median (equal mean) and the standard deviation in the $\log_{10}$ distribution is respectively $\alpha = \log_{10}(100) = 2$ and $\sigma = \log_{10}(2) = 0.301$ (Limbert et al., 2001).

In case the uncertainty is much smaller than the mean value then the normal and log-normal distributions will not differ much, cf. Figure 1.6, where the relationship between normal and log-normal distributions are illustrated (Limbert et al., 2001).

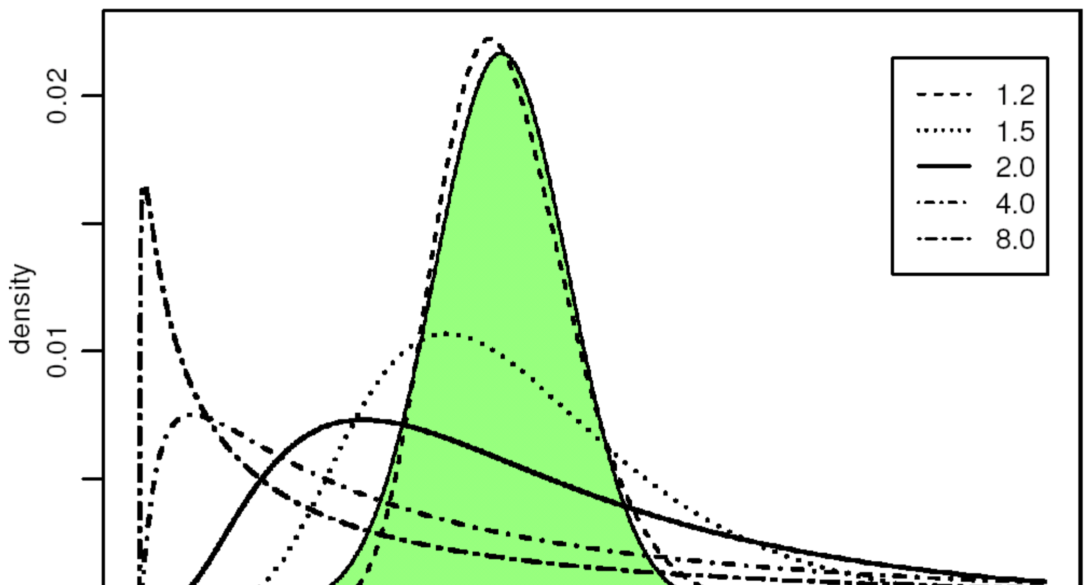


Figure 1.6 Comparison between the normal distribution (green area, median 100, standard deviation 20) the different degrees of variability (described by σ^*) for log-normal distributions that all have the same median value, i.e. α^* on original scale, of 100 (Limbert et al., 2001).

The difference in shape between a normal and log-normal distribution is seen in Figure 1.6 for different values of σ^*. The standard deviation for the normal distribution is 20 and thus equal to 20 % of the mean value and the log-normal distribution having a σ^* value of 1.2 reflects the same level of "deviation" as in the normal distribution. So, the discrepancy between the green area and the curve for σ^*=1.2 illustrates the difference in interpretation of a 20 % deviation as measured by respectively the normal and log-normal distribution. This discrepancy is so limited that it is overruled by the vagueness related to empirical quantification of the uncertainty level based on expert knowledge and data and the fact that any assumed distribution function is an approximation. Therefore, by using log-normal distributions as standard description of all uncertainty input it will in reality include normal distributions when the magnitude of uncertainty is limited to a minor fraction of the mean value.

A way of calculating the intervals of confidence, expressed by the median (α^*) and standard deviation (σ^*), for a log-normal distribution on original scale, cf. Figure 1a, is presented in Limbert et al. (2001). For normally distributed data, the interval [median ± standard deviation] covers a probability of 68.3 %, while [median ± 2*standard deviation] covers 95.5 %. Correspondingly for log normal data on original scale, cf. Figure 1a, the interval [α^* / σ^*, α^* * σ^*] covers 68.3 % and the interval [α^* / $(\sigma^*)^2$, α^* * $(\sigma^*)^2$] covers 95.5 %.

Often the default uncertainty values in IPCC (2000) e.g. for emission factors, are expressed as a percentage, e.g. 30 %. When this represents a standard deviation (68.3 %) on original scale we will proceed using σ^* = 1.3 in the uncertainty analysis. When it represents a 95 % interval of confidence, we will use σ^* = (1.3)^0.5 = 1.14 in the uncertainty analysis. When the 95 % interval of confidence on original scale is below approximately 300 % the standard deviation for a log-normal distribution on original scale, can be approximated by dividing with a factor of 2, i.e. 0.3/2 = 0.15, and thus σ^* = 1.15.

Procedure of Tier 2 (Monte Carlo method)

The procedure of the Tier 2 (MC) analysis consists of four steps where only Step 1 requires effort from the user:

- Step 1: Estimation of activity data and emission factors, their associated mean values, uncertainties such as standard deviation, probability density functions and any correlations.
- Step 2: Selection of random values of activity data and emission factors.
- Step 3: Calculate emissions from selected random values.
- Step 4: The calculated result in step 3 is stored and the process is repeated from step 2.

Repetition of steps 2 and 3 are continued until the calculated mean value and error intervals are sufficiently determined (typically 10,000 times). Each single repetition is denoted a "single sample" in the following and one execution of steps 2 and 3 is denoted a "MC sample".

The software used is the RiskAMP package (http://www.riskamp.com/) combined with VBA programming.

Different criteria and guidelines for estimation of value uncertainty for activity data and emission factors are outlined in the next section. Whether they are based on information from models, empirical data or expert judgement, they form lines of evidence towards the most appropriate estimate. The basic paradigm for a MC analysis is outlined in Figure 1.7.

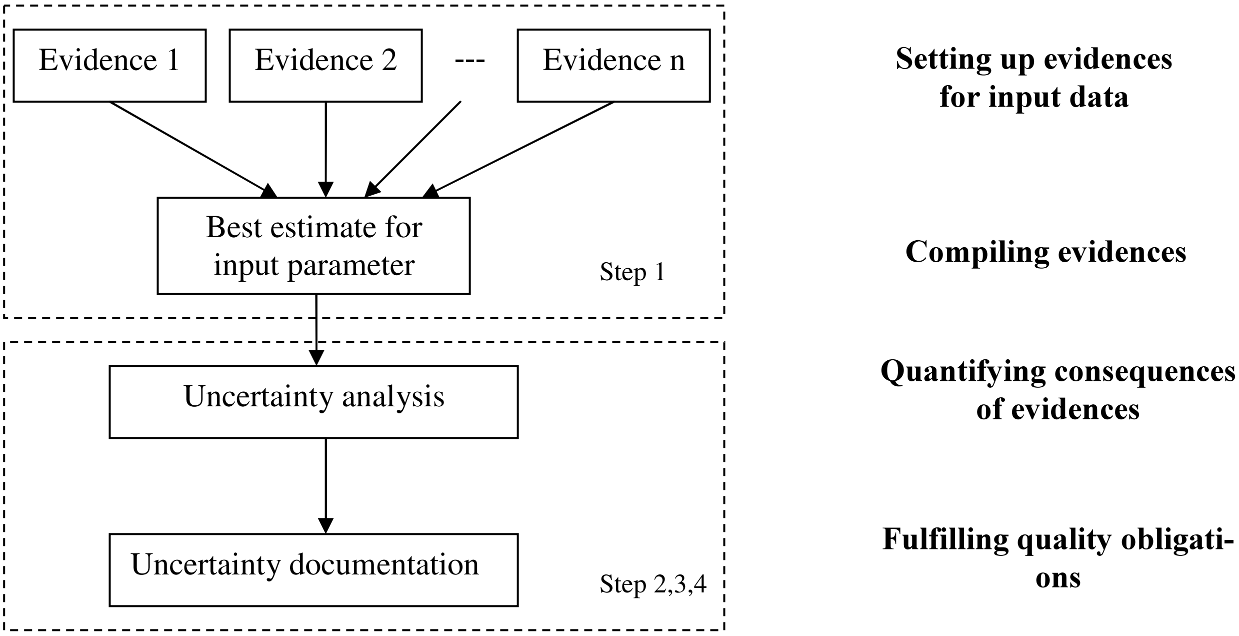


Figure 1.7 Methodological principle in compiling and quantifying input data for input parameters, e.g. emission factors, which are to be used in Tier 2 (MC) uncertainty analysis. Each evidence is formed from assessment of information from models, empirical data or expert judgement. The upper dotted box represents step 1 in the MC analysis, which is performed for each input parameter. The lower dotted box represents steps 2 to 4, and is performed in the emission modelling with all input parameters.

The principle of the MC method is to generate many "possible" calculations and thus map the resulting "possible" results. The possible calculations are made based on the "realistic" variability (uncertainty) related to the input parameter values. This variability needs to be described as a distribution function. The MC method is considered in two parts: (1) A distribution estimation part, where the variabilities of the input parameters are parameterised; (2) A technical part that makes the simulation based on the estimated distributions. The first part is highly critical and requires high attention. The second part is a question of programming and therefore mostly a technical issue. The MC method is a model for how uncertainty of input parameters influences the calculation results, so the MC also involves uncertainty in the prediction of uncertainty. It is therefore important to predict the variability of the input parameters as correctly as possible. The MC method does not include the validity of the calculations as estimators of reality but only the uncertainty of the input parameter values. Consequently, there are many fundamental types of uncertainty that are not included in the MC method.

The method is based on single samples, where the mean is unity and where the variability is determined by the uncertainty of the parameter as discussed above (see Figure 1.8). This sampled value is subsequently multiplied with the best estimate of the parameter value to yield a sampled value for this parameter. The reason for this two stage sampling is that it makes it possible directly to include correlation in uncertainty between years as explained below.

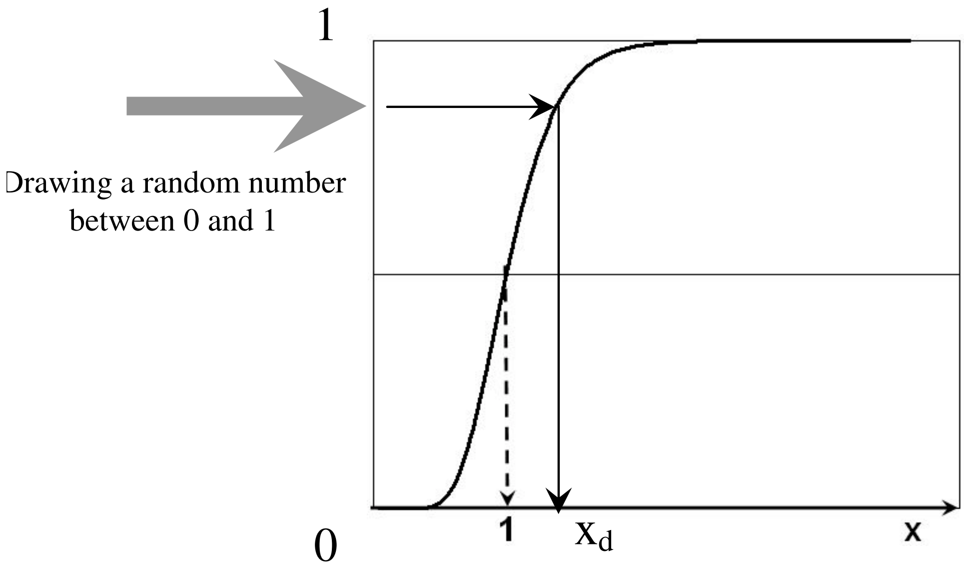


Figure 1.8 The principle in a single MC draw of the value x_d, where the median (α^*) is unity and where the standard deviation (σ^*) determines the variation around 1.

Correlation in the uncertainty may occur between years, e.g. when the same sources are responsible for uncertainties in several years. This takes place because many sources of uncertainty are dependent between years, so if a parameter is over-estimated for one year then this parameter may also tend to be overestimated other years. This implies that when the uncertainty is high one year the uncertainty will also be high the other year(s). The principle of performing a MC analysis with an emission factor and activity data that have uncertainties that are correlated between one or more years is illustrated in Figure 1.9.

The principle in Figure 1.9 is to sample a value (x) as shown in Figure 4, where the median value is unity and subsequently multiply the sampled value with the estimated median value (e.g. $AD_{s1}=AD_1 \cdot x$). This two-step approach makes is possible to include correlating uncertainty between different years. If two years are correlated then a deviation from the estimated mean value is assumed to be the same in relative terms for the two years. By sampling, using the median of unity once, and subsequently use this value to estimate the value for the two years, using the two medians for each year, this will yield the correlation between the two years as a simple consequence and thereby be directly simulated in the MC sampling.

The MC sampling is illustrated in Figure 1.9 for a single source, where s is the sampling number index, counting up to e.g. 10,000. In Figure 5 there will be a strong correlation between year 2 and 3, because both the uncertainty of *EF* and *AD* is correlated, for year 1 there will be a partial correlation with respectively year 2 and 3 because the uncertainty of the *EF* value is correlated, but the uncertainty is independent for *AD*. Year 4 is completely independent of the other years. The figure is only illustrating a single source and typically the emission estimates includes several sources each having some more or less correlated uncertainty. The final emission estimates are thus more or less correlated between years in a highly complex way.

Performing MC analysis for correlated parameters corresponds to the calculation scheme for MC analysis of emissions and the trend of a category as shown in Appendix A (IPCC, 2006) (Figure 3.7 pp. 3.36). The scheme shows calculations for correlated and non-correlated parameters.

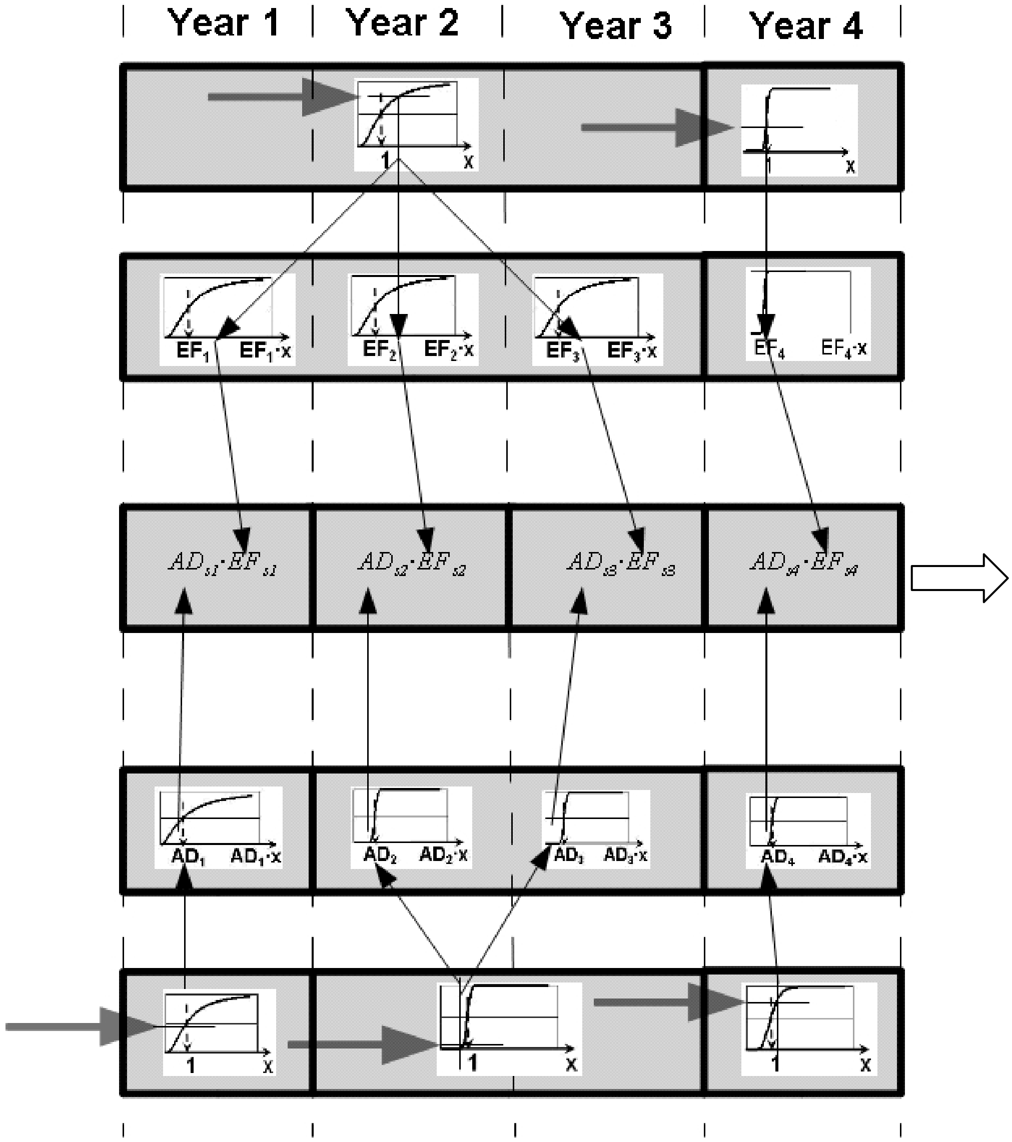


Figure 1.9 The principle of a MC sample for draws of random numbers and generation of any emission factor and activity data for a four year period. The upper half illustrates the sampling of any emission factor for year 1 to year 4. The uncertainty associated to the emission factor is correlated for year 1, 2 and 3 and therefore the same random number is used for generating EF1, EF2 and EF3. The lower half illustrates the sampling of activity data. The uncertainty associated to the activity data is correlated for year 2 and 3 and therefore the same random number is used for generating AC2 and AC3. In the middle row the emission factor and activity data are multiplied for each year.

In some cases there exist additional a priori information about categories of activity data, where the total sum is know with high certainty, but where the sub categories are more uncertain. In this case the single samples within one year are adjusted so all sub sources together adds up to the correct total number and the single sampling in this case will describe the uncertainty between the single categories.

MC analyses for emissions

When standard deviations have been entered as percentages of median values of the input parameters, i.e. emission factors and activity data, for source categories and sub-categories, the above MC procedure is executed 10,000 times. The output of the MC analysis is reported as in Table 1.5 where the median emissions are shown together with the 95% confidence interval (2.5% - 97.5%).

Two basic questions are important to answer: (1) What is the uncertainty for a time trend estimate; (2) What is the uncertainty within the same year of the single sub-categories, source categories and the total estimate. The first question takes correlation of uncertainty between years into account and the second question considers one year at a time and correlation between years is not relevant.

In the ideal case it will be possible to answer the two questions based on the same MC samples, where every single sample is stored for every source and for every year. However, this is not possible in the VBA programming due to limitations in variable table on a normal pc. Thus two MC samplings take place: (1) The total emission is calculated for every year and every MC sample, so for 10,000 MC samples and 20 years, this needs storage of 200,000 numbers; (2) Every year is analysed separately where only results for one year is stored at a time, so for 10,000 MC samples and 50 sources this yields 500,000 numbers to be stored. Using this two-stage approach it is easily possible to run the MC analysis in Excel. Consequently, the exact value for the median analysed for a specific year (question 2 above) is not similar with the medians in the time trend analysis (question 1 above) due to a finite number of MC samples, but this is not a real problem. If this discrepancy is considered as critical then it simply tells that the number of MC samples should be increased and that the analysis thus has to be redone.

Table 1.5 Example of output scheme for tier 2 MC uncertainty analysis. Median emissions and 95 % confidence intervals are calculated for total emission, emissions for source categories and emissions for sub-categories. Calculated 95% confidence intervals are furthermore calculated for activity data and emission factors.

Source category	Sub-categories	Activity			EF			Emissions			
		< 2.5%	>97.5%	Interval	< 2.5%	> 97.5%	Interval	Median	< 2.5%	> 97.5%	Interval
all	all	-	-	-	-	-	-				
A	all	-	-	-	-	-	-				
B	all	-	-	-	-	-	-				
C	all	-	-	-	-	-	-				
A	1										
A	2										
A	3										
B	1										
B	2										
C	1										
C	2										
C	3										
C	4										

Results for each row can also be reported as:

Median emission [- (median - <2.5%)/median/100%, + (>97.5% - median)/median/100%]

MC trend analysis

The trend analysis is performed by comparing emissions two years at a time. The probability for Year 1 to be above Year 2 is calculated using the equation:

$$P_{Year1>Year2} = \frac{N_{year1>year2} - N_{year2>year1}}{N_{year1>year2} + N_{year2>year1}},$$

where $N_{year1>year\,2}$ is the number of MC samples where year 1 is estimated to have higher emission than year 2, while $N_{year2>year2}$ is the reverse, where year 2 is estimated to have higher emission compared to year 1. In case of $P_{year1>year2} \approx 1$ it is strongly significant to conclude that year 1 has higher emission than year 2, and reverse (significant that year 2 > year 1) for $P_{year1>year2} \approx -1$. This is a comparison between years in pairs that can be filled in to a matrix, where all years are compared with all other years.

Table 1.6 Comparison of emissions between years in trend analysis.

	year 1	year 2	year 3	year 4
year 1	0			
year 2		0		
year 3			0	
year 4				0

Results for trend analysis of emissions between two years, year 1 and year 2, can be reported as median difference, <2.5% and >97.5%, or as:

Median difference [- (median difference - <2.5%)/median difference/100%, + (>97.5% - median difference)/median difference/100%]

Quantifying uncertainties in Tier 2

In order to perform the four steps of a Tier 2 (MC) uncertainty analysis as described in the previous paragraph the user has to gather the information stated in step 1. It is essential to establish the best possible estimate, and the following guide sets up a procedure for assessing, quantifying and compiling uncertainties for the parameters that are entered in the emission models. The guide is based on IPCC guidelines (IPCC, 2000 & 2006) and NUSAP and expert elicitation in van der Sluijs et al. (2004).

The uncertainty of a parameter, e.g. activity data and emission factor, is considered to be proportional to the associated parameter. This means that the uncertainty is expressed as a percentage of the parameter value. The median value is used and the uncertainties represent the parameter standard deviation, σ^*. We assume log-normal distributions, which equals normal distributions at low uncertainty values. Although van der Sluijs et al. (2004) suggest different probability distribution functions depending on the level of knowledge on input parameters we will use log-normal distributions for all parameters, as argued in the previous sectio.

The methodology offers a possibility for correlating the uncertainties of two or more parameters. When uncertainties of two or more parameters are assumed to be correlated they will be attributed the same random number in any MC sample, as explained in the previous paragraph.

Uncertainties will be reported according to the IPCC General Reporting Table for Uncertainty. Uncertainties will be reported for:

- Total uncertainty of the entire sector
- Key source categories
- Aggregated CRF levels
- Most differentiated CRF category levels that are entered by the user

IPCC guideline - Sources of data

Quantifying uncertainties is dependent on the source of data, and in general there are three broad sources of data and information (IPCC, 2000 & 2006):

Information contained in models

A model is a representation of the real world and does therefore not exactly mimic real-world systems. The structure of a model is often thought of in terms of the equations used. The key considerations in model uncertainty are; has the correct, most relevant real-world system been identified and are the model equations accurate representations of the chosen system. Typically the model equations are the product of activity data and emission factors, cf. Eq 1, but there may also be more complex model equations for emissions and also for derivation of activity data and emission factors.

In some cases, model uncertainty can be significant. It is typically poorly characterised and may not be characterised at all. The inventory expert must consider the parameters that are used and assess if there are model assumptions that are imprecise or inaccurate. For the most critical models an effort can be made to evaluate and quantify the size of the potential error that occurs from using the model. There are at least three approaches for estimating the model uncertainty: 1) comparison of a model result with independent data, 2) comparison of a model result with the result of alternative models, and 3) expert judgement regarding the magnitude of the model uncertainty. These approaches can be used in combination.

Empirical data for sources and sinks and activity

This implies empirical data associated with measurements of emissions, emission factors and activity data from surveys and censuses. When estimating uncertainty from measured emissions data, considerations include; Representativeness of the data and potential for bias, precision and accuracy of the measurements, sample size and inter-individual variability in measurements and their implications for uncertainty in mean annual emissions, inter-annual variability in emissions and whether estimates are based on an average of several years or on the basis of a particular year.

Quantification of uncertainties and defining the probability distribution function (PDF) for empirical data can be summarised as follows: 1) Compilation of activity data, emission factors and other parameters. These data typically represent variability, 2) Visualisation of data by plotting empirical distribution functions for each parameter; horizontally according to numerical value or interval and vertically by frequency, 3) Fitting, evaluation and selection of PDFs for representing variability of data, 4) Characterisation of mean value and of uncertainty in the mean of the distributions for variability. If the standard error of the mean is small, a normality assumption can be made regardless of the sample size or skewness of data. If the standard error of the mean is large, then typically a log-normality assumption can be made, 5) Once mean values, uncertainties and standard errors have been specified, these can be used as input to Tier 2 MC analysis for estimating uncertainties in total emissions, 6) Sensitivity analysis can be used to determine which parameters induce highest uncertainties in the total uncertainty, and prioritise efforts to develop good estimates of these key uncertainties.

Expert judgement as a source of information

In many situations, relevant empirical data are not available for activity data, emission factors etc. to an inventory. In such situations, a practical solution is to obtain well informed judgements from domain experts regarding best estimates and uncertainties of input data.

Commonly used methods for converting an expert's judgement regarding uncertainty into a quantitative PDF are: 1) Fixed value; Estimate the probability of being higher (or lower) than an arbitrary value and repeat, three or five times. For example, what is the probability that an emission factor would be less than 100? 2) Fixed probability; Estimate the value associated with a specified probability of being higher (or lower). For example, what is the emission factor such that there is only a 2.5% probability that the emission factor could be lower (or higher) than that value, 3) Interval methods; For example, choose a value of the emission factor such that it is equally likely that the true emission factor would be higher or lower than that value. This yields the median. Then divide the lower range into two bins such that there is assumed to be equally likely (25% probability) that the emission factor could be in either bin. Repeat this for the other end of the distribution. Finally, either fixed probability or fixed value methods could be used to get judgements for extreme values, 4) Graphing; the expert draws a distribution. This should be used cautiously because some experts are overconfident about their knowledge of PDFs.

Sometimes the only available expert judgement consists of a range, maybe quoted together with a most likely value. Under these circumstances the following rules are considered good practice: Where experts only provide an upper and a lower value, assume that the PDF is uniform and that the range corresponds to the 95 percent confidence interval. Where experts also provide a most likely value (point estimate), assume a triangular PDF using the most likely values as the mode and assume that the upper and lower values each exclude 2.5% of the population. The distribution needs not to be symmetrical. Normal or log-normal distributions can be used given appropriate justifications.

Concluding remarks and planned improvements

Tier 2 uncertainties are found to be greater than Tier 1 uncertainties. When large input uncertainties, e.g. > 10%, are used, the deviation becomes pronounced. For smaller input uncertainties, e.g. < 1%, tier1 approximates Tier 2 calculations.

The Log-normal distribution was selected due the likely conditions for the distribution as being close to a normal distribution for smaller uncertainties on one hand and close to the understanding of larger uncertainties on the other hand. However, in case of larger uncertainty the outcome of the MC analysis includes rather extreme values that in some cases seem unrealistic. This topic will be discussed and further analysed in a workshop during 2010.

1.8 General assessment of the completeness

The present Danish greenhouse gas emission inventory includes all major sources identified by the Revised IPPC Guidelines. Please see Annex 5 for detailed discussion on minor sources that are not included.

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2 Trends in Greenhouse Gas Emissions

The trends presented in this Chapter cover the emissions from Denmark. Due to the small emissions originating from Greenland the trends are very similar in fact close to identical. A trend discussion of the aggregated greenhouse gas emissions from Denmark and Greenland is included

2.1 Description and interpretation of emission trends for aggregated greenhouse gas emissions

Greenhouse Gas Emissions

The greenhouse gas emissions are estimated according to the IPCC guidelines and are aggregated into seven main sectors. The greenhouse gases include CO_2, CH_4, N_2O, HFCs, PFCs and SF_6. Figure 2.1 shows the estimated total greenhouse gas emissions in CO_2 equivalents from 1990 to 2008. The emissions are not corrected for electricity trade or temperature variations. CO_2 is the most important greenhouse gas contributing in 2008 to National total in CO_2 equivalents excluding LULUCF (Land Use and Land Use Change and Forestry) with 79.4 % followed by N_2O with 10.5 %, CH_4 8.7 % and F-gases (HFCs, PFCs and SF_6) with 1.4 %. Seen over the time-series from 1990 to 2008 these percentages have been increasing for F-gases, almost constant for CO_2 and CH_4 and falling for N_2O. Stationary combustion plants, transport and agriculture represent the largest categories, followed by Industrial processes, Waste and Solvents, see Figure 2.1. The net CO_2 emission by LULUCF in 2008 is 2.0 % of the total emission in CO_2 equivalents excl. LULUCF. The National total greenhouse gas emission in CO_2 equivalents excluding LULUCF has decreased by 7.4 % from 1990 to 2008 and increased 4.0 % including LULUCF. Comments on the overall trends etc seen in Figure 2.1 are given in the sections below on the individual greenhouse gases.

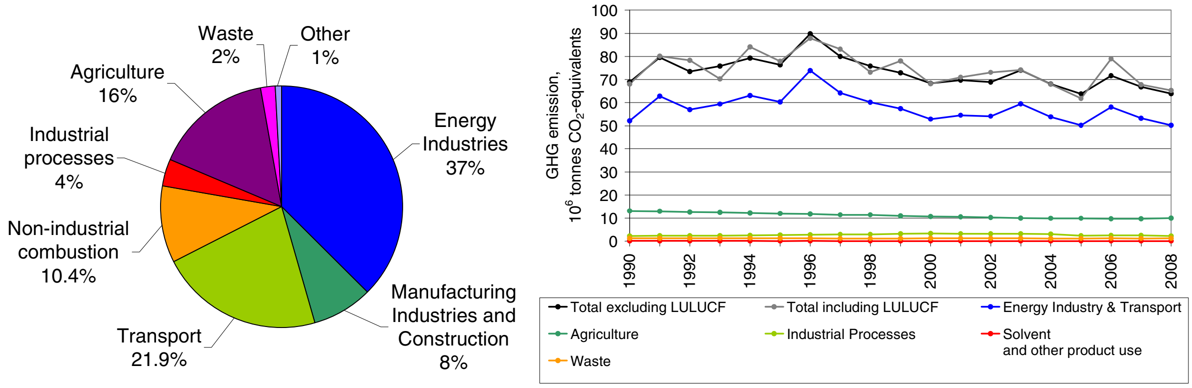


Figure 2.1 Greenhouse gas emissions in CO_2 equivalents distributed on main sectors for 2008 (excluding LULUCF) and time-series for 1990 to 2008 (including LULUCF).

2.2 Description and interpretation of emission trends by gas

2.2.1 Carbon dioxide

The largest source to the emission of CO_2 is the energy sector, which includes combustion of fossil fuels like oil, coal and natural gas (Figure 2.2). Energy Industries contribute with 47 % of the emissions (excl. LULUCF). About 27 % come from the transport sector. The CO_2 emission (excl. LULUCF) decreased by 6 % from 2007 to 2008. The main reason for this decrease was a change from export of electricity in 2007 to import in 2008. In 2008, the actual CO_2 emission (incl. LULUCF) was 0.3 % higher than the emission in 1990.

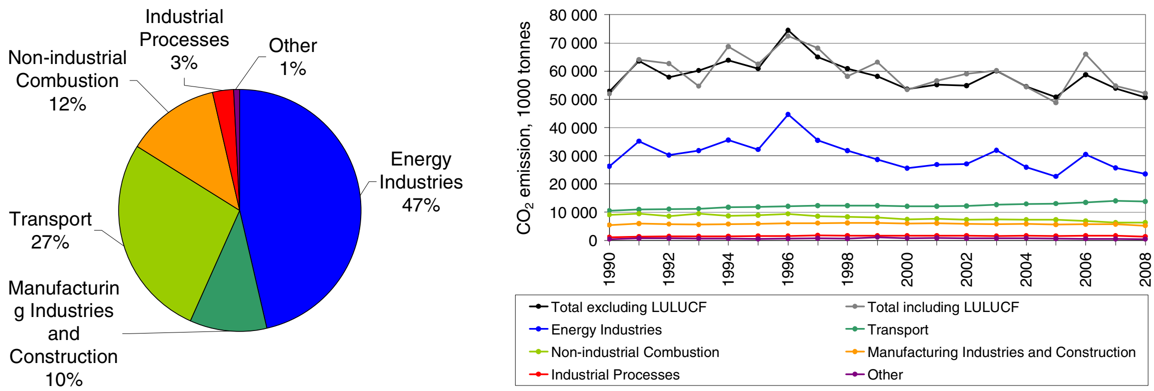


Figure 2.2 CO_2 emissions. Distribution according to the main sectors (2008) and time-series for 1990 to 2008.

2.2.2 Nitrous oxide

Agriculture is the most important N_2O emission source in 2008 contributing 91 % (Figure 2.3) of which N_2O from agricultural soils accounts for 83 %. N_2O is emitted as a result of microbial processes in the soil. Substantial emissions also come from drainage water and coastal waters where nitrogen is converted to N_2O through bacterial processes. However, the nitrogen converted in these processes originates mainly from the agricultural use of manure and nitrogen fertilisers. The main reason for the drop in the emissions of N_2O in the agricultural sector of 32 % from 1990 to 2008 is legislation to improve the utilisation of nitrogen in manure. The legislation has resulted in less nitrogen excreted pr unit of livestock produced and a considerable reduction in the use of nitrogen fertilisers. The basis for the N_2O emission is then reduced. Combustion of fossil fuels in the energy sector, both stationary and mobile sources, contributes 6.5 %. The N_2O emission from transport contributes by 2.1 % in 2008. This emission has increased during the nineties because of the increase in the use of catalyst cars. Production of nitric acid stopped in 2004 and the emissions from industrial processes is therefore not occurring from 2005 onwards. The sector Solvent and Other Product Use covers N_2O from e.g. anaesthesia.

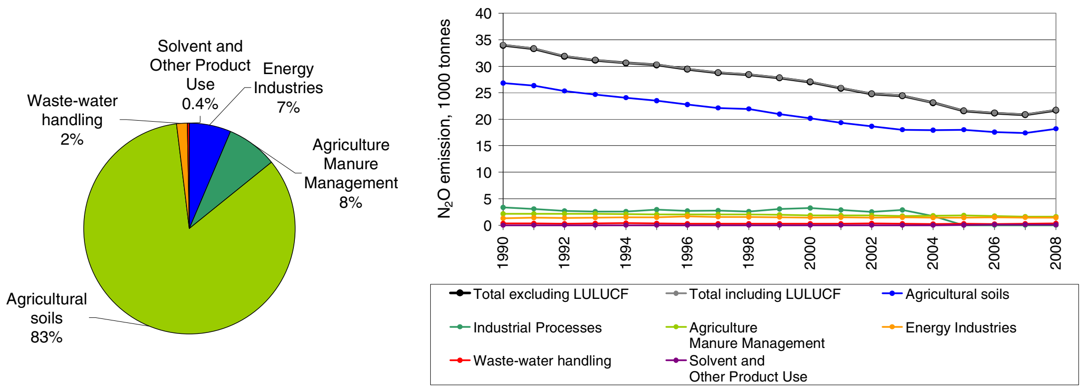


Figure 2.3 N_2O emissions. Distribution according to the main sectors (2008) and time-series for 1990 to 2008.

2.2.3 Methane

The largest sources of anthropogenic CH_4 emissions are agricultural activities contributing in 2008 with 69.6 %, waste (20.0 %), public power and district heating plants (3.3 %), see Figure 2.4. The emission from agriculture derives from enteric fermentation and management of animal manure contributing with 50.7 % and 18.9 % of the national CH_4 emission excl LULUCF in 2008. The CH_4 emission from public power and district heating plants increased in the nineties, mainly 1992-1996, due to the increasing use of gas engines in the decentralised cogeneration plant sector. Up to 3 % of the natural gas in the gas engines is not combusted. The deregulation of the electricity market has made production of electricity in gas engines less favourable, therefore the fuel consumption has decreased and hence the CH_4 emission has decreased. Over the time-series from 1990 to 2008, the emission of CH_4 from enteric fermentation has decreased 13.5 % due to the decrease in the number of cattle. However, the emission from manure management has in the same period increased 20.8 % due to a change in traditional stable systems towards an increase in slurry-based stable systems. Altogether, the emission of CH_4 from the agriculture sector has decreased by 6.3 % from 1990 to 2008. The emission of CH_4 from solid waste disposal has decreased 3.1 % since 1990 due to an increase in the incineration of waste.

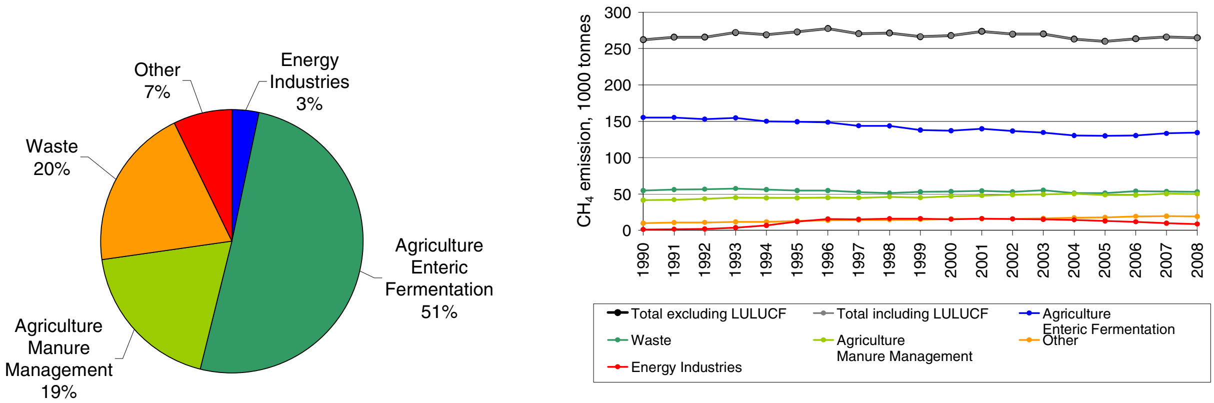


Figure 2.4 CH_4 emissions. Distribution according to the main sectors (2008) and time-series for 1990 to 2008.

2.2.4 HFCs, PFCs and SF_6

This part of the Danish inventory only comprises a full data set for all substances from 1995. From 1995 to 2000, there has been a continuous and substantial increase in the contribution from the range of F-gases as a whole, calculated as the sum of emissions in CO_2 equivalents, see Figure 2.5. This increase is simultaneous with the increase in the emission of HFCs. For the time-series 2000-2008, the increase is lower than for the years 1995 to 2000. The increase from 1995 to 2008 for the total F-gas emission is 176 %. SF_6 contributed considerably to the F-gas sum in earlier years, with 33 % in 1995. Environmental awareness and regulation of this gas under Danish law has reduced its use in industry, see Figure 2.5. A further result is that the contribution of SF_6 to F-gases in 2008 was only 3.5 %. The use of HFCs has increased several folds. HFCs have, therefore, become the even more dominant F-gases, comprising 66.9 % in 1995, but 95.1 % in 2008. HFCs are mainly used as a refrigerant. Danish legislation regulates the use of F-gases, e.g. since January 1, 2007 new HFC-based refrigerant stationary systems are forbidden. Refill of old systems are still allowed. The use of air conditioning in mobile systems and the amount of HFC for this purpose increases.

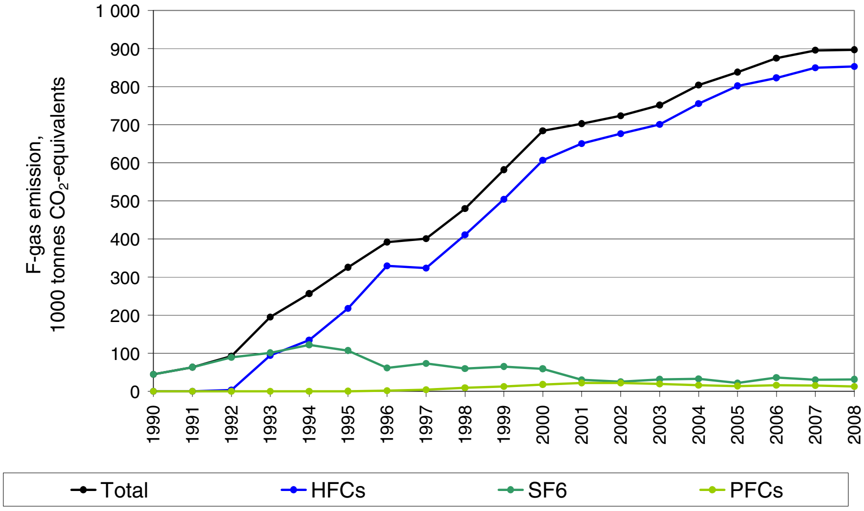


Figure 2.5 F-gas emissions. Time-series for 1990 to 2008.

2.3 Description and interpretation of emission trends by source

2.3.1 Energy

The emission of CO_2 from Energy Industries has decreased by 10.2 % from 1990 to 2008. The relatively large fluctuation in the emission is due to inter-country electricity trade. Thus, the high emissions in 1991, 1996, 2003 and 2006 reflect a large electricity export and the low emissions in 1990 and 2005 are due to a large import of electricity. The increasing emission of CH_4 during the nineties is due to the increasing use of gas engines in decentralised cogeneration plants, the CH_4 emissions from this sector has been decreasing since 2001 due to the liberalisation of the electricity market. The CO_2 emission from the transport sector increased by 31.1 % from 1990 to 2008, mainly due to increasing road traffic.

2.3.2 Industrial processes

The emissions from industrial process, i.e. emissions from processes other than fuel combustion, amount in 2008 to 3.5 % of the total emission in CO_2 equivalents (excl. LULUCF). The main sources are cement production, refrigeration, foam blowing and calcination of limestone. The CO_2 emission from cement production – which is the largest source contributing in 2008 with 2.6 % of the National total – increased by 23.6 % from 1990 to 2008. The second largest source has previously been N_2O from the production of nitric acid. However, the production of nitric acid/fertiliser ceased in 2004 and therefore the emission of N_2O also ceased.

2.3.3 Agriculture

The agricultural sector contributes in 2008 with 15.7 % of the total greenhouse gas emission in CO_2 equivalents (excl. LULUCF) and is the most important sector regarding the emissions of N_2O and CH_4. In 2008, the contribution of N_2O and CH_4 to the total emission of these gases was 91.5 % and 69.6 %, respectively. The N_2O emission from agriculture decreased by 31.5 % and the CH_4 emission including field burning and reduction of biogas decreased by 7 % from 1990 to 2008.

2.3.4 Forestry

The carbon stock change for forests has been estimated based on best available data. Based on mapped forest area in 1990 and in 2005 a calculation of carbon stored in both forest remaining forest and in afforestation since 1990 have been performed. The forest areas in 1990 as well as in 2005 have been mapped to be larger than previously estimated for the times. The calculation of carbon stock in 1990 and in 2000 used age distribution as reported in census 1990 and in 2000 as an expression of the total forest land allocation to species and ages. Based on the actual measurements of carbon storage in different species and age classes with the current National Forest Inventory, the total standing carbon stock was calculated. For each of the years 1990 - 2000 calculated a standing carbon stock as a moving average, corrected for the deforestation which was detected. Windthrows and the effects of these are included in the overall estimation of changes in carbon stock. As carbon stock is based on moving average the annual effect is not dramatically.

Since the NFI was initiated in 2002, it is representative from 2005. Calculation of carbon stock in the period 2000-2004 is based on NFI in 2005 and carbon stock as calculated for 2000. For 2005-2009 carbon stock is calculated solely on the basis of the NFI - with additional information about the total forest area from satellite image mapping.

The forecast for the period 2008 - 2020 show a decreasing trend of forest carbon stock. This is due to the current high proportion of old trees, which face rejuvenation. Hereby large old trees felled and replaced by new small trees. The net result is that the total carbon stock decreases. This has gradually affected the estimates for the years since 2007 and hence a decline in carbon stock is seen for 2008. If the forests had a completely even distribution of ages, carbon stock would be virtually constant - assuming unchanged harvesting and growth. Changes in forest management, may affect the development of forests. Thus, a postponement of cutting of old trees - will postpone the decline in carbon storage. Conversely, increased logging (e.g. due to increased demand, increased price or similar) may lead to a sharper decline in carbon stock.

For the afforestated areas a steady increase in carbon stocks is expected also in the future years. The rate of increase of area will depend on both availability of land and on possible subsidies for afforestation. Deforestation occurs mainly in relation to other specific projects e.g. for nature restoration or test areas for wind mills.

2.3.5 Cropland, grassland and wetlands

The emission estimates from mineral soils is very variable across the years due to variations in yield level and annual temperatures which affect the degradation rate of C in the soil when using the applied Tier 3 model. In 2008 the emission from cropland has been estimated to 837 Gg CO_2 despite the very warm year. The emission is mainly due to a emission from the organic soils which is relatively constant between years because it is based on a fixed annual emission factor. Since 1990 there has been a decrease in the total C-stock in soil. Despite the global warming it seems that this decrease has stabilized so that it is possible to maintain the current C stock level in soil. A continuous increase in raised number of shelterbelts increases the C sequestration here. Emissions from managed wetlands with peat extraction are unaltered at a low level.

2.3.6 Waste

The waste sector contributes in 2008 with 1.9 % to the National total of greenhouse gas emissions (excl. LULUCF), 20.0 % of the total CH_4 emission and 1.6 % of the total N_2O emission. The GHG emission from the sector has decreased by 2.4 % from 1990 to 2008. This decrease is a result of (1) a decrease in the CH_4 emission from solid waste disposal sites (SWDS) by 4.9 % due to the increasing use of waste for power and heat production, and (2) a decrease in emission of N_2O from wastewater (WW) handling systems of 1.6 % due to upgrading of WW treatment plants. These decreases are counteracted by an increase in CH_4 from WW of 55.5 % due to increasing industrial load to WW systems. In 2008 the contribution of CH_4 from SWDS was 19.0 % of the total CH_4 emission. The CH_4 emission from WW amounts in 2008 to 0.9 % of the total CH_4 emissions. The emission of N_2O from WW is in 2008 1.6 % of national total of N_2O. Since all incinerated waste is used for power and heat production, the emissions are included in the 1A IPCC category.

2.4 Description and interpretation of emission trends for indirect greenhouse gases and SO_2

2.4.1 NO_x

The largest sources of emissions of NO_x are road transport followed by other mobile sources and combustion in energy industries (mainly public power and district heating plants). The transport sector is the sector contributing the most to the emission of NO_X and, in 2007, 47 % of the Danish emissions of NO_X stems from road transport, national navigation, railways and civil aviation. Also emissions from national fishing and off-road vehicles contribute significantly to the NO_X emission. For non-industrial combustion plants, the main sources are combustion of wood, gas oil and natural gas in residential plants. The emissions from energy industries have decreased by 73 % from 1985 to 2008. In the same period, the total emission decreased by 48 %. The reduction is due to the increasing use of catalyst cars and installation of low-NO_X burners and denitrifying units in power and district heating plants.

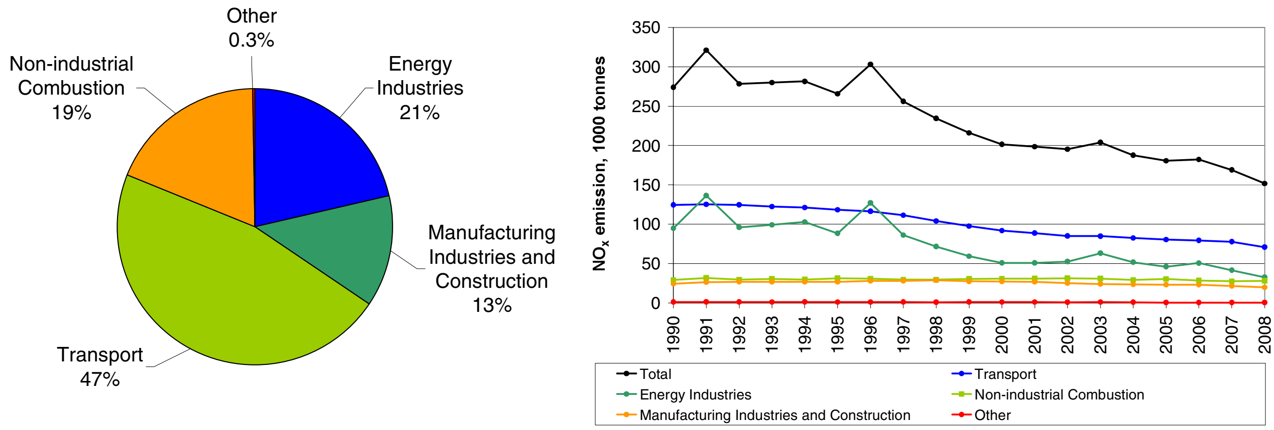


Figure 2.6 NO_X emissions. Distribution according to the main sectors (2008) and time-series for 1990 to 2008.

2.4.2 CO

Non-industrial combustion plants and transport is by far the major contributors to the total emission of this pollutant with 59 5 and 34 % of the total CO emission. The emission decreased by 40 % from 1990 to 2008, largely because of decreasing emissions from road transportation due to the introduction of private catalyst cars in 1990 and the introduction of even more emission-efficient private cars in the following years.

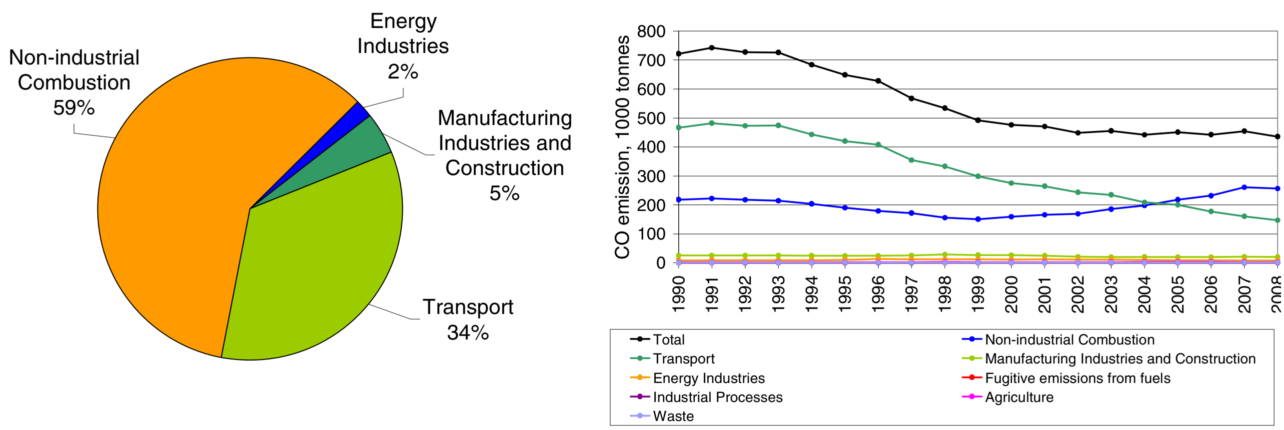


Figure 2.7 CO emissions. Distribution according to the main sectors (2008) and time-series for 1990 to 2008.

2.4.3 NMVOC

The emissions of NMVOC originate from many different sources and can be divided into two main groups: incomplete combustion and evaporation. Road vehicles and other mobile sources such as national navigation vessels and off-road machinery are the main sources of NMVOC emissions from incomplete combustion processes. Road transportation vehicles are still the main contributors even though the emissions have declined since the introduction of catalyst cars in 1990. The evaporative emissions mainly originate from the use of solvents and the extraction, handling and storage of oil and natural gas. The emissions from the energy industries have increased during the nineties due to the increasing use of stationary gas engines, which have much higher emissions of NMVOC than conventional boilers. The total anthropogenic emissions have decreased by 45 % from 1985 to 2008, largely due to the increased use of catalysts in cars and reduced emissions from use of solvents.

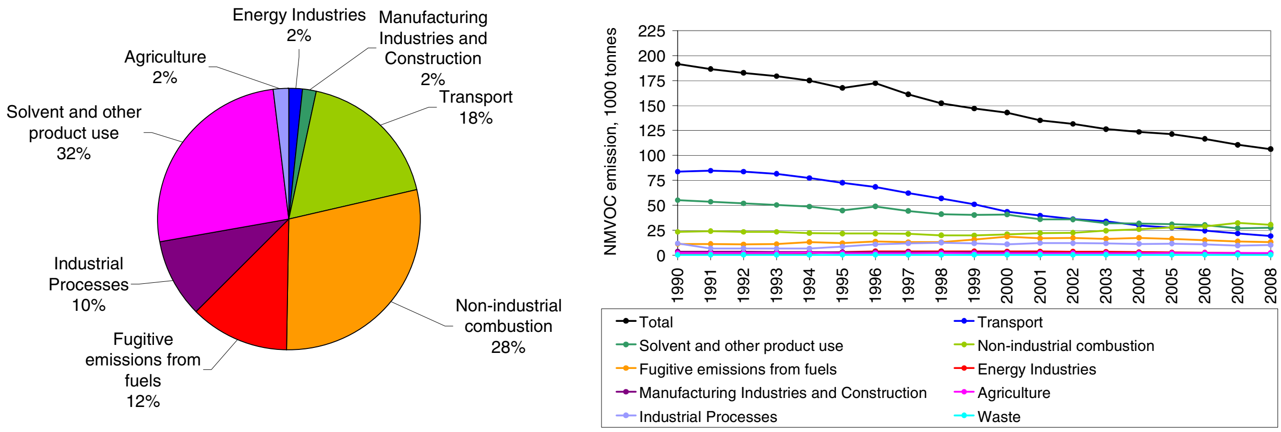


Figure 2.8 NMVOC emissions. Distribution according to the main sectors (2008) and time-series for 1990 to 2008.

2.4.4 SO_2

The main part of the SO_2 emission originates from combustion of fossil fuels, i.e. mainly coal and oil, in public power and district heating plants. From 1980 to 2008, the total emission decreased by 96 %. The large reduction is mainly due to installation of desulphurisation plant and use of fuels with lower content of sulphur in public power and district heating plants. Despite the large reduction of the SO_2 emissions, these plants make up 34 % of the total emission. Also emissions from industrial combustion plants, non-industrial combustion plants and other mobile sources are important. National sea traffic (navigation and fishing) contributes with about 5 % of the total SO_2 emission. This is due to the use of residual oil with high sulphur content.

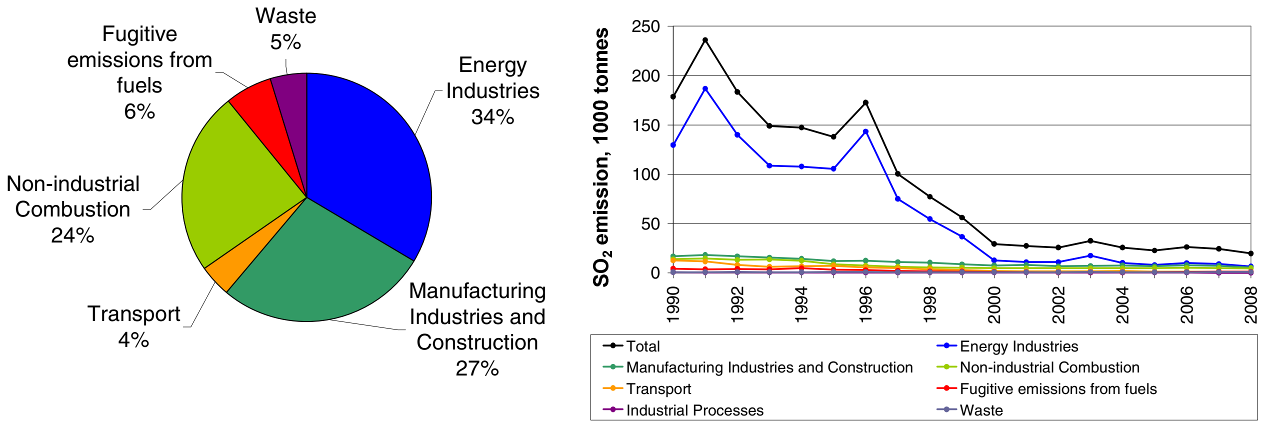


Figure 2.9 SO_2 emissions. Distribution according to the main sectors (2008) and time-series for 1990 to 2008.

2.5 Description and interpretation of emission trends for KP-LULUCF inventory in aggregate, by activity and by gas

Coverage relating to reporting of activities under Article 3.3 and elected activities under Article 3.4 are listed in table 2.10 for reporting concerning change in carbon pool and for greenhouse gas sources. Change of carbon pools in soils under Article 3.3 is not reported and carbon stock change in below-ground biomass for Cropland Management and Grazing Land Management under Article 3.4 are included under Above-ground biomass for the same area categories. Fertilisation of forests and other land is negligible and all fertiliser consumption is therefore reported in the agricultural sector. Drainage of forest soils are reported for the first time. All liming is reported under Cropland because only very limited amounts are used in forestry and on permanent grassland. Field burning of wooden biomass is prohibited in Denmark and therefore reported as not occurring. Wildfires are very seldom and if occurring very small in Denmark and hence reported as NO.

CO_2 is by far the most important greenhouse gas relating to activities under Article 3.3 and Article 3.4. There is however a minor contribution of N_2O due to Deforestation (1.1 % of GHG from Deforestation in 2008) and Forest Management (4.2 % of GHG from Forest Management in 2008).

Table 2.10 Coverage of reporting of change of carbon pools relating to activities under Article 3.3 and elected activities under Article 3.4.

		Change in carbon pool reported					Greenhouse gas sources reported						
		Above-ground bio-mass	Below-ground bio-mass	Litter	Dead wood	Soil	Fertili-zation	Drainage of soils under forest manage-ment	Disturbance associated with land-use conver-sion to croplands	Liming	Biomass burning		
							N_2O	N_2O	N_2O	CO_2	CO_2	CH_4	N_2O
Article 3.3	Afforestation and Reforestation	R	R	R	R	NR	IE			IE	NO	NO	NO
	Deforestation	R	R	R	R	NR			R	IE	NO	NO	NO
Article 3.4	Forest Management	R	R	R	R	R	IE	R		IE	NO	NO	NO
	Cropland Management	R	IE	NO	NO	R			R	R	NO	NO	NO
	Grazing Land Management	R	IE	NO	NO	R				IE	NO	NO	NO
	Revegetation	NA	NA	NA	NA	NA				NA	NA	NA	NA

R: reported, NR: not reported, IE: included elsewhere, NO: not occurring, NA: not applicable.

2.5.1 Forest

The trends in forest in the first commitment period are dependent on both the current structure of the forests and the management actions in the coming years. If similar management is applied as in the previous 15 years a decline in the total carbon stock in the forest remaining forest is expected. For the afforestated areas a steady increase in carbon stocks is expected also in the future years. The rate of increase of area will depend on both availability of land and on possible subsidies for afforestation. Deforestation occurs mainly in relation to other specific projects e.g. for nature restoration or test areas for wind mills.

2.5.2 Cropland, Grassland and Wetlands

The trend for the Cropland and Grassland under KP-LULUCF seems to be that there has been a stabilisation of the loss of C from agricultural soils compared to previous. However, the loss depends much of the climatic conditions. As a consequence of the global warming, where 18 years out of the last 20 years has been above the average for 1961-1990, it is difficult to avoid substantial losses of C from the agricultural soils. The changes in Cropland management since 1990 have undoubtedly prevented further losses of soil carbon. A further increase in the actual temperature will have consequences for the ability to maintain or even to prevent further losses of soil carbon.

The reestablishment of wetlands on agricultural land is especially targeted towards organic soils which lead to a decreased emission from these soils. Further reestablishments are expected to take place in the future.

3 Energy (CRF sector 1)

3.1 Overview of the sector

The energy sector has been reported in four main chapters:

3.2 Stationary combustion plants (CRF sector 1A1, 1A2 and 1A4)
3.3 Transport (CRF sector 1A2, 1A3, 1A4 and 1A5)
3.4 Additional information on fuel combustion (CRF sector 1A)
3.5 Fugitive emissions (CRF sector 1B)

Though industrial combustion is part of stationary combustion, detailed documentation for some of the specific industries is discussed in the industry chapters. Table 3.1.1 shows detailed source categories for the energy sector and plant category in which the sector is discussed in this report.

Table 3.1.1 CRF energy sectors and relevant NIR chapters.

IPCC id	IPCC sector name	NERI documentation
1	Energy	Stationary combustion, Transport, Fugitive, Industry
1A	Fuel Combustion Activities	Stationary combustion, Transport, Industry
1A1	Energy Industries	Stationary combustion
1A1a	Electricity and Heat Production	Stationary combustion
1A1b	Petroleum Refining	Stationary combustion, Fugitive
1A1c	Solid Fuel Transf./Other Energy Industries	Stationary combustion
1A2	Fuel Combustion Activities/Industry (ISIC)	Stationary combustion, Transport, Industry
1A2a	Iron and Steel	Stationary combustion, Industry
1A2b	Non-Ferrous Metals	Stationary combustion, Industry
1A2c	Chemicals	Stationary combustion, Industry
1A2d	Pulp, Paper and Print	Stationary combustion, Industry
1A2e	Food Processing, Beverages and Tobacco	Stationary combustion, Industry
1A2f	Other (please specify)	Stationary combustion, Transport, Industry
1A3	Transport	Transport
1A3a	Civil Aviation	Transport
1A3b	Road Transportation	Transport
1A3c	Railways	Transport
1A3d	Navigation	Transport
1A3e	Other (please specify)	Transport
1A4	Other Sectors	Stationary combustion, Transport
1A4a	Commercial/Institutional	Stationary combustion
1A4b	Residential	Stationary combustion, Transport
1A4c	Agriculture/Forestry/Fishing	Stationary combustion, Transport
1A5	Other (please specify)	Stationary combustion, Transport
1A5a	Stationary	Stationary combustion
1A5b	Mobile	Transport
1B	Fugitive Emissions from Fuels	Fugitive
1B1	Solid Fuels	Fugitive
1B1a	Coal Mining	Fugitive
1B1a1	Underground Mines	Fugitive
1B1a2	Surface Mines	Fugitive
1B1b	Solid Fuel Transformation	Fugitive
1B1c	Other (please specify)	Fugitive
1B2	Oil and Natural Gas	Fugitive
1B2a	Oil	Fugitive
1B2a2	Production	Fugitive
1B2a3	Transport	Fugitive
1B2a4	Refining/Storage	Fugitive
1B2a5	Distribution of oil products	Fugitive
1B2a6	Other	Fugitive
1B2b	Natural Gas	Fugitive
1B2b1	Production/processing	Fugitive
1B2b2	Transmission/distribution	Fugitive
1B2c	Venting and Flaring	Fugitive
1B2c1	Venting and Flaring Oil	Fugitive
1B2c2	Venting and Flaring Gas	Fugitive
1B2d	Other	Fugitive

Summary tables for the energy sector are shown below.

Table 3.1.2 CO_2 emission from the energy sector.

Greenhouse gas source categories	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
					(Gg)					
1. Energy	51543	62097	56275	58615	62239	59277	72713	63093	59009	56313
A. Fuel Combustion (Sectoral Approach)	51243	61505	55664	58082	61708	58862	72258	62452	58535	55303
1. Energy Industries	26215	35159	30206	31801	35533	32204	44674	35465	31766	28643
2. Manufacturing Industries and Construction	5424	5944	5769	5609	5769	5892	6081	6124	6154	6222
3. Transport	10528	10904	11102	11226	11712	11852	12109	12303	12275	12271
4. Other Sectors	8957	9211	8447	9208	8441	8663	9218	8390	8136	7985
5. Other	119	287	141	237	252	252	176	171	204	182
B. Fugitive Emissions from Fuels	300	592	611	534	531	415	456	641	475	1009
1. Solid Fuels	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
2. Oil and Natural Gas	300	592	611	534	531	415	456	641	475	1009
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
1. Energy	51785	53399	53029	58369	52725	49142	56941	52160	49212	
A. Fuel Combustion (Sectoral Approach)	51122	52691	52433	57753	52041	48644	56463	51742	48836	
1. Energy Industries	25572	26880	27080	31904	25929	22662	30423	25696	23553	
2. Manufacturing Industries and Construction	6012	6087	5815	5772	5826	5605	5750	5688	5199	
3. Transport	12061	12059	12161	12623	12934	13052	13417	14028	13802	
4. Other Sectors	7367	7568	7289	7362	7112	7054	6746	6156	6175	
5. Other	111	97	89	92	239	271	126	175	108	
B. Fugitive Emissions from Fuels	662	708	595	615	684	499	478	418	376	
1. Solid Fuels	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	
2. Oil and Natural Gas	662	708	595	615	684	499	478	418	376	

Table 3.1.3 CH_4 emission from the energy sector.

Greenhouse gas source categories	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
					(Gg)					
1. Energy	10.88	12.21	12.68	15.03	18.31	24.55	29.17	29.17	30.55	30.87
A. Fuel Combustion (Sectoral Approach)	8.81	9.65	10.23	12.35	15.51	21.34	26.08	25.85	27.24	27.08
1. Energy Industries	1.11	1.54	1.86	3.46	6.53	11.85	15.42	14.92	16.16	16.09
2. Manufacturing Industries and Construction	0.71	0.74	0.72	0.73	0.74	0.84	1.28	1.28	1.37	1.37
3. Transport	2.67	2.71	2.68	2.65	2.56	2.43	2.32	2.23	2.14	2.03
4. Other Sectors	4.31	4.63	4.96	5.50	5.67	6.21	7.05	7.40	7.55	7.57
5. Other	0.01	0.02	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.01
B. Fugitive Emissions from Fuels	2.07	2.57	2.46	2.68	2.80	3.21	3.09	3.32	3.32	3.79
1. Solid Fuels	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
2. Oil and Natural Gas	2.07	2.57	2.46	2.68	2.80	3.21	3.09	3.32	3.32	3.79
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
1. Energy	30.62	31.95	31.49	31.38	31.63	30.38	30.94	29.04	27.62	
A. Fuel Combustion (Sectoral Approach)	26.65	27.81	27.31	27.09	26.52	25.28	24.54	22.88	21.50	
1. Energy Industries	15.28	16.16	15.74	15.11	14.40	12.80	11.78	9.64	8.69	
2. Manufacturing Industries and Construction	1.57	1.61	1.45	1.43	1.43	1.26	1.18	0.98	1.02	
3. Transport	1.91	1.79	1.69	1.63	1.53	1.44	1.35	1.24	1.09	
4. Other Sectors	7.88	8.24	8.43	8.92	9.15	9.77	10.23	11.00	10.70	
5. Other	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.01	0.00	
B. Fugitive Emissions from Fuels	3.97	4.15	4.18	4.28	5.11	5.10	6.40	6.16	6.12	
1. Solid Fuels	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	
2. Oil and Natural Gas	3.97	4.15	4.18	4.28	5.11	5.10	6.40	6.16	6.12	

Table 3.1.4 N_2O emission from the energy sector.

Greenhouse gas source categories	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
					(Gg)					
1. Energy	1.28	1.42	1.37	1.41	1.47	1.48	1.68	1.58	1.52	1.51
A. Fuel Combustion (Sectoral Approach)	1.28	1.41	1.36	1.41	1.46	1.48	1.67	1.58	1.52	1.50
1. Energy Industries	0.38	0.47	0.43	0.44	0.49	0.48	0.64	0.55	0.52	0.50
2. Manufacturing Industries and Construction	0.18	0.19	0.18	0.18	0.18	0.18	0.19	0.19	0.19	0.19
3. Transport	0.37	0.40	0.42	0.43	0.46	0.48	0.50	0.51	0.51	0.50
4. Other Sectors	0.34	0.35	0.33	0.35	0.32	0.33	0.34	0.31	0.30	0.30
5. Other	0.00	0.01	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01
B. Fugitive Emissions from Fuels	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
1. Solid Fuels	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
2. Oil and Natural Gas	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
1. Energy	1.45	1.47	1.45	1.49	1.43	1.40	1.48	1.45	1.41	
A. Fuel Combustion (Sectoral Approach)	1.44	1.46	1.45	1.49	1.43	1.40	1.48	1.45	1.41	
1. Energy Industries	0.47	0.48	0.49	0.52	0.46	0.42	0.50	0.44	0.43	
2. Manufacturing Industries and Construction	0.19	0.19	0.18	0.18	0.19	0.18	0.19	0.19	0.19	
3. Transport	0.49	0.47	0.46	0.47	0.46	0.45	0.45	0.46	0.45	
4. Other Sectors	0.29	0.31	0.30	0.32	0.31	0.33	0.34	0.34	0.35	
5. Other	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.01	0.00	
B. Fugitive Emissions from Fuels	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00	
1. Solid Fuels	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	
2. Oil and Natural Gas	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00	

3.2 Stationary combustion (CRF sector 1A1, 1A2 and 1A4)

3.2.1 Source category description

In the Danish emission database all activity rates and emissions are defined in SNAP sector categories (Selected Nomenclature for Air Pollution) according the CORINAIR system. The emission inventories are prepared from a complete emission database based on the SNAP source categories. Aggregation to the IPCC source category codes is based on a correspondence list enclosed in Annex 3A-1. Stationary combustion is defined as combustion activities in the SNAP sectors 01 – 03.

Stationary combustion plants are included in the emission source subcategories to *Energy, Fuel combustion*:

- 1A1 Energy Industries.
- 1A2 Manufacturing Industries and Construction.
- 1A4 Other Sectors.

However, the emission sources *1A2* and *1A4* also include emission from transport subcategories. The emission source *1A2* includes emissions from some off-road machinery in the industry. The emission source *1A4* includes off-road machinery in agriculture, forestry and household/gardening. Further emissions from national fishing are included in subcategory *1A4*.

The emission and fuel consumption data included in tables and figures in Chapter 3.2 only include emissions originating from stationary combustion plants of a given IPCC source category. The IPCC source category codes have been applied unchanged, but some source category names have been changed to reflect the stationary combustion element of the source.

The CO_2 emission from calcinations is not part of the source category *Energy*. This emission is included in the source category *Industrial Processes*.

3.2.2 Fuel consumption data

In 2008 the total fuel consumption for stationary combustion plants was 531 PJ of which 423 PJ was fossil fuels and 108 PJ was biomass.

Fuel consumption distributed according to the stationary combustion subcategories is shown in Figure 3.2.1 and Figure 3.2.2. The majority - 58 % - of all fuels is combusted in the source category, *Public electricity and heat production*. Other source categories with high fuel consumption are *Residential* and *Industry*.

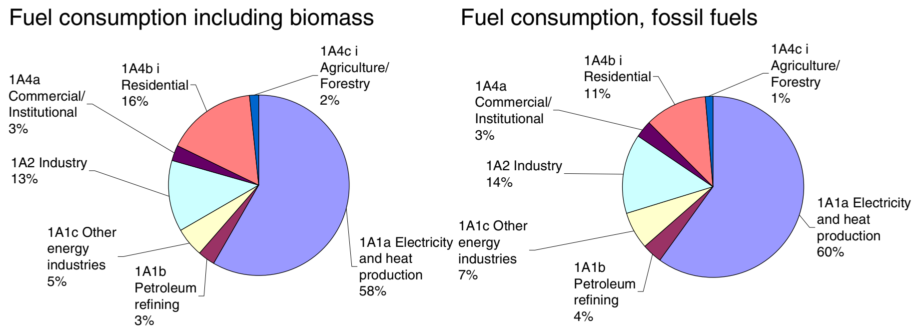


Figure 3.2.1 Fuel consumption of stationary combustion source categories, 2008 (based on DEA (2009a)).

Coal and natural gas are the most utilised fuels for stationary combustion plants. Coal is mainly used in power plants and natural gas is used in power plants and decentralised combined heating and power (CHP) plants, as well as in industry, district heating, residential plants and offshore gas turbines (see Figure 3.2.2).

Detailed fuel consumption rates are shown in Annex 3A-2.

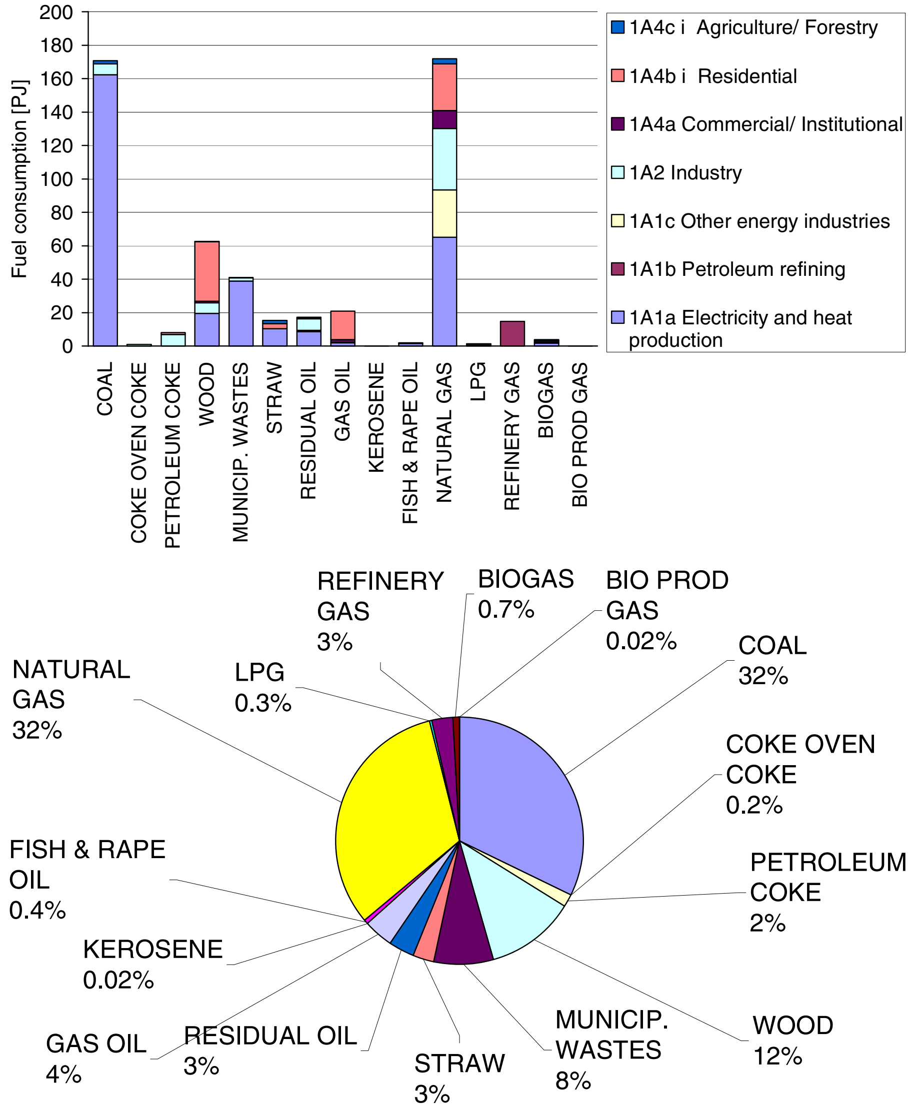


Figure 3.2.2 Fuel consumption of stationary combustion 2008, disaggregated to fuel type (based on DEA, 2009a).

Fuel consumption time-series for stationary combustion plants are presented in Figure 3.2.3. The fuel consumption for stationary combustion was 7 % higher in 2008 than in 1990, while the fossil fuel consumption was 7 % lower and the biomass fuel consumption 153 % higher than in 1990.

The consumption of natural gas and biomass has increased since 1990 whereas coal consumption has decreased.

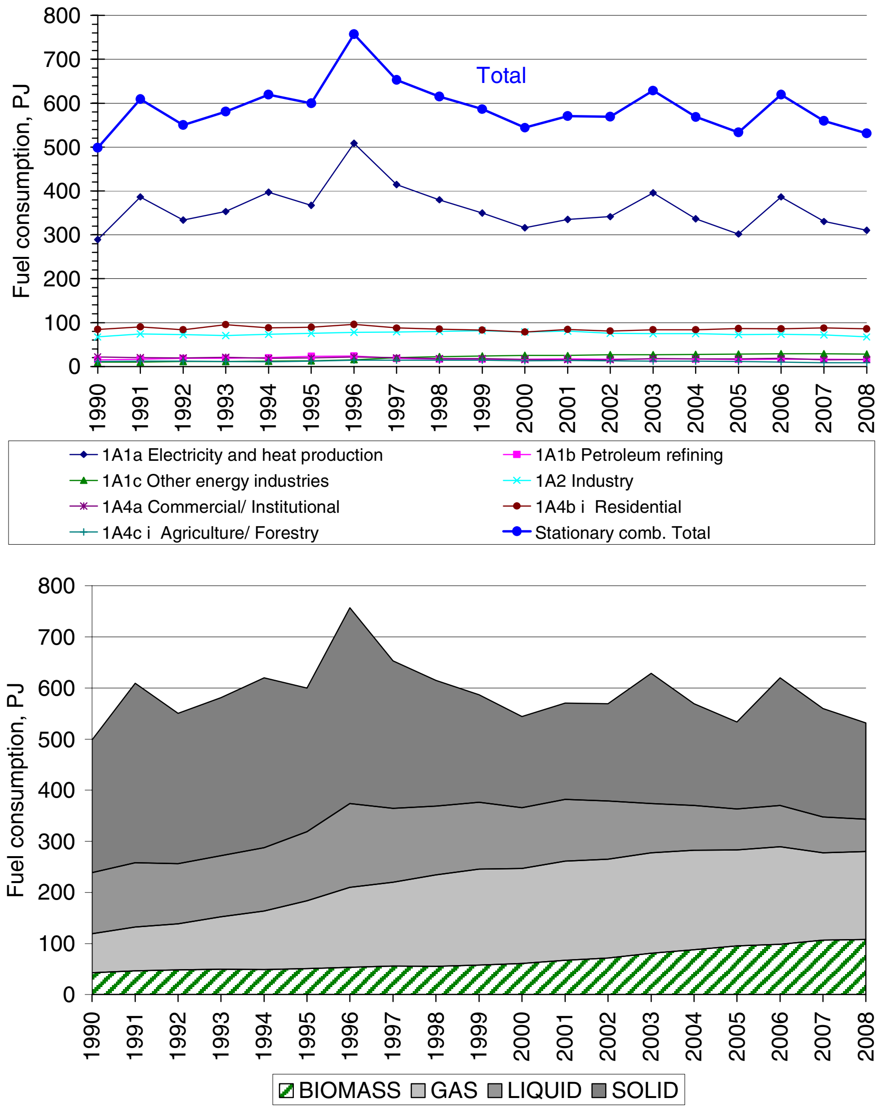


Figure 3.2.3 Fuel consumption time-series, stationary combustion (based on DEA, 2009a).

The fluctuations in the time-series for fuel consumption are mainly a result of electricity import/export, but also of outdoor temperature variations from year to year. This, in turn, leads to fluctuations in emission levels. The fluctuations in electricity trade, fuel consumption, CO_2 and NO_x emission are illustrated and compared in Figure 3.2.4. In 1990 the Danish electricity import was large causing relatively low fuel consumption, whereas the fuel consumption was high in 1996 due to a large electricity export. In 2008 the net electricity import was 5234 TJ, whereas there was a 3420 TJ electricity import in 2007. The large electricity export that occurs some years is a result of low rainfall in Norway and Sweden causing insufficient hydropower production in both countries.

To be able to follow the national energy consumption as well as for statistical and reporting purposes, the Danish Energy Agency produces a correction of the actual fuel consumption and CO_2 emission without random variations in electricity imports/exports and in ambient temperature. This fuel consumption trend is also illustrated in Figure 3.2.4. The corrections are included here to explain the fluctuations in the time-series for fuel rate and emission.

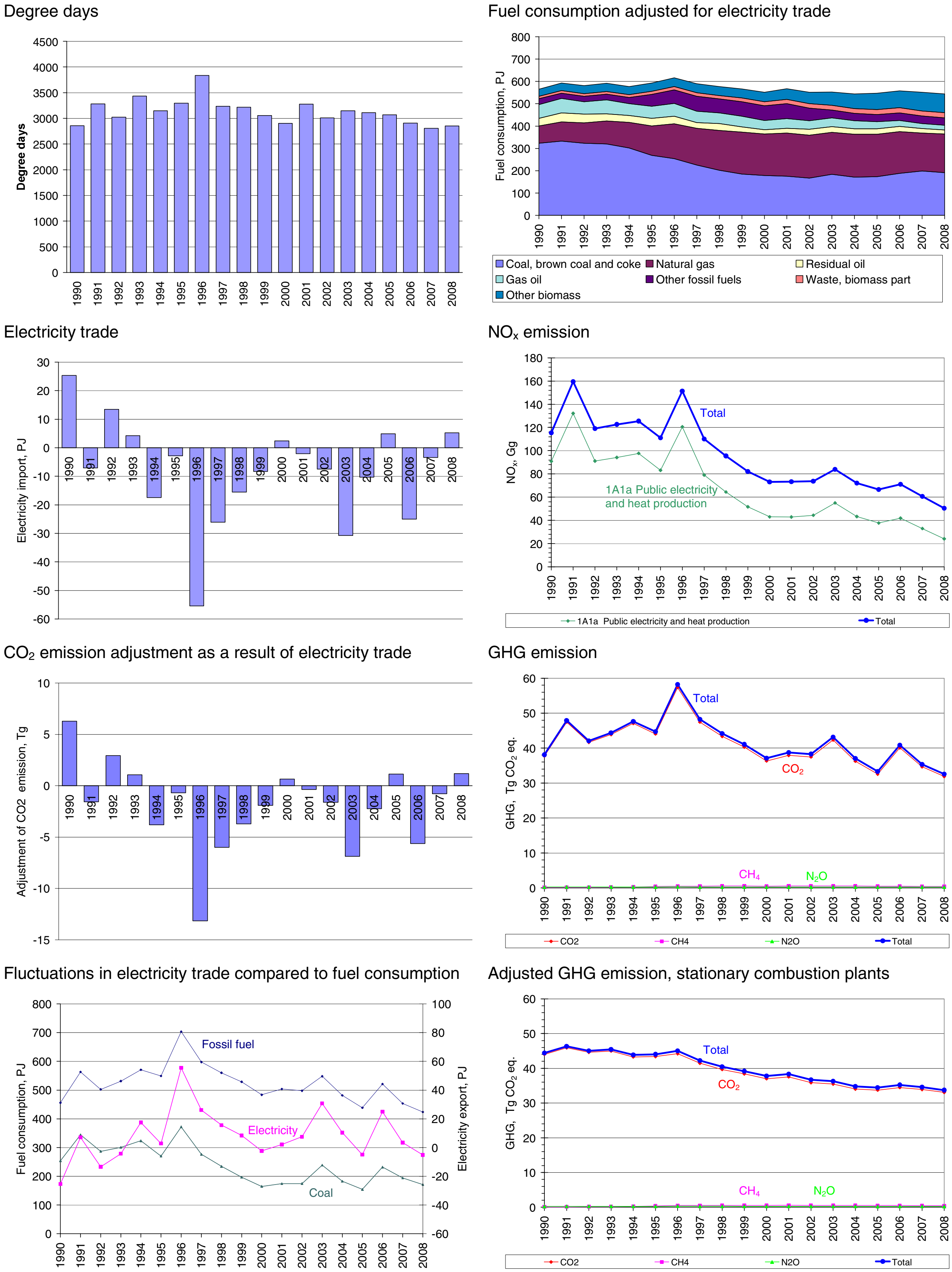


Figure 3.2.4 Comparison of time-series fluctuations for electricity trade, fuel consumption and NO_x emission (based on DEA 2009b).

Fuel consumption time-series for the subcategories to stationary combustion are shown in Figure 3.2.5a, 3.2.5b and 3.2.5c.

Fuel consumption for *Energy Industries* fluctuates due to electricity trade as discussed above. The fuel consumption in 2008 was 13 % higher than in 1990. The fluctuation in electricity production is based on fossil fuel consumption in the subcategory *Electricity and Heat Production*. The energy consumption in *Other energy industries* is mainly natural gas used in gas turbines in the off-shore industry. The biomass fuel consumption in *Energy Industries* 2008 added up to 56 PJ, which is 3.1 times the level in 1990.

The fuel consumption in *Industry* was the same in 2008 as it was in 1990 (Figure 3.2.5b). However, in recent years the fuel consumption has been decreasing and the consumption in 2008 was 15 % lower than in 1990. The biomass fuel consumption in *Industry* in 2008 added up to 8 PJ which is a 36 % increase since 1990.

The fuel consumption in *Other Sectors* decreased 6 % since 1990 (Figure 3.2.5c). The biomass part of the fuel consumption has increased from 16 % in 1990 to 40 % in 2008. Wood consumption in residential plants in 2008 was 2.4 times the consumption in year 2000.

Time-series for subcategories are shown in Chapter 0.

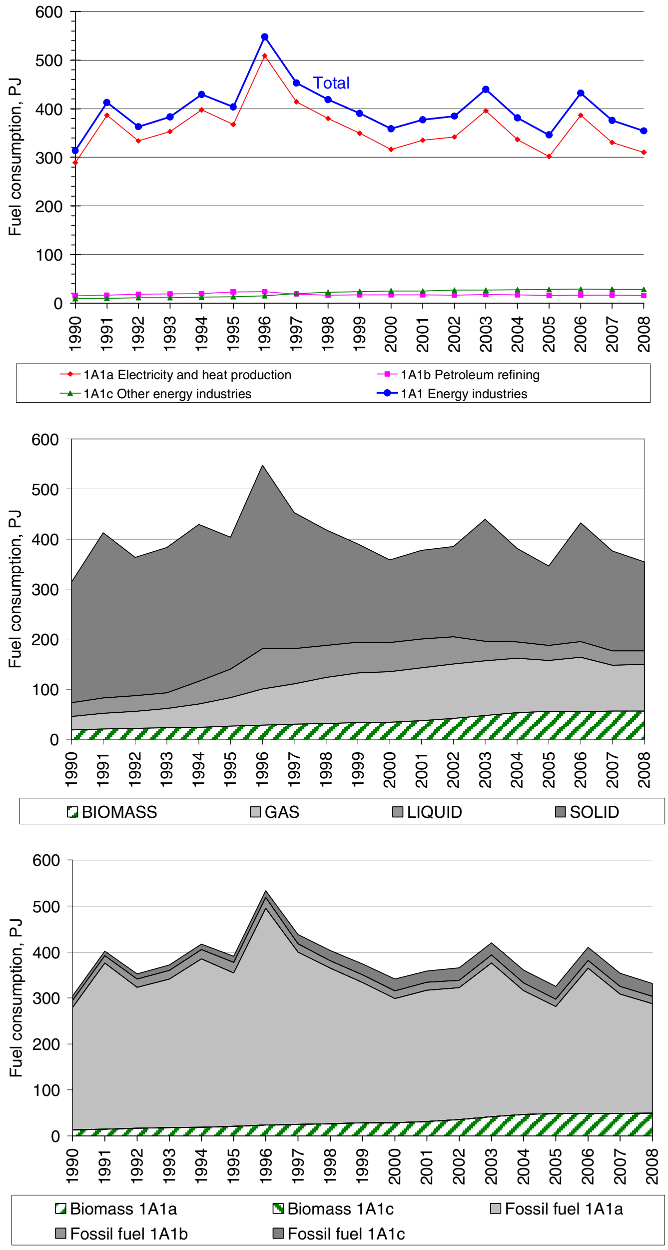


Figure 3.2.5a   Fuel consumption time-series for subcategories - 1A1 Energy Industries.

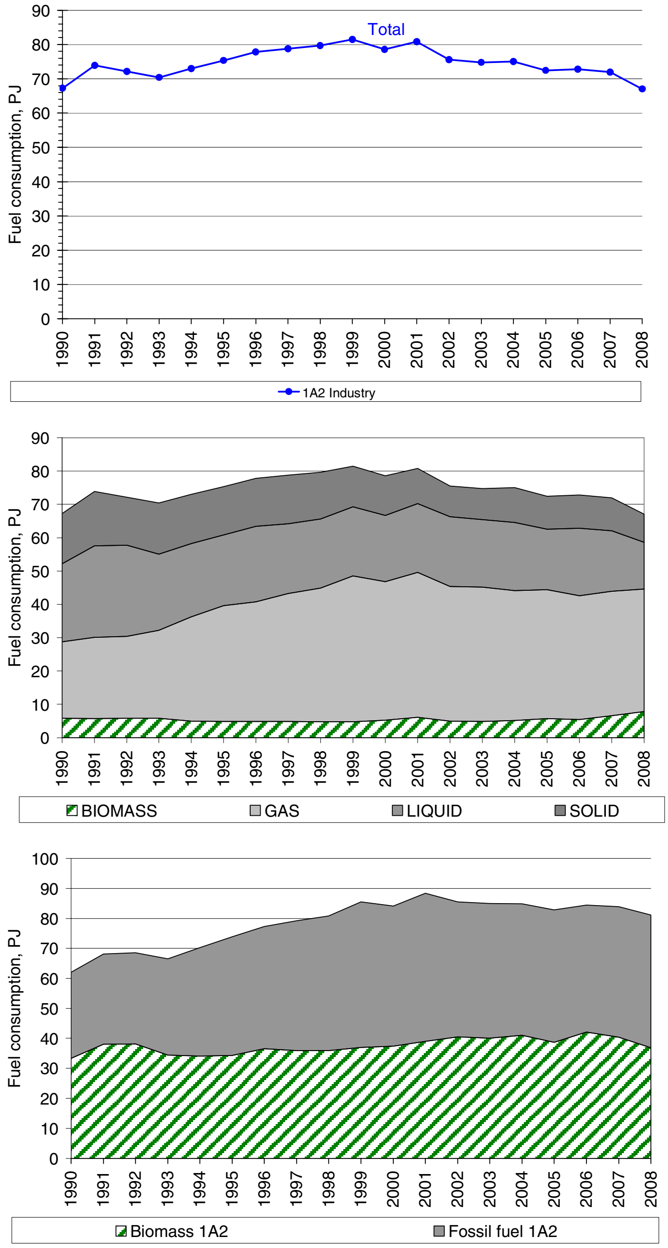


Figure 3.2.5b Fuel consumption time-series for subcategories - 1A2 Industry.

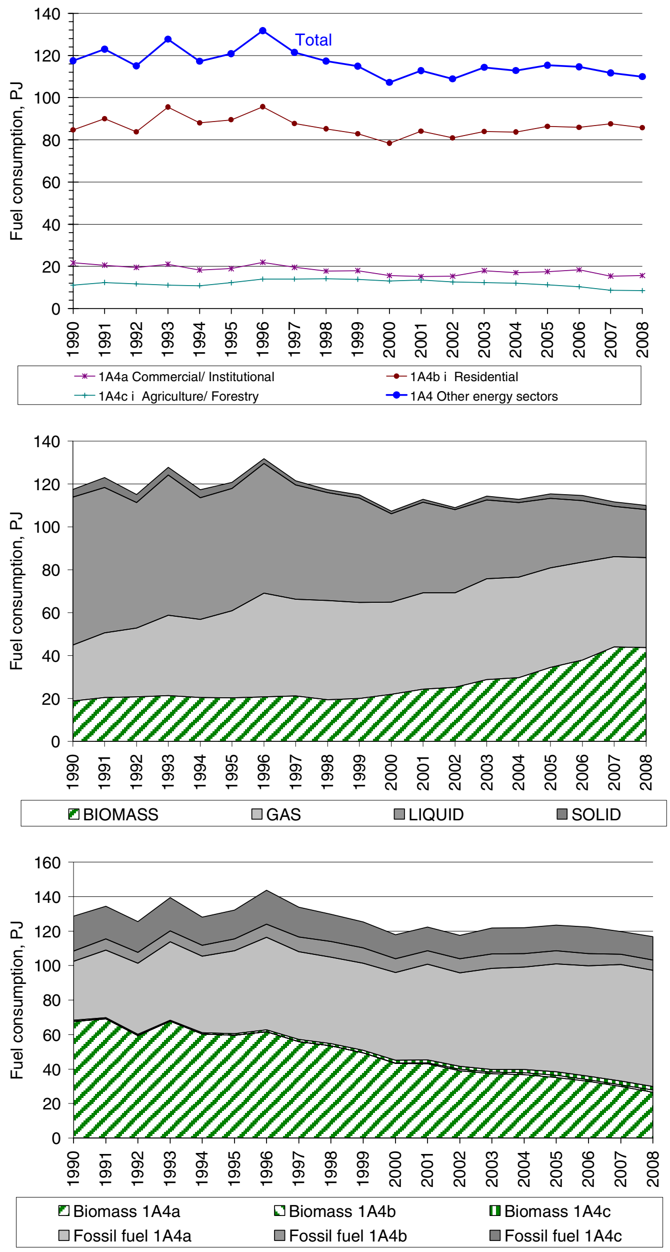


Figure 3.2.5c Fuel consumption time-series for subcategories - 1A4 Other Sectors.

3.2.3 Emissions

Greenhouse gas emission

The GHG emissions from stationary combustion are listed in Table 3.2.1. The emission from stationary combustion accounted for 51 % of the national GHG emission (excluding LULUCF) in 2008.

The CO_2 emission from stationary combustion plants accounts for 63 % of the national CO_2 emission (not including LULUCF). The CH_4 emission accounts for 8 % of the national CH_4 emission and the N_2O emission for 4 % of the national N_2O emission.

Table 3.2.1 Greenhouse gas emission, 2008 [1)].

	CO_2	CH_4	N_2O
	Gg CO_2 equivalent		
1A1 Fuel Combustion, Energy industries	23553	183	133
Fuel Combustion, Manufacturing Industries and Construction[1)]	4081	20	43
1A4 Fuel Combustion, Other sectors [1)]	4239	218	81
Emission from stationary combustion plants	31872	421	257
Emission share for stationary combustion	63 %	8 %	4 %

[1)] Only stationary combustion sources of the category is included.

CO_2 is the most important GHG pollutant accounting for 97.9 % of the GHG emission (CO_2 eq.) from stationary combustion. CH_4 accounts for 1.3 % and N_2O for 0.8 % of the GHG emission (CO_2 eq.) from stationary combustion (Figure 3.2.6).

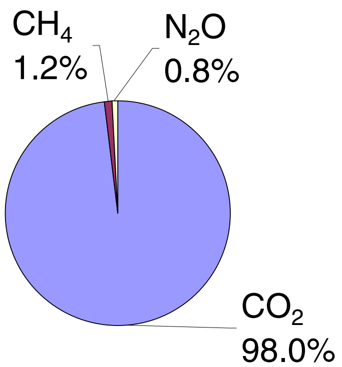


Figure 3.2.6 Stationary combustion - GHG emission (CO_2 equivalent), contribution from each pollutant.

Figure 3.2.7 depicts the time-series of GHG emission (CO_2 eq.) from stationary combustion and it can be seen that the GHG emission development follows the CO_2 emission development very closely. Both the CO_2 and the total GHG emission are lower in 2008 than in 1990, CO_2 by 16 % and GHG by 15 %. However, fluctuations in the GHG emission level are large.

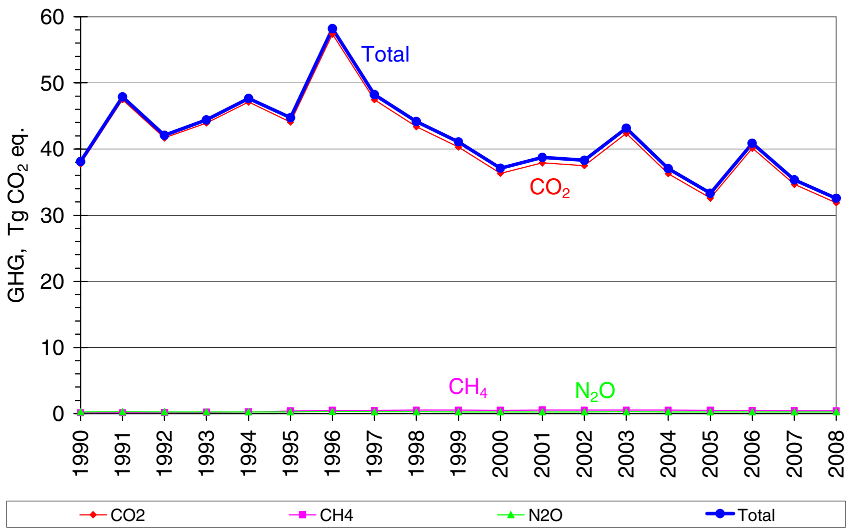


Figure 3.2.7 GHG emission time-series for stationary combustion.

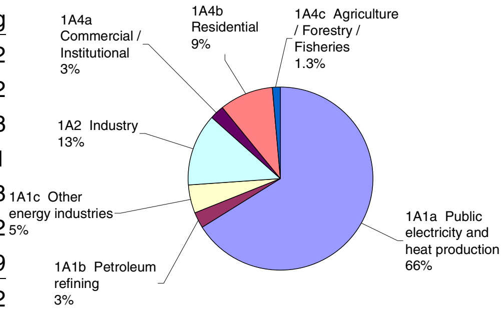
The fluctuations in the time-series are largely a result of electricity import/export, but also of outdoor temperature variations from year to year. The fluctuations follow the fluctuations in fuel consumption discussed in Chapter 3.2.2. As mentioned in Chapter 3.2.2, the Danish Energy Agency estimates a correction of the actual CO_2 emission without random variations in electricity imports/exports and in ambient temperature. The GHG emission corrected for electricity import/export and ambient temperature has decreased by 24 % since 1990, and the CO_2 emission by 25 %. These data are included here to explain the fluctuations in the emission time-series.

CO_2

The carbon dioxide (CO_2) emission from stationary combustion plants is one of the most important GHG emission sources. Thus the CO_2 emission from stationary combustion plants accounts for 63 % of the national CO_2 emission. Table 3.2.2 lists the CO_2 emission inventory for stationary combustion plants for 2008. *Electricity and heat production* accounts for 66 % of the CO_2 emission from stationary combustion. This share is somewhat higher than the fossil fuel consumption share for this category, which is 60 % (Figure 3.2.1). This is due to a large share of coal in this category. Other large CO_2 emission sources are *Industry* and *Residential* plants. These are the source categories, which also account for a considerable share of fuel consumption.

Table 3.2.2 CO_2 emission from stationary combustion plants, 2008[1)].

		CO_2 Gg
1A1a	Public electricity and heat production	21032
1A1b	Petroleum refining	912
1A1c	Other energy industries	1608
1A2	Industry	4081
1A4a	Commercial/Institutional	818
1A4b	Residential	3012
1A4c	Agriculture/Forestry/Fisheries	409
Total		31872

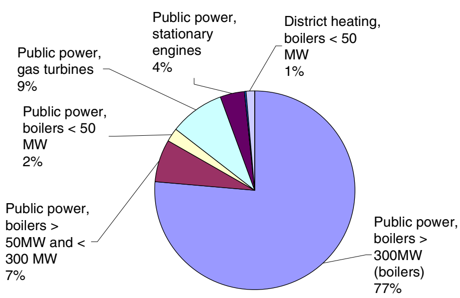


1) Only emission from stationary combustion plants in the categories is included.

In the Danish inventory the source category *Electricity and heat production* is further disaggregated. The CO_2 emission from each of the subcategories is shown in Table 3.2.3. The largest subcategory is power plant boilers >300MW.

Table 3.2.3 CO_2 emission from subcategories to 1A1a Electricity and heat production.

Sub-category ID (SNAP)	Subcategory name	CO_2, Gg
0101	Public power	
010100	Public power	0
010101	Combustion plants ≥ 300MW (boilers)	16094
010102	Combustion plants ≥ 50MW and < 300 MW (boilers)	1460
010103	Combustion plants <50 MW (boilers)	432
010104	Gas turbines	1875
010105	Stationary engines	829
0102	District heating plants	
010200	District heating plants	
010201	Combustion plants ≥ 300MW (boilers)	4
010202	Combustion plants ≥ 50MW and < 300 MW (boilers)	47
010203	Combustion plants <50 MW (boilers)	285
010204	Gas turbines	0
010205	Stationary engines	8



CO_2 emission from combustion of biomass fuels is not included in the total CO_2 emission data, because biomass fuels are considered CO_2 neutral. The CO_2 emission from biomass combustion is reported as a memo item in the Climate Convention reporting. In 2008 the CO_2 emission from biomass combustion was 11 688 Gg.

In Figure 3.2.8 the fuel consumption share (fossil fuels) is compared to the CO_2 emission share disaggregated to fuel origin. Due to the higher CO_2 emission factor for coal than oil and gas, the CO_2 emission share from coal combustion is higher than the fuel consumption share. Coal accounts for 40 % of the fossil fuel consumption and for 51 % of the CO_2 emission. Natural gas accounts for 42 % of the fossil fuel consumption but only 31 % of the CO_2 emission.

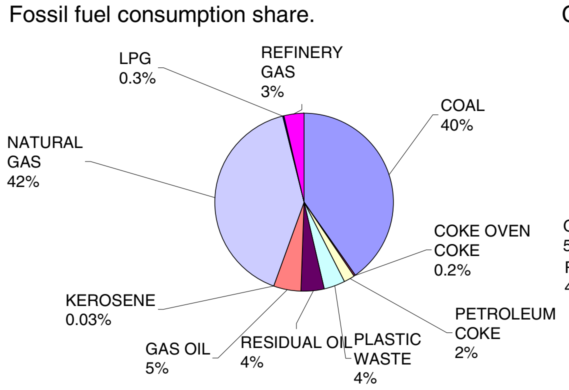


Figure 3.2.8 CO_2 emission, fuel origin.

Time-series for CO_2 emission are provided in Figure 3.2.9. Despite an increase in fuel consumption of 7 % since 1990 CO_2 emission from stationary combustion has decreased by 16 % because of the change of fuel type used.

The fluctuations in total CO_2 emission follow the fluctuations in CO_2 emission from *Electricity and heat production* (Figure 3.2.9) and in coal consumption (Figure 3.2.4). The fluctuations are a result of electricity import/export as discussed in Chapter 3.2.2.

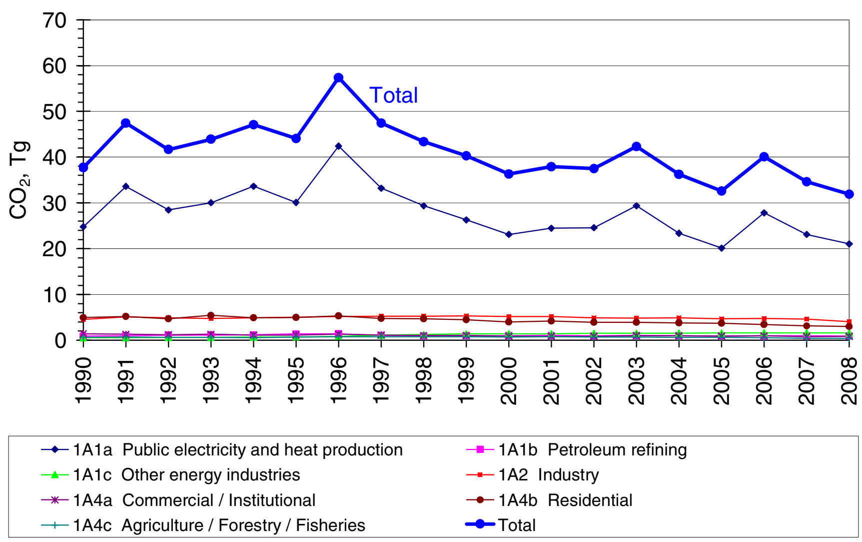


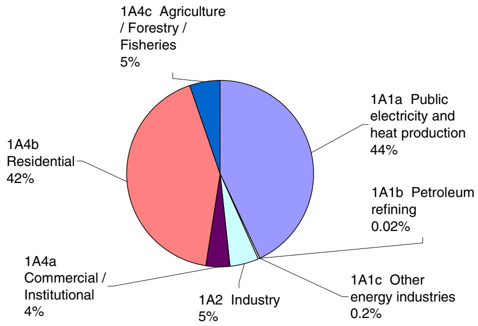
Figure 3.2.9 CO_2 emission time-series for stationary combustion plants.

CH_4

The methane (CH_4) emission from stationary combustion plants accounts for 8 % of the national CH_4 emission. Table 3.2.4 lists the CH_4 emission inventory for stationary combustion plants in 2008. *Electricity and heat production* accounts for 43 % of the CH_4 emission from stationary combustion, which is somewhat less than the fuel consumption share. The emission from residential plants adds up to 42 % of the emission.

Table 3.2.4 CH_4 emission from stationary combustion plants, 2008[1)].

	CH_4 2008 Mg
1A1a Public electricity and heat production	8643
1A1b Petroleum refining	4
1A1c Other energy industries	45
1A2 Industry	976
1A4a Commercial/Institutional	848
1A4b Residential	8477
1A4c Agriculture/Forestry/Fisheries	1040
Total	20033



1) Only emission from stationary combustion plants in the source categories is included.

The CH_4 emission factor for reciprocating gas engines is much higher than for other combustion plants due to the continuous ignition/burn-out of the gas. Lean-burn gas engines have an especially high emission factor. A considerable number of lean-burn gas engines are in operation in Denmark and in 2008 these plants accounted for 49 % of the CH_4 emission from stationary combustion plants (Figure 3.2.10). Most engines are installed in CHP plants and the fuel used is either natural gas or biogas. Residential wood combustion is also a large emission source.

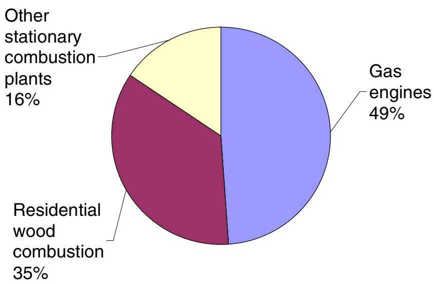


Figure 3.2.10 CH_4 emission share for gas engines and residential wood combustion, 2008.

Figure 3.2.11 shows the time-series for CH_4 emission. The CH_4 emission from stationary combustion has increased by a factor of 3.5 since 1990. This results from the considerable number of lean-burn gas engines installed in CHP plants in Denmark during the 1990s. Figure 3.2.12 provides time-series for the fuel consumption rate in gas engines and the corresponding increase of CH_4 emission. The decline in later years is due to structural changes in the Danish electricity market, which means that the fuel consumption in gas engines has been decreasing.

The emission from residential plants has increased since 1990 due to increased combustion of biomass in residential plants. Combustion of wood accounted for more than 80 % of the emission from residential plants in 2008.

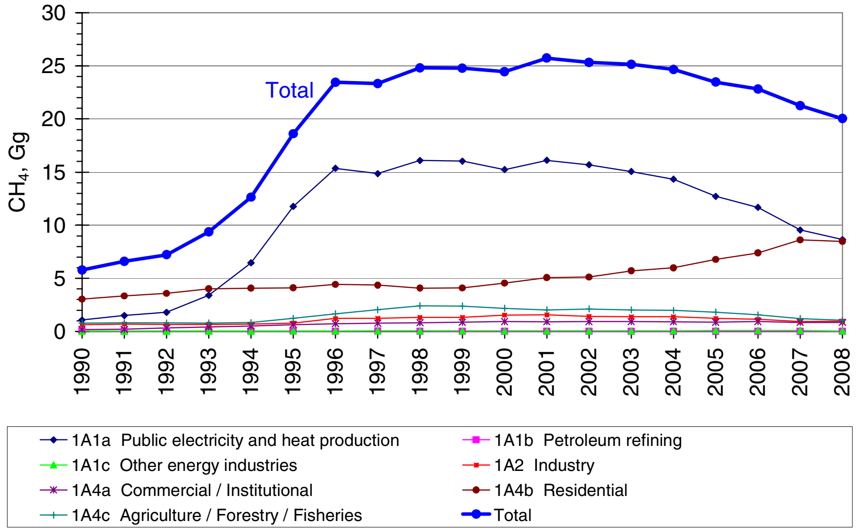


Figure 3.2.11 CH_4 emission time-series for stationary combustion plants.

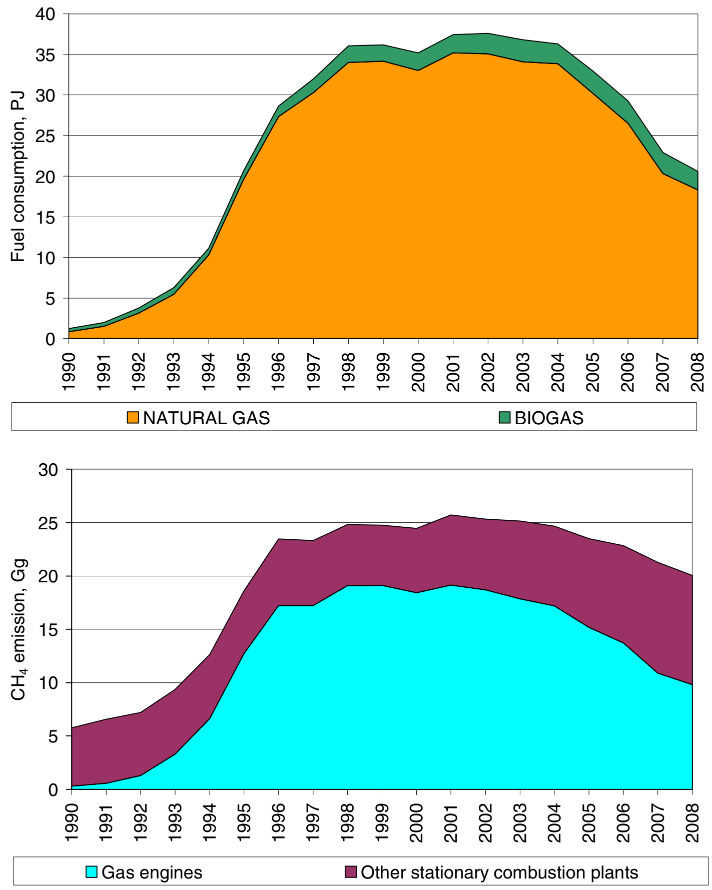


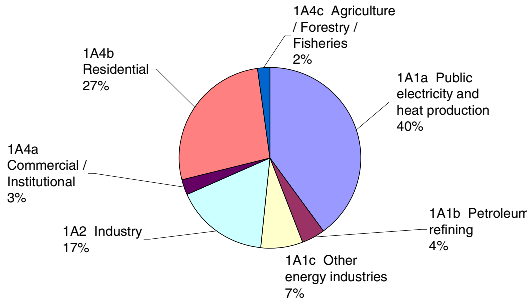
Figure 3.2.12 Fuel consumption and CH_4 emission from gas engines, time-series.

N_2O

The nitrous oxide (N_2O) emission from stationary combustion plants accounts for 4 % of the national N_2O emission. Table 3.2.5 lists the N_2O emission inventory for stationary combustion plants in the year 2008. *Electricity and heat production* accounts for 40 % of the N_2O emission from stationary combustion.

Table 3.2.5 N_2O emission from stationary combustion plants, 2008[1].

	N_2O 2008 Mg
1A1a Public electricity and heat production	332
1A1b Petroleum refining	34
1A1c Other energy industries	62
1A2 Industry	138
1A4a Commercial/Institutional	22
1A4b Residential	221
1A4c Agriculture/Forestry/Fisheries	19
Total	829



[1] Only emission from stationary combustion plants in the source categories is included.

Figure 3.2.13 shows time-series for N_2O emission. The N_2O emission from stationary combustion has increased by 7 % from 1990 to 2008, but again fluctuations in emission level due to electricity import/export are considerable.

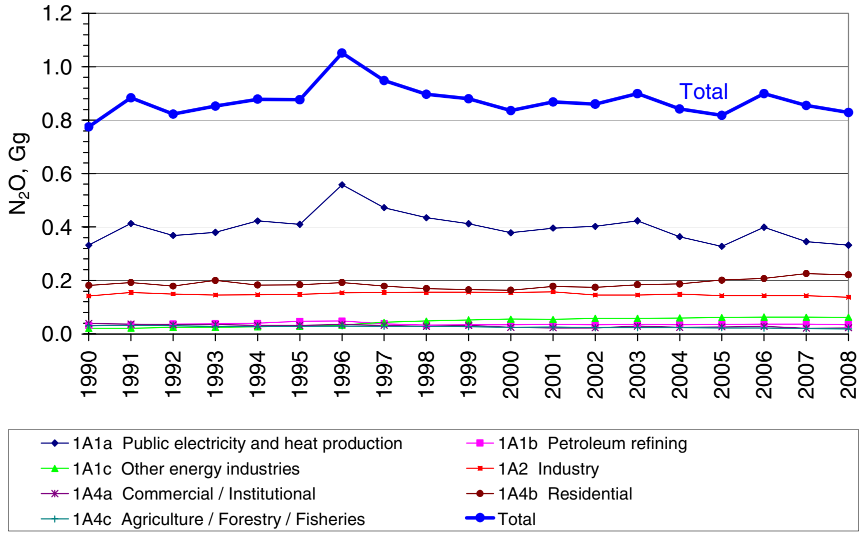


Figure 3.2.13 N_2O emission time-series for stationary combustion plants.

SO_2, NO_x, NMVOC and CO

The emissions of sulphur dioxide (SO_2), nitrogen oxides (NO_x), non volatile organic compounds (NMVOC) and carbon monoxide (CO) from Danish stationary combustion plants 2008 are presented in Table 3.2.6.

SO_2 from stationary combustion plants accounts for 83 % of the national emission. NO_x, CO and NMVOC account for 33 %, 38 % and 21 % of national emissions, respectively.

Table 3.2.6 SO_2, NO_x, NMVOC and CO emission, 2008[1].

Pollutant	NO_x	CO	NMVOC	SO_2
	Gg	Gg	Gg	Gg
1A1 Fuel consumption, Energy industries	32.6	8.2	1.9	6.6
1A2 Fuel consumption, Manufacturing Industries and Construction[1]	9.6	12.9	0.4	5.4
1A4 Fuel consumption, Other sectors[1]	8.2	144.0	20.1	4.3
Emission from stationary combustion plants	50.4	165.1	22.3	16.3
Emission share for stationary combustion	33	38	21	83

[1] Only emissions from stationary combustion plants in the source categories are included.

SO_2

Stationary combustion is the most important emission source for SO_2 accounting for 83 % of the national emission. Table 3.2.7 presents the SO_2 emission inventory for the stationary combustion subcategories.

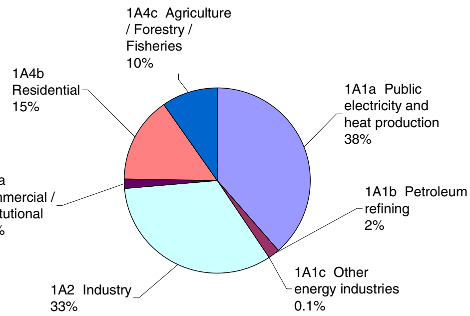
Electricity and heat production is the largest emission source accounting for 39 % of the emission. However, the SO_2 emission share is lower than the fuel consumption share for this source category, which is 58 %. This is a result of effective flue gas desulphurisation equipment installed in power plants combusting coal. In the Danish inventory the source category *Electricity and heat production* is further disaggregated. Figure 3.2.14 shows the SO_2 emission from *Electricity and heat production* on a disaggregated level. Power plants >300MW_{th} are the main emission source, accounting for 70 % of the emission.

The SO_2 emission from industrial plants is 33 %, a remarkably high emission share compared with fuel consumption. The main emission sources in the industrial category are combustion of coal and residual oil, but emissions from the cement industry is also a considerable emission source. Ten years ago SO_2 emission from the industrial category only accounted for a small part of the emission from stationary combustion, but as a result of reduced emissions from power plants the share has now increased.

Time-series for SO_2 emission from stationary combustion are shown in Figure 3.2.15. The SO_2 emission from stationary combustion plants has decreased by 90 % since 1990. The large emission decrease is mainly a result of the reduced emission from *Electricity and heat production*, made possible due to installation of desulphurisation plants and due to the use of fuels with lower sulphur content. Despite the considerable reduction in emission from electricity and heat production plants, these still account for 39 % of the emission from stationary combustion, as mentioned above. The emission from other source categories also decreased considerably since 1990. Time-series for subcategories are shown in Chapter 0.

Table 3.2.7 SO_2 emission from stationary combustion plants, 2008[1].

	SO_2 2008 Mg
1A1a Public electricity and heat production	6281
1A1b Petroleum refining	316
1A1c Other energy industries	8
1A2 Industry	5383
1A4a Commercial/Institutional	273
1A4b Residential	2466
1A4c Agriculture/Forestry/Fisheries	1572
Total	16299



[1] Only emission from stationary combustion plants in the source categories is included.

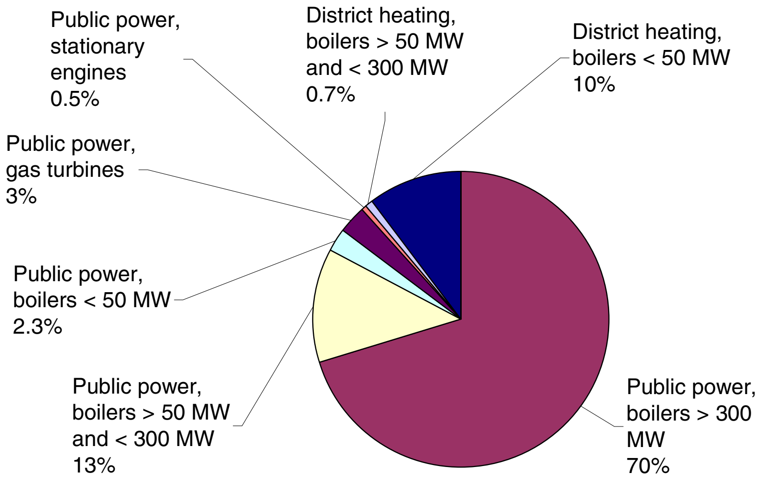


Figure 3.2.14 Disaggregated SO_2 emissions from 1A1a Energy and heat production.

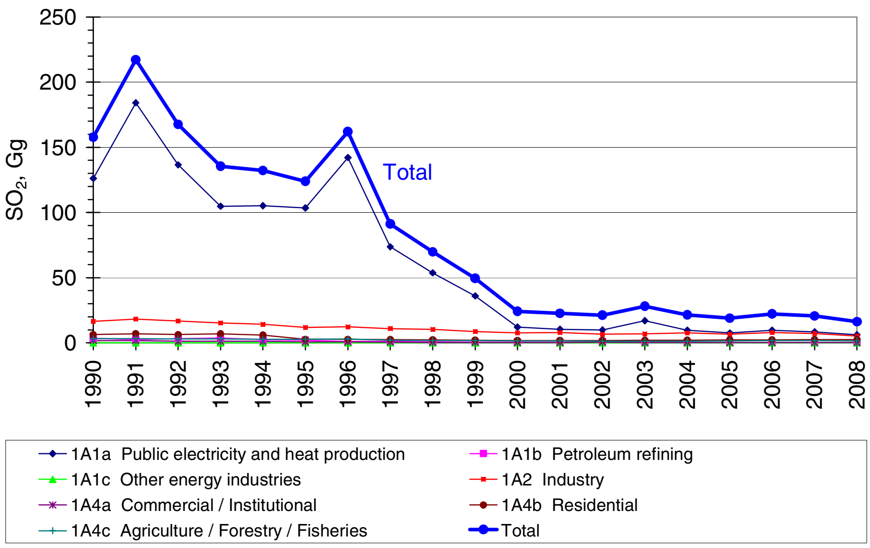


Figure 3.2.15 SO_2 emission time-series for stationary combustion.

NO_x

Stationary combustion accounts for 33 % of the national NO_x emission. Table 3.2.8 shows the NO_x emission inventory for stationary combustion subcategories.

Electricity and heat production is the largest emission source accounting for 48 % of the emission from stationary combustion plants. The emission from public power boilers > 300 MW_{th} accounts for 45 % of the emission in this subcategory.

Industrial combustion plants are also an important emission source accounting for 19 % of the emission. The main industrial emission source is cement production, which accounts for 61 % of the emission.

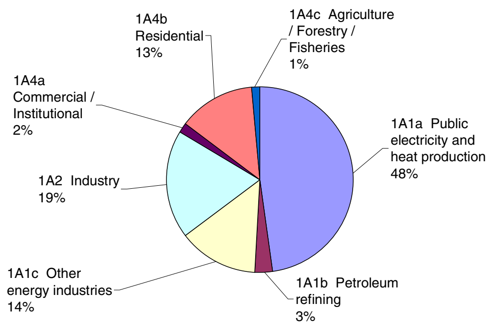
Residential plants account for 13 % of the NO_x emission. The fuel origin of this emission is mainly wood, gas oil and natural gas accounting for 64 %, 13 % and 14 % of the residential plant emission, respectively.

Other energy industries which is mainly off-shore gas turbines accounts for 14 % of the NO_x emission.

Time-series for NO_x emission from stationary combustion are shown in Figure 3.2.16. NO_x emission from stationary combustion plants has decreased by 56 % since 1990. The reduced emission is largely a result of the reduced emission from electricity and heat production due to installation of low NO_x burners, selective catalytic reduction (SCR) units and selective non-catalytic reduction (SNCR) units. The fluctuations in the time-series follow the fluctuations in electricity and heat production, which, in turn, result from electricity trade fluctuations.

Table 3.2.8 NO_x emission from stationary combustion plants, 2008[1].

	NO_x 2008 Mg
1A1a Public electricity and heat production	24056
1A1b Petroleum refining	1490
1A1c Other energy industries	7031
1A2 Industry	9557
1A4a Commercial/Institutional	811
1A4b Residential	6702
1A4c Agriculture/Forestry/Fisheries	715
Total	50361



[1] Only emission from stationary combustion plants in the source categories is included.

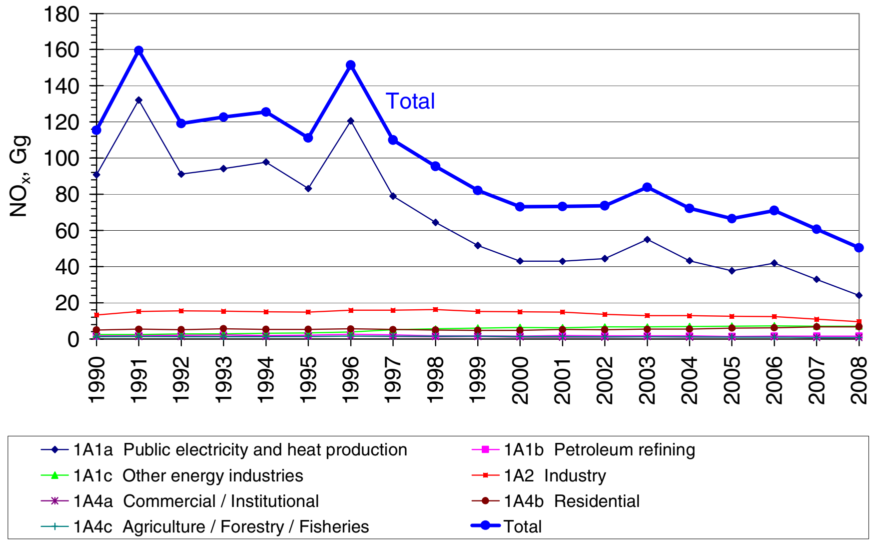


Figure 3.2.16 NO_x emission time-series for stationary combustion.

NMVOC

Stationary combustion plants account for 21 % of the national NMVOC emission. Table 3.2.9 presents the NMVOC emission inventory for the stationary combustion subcategories.

Residential plants are the largest emission source accounting for 86 % of the emission from stationary combustion plants. For residential plants NMVOC is mainly emitted from wood and straw combustion, see Figure 3.2.17.

Electricity and heat production is also a considerable emission source, accounting for 8 % of the emission. Lean-burn gas engines have a relatively high NMVOC emission factor and are the most important emission source in this subcategory (see Figure 3.2.17). The gas engines are either natural gas or biogas fuelled.

Time-series for NMVOC emission from stationary combustion are shown in Figure 3.2.18. The emission has increased by 50 % from 1990. The increased emission is mainly a result of the increasing wood consumption in residential plants and of the increased use of lean-burn gas engines in CHP plants.

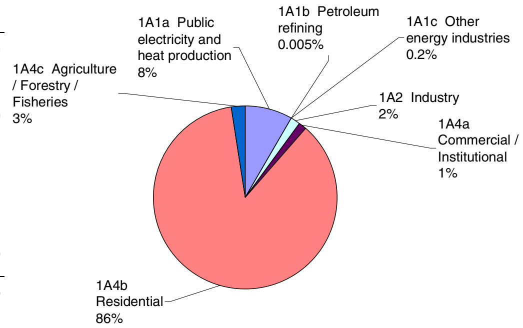
The emission from residential plants increased 59 % since 1990. The NMVOC emission from wood combustion in 2008 was 2.9 times the 1990 level due to increased wood consumption. However, the emission factor has decreased since 1990 due to installation of modern stoves and boilers with improved combustion technology. Further the emission from straw combustion in farmhouse boilers has decreased (75 %) over this period due to both a decreasing emission factor and decrease in straw consumption in this source category.

The use of wood in residential boilers and stoves was relatively low in 1998-99 resulting in a lower emission level.

The small decrease of the NMVOC emission in 2008 is a result of both a small decline of the consumption of wood pellets in residential plants and a decreasing emission factor for firewood combustion in residential plants. The DEA has assumed that the consumption of firewood in residential plants in 2008 was the same as in 2007; however, the 2008 consumption will be recalculated by the DEA again in 2010.

Table 3.2.9 NMVOC emission from stationary combustion plants, 2008[1)].

	NMVOC 2008 Mg
1A1a Public electricity and heat production	1838
1A1b Petroleum refining	1
1A1c Other energy industries	40
1A2 Industry	371
1A4a Commercial/Institutional	271
1A4b Residential	19222
1A4c Agriculture/Forestry/Fisheries	570
Total	22313



1) Only emission from stationary combustion plants in the categories is included.

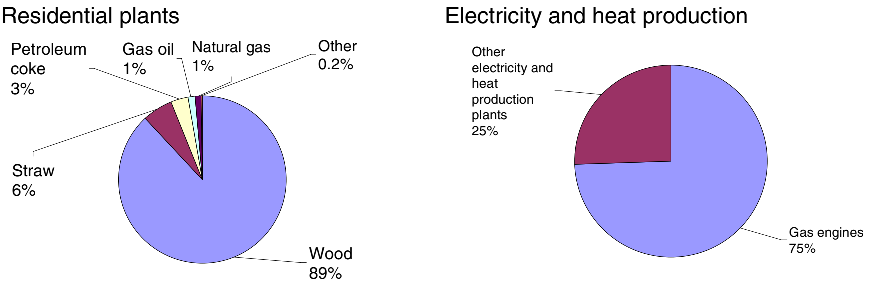


Figure 3.2.17 NMVOC emission from Residential plants and from Electricity and heat production, 2008.

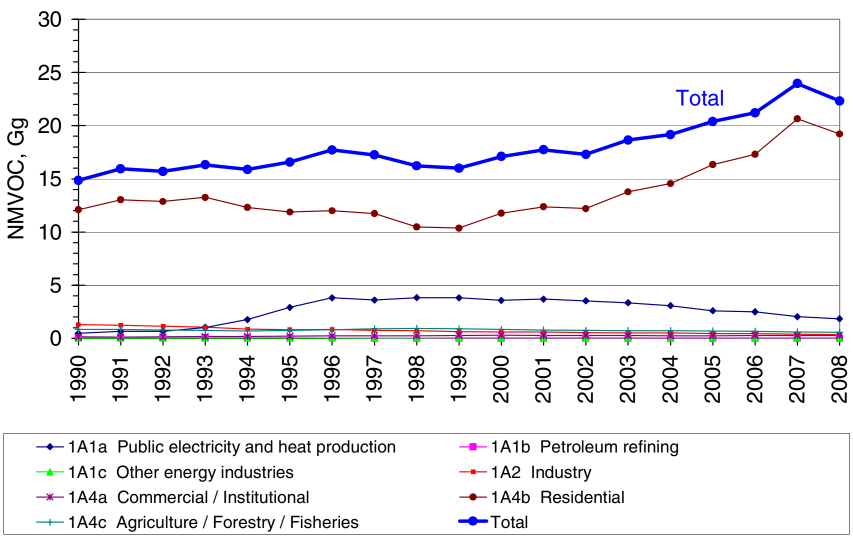


Figure 3.2.18 NMVOC emission time-series for stationary combustion.

CO

Stationary combustion accounts for 38 % of the national CO emission. Table 3.2.9 presents the CO emission inventory for stationary combustion subcategories.

Residential plants are the largest emission source, accounting for 81 % of the emission. Wood combustion accounts for 89 % of the emission from residential plants, see Figure 3.2.19. This is in spite of the fact that the fuel consumption share is only 41 %. Combustion of straw is also a considerable emission source whereas the emission from other fuels used in residential plants is almost negligible.

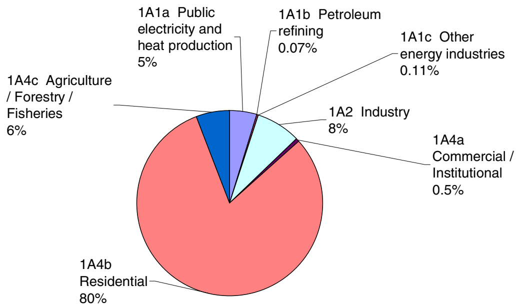
Time-series for CO emission from stationary combustion are shown in Figure 3.2.20. The emission has increased by 16 % from 1990. The time-series for CO from stationary combustion plants follows the time-series for CO emission from residential plants.

The consumption of wood in residential plants in 2008 was 4.0 times the 1990 level. However, the CO emission factor for wood has decreased since 1990 causing the CO emission from wood combustion in residential plants in 2008 to be only 3.2 times the 1990 level. Both straw consumption and CO emission factor for residential plants have decreased since 1990.

The small decrease of the CO emission in 2008 is a result of both a small decline of the consumption of wood pellets in residential plants and a decreasing emission factor for firewood combustion in residential plants. The DEA has assumed that the consumption of firewood in residential plants in 2008 was the same as in 2007; however the 2008 consumption will be recalculated by the DEA again in 2010.

Table 3.2.9 CO emission from stationary combustion plants, 2008[1).]

	CO 2008 Mg
1A1a Public electricity and heat production	7909
1A1b Petroleum refining	119
1A1c Other energy industries	183
1A2 Industry	12879
1A4a Commercial/Institutional	839
1A4b Residential	133437
1A4c Agriculture/Forestry/Fisheries	9709
Total	165077



[1)] Only emission from stationary combustion plants in the source categories is included.

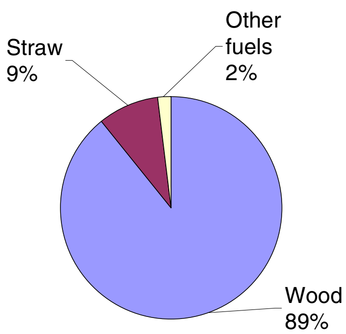
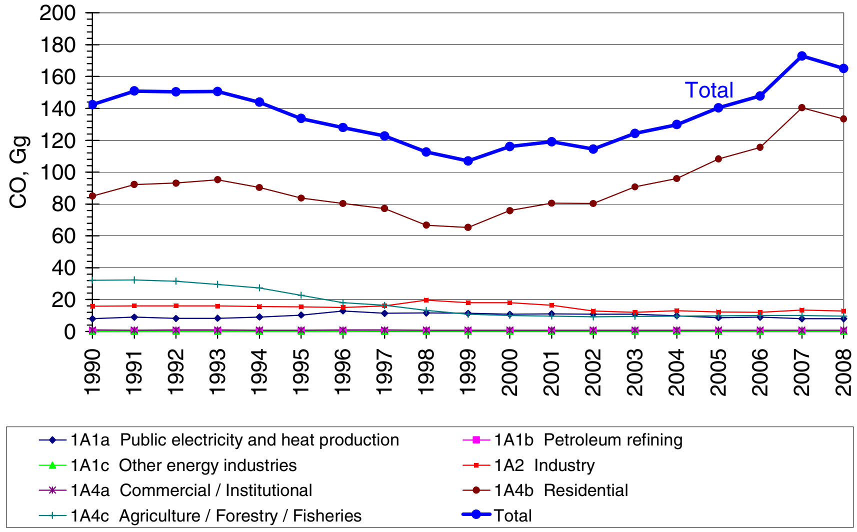


Figure 3.2.19 CO emission sources, residential plants, 2008.

Stationary combustion



1A4b Residential plants, fuel origin

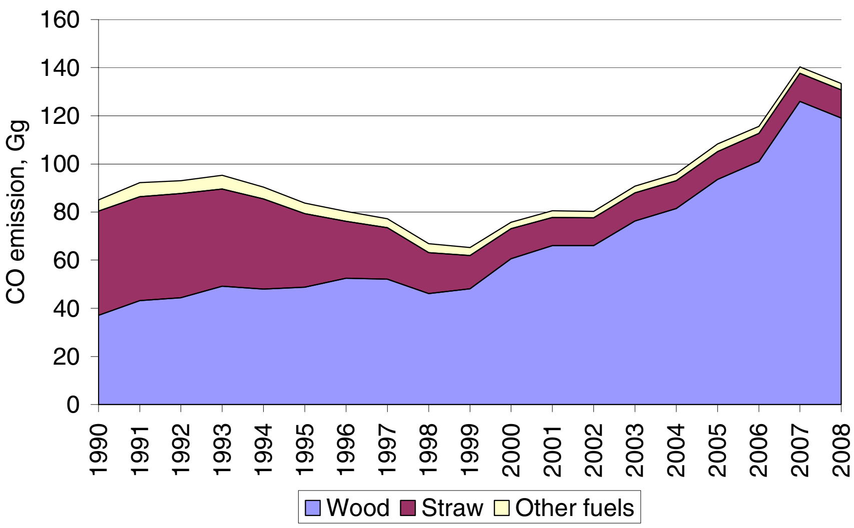


Figure 3.2.20 CO emission time-series for stationary combustion.

3.2.4 Sectoral trend

In addition to the data for stationary combustion this chapter presents and discusses data for each of the subcategories in which stationary combustion is included. Time-series are presented for fuel consumption and emissions.

1A1 Energy industries

The emission source category *1A1 Energy Industries* consists of the subcategories:

- 1A1a Electricity and heat production.
- 1A1b Petroleum refining.
- 1A1c Other energy industries.

Figure 3.2.21 – 3.2.23 present time-series for the *Energy Industries*. *Electricity and heat production* is the largest subcategory accounting for the main part of all emissions. Time-series are discussed below for each subcategory.

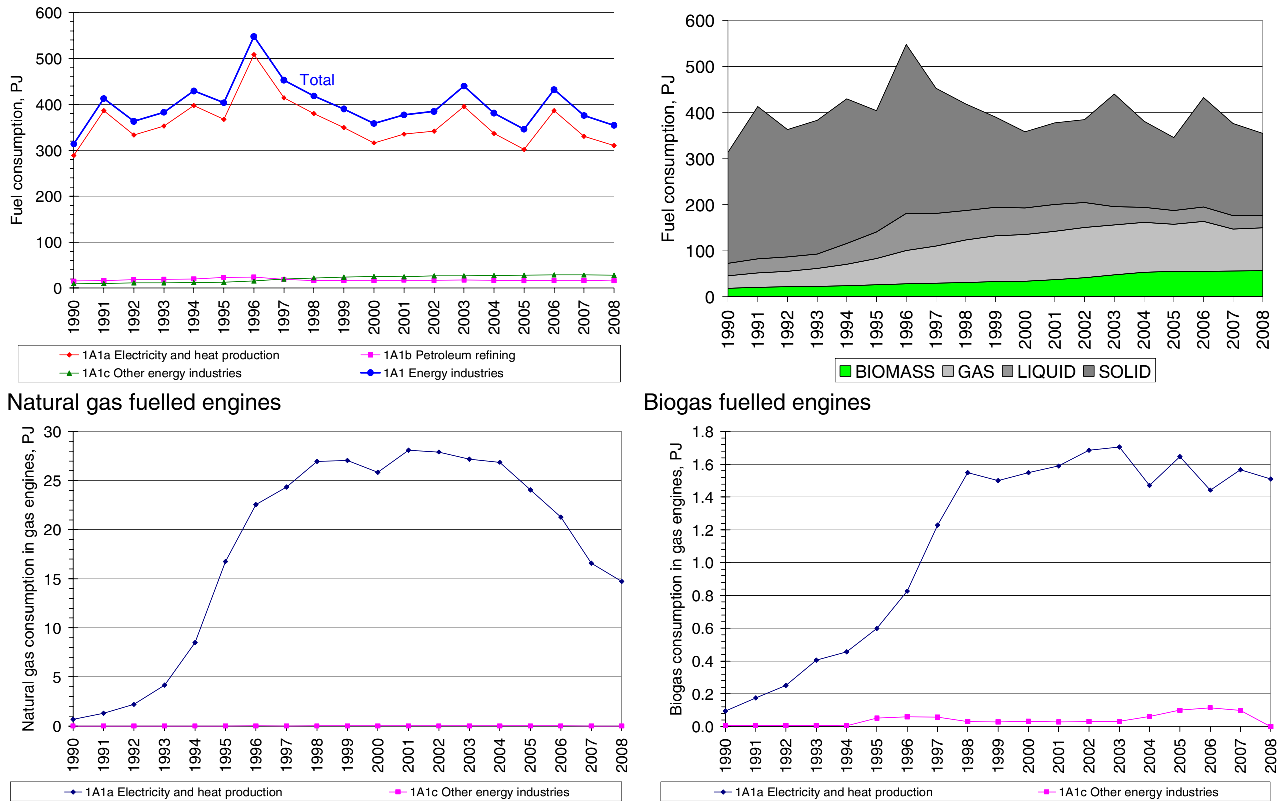


Figure 3.2.21 Time-series for fuel consumption, 1A1 Energy industries.

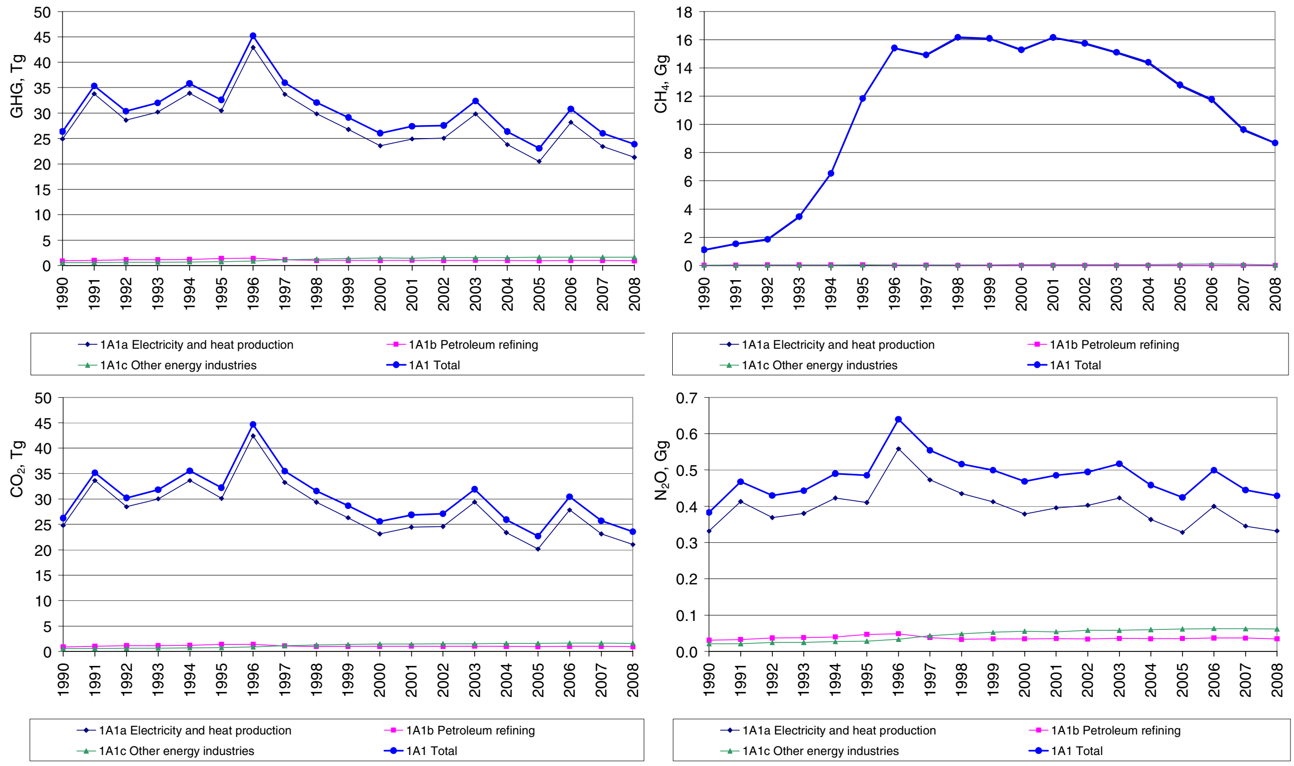


Figure 3.2.22 Time-series for greenhouse gas emission, 1A1 Energy industries.

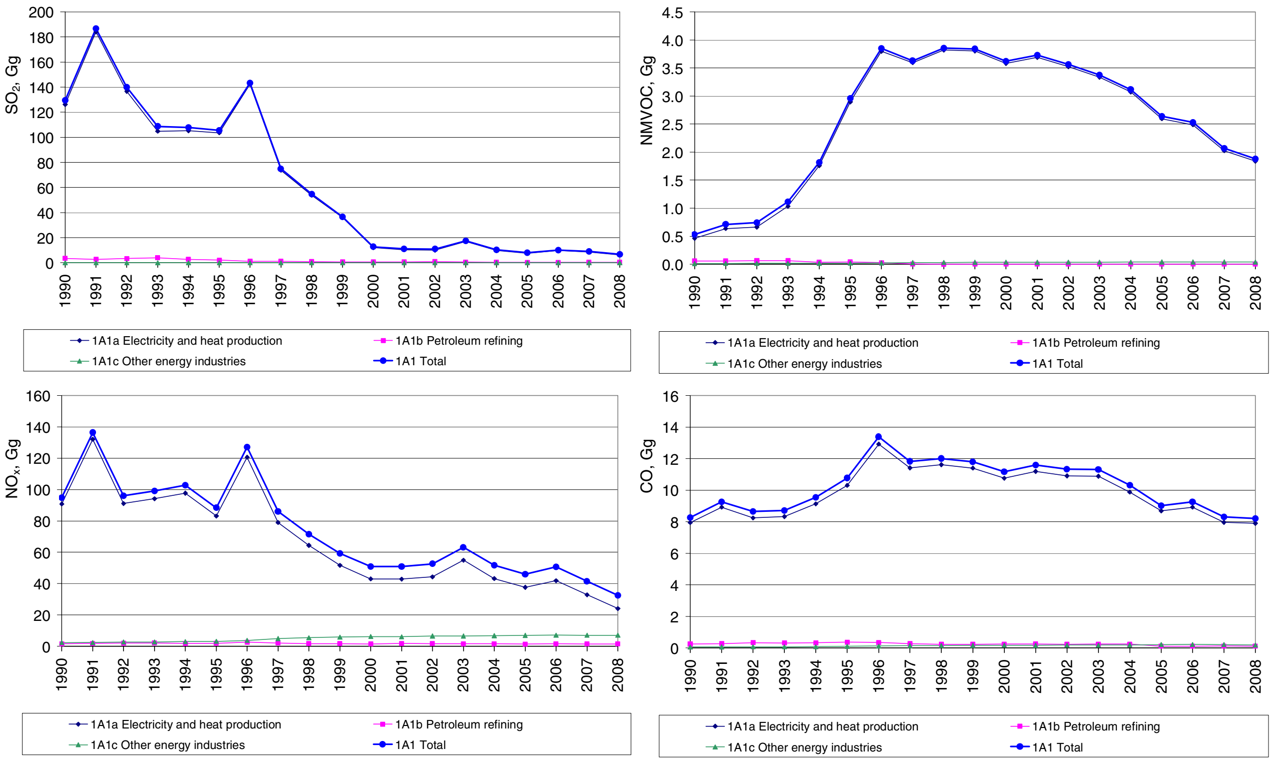


Figure 3.2.23 Time-series for SO_2, NO_x, NMVOC and CO emission, 1A1 Energy industries.

1A1a Electricity and heat production

Public electricity and heat production is the largest source category regarding both fuel consumption and greenhouse gas emissions for stationary combustion. Figure 3.2.24 shows the time-series for fuel consumption and emissions.

The fuel consumption in electricity and heat production was 7 % higher in 2008 than in 1990. As discussed in Chapter 3.2.2 the fuel consumption fluctuates mainly as a consequence of electricity trade. Coal is the fuel that is affected the most by the fluctuating electricity trade. Coal is the main fuel in the source category even in years with electricity import. The coal consumption in 2008 was 31 % lower than in 1990. Natural gas is also an important fuel and the consumption of natural gas has increased since 1990, but decreased since 2003. A considerable part of the natural gas is combusted in gas engines (Figure 3.2.21). The consumption of municipal waste and biomass has increased.

The CO_2 emission was 15 % lower in 2008 than in 1990. This decrease – in spite of higher fuel consumption - is a result of the change of fuel discussed above.

For CH_4 the emission increase until the mid-nineties is a result of the considerable number of lean-burn gas engines installed in CHP plants in Denmark in this period. The decline in later years is due to structural changes in the Danish electricity market, which means that the fuel consumption in gas engines has been decreasing (Figure 3.2.21). The emission in 2008 was 8.1 times the 1990 emission level.

The N_2O emission was the same in 2008 as in 1990. The emission fluctuates similar to the fuel consumption.

The SO_2 emission has decreased 95 % since 1990. This decrease is a result of both lower sulphur content in fuels and installation and improved performance of desulphurisation plants.

The NO_x emission has decreased 73 % due to installation of low NO_x burners, selective catalytic reduction (SCR) units and selective non-catalytic reduction (SNCR) units. The fluctuations in time-series follow the fluctuations in fuel consumption and electricity trade.

The emission of NMVOC in 2008 was four times the 1990 emission level. This is a result of the large number of gas engines that has been installed in Danish CHP plants as mentioned above.

The CO emission was 1 % lower in 2008 than in 1990. The fluctuations follow the fluctuations of the fuel consumption. In addition the emission from gas engines is considerable.

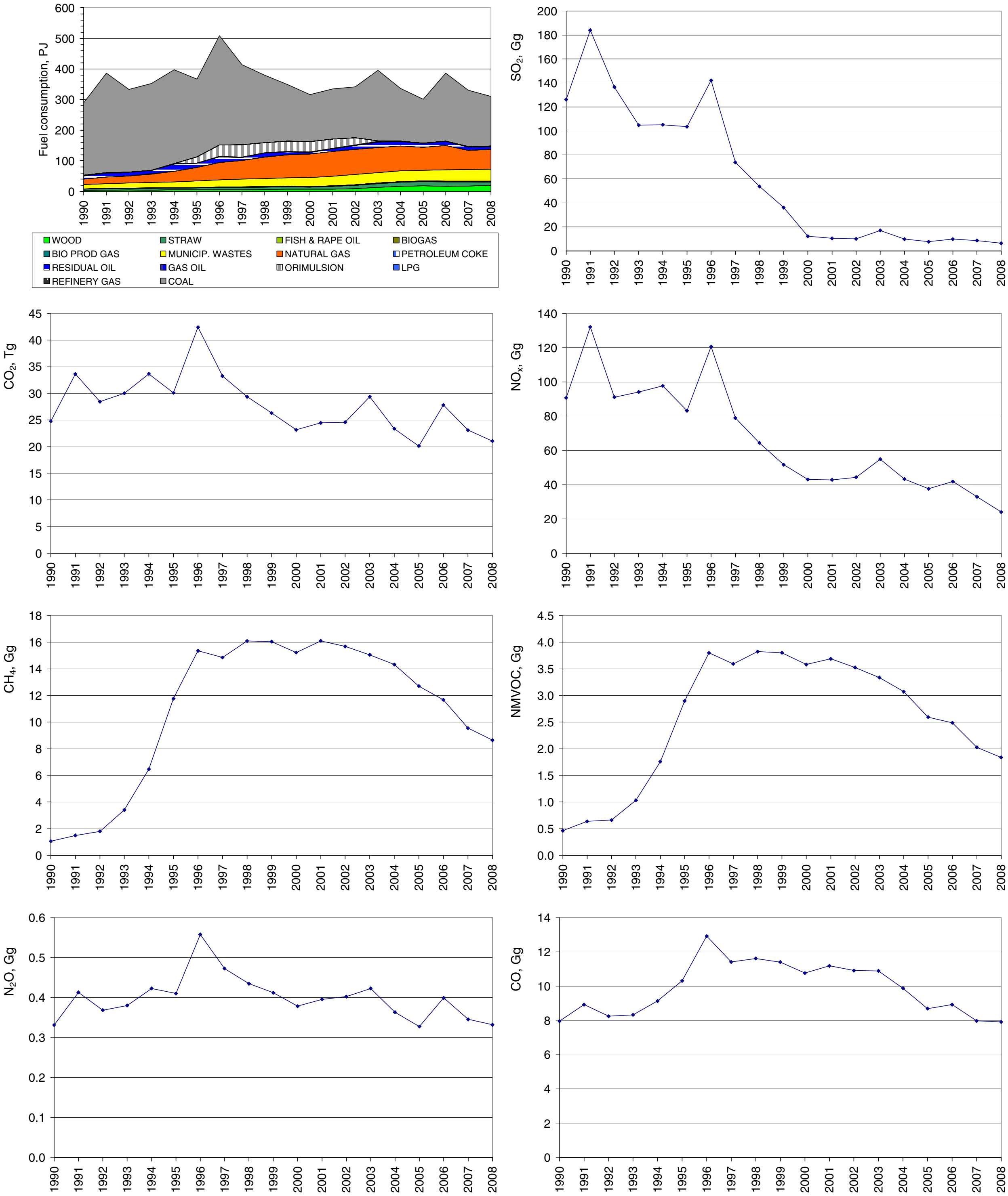


Figure 3.2.24 Time-series for 1A1a Electricity and heat production.

1A1b Petroleum refining

Petroleum refining is a small source category regarding both fuel consumption and greenhouse gas emissions for stationary combustion. There are presently only two refineries operating in Denmark. Figure 3.2.25 shows the time-series for fuel consumption and emissions.

The significant decrease in both fuel consumption and emissions in 1996 is a result of the closure of a third refinery.

The fuel consumption has increased 3 % since 1990 and the CO_2 emission has increased 2 %.

The reduction in CH_4 emission from 1995 to 1999 is due to a combination of the closure of a refinery and a change of emission factor.

The N_2O emission has increased 12 %.

The emission of SO_2 has shown a pronounced decrease (91 %) since 1990, mainly because of technical improvements at the refineries. The NO_x emission decreased 8 %. In recent years data for both SO_2 and NO_x are plant specific data stated by the refineries.

Emissions from refineries are further discussed in Chapter 3.5.

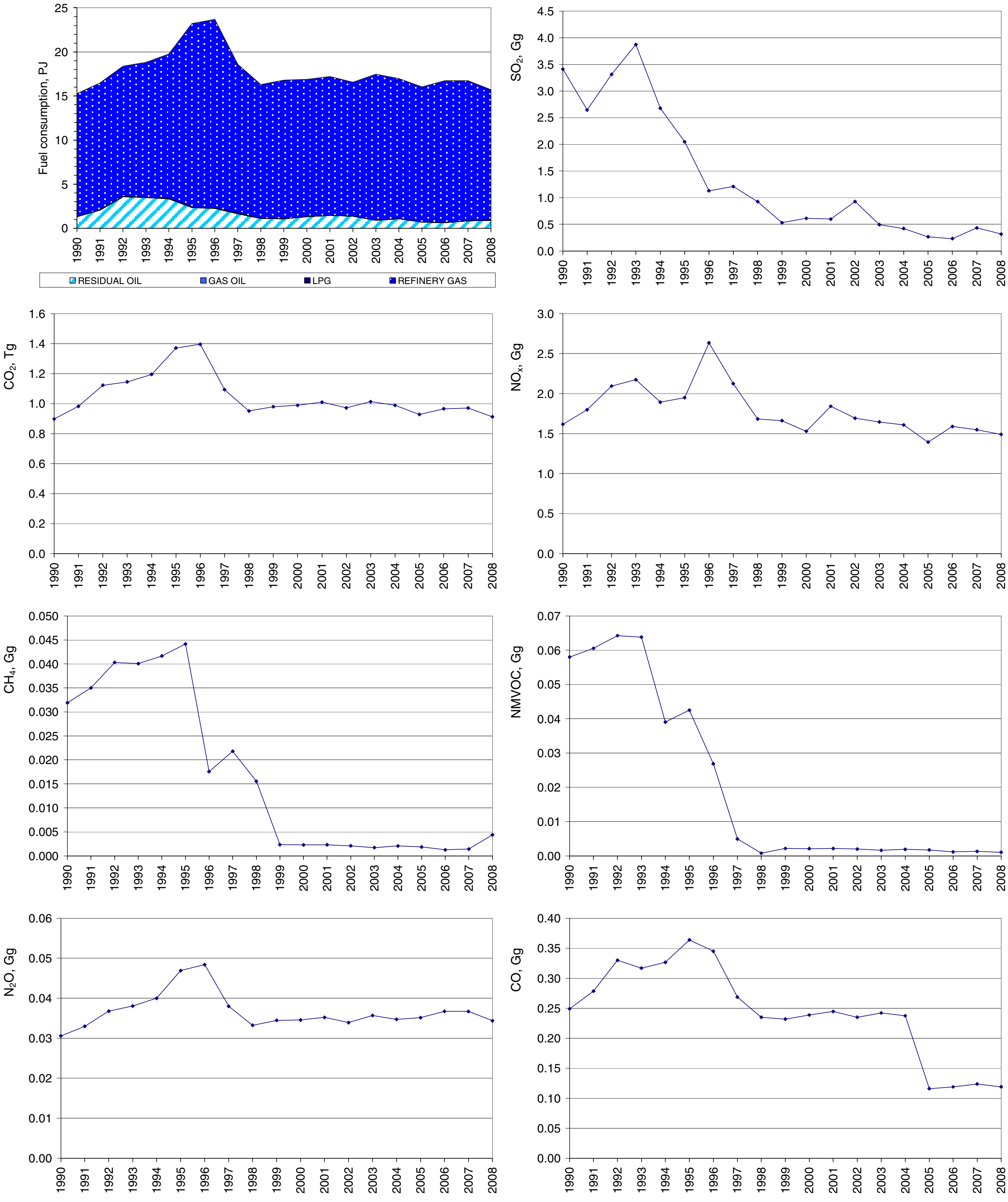


Figure 3.2.25 Time-series for 1A1b Petroleum refining.

1A1c Other energy industries

The source category *Other energy industries* comprises natural gas consumption in the off-shore industry. Gas turbines are the main plant type. Figure 3.2.26 shows the time-series for fuel consumption and emissions.

The fuel consumption in 2008 was three times the consumption in 1990. The CO_2 emission follows the fuel consumption and the emission in 2008 was also three times the emission in 1990.

The two main sources for CH_4 emission in 2008 was off-shore gas turbines and biogas fuelled gas engines[1]. The increase in emission from 2003 to 2006 is due to an increase in biogas consumption in gas engines. The CH_4 emission factor for biogas fuelled gas engines (434 g pr GJ[2]) is much higher than emission factors for off-shore gas turbines (1.7 g pr GJ[2]) and this causes the increase in CH_4 emission despite the low consumption of biogas in this emission source category.

The emissions from other pollutants follow the increase of fuel consumption.

[1] The consumption of biogas will be relocated to other emission source categories in future inventories.
[2] In 2008.

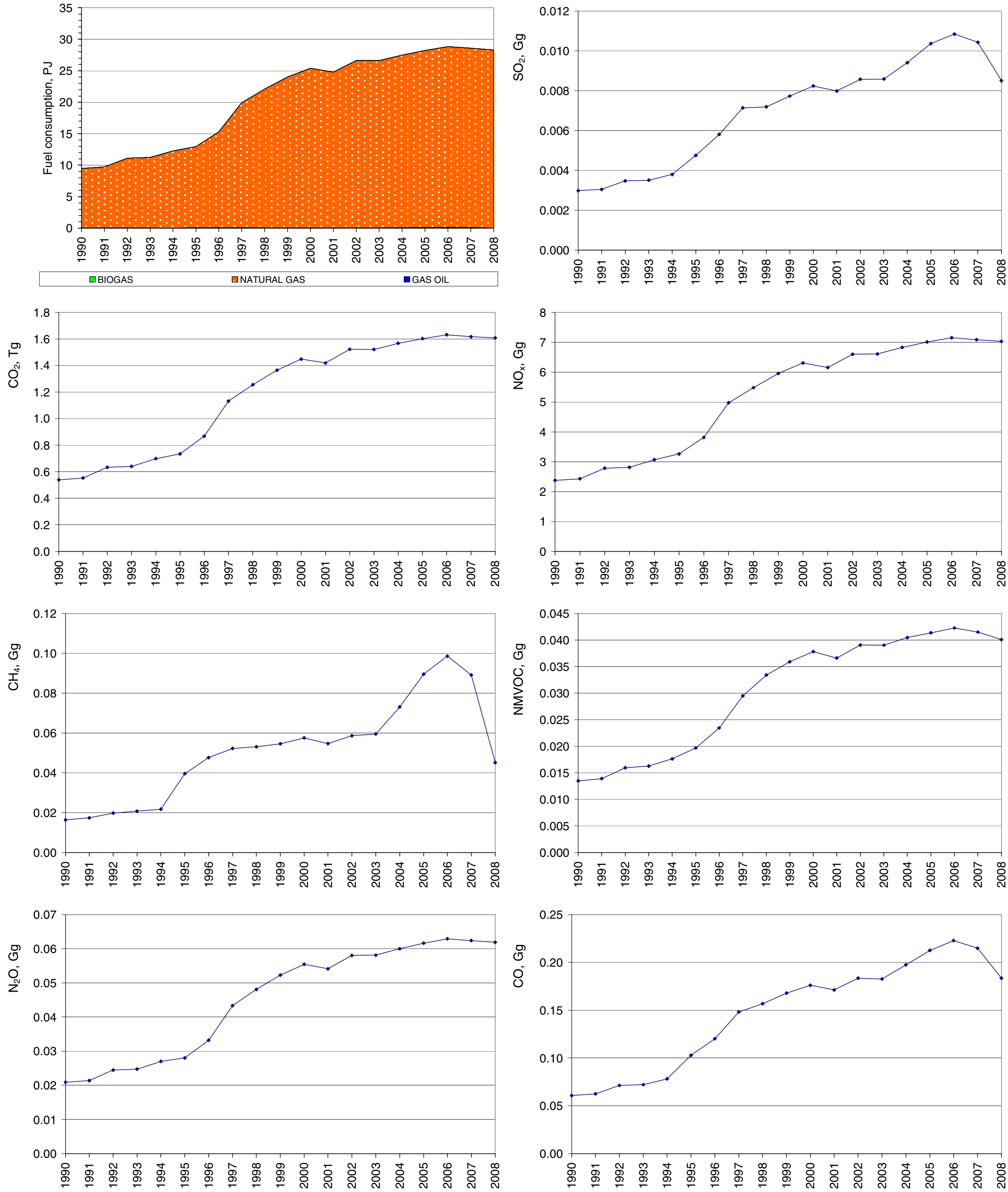


Figure 3.2.26 Time-series for 1A1c Other energy industries.

1A2 Industry

Manufacturing industries and construction (Industry) consists of both stationary and mobile sources. In this chapter only stationary sources are included.

Figure 3.2.27 – 3.2.29 show the time-series for fuel consumption and emissions. The data have not been disaggregated to industrial subcategories due to the fact that the Danish inventory is based on data for the industrial plants as a whole. Disaggregation to subcategories for the re-

porting to the Climate Convention is discussed in the methodology chapter (page 155).

The total fuel consumption in industrial combustion has been rather stable since 1990 and was almost the same in 2008 as in 1990. However, the consumption of gas has increased whereas the consumption of coal has decreased. The consumption of residual oil has decreased, but the consumption of petroleum coke increased. The biomass part of fuel has not changed considerably since 1990.

The GHG emission and the CO_2 emission are both rather stable following the small fluctuations in fuel consumption. In spite of the unchanged of fuel consumption the CO_2 emission has decreased 11 % since 1990 due to the change of fuels.

The CH_4 emission has increased from 1995-2000 and decreased again from 2004 onwards. In 2008 the emission was 51 % higher than in 1990. The CH_4 emission follows the consumption of natural gas in gas engines. Most industrial CHP plants based on gas engines came in operation during 1995 to 1999. The decrease in later years is a result of the liberalisation of the electricity market.

The N_2O emission follows the small fluctuations of the fuel consumption in industrial plants. In 2008 the emission was 3 % lower than in 1990.

The SO_2 emission has decreased 68 % since 1990. This is mainly a result of lower consumption of residual oil in the industrial sector. Further the sulphur content of residual oil and several other fuels has decreased since 1990 due to legislation and tax laws.

The NO_x emission fluctuations follow the fuel consumption in the cement production. However, the NO_x emission has decreased 27 % since 1990 due to the reduced emission from industrial boilers in general.

The NMVOC emission has decreased 71 % since 1990. The decrease is a mainly result of decreased emission factor for combustion of wood in industrial boilers. The emission from gas engines has however increased considerably after 1995 due to the increased fuel consumption that is a result of the installation of a large number of industrial CHP plants. The NMVOC emission factor for gas engines is much higher than for boilers regardless of the fuel.

The CO emission in 2008 was 19 % lower than in 1990. The main source of emission is combustion in mineral wool production. This emission follows the fuel consumption in the mineral wool production plants.

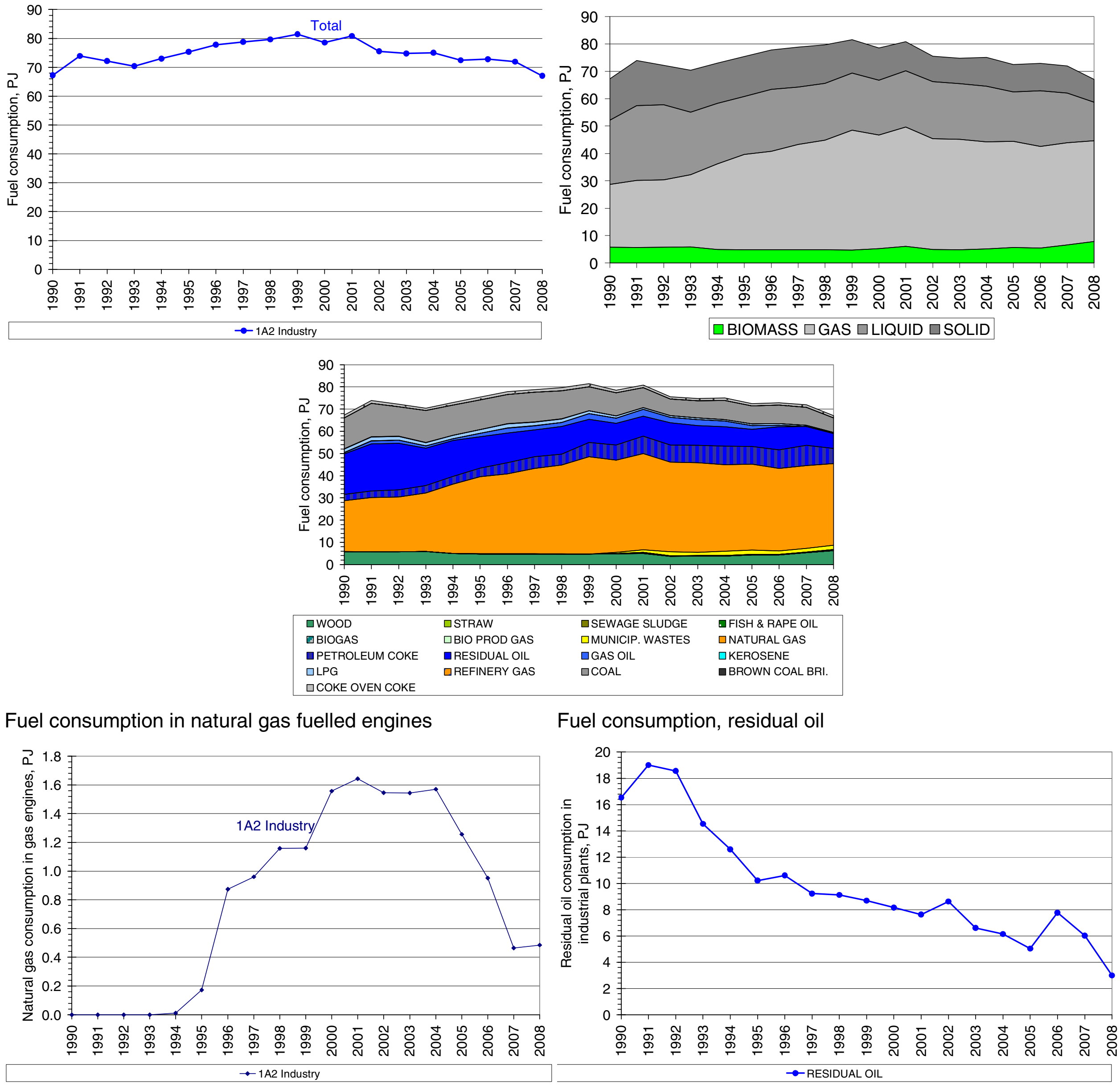


Figure 3.2.27   Time-series for fuel consumption, 1A2 Industry.

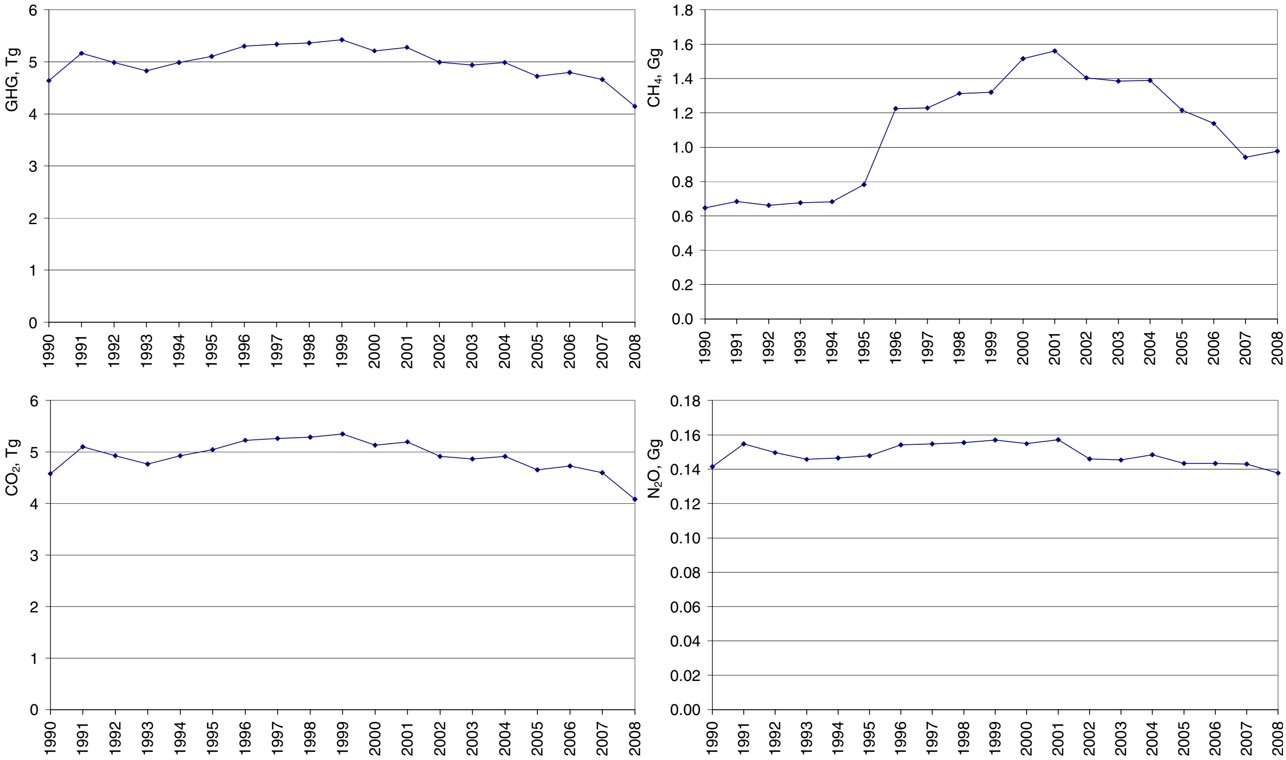


Figure 3.2.28 Time-series for greenhouse gas emission, 1A2 Industry.

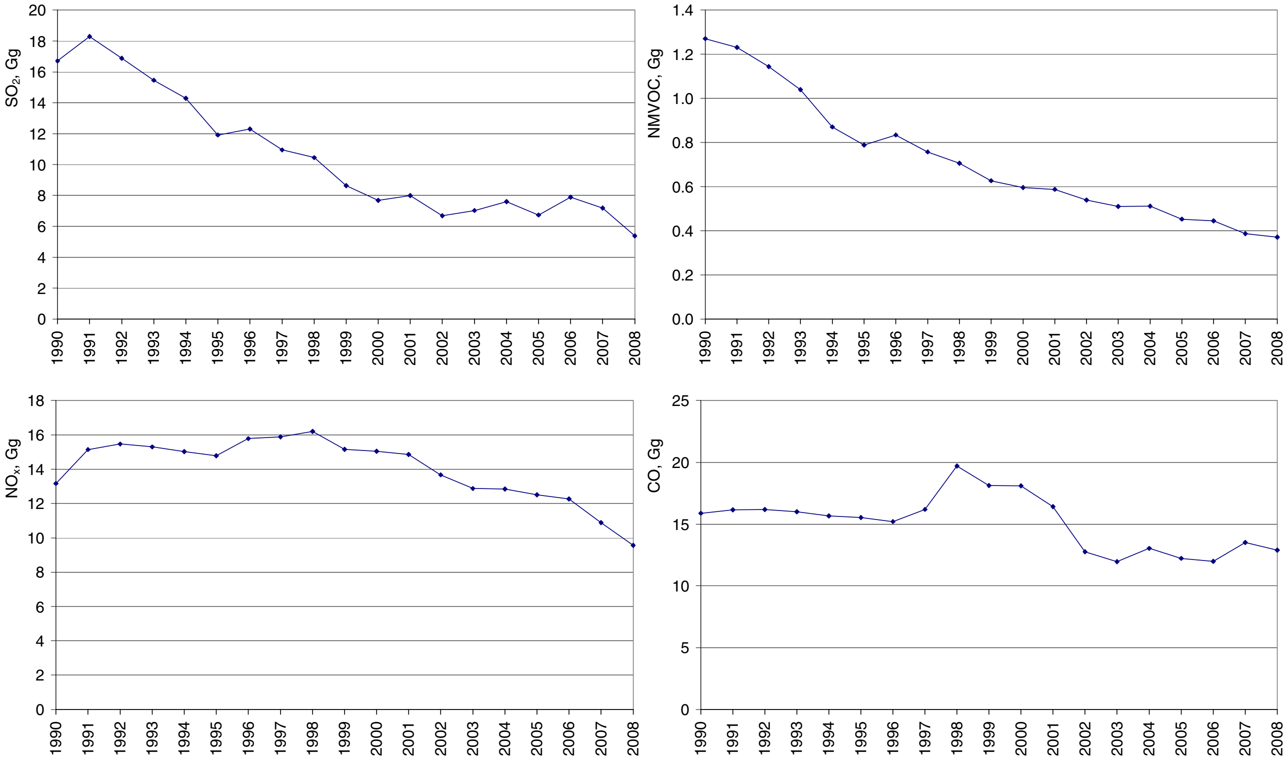


Figure 3.2.29 Time-series for SO_2, NO_x, NMVOC and CO emission, 1A2 Industry.

1A4 Other Sectors

The emission source category *1A4 Other Sectors* consists of the subcategories:

- 1A4a Commercial/Institutional plants.
- 1A4b Residential plants.
- 1A1c Agriculture/Forestry.

Figure 3.2.30-32 present time-series for this emission source category. Residential plants is the largest subcategory accounting for the largest part of all emissions. Time-series are discussed below for each subcategory.

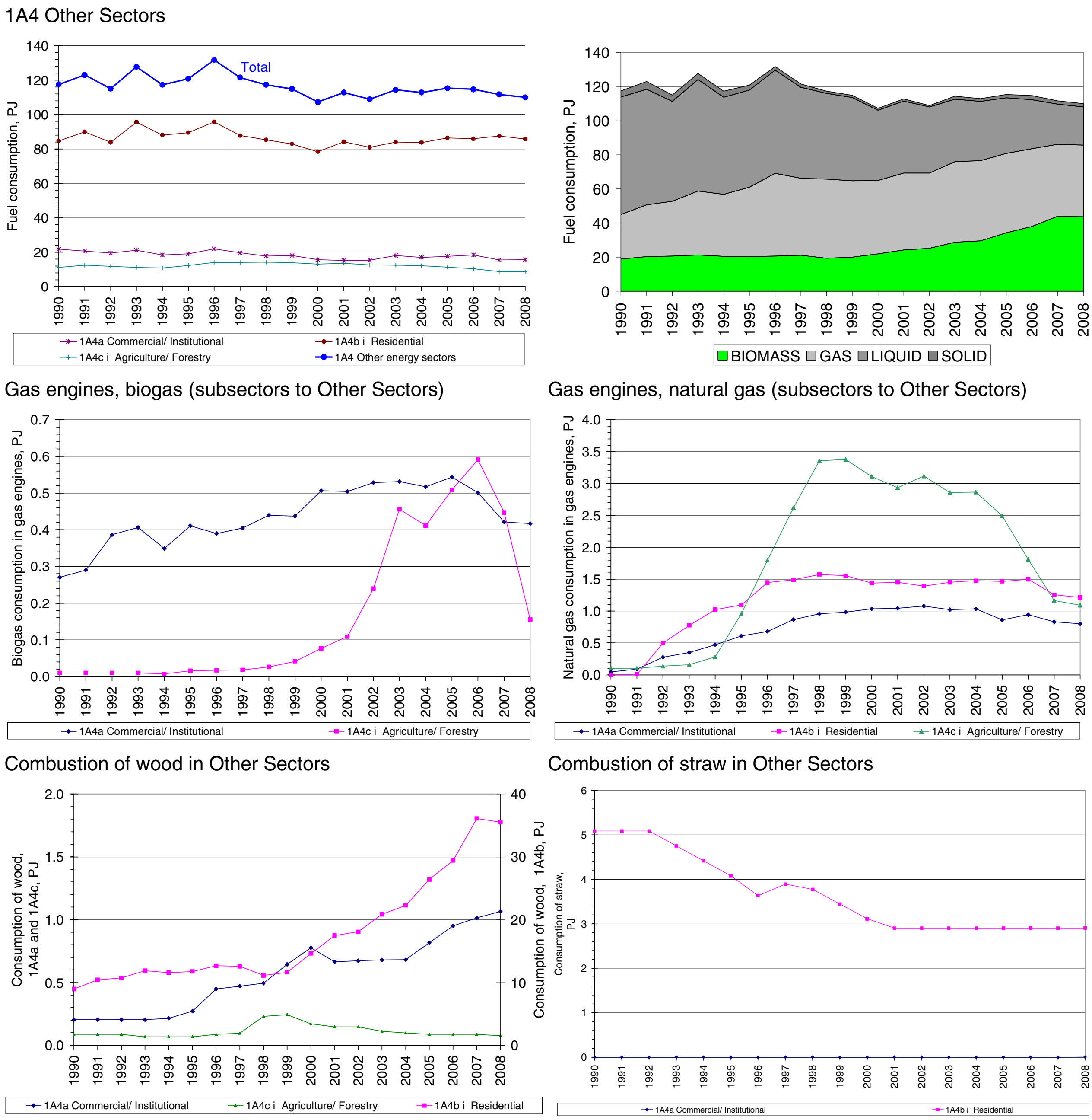


Figure 3.2.30 Time-series for fuel consumption, 1A4 Other Sectors.

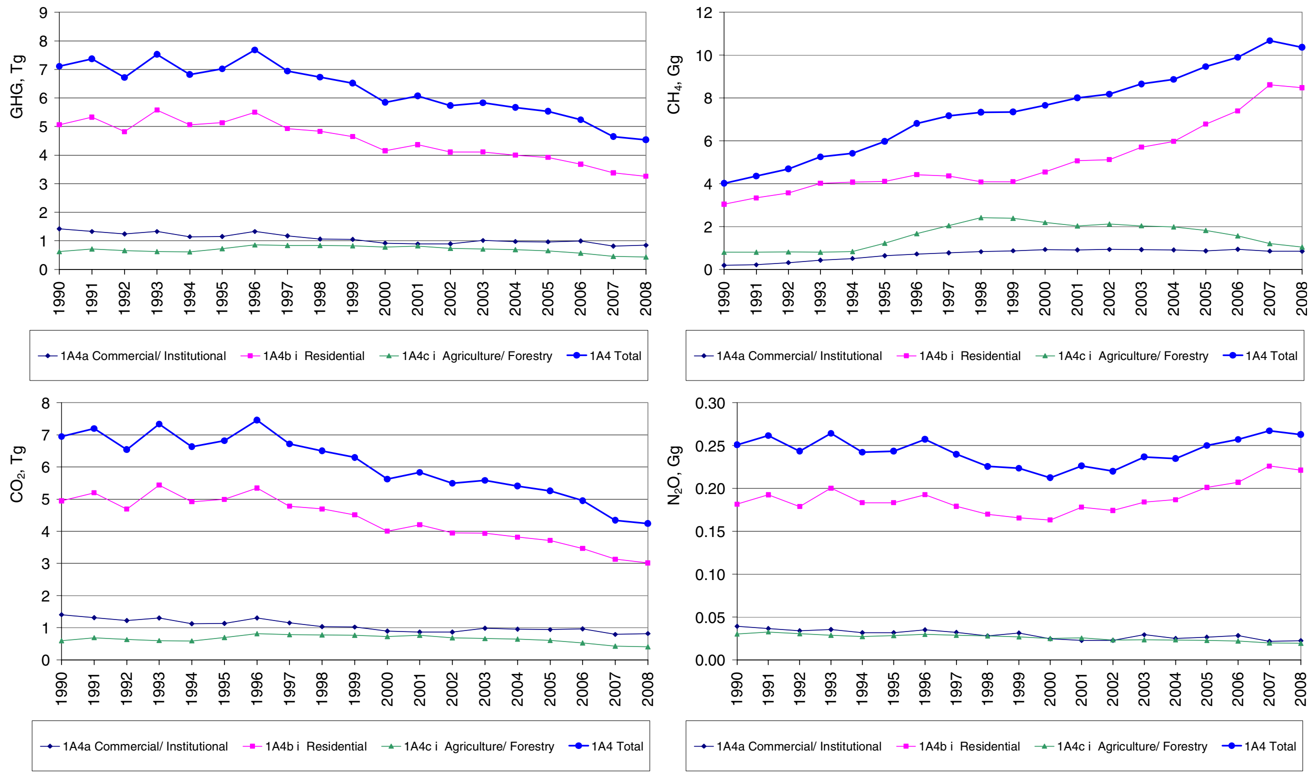


Figure 3.2.31 Time-series for greenhouse gas emission, 1A4 Other Sectors.

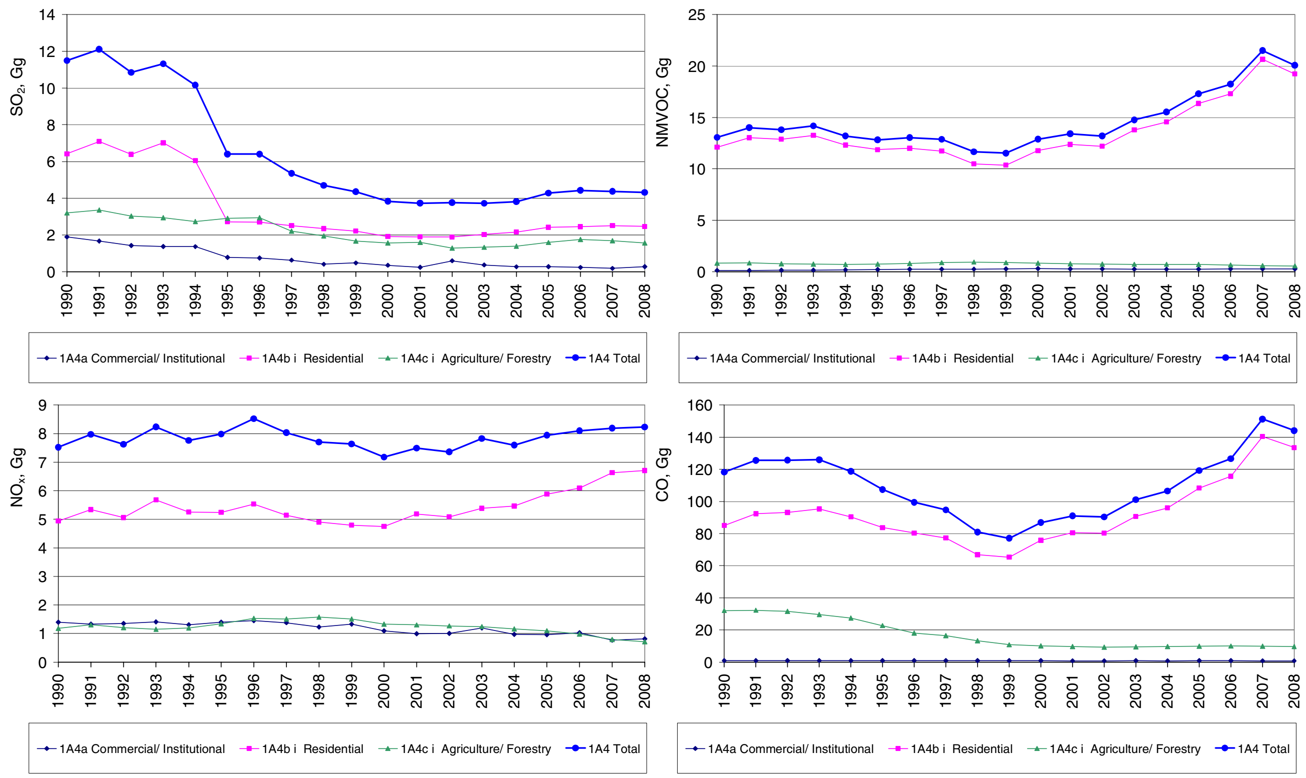


Figure 3.2.32 Time-series for SO_2, NO_x, NMVOC and CO emission, 1A4 Other Sectors.

1A4a Commercial and institutional plants

The subcategory *1A4a Commercial and institutional plants* has low fuel consumption and emissions compared to the other stationary combustion emission source categories. Figure 3.2.33 shows the time-series for fuel consumption and emissions.

The fuel consumption in commercial/institutional plants has decreased 28 % since 1990 and there has been a change of fuel type. The fuel consumption consists mainly of gas oil and natural gas. The consumption of gas oil has decreased and the consumption of natural gas has increased since 1990. The consumption of wood and biogas has also increased. The wood consumption in 2008 was five times the consumption in 1990.

The CO_2 emission has decreased 42 % since 1990. Both the decrease of fuel consumption and the change of fuels – from gas oil to natural gas - contribute to the decreased CO_2 emission.

The CH_4 emission in 2008 was 4.5 times the 1990 level. The increase is mainly a result of the increased emission from natural gas fuelled engines. The emissions from biogas fuelled engines and from combustion of wood also contribute to the increase. The time-series for consumption of natural gas and biogas are shown in Figure 3.2.30.

The N_2O emission in 2008 was 43 % lower than in 1990. This decrease is a result of lower fuel consumption and of the change of fuel from gas oil to natural gas. The emission from wood combustion have, however, been increasing. The fluctuations of the N_2O emission follow the fuel consumption.

The SO_2 emission has decreased 86 % since 1990. The decrease is a result of both the change of fuel from gas oil to natural gas and of the lower sulphur content in gas oil and in residual oil. The lower sulphur content (0.05 % for gas oil since 1995 and 0.7 % for residual oil since 1997) is a result of Danish tax laws (MST 1998).

The NO_x emission was 42 % lower in 2008 than in 1990. The decrease is mainly a result of the lower fuel consumption but also the change from gas oil to natural gas has contributed to the decrease. The emission from gas engines and wood combustion has increased.

The NMVOC emission in 2008 was more than twice the 1990 emission level. The large increase is a result of the increased combustion of wood that is the main source of emission. The increased consumption of natural gas in gas engines also contribute to the increased NMVOC emission.

The CO emission has decreased 14 % since 1990. The emission from wood and from natural gas fuelled engines and boilers has increased whereas the emission from gas oil has decreased. This is a result of the change of fuels applied in the sector.

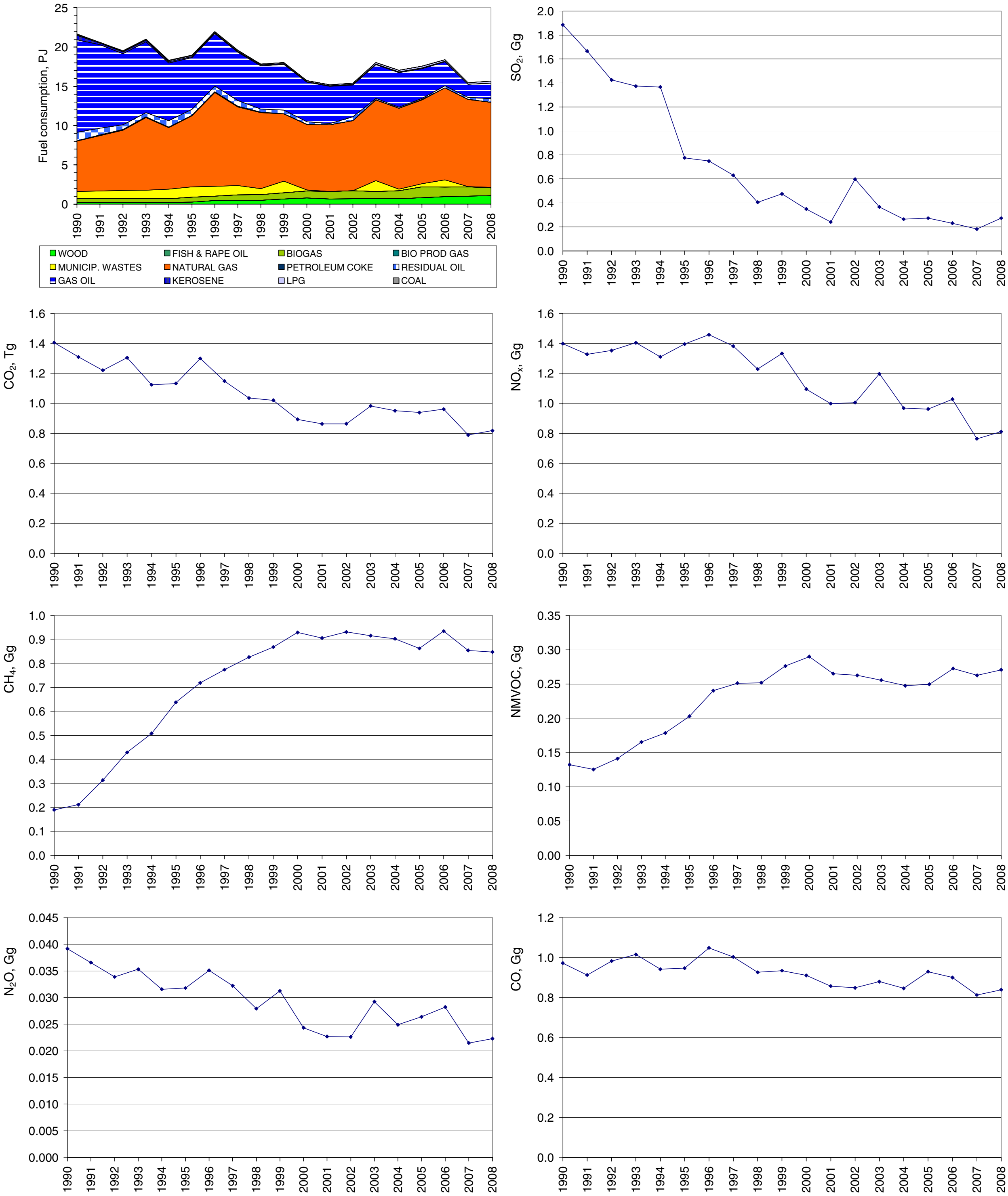


Figure 3.2.33   Time-series for 1A4a Commercial /institutional.

1A4b Residential plants

The emission source category *1A4b Residential plants* consists of both stationary and mobile sources. In this chapter only stationary sources are included. Figure 3.2.34 shows the time-series for fuel consumption and emissions.

For residential plants the total fuel consumption has been rather stable, and in 2008 the consumption was 1 % higher than in 1990. However, the consumption of gas oil has decreased since 1990 whereas the consumption of wood has increased considerably (four times the 1990 level). The consumption of natural gas has also increased since 1990.

The CO_2 emission has decreased by 39 % since 1990. This decrease is mainly a result of the considerable change of applied fuel from gas oil to wood and natural gas.

The CH_4 emission from residential plants has increased to almost three times the 1990 level due to the increased combustion of wood in residential plants, which is the main source of emission. The increased emission from gas engines also contributes to the increased emission.

The N_2O emission follows the fluctuations of the total fuel consumption. The change of fuel from gas oil to wood has resulted in a 22 % increase of N_2O emission since 1990 due to a higher emission factor for wood than for gas oil.

The large decrease (62 %) of SO_2 emission from residential plants is mainly a result of a change of sulphur content in gas oil since 1995. The lower sulphur content (0.05 %) is a result of Danish tax laws (MST 1998).

The NO_x emission has increased by 36 % since 1990 due to the increased emission from wood combustion. The emission factor for wood is higher than for gas oil.

The emission of NMVOC has increased 59 % since 1990 due to the increased combustion of wood. The emission factor for wood has decreased since 1990, but not as much as the increase in consumption of wood. The emission factor for wood and straw is higher than for liquid or gaseous fuels.

The CO emission has increased 57 % due to the increased use of wood that is the main source of emission. The emission from combustion of straw has decreased since 1990.

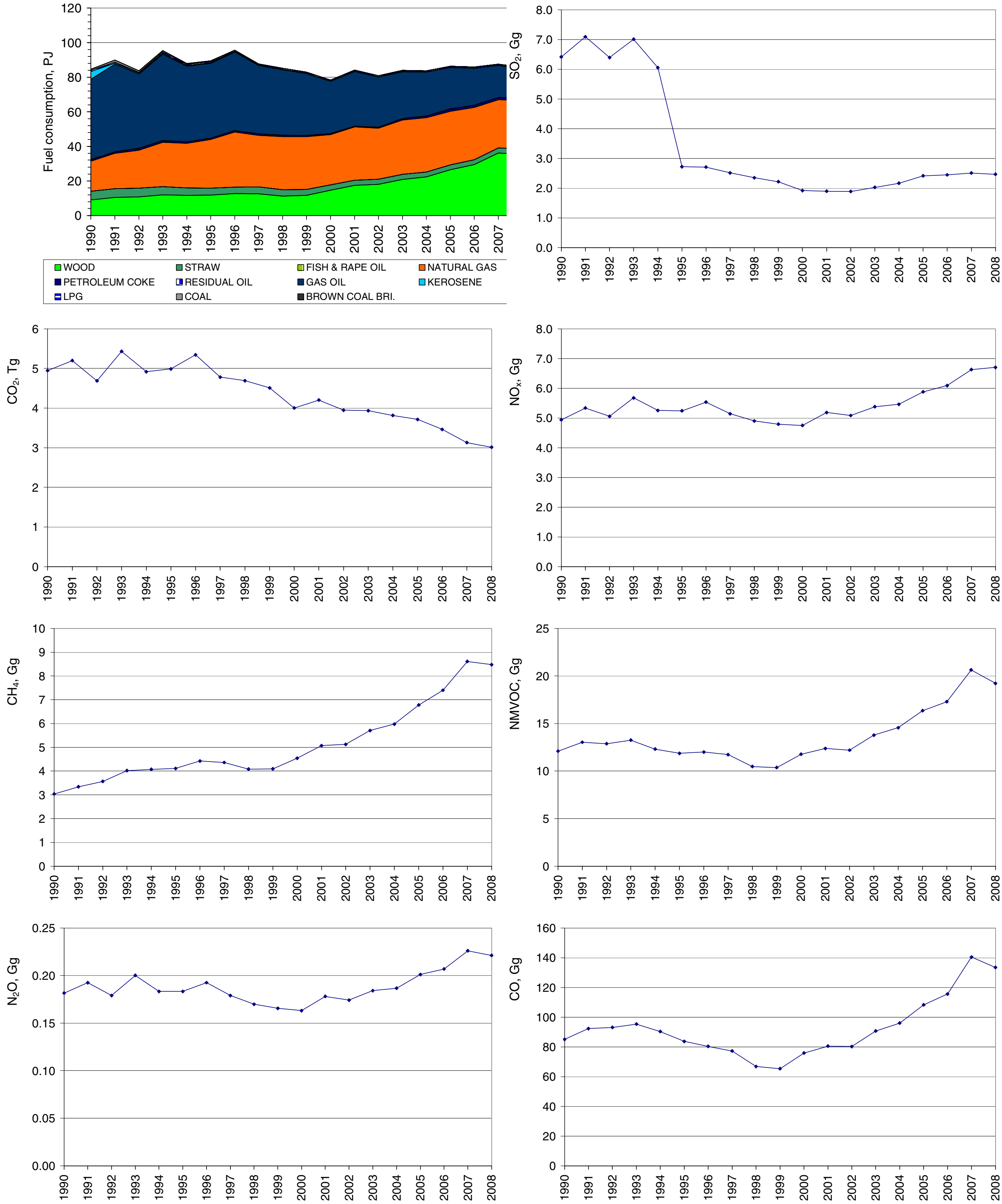


Figure 3.2.34 Time-series for 1A4b Residential plants.

1A4c Agriculture/forestry

The emission source category *1A4c Agriculture/forestry* consists of both stationary and mobile sources. In this chapter only stationary sources are included. Figure 3.2.35 shows the time-series for fuel consumption and emissions.

For plants in agriculture/forestry the fuel consumption has decreased 23 % since 1990. A remarkable decrease of fuel consumption has taken place in recent years.

The type of fuel that has been applied has changed since 1990. In the years 1994-2004 the consumption of natural gas was high, but in recent years the consumption decreased again. A large part of the natural gas consumption has been applied in gas engines (Figure 3.2.30). Most CHP plants in agriculture/forestry based on gas engines came in operation in 1995-1999. The decrease in later years is a result of the liberalisation of the electricity market.

The consumption of straw has decreased since 1990. The consumption of both residual oil and gas oil has increased after 1990 but has decreased again in recent years.

The CO_2 emission in 2008 was 31 % lower than in 1990. The CO_2 emission increased from 1990 to 1996 due to increased fuel consumption. Since 1996 the CO_2 emission has decreased in line with the decrease in fuel consumption.

The CH_4 emission in 2008 was 31 % higher than the emission in 1990. The emission follows the time-series for natural gas combusted in gas engines (Figure 3.2.30). The emission from combustion of straw has decreased as a result of the decreasing consumption of straw in the sector.

The emission of N_2O has decreased by 36 % since 1990. The decrease is a result of the lower fuel consumption as well as the change of fuel. The decreasing consumption of straw contributes considerably to the decrease of emission.

The SO_2 emission was 51 % lower in 2008 than in 1990. The emission decreased from 1990 to 2002 and increased after 2002. The main emission sources are coal, residual oil and straw and it is mainly the increase of coal combustion in the sector that has caused the increase of SO_2 emission in recent years.

The emission of NO_x was 39 % lower in 2008 than in 1990. This is in line with the decrease of fuel consumption.

The emission of NMVOC has decreased 31 % since 1990. The major emission source is combustion of straw. The consumption of straw has decreased since 1990. The emission from gas engines has increased mainly due to increased fuel consumption.

The CO emission has decreased 70 % since 1990. The major emission source is combustion of straw. In addition to the decrease of straw consumption the emission factor for straw has also decreased since 1990.

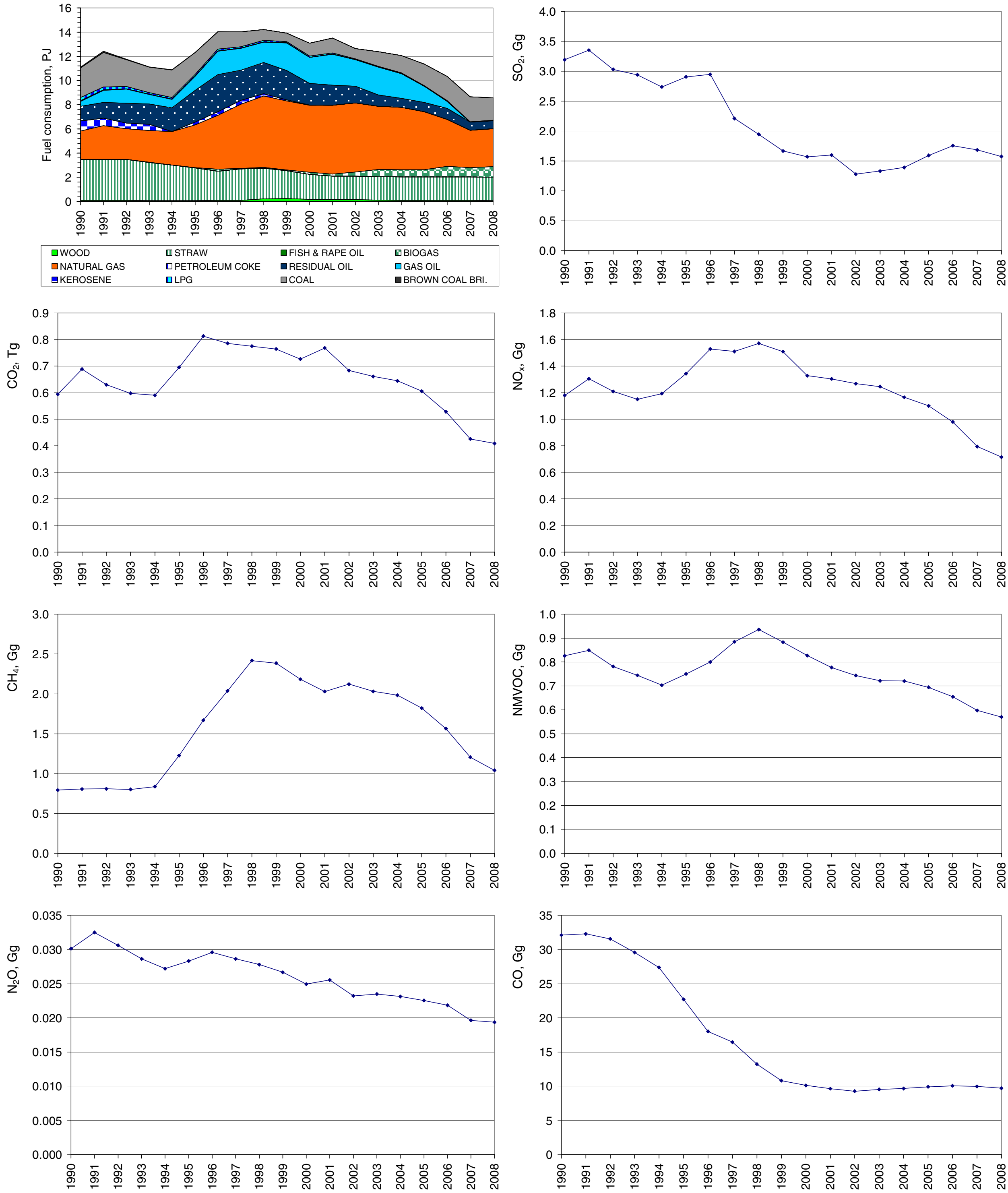


Figure 3.2.35 Time-series for 1A4c Agriculture/Forestry.

3.2.5 Methodological issues

The Danish emission inventory is based on the CORINAIR (CORe INventory on AIR emissions) system, which is a European program for air emission inventories. CORINAIR includes methodology structure and software for inventories. The methodology is described in the EMEP/CORINAIR Emission Inventory Guidebook 2007 update, prepared by the UNECE/EMEP Task Force on Emissions Inventories and Projections (EEA 2007). Emission data are stored in an Access database, from which data are transferred to the reporting formats.

In the Danish emission database all activity rates and emissions are defined in SNAP sector categories (Selected Nomenclature for Air Pollution) according the CORINAIR system. The emission inventories are prepared from a complete emission database based on the SNAP source categories. Aggregation to the source category codes used in CRF is based on a correspondence list enclosed in Annex 3A-1.

The emission inventory for stationary combustion is based on activity rates from the Danish energy statistics. General emission factors for various fuels, plants and sectors have been determined. Some large plants, such as power plants, are registered individually as large point sources and plant-specific emission data are used.

Tiers

The emission inventory is based on the methodology referred to as Tier 2 and Tier 3 in the IPCC Guidelines (IPCC 1996).

Large point sources

Large emission sources such as power plants, industrial plants and refineries are included as large point sources in the Danish emission database. Each point source may consist of more than one part, e.g. a power plant with several units. By registering the plants as point sources in the database it is possible to use plant-specific emission factors.

In the inventory for the year 2008, 70 stationary combustion plants are specified as large point sources. These point sources include:

- Power plants and decentralised CHP plants (combined heat and power plants).
- Municipal waste incineration plants.
- Large industrial combustion plants.
- Petroleum refining plants.

The criteria for selection of point sources consist of the following:

- All centralized power plants, including smaller units.
- All units with a capacity of above 25 MW_e.
- All district heating plants with an installed effect of 50 MW_{th} or above and significant fuel consumption.
- All waste incineration plants obliged to publish annual environmental reports according to Danish law (MST 2006).
- Industrial plants,
  - with an installed effect of 50 MW_{th} or above and significant fuel consumption.
  - with a significant process related emission.

The fuel consumption of stationary combustion plants registered as large point sources in the 2008 inventory was 309 PJ. This corresponds to 58 % of the overall fuel consumption for stationary combustion.

A list of the large point sources for 2008 and the fuel consumption rates is provided in Annex 3A-5. The number of large point sources registered in the databases increased from 1990 to 2008.

The emissions from a point source are based either on plant specific emission data or, if plant specific data are not available, on fuel consumption data and the general Danish emission factors. Annex 3A-5 shows which of the emission data for large point sources are plant-specific and the corresponding share of the emission from stationary combustion.

SO_2 and NO_x emissions from large point sources are often plant-specific based on emission measurements. CO_2 emission factors are plant specific for the major power plants. Emissions of CO and NMVOC are also plant-specific for some plants. Plant-specific emission data are obtained from:

- Annual environmental reports.
- Annual plant-specific reporting of SO_2 and NO_x from power plants >25MW_e prepared for the Danish Energy Agency due to Danish legislatory requirement.
- Emission data reported by DONG Energy and Vattenfall, the two major electricity suppliers.
- CO_2 data reported under the EU Emission Trading Scheme.
- Emission data reported from industrial plants.

Annual environmental reports for the plants include a considerable number of emission data sets. Emission data from annual environmental reports are, in general, based on emission measurements, but some emissions have potentially been calculated from general emission factors.

If plant-specific emission factors are not available, general area source emission factors are used. Emissions of the greenhouse gases CH_4 and N_2O from the large point sources are all based on the area source emission factors.

Area sources

Fuels not combusted in large point sources are included as source category specific area sources in the emission database. Plants such as residential boilers, small district heating plants, small CHP plants and some industrial boilers are defined as area sources. Emissions from area sources are based on fuel consumption data and emission factors. Further information on emission factors is provided below in the chapter Emission factors (page 138).

Activity rates, fuel consumption

The fuel consumption rates are based on the official Danish energy statistics prepared by the Danish Energy Agency (DEA). The DEA aggregates fuel consumption rates to SNAP categories (DEA 2009a). Some fuel types in the official Danish energy statistics are added to obtain a less detailed fuel aggregation level cf. Annex 3A-3. The calorific values on which the energy statistics are based are also enclosed in Annex 3A-3. The correspondence list between the energy statistics and SNAP categories is enclosed in Annex 3A-9.

The fuel consumption of the IPCC category *Manufacturing industries and construction* (corresponding to SNAP category *03 Combustion in manufacturing industries)* is not disaggregated into specific industries in the NERI emission database. Disaggregations into specific industries have been estimated for the reporting to the Climate Convention. The disaggregation of fuel consumption and emissions from the industrial category is discussed below on page 155.

Both traded and non-traded fuels are included in the Danish energy statistics. Thus, for example, estimation of the annual consumption of non-traded wood is included.

Petroleum coke purchased abroad and combusted in Danish residential plants (border trade of 251 TJ) is added to the apparent consumption of petroleum coke and the emissions are included in the inventory.

The fuel consumption data for large point sources refer to the EU Emission Trading Scheme (EU ETS) data for plants for which the CO_2 emission also refer to EU ETS, see page 138.

For all other large point sources the fuel consumption refers to a DEA database (DEA 2009c). The DEA compiles a database for the fuel consumption of each district heating and power-producing plant, based on data reported by plant operators.

The fuel consumption of area sources is calculated as total fuel consumption minus fuel consumption of large point sources.

The Danish national energy statistics includes three fuels used for non-energy purposes, bitumen, white spirit and lubricants. The total consumption for non-energy purposes is relatively low, e.g. 11.1 PJ in 2008. The use of white spirit is included in the inventory in *Solvent and other product use*. The emissions associated with the use of bitumen and lubricants are included in *Industrial Processes.* The non-energy use of fuels is included in the reference approach for Climate Convention reporting.

In Denmark all municipal waste incineration are utilised for heat and power production. Thus, incineration of waste is included as stationary combustion in the source category *Energy* (subcategories *1A1*, *1A2* and *1A4)*.

Fuel consumption data are presented in Chapter 3.2.2.

Town gas

Town gas has been included in the fuel category natural gas. The consumption of town gas in Denmark is very low, e.g. 0.4 PJ in 2008. In 1990 the town gas consumption was 1.5 PJ and the consumption has been steadily decreasing through out the time-series.

In Denmark town gas is produced based on natural gas. The use of coal for town gas production ceased in the early 1980s.

An indicative composition of town gas according to the largest supplier of town gas in Denmark is shown in Table 3.2.10 (KE, 2009).

Table 3.2.10 Composition of town gas currently used (KE, 2009).

Component	Town gas, % (mol.)
Methane	43.9
Ethane	2.9
Propane	1.1
Butane	0.5
Carbon dioxide	0.4
Nitrogen	40.5
Oxygen	10.7

The lower heating value of the town gas currently used is 19.3 MJ pr Nm^3 and the CO_2 emission factor 56.4 kg pr GJ. This is very close to the emission factor used for natural gas of 56.77 kg pr GJ. According to the supplier both the composition and heating value will change during the year. It has not been possible to obtain a yearly average.

In earlier years the composition of town gas was somewhat different. Table 3.2.11 is constructed with the input from Københavns Energi (KE) (Copenhagen Energy) and Danish Gas Technology Centre (DGC), (Jeppesen, 2008; Kristensen, 2007). The data refer to three measurements performed several years apart; the first in 2000 and the latest in 2005.

Table 3.2.11 Composition of town gas, information from the period 2000-2005.

Component	Town gas, % (mol.)
Methane	22.3-27.8
Ethane	1.2-1.8
Propane	0.5-0.9
Butane	0.13-0.2
Higher hydrocarbons	0-0.6
Carbon dioxide	8-11.6
Nitrogen	15.6-20.9
Oxygen	2.3-3.2
Hydrogen	35.4-40.5
Carbon monoxide	2.6-2.8

The lower calorific value has been between 15.6 and 17.8 MJ pr Nm^3. The CO_2 emission factors - derived from the few available measurements - are in the range of 52-57 kg pr GJ.

The Danish approach includes town gas as part of the fuel category natural gas and thus indirectly assumes the same CO_2 emission factor. This is a conservative approach ensuring that the CO_2 emissions are not underestimated.

Due to the scarce data available and the very low consumption of town gas compared to consumption of natural gas, the methodology will be applied unchanged in future inventories.

Emission factors

For each fuel and SNAP category (sector and e.g. type of plant) a set of general area source emission factors has been determined. The emission factors are either nationally referenced or based on the international guidebooks: EEA/CORINAIR Guidebook (EEA 2009)[3] and IPCC Reference Manual (IPCC 1996).

[3] And former editions of the EMEP/Corinair Guidebook.

A complete list of emission factors including time-series and references is provided in Annex 3A-4.

CO_2, use of EU ETS data

The CO_2 emission factors for some large power plants and for combustion in the cement industry are plant specific and based on the reporting to the EU Emission Trading Scheme (EU ETS). The EU ETS data have been applied for the years 2006 - 2008.

The Danish emission inventory only includes data from plants using higher tier methods as defined in an EU decision (EU Commission 2004), where the specific methods for determining carbon contents, oxidation factor and calorific value are specified. The EU decision includes rules for measuring, reporting and verification. For more information regarding the specifics of the EU ETS please refer to the Commission webpage: http://ec.europa.eu/environment/climat/emission/implementation_en.htm

NERI performs some QA/QC checks on the emission reports made by the plants.

The EU ETS data for power plants include plant specific emission factors for coal, residual oil and gas oil. The EU ETS data account for 50 % of the CO_2 emission from stationary combustion.

EU ETS data for 2008 were available from 17 coal fired power plant units. The plant specific information accounts for 95 % of the Danish coal consumption and 48 % of the total CO_2 emission from stationary combustion plants. The average CO_2 emission factor for coal for these 17 units was 94.0 kg pr GJ (Table 3.2.12).

Table 3.2.12 EU ETS data for 17 coal fired power plant units, 2008.

	Average	Min	Max
Heating value, GJ pr tonne	24.3	23.2	25.3
CO_2 implied emission factor, kg pr GJ	94.0	93.2	96.2
Oxidation factor	0.995	0.985	1.000

EU ETS data for 2008 based on higher tier methodologies were available from 19 units combusting residual oil and for 5 units combusting gas oil. Aggregated data are shown in Table 3.2.13 and Table 3.2.14. The EU ETS data accounts for 43 % of the residual oil consumption in stationary combustion and 5 % of the gas oil consumption.

Table 3.2.13 EU ETS data for 19 power plant units combusting residual oil.

	Average	Min	Max
Heating value, GJ pr tonne	40.5	40.1	41.4
CO_2 implied emission factor, kg pr GJ	78.6	77.2	79.8
Oxidation factor	1.00	1.00	1.00

Table 3.2.14 EU ETS data for 5 power plant units combusting gas oil.

	Average	Min	Max
Heating value, GJ pr tonne	42.7	42.5	42.8
CO_2 implied emission factor, kg pr GJ	73.7	73.4	75.2
Oxidation factor	1.00	1.00	1.00

Plant specific CO_2 emission factors have also been applied for the cement production, which is part of source category 1A2f Industry. The CO_2 emission factors refer to EU ETS for coal and residual oil.

CO_2, other emission factors

The CO_2 emission factors that are not included in EU ETS data or that are included but based on lower tier methodologies are not plant specific in the Danish inventory. The emission factors that are not plant specific accounts for 50 % of the CO_2 emission.

The CO_2 emission factors applied for 2008 are presented in Table 3.2.15. For municipal waste and natural gas time-series have been estimated. For all other fuels the same emission factor has been applied for 1990-2008.

In reporting for the Climate Convention, the CO_2 emission is aggregated to five fuel types: Solid fuel, Liquid fuel, Gas, Biomass and Other fuels. The correspondence list between the NERI fuel categories and the IPCC fuel categories is also provided in Table 3.2.20.

Only emissions from fossil fuels are included in the total national CO_2 emission. The biomass emission factors are also included in the table, because emissions from biomass are reported to the Climate Convention as a memo item.

The CO_2 emission from incineration of municipal waste (79.6 + 32.5 kg pr GJ) is divided into two parts: The emission from combustion of the plastic content of the waste, which is included in the national total, and the emission from combustion of the rest of the waste – the biomass part, which is reported as a memo item. In the IPCC reporting, the fuel consumption and emissions from the plastic content of the waste is reported in the fuel category, *Other fuels*.

The CO_2 emission factors have been confirmed by the two major power plant operators, both directly (Christiansen 1996 and Andersen 1996) and indirectly, by applying the NERI emission factors in the annual environmental reports[4] for the large power plants and by accepting use of the NERI factors in Danish legislation. However, for recent years CO_2 emission factors for most power plants refer to EU ETS data.

[4] Until 2006. After that EU ETS data have been applied.

Table 3.2.15 CO_2 emission factors, 2008.

Fuel	Emission factor kg pr GJ Biomass	Fossil fuel	Reference type	IPCC fuel Category
Coal		95 1)3)	Country specific	Solid
Brown coal briquettes		94.6 2)	IPCC 1996	Solid
Coke oven coke		108	IPCC 1996	Solid
Petroleum coke		92 3)	Country specific	Liquid
Wood	102		EEA 2002	Biomass
Municipal waste	79.6 3)4)	+ 32.5 3)4)	Country specific	Biomass and Other fuels
Straw	102		EEA 2002	Biomass
Residual oil		78 1)3)	EEA 2007	Liquid
Gas oil		74 1)	EEA 2007	Liquid
Kerosene		72	IPCC 1996	Liquid
Fish & rape oil	74		Country specific	Biomass
Orimulsion		80 2)	Country specific	Liquid
Natural gas		56.77	Country specific	Gas
LPG		65	EEA 2007	Liquid
Refinery gas		56.9	Country specific	Liquid
Biogas	83.6		Country specific	Biomass
Biomass producer gas	102 5)		Country specific	Biomass

1) Plant specific data from EU ETS incorporated for individual plants.

2) Not applied in 2008.

3) Plant specific data from EU ETS incorporated for cement production.

4) The emission factor for municipal waste is (76.6+32.5) kg CO_2 pr GJ municipal waste. The fuel consumption and the CO_2 emission have been disaggregated to the two IPCC fuel categories *Biomass* and *Other fuels* in CRF. The IEF for CO_2, Other fuels is 78.88 kg CO_2 pr GJ fossil municipal waste.

5) The CO_2 emission factor for wood has been applied. However the composition of the gas is well-known and the emission factor will be recalculated.

Coal

The emission factor for coal, 95 kg pr GJ, is based on Fenhann & Kilde (1994). The CO_2 emission factors have been confirmed by the two major power plant operators in 1996 (Christiansen 1996 and Andersen 1996). One of the major power plant owners (Elsam[5]) reconfirmed the factor in 2001 (Christiansen 2001). The same emission factor has been applied for 1990-2008.

As mentioned above EU ETS data have been utilised for the 2006 - 2008 emission inventories. In 2008 the implied emission factor for the power plants using coal was 94.0 kg pr GJ. However, the CO_2 emission factor was above 95 kg pr GJ for several plants. Thus the emission factor 95 kg pr GJ is a slightly conservative estimate within the range of the EU ETS data.

In 2008 only 3 % of the CO_2 emission from coal consumption was based on the general emission factor, whereas 97 % of the coal consumption was covered by EU ETS data[6].

Brown coal briquettes

The emission factor for brown coal briquettes, 94.6 kg pr GJ, is based on a default value from the IPCC Guidelines (IPCC 1996) assuming full oxidation. The default value in the IPCC Guidelines is 25.8 t C pr TJ, corresponding to $25.8 \cdot (12+2 \cdot 16)/12 = 94.6$ kg CO_2 pr GJ assuming full oxidation. The same emission factor has been applied for 1990-2008.

[5] Elsam was one of the tow major power plant owners. Now part of DONG Energy.

[6] Including EU ETS data for cement production.

Coke oven coke

The emission factor for coke oven coke, 108 kg pr GJ, is based on a default value from the IPCC Guidelines (IPCC 1996) assuming full oxidation. The default value in the IPCC guidelines is 29.5 t C pr TJ, corresponding to $29.5 \cdot (12+2 \cdot 16)/12 = 108$ kg CO_2 pr GJ assuming full oxidation. The same emission factor has been applied for 1990-2008.

Petroleum coke

The emission factor for petroleum coke, 92 kg pr GJ, has been estimated by SK Energy (a former major power plant operator in eastern Denmark) in 1999 based on a fuel analysis carried out by dk-Teknik in 1993 (Bech, 1999). The emission factor level was confirmed by a new fuel analysis, which, however, is considered confidential. The same emission factor has been applied for 1990-2008.

Plant specific EU ETS data have been utilised for the cement production in the 2006 - 2008 emission inventories.

Wood

The emission factor for wood, 102 kg pr GJ, refers to Fenhann & Kilde (1994). The factor is based on the interval stated in a former edition of the EMEP/CORINAIR Guidebook (EEA 2002) and the actual value is the default value from the CollectER database. The same emission factor has been applied for 1990-2008.

Municipal waste

The CO_2 emission from incineration of municipal waste is divided into two parts: The emission from combustion of the plastic content of the waste, which is included in the national total, and the emission from combustion of the rest of the waste – the biomass part, which is reported as a memo item.

The total CO_2 emission factor for municipal waste refers to a Danish study (Jørgensen & Johansen 2003). Based on emission measurements on five municipal waste incineration plants the total CO_2 emission factor for municipal waste incineration has been determined to 112.1 kg pr GJ.

The current disaggregation of the emission factor in a fossil part and a biomass part has been estimated by a working group to be between 30 and 35 kg CO_2 pr GJ municipal waste (Nielsen 2009). NERI has assumed that the fossil fuel emission factor is 32.5 kg CO_2 pr GJ municipal waste.

An ongoing project, *Biogenic carbon in Danish combustible waste* (DTU 2008), will further improve knowledge concerning the disaggregation of the CO_2 emission factor in a fossil and a biomass fraction.

The lower calorific value of municipal waste refers to the Danish energy statistics (DEA 2009b). Time-series for the CO_2 emission factors have been based on the assumption that the increasing calorific value of the waste is a result of the increased fraction of fossil waste since 1990. This assumption is highly uncertain, but better data are not available at present. Table 3.2.16 shows time-series for the CO_2 emission factors. The CO_2 emission from the biomass part is the total CO_2 emission minus the CO_2 emission from the plastic part.

Emission data from four waste incineration plants (Jørgensen & Johansen, 2003) demonstrate the fraction of the carbon content of the waste not oxidised to be approximately 0.3 %. The un-oxidised fraction of the carbon content is assumed to originate from the biomass content, and all carbon originating from plastic are assumed to be oxidised.

Table 3.2.16 CO_2 emission factors for municipal waste, time-series.

Year	Lower heating value of municipal waste [1]	CO_2 emission factor, fossil	CO_2 emission factor for municipal waste, total [2]	CO_2 emission factor, biomass
	GJ pr Mg waste	kg pr GJ waste	kg pr GJ waste	kg pr GJ waste
1990	8.2	25.4	112.1	86.7
1991	8.2	25.4	112.1	86.7
1992	9.0	27.9	112.1	84.2
1993	9.4	29.1	112.1	83.0
1994	9.4	29.1	112.1	83.0
1995	10.0	31.0	112.1	81.1
1996	10.5	32.5	112.1	79.6
1997	10.5	32.5	112.1	79.6
1998	10.5	32.5	112.1	79.6
1999	10.5	32.5	112.1	79.6
2000	10.5	32.5	112.1	79.6
2001	10.5	32.5	112.1	79.6
2002	10.5	32.5	112.1	79.6
2003	10.5	32.5	112.1	79.6
2004	10.5	32.5	112.1	79.6
2005	10.5	32.5	112.1	79.6
2006	10.5	32.5	112.1	79.6
2007	10.5	32.5	112.1	79.6
2008	10.5	32.5	112.1	79.6

[1] DEA 2009b.

[2] Based on data from Jørgensen & Johansen (2003).

The composition of the fossil part of the municipal waste has been estimated by NERI. The lower heating values and CO_2 emission factors for different plastic types refer to Hulgaard (2003), see Table 3.2.17.

Table 3.2.17 Composition of the fossil part of municipal waste in Denmark.

Plastic type	Mass share in municipal waste in Denmark		Lower heating value of plastic	Energy content of plastic	CO_2 emission factor for plastic
	kg plastic pr kg municipal waste	% of plastic	GJ pr ton	GJ pr ton municipal waste	kg pr GJ municipal waste
PE	0.058	46	41	2.36	16.3
PS/EPS	0.035	28	37	1.29	10.6
PVC	0.019	15	18	0.34	2.5
Other (PET, PUR, PC, POM, ABS, PA etc.)	0.014	11	24	0.34	3.1
Total	0.13	100	34.5	4.33	32.5

Plant specific EU ETS data have been utilised for cement production in the 2006 - 2008 emission inventories.

Straw

The emission factor for straw, 102 kg pr GJ refers to Fenhann & Kilde (1994). The factor is based on the interval stated in the EMEP/Corinair Guidebook (EEA 2002) and the actual value is the default value from the Collecter database. The same emission factor has been applied for 1990-2008.

Residual oil

The emission factor of 78 kg pr GJ refers to Fenhann & Kilde (1994). The factor refers to the EMEP/Corinair Guidebook (EEA 2007). The factor is slightly higher than the IPCC default emission factor for residual fuel oil (77.4 kg pr GJ assuming full oxidation). The CO_2 emission factor has been confirmed by the two major power plant operators in 1996 (Christiansen, 1996 and Andersen, 1996). The same emission factor has been applied for 1990-2008.

Plant specific EU ETS data have been utilised for some power plants and for cement production in the 2006 - 2008 emission inventories. In 2008 the implied emission factor for the power plants using residual oil was 78.6 kg pr GJ. However, the EU ETS CO_2 emission factors for power plants were in the interval 77.2 - 79.8 kg pr GJ. In 2008 54 % of the CO_2 emission from residual oil consumption was based on the general emission factor, whereas 46 % was covered by EU ETS data[7].

Gas oil

The emission factor for gas oil, 74 kg pr GJ, refers to Fenhann & Kilde (1994). The factor is based on the interval stated in the EMEP/Corinair Guidebook (EEA 2007). The factor agrees with the IPCC default emission factor for gas oil (74.1 kg pr GJ assuming full oxidation). The CO_2 emission factor has been confirmed by the two major power plant operators in 1996 (Christiansen, 1996 and Andersen, 1996). The same emission factor has been applied for 1990-2008.

Plant specific EU ETS data have been utilised for a few power plants in the 2006 - 2008 emission inventories. In 2008 the implied emission factor for the power plants using gas oil was 73.7 kg pr GJ. The EU ETS CO_2 emission factors for power plants were in the interval 73.4 - 75.2 kg pr GJ. In 2008 only 5 % of the CO_2 emission from gas oil consumption was based on EU ETS data[8].

Kerosene

The emission factor for kerosene, 72 kg pr GJ, refers to Fenhann & Kilde (1994). The factor agrees with the IPCC default emission factor for other kerosene (71.9 kg pr GJ assuming full oxidation). The same emission factor has been applied for 1990-2008.

Fish & rape oil

The emission factor is assumed to be the same as for gas oil – 74 kg pr GJ. The consumption of fish and rape oil is relatively low.

Orimulsion

The emission factor for orimulsion, 80 kg pr GJ, refers to the Danish Energy Agency (DEA 2009b). The IPCC default emission factor is almost the same: 80.7 kg pr GJ assuming full oxidation. The CO_2 emission factor has been confirmed by the only major power plant operator using orimulsion (Andersen 1996). The same emission factor has been applied for all years. Orimulsion has not been applied in Denmark in recent years.

[7] Including EU ETS data for cement production

[8] Including EU ETS data for cement production

Natural gas

The emission factor for natural gas is estimated by the Danish gas transmission company, Energinet.dk[9]. Only natural gas from the Danish gas fields is utilised in Denmark. The calculation is based on gas analysis carried out daily by Energinet.dk. Energinet.dk and the Danish Gas Technology Centre have calculated emission factors for 2000-2008. The emission factor applied for 1990-1999 refers to Fenhann & Kilde (1994). This emission factor was confirmed by the two major power plant operators in 1996 (Christiansen 1996 and Andersen 1996). Time-series for the CO_2 emission factors are provided in Table 3.2.18.

Table 3.2.18 CO_2 emission factor for natural gas.

Year	CO_2 emission factor kg pr GJ
1990-1999	56.9
2000	57.1
2001	57.25
2002	57.28
2003	57.19
2004	57.12
2005	56.96
2006	56.78
2007	56.78
2008	56.77

LPG

The emission factor for LPG, 65 kg pr GJ, refers to Fenhann & Kilde (1994). The emission factor is based on the EMEP/Corinair Guidebook (EEA 2007). The emission factor is somewhat higher than the IPCC default emission factor (63 kg pr GJ assuming full oxidation). The same emission factor has been applied for 1990-2008.

Refinery gas

The emission factor applied for refinery gas is the same as the emission factor for natural gas 1990-1999. The emission factor is within the interval of the emission factor for refinery gas stated in the EMEP/Corinair Guidebook (EEA 2007). The same emission factor has been applied for 1990-2008.

Biogas

The emission factor for biogas, 83.6 kg pr GJ, is based on a biogas with 65 % (vol.) CH_4 and 35 % (vol.) CO_2. Danish Gas Technology Centre has stated that this is a typical manure-based biogas as utilised in stationary combustion plants (Kristensen 2001). The same emission factor has been applied for 1990-2008.

Biomass producer gas

The CO_2 emission factor for biomass producer gas has been assumed equal to the emission factor for wood. However, the gas composition is well-known and in future inventories a recalculated emission factor will be applied. The consumption of biomass producer gas is low; 87 TJ in 2008.

[9] Former Gastra and before that part of DONG. Historical data refer to these companies.

CH_4

The CH_4 emission factors applied for 2008 are presented in Table 3.2.19. In general, the same emission factors have been applied for 1990-2008. However, time-series have been estimated for both natural gas fuelled engines and biogas fuelled engines. Time-series has also been estimated for MSW incineration plants that is, however, not a large emission source.

Emission factors for CHP plants < 25 MW_e refer to emission measurements carried out on Danish plants (Nielsen et al. 2010; Nielsen & Illerup 2003; Nielsen et al. 2008). Most other emission factors refer to the EMEP/Corinair Guidebook, 2007 update (EEA 2007).

Gas engines combusting natural gas or biogas accounts for approximately half the CH_4 emission from stationary combustion plants. The relatively high emission factor for gas engines is well-documented and further discussed below.

Time-series for the CH_4 emission factor for wood combustion in residential plants have not been estimated. Due to the increasing importance of this source this will be considered in future inventories.

Table 3.2.19 CH_4 emission factors 2008.

Fuel group	Fuel	CRF source category	CRF source category	SNAP	Emission factor, g pr GJ	Reference
BIOMASS	WOOD	1A1a	Electricity and heat production	010102, 010103, 010104	3.1	Nielsen et al. 2010
				010202, 010203	32	EEA 2007
		1A2	Industry	030100, 030102	32	EEA 2007
		1A4a	Commercial/Institutional	020100	200	EEA 2007
		1A4b i	Residential	020200	200	EEA 2007
		1A4c i	Agriculture/Forestry	020300	200	EEA 2007
	STRAW	1A1a	Electricity and heat production	010101, 010102, 010103, 010104	0.47	Nielsen et al. 2010
				010202, 010203	32	EEA 2007
		1A4b i	Residential	020200	200	EEA 2007
		1A4c i	Agriculture/Forestry	020300	200	EEA 2007
	FISH & RAPE OIL	1A1a	Electricity and heat production	010101, 010102, 010103, 010202, 010203	1.5	EEA 2007, assuming same emission factor as for gas oil
		1A2	Industry	030105	1.5	EEA 2007, assuming same emission factor as for gas oil
		1A4b i	Residential	020200	1.5	EEA 2007, assuming same emission factor as for gas oil
	BIOGAS	1A1a	Electricity and heat production	010102, 010103, 010203	4	EEA 2007
				010105, 010205	434	Nielsen et al. 2010
		1A2	Industry	030100, 030102, 030103	4	EEA 2007
				030105	434	Nielsen et al. 2010
		1A4a	Commercial/Institutional	020100, 020103	4	EEA 2007
				020105	434	Nielsen et al. 2010
		1A4c i	Agriculture/Forestry	020300	4	EEA 2007
				020304	434	Nielsen et al. 2010
	BIO PROD GAS	1A1a	Electricity and heat production	010105	13	Nielsen et al. 2010
		1A2	Industry	030105	13	Nielsen et al. 2010
		1A4a	Commercial/Institutional	020105	13	Nielsen et al. 2010
OTHER 1	MUNICIP. WASTES	1A1a	Electricity and heat production	010102, 010103	0.34	Nielsen et al. 2010
				010203	6	EEA 2007
		1A2	Industry	030102	6	EEA 2007
		1A4a	Commercial/Institutional	020103	6	EEA 2007
GAS	NATURAL GAS	1A1a	Electricity and heat production	010101, 010102, 010202	6	DGC 2001
				010103, 010203	15	Gruijthuijsen & Jensen 2000
				010104 (Gas turbines)	1.7	Nielsen et al. 2010
				010105, 010205 (Gas engines)	481	Nielsen et al. 2010
		1A1c	Other energy industries	010504 (Gas turbines)	1.5	Nielsen & Illerup 2003
				010505 (Gas engines)	481	Nielsen et al. 2010
		1A2	Industry	030100	6	DGC 2001
				030103	15	Gruijthuijsen & Jensen 2000
				030104 (Gas turbines)	1.7	Nielsen et al. 2010
				030105 (Gas engines)	481	Nielsen et al. 2010
		1A4a	Commercial/Institutional	020100	6	DGC 2001
				020103	15	Gruijthuijsen & Jensen 2000
				020105 (Gas engines)	481	Nielsen et al. 2010
		1A4b i	Residential	020200	6	DGC 2001
				020202	15	Gruijthuijsen & Jensen 2000
				020204 (Gas engines)	481	Nielsen et al. 2010
		1A4c i	Agriculture/Forestry	020300	6	DGC 2001
				020303 (Gas turbines)	1.7	Nielsen et al. 2010
				020304 (Gas engines)	481	Nielsen et al. 2010
LIQUID	PETROLEUM COKE	1A4a	Commercial/Institutional	020100	15	EEA 2007
		1A4b i	Residential	020200	15	EEA 2007
	RESIDUAL OIL	1A1a	Electricity and heat production	010101, 010104, 010202, 010203	3	EEA 2007
				010102, 010203	1.3	Nielsen et al. 2010
		1A1b	Petroleum refining	010306	3	EEA 2007
		1A2	Industry	030100, 030105	3	EEA 2007
				030102, 030103	1.3	Nielsen et al. 2010
		1A4a	Commercial/Institutional	020100	3	EEA 2007
		1A4b i	Residential	020200	3	EEA 2007
		1A4c i	Agriculture/Forestry	020300, 020302	3	EEA 2007
	GAS OIL	1A1a	Electricity and heat production	010101, 010102, 010103, 010104, 010201, 010202, 010203	1.5	EEA 2007
				010105, 010205	24	Nielsen et al. 2010
		1A1b	Petroleum refining	010306	1.5	EEA 2007
		1A2	Industry	030100, 030102, 030103, 030104	1.5	EEA 2007
				030105	24	Nielsen et al. 2010
		1A4a	Commercial/Institutional	020100, 020103	1.5	EEA 2007
				020105	24	Nielsen et al. 2010
		1A4b i	Residential	020200	1.5	EEA 2007
				020105	24	Nielsen et al. 2010
	KEROSENE	1A2	Industry	030100	7	EEA 2007
		1A4a	Commercial/Institutional	020100	7	EEA 2007
		1A4b i	Residential	020200	7	EEA 2007
		1A4c i	Agriculture/Forestry	020300	7	EEA 2007

Fuel group	Fuel	CRF source category	CRF source category	SNAP	Emission factor, g pr GJ	Reference
	LPG	1A1a	Electricity and heat production	010102, 010203	1	EEA 2007
		1A2	Industry	030100	1	EEA 2007
		1A4a	Commercial/Institutional	020100, 020105	1	EEA 2007
		1A4b i	Residential	020200	1	EEA 2007
		1A4c i	Agriculture/Forestry	020300	1	EEA 2007
	REFINERY GAS	1A1b	Petroleum refining	010304, 010306	1.5	EEA 2007
SOLID	COAL	1A1a	Electricity and heat production	010101, 010102, 010103	1.5	EEA 2007
		1A2	Industry	030100	15	EEA 2007
		1A4b i	Residential	020200	15	EEA 2007
		1A4c i	Agriculture/Forestry	020300	15	EEA 2007
	COKE OVEN COKE	1A2	Industry	030100	15	EEA 2007, assuming same emission factor as for coal
		1A4b i	Residential	020200	15	EEA 2007, assuming same emission factor as for coal

CHP plants

A considerable part of the electricity production in Denmark is based on decentralised CHP plants, and well-documented emission factors for these plants are, therefore, of importance. In a project carried out for the electricity transmission company, Energinet.dk, emission factors for CHP plants <25MW_e have been estimated. The work was reported in 2010 (Nielsen et al. 2010).

The work included MSW incineration plants, CHP plants combusting wood and straw, natural gas and biogas-fuelled (reciprocating) engines, natural gas fuelled gas turbines, gas oil fuelled engines, gas oil fuelled gas turbines, steam turbines fuelled by residual oil and engines fuelled by biomass producer gas. CH_4 emission factors for these plants all refer to Nielsen et al. (2010). The estimated emission factors were based on existing emission measurements as well as on emission measurements carried out within the project. The number of emission data sets was comprehensive. Emission factors for subgroups of each plant type were estimated, e.g. the CH_4 emission factor for different gas engine types has been determined.

Time-series for the CH_4 emission factors are based on a similar project estimating emission factors for year 2000 (Nielsen & Illerup 2003).

Natural gas, gas engines

SNAP 010105, 010205, 010505, 030105, 020105, 020204 and 020304

The emission factor for natural gas engines refers to the Nielsen et al. (2010). The emission factor includes the increased emission during start/stop of the engines estimated by Nielsen et al. (2008). Emission factor time-series for the years 1990-2007 have been estimated based on Nielsen & Illerup (2003). These three references are discussed below.

Nielsen et al. 2010:

> *CH_4 emission factors for gas engines were estimated for 2003-2006 and for 2007-2009. The dataset was split in two due to new emission limits for the engines from October 2006. The emission factors were based on emission measurements from 366 (2003-2006) and 157 (2007-2009) engines respectively. The engines from which emission measurements were available for 2007-2009 represent 38 % of the gas consumption. The emission factors were estimated based on fuel consumption for each gas engine type and the emission factor for each engine type. The majority of emission measure-*

ments that were not performed within the project related solely to the emission of total unburned hydrocarbon (CH_4 + NMVOC). A constant disaggregation factor was estimated based on 9 emission measurements including both CH_4 and NMVOC.

Nielsen & Illerup (2003):

The emission factor for natural gas engines was based on 291 emission measurements in 114 different plants. The plants from which emission measurements were available represented 44 % of the total gas consumption in gas engines in year 2000.

Nielsen et al. (2008):

This study calculated a start/stop correction factor. This factor was applied to the time-series estimated in Nielsen & Illerup (2003). Further the correction factors were applied in Nielsen et al. (2010).

The emission factor for lean-burn gas engines is relatively high, especially for pre-chamber engines, which account for more than half the gas consumption in Danish gas engines. However, the emission factors for different pre-chamber engine types differ considerably.

The installation of natural gas engines in decentralised CHP plants in Denmark has taken place since 1990. The first engines installed were relatively small open-chamber engines but later mainly pre-chamber engines were installed. As mentioned above, pre-chamber engines have a higher emission factor than open-chamber engines; therefore, the emission factor has increased during the period 1990-1995. After that technical improvements of the engines have been implemented as a result of upcoming emission limits that most installed gas engines had to meet in late 2006 (MST 2005).

The time-series were based on:

- Full load emission factors for different engine types in year 2000 (Nielsen & Illerup 2003), 2003-2006 and 2007-2009 (Nielsen et al. 2010).
- Data for year of installation for each engine and fuel consumption of each engine 1994-2002 from the Danish Energy Agency (DEA 2003).
- Research concerning the CH_4 emission from gas engines carried out in 1997 (Nielsen & Wit, 1997).
- Correction factors including increased emission during start/stop of the engines (Nielsen et al. 2008).

Table 3.2.20 Time-series for the CH_4 emission factor for natural gas fuelled engines.

Year	Emission factor, g pr GJ
1990	266
1991	309
1992	359
1993	562
1994	623
1995	632
1996	616
1997	551
1998	542
1999	541
2000	537
2001	522
2002	508
2003	494
2004	479
2005	465
2006	473
2007	481
2008	481

Gas engines, biogas

SNAP 010105, 010205, 030105, 020105 and 020304

The emission factor for biogas engines was estimated to 434 g pr GJ in 2008. The emission factor is lower than the factor for natural gas, mainly because most engines are lean-burn open-chamber engines - not pre-chamber engines.

Time-series for the emission factor have been estimated. The emission factors for biogas engines were based on Nielsen et al. (2010) and Nielsen & Illerup (2003). The two references are discussed below. The time-series are shown in Table 3.2.21.

Nielsen et al. 2010:

> *CH_4 emission factors for gas engines were estimated for 2006 based on emission measurements performed in 2003-2009. The emission factor was based on emission measurements from 10 engines. The engines from which emission measurements were available represent 8 % of the gas consumption. The emission factor was estimated based on fuel consumption for each gas engine type and the emission factor for each engine type. The majority of emission measurements that were not performed within the project related solely to the emission of total unburned hydrocarbon (CH_4 + NMVOC). A constant disaggregation factor was estimated based on 3 emission measurements including both CH_4 and NMVOC.*

Nielsen & Illerup (2003):

> *The emission factor for natural gas engines was based on 18 emission measurements from 13 different engines. The engines from which emission measurements were available represented 18 % of the total biogas consumption in gas engines in year 2000.*

Table 3.2.21 Time-series for the CH_4 emission factor for biogas fuelled engines.

Year	Emission factor, g pr GJ
1990	239
1991	251
1992	264
1993	276
1994	289
1995	301
1996	305
1997	310
1998	314
1999	318
2000	323
2001	342
2002	360
2003	379
2004	397
2005	416
2006	434
2007	434
2008	434

Gas turbines, natural gas
SNAP 010104, 020104, 020303 and 030104

The emission factor for gas turbines was estimated to be below 1.7 g pr GJ in 2005 (Nielsen et al. 2010). The emission factor was based on emission measurements on five plants. The emission factor in year 2000 was 1.5 g pr GJ (Nielsen & Illerup 2003). A time series have been estimated.

CHP, wood
SNAP 010102 and, 010103 and 010104

The emission factor for CHP plants combusting wood was estimated to be below 3.1 g pr GJ (Nielsen et al. 2010) and the emission factor 3.1 g pr GJ has been applied for all years. The emission factor was based on emission measurements on two plants.

CHP, straw
SNAP 010101, 010102 and 010103

The emission factor for CHP plants combusting straw was estimated to be below 0.47 g pr GJ (Nielsen et al. 2010) and the emission factor 0.47 g pr GJ has been applied for all years. The emission factor was based on emission measurements on four plants.

CHP, municipal waste
SNAP 010102 and 010103

The emission factor for CHP plants combusting municipal waste was estimated to be below 0.34 g pr GJ in 2006 (Nielsen et al. 2010) and 0.59 g pr GJ in year 2000 (Nielsen & Illerup 2003). A time-series have been estimated. The emission factor was based on emission measurements on nine plants.

Other stationary combustion plants
Emission factors for other plants refer to the EMEP/Corinair Guidebook (EEA 2007), the Danish Gas Technology Centre (DGC 2001), Nielsen &

Illerup (2003) or Gruijthuijsen & Jensen (2000). The same emission factors have been applied for 1990-2008.

N_2O

The N_2O emission factors applied for the 2008 inventory are listed in Table 3.22. Time-series have been estimated for natural gas fuelled gas turbines. All other emission factors have been applied unchanged for 1990-2008.

Emission factors for natural gas fuelled reciprocating engines, natural gas fuelled gas turbines, CHP plants < 300 MW combusting wood, straw or residual oil, MSW incineration plants, engines fuelled by gas oil and gas engines fuelled by biomass producer gas all refer to emission measurements carried out on Danish plants (Nielsen et al. 2010).

The emission factor for coal-powered plants in public power plants refers to research conducted by Elsam (now part of DONG Energy). The emission factor for off-shore gas turbines refer to a Danish study concerning CHP plants (Nielsen & Illerup 2003).

All other emission factors refer to the EMEP/CORINAIR Guidebook, 2007 update (EEA 2007).

Table 3.2.22 N_2O emission factors 1990-2008.

Fuel group	Fuel	CRF source category	CRF source category	SNAP	Emission factor g/GJ	Reference
BIOMASS	WOOD	1A1a	Electricity and heat production	010102, 010103, 010104	0.8	Nielsen et al. 2010
				010202, 010203	4	EEA 2007
		1A2	Industry	all	4	EEA 2007
		1A4a	Commercial/Institutional	020100	4	EEA 2007
		1A4b i	Residential	020200	4	EEA 2007
		1A4c i	Agriculture/Forestry	020300	4	EEA 2007
	STRAW	1A1a	Electricity and heat production	010101, 010102, 010103, 010104	1.1	Nielsen et al. 2010
				010202, 010203	4	EEA 2007
		1A4b i	Residential	020200	4	EEA 2007
		1A4c i	Agriculture/Forestry	020300	4	EEA 2007
	FISH & RAPE OIL	1A1a	Electricity and heat production	All	2	EEA 2007, assuming same emission factor as gas oil
		1A2	Industry	030105	2	EEA 2007, assuming same emission factor as gas oil
		1A4b i	Residential	020200	2	EEA 2007, assuming same emission factor as gas oil
	BIOGAS	1A1a	Electricity and heat production	010102, 010103, 010203	2	EEA 2007
				010105, 010205 (Gas engines)	1.6	Nielsen et al. 2010
		1A2	Industry	030100, 030102, 030103	2	EEA 2007
				030105 (Gas engines)	1.6	Nielsen et al. 2010
		1A4a	Commercial/Institutional	020100, 020103	2	EEA 2007
				020105 (Gas engines)	1.6	Nielsen et al. 2010
		1A4c i	Agriculture/Forestry	020300	2	EEA 2007
				020304 (Gas engines)	1.6	Nielsen et al. 2010
	BIO PROD GAS	1A1a	Electricity and heat production	010105	2.7	Nielsen et al. 2010
		1A2	Industry	030105	2.7	Nielsen et al. 2010
		1A4a	Commercial/Institutional	020105	2.7	Nielsen et al. 2010
OTHER 1	MUNICIP. WASTES	1A1a	Electricity and heat production	010102, 010103	1.2	Nielsen et al. 2010
				010203	4	EEA 2007
		1A2	Industry	030102	4	EEA 2007
		1A4a	Commercial/Institutional	020103	4	EEA 2007
GAS	NATURAL GAS	1A1a	Electricity and heat production	010101, 010102, 010103, 010202, 010203	1	EEA 2007
				010104 (Gas turbines)	1	Nielsen et al. 2010
				010105, 010205 (Gas engines)	0.58	Nielsen et al. 2010
		1A1c	Other energy industries	010504 (Gas turbines)	2.2	Nielsen & Illerup 2003
				010505 (Gas engines)	0.58	Nielsen et al. 2010
		1A2	Industry	030100, 030103	1	EEA 2007
				030104 (Gas turbines)	1	Nielsen et al. 2010
				030105 (Gas engines)	0.58	Nielsen et al. 2010
		1A4a	Commercial/Institutional	020100, 020103	1	EEA 2007
				020105 (Gas engines)	0.58	Nielsen et al. 2010
		1A4b i	Residential	020200, 020202	1	EEA 2007
				020204 (Gas engines)	0.58	Nielsen et al. 2010
		1A4c i	Agriculture/Forestry	020300, 020303	1	EEA 2007
				020303 (Gas turbines)	1	Nielsen et al. 2010
				020304 (Gas engines)	0.58	Nielsen et al. 2010
LIQUID	PETROLEUM COKE	1A4a	Commercial/Institutional	020100	3	EEA 2007
		1A4b i	Residential	020200	3	EEA 2007
	RESIDUAL OIL	1A1a	Electricity and heat production	010101, 010104, 010202, 010203	2	EEA 2007
				010102, 010103	5	Nielsen et al. 2010
		1A1b	Petroleum refining	010306	2	EEA 2007
		1A2	Industry	030100, 030105	2	EEA 2007
				030102, 030103	5	Nielsen et al. 2010
		1A4a	Commercial/Institutional	020100	2	EEA 2007
		1A4b i	Residential	020200	2	EEA 2007
		1A4c i	Agriculture/Forestry	020300, 020302	2	EEA 2007
	GAS OIL	1A1a	Electricity and heat production	010101, 010102, 010103, 010104, 010201, 010202, 010203	2	EEA 2007
				010105, 020105 (Engines)	2.1	Nielsen et al. 2010
		1A1b	Petroleum refining	010306	2	EEA 2007
		1A1c	Other energy industries	010505	2	EEA 2007
		1A2	Industry	030100, 030102, 030103, 030104	2	EEA 2007
				030105 (Engines)	2.1	Nielsen et al. 2010
		1A4a	Commercial/Institutional	020100, 020103	2	EEA 2007
				020105 (Engines)	2.1	Nielsen et al. 2010
		1A4b i	Residential	020200	2	EEA 2007
				020104 (Engines)	2.1	Nielsen et al. 2010
	KEROSENE	1A2	Industry	030100	2	EEA 2007
		1A4a	Commercial/Institutional	020100	2	EEA 2007
		1A4b i	Residential	020200	2	EEA 2007
		1A4c i	Agriculture/Forestry	020300	2	EEA 2007
	LPG	1A1a	Electricity and heat production	010102, 010203	2	EEA 2007
		1A2	Industry	030100	2	EEA 2007

Fuel group	Fuel	CRF source category	CRF source category	SNAP	Emission factor g/GJ	Reference
		1A4a	Commercial/Institutional	020100, 020105	2	EEA 2007
		1A4b i	Residential	020200	2	EEA 2007
		1A4c i	Agriculture/Forestry	020300	2	EEA 2007
	REFINERY GAS	1A1b	Petroleum refining	010304, 010306	2.2	Nielsen & Illerup 2003, assuming same emission factor as for natural gas
SOLID	COAL	1A1a	Electricity and heat production	010101, 010102, 010103	0.8	Elsam 2005
		1A2	Industry	030100	3	EEA 2007
		1A4b i	Residential	020200	3	EEA 2007
		1A4c i	Agriculture/Forestry	020300	3	EEA 2007
	COKE OVEN COKE	1A2	Industry	030100	3	EEA 2007
		1A4b i	Residential	020200	3	EEA 2007

SO_2, NO_x, NMVOC and CO

Emission factors for SO_2, NO_x, NMVOC and CO are listed in Annex 3A-4. The annex includes references and time-series.

The emission factors refer to:

- The EMEP/CORINAIR Guidebook (EEA, 2007 and EEA, 2009).
- The IPCC Guidelines, Reference Manual (IPCC, 1996).
- Danish legislation:
  - Miljøstyrelsen, 2001 (Danish Environmental Protection Agency).
  - Miljøstyrelsen, 1990 (Danish Environmental Protection Agency).
- Danish research reports including:
  - Two emission measurement program for decentralised CHP plants (Nielsen et al. 2010; Nielsen & Illerup, 2003).
  - Research and emission measurements programs for biomass fuels:
    - Nikolaisen et al. (1998).
    - Jensen & Nielsen (1990).
    - Serup et al. (1999).
    - Christiansen et al. (1997).
  - Research and environmental data from the gas sector:
    - Gruijthuijsen & Jensen (2000).
    - Danish Gas Technology Centre (DGC) (2001).
    - Wit & Andersen (2003).
- Aggregated emission factors for residential wood combustion based on technology distribution (Illerup et al. 2007) and technology specific emission factors (EEA 2009; DEPA 2010).
- Calculations based on plant-specific emissions from a considerable number of power plants.
- Calculations based on plant-specific emission data from a considerable number of municipal waste incineration plants. These data refer to annual environmental reports published by plant operators.
- Sulphur content data from oil companies and the Danish gas transmission company, Energinet.dk.
- Additional personal communication.
-

The emission factors for NMVOC that are not nationally referenced have been updated according to EEA (2009).

Emission factor time-series have been estimated for a considerable number of the emission factors. These are provided in Annex 3A-4.

Disaggregation to specific industrial subcategories

The national statistics, on which the emission inventories are based, do not include a direct disaggregation to specific industrial subsectors. However, separate national statistics from Statistics Denmark include a disaggregation to industrial subsectors. This part of the energy statistics is also included in the official energy statistics from the DEA.

Every other year Statistics Denmark collects fuel consumption data for all industrial companies of a considerable size. The deviation between the total fuel consumption from the DEA and the data collected by Statistics Denmark is rather small. Thus the disaggregation to industrial subsectors available from Statistics Denmark can be applied for estimating disaggregation keys for fuel consumption and emissions.

The industrial fuel consumption is considered in three aspects:

- Fuel consumption for transport. This part of the fuel consumption is not disaggregated to the industrial subcategories.
- Fuel consumption applied in power or district heating plants. Disaggregation of fuel and emissions is plant specific.
- Fuel consumption for other purposes. The total fuel consumption and the total emissions are disaggregated to industrial subcategories.

All pollutants included in the Climate Convention reporting have been disaggregated to industrial subcategories.

3.2.6 Uncertainty

Uncertainty estimates include uncertainty with regard to the total emission inventory as well as uncertainty with regard to trends.

Methodology

Greenhouse gases

The uncertainty for GHG emissions have been estimated according to the IPCC Good Practice Guidance (IPCC 2000). The uncertainty has been estimated by two approaches; tier 1 and a tier 2. Both approaches are further described in the NIR Chapter 1.7.

The tier 1 approach is based on a normal distribution and a confidence interval of 95 %.

The input data for the tier 1 approach are:

- Emission data for the base year and the latest year.
- Uncertainties for emission factors
- Uncertainty for fuel consumption rates.

The emission source categories applied are listed in Table 3.23.

The tier 2 approach is a Monte Carlo approach based on a lognormal distribution. The input data for the model is based on 67 % confidence interval (standard deviation) whereas the results are given as 95 % confidence intervals. The input data for the tier 2 approach are:

- Fuel consumption data for the base year and the latest year.
- Emission factors or implied emission factors (IEF) for the base year and the latest year
- Standard deviation for emission factors for the base year and the latest year. If the same standard deviation is applied for both years the data can be indicated as statistically dependent or independent.
- Standard deviation for fuel consumption rates in the base year and the latest year. If the same standard deviation is applied for both years the data can be indicated as statistically dependent or independent.

The same emission source categories and emission data have been applied for both approaches. In general the same uncertainty levels have been applied for both approaches. However the tier 2 approach allows different uncertainty levels for 1990 and 2008 and this is relevant to a few uncertainties as discussed below. The 2008 uncertainty levels have been applied in the tier 1 approach. Due to the difference of confidence interval of the input data in the two approaches the uncertainty input for the tier 2 approach have been estimated based on the tier 1 approach divided by a factor 2.

Most of the applied uncertainty estimates for activity rates and emission factors are default values from the IPCC Reference Manual or aggregated by NERI based on the default values. Some of the uncertainty estimates are, however, based on national estimates.

In general the uncertainty of the fuel consumption data have been assumed to be the same in 1990 and 2008 and the uncertainty has been assumed to be statistically independent. However, a considerable part of the residential wood consumption is non-traded and the uncertainty of biomass consumption has been assumed statistically dependent.

For coal combustion the uncertainty of the CO_2 emission factor is lower in 2008 than in 1990 due to availability of EU ETS data. Further the CO_2 emission factor for the fossil part of municipal waste is less uncertain for 2008 than for 1990.

The uncertainty of the CH_4 emission factors for gas engines have been assumed higher in 1990 than in 2008 due to the emission measurement programmes on which the emission factors in later years are based.

All other uncertainty levels for emission factors have been assumed equal in 1990 and 2008 and statistically dependent.

Uncertainty estimates for the non-CO_2 emission factors for decentralised CHP plants will be updated in the next inventory when uncertainty estimates for the emission measurement programme (Nielsen et al. 2010), on which these emission factors are based, have been reported.

Table 3.2.23 Uncertainty rates for fuel consumption and emission factors, 2008.

IPCC Source category	Gas	Fuel consumption uncertainty %			Emission factor uncertainty %		
		Tier 1[1]	Tier 2[2]		Tier 1[1]	Tier 2[2]	
			1990	2008		1990	2008
Stationary Combustion, Coal	CO_2	1.1[3]	0.55	0.55	1.1[9]	2.5[6]	0.55
Stationary Combustion, BKB	CO_2	3.0[3]	1.5	1.5	5[4]	2.5	
Stationary Combustion, Coke	CO_2	2.0[3]	1.05	1	5[4]	2.5	
Stationary Combustion, Petroleum coke	CO_2	2.2[3]	1.2	1.1	5[4]	2.5	
Stationary Combustion, Plastic waste	CO_2	5.0[7]	5	2.5	25[7]	17.5	12.5
Stationary Combustion, Residual oil	CO_2	1.5[3]	0.85	0.75	2[6]	1	
Stationary Combustion, Gas oil	CO_2	2.8[3]	1.45	1.4	5[4]	2.5	
Stationary Combustion, Kerosene	CO_2	2.9[3]	1.5	1.45	5[4]	2.5	
Stationary Combustion, Natural gas	CO_2	1.7[3]	1	0.85	1[6]	0.5	
Stationary Combustion, LPG	CO_2	2.7[3]	1.2	1.35	5[4]	2.5	
Stationary Combustion, Refinery gas	CO_2	1.0[3]	0.5	0.5	5[4]	2.5	
1A1+1A2+1A4, BIOMASS	CH_4	15.9[3]	7.95		100[4]	50	
Biogas fuelled engines, BIOMASS	CH_4	3.0[3]	1.5	1.5	10[5]	10	5
1A1+1A2+1A4, GAS	CH_4	1.7[3]	0.85	0.85	100[4]	50	
Natural gas fuelled engines, GAS	CH_4	1.0[3]	0.5	0.5	5[5]	5	2.5
1A1+1A2+1A4, LIQUID	CH_4	1.9[3]	0.95	0.95	100[4]	50	
1A1+1A2+1A4, WASTE	CH_4	5.0[3]	2.5	2.5	100[4]	50	
1A1+1A2+1A4, SOLID	CH_4	1.1[3]	0.55	0.55	100[4]	50	
1A1 + 1A2 + 1A4, BIOMASS	N_2O	15.9[3]	7.95		400[8]	200	
1A1 + 1A2 + 1A4, GAS	N_2O	1.7[3]	0.85	0.85	300[8]	150	
1A1 + 1A2 + 1A4, LIQUID	N_2O	1.9[3]	0.95	0.95	400[8]	200	
1A1 + 1A2 + 1A4, WASTE	N_2O	5.0[3]	2.5	2.5	200[8]	100	
1A1 + 1A2 + 1A4, SOLID	N_2O	1.1[3]	0.55	0.55	200[8]	100	

1) Based on 95 % confidence interval
2) Based on 67 % confidence interval (standard deviation). Estimated as ½ the tier 1 uncertainty.
3) Estimated by NERI based on default uncertainty levels in IPCC Good Practice Guidance, Table 2.6 (IPCC 2000).
4) IPCC Good Practice Guidance, default value (IPCC 2000).
5) Estimated by NERI based on Nielsen et al. (2010).
6) Jensen & Lindroth (2002).
7) Estimated by NERI based on ongoing work (Nielsen 2009).
8) NERI, rough estimate based on a default value of ± 400 % and an uncertainty of ± 200 % when the emission factor is based on emission measurements from plants in Denmark. Input data will be improved when ongoing work has been reported (Nielsen et al. 2010).
9) NERI estimate based on EU ETS data.

The separate uncertainty estimation for gas engine CH_4 emission and CH_4 emission from other plants does not follow the recommendations in the IPCC Good Practice Guidance. Disaggregation is applied, because in Denmark the CH_4 emission from gas engines is much larger than the emission from other stationary combustion plants, and the CH_4 emission factor for gas engines is estimated with a much smaller uncertainty level than for other stationary combustion plants.

Other pollutants

With regard to other pollutants, IPCC methodologies for uncertainty estimates have been adopted for the LRTAP Convention reporting activities (Pulles & Aardenne, 2003). The Danish uncertainty estimates are based on the simple Tier 1 approach.

The uncertainty estimates are based on emission data for the base year and year 2008 as well as on uncertainties for fuel consumption and emission factors for each of the main SNAP source categories. The applied uncertainties for activity rates and emission factors are default values referring to Pulles & Aardenne (2003). The default uncertainties for emission factors are given in letter codes representing an uncertainty range. It has been assumed that the uncertainties were in the lower end of the range for all sources and pollutants. The applied uncertainties for emission factors are listed in Table 3.2.24. The uncertainty for fuel consumption in stationary combustion plants is assumed to be 2 %.

Table 3.2.24 Uncertainty rates for emission factors, %.

SNAP source category	SO_2	NO_x	NMVOC	CO
01	10	20	50	20
02	20	50	50	50
03	10	20	50	20

Results

The tier 1 uncertainty estimates for stationary combustion emission inventories are shown in Table 3.2.25. Detailed calculation sheets are provided in Annex 3A-7. The tier 2 uncertainty estimates are shown in Table 3.2.26 and detailed results are provided in Annex 3A-7.

The tier 1 uncertainty interval for GHG is estimated to be ±2.1 % and trend in GHG emission is -14.6 % ± 1.4 %-age points. The main sources of uncertainty for GHG emission 2008 are the CO_2 emission from the fossil part of municipal waste, the CO_2 emission from coal combustion and the N_2O emission from biomass combustion. The main source of uncertainty in the trend in GHG emission is CO_2 emission from the combustion of coal, municipal waste and natural gas and N_2O emission from biomass combustion.

The total emission uncertainty is 7.5 % for SO_2, 16 % for NO_x, 45 % for NMVOC and 44 % for CO.

The tier 1 and tier 2 approaches points out the same emission source categories as main contributors to the total uncertainty for GHG emission from stationary combustion.

Table 3.2.25 Danish uncertainty estimates, tier 1 approach, 2008.

Pollutant	Uncertainty Total emission, %	Trend 1990-2008, %	Uncertainty trend, %-age points
GHG	± 2.1	-14.6	± 1.4
CO_2	± 1.5	-15.6	± 1.2
CH_4	± 45	+247	± 99
N_2O	± 167	+6.9	± 101
SO_2	± 7.5	-90	± 0.6
NO_x	± 16	-56	± 2.8
NMVOC	± 45	+50	± 7.5
CO	± 44	+16	± 3.8

Table 3.2.26 Danish uncertainty estimates, tier 2 approach, 2008.

Pollutant	Uncertainty of total emission, %		Trend 1990-2008, %	Uncertainty of trend, %-age points	
GHG	-3.0%	+3.7%	-14.6	-1.8	+2.0
CO_2	-2.8%	+3.0%	-15.6	-1.7	+1.7
CH_4	-26%	+55%	+247	-51	+104
N_2O	-60%	+221%	+6.9	-73	+111

3.2.7 Source specific QA/QC and verification

The elaboration of a formal QA/QC plan started in 2004. A first version is available from Sørensen et al. (2005).

The quality manual describes the concepts of quality work and definitions of sufficient quality, critical control points and a list of Point for Measuring. Please see the general chapter on QA/QC. Source specific QA/QC is discussed below.

The work on expanding the QC will be ongoing in future years.

Documentation concerning verification of the Danish emission inventories has been published by Fauser et al. (2007). The reference approach for the energy sector is shown is shown in Chapter 3.4.

The sector report for stationary combustion (Nielsen et al. 2009) has been reviewed by external Danish experts in 2005, 2007 and 2009.

Data storage, level 1

Table 3.2.27 List of external data sources.

Dataset	Description	AD or Emf.	Reference	Contact(s)	Data agreement/ Comment
Energiproducenttællingen.xls	Data set for all electricity and heat producing plants.	Activity data	The Danish Energy Agency (DEA)	Peter Dal	Data agreement in place
Gas consumption for gas engines and gas turbines 1990-1994		Activity data	The Danish Energy Agency (DEA)	Peter Dal	No data agreement. Historical data
Basic data (Grunddata.xls)	Data set used for IPCC reference approach	Activity data	The Danish Energy Agency (DEA)	Peter Dal	Not necessary. Published as part of national energy statistics
Energy statistics	The Danish energy statistics on SNAP level	Activity data	The Danish Energy Agency (DEA)	Peter Dal	Data agreement in place
SO_2 & NO_x data, plants>25 MW_e		Emissions	The Danish Energy Agency (DEA)	Rasmus Sørensen	No data agreement in place
Emission factors	Emission factors stems from a large number of sources	Emission factors	See chapter regarding emission factors		
Environmental reports	Emissions from plants defined as large point sources	Emissions	Various plants		No data agreement necessary. Plants are obligated by law.
EU ETS data	Plant specific CO_2 emission factors	Emission factors	The Danish Energy Agency (DEA)	Dorte Maimann Helen Falster	Plants are obligated by law. The availability of detailed information is part of a future data agreement with DEA.

Data Storage level 1	1. Accuracy	DS.1.1.1	General level of uncertainty for every dataset including the reasoning for the specific values

Since the DEA are responsible for the official Danish energy statistics as well as reporting to the IEA, NERI regards the data as being complete and in accordance with the official Danish energy statistics and IEA reporting. The uncertainties connected with estimating fuel consumption do not, therefore, influence the accordance between IEA data, the energy statistics and the dataset on SNAP level utilised by NERI. For the remainder of the datasets, it is assumed that the level of uncertainty is relatively low. For further comments regarding uncertainties, see Chapter 3.2.6.

Data Storage level 1	1. Accuracy	DS.1.1.2	Quantification of the uncertainty level of every single data value including the reasoning for the specific values.

The uncertainty for external data is not quantified. The uncertainties of activity data and emission factors are quantified see Chapter 3.2.6.

Data Storage level 1	2.Comparability	DS.1.2.1	Comparability of the data values with similar data from other countries, which are comparable with Denmark, and evaluation of discrepancy.

On the external data the comparability has not been checked. However, at CRF level a project has been carried out comparing the Danish inventories with those of other countries (Fauser et al. 2008).

Data Storage level 1	3.Completeness	DS.1.3.1	Documentation showing that all possible national data sources are included by setting up the reasoning for the selection of datasets.

See the above Table 3.2.27 for an overview of external datasets.

Danish Energy Authority

Statistic on fuel consumption from district heating and power plants

A spreadsheet from DEA is listing fuel consumption of all plants included as large point sources in the emission inventory. The statistic on fuel consumption from district heating and power plants is regarded as complete and with no significant uncertainty since the plants are bound by law to report their fuel consumption and other information.

Gas consumption for gas engines and gas turbines 1990-1994

For the years 1990-1994 DEA has estimated consumption of natural gas and biogas in gas engines and gas turbines. NERI assesses that the estimation by the DEA are the best available data.

Basic data

A spreadsheet from DEA is used for the CO_2 emission calculation in accordance with the IPCC reference approach. It is published annually on DEA's webpage; therefore, a formal data delivery agreement is not deemed necessary.

Energy statistics on SNAP level

The DEA reports fuel consumption statistics on SNAP level based on a correspondence table developed in co-operation with NERI. Both traded and non-traded fuels are included in the Danish energy statistics. Thus, for example, estimation of the annual consumption of non-traded wood is included. Petroleum coke, purchased abroad and combusted in Danish residential plants (border trade), is added to the apparent consumption of petroleum coke and the emissions are included in the inventory.

Emissions from non-energy use of fuels have been included in other source categories of the Danish inventory. The non-energy use of fuels is, however, included in the reference approach for Climate Convention reporting.

SO_2 and NO_x emission data from electricity producing plants > 25MWe

Plants larger than 25 MW_e are obligated to report emission data for SO_2 and NO_x to the DEA annually. Data are on block level and classified. The data on plant level are part of the plants annually environmental reports. NERI's QC of the data consists of a comparison with data from previous years and with data from the plants' annual environmental reports.

Emission factors from a wide range of sources

For specific references, see the chapter regarding emission factors.

Annual environmental reports from plants defined as large point sources

A large number of plants are obligated by law to publish an annual environmental report with information on, among other things, emissions. NERI compares the data with those from previous years and large discrepancies are checked.

EU ETS data

EU ETS data are information on fuel consumption, heating values, carbon content of fuel, oxidation factor and CO_2 emissions. NERI receives the verified reports for all plants which utilises a detailed estimation methodology. NERI's QC of the received data consists of comparing to calculation using standard emission factors as well as comparing reported values with those for previous years.

Data Storage level 1	4.Consistency	DS.1.4.1	The origin of external data has to be preserved whenever possible without explicit arguments (referring to other PM's)

It is ensured that all external data are archived at NERI. Subsequent data processing takes place in other spreadsheets or databases. The datasets are archived annually in order to ensure that the basic data for a given report are always available in their original form.

Data Storage level 1	6.Robustness	DS.1.6.1	Explicit agreements between the external institution of data delivery and NERI about the condition of delivery

For stationary combustion a data delivery agreement is made with the DEA. Most of the other external data sources are available due to legislatory requirements. See Table 3.2.27.

Data Storage level 1	7.Transparency	DS.1.7.1	Summary of each dataset including the reasoning for selecting the specific dataset

See DS 1.3.1

Data Storage level 1	7.Transparency	DS.1.7.3	References for citation for any external data set have to be available for any single number in any dataset.

See Table 3.2.27 for general references. Much documentation already exists. However, some of the information used is classified and therefore not publicly available.

Data Storage level 1	7.Transparency	DS.1.7.4	Listing of external contacts for every dataset

See Table 3.2.27.

Data processing, level 1

Data Processing level 1	1. Accuracy	DP.1.1.1	Uncertainty assessment for every data source as input to Data Storage level 2 in relation to type of variability. (Distribution as: normal, log normal or other type of variability)

The uncertainty assessment of activity data and emission factors are discussed in the chapter concerning uncertainties.

Data Processing level 1	1. Accuracy	DP.1.1.2	Uncertainty assessment for every data source as input to Data Storage level 2 in relation to scale of variability (size of variation intervals)

The uncertainty assessment of activity data and emission factors are discussed in the chapter concerning uncertainties.

Data Processing level 1	1. Accuracy	DP.1.1.3	Evaluation of the methodological approach using international guidelines

The methodological approach is consistent with international guidelines. For the majority of sources tier 2 or tier 3 methodologies are used.

Data Processing level 1	1. Accuracy	DP.1.1.4	Verification of calculation results using guideline values

Calculated emission factors are compared with guideline emission factors to ensure that they are within reason.

Data Processing level 1	2.Comparability	DP.1.2.1	The inventory calculation has to follow the international guidelines suggested by UNFCCC and IPCC.

The calculations follow the principle in international guidelines.

Data Processing level 1	3.Completeness	DP.1.3.1	Assessment of the most important quantitative knowledge which is lacking.

Regarding the distribution of energy consumption for industrial sources (CRF sector 1A2), a more detailed and frequently updated data material would be preferred. There is ongoing work to increase the accuracy and completeness of this IPCC source category. It is not assessed that this has any influence on the overall emission level of greenhouse gases.

Data Processing level 1	3.Completeness	DP.1.3.2	Assessment of the most important cases where accessibility to critical data sources that could improve quantitative knowledge is missing.

There is no missing accessibility to critical data sources.

Data Processing level 1	4.Consistency	DP.1.4.1	In order to keep consistency at a higher level, an explicit description of the activities needs to accompany any change in the calculation procedure.

A change in calculation procedure would entail that an updated description would be elaborated.

Data Processing level 1	5.Correctness	DP.1.5.1	Show at least once, by independent calculation, the correctness of every data manipulation.

During data processing it is checked that calculations are done correctly. This is to a wide degree documented in the data processing spreadsheets.

Data Processing level 1	5.Correctness	DP.1.5.2	Verification of calculation results using time-series

Time-series for activity data on SNAP level, as well as emission factors, are used to identify possible errors in the calculation procedure.

Data Processing level 1	5.Correctness	DP.1.5.3	Verification of calculation results using other measures

The IPCC reference approach validates the fuel consumption rates and CO_2 emissions of fuel combustion. Fuel consumption rates and CO_2 emissions differ by less than 1.9 % (1990-2008). The reference approach is further discussed below.

Data Processing level 1	5.Correctness	DP.1.5.4	Show one-to-one correctness between external data sources and the databases at Data Storage level 2.

There is a direct line between the external datasets, the calculation process and the input data used to Data Storage level 2. During the calculation process numerous controls are conducted to ensure correctness, e.g. sum checks of the various stages in the calculation procedure.

Data Processing level 1	7.Transparency	DP.1.7.1	The calculation principle and equations used must be described.
Data Processing level 1	7.Transparency	DP.1.7.2	The theoretical reasoning for all methods must be described.
Data Processing level 1	7.Transparency	DP.1.7.3	Explicit listing of assumptions behind all methods

Where appropriate, this is included in the present report with annexes.

Data Processing level 1	7.Transparency	DP.1.7.4	Clear reference to dataset at Data Storage level 1

There is a clear line between the external data and the data processing.

Data Processing level 1	7.Transparency	DP.1.7.5	A manual log to collect information about recalculations

At present, a manual log table is not in place at this level. However, this feature will be implemented in the future. A manual log table is incorporated in the national emission database, Data Storage level 2.

Data storage, level 2

Data Storage level 2	5.Correctness	DS.2.5.1	Documentation of a correct connection between all data types at level 2 to data at level 1

To ensure a correct connection between data on level 2 and data on level 1, different controls are in place, e.g. control of sums and random tests.

Data Storage level 2	5.Correctness	DS.2.5.2	Check if a correct data import to level 2 has been made.

Data import is checked by use of sum control and random testing. The same procedure is applied every year in order to minimise the risk of data import errors.

Other QC procedures

The emission from each large point source is compared with the emission reported the previous year.

Some automated checks have been prepared for the emission databases:

- Check of units for fuel rate, emission factors and plant-specific emissions.
- Check of emission factors for large point sources. Emission factors for pollutants that are not plant-specific should be the same as those defined for area sources.
- Additional checks on database consistency.
- Most emission factor references are now incorporated in the emission database, itself.

- Annual environmental reports are kept for subsequent control of plant-specific emission data.
- QC checks of the country-specific emission factors have not been performed, but most factors are based on input from companies that have implemented some QA/QC work. The major power plant owner/operators in Denmark, DONG Energy and Vattenfall have obtained the ISO 14001 certification for an environmental management system. The Danish Gas Technology Centre and Force Technology both run accredited laboratories for emission measurements.

Suggested QA/QC plan for stationary combustion

The following points make up the list of QA/QC tasks to be carried out directly in relation to the stationary combustion part of the Danish emission inventories. The time plan for the individual tasks has not yet been made.

Data storage level 1

A comparison with external data from other countries in order to evaluate discrepancies.

Data processing level 1

Documentation list of model and independent calculations to test every single mathematical relation.

National external review

The 2005, 2007 and 2009 updates of the sector report for stationary combustion (Nielsen et al. 2005; Nielsen et al. 2007; Nielsen et al. 2009) have been reviewed by Jan Erik Johnsson from the Technical University of Denmark, Bo Sander from Elsam Engineering and Annemette Geertinger from FORCE Technology.

3.2.8 Source specific recalculations and improvements

Improvements and recalculations since the 2009 emission inventory submission include:

- The national energy statistics has been updated for the years 1980-2007. This has only resulted in small differences.
- The split of the CO_2 emission factor for municipal waste between biomass and fossil fuel have been recalculated.
- In CRF the fossil fuel content of municipal waste and the corresponding emissions are now included in fuel category *Other fuels.* The biomass content of municipal waste and the corresponding emissions are reported as part of the fuel category *Biomass*.
- Improved emission factors for decentralised CHP plants referring to a Danish emission measurement program (Nielsen et al. 2010) have been implemented.
- A tier 2 approach for uncertainty has been applied for greenhouse gases.
- Data from the EU ETS have been utilised for the third time in the 2009 inventory submission. The uncertainty estimates (tier 1 and tier 2) now takes into account the lower uncertainty of the heating values

and CO_2 emission factors based on the EU ETS data compared to the national heating values and emission factors.

- The NMVOC emission factors that are not country specific now all refer to EEA (2009). The emission factors for the key-sources are country specific and are not affected by this recalculation.
- For residential wood combustion the NMVOC emission factor has been updated for some technologies. The recalculation is done for the years 2000-2007. The update in emission factors refer to a study funded

3.2.9 Source specific planned improvements

A number of planned improvements to the emission inventories are discussed below.

1) Improved documentation for emission factors

The reporting of, and references for, the applied emission factors will be further developed in future inventories.

2) Uncertainty estimates

Uncertainty estimates are based mainly on default uncertainty levels for activity rates and emission factors. Default uncertainty levels will be updated according to the updated EEA Guidebook (EEA 2009). More country-specific uncertainty estimates will be incorporated in future inventories. Uncertainty data for emission factors for decentralised CHP plants will be included (Nielsen et al. 2010).

3) Improved CO_2 emission factor for municipal waste

Ongoing work will further improve the CO_2 emission factor for municipal waste (DTU 2008).

4) Implementation of emission factors from EEA 2009

Some emission factors refer to older version of the EMEP/CORINAIR Guidebook. The emission factors will be updated according to EEA (2009).

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3.3 Transport and other mobile sources (CRF sector 1A2, 1A3, 1A4 and 1A5)

The emission inventory basis for mobile sources is fuel consumption information from the Danish energy statistics. In addition, background data for road transport (fleet and mileage), air traffic (aircraft type, flight numbers, origin and destination airports) and non-road machinery (engine no., engine size, load factor and annual working hours) are used to make the emission estimates sufficiently detailed. Emission data mainly comes from the EMEP/EEA air pollutant emission inventory guidebook. However, for railways, specific Danish measurements are used.

In the Danish emissions database, all activity rates and emissions are defined in SNAP sector categories (Selected Nomenclature for Air Pollution) according to the CORINAIR system. The emission inventories are prepared from a complete emission database based on the SNAP sectors. The aggregation to the sector codes used for both the UNFCCC and UNECE Conventions is based on a correspondence list between SNAP and IPCC classification codes (CRF), shown in Table 3.3.1 (mobile sources only).

Table 3.3.1 SNAP – CRF correspondence table for transport.

SNAP classification	IPCC classification
07 Road transport	1A3b Transport-Road
0801 Military	1A5 Other
0802 Railways	1A3c Railways
0803 Inland waterways	1A3d Transport-Navigation
080402 National sea traffic	1A3d Transport-Navigation
080403 National fishing	1A4c Agriculture/forestry/fisheries
080404 International sea traffic	1A3d Transport-Navigation (international)
080501 Dom. airport traffic (LTO < 1000 m)	1A3a Transport-Civil aviation
080502 Int. airport traffic (LTO < 1000 m)	1A3a Transport-Civil aviation (international)
080503 Dom. cruise traffic (> 1000 m)	1A3a Transport-Civil aviation
080504 Int. cruise traffic (> 1000 m)	1A3a Transport-Civil aviation (international)
0806 Agriculture	1A4c Agriculture/forestry/fisheries
0807 Forestry	1A4c Agriculture/forestry/fisheries
0808 Industry	1A2f Industry-Other
0809 Household and gardening	1A4b Residential

Military transport activities (land and air) refer to the CRF/NFR sector Other (1A5), while the Transport-Navigation sector (1A3d) comprises national sea transport (ship movements between two Danish ports) and recreational craft (SNAP code 0803). For aviation, LTO (Landing and Take Off)[10] refer to the part of flying which is below 1000 m. The working machinery and equipment in industry (SNAP code 0808) is grouped in Industry-Other (1A2f), while agricultural and forestry non-road machinery (SNAP codes 0806 and 0807) is accounted for in the Agriculture/forestry/fisheries (1A4c) sector together with fishing activities.

For mobile sources, internal NERI databases for road transport, air traffic, sea transport and non road machinery have been set up in order to

[10] A LTO cycle consists of the flying modes approach/descent, taxiing, take off and climb out. In principle the actual times-in-modes rely on the actual traffic circumstances, the airport configuration, and the aircraft type in question.

produce the emission inventories. The output results from the NERI databases are calculated in a SNAP format, as activity rates (fuel consumption) and emission factors, which are then exported directly to the central Danish CollectER database. Apart from national inventories, the NERI databases are used also as a calculation tool in research projects, environmental impact assessment studies, and to produce basic emission information which requires various aggregation levels.

3.3.1 Source category description

The following description of source categories explains the development in fuel consumption and emissions for road transport and other mobile sources.

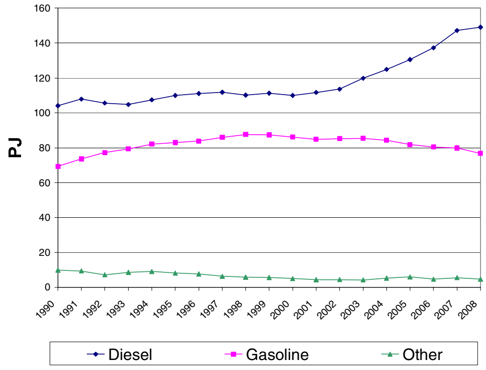
Fuel consumption

Table 3.3.2 Fuel consumption (PJ) for domestic transport in 2008 in CRF sectors.

CRF ID	Fuel use (PJ)
Industry-Other (1A2f)	15.2
Civil Aviation (1A3a)	2.3
Road (1A3b)	176.2
Railways (1A3c)	3.2
Navigation (1A3d)	6.1
Residential (1A4b)	3.3
Ag./for./fish. (1A4c)	22.9
Military (1A5)	1.5
Total	230.7

Table 3.3.2 shows the fuel consumption for domestic transport based on DEA statistics for 2008 in CRF sectors. The fuel consumption figures in time-series 1990-2008 are given in Annex 3.B.15 (CRF format) and are shown for 1990 and 2008 in Annex 3.B.14 (CollectER format). Road transport has a major share of the fuel consumption for domestic transport. In 2008 this sector's fuel consumption share is 76 %, while the fuel consumption shares for Agriculture/forestry/fisheries and Industry-Other are 10 and 7 %, respectively. For the remaining sectors the total fuel consumption share is 7 %.

From 1990 to 2008, diesel and gasoline fuel consumption has increased by 43 % and 11 %, respectively, and in 2008 the fuel consumption shares for diesel and gasoline were 66 % and 33 %, respectively (Figures 3.3.1 and 3.3.2). Other fuels only have a 1 % share of the domestic transport total. Almost all gasoline is used in road transportation vehicles. Gardening machinery and recreational craft are merely small consumers. Regarding diesel, there is considerable fuel consumption in most of the domestic transport categories, whereas a more limited use of residual oil and jet fuel is being used in the navigation sector and by aviation (civil and military flights), respectively.



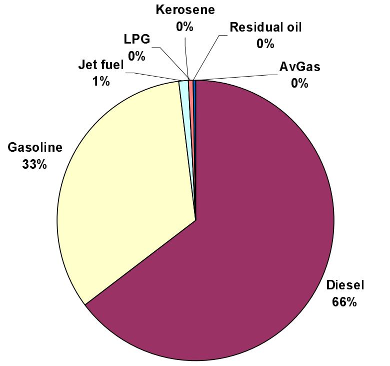


Figure 3.3.1 Fuel consumption pr fuel type for domestic transport 1990-2008.

Figure 3.3.1 Fuel consumption share pr fuel type for domestic transport in 2008.

Road transport

As shown in Figure 3.3.3, the energy use for road transport has generally increased except from a small fuel consumption decline noted in 2000. The fuel consumption development is due to a slight decreasing trend in the use of gasoline fuels from 1999 onwards combined with a steady growth in the use of diesel. Within sub-sectors, passenger cars represent the most fuel-consuming vehicle category, followed by heavy-duty vehicles, light duty vehicles and 2-wheelers, in decreasing order (Figure 3.3.4).

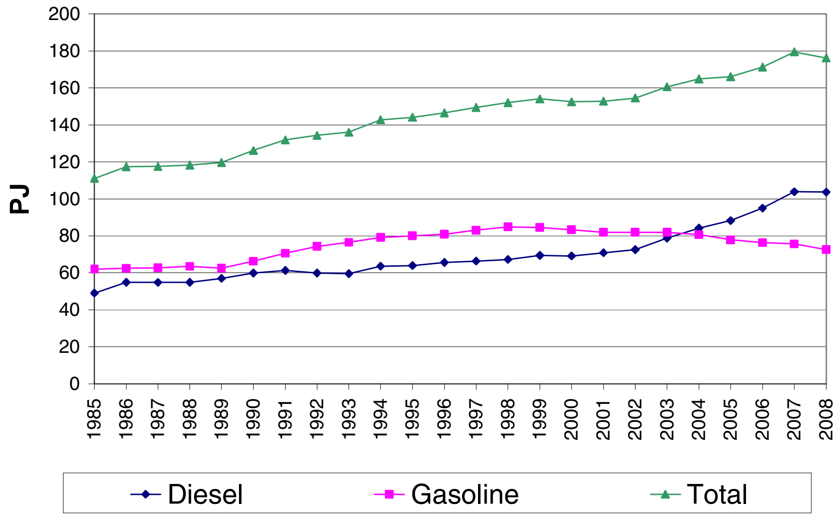


Figure 3.3.3 Fuel consumption pr fuel type and as totals for road transport 1990-2008.

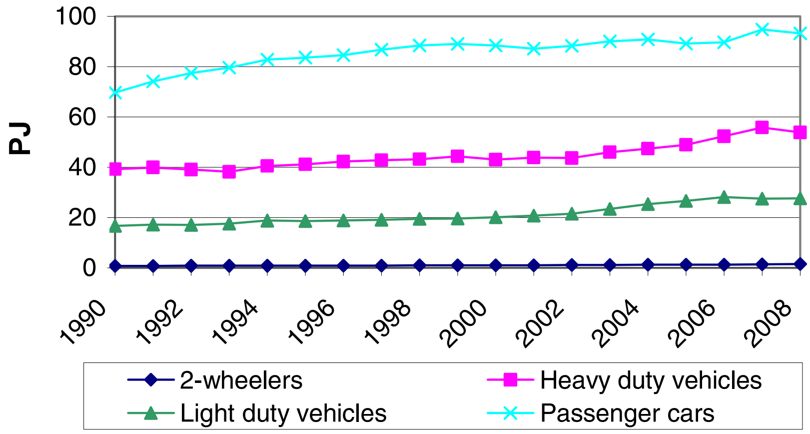


Figure 3.3.4 Total fuel consumption pr vehicle type for road transport 1990-2008.

As shown in Figure 3.3.5, fuel consumption for gasoline passenger cars dominates the overall gasoline consumption trend. The development in diesel fuel consumption in recent years (Figure 3.3.6) is characterised by increasing fuel consumption for diesel passenger cars and light duty vehicles, while a small drop in the fuel consumption for trucks and buses (heavy-duty vehicles) is noted for 2008.

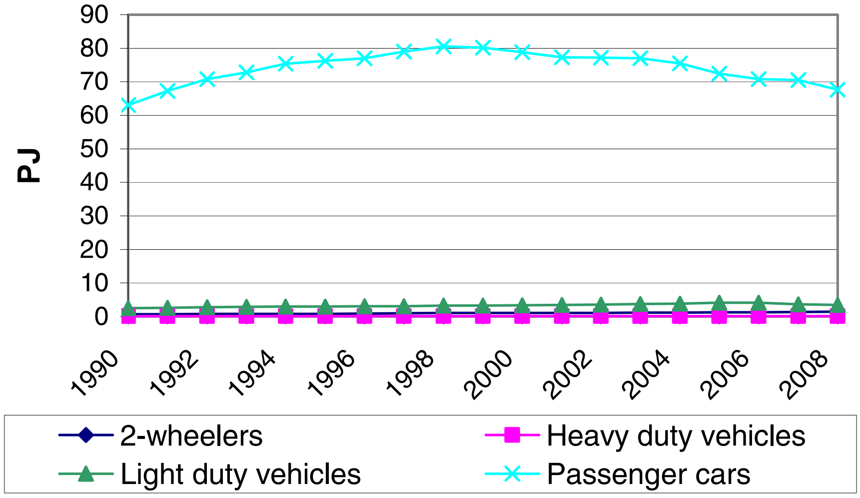


Figure 3.3.5 Gasoline fuel consumption pr vehicle type for road transport 1990-2008.

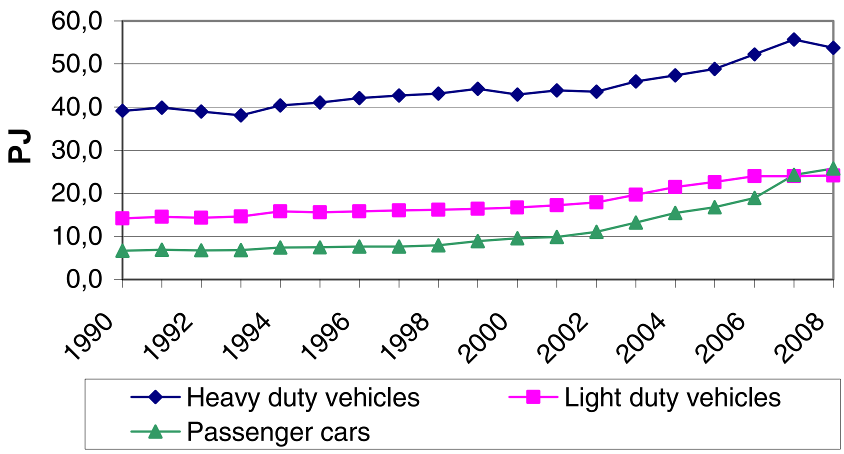


Figure 3.3.6 Diesel fuel consumption pr vehicle type for road transport 1990-2008.

In 2008, fuel consumption shares for gasoline passenger cars, heavy-duty vehicles, diesel passenger cars, diesel light duty vehicles and gasoline light duty vehicles were 37, 31, 15, 14 and 2 %, respectively (Figure 3.3.7).

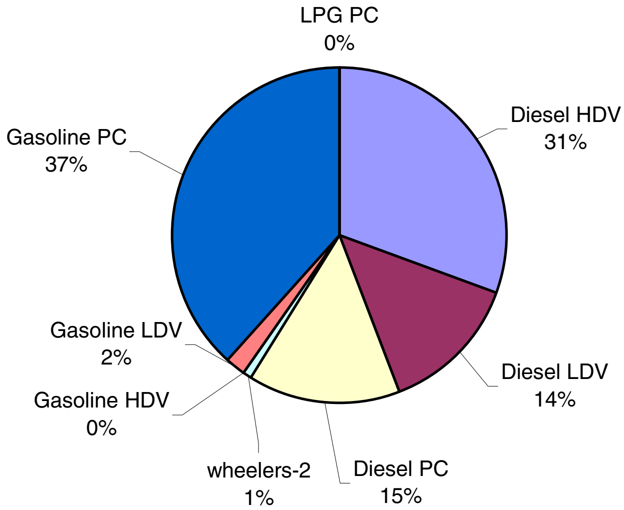


Figure 3.3.7 Fuel consumption share (PJ) pr vehicle type for road transport in 2008.

Other mobile sources

It must be noted that the fuel consumption figures behind the Danish inventory for mobile equipment in the agriculture, forestry, industry, household and gardening (residential), and inland waterways (part of navigation) sectors, are less certain than for other mobile sectors. For these types of machinery, the DEA statistical figures do not directly provide fuel consumption information, and fuel consumption totals are subsequently estimated from activity data and fuel consumption factors. For recreational craft the latest historical year is 2004.

As seen in Figure 3.3.8, classified according to CRF the most important sectors are Agriculture/forestry/fisheries (1A4c), Industry-other (mobile machinery part of 1A2f) and Navigation (1A3d). Minor fuel consuming sectors are Civil Aviation (1A3a), Railways (1A3c), Other (military mobile fuel consumption: 1A5) and Residential (1A4b).

The 1985-2008 time-series are shown pr fuel type in Figures 3.3.9-3.3.12 for diesel, gasoline and jet fuel, respectively.

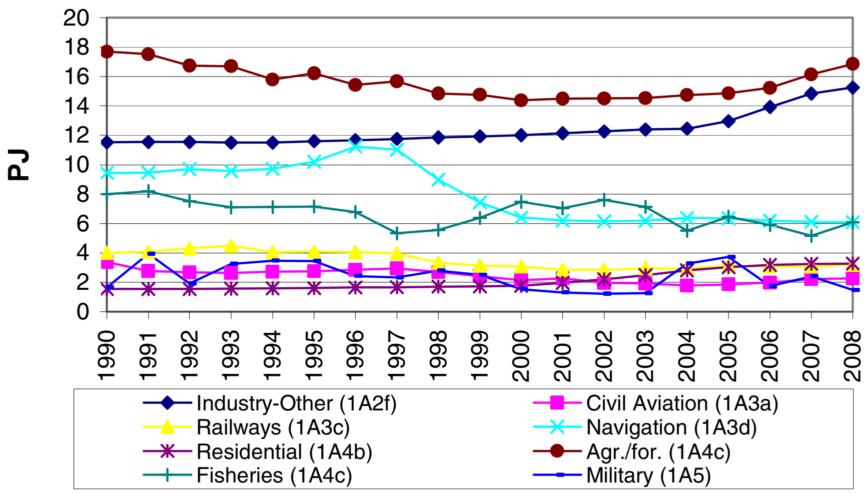


Figure 3.3.8 Total fuel consumption in CRF sectors for other mobile sources 1990-2008.

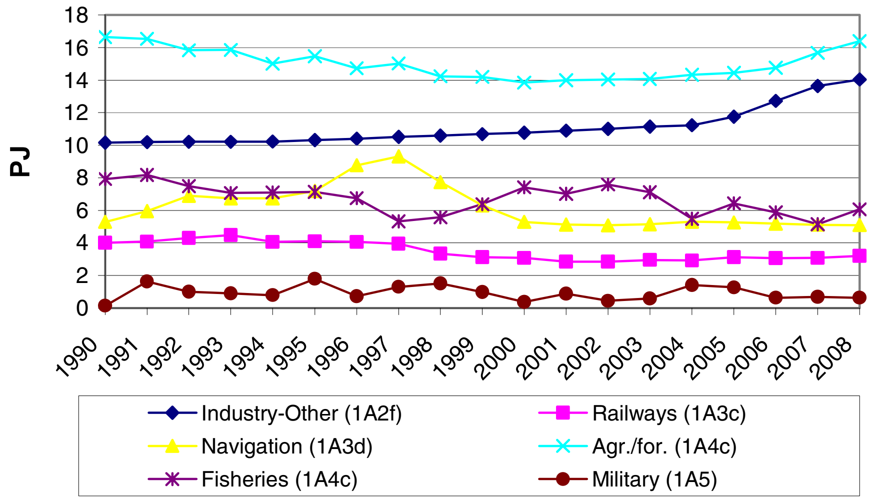


Figure 3.3.9 Diesel fuel consumption in CRF sectors for other mobile sources 1990-2008.

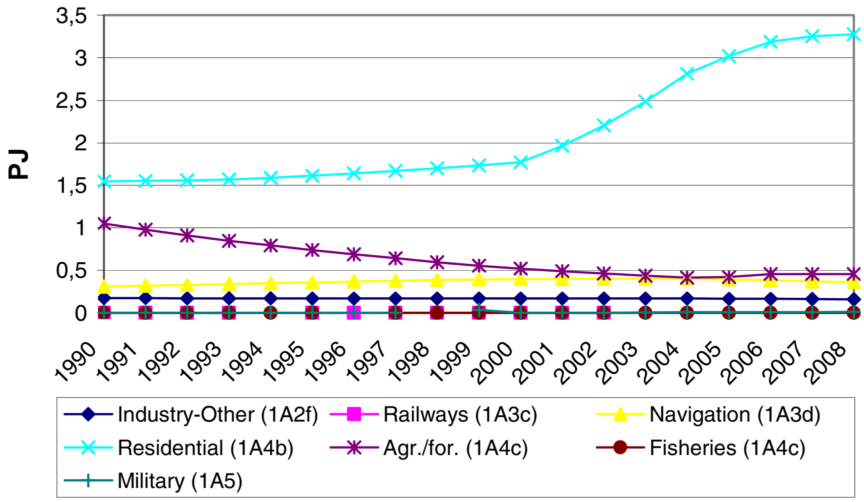


Figure 3.3.10 Gasoline fuel consumption in CRF sectors for other mobile source 1990-2008.

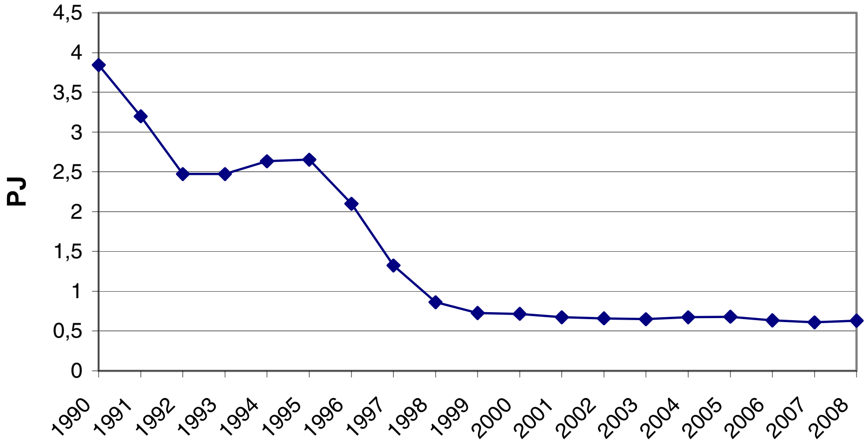


Figure 3.3.11 Residual oil fuel consumption in CRF sectors for other mobile sources 1990-2008.

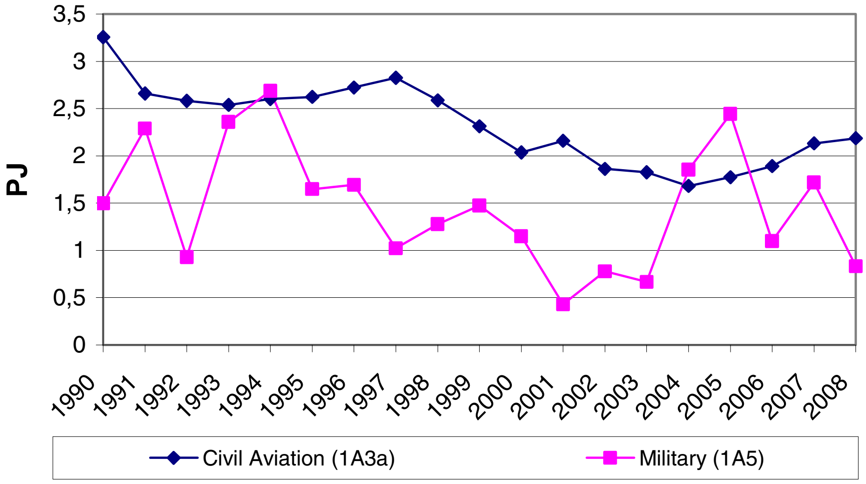


Figure 3.3.12 Jet fuel consumption in CRF sectors for other mobile sources 1990-2008.

In terms of diesel, the fuel consumption decreases for agricultural machines until 2000, due to fewer numbers of tractors and harvesters. After that, the increase in the engine sizes of new sold machines has more than outbalanced the trend towards smaller total stock numbers. The fuel consumption for industry has increased from the beginning of the 1990's, due to an increase in the activities for construction machinery. The fuel consumption increase has been very pronounced in 2005-2008. For fisheries, the development in fuel consumption reflects the activities in this sector.

The Navigation sector comprises national sea transport (fuel consumption between two Danish ports) and recreational craft. For the latter category, fuel consumption has increased significantly from 1990 to 2004 due to the rising number diesel-fuelled private boats. For national sea transport, the diesel fuel consumption curve reflects the combination of traffic and ferries in use for regional ferries. From 1998 to 2000, a significant decline in fuel consumption is apparent. The most important explanation here is the closing of ferry service routes in connection with the opening of the Great Belt Bridge in 1997. For railways, the gradual shift towards electrification explains the lowering trend in diesel fuel consumption and the emissions for this transport sector. The fuel consumed (and associated emissions) to produce electricity is accounted for in the stationary source part of the Danish inventories.

The largest gasoline fuel use is found for household and gardening machinery in the Residential (1A4b) sector. Especially from 2001-2006, a significant fuel consumption increase is apparent due to considerable growth in the machinery stock. The decline in gasoline fuel consumption for Agriculture/forestry/fisheries (1A4c) is due to the gradual phasing out of gasoline-fuelled agricultural tractors.

In terms of residual oil there has been a substantial decrease in the fuel consumption for regional ferries. The fuel consumption decline is most significant from 1990-1992 and from 1997-1999.

The considerable variations from one year to another in military jet fuel consumption are due to planning and budgetary reasons, and the passing demand for flying activities. Consequently, for some years, a certain amount of jet fuel stock-building might disturb the real picture of aircraft fuel consumption. Civil aviation has decreased until 2004, since the opening of the Great Belt Bridge in 1997, both in terms of number of flights and total jet fuel consumption. After 2004 an increase in the consumption of jet fuel is noted.

Bunkers

The residual oil and diesel oil fuel consumption fluctuations reflect the quantity of fuel sold in Denmark to international ferries, international warships, other ships with foreign destinations, transport to Greenland and the Faroe Islands, tank vessels and foreign fishing boats. For jet petrol, the sudden fuel consumption drop in 2002 is explained by the recession in the air traffic sector due to the events of September 11, 2001 and structural changes in the aviation business.

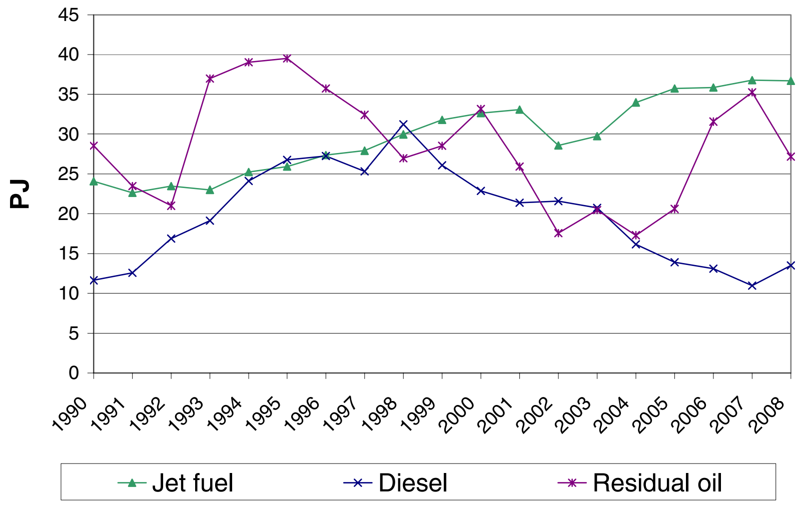


Figure 3.3.13 Bunker fuel consumption 1990-2008.

Emissions of CO_2, CH_4 and N_2O

In Table 3.3.3 the CO_2, CH_4 and N_2O emissions for road transport and other mobile sources are shown for 2008 in CRF sectors. The emission figures in time-series 1990-2008 are given in Annex 3:B.13 (CRF format) and are shown for 1990 and 2008 in Annex 3.B.14 (CollectER format).

From 1990 to 2008 the road transport emissions of CO_2 and N_2O have increased by 40 and 29 %, respectively, whereas the emissions of CH_4 have decreased by 60 % (from Figures 3.3.14 - 3.3.16). From 1990 to 2008 the other mobile CO_2 emissions have decreased by 5 %, (from Figures 3.3.18 - 3.3.20).

Table 3.3.3 Emissions of CO_2, CH_4 and N_2O in 2008 for road transport and other mobile sources.

CRF Sector	CH_4 tonnes	CO_2 tonnes	N_2O tonnes
Industry-Other (1A2f)	41	1 119	47
Civil Aviation (1A3a)	6	164	9
Railways (1A3c)	8	237	7
Navigation (1A3d)	32	453	26
Residential (1A4b)	240	239	4
Ag./for./fish. (1A4c)	91	1 697	81
Military (1A5)	5	108	4
Total other mobile	423	4 016	177
Road (1A3b)	1 046	12 948	405
Total mobile	1 470	16 964	582

Road transport

CO_2 emissions are directly fuel-use dependent and, in this way, the development in the emission reflects the trend in fuel consumption. As shown in Figure 3.3.14, the most important emission source for road transport is passenger cars, followed by heavy-duty vehicles, light-duty vehicles and 2-wheelers in decreasing order. In 2008, the respective emission shares were 52, 31, 16 and 1 %, respectively (Figure 3.3.17).

The majority of CH_4 emissions from road transport come from gasoline passenger cars (Figure 3.3.15). The emission drop from 1992 onwards is explained by the penetration of catalyst cars into the Danish fleet. The 2008 emission shares for CH_4 were 47, 32, 16 and 5 % for passenger cars, heavy-duty vehicles, 2-wheelers and light-duty vehicles, respectively (Figure 3.3.17).

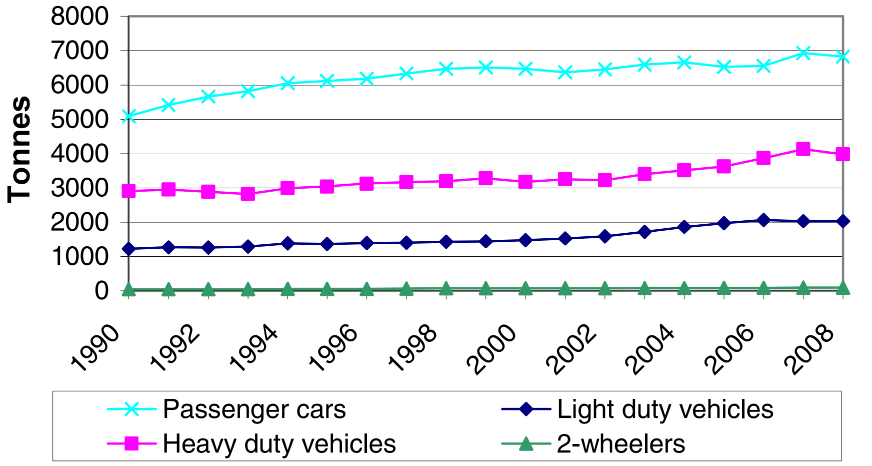


Figure 3.3.14 CO_2 emissions (k-tonnes) pr vehicle type for road transport 1990-2008.

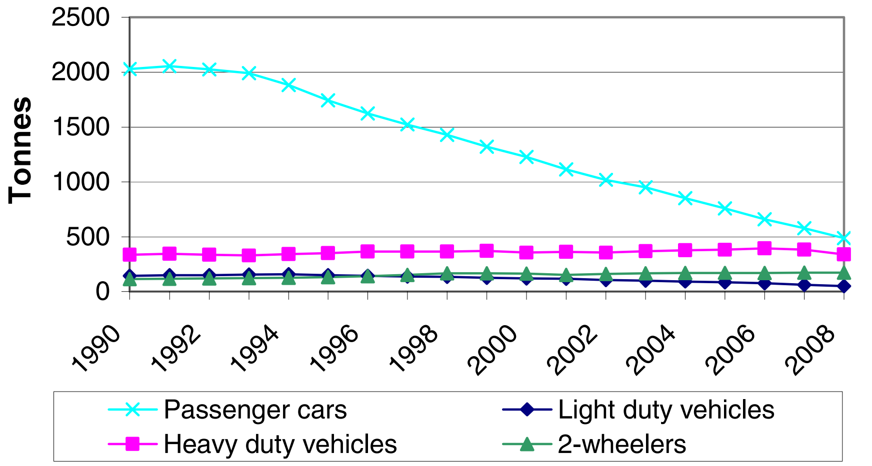


Figure 3.3.15 CH_4 emissions (tonnes) pr vehicle type for road transport 1990-2008.

An undesirable environmental side effect of the introduction of catalyst cars is the increase in the emissions of N_2O from the first generation of catalyst cars (Euro 1) compared to conventional cars. The emission factors for later catalytic converter technologies are considerably lower than the ones for Euro 1, thus causing the emissions to decrease from 1998 onwards (Figure 3.3.16). In 2008, emission shares for passenger cars, heavy and light-duty vehicles were 46, 40 and 14 %, of the total road transport N_2O, respectively (Figure 3.3.17).

Referring to the third IPCC assessment report, 1 g CH_4 and 1 g N_2O has the greenhouse effect of 21 and 310 g CO_2, respectively. In spite of the relatively large CH_4 and N_2O global warming potentials, the largest contribution to the total CO_2 emission equivalents for road transport comes from CO_2, and the CO_2 emission equivalent shares pr vehicle category are almost the same as the CO_2 shares.

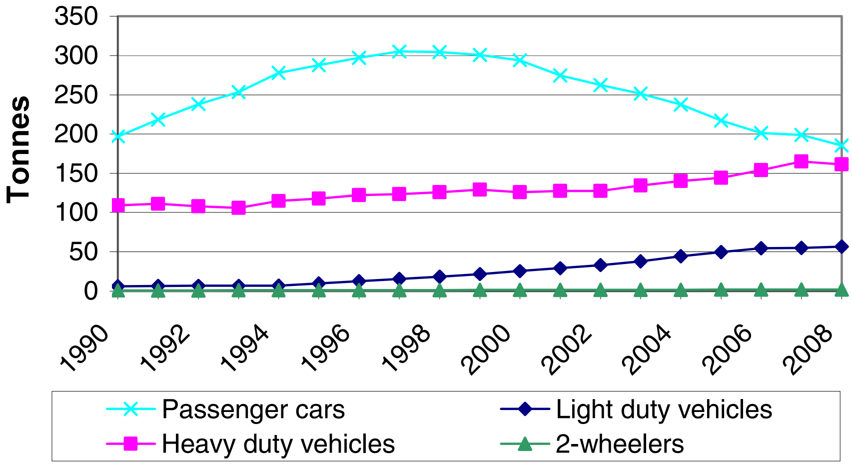


Figure 3.3.16 N_2O emissions (tonnes) pr vehicle type for road transport 1990-2008.

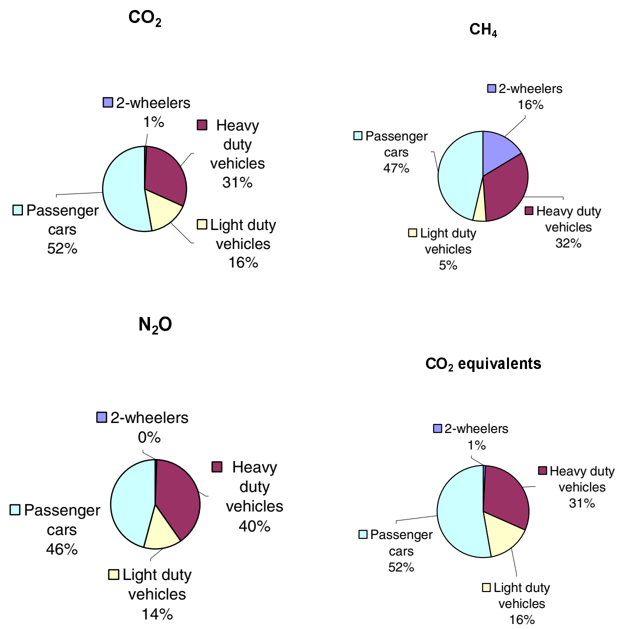


Figure 3.3.17 CO_2, CH_4 and N_2O emission shares and GHG equivalent emission distribution for road transport in 2008.

Other mobile sources

For other mobile sources, the highest CO_2 emissions in 2007 come from Agriculture/forestry/fisheries (1A4c), Industry-other (1A2f), Navigation (1A3d), with shares of 42, 28 and 11 %, respectively (Figure 3.3.21). The 1990-2008 emission trend is directly related to the fuel-use development in the same time-period. Minor CO_2 emission contributors are sectors such as Residential (1A4b), Railways (1A3c), Civil Aviation (1A3a) and Military (1A5). In 2008, the CO_2 emission shares for these sectors were 6, 6, 4 and 3 %, respectively (Figure 3.3.21).

For CH_4, far the most important sector is Residential (1A4b), see Figure 3.3.21. The emission share of 56 % in 2008 is due to relatively large gasoline fuel consumption for gardening machinery. The 2008 emission shares for Agriculture/forestry/fisheries (1A4c), Industry (1A2f) and Navigation (1A3d) are 22, 10 and 8 %, respectively, whereas the remaining sectors have emission shares of 2 % or less.

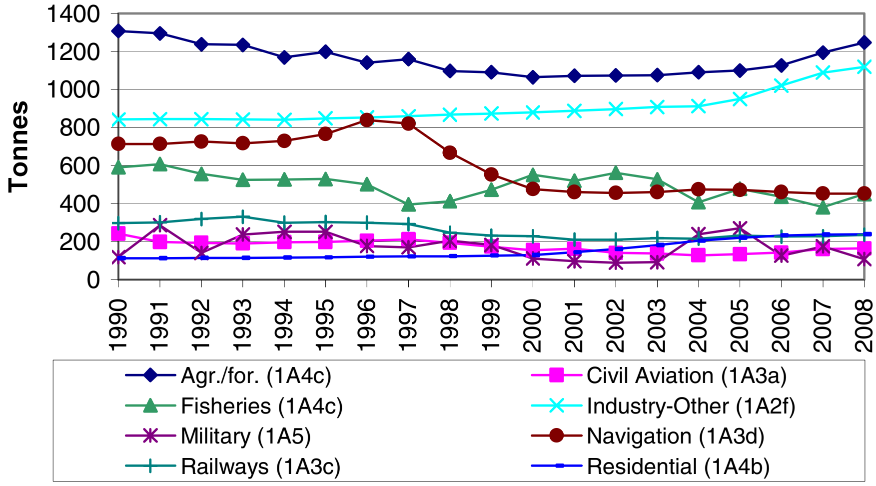


Figure 3.3.18 CO_2 emissions (k-tonnes) in CRF sectors for other mobile sources 1990-2008.

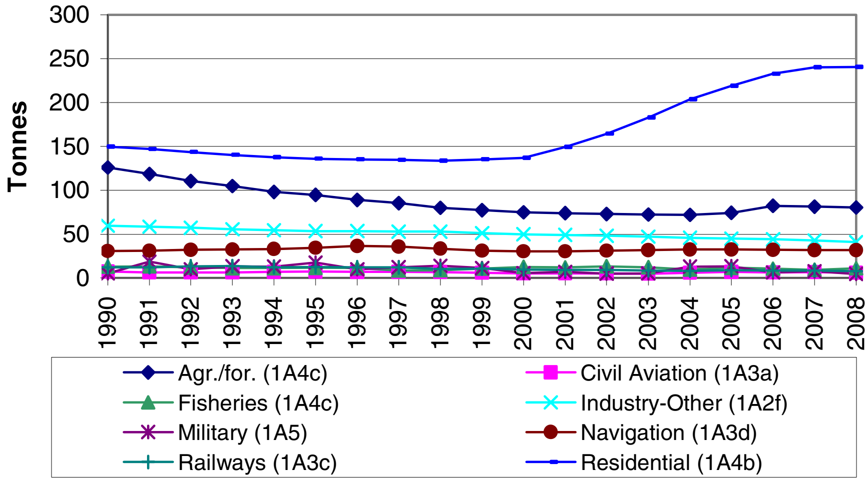


Figure 3.3.19 CH_4 emissions (tonnes) in CRF sectors for other mobile sources 1990-2008.

For N_2O, the emission trend in sub-sectors is the same as for fuel consumption and CO_2 emissions (Figure 3.3.20).

As for road transport, CO_2 alone contributes with by far the most CO_2 emission equivalents in the case of other mobile sources, and pr sector the CO_2 emission equivalent shares are almost the same as those for CO_2, itself (Figure 3.3.21).

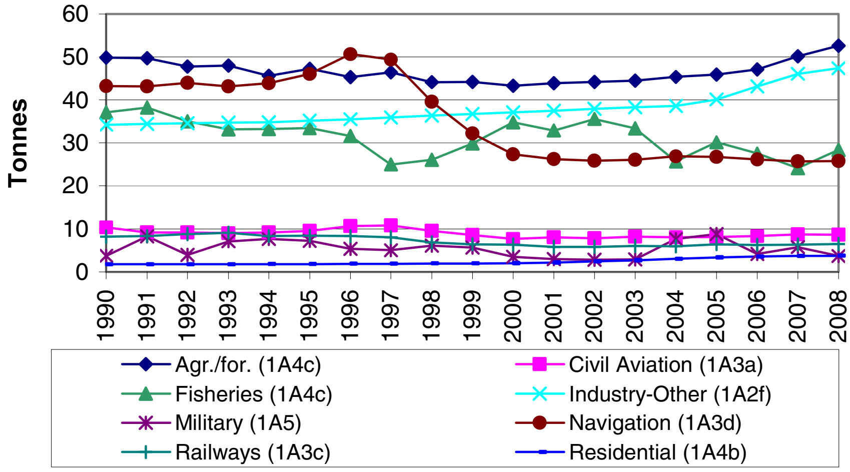


Figure 3.3.20 N_2O emissions (tonnes) in CRF sectors for other mobile sources 1990-2008.

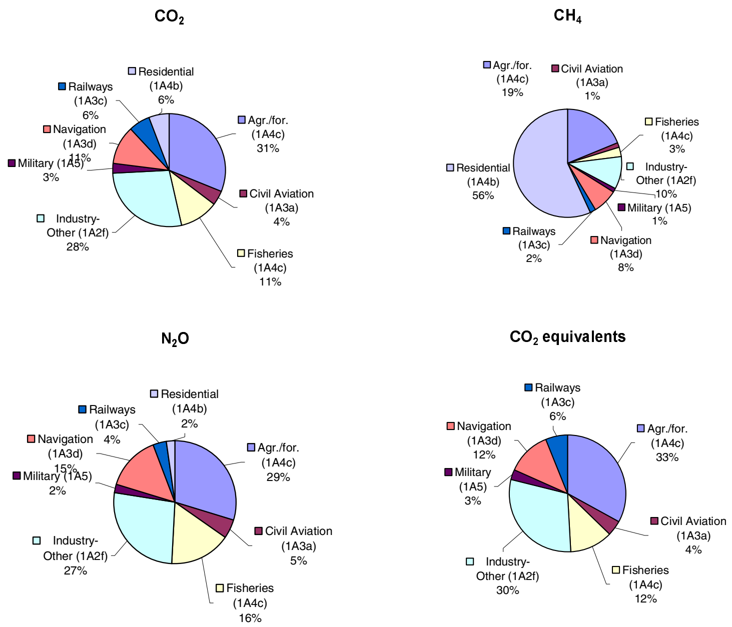


Figure 3.3.21 CO_2, CH_4 and N_2O emission shares and GHG equivalent emission distribution for other mobile sources in 2008.

Emissions of SO_2, NO_X, NMVOC and CO

In Table 3.3.4 the SO_2, NO_X, NMVOC and CO emissions for road transport and other mobile sources are shown for 2008 in CRF sectors. The emission figures in the time-series 1990-2008 are given in Annex 3.B.15 (CRF format) and are shown for 1990 and 2008 in Annex 3.B.14 (CollectER format).

From 1990 to 2008, the road transport emissions of NMVOC, CO and NO_X emissions have decreased by 78, 70 and 42 %, respectively (Figures 3.3.23-3.3.25).

For other mobile sources, the emissions of NO_X decreased by 22 % from 1990 to 2008 and for SO_2 the emission drop is as much as 88 %. In the same period, the emissions of NMVOC have declined by 11 %, whereas the CO emissions have increased by 8 % (Figures 3.3.27-3.3.30).

Table 3.3.20 Emissions of SO_2, NO_X, NMVOC and CO in 2008 for road transport and other mobile sources.

CRF ID	SO_2 tonnes	NO_x tonnes	NMVOC tonnes	CO tonnes
Industry-Other (1A2f)	33	10 100	1 375	7 060
Civil Aviation (1A3a)	52	704	148	828
Railways (1A3c)	1	2 920	205	526
Navigation (1A3d)	655	5 985	986	6 202
Residential (1A4b)	1	304	7 954	95 382
Agri./for./fish. (1A4c)	323	19 135	2 388	16 802
Military (1A5)	19	520	44	309
Total other mobile	1 085	39 667	13 099	127 111
Road (1A3b)	82	61 250	17 754	139 272
Total mobile	1 167	100 918	30 852	266 383

Road transport

The step-wise lowering of the sulphur content in diesel fuel has given rise to a substantial decrease in the road transport emissions of SO_2 (Figure 3.3.22). In 1999, the sulphur content was reduced from 500 ppm to 50 ppm (reaching gasoline levels), and for both gasoline and diesel the sulphur content was reduced to 10 ppm in 2005. Since Danish diesel and gasoline fuels have the same sulphur percentages, at present, the 2008 shares for SO_2 emissions and fuel consumption for passenger cars, heavy-duty vehicles, light-duty vehicles and 2-wheelers are the same in each case: 52, 31, 16 and 1 %, respectively (Figure 3.3.26).

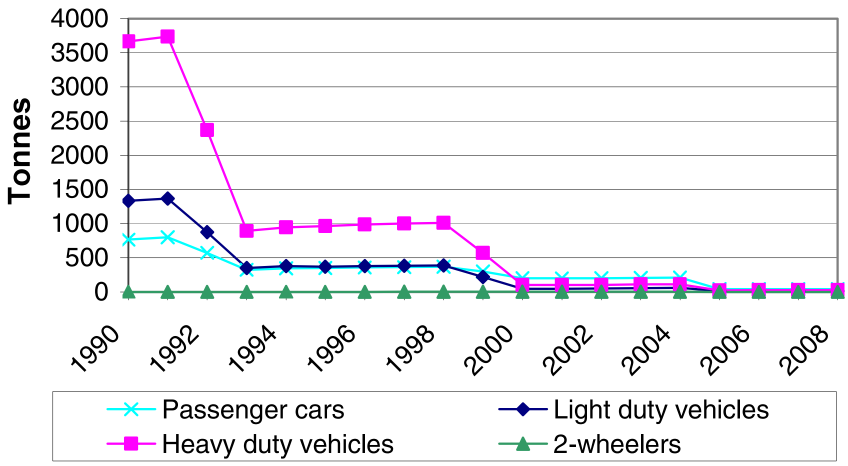


Figure 3.3.22 SO_2 emissions (tonnes) pr vehicle type for road transport 1990-2008.

Historically, the emission totals of NMVOC and CO have been very dominated by the contributions coming from private cars, as shown in Figures 3.3.24-3.3.25. However, the NMVOC and CO (and NO_x) emissions from this vehicle type have shown a steady decreasing tendency since the introduction of private catalyst cars in 1990 (EURO I) and the introduction of even more emission-efficient EURO II, III and IV private cars (introduced in 1997, 2001 and 2006, respectively).

In the case of NO_x, the real traffic emissions for heavy duty vehicles do not decline follow the reductions as intended by the EU emission legislation. This is due to the so-called engine cycle-beating effect. Outside the legislative test cycle stationary measurement points, the electronic engine control for heavy duty Euro II and III engines switches to a fuel efficient engine running mode, thus leading to increasing NO_x emissions.

The 2008 emission shares for heavy-duty vehicles, passenger cars, light-duty vehicles and 2-wheelers for NO_x (60, 28, 12 and 0 %), NMVOC (8, 64, 7 and 21 %), CO (6, 75, 7, 12 %), PM (37, 30, 31 and 2 %) and NH_3 (1, 95, 4 and 0 %), are also shown in Figure 3.3.26.

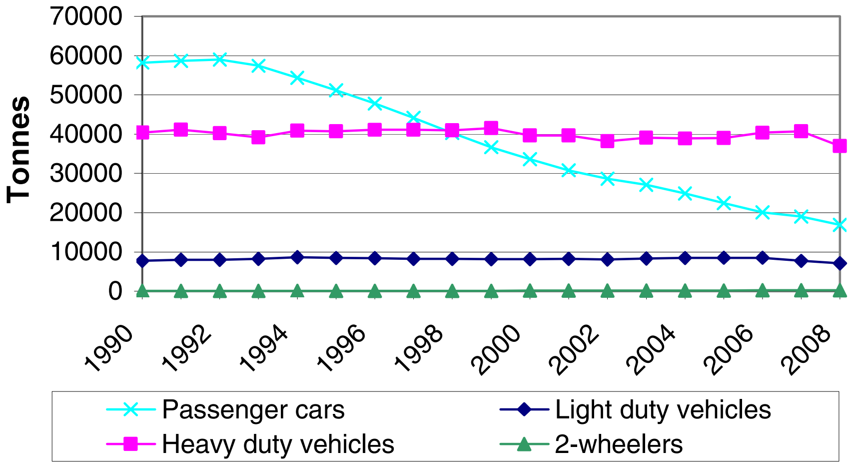


Figure 3.3.23 NO_X emissions (tonnes) pr vehicle type for road transport 1990-2008.

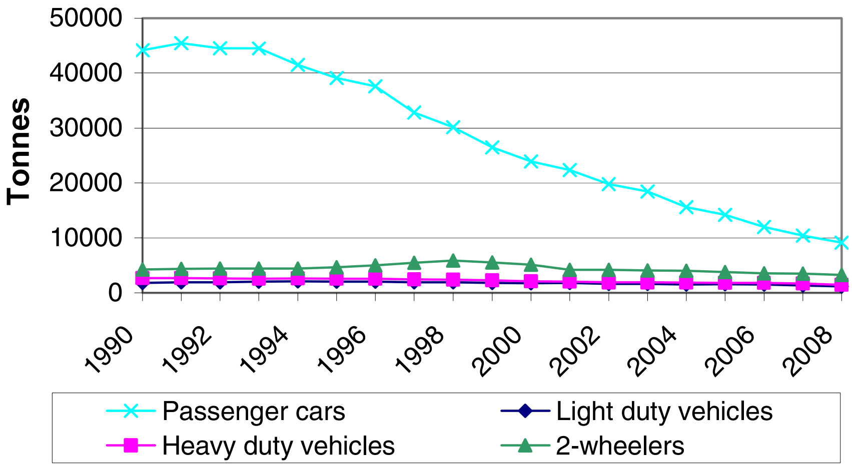


Figure 3.3.24 NMVOC emissions (tonnes) pr vehicle type for road transport 1990-2008

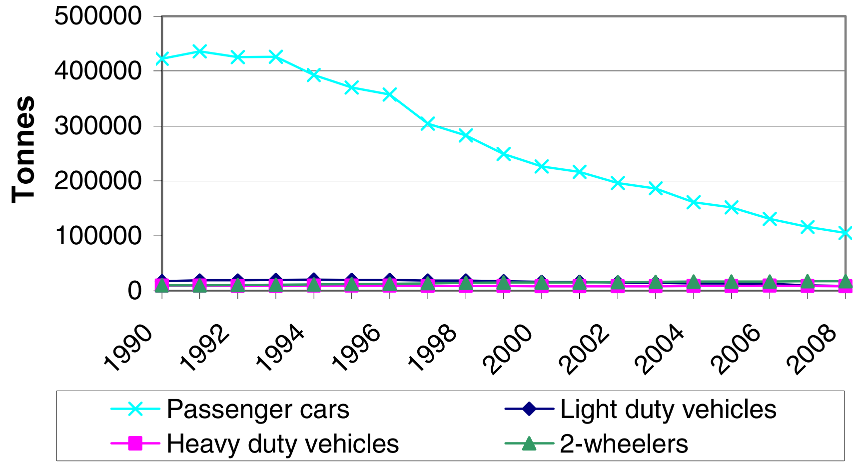


Figure 3.3.25 CO emissions (tonnes) pr vehicle type for road transport 1990-2008.

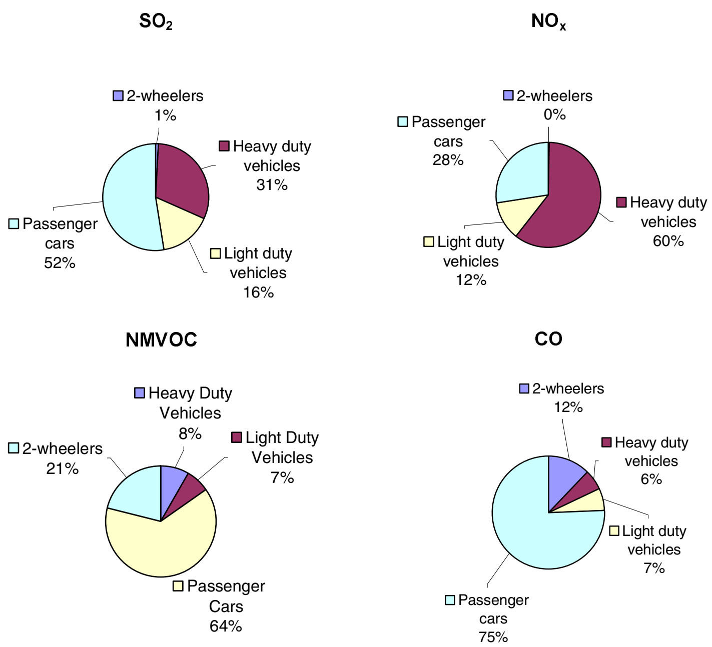


Figure 3.3.26 SO_2, NO_X, NMVOC and CO emission shares pr vehicle type for road transport in 2008.

Other mobile sources

For SO_2 the trends in the Navigation (1A3d) emissions shown in Figure 3.3.27 mainly follow the development of the heavy fuel consumption (Figure 3.25). Though, from 1993 to 1995 relatively higher contents of sulphur in the fuel (estimated from sales) cause a significant increase in the emissions of SO_2. The SO_2 emissions for Fisheries (1A4c) correspond with the development in the consumption of marine gas oil. The main explanation for the development of the SO_2 emission curves for Railways (1A3c) and non-road machinery in Agriculture/forestry (1A4c) and Industry (1A2f), are the stepwise sulphur content reductions for diesel used by machinery in these sectors.

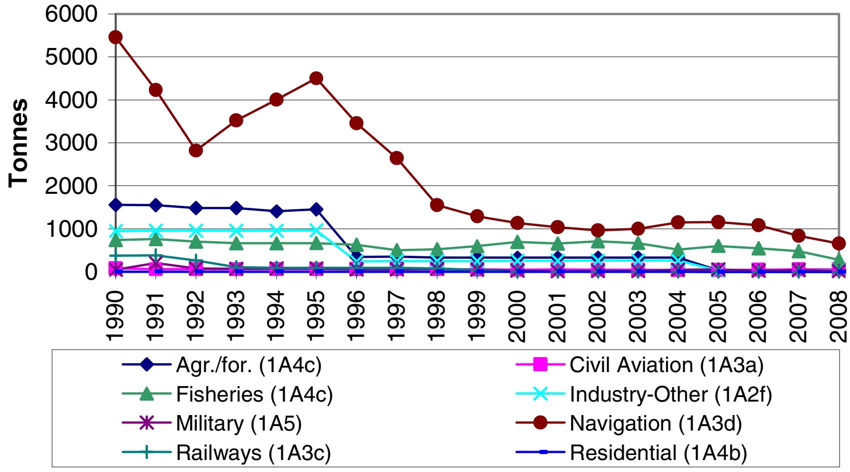


Figure 3.3.27 SO_2 emissions (tonnes) in CRF sectors for other mobile sources 1990-2008.

In general, the emissions of NO_X, NMVOC and CO from diesel-fuelled working equipment and machinery in agriculture, forestry and industry have decreased slightly since the end of the 1990s due to gradually strengthened emission standards given by the EU emission legislation directives.

NO_X emissions mainly come from diesel machinery, and the most important sources are Agriculture/forestry/fisheries (1A4c), Industry (1A2f), Navigation (1A3d) and Railways (1A3c), as shown in Figure 3.3.20. The 2008 emission shares are 49, 25, 15 and 7 %, respectively (Figure 3.3.23). Minor emissions come from the sectors, Civil Aviation (1A3a), Military (1A5) and Residential (1A4b).

The NO_X emission trend for Navigation, Fisheries and Agriculture is determined by fuel use fluctuations for these sectors, and the development of emission factors. For ship engines the emission factors tend to increase for new engines until mid-1990s. After that, the emission factors gradually reduce until 2000, bringing them to a level comparable with the emission limits for new engines in this year. For agricultural machines, there have been somewhat higher NO_x emission factors for 1991-stage I machinery, and an improved emission performance for stage I and II machinery since the late 1990s.

The emission development for industry NO_x is the product of a fuel consumption increase from 1985 to 2008, most pronounced from 2005 onwards, and a development in emission factors as explained for agricultural machinery. For railways, the gradual shift towards electrification explains the declining trend in diesel fuel use and NO_X emissions for this transport sector until 2001.

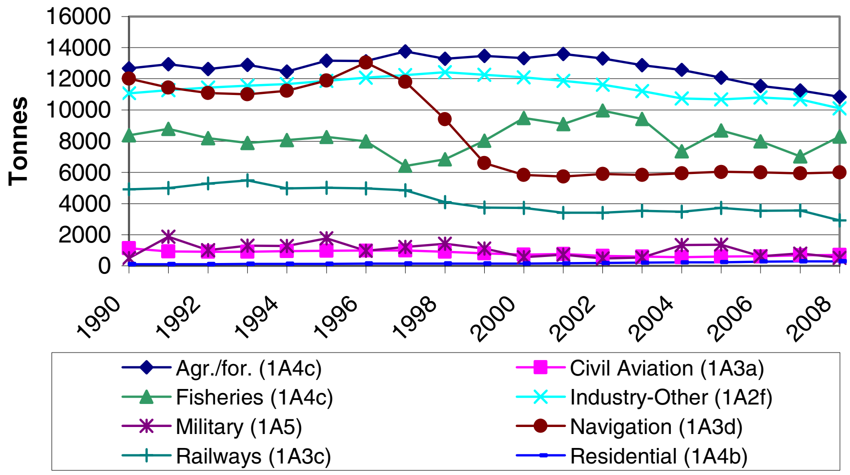


Figure 3.3.28 NO_X emissions (tonnes) in CRF sectors for other mobile sources 1990-2008.

The 1990-2008 time-series of NMVOC and CO emissions are shown in Figures 3.3.29 and 3.3.30 for other mobile sources. The 2008 sector emission shares are shown in Figure 3.3.31. For NMVOC, the most important sectors are Residential (1A4b), Agriculture/forestry/fisheries (1A4c), Industry (1A2f) and Navigation (1A3d), with 2008 emission shares of 60, 19, 10 and 8 %, respectively. The same four sectors also contribute with most of the CO emissions in the same consecutive order; the emission shares are 75, 13, 6 and 5 %, respectively. Minor NMVOC and CO emissions come from Railways (1A3c), Civil Aviation (1A3a) and Military (1A5).

For NMVOC and CO, the significant emission increases for the residential sector after 2000 are due to the increased number of gasoline working machines. Improved NMVOC emission factors for diesel machinery in agriculture and gasoline equipment in forestry (chain saws) are the most important explanations for the NMVOC emission decline in the Agriculture/forestry/fisheries sector. This explanation also applies for the industrial sector, which is dominated by diesel-fuelled machinery. From 1997 onwards, the NMVOC emissions from Navigation decrease due to the gradually phase-out of the 2-stroke engine technology for recreational craft. The main reason for the significant 1985-2006 CO emission decrease for Agriculture/forestry/fisheries is the phasing out of gasoline tractors.

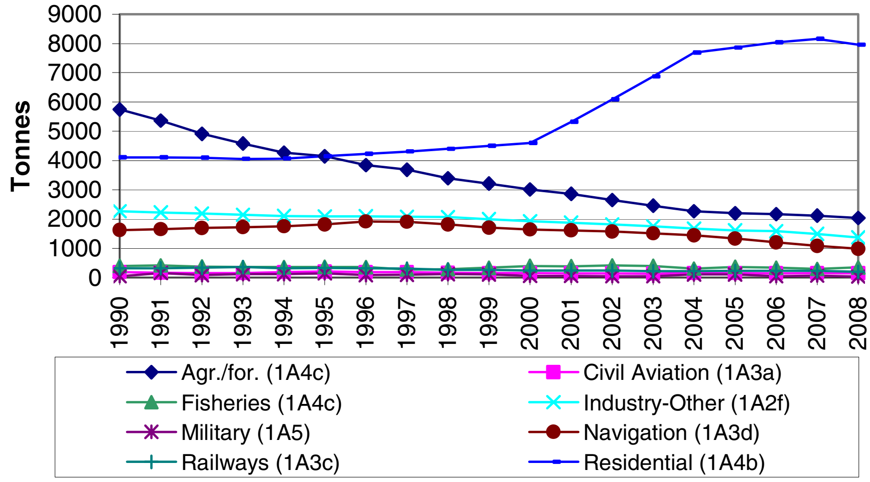


Figure 3.3.29 NMVOC emissions (tonnes) in CRF sectors for other mobile sources 1990-2008.

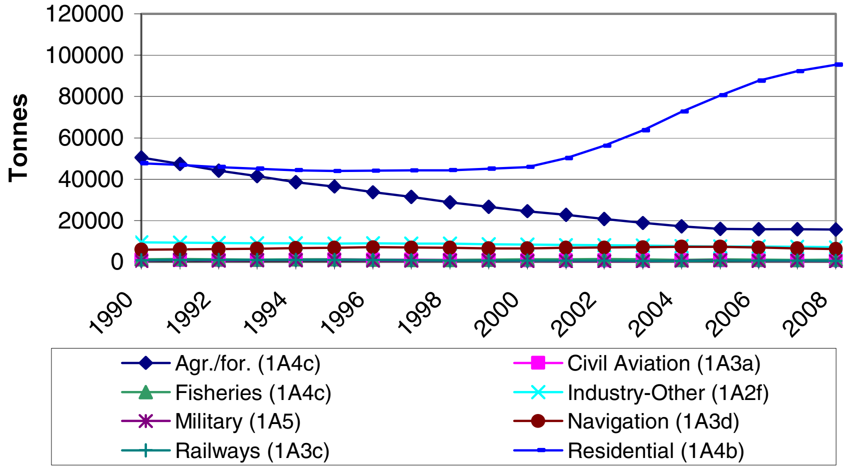


Figure 3.3.30 CO emissions (tonnes) in CRF sectors for other mobile sources 1990-2008.

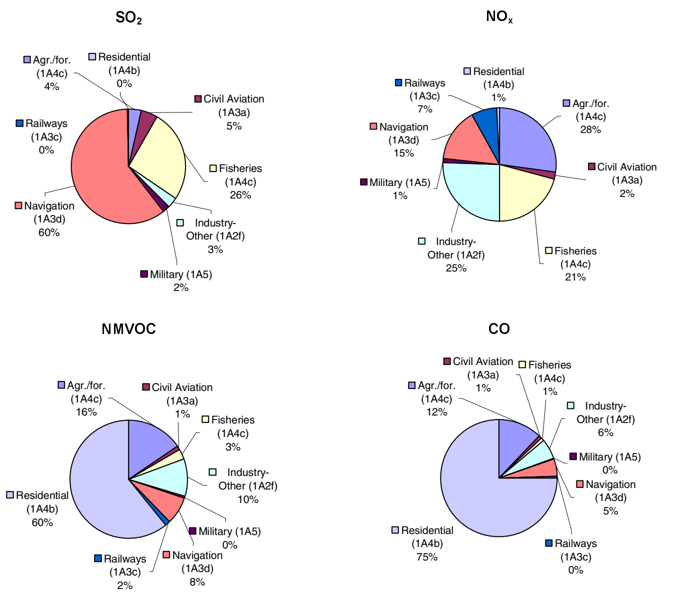


Figure 3.3.31 SO_2, NO_X, NMVOC and CO emission shares pr vehicle type for other mobile sources in 2008.

Bunkers

The most important emissions from bunker fuel consumption (fuel consumption for international transport) are SO_2, NO_X and CO_2 (and TSP, not shown). However, compared with the Danish national emission total (all sources), the greenhouse gas emissions from bunkers are small. The bunker emission totals are shown in Figure 3.3.7 for 2008, split into sea transport and civil aviation. All emission figures in the 1990-2008 time-series are given in Annex 3.B.15 (CRF format). In Annex 3.B.14, the emissions are also given in CollectER format for the years 1990 and 2008.

Table 3.3.5 Emissions in 2008 for international transport.

CRF sector	SO_2	NO_X	NMVOC	CH_4	CO	CO_2	N_2O
	tonnes	tonnes	tonnes	tonnes	tonnes	k-tonnes	tonnes
Navigation int. (1A3d)	20 557	77 545	2 433	75	8 028	3 118	196
Civil Aviation int. (1A3a)	844	11 299	485	51	2 003	2 642	90
International total	20 557	77 545	2 433	75	8 028	3 118	196

The differences in emissions between navigation and civil aviation are much larger than the differences in fuel consumption (and derived CO_2 emissions), and display a poor emission performance for international sea transport. In broad terms, the emission trends shown in Figure 3.3.32 are similar to the fuel-use development.

However, for navigation minor differences occur for the emissions of SO_2, NO_X and CO_2 due to varying amounts of marine gas oil and residual oil, and for SO_2 and NO_X the development in the emission factors also have an impact on the emission trends. For civil aviation, apart from the annual consumption of jet fuel, the development of the NO_X emissions is also due to yearly variations in LTO/aircraft type (earlier than 2001) and city-pair statistics (2001 onwards).

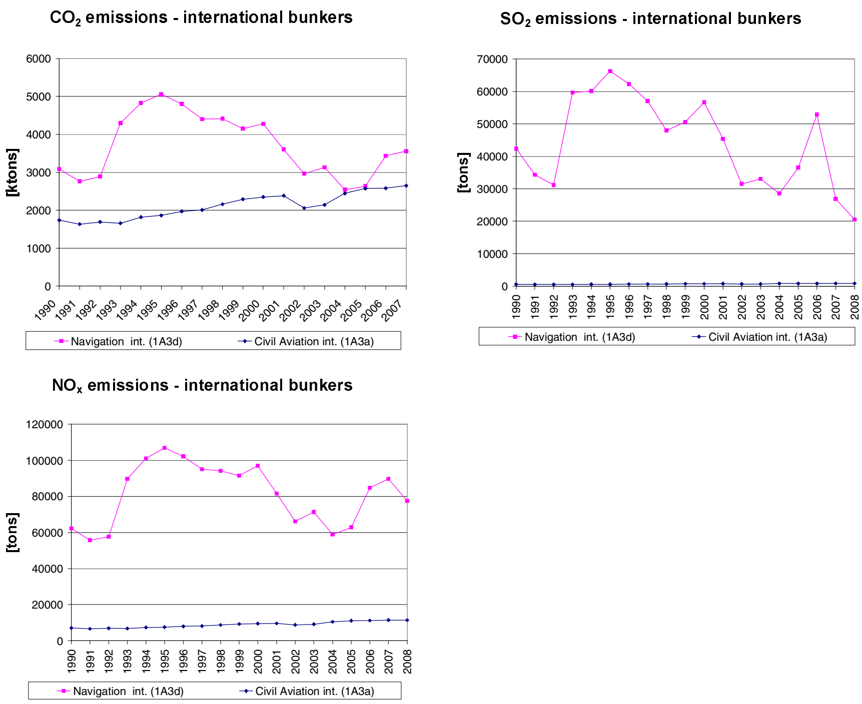


Figure 3.3.32 CO_2, SO_2 and NO_X emissions for international transport 1990-2008.

3.3.2 Methodological issues

The description of methodologies and references for the transport part of the Danish inventory is given in two sections: one for road transport and one for the other mobile sources.

Methodology and references for Road Transport

For road transport, the detailed methodology is used to make annual estimates of the Danish emissions, as described in the EMEP/EEA air pollutant emission inventory guidebook (EMEP/EEA, 2009). The actual calculations are made with a model developed by NERI, using the European COPERT III model methodology, and updated fuel consumption and emission factors from the latest version of COPERT - COPERT IV. The latter model approach is explained in (EMEP/EEA, 2009). In COPERT, fuel consumption and emission simulations can be made for operationally hot engines, taking into account gradually stricter emission standards and emission degradation due to catalyst wear. Furthermore, the emission effects of cold-start and evaporation are simulated.

Vehicle fleet and mileage data

Corresponding to the COPERT III fleet classification, all present and future vehicles in the Danish fleet are grouped into vehicle classes, subclasses and layers. The layer classification is a further division of vehicle sub-classes into groups of vehicles with the same average fuel consumption and emission behaviour, according to EU emission legislation levels. Table 3.3.6 gives an overview of the different model classes and subclasses, and the layer level with implementation years are shown in Annex 3.B.1.

Table 3.3.6 Model vehicle classes and sub-classes, trip speeds and mileage split.

			Trip speed [km pr h]			Mileage split [%]		
Vehicle classes	Fuel type	Engine size/weight	Urban	Rural	Highway	Urban	Rural	Highway
PC	Gasoline	< 1.4 l.	40	70	100	35	46	19
PC	Gasoline	1.4 – 2 l.	40	70	100	35	46	19
PC	Gasoline	> 2 l.	40	70	100	35	46	19
PC	Diesel	< 2 l.	40	70	100	35	46	19
PC	Diesel	> 2 l.	40	70	100	35	46	19
PC	LPG		40	70	100	35	46	19
PC	2-stroke		40	70	100	35	46	19
LDV	Gasoline		40	65	80	35	50	15
LDV	Diesel		40	65	80	35	50	15
Trucks	Gasoline		35	60	80	32	47	21
Trucks	Diesel	3.5 – 7.5 tonnes	35	60	80	32	47	21
Trucks	Diesel	7.5 – 16 tonnes	35	60	80	32	47	21
Trucks	Diesel	16 – 32 tonnes	35	60	80	19	45	36
Trucks	Diesel	> 32 tonnes	35	60	80	19	45	36
Urban buses	Diesel		30	50	70	51	41	8
Coaches	Diesel		35	60	80	32	47	21
Mopeds	Gasoline		30	30	-	81	19	0
Motorcycles	Gasoline	2 stroke	40	70	100	47	39	14
Motorcycles	Gasoline	< 250 cc.	40	70	100	47	39	14
Motorcycles	Gasoline	250 – 750 cc.	40	70	100	47	39	14
Motorcycles	Gasoline	> 750 cc.	40	70	100	47	39	14

Fleet numbers in total vehicle categories for 2008 has been obtained from Statistics Denmark (2008). Corresponding fleet figures have been provided annually by Statistics Denmark for the years before 2008, as input data for previous years inventory calculations.

The Danish fleet data is distributed into annual fleet numbers pr first registration year for the different vehicle categories in the inventory, by using the 1990-2004 baseline vehicle stock and annual mileage information obtained from the Danish Road Directorate (Ekman, 2005). For 2005-2008 the fleet data are split into vehicle categories-first registration years, by using the 2004 year distribution matrix together with appropriate assumptions of scrapping of new vehicles, and the use of simple fleet scaling factors in order to maintain the total fleet numbers.

Information of total mileage for passenger cars, light duty trucks, heavy duty trucks and buses are gathered by the Danish Road Directorate, and these mileage figures are publically available from Statistics Denmark (2008). For 2001-2004 the mileage data is derived from the Danish vehicle inspection programme, and backcasted mileage data for 1990-2000 are estimated by using appropriate assumptions. The total mileage pr vehicle category from 2005-2008 have been estimated based on the traffic index development (derived from traffic counts on selected roads) from the Danish Road Directorate.

In addition new data prepared by DTU Transport for the Danish Infrastructure Commission has given information of the total mileage driven by foreign trucks on Danish roads. This mileage contribution has been added to the total mileage for Danish trucks on Danish roads, for trucks > 16 tonnes of gross vehicle weight. The data from DTU Transport was estimated for 2005, and by using appropriate assumptions the mileage have been backcasted to 1990 and forecasted to 2008.

The Danish mileage data is distributed into annual mileage numbers pr first registration year for the different vehicle categories in the inventory, by using the 1990-2004 baseline vehicle stock and annual mileage information obtained from the Danish Road Directorate (Ekman, 2005). For 2005-2008 the annual mileage data are split into vehicle categories-first registration years, by using the 2004 year distribution matrix. For all years the annual mileage pr first registration year is adjusted in order to maintain the total mileage figures.

The data set from Ekman (2005) which underpinned the Danish 2004 emission inventory also cover information of the mileage split between urban, rural and highway driving, and the respective average speeds. Additional data for the moped fleet and motorcycle fleet disaggregation information is given by The National Motorcycle Association (Markamp, 2009).

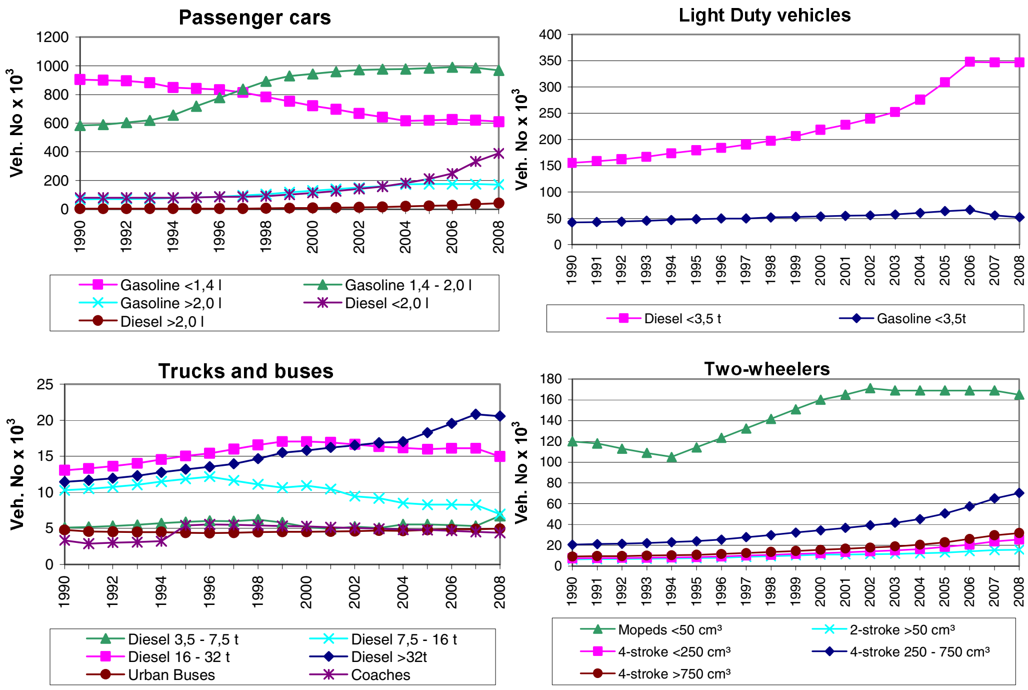


Figure 3.3.33 Number of vehicles in sub-classes in 1990-2008.

The vehicle numbers pr sub-class are shown in Figure 3.3.33. It must be noted that for 2005-2008, the 2004 stock shares are used to distribute the fleet into the different vehicle sub-categories for passenger cars and heavy duty trucks. Consequently, it gives less meaning to explain the fleet curves beyond 2004 for these vehicle types.

For passenger cars, the engine size differentiation is associated with some uncertainty. The increase in the total number of passenger cars is mostly due to a growth in the number of gasoline cars with engine sizes between 1.4 and 2 litres (from 1990-2002) and an increase in the number of gasoline cars (>2 litres) and diesel cars (< 2 litres). In the later years, there has been a decrease in the number of cars with an engine size smaller than 1.4 litres.

There has been a considerable growth in the number of diesel light-duty vehicles from 1985 to 2006; the number of vehicles has however decreased somewhat during 2007 and 2008. The two largest truck sizes have also increased in numbers during the 1990s. From 2000-2007, this growth has continued for trucks larger than 32 tonnes, whereas the number of trucks with gross vehicle weights between 16 and 32 tonnes has decreased slightly.

The number of urban buses has been almost constant between 1990 and 2008. The sudden change in the level of coach numbers from 1994 to 1995 is due to uncertain fleet data.

The reason for the significant growth in the number of mopeds from 1994 to 2002 is the introduction of the so-called Moped 45 vehicle type. For motorcycles, the number of vehicles has grown in general throughout the entire 1990-2008 period. The increase is, however, most visible from the mid-1990s and onwards.

The vehicle numbers are summed up in EU emission layers for each year (Figure 3.3.34) by using the correspondence between layers and first year of registration:

$$N_{j,y} = \sum_{i=FYear(j)}^{LYear(j)} N_{i,y} \quad (1)$$

Where N = number of vehicles, j = layer, y = year, i = first year of registration.

Weighted annual mileages pr layer are calculated as the sum of all mileage driven pr first registration year divided by the total number of vehicles in the specific layer.

$$M_{j,y} = \frac{\sum_{i=FYear(j)}^{LYear(j)} N_{i,y} \cdot M_{i,y}}{\sum_{i=FYear(j)}^{LYear(j)} N_{i,y}} \quad (2)$$

For heavy duty trucks, there is a slight deviation from the strict correspondence between EU emission layers and first registration year. In this case, specific information from the Danish Car Importers Association (Danske Bilimportører, DBI, 2008) of the Euro level for the trucks sold in Denmark between 2001 and 2007 is used to estimate a percentage new sales/Euro level matrix for truck engines for these inventory years. A full new sales matrix covering all relevant inventory years is subsequently made, based on a broader view of the 2001-2007 DBI data, and taking into account the actual starting dates for Euro 0-6 engines, see Annex 3.B.16.

Vehicle numbers and weighted annual mileages pr layer are shown in Annex 3.B.1 and 3.B.2 for 1990-2008. The trends in vehicle numbers pr layer are also shown in Figure 3.3.34. The latter figure shows how vehicles complying with the gradually stricter EU emission levels (EURO I, II, III etc.) have been introduced into the Danish motor fleet.

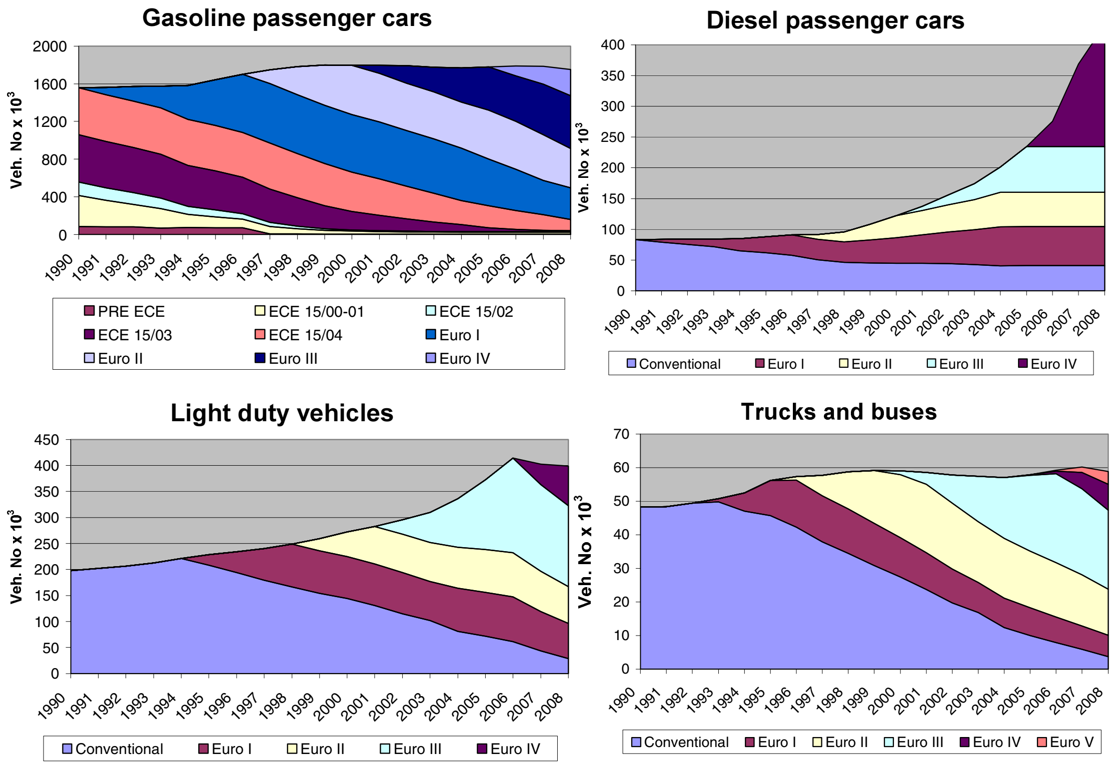


Figure 3.3.34 Layer distribution of vehicle numbers pr vehicle type in 1990-2008.

Emission legislation

The EU 443/2009 regulation sets new emission performance standards for new passenger cars as part of the Community's integrated approach to reduce CO_2 emissions from light-duty vehicles. Some key elements of the adopted text are as follows:

- **Limit value curve**: the fleet average to be achieved by all cars registered in the EU is 130 grams pr kilometre (g pr km). A so-called limit value curve implies that heavier cars are allowed higher emissions than lighter cars while preserving the overall fleet average.

- **Further reduction:** A further reduction of 10 g CO_2 pr km, or equivalent if technically necessary, will be delivered by other technological improvements and by an increased use of sustainable biofuels.

- **Phasing-in of requirements**: in 2012, 65% of each manufacturer's newly registered cars must comply on average with the limit value curve set by the legislation. This will rise to 75% in 2013, 80% in 2014, and 100% from 2015 onwards.

- **Lower penalty payments for small excess emissions** until 2018: If the average CO2 emissions of a manufacturer's fleet exceed its limit value in any year from 2012, the manufacturer has to pay an excess emissions premium for each car registered. This premium amounts to €5 for the first g pr km of exceedance, €15 for the second g pr km, €25 for the third g pr km, and €95 for each subsequent g pr km. From 2019, already the first g pr km of exceedance will cost €95.

- **Long-term target**: a target of 95g pr km is specified for the year 2020. The modalties for reaching this target and the aspects of its implementation including the excess emissions premium will have to be defined in a review to be completed no later than the beginning of 2013.

- **Eco-innovations**: because the test procedure used for vehicle type approval is outdated, certain innovative technologies cannot demonstrate their CO2-reducing effects under the type approval test. As an interim procedure until the test procedure is reviewed by 2014, manufacturers can be granted a maximum of 7g pr km of emission credits on average for their fleet if they equip vehicles with innovative technologies, based on indepently verified data.

On 28 October 2009 the European Commission adopted a new legislative proposal to reduce CO2 emissions from light commercial vehicles (vans). The main content of the proposal is given below in bullet points:

- Target dates: the EU fleet average for all new light commercial vehicles (vans) of 175 g pr km will apply as of 2014. The requirement will be phased-in as of 2014 when 75% of each manufacturer's newly registered vans must comply on average with the limit value curve set by the legislation. This will rise to 80 % in 2015, and 100% from 2016 onwards.

- Limit value curve: emissions limits are set according to the mass of vehicle, using a limit value curve. The curve is set in such a way that a fleet average of 175 grams of CO_2 pr kilometre is achieved. A so-called limit value curve of 100% implies that heavier vans are allowed higher emissions than lighter vans while preserving the overall fleet average. Only the fleet average is regulated, so manufacturers will still be able to make vehicles with emissions above the limit value curve provided these are balanced by other vehicles which are below the curve.

- Vehicles affected: the vehicles affected by the legislation are vans, which account for around 12% of the market for light-duty vehicles. This includes vehicles used to carry goods weighing up to 3.5t (vans and car-derived vans, known as N1) and which weigh less than 2610 kg when empty.

- Long-term target: a target of 135g pr km is specified for the year 2020. Confirmation of the target with the updated impact assessment, the modalities for reaching this target, and the aspects of its implementation, including the excess emissions premium, will have to be defined in a review to be completed no later than the beginning of 2013.

- Excess emissions premium for small excess emissions until 2018: if the average CO2 emissions of a manufacturer's fleet exceed its limit value in any year from 2014, the manufacturer has to pay an excess emissions premium for each van registered. This premium amounts to €5 for the first g pr km of exceedance, €15 for the second g pr km, €25 for the third g pr km, and €120 for each subsequent g pr km. From 2019, already the first g pr km of exceedance will cost €120. This value is higher than the one for cars (€95) because of the differences in compliance costs.

- Super-credits: vehicles with extremely low emissions (below 50g pr km) will be given additional incentives whereby 1 low-emitting van will be counted as 2.5 vehicles in 2014, as 1.5 vehicles in 2015, and 1 vehicle from 2016.

- Eco-innovations: because the test procedure used for vehicle type approval is outdated, certain innovative technologies cannot demonstrate their CO2-reducing effects under the type approval test. As an interim procedure until the test procedure is reviewed by 2014, manufacturers can be granted a maximum of 7g pr km of emission credits on average for their fleet if they equip vehicles with innovative technologies, based on independently verified data.

- Other flexibilities: manufacturers may group together to form a pool and act jointly in meeting the specific emissions targets. Independent manufacturers who sell fewer than 22,000 vehicles pr year can also apply to the Commission for an individual target instead.

For Euro 1-4 passenger cars and light duty trucks, the chassis dynamometer test cycle used in the EU for measuring fuel is the NEDC (New European Driving Cycle), see Nørgaard and Hansen (2004). The test cycle is also used also for emissions testing. The NEDC cycle consists of two parts, the first part being a 4-time repetition (driving length: 4 km) of the ECE test cycle. The latter test cycle is the so-called urban driving cycle11 (average speed: 19 km pr h). The second part of the test is the run-through of the EUDC (Extra Urban Driving Cycle) test driving segment, simulating the fuel consumption under rural and highway driving conditions. The driving length of EUDC is seven km at an average speed of 63 km pr h. More information regarding the fuel measurement procedure can be found in the EU-directive 80/1268/EØF.

For NO_X, VOC (NMVOC + CH_4), CO and PM, the emissions from road transport vehicles have to comply with the different EU directives listed in Table 3.3.7. The emission directives distinguish between three vehicle classes according to vehicle reference mass[12]: Passenger cars and light duty trucks (<1305 kg), light duty trucks (1305-1760 kg) and light duty trucks (>1760 kg).The specific emission limits are shown in Annex 3.B.3.

[11] For Euro 3 and on, the emission approval test procedure was slightly changed. The 40 s engine warm up phase before start of the urban driving cycle was removed.

[12] Reference mass: net vehicle weight + mass of fuel and other liquids + 100 kg.

Table 3.3.7 Overview of the existing EU emission directives for road transport vehicles.

Vehicle category	Emission layer	EU directive	First reg. date
Passenger cars (gasoline)	PRE ECE		0
	ECE 15/00-01	70/220 - 74/290	1972[a]
	ECE 15/02	77/102	1981[b]
	ECE 15/03	78/665	1982[c]
	ECE 15/04	83/351	1987[d]
	Euro I	91/441	1.10.1990[e]
	Euro II	94/12	1.1.1997
	Euro III	98/69	1.1.2001
	Euro IV	98/69	1.1.2006
	Euro V	715/2007	1.1.2011
	Euro VI	715/2007	1.9.2015
Passenger cars (diesel and LPG)		Conventional	0
	ECE 15/04	83/351	1987[d]
	Euro I	91/441	1.10.1990[e]
	Euro II	94/12	1.1.1997
	Euro III	98/69	1.1.2001
	Euro IV	98/69	1.1.2006
	Euro V	715/2007	1.1.2011
	Euro VI	715/2007	1.9.2015
Light duty trucks (gasoline and diesel)		Conventional	0
	ECE 15/00-01	70/220 - 74/290	1972[a]
	ECE 15/02	77/102	1981[b]
	ECE 15/03	78/665	1982[c]
	ECE 15/04	83/351	1987[d]
	Euro I	93/59	1.10.1994
	Euro II	96/69	1.10.1998
	Euro III	98/69	1.1.2002
	Euro IV	98/69	1.1.2007
	Euro V	715/2007	1.1.2012
	Euro VI	715/2007	1.9.2016
Heavy duty vehicles	Euro 0	88/77	1.10.1990
	Euro I	91/542	1.10.1993
	Euro II	91/542	1.10.1996
	Euro III	1999/96	1.10.2001
	Euro IV	1999/96	1.10.2006
	Euro V	1999/96	1.10.2009
	Euro VI	595/2009	1.10.2014
Mopeds		Conventional	0
	Euro I	97/24	2000
	Euro II	2002/51	2004
Motor cycles		Conventional	0
	Euro I	97/24	2000
	Euro II	2002/51	2004
	Euro III	2002/51	2007

a,b,c,d: Expert judgement suggest that Danish vehicles enter into the traffic before EU directive first registration dates. The effective inventory starting years are a: 1970; b: 1979; c: 1981; d: 1986.

e: The directive came into force in Denmark in 1991 (EU starting year: 1993).

In practice, the emissions from vehicles in traffic are different from the legislation limit values and, therefore, the latter figures are considered to be too inaccurate for total emission calculations. A major constraint is that the emission approval test conditions reflect only to a small degree the large variety of emission influencing factors in the real traffic situation, such as cumulated mileage driven, engine and exhaust after treatment maintenance levels and driving behaviour.

Therefore, in order to represent the Danish fleet and to support average national emission estimates, emission factors must be chosen which derive from numerous emissions measurements, using a broad range of real world driving patterns and a sufficient number of test vehicles. It is similar important to have separate fuel consumption and emission data for cold-start emission calculations and gasoline evaporation (hydrocarbons).

For heavy-duty vehicles (trucks and buses), the emission limits are given in g pr kWh and the measurements are carried out for engines in a test bench, using the EU ESC (European Stationary Cycle) and ETC (European Transient Cycle) test cycles, depending on the Euro norm and exhaust gas after-treatment system installed. A description of the test cycles is given by Nørgaard and Hansen, 2004). Measurement results in g pr kWh from emission approval tests cannot be directly used for inventory work. Instead, emission factors used for national estimates must be transformed into g pr km, and derived from a sufficient number of measurements which represent the different vehicle size classes, Euro engine levels and real world variations in driving behaviour.

Fuel consumption and emission factors

Trip-speed dependent basis factors for fuel consumption and emissions are taken from the COPERT model using trip speeds as shown in Table 3.3.6. The factors are listed in Annex 3.B.4. For EU emission levels not represented by actual data, the emission factors are scaled according to the reduction factors given in Annex 3.B.5.

The fuel consumption and emission factors used in the Danish inventory come from the COPERT IV model. The scientific basis for COPERT IV is fuel consumption and emission information from the European 5th framework research projects ARTEMIS and Particulates. In cases where no updates are made for vehicle categories and fuel consumption/emission components, COPERT IV still uses COPERT III data; the source for these data are various European measurement programmes. In general the COPERT data are transformed into trip-speed dependent fuel consumption and emission factors for all vehicle categories and layers.

For passenger cars, real measurement results are behind the emission factors for Euro 1-4 vehicles (updated figures), and those earlier (COPERT III data). For light duty trucks the measurements represent Euro 1 and prior vehicle technologies from COPERT III. For mopeds and motorcycles, updated fuel consumption and emission figures are behind the conventional and Euro 1-3 technologies.

The experimental basis for heavy-duty trucks and buses is updated computer simulated emission factors for Euro 0-V engines. In COPERT IV the number of heavy duty vehicle categories has increased substantially, and from the traffic data side it is not possible to support all these new vehicle categories with consistent fleet and mileage data. Thus, the

COPERT III vehicle size classification still remains as the Danish inventory basis for heavy duty vehicles.

However, in order to use the new COPERT IV fuel consumption and emission information, the decision is to calculate average fuel consumption and emission factors pr technology level (Euro O-V) from COPERT IV. The average factors comprise the specific COPERT IV size categories in overlap with a given COPERT III size category. Next, these average COPERT IV factors are scaled with the ratio of fuel consumption factors between COPERT III and "average COPERT IV" in order to end up with vehicle sizes corresponding to COPERT III weight classes.

For all vehicle categories/technology levels not represented by measurements, the emission factors are produced by using reduction factors. The latter factors are determined by assessing the EU emission limits and the relevant emission approval test conditions, for each vehicle type and Euro class.

Deterioration factors

For three-way catalyst cars the emissions of NO_X, NMVOC and CO gradually increase due to catalyst wear and are, therefore, modified as a function of total mileage by the so-called deterioration factors. Even though the emission curves may be serrated for the individual vehicles, on average, the emissions from catalyst cars stabilise after a given cut-off mileage is reached due to OBD (On Board Diagnostics) and the Danish inspection and maintenance programme.

For each forecast year, the deterioration factors are calculated pr first registration year by using deterioration coefficients and cut-off mileages, as given in EMEP/EEA (2009), for the corresponding layer. The deterioration coefficients are given for the two driving cycles: ”Urban Driving Cycle” (UDF) and ”Extra Urban Driving Cycle” (EUDF: urban and rural), with trip speeds of 19 and 63 km pr h, respectively.

Firstly, the deterioration factors are calculated for the corresponding trip speeds of 19 and 63 km pr h in each case determined by the total cumulated mileage less than or exceeding the cut-off mileage. The Formulas 3 and 4 show the calculations for the ”Urban Driving Cycle”:

$$UDF = U_A \cdot MTC + U_B \text{, MTC} < U_{MAX} \quad (3)$$

$$UDF = U_A \cdot U_{MAX} + U_B \text{, MTC} >= U_{MAX} \quad (4)$$

where UDF is the urban deterioration factor, U_A and U_B the urban deterioration coefficients, MTC = total cumulated mileage and U_{MAX} urban cut-off mileage.

In the case of trip speeds below 19 km pr h the deterioration factor, DF, equals UDF, whereas for trip speeds exceeding 63 km pr h, DF=EUDF. For trip speeds between 19 and 63 km pr h the deterioration factor, DF, is found as an interpolation between UDF and EUDF. Secondly, the deterioration factors, one for each of the three road types, are aggregated into layers by taking into account vehicle numbers and annual mileage levels pr first registration year:

$$DF_{j,y} = \frac{\sum_{i=FYear(j)}^{LYear(j)} DF_{i,y} \cdot N_{i,y} \cdot M_{i,y}}{\sum_{i=FYear(j)}^{LYear(j)} DF_{i,y} \cdot N_{i,y}} \quad (5)$$

where DF is the deterioration factor.

For N_2O and NH_3, COPERT IV takes into account deterioration as a linear function of mileage for gasoline fuelled EURO 1-4 passenger cars and light duty vehicles. The level of emission deterioration also relies on the content of sulphur in the fuel. The deterioration coefficients are given in EMEP/EEA (2009), for the corresponding layer. A cut-off mileage of 120 000 km (pers. comm. Ntziachristos, 2007) is behind the calculation of the modified emission factors, and for the Danish situation the low sulphur level interval is assumed to be most representative.

Emissions and fuel consumption for hot engines

Emissions and fuel-use results for operationally hot engines are calculated for each year and for layer and road type. The procedure is to combine fuel consumption and emission factors (and deterioration factors for catalyst vehicles), number of vehicles, annual mileage levels and the relevant road-type shares given in Table 3.3.7. For non-catalyst vehicles this yields:

$$E_{j,k,y} = EF_{j,k,y} \cdot S_k \cdot N_{j,y} \cdot M_{j,y} \quad (6)$$

Here E = fuel consumption/emission, EF = fuel consumption/emission factor, S = road type share and k = road type.

For catalyst vehicles the calculation becomes:

$$E_{j,k,y} = DF_{j,k,y} \cdot EF_{j,k,y} \cdot S_k \cdot N_{j,y} \cdot M_{j,y} \quad (7)$$

Extra emissions and fuel consumption for cold engines

Extra emissions of NO_X, VOC, CH_4, CO, PM, N_2O, NH_3 and fuel consumption from cold start are simulated separately. For SO_2 and CO_2, the extra emissions are derived from the cold start fuel consumption results.

In terms of cold start data for NO_X, VOC, CO, PM and fuel consumption no updates are made to the COPERT IV methodology, and the calculation approach is the same as in COPERT III. Each trip is associated with a certain cold-start emission level and is assumed to take place under urban driving conditions. The number of trips is distributed evenly across the months. First, cold emission factors are calculated as the hot emission factor times the cold:hot emission ratio. Secondly, the extra emission factor during cold start is found by subtracting the hot emission factor from the cold emission factor. Finally, this extra factor is applied on the fraction of the total mileage driven with a cold engine (the β-factor) for all vehicles in the specific layer.

The cold:hot ratios depend on the average trip length and the monthly ambient temperature distribution. The Danish temperatures for 2006, 2005 and 2004 are given in Cappelen et al. (2009, 2008, 2007, 2006, 2005).

For 2000-2003, 1990-1999 and 1980-1989 the temperature data are from Cappelen (2004, 2000 and 2003). The cold:hot ratios are equivalent for gasoline fuelled conventional passenger cars and vans and for diesel passenger cars and vans, respectively, see Ntziachristos et al. (2000). For conventional gasoline and all diesel vehicles the extra emissions become:

$$CE_{j,y} = \beta \cdot N_{j,y} \cdot M_{j,y} \cdot EF_{U,j,y} \cdot (CEr - 1) \quad (8)$$

Where CE is the cold extra emissions, β = cold driven fraction, CEr = Cold:Hot ratio.

For catalyst cars, the cold:hot ratio is also trip speed dependent. The ratio is, however, unaffected by catalyst wear. The Euro I cold:hot ratio is used for all future catalyst technologies. However, in order to comply with gradually stricter emission standards, the catalyst light-off temperature must be reached in even shorter periods of time for future EURO standards. Correspondingly, the β-factor for gasoline vehicles is reduced step-wise for Euro II vehicles and their successors.

For catalyst vehicles the cold extra emissions are found from:

$$CE_{j,y} = \beta_{red} \cdot \beta_{EUROI} \cdot N_{j,y} \cdot M_{j,y} \cdot EF_{U,j,y} \cdot (CEr_{EUROI} - 1) \quad (9)$$

where β_{red} = the β reduction factor.

For CH_4, specific emission factors for cold driven vehicles are included in COPERT IV. The β and β_{red} factors for VOC is used to calculate the cold driven fraction for each relevant vehicle layer. The NMVOC emissions during cold start are found as the difference between the calculated results for VOC and CH_4.

For N_2O and NH_3, specific cold start emission factors are also proposed by COPERT IV. For catalyst vehicles, however, just like in the case of hot emission factors, the emission factors for cold start are functions of cumulated mileage (emission deterioration). The level of emission deterioration also relies on the content of sulphur in the fuel. The deterioration coefficients are given in EMEP/EEA (2009), for the corresponding layer. For cold start, the cut-off mileage and sulphur level interval for hot engines are used, as described in the deterioration factors paragraph.

Evaporative emissions from gasoline vehicles

For each year, evaporative emissions of hydrocarbons are simulated in the forecast model as hot and warm running losses, hot and warm soak loss and diurnal emissions. For evaporation, no updates are made to the COPERT IV methodology, and the calculation approach is the same as in COPERT III. All emission types depend on RVP (Reid Vapour Pressure) and ambient temperature. The emission factors are shown in Ntziachristos et al. (2000).

Running loss emissions originate from vapour generated in the fuel tank while the vehicle is running. The distinction between hot and warm running loss emissions depends on engine temperature. In the model, hot and warm running losses occur for hot and cold engines, respectively. The emissions are calculated as annual mileage (broken down into cold and hot mileage totals using the β-factor) times the respective emission factors. For vehicles equipped with evaporation control (catalyst cars), the emission factors are only one tenth of the uncontrolled factors used for conventional gasoline vehicles.

$$R_{j,y} = N_{j,y} \cdot M_{j,y} \cdot ((1-\beta) \cdot HR + \beta \cdot WR) \quad (10)$$

where R is running loss emissions and HR and WR are the hot and warm running loss emission factors, respectively.

In the model, hot and warm soak emissions for carburettor vehicles also occur for hot and cold engines, respectively. These emissions are calculated as number of trips (broken down into cold and hot trip numbers using the β-factor) times respective emission factors:

$$S_{j,y}{}^{C} = N_{j,y} \cdot \frac{M_{j,y}}{l_{trip}} \cdot ((1-\beta) \cdot HS + \beta \cdot WS) \quad (11)$$

where S^C is the soak emission, l_{trip} = the average trip length, and HS and WS are the hot and warm soak emission factors, respectively. Since all catalyst vehicles are assumed to be carbon canister controlled, no soak emissions are estimated for this vehicle type. Average maximum and minimum temperatures pr month are used in combination with diurnal emission factors to estimate the diurnal emissions from uncontrolled vehicles $E^d(U)$:

$$E_{j,y}{}^{d}(U) = 365 \cdot N_{j,y} \cdot e^{d}(U) \quad (12)$$

Each year's total is the sum of each layer's running loss, soak loss and diurnal emissions.

Fuel consumption balance

The calculated fuel consumption in COPERT III must equal the statistical fuel sale totals according to the UNFCCC and UNECE emissions reporting format. The statistical fuel sales for road transport are derived from the Danish Energy Authority data (see DEA, 2009). The DEA data are further processed for gasoline in order to account for e.g. non road and recreational craft fuel consumption, which are not directly stated in the statistics, please refer to paragraph 1.1.4 for further information regarding the transformation of DEA fuel data.

The standard approach to achieve a fuel balance in annual emission inventories is to multiply the annual mileage with a fuel balance factor derived as the ratio between simulated and statistical fuel figures for gasoline and diesel, respectively. This method is also used in the present model.

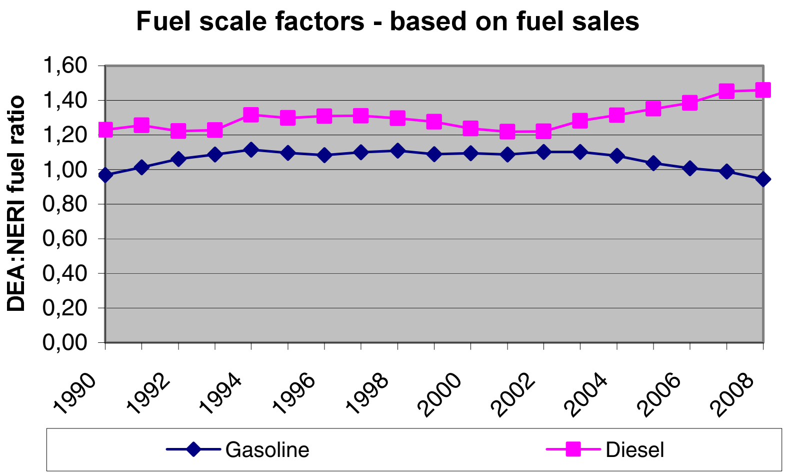


Figure 3.3.35 DEA:NERI Fuel ratios and diesel mileage adjustment factor based on DEA fuel sales data and NERI fuel consumption estimates.

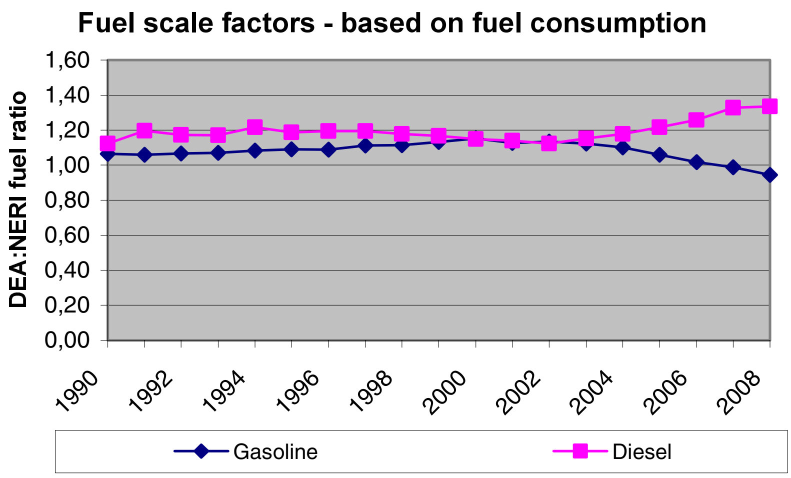


Figure 3.3.36 DEA:NERI Fuel ratios and diesel mileage adjustment factor based on DEA fuel consumption data and NERI fuel consumption estimates.

In Figure 3.3.35 and Figure 3.3.36 the COPERT IV:DEA gasoline and diesel fuel consumption ratios are shown for fuel sales and fuel consumption from 1990-2008. The data behind the figures are also listed in Annex 3.B.8. The fuel consumption figures are related to the traffic on Danish roads.

Pr fuel type, all mileage numbers are equally scaled in order to obtain fuel equilibrium, and hence the mileage factors used are the reciprocal values of the COPERT IV:DEA fuel consumption: fuel sales ratio.

From the Figures 3.3.35 and 3.3.36 it appears that the inventory fuel balances for gasoline and diesel would be improved, if the DEA statistical figures for fuel consumption were used instead of fuel sale numbers. The fuel difference for diesel is, however, increasing from 2003 onwards and reaches a level of 34 % in 2008. The reasons for this inaccuracy are a combination of the uncertainties related to COPERT IV fuel consumption factors, allocation of vehicle numbers in sub-categories, annual mileage, trip speeds and mileage splits for urban, rural and highway driving conditions.

For future inventories it is intended to use improved fleet and mileage data and improved data for trip speed and mileage split for urban, rural and highway driving. The update of road traffic fleet and mileage data will be made as soon as this information is provided from the Danish Ministry of Transport and Energy in a COPERT IV model input format.

The final fuel consumption and emission factors pr vehicle type are shown in Annex 3.B.6 for 1990-2008. The total fuel consumption and emissions are shown in Annex 3.B.7, pr vehicle category and as grand totals, for 1990-2008 (and CRF format in Annex 3.B.15). In Annex 3.B.14, fuel-use and emission factors as well as total emissions are given in CollectER format for 1990 and 2008.

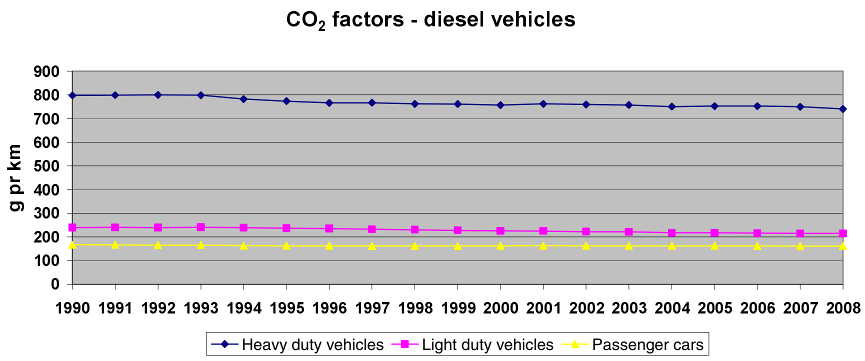
In the following Figures 3.3.37 - 3.3.40, the fuel and km related emission factors for CO_2 (km related only), CH_4 and N_2O are shown pr vehicle type for the Danish road transport (from 1990-2008). For CO_2 the emission factors are country specific values, and come from the DEA. From 2006, bio ethanol has become available from a limited number of gas filling stations in Denmark. Following the IPCC guideline definitions, bio ethanol is regarded as CO_2 neutral for the transport sector as such. The sulphur content for bioethanol is zero, and hence, the aggregated CO_2 (and SO_2) factors for gasoline have been adjusted, on the basis of the energy content of pure gasoline and bio ethanol.

In Denmark, only E5 gasoline-ethanol blends is sold at the gas stations in negligible amounts. Currently no consistent sets of emission factor changes are available to modify the emission factors for the neat gasoline case. However, a literature review in a Danish research project (REBECA) currently carried out seeks to sort out these emission changes. If this study, and research studies made by other researchers points out significant emission changes from using E5 blends compared to neat gasoline, these emission changes will be incorporated in the basis emission factors used to calculate the Danish road transport emissions, and subsequently reflected in the implied emission factors for this sector.

The CO_2 factors are shown pr fuel type in Table 3.3.8.

Table 3.3.8 Fuel-specific emission factors for CO_2 (kg pr GJ) for road transport in Denmark.

Fuel type	1990-2005	2006	2007
Gasoline	73	72.9	72.8
Diesel	74	74	74
LPG	65	65	65



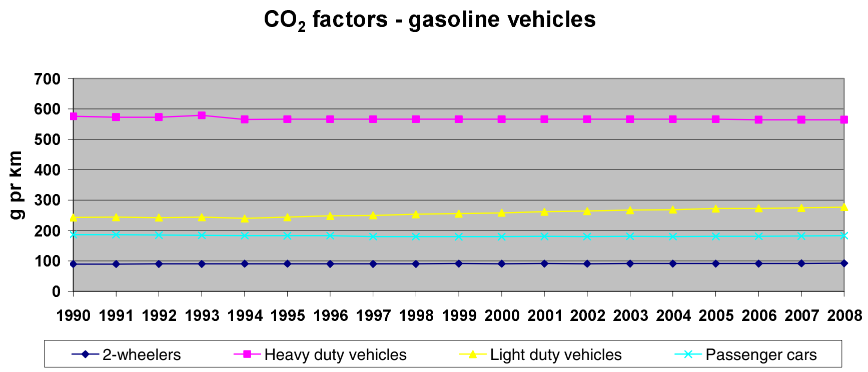


Figure 3.3.37 Km related CO_2 emission factors pr vehicle type for Danish road transport (1990-2008).

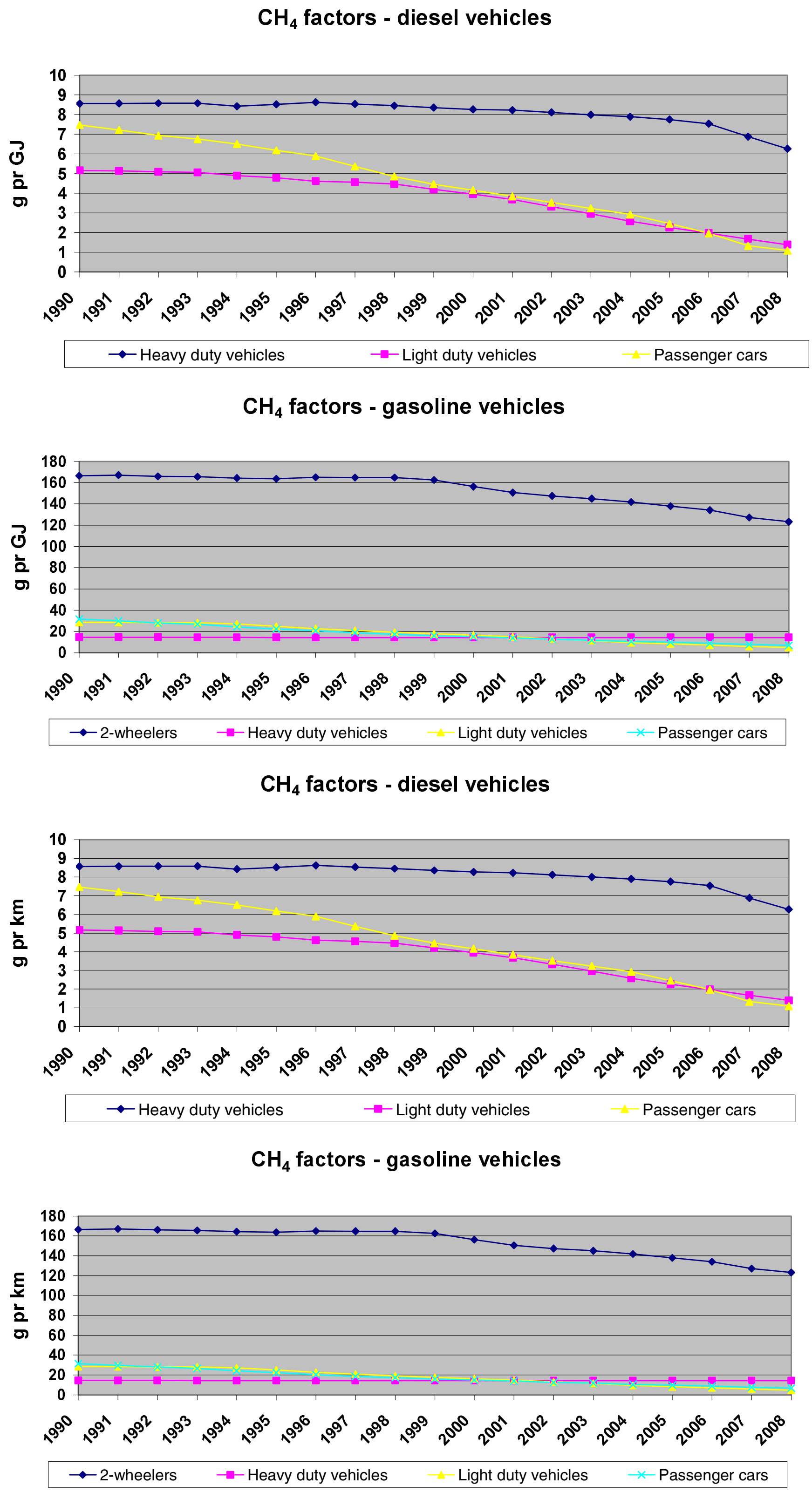


Figure 3.3.38 Fuel and km related CH_4 emission factors pr vehicle type for Danish road transport (1990-2008).

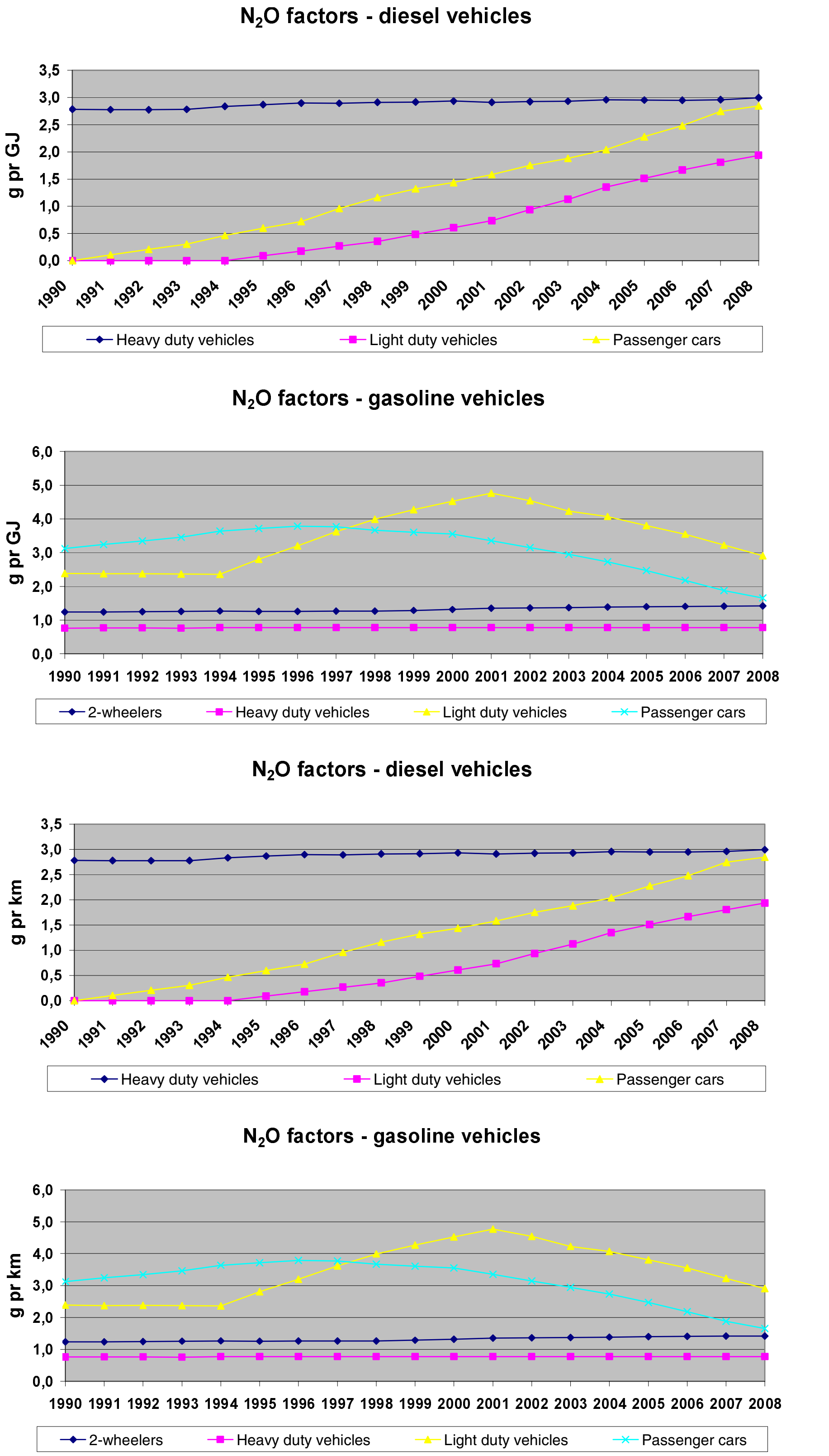


Figure 3.3.39 Fuel and km related N_2O emission factors pr vehicle type for Danish road transport (1990-2008).

Methodologies and references for other mobile sources

Other mobile sources are divided into several sub-sectors: sea transport, fishery, air traffic, railways, military, and working machinery and equipment in the sectors agriculture, forestry, industry and residential. The emission calculations are made using the detailed method as described in the EMEP/EEA air pollutant emission inventory guidebook

(EMEP/EEA, 2009) for air traffic, off-road working machinery and equipment, and ferries, while for the remaining sectors the simple method is used.

3.3.3 Activity data

Air traffic

The activity data for air traffic consists of air traffic statistics provided by the Danish Civil Aviation Agency (CAA-DK) and Copenhagen Airport. Fuel statistics for jet fuel use and aviation gasoline are obtained from the Danish energy statistics (DEA, 2008).

For 2001 onwards, pr flight records are provided by CAA-DK as data codes for aircraft type, and origin and destination airports (city-pairs).

Subsequently the aircraft types are separated by NERI into larger aircraft using jet fuel (jet engines, turbo props, helicopters) and small aircraft types with piston engines using aviation gasoline. This is done by using different aircraft dictionaries, internet look-ups and by communication with the CAA-DK. Each of the larger aircraft type is then matched with a representative type for which fuel consumption and emission data are available from the EMEP/EEA databank. Relevant for this selection is aircraft maximum take off mass, engine types, and number of engines. A more thorough explanation is given in Winther (2001a, b).

The ideal flying distance (great circle distance) between the city-pairs is calculated by NERI in a separate database. The calculation algorithm uses a global latitude/altitude coordinate table for airports. In cases when airport coordinates are not present in the NERI database, these are looked up on the internet and entered into the database accordingly.

For inventory years prior to 2001, detailed LTO/aircraft type statistics are obtained from Copenhagen Airport (for this airport only), while information of total take-off numbers for other Danish airports is provided by CAA-DK. The assignment of representative aircraft types for Copenhagen Airport is done as described above. For the remaining Danish airports representative aircraft types are not directly assigned. Instead appropriate average assumptions are made relating to the fuel consumption and emission data part.

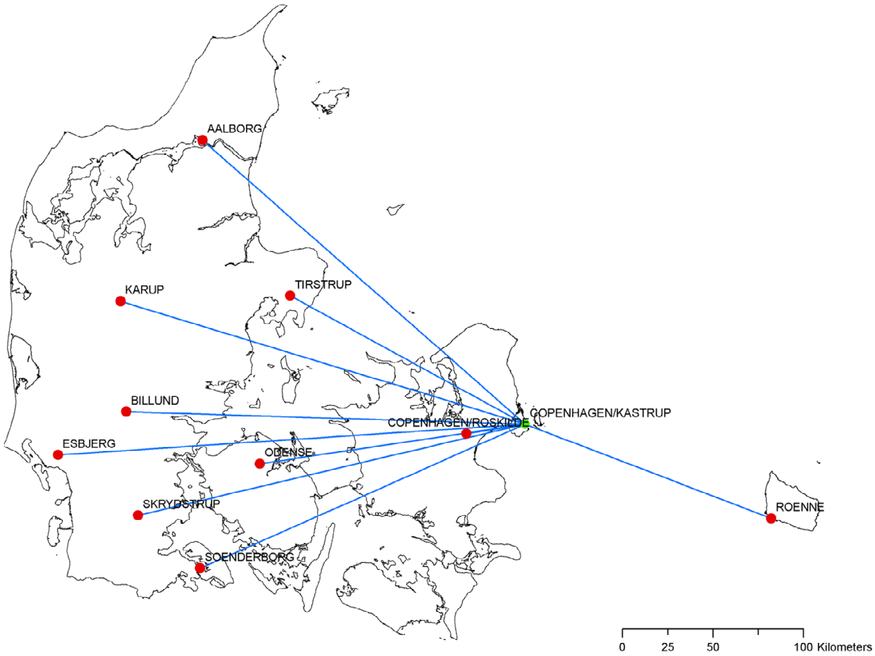


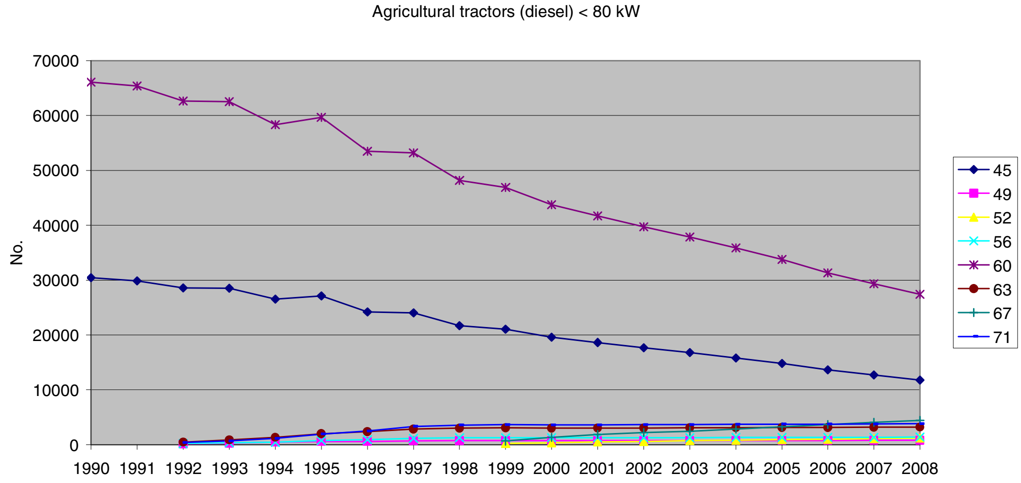
Figure 3.3.40 Most frequent domestic flying routes for large aircraft in Denmark.

Copenhagen Airport is the starting or end point for most of the domestic aviation made by large aircraft in Denmark (Figure 3.3.40). Even though many domestic flights not touching Copenhagen Airport are also reported in the flight statistics kept by CAA-DK, these flights, however, are predominantly made with small piston engine aircraft using aviation gasoline. Hence, the consumption of jet fuel by flights not using Copenhagen is merely marginal.

Non-road working machinery and equipment

Non-road working machinery and equipment are used in agriculture, forestry and industry, for household/gardening purposes and in inland waterways (recreational craft). Information on the number of different types of machines, their respective load factors, engine sizes and annual working hours has been provided by Winther et al. (2006). The stock development from 1990-2007 for the most important types of machinery are shown in Figures 3.3.41 - 3.3.48. The stock data are also listed in Annex 3.B.10, together with figures for load factors, engine sizes and annual working hours. As regards stock data for the remaining machinery types, please refer to (Winther et al., 2006).

For agriculture, the total number of agricultural tractors and harvesters pr yr are shown in the Figures 3.3.41 - 3.3.42, respectively. The figures clearly show a decrease in the number of small machines, these being replaced by machines in the large engine-size ranges.



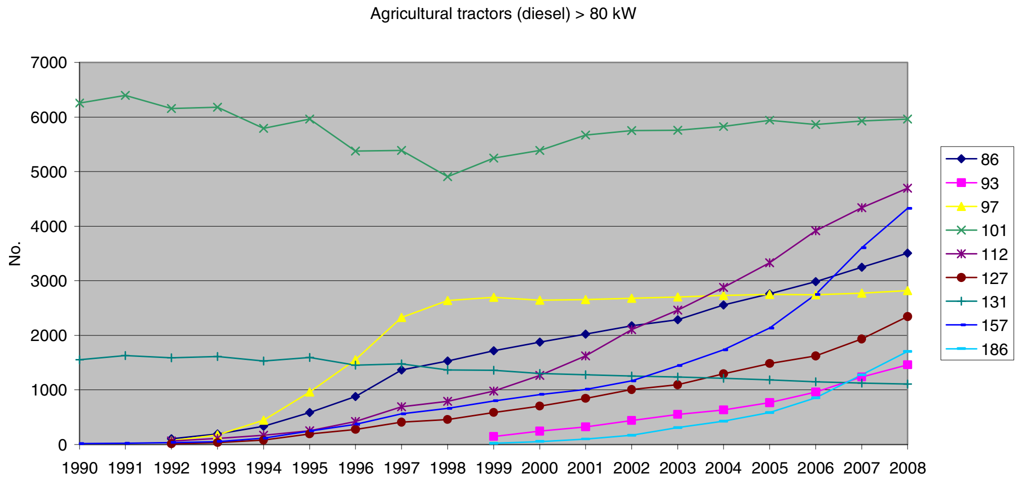


Figure 3.3.41 Total numbers in kW classes for tractors from 1990 to 2008.

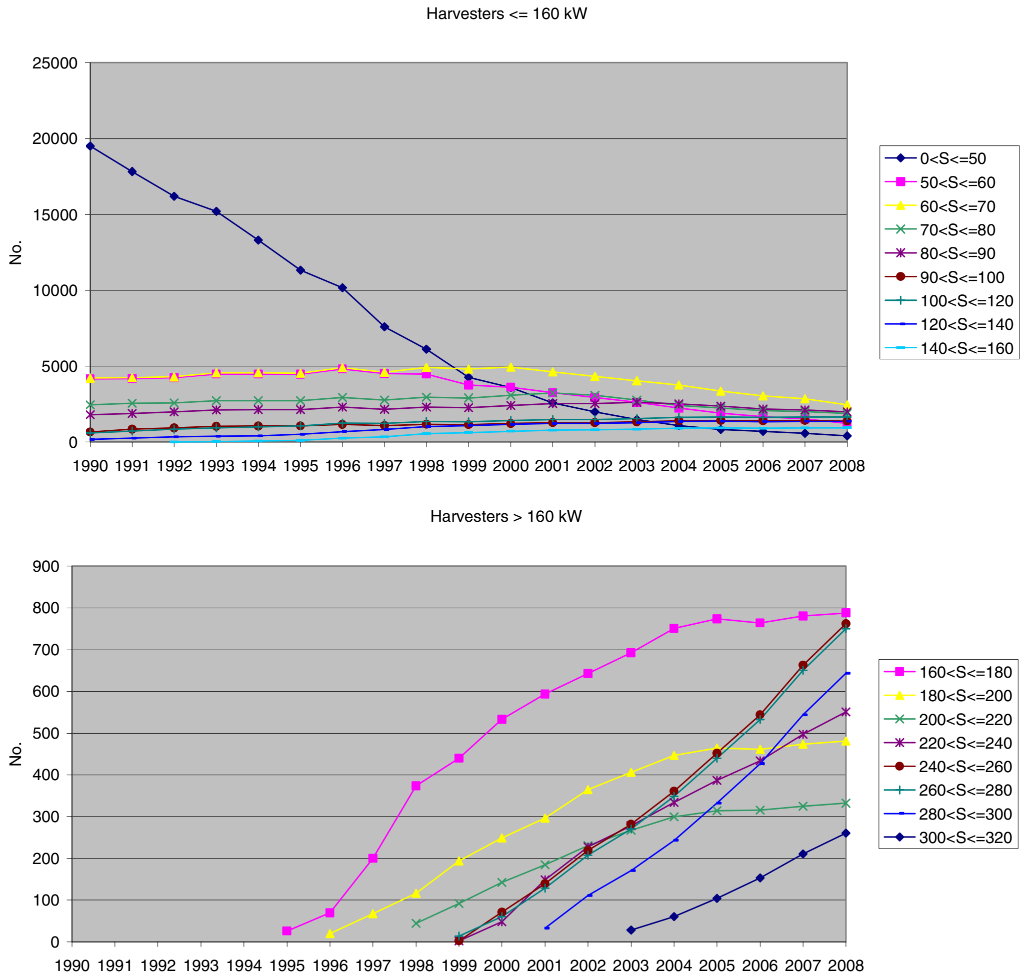


Figure 3.3.42 Total numbers in kW classes for harvesters from 1990 to 2008.

The tractor and harvester developments towards fewer vehicles and larger engines, shown in Figure 3.3.43, are very clear. From 1990 to 2008, tractor and harvester numbers decrease by around 22 % and 47 %, respectively, whereas the average increase in engine size for tractors is 25 % and more than 120 % for harvesters, in the same time period.

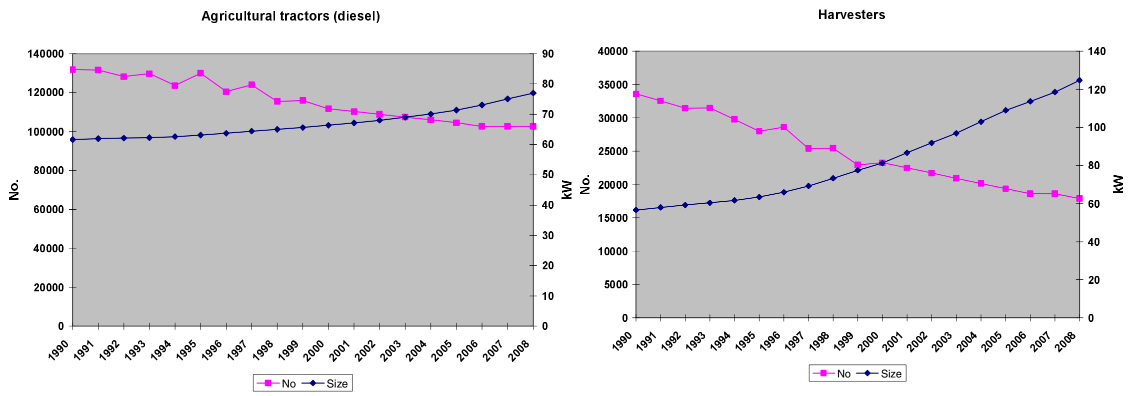


Figure 3.3.43 Total numbers and average engine size for tractors and harvesters (1990 to 2008).

The most important machinery types for industrial use are different types of construction machinery and fork lifts. The Figures 3.3.44 and 3.3.45 show the 1990-2008 stock development for specific types of construction machinery and diesel fork lifts. For most of the machinery types there is an increase in machinery numbers from 1990 onwards, due to increased construction activities. It is assumed that track type excavators/wheel type loaders (0-5 tonnes), and telescopic loaders first enter into use in 1991 and 1995, respectively.

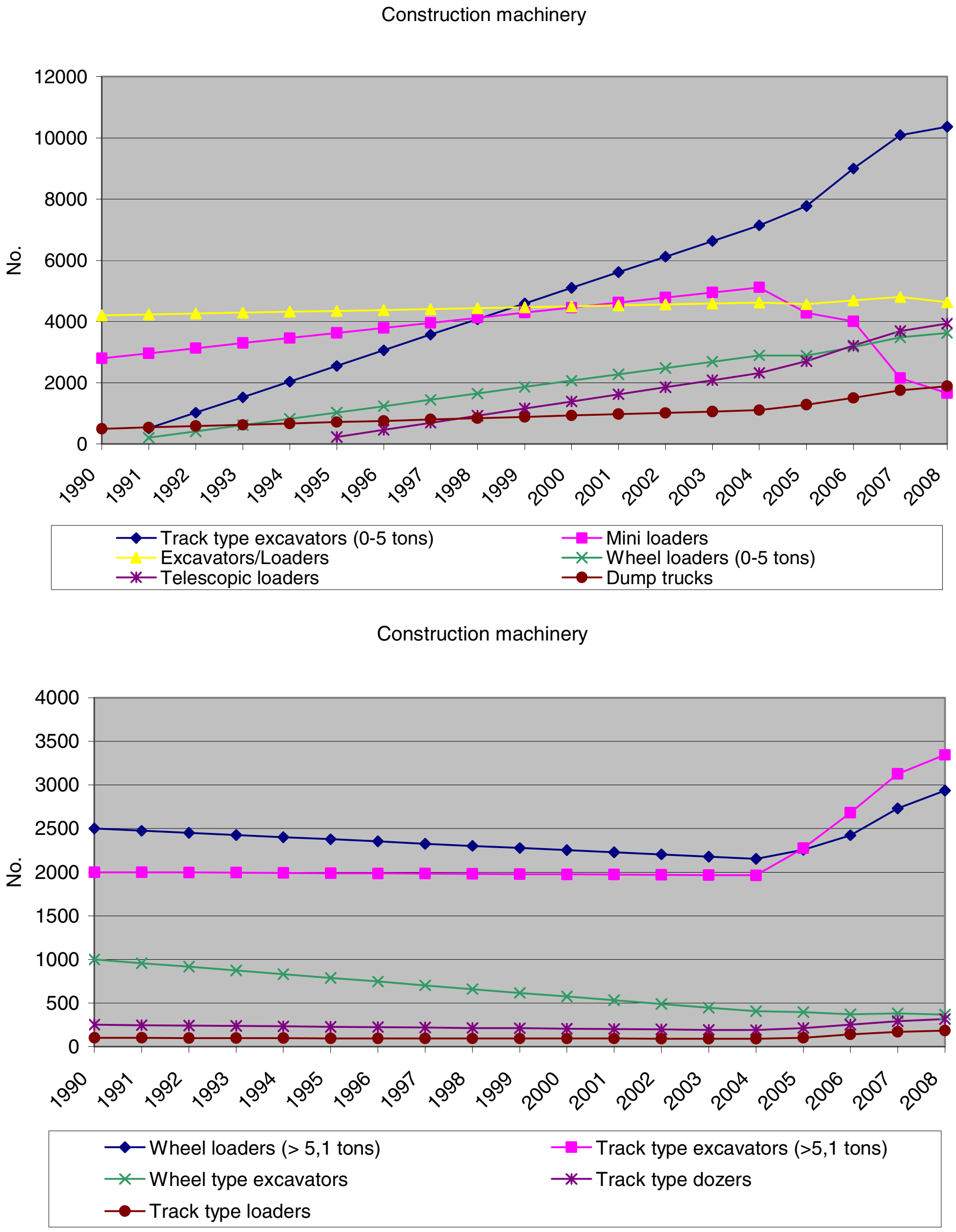


Figure 3.3.44 1990-2008 stock development for specific types of construction machinery.

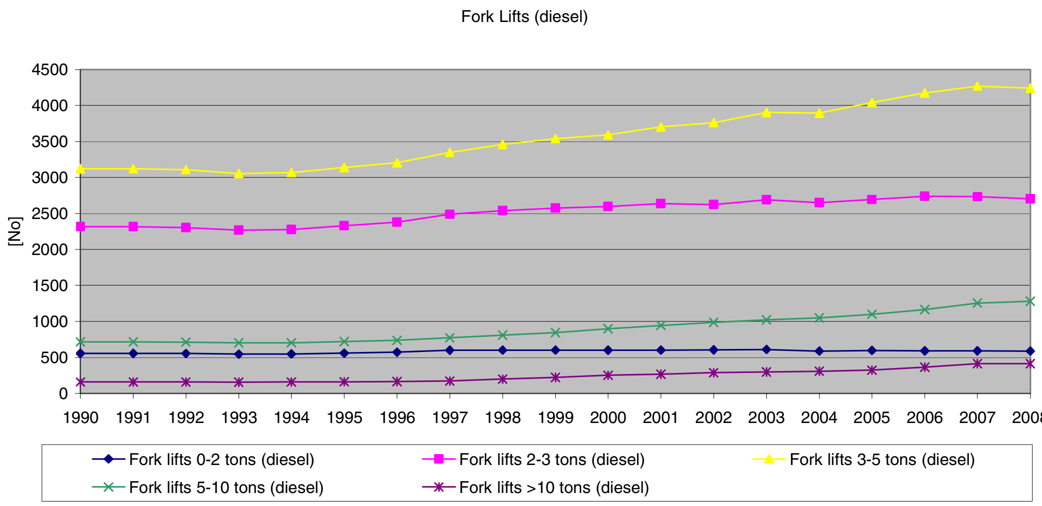


Figure 3.3.45 Total numbers of diesel fork lifts in kW classes from 1990 to 2008.

The emission level shares for tractors, harvesters, construction machinery and diesel fork lifts are shown in Figure 3.3.46, and present an overview of the penetration of the different pre-Euro engine classes, and engine stages complying with the gradually stricter EU stage I and II emission limits. The average lifetimes of 30, 25, 20 and 10 years for tractors, harvesters, fork lifts and construction machinery, respectively, influence the individual engine technology turn-over speeds.

The EU emission directive Stage I and II implementation years relate to engine size, and for all four machinery groups the emission level shares for the specific size segments will differ slightly from the picture shown in Figure 3.3.46. Due to scarce data for construction machinery, the emission level penetration rates are assumed to be linear and the general technology turnover pattern is as shown in Figure 3.3.46.

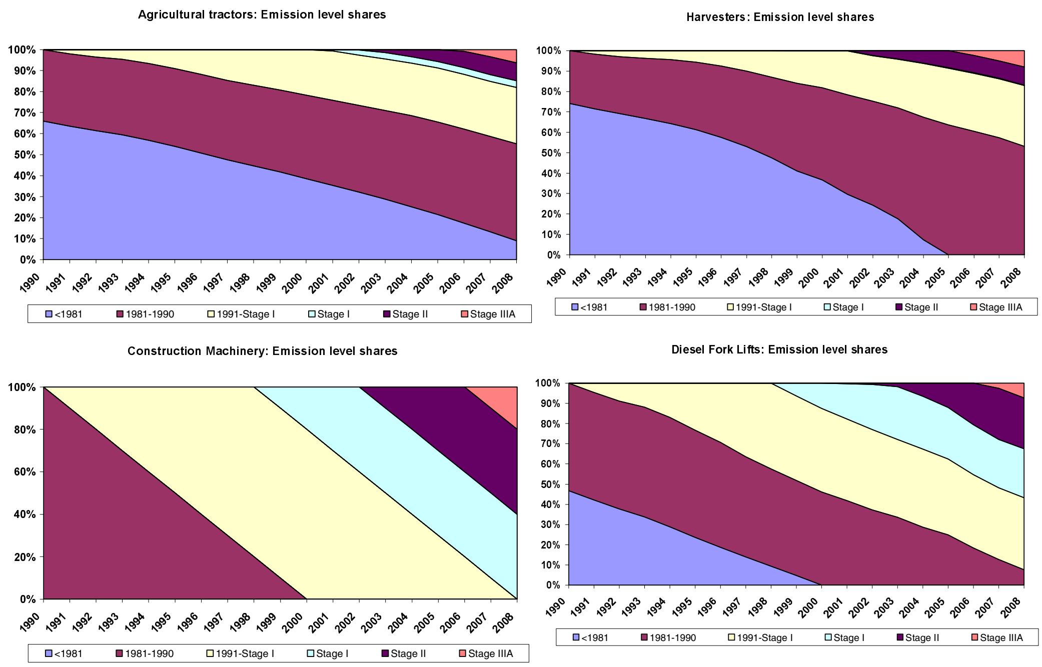


Figure 3.3.46 Emission level shares for tractors, harvesters, construction machinery and diesel fork lifts (1990 to 2008).

The 1990-2008 stock development for the most important household and gardening machinery types is shown in Figure 3.3.47.

For lawn movers and cultivators, the machinery stock remains approximately the same for all years. The stock figures for chain saws, shrub clearers, trimmers and hedge cutters increase from 1990 until 2004, and for riders this increase continues also after 2004. The yearly stock increases, in most cases, become larger after 2000. The lifetimes for gasoline machinery are short and, therefore, there new emission levels (not shown) penetrate rapidly.

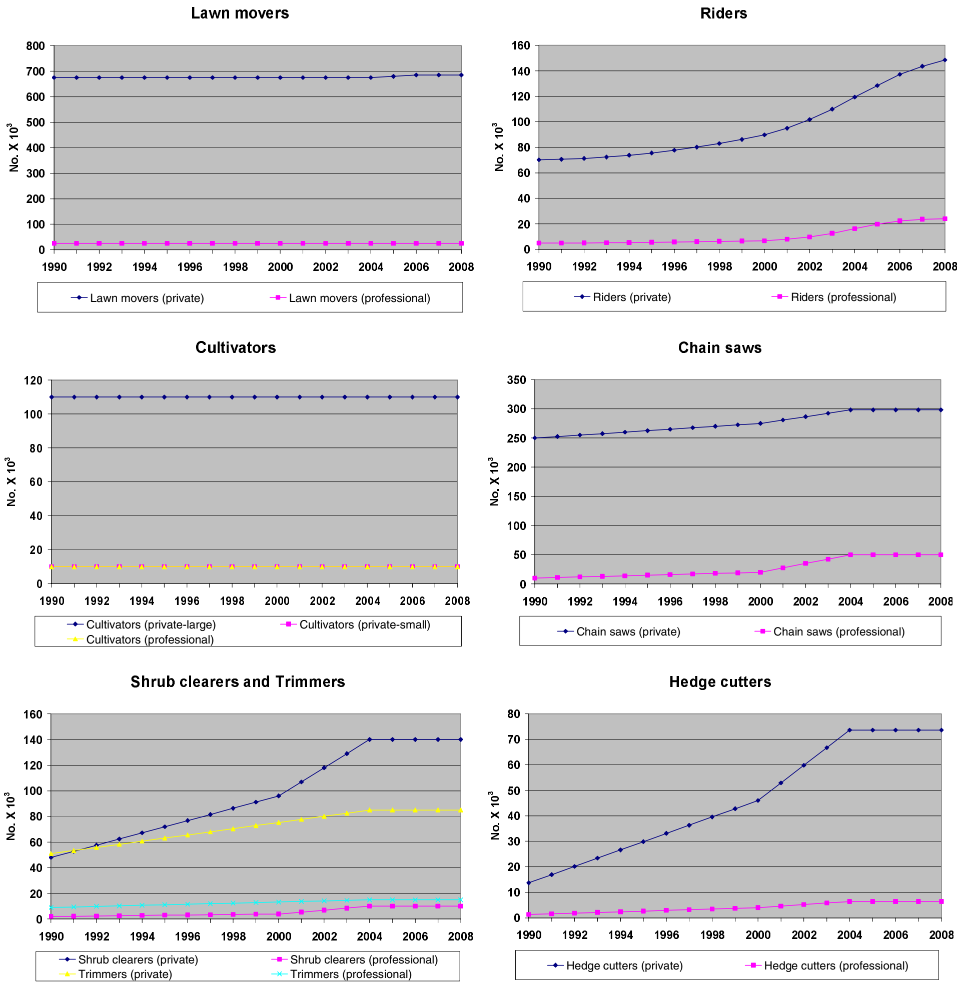


Figure 3.3.47 Stock development 1990-2008 for the most important household and gardening machinery types.

Figure 3.3.48 shows the development in numbers of different recreational craft from 1990-2008. The 2004 stock data for recreational craft are repeated for 2005-2008, since no new fleet information has been obtained.

For diesel boats, increases in stock and engine size are expected during the whole period, except for the number of motor boats (< 27 ft.) and the engine sizes for sailing boats (<26 ft.), where the figures remain unchanged. A decrease in the total stock of sailing boats (<26 ft.) by 21 % and increases in the total stock of yawls/cabin boats and other boats (<20 ft.) by around 25 % are expected. Due to a lack of information specific to Denmark, the shifting rate from 2-stroke to 4-stroke gasoline engines is based on a German non-road study (IFEU, 2004).

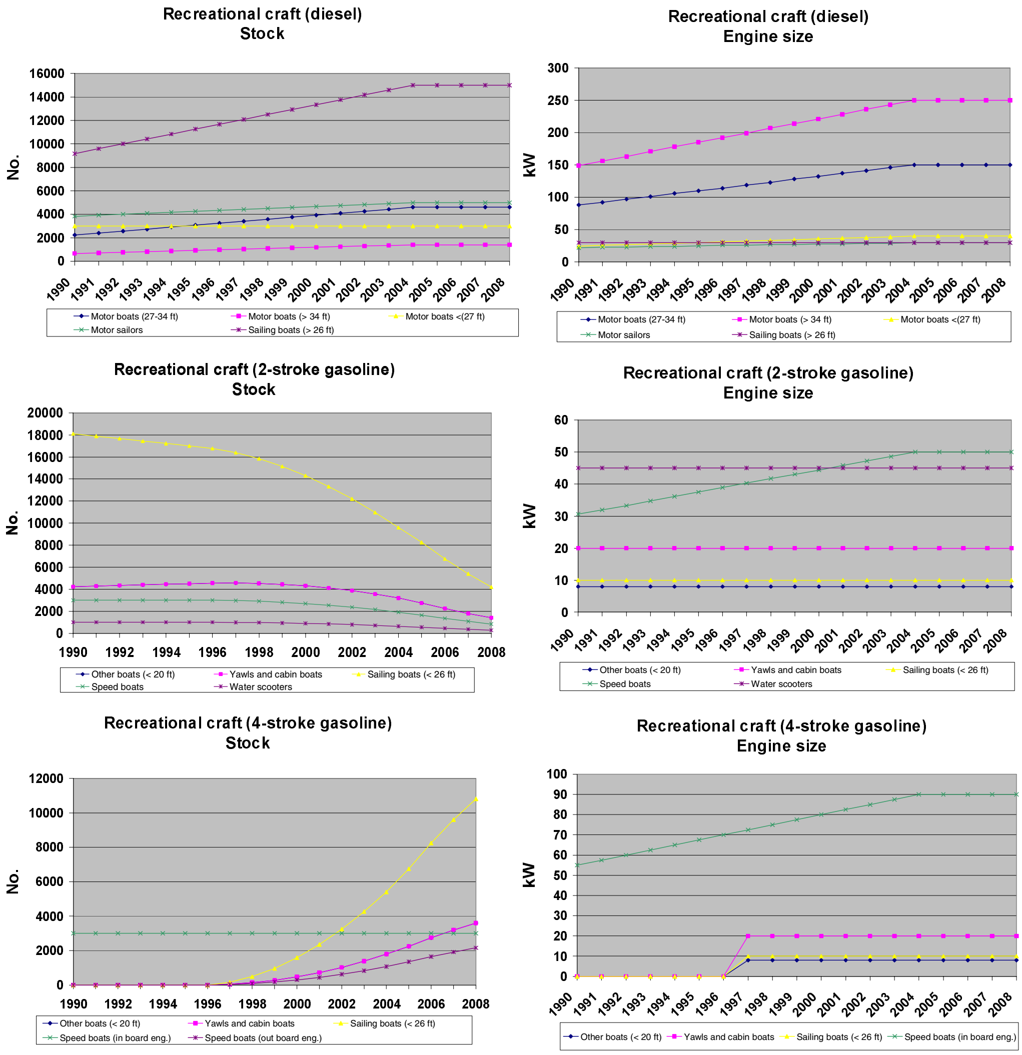


Figure 3.3.48 1990-2008 Stock and engine size development for recreational craft.

National sea transport

A new methodology is used to estimate the fuel consumption figures for national sea transport, based on fleet activity estimates for regional ferries, local ferries and other national sea transport (Winther, 2008a).

Table 3.3.9 lists the most important domestic ferry routes in Denmark in the period 1990-2008. For these ferry routes and the years 1990-2005, the following detailed traffic and technical data have been gathered by Winther (2008a): Ferry name, year of service, engine size (MCR), engine type, fuel type, average load factor, auxiliary engine size and sailing time (single trip).

For 2006 and 2007, the above mentioned traffic and technical data for specific ferries have been provided by Kristensen (2008) in the case of Mols-Linien (Sjællands Odde-Ebeltoft, Sjællands Odde-Århus, Kalundborg-Århus), by Hjortberg (2008) for Bornholmstrafikken (Køge-Rønne) and by Simonsen (2008) for Langelandstrafikken A/S (Tårs-Spodsbjerg). The data for 2007 have been repeated for the year 2008.

Table 3.3.9 Ferry routes comprised in the Danish inventory.

Ferry service	Service period
Halsskov-Knudshoved	1990-1999
Hundested-Grenaa	1990-1996
Kalundborg-Juelsminde	1990-1996
Kalundborg-Samsø	1990-
Kalundborg-Århus	1990-
Korsør-Nyborg, DSB	1990-1997
Korsør-Nyborg, Vognmandsruten	1990-1999
København-Rønne	1990-2004
Køge-Rønne	2004-
Sjællands Odde-Ebeltoft	1990-
Sjællands Odde-Århus	1999-
Tårs-Spodsbjerg	1990-

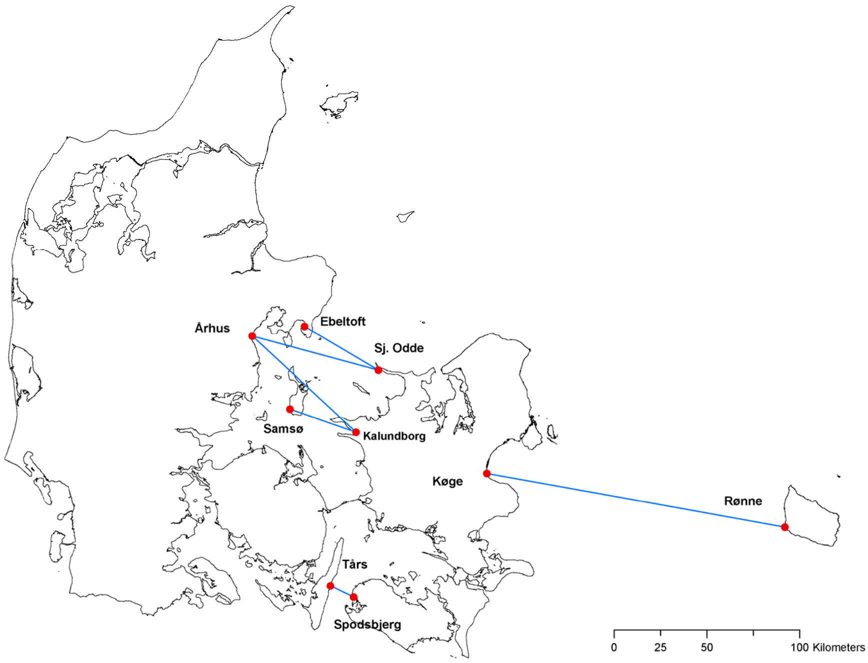


Figure 3.3.50 Domestic regional ferry routes in Denmark (2008).

The number of round trips pr ferry route is shown in Figure 3.3.50. The traffic data are also listed in Annex 3.B.11, together with different ferry specific technical and operational data.

For each ferry, Annex 3.B.12 lists the relevant information as regards ferry route, name, year of service, engine size (MCR), engine type, fuel type, average load factor, auxiliary engine size and sailing time (single trip).

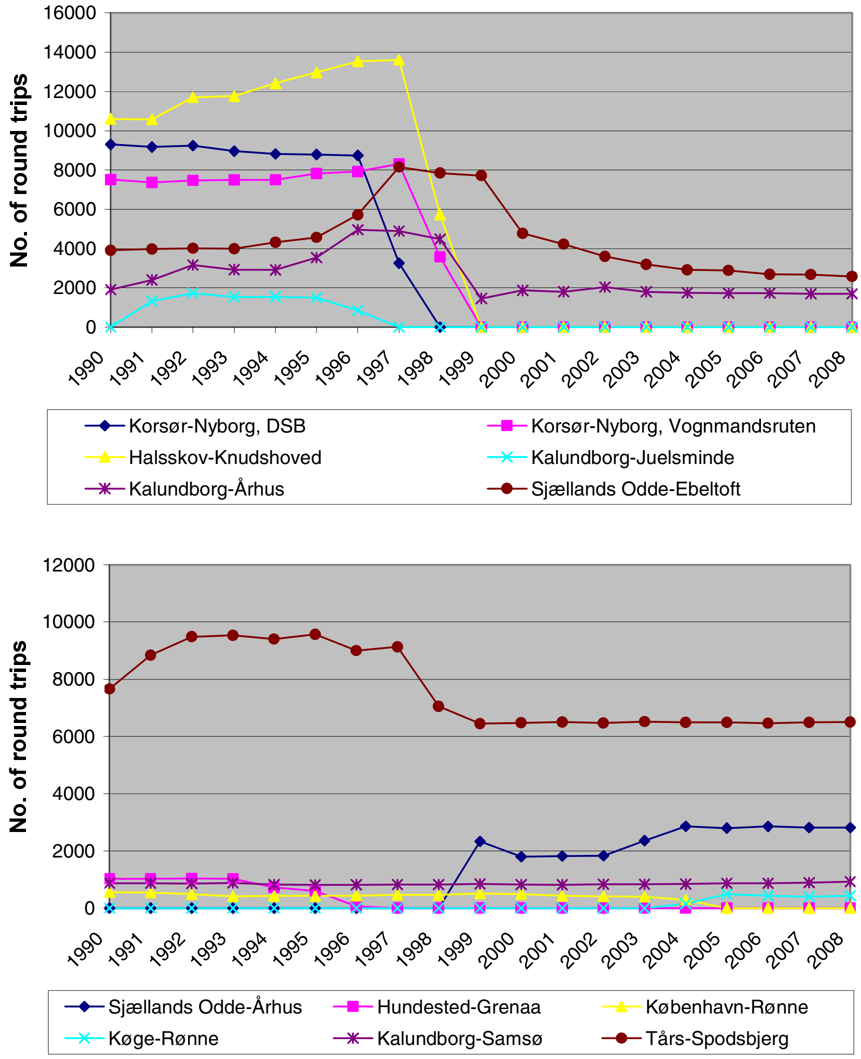


Figure 3.3.51 No. of round trips for the most important ferry routes in Denmark 1990-2008.

It is seen from Table 3.3.9 (and Figure 3.3.51) that several ferry routes were closed in the time period from 1996-1998, mainly due to the opening of the Great Belt Bridge (connecting Zealand and Funen) in 1997. Hundested-Grenaa and Kalundborg-Juelsminde was closed in 1996, Korsør-Nyborg (DSB) closed in 1997, and Halsskov-Knudshoved and Korsør-Nyborg (Vognmandsruten) was closed in 1998. The ferry line København-Rønne was replaced by Køge-Rønne in 2004 and from 1999 a new ferry connection was opened between Sjællands Odde and Århus.

For the local ferries, a bottom-up estimate of fuel consumption for 1996 has been taken from the Danish work in Wismann (2001). The latter project calculated fuel consumption and emissions for all sea transport in Danish waters in 1995/1996 and 1999/2000. In order to cover the entire 1990-2008 inventory period, the fuel figure for 1996 has been adjusted according to the developments in local ferry route traffic shown in Annex 3.B.11.

For the remaining part of the traffic between two Danish ports, other national sea transport, new bottom-up estimates for fuel consumption have been calculated for the years 1995 and 1999 by Wismann (2007). The calculations use the database set up for Denmark in the Wismann (2001) study, with actual traffic data from the Lloyd's LMIS database (not including ferries). The database was split into three vessel types: bulk carriers, container ships, and general cargo ships; and five size classes: 0-1000, 1000-3000, 3000-10000, 10000-20000 and >20000 DTW. The calculations assume that bulk carriers and container ships use heavy fuel oil, and that general cargo ships use gas oil. For further information regarding activity data for local ferries and other national sea transport, please refer to Winther (2008a).

The fleet activity data for regional ferries, and the fleet activity based fuel consumption estimates for local ferries and other national sea transport provided by Winther (2008a) replace the previous fuel based activity data which originated directly from the DEA statistics.

Other sectors

The activity data for military, railways, international sea transport and fishery consists of fuel consumption information from DEA (2008). For international sea transport, the basis is fuel sold in Danish ports for vessels with a foreign destination, as prescribed by the IPCC guidelines.

For fisheries, the calculation methodology described by Winther (2008a) remains fuel based. However, the input fuel data differ from the fuel sales figures previously used. The changes are the result of further data processing of the DEA reported gas oil sales for national sea transport and fisheries, prior to inventory input. For years when the fleet activity estimates of fuel consumption for national sea transport are smaller than reported fuel sold, fuel is added to fisheries in the inventory. Conversely, lower fuel sales in relation to bottom-up estimates for national sea transport means that fuel is being subtracted from the original fisheries fuel sales figure in order to make up the final fuel consumption input for fisheries.

The updated fuel consumption time-series for national sea transport lead, in turn, to changes in the energy statistics for fisheries (gas oil) and industry (heavy fuel oil), so the national energy balance can remain unchanged.

For all sectors, fuel consumption figures are given in Annex 3.B.14 for the years 1990 and 2008 in CollectER format.

Emission legislation

For the engines used by other mobile sources, no legislative limits exist for specific fuel consumption. And no legislative limits exist for the emissions of CO_2 which are directly fuel dependent. The engines, however, do have to comply with the emission legislation limits agreed by the EU and, except for ships, the VOC emission limits influence the emissions of CH_4, these forming part of total VOC.

For non-road working machinery and equipment, and recreational craft and railway locomotives/motor cars, the emission directives list specific emission limit values (g pr kWh) for CO, VOC, NO_x (or VOC + NO_x) and TSP, depending on engine size (kW for diesel, ccm for gasoline) and date of implementation (referring to engine market date).

For diesel, the directives 97/68 and 2004/26 relate to non-road machinery other than agricultural and forestry tractors, and the directives have different implementation dates for machinery operating under transient and constant loads. The latter directive also comprises emission limits for railway machinery. For tractors the relevant directives are 2000/25 and 2005/13. For gasoline, the directive 2002/88 distinguishes between hand-held (SH) and not hand-held (NS) types of machinery.

For engine type approval, the emissions (and fuel consumption) are measured using various test cycles (ISO 8178). Each test cycle consists of a number of measurement points for specific engine loads during constant operation. The specific test cycle used depends on the machinery type in question and the test cycles are described in more details in the directives.

Table 3.3.10 Overview of EU emission directives relevant for diesel fuelled non-road machinery.

Stage/Engine	CO	VOC	NO_X	VOC+NO_X	PM	Diesel machinery			Tractors	
size [kW]							Implement. date		EU	Implement.
	[g pr kWh]					EU Directive	Transient	Constant	directive	date
Stage I										
37<=P<75	6.5	1.3	9.2	-	0.85	97/68	1/4 1999	-	2000/25	1/7 2001
Stage II										
130<=P<560	3.5	1	6	-	0.2	97/68	1/1 2002	1/1 2007	2000/25	1/7 2002
75<=P<130	5	1	6	-	0.3		1/1 2003	1/1 2007		1/7 2003
37<=P<75	5	1.3	7	-	0.4		1/1 2004	1/1 2007		1/1 2004
18<=P<37	5.5	1.5	8	-	0.8		1/1 2001	1/1 2007		1/1 2002
Stage IIIA										
130<=P<560	3.5	-	-	4	0.2	2004/26	1/1 2006	1/1 2011	2005/13	1/1 2006
75<=P<130	5	-	-	4	0.3		1/1 2007	1/1 2011		1/1 2007
37<=P<75	5	-	-	4.7	0.4		1/1 2008	1/1 2012		1/1 2008
19<=P<37	5.5	-	-	7.5	0.6		1/1 2007	1/1 2011		1/1 2007
Stage IIIB										
130<=P<560	3.5	0.19	2	-	0.025	2004/26	1/1 2011	-	2005/13	1/1 2011
75<=P<130	5	0.19	3.3	-	0.025		1/1 2012	-		1/1 2012
56<=P<75	5	0.19	3.3	-	0.025		1/1 2012	-		1/1 2012
37<=P<56	5	-	-	4.7	0.025		1/1 2013	-		1/1 2013
Stage IV										
130<=P<560	3.5	0.19	0.4	-	0.025	2004/26	1/1 2014		2005/13	1/1 2014
56<=P<130	5	0.19	0.4	-	0.025		1/10 2014			1/10 2014

Table 3.3.11 Overview of the EU Emission Directive 2002/88 for gasoline fuelled non-road machinery.

	Category	Engine size [ccm]	CO [g pr kWh]	HC [g pr kWh]	NO_X [g pr kWh]	HC+NO_X [g pr kWh]	Implementation date
	Stage I						
Hand held	SH1	S<20	805	295	5.36	-	1/2 2005
	SH2	20=<S<50	805	241	5.36	-	1/2 2005
	SH3	50=<S	603	161	5.36	-	1/2 2005
Not hand held	SN3	100=<S<225	519	-	-	16.1	1/2 2005
	SN4	225=<S	519	-	-	13.4	1/2 2005
	Stage II						
Hand held	SH1	S<20	805	-	-	50	1/2 2008
	SH2	20=<S<50	805	-	-	50	1/2 2008
	SH3	50=<S	603	-	-	72	1/2 2009
Not hand held	SN1	S<66	610	-	-	50	1/2 2005
	SN2	66=<S<100	610	-	-	40	1/2 2005
	SN3	100=<S<225	610	-	-	16.1	1/2 2008
	SN4	225=<S	610	-	-	12.1	1/2 2007

For recreational craft, Directive 2003/44 comprises the emission legislation limits for diesel engines, and for 2-stroke and 4-stroke gasoline engines, respectively. The CO and VOC emission limits depend on engine size (kW) and the inserted parameters presented in the calculation formulas in Table 3.3.12. For NO_X, a constant limit value is given for each of the three engine types. For TSP, the constant emission limit regards diesel engines only.

Table 3.3.12 Overview of the EU Emission Directive 2003/44 for recreational craft.

Engine type	Impl. date	CO=A+B/P^n			HC=A+B/P^n			NO_X	TSP
		A	B	n	A	B	n		
2-stroke gasoline	1/1 2007	150.0	600.0	1.0	30.0	100.0	0.75	10.0	-
4-stroke gasoline	1/1 2006	150.0	600.0	1.0	6.0	50.0	0.75	15.0	-
Diesel	1/1 2006	5.0	0.0	0	1.5	2.0	0.5	9.8	1.0

Table 3.2.13 Overview of the EU Emission Directive 2004/26 for railway locomotives and motorcars.

	Engine size [kW]		CO [g pr kWh]	HC [g pr kWh]	NO_x [g pr kWh]	HC+NOX [g pr kWh]	PM [g pr kWh]	Implement. date
Locomotives	Stage IIIA							
	130<=P<560	RL A	3.5	-	-	4	0.2	1/1 2007
	560<P	RH A	3.5	0.5	6	-	0.2	1/1 2009
	2000<=P and piston displacement >= 5 l/cyl.	RH A	3.5	0.4	7.4	-	0.2	1/1 2009
	Stage IIIB	RB	3.5	-	-	4	0.025	1/1 2012
Motor cars	Stage IIIA							
	130<P	RC A	3.5	-	-	4	0.2	1/1 2006
	Stage IIIB							
	130<P	RC B	3.5	0.19	2	-	0.025	1/1 2012

Aircraft engine emissions of NO_x, CO, VOC and smoke are regulated by ICAO (International Civil Aviation Organization). The engine emission certification standards are contained in Annex 16 — Environmental Protection, Volume II — Aircraft Engine Emissions to the Convention on International Civil Aviation (ICAO Annex 16, 1993). The emission standards relate to the total emissions (in grams) from the so-called LTO

(Landing and Take Off) cycle divided by the rated engine thrust (kN). The ICAO LTO cycle contains the idealised aircraft movements below 3000 ft (915 m) during approach, landing, airport taxiing, take off and climb out.

For smoke all aircraft engines manufactured from 1 January 1983 have to meet the emission limits agreed by ICAO. For NO_x, CO, VOC The emission legislation is relevant for aircraft engines with a rated engine thrust larger than 26.7 kN. In the case of CO and VOC, the ICAO regulations apply for engines manufactured from from 1 January 1983.

For NO_x, the emission regulations fall in four categories

a) For engines of a type or model for which the date of manufacture of the first individual production model is on or before 31 December 1995, and for which the production date of the individual engine is on or before 31 December 1999.
b) For engines of a type or model for which the date of manufacture of the first individual production model is after 31 December 1995, or for individual engines with a production date after 31 December 1999.
c) For engines of a type or model for which the date of manufacture of the first individual production model is after 31 December 2003.
d) For engines of a type or model for which the date of manufacture of the first individual production model is after 31 December 2007.

The regulations published by ICAO are given in the form of the total quantity of pollutants (D_p) emitted in the LTO cycle divided by the maximum sea level thrust (F_{oo}) and plotted against engine pressure ratio at maximum sea level thrust.

The limit values for NO_x are given by the formular in Table 3.3.14.

Table 3.3.14 Current certification limits for NO_x for turbo jet and turbo fan engines.

	Engines first produced before 31.12.1995 & for engines manufactured up to 31.12.1999	Engines first produced after 31.12.1995 & for engines manufactured after 31.12.1999	Engines for which the date of manufacture of the first individual production model was after 31 December 2003	Engines for which the date of manufacture of the first individual production model was after 31 December 2007
Applies to engines >26.7 kN	$Dp/F_{oo} = 40 + 2\pi_{oo}$	$Dp/F_{oo} = 32 + 1.6\pi_{oo}$		
Engines of pressure ratio less than 30				
Thrust more than 89 kN			$Dp/F_{oo} = 19 + 1.6\pi_{oo}$	$Dp/F_{oo} = 16.72 + 1.4080\pi_{oo}$
Thrust between 26.7 kN and not more than 89 kN			$Dp/F_{oo} = 37.572 + 1.6\pi_{oo} - 0.208F_{oo}$	$Dp/F_{oo} = 38.54862 + (1.6823\pi_{oo}) - (0.2453F_{oo}) - (0.00308\pi_{oo}F_{oo})$
Engines of pressure ratio more than 30 and less than 62.5				
Thrust more than 89 kN			$Dp/F_{oo} = 7+2.0\pi_{oo}$	$Dp/F_{oo} = -1.04+ (2.0*\pi_{oo})$
Thrust between 26.7 kN and not more than 89 kN			$Dp/F_{oo} = 42.71 +1.4286\pi_{oo} -0.4013F_{oo} +0.00642\pi_{oo}F_{oo}$	$Dp/F_{oo} = 46.1600 + (1.4286\pi_{oo}) - (0.5303F_{oo}) - (0.00642\pi_{oo}F_{oo})$
Engines with pressure ratio 82.6 or more			$Dp/F_{oo} = 32+1.6\pi_{oo}$	$Dp/F_{oo} = 32+1.6\pi_{oo}$

Source: International Standards and Recommended Practices, Environmental Protection, ICAO Annex 16 Volume II Part III Paragraph 2.3.2, 2nd edition July 1993, plus amendments: Amendment 3 (20 March 1997),Amendment 4 (4 November 1999),Amendment 5 (24 November 2005).

where:

D_p = the sum of emissions in the LTO cycle in g

F_{oo} = thrust at sea level take-off (100 %)

π_{oo} = pressure ratio at sea level take-off thrust point (100 %)

The equivalent limits for HC and CO are D_p/F_{oo} = 19.6 for HC and D_p/F_{oo} = 118 for CO (ICAO Annex 16 Vol. II paragraph 2.2.2). Smoke is limited to a regulatory smoke number = 83 $(F_{oo})^{-0.274}$ or a value of 50, whichever is the lower.

A further description of the technical definitions in relation to engine certification as well as actual engine exhaust emission measurement data can be found in the ICAO Engine Exhaust Emission Database. The latter database is accessible from http://www.caa.co.uk, hosted by the UK Civil Aviation Authority.

For seagoing vessels, NO_x emissions are regulated as explained in Marpol 73/78 Annex VI, formulated by IMO (International Maritime Organisation). The legislation is relevant for diesel engines with a power output higher than 130 kW, which are installed on a ship constructed on or after 1 January 2000 and diesel engines with a power output higher than 130 kW which undergo major conversion on or after 1 January 2000.

The NO_x emission limits for ship engines in relation to their rated engine speed (n) given in RPM (Revolutions Per Minute) are the following:

- 17 g pr kWh, n < 130 RPM
- 45 x n-0.2 g pr kWh, 130 ≤ n < 2000 RPM
- 9,8 g pr kWh, n ≥ 2000 RPM

Further, the Marine Environment Protection Committee (MEPC) of IMO has approved proposed amendments to MARPOL Annex VI to be agreed by IMO in October 2008 in order to strengthen the emission standards for NO_x and the sulphur contents of heavy fuel oil used by ship engines.

For NO_x emission regulations, a three tiered approach is considered, which comprises the following:

- Tier I: Diesel engines (> 130 kW) installed on a ship constructed on or after 1 January 2000 and prior to 1 January 2011.
- Tier II: Diesel engines (> 130 kW) installed on a ship constructed on or after 1 January 2011.
- Tier III[13]: Diesel engines (> 130 kW) installed on a ship constructed on or after 1 January 2016.

As for the existing NO_x emission limits, the new Tier I-III NO_x legislation values rely on the rated engine speeds. The emission limit equations are shown in Table 3.3.15.

Table 3.3.15 Tier I-III NOx emission limits for ship engines (amendments to MARPOL Annex VI).

	NO_x limit	RPM (n)
Tier I	17 g pr kWh	n < 130
	45 x n-0.2 g pr kWh	130 ≤ n < 2000
	9,8 g pr kWh	n ≥ 2000
Tier II	14.4 g pr kWh	n < 130
	44 x n-0.23 g pr kWh	130 ≤ n < 2000
	7.7 g pr kWh	n ≥ 2000
Tier III	3.4 g pr kWh	n < 130
	9 x n-0.2 g pr kWh	130 ≤ n < 2000
	2 g pr kWh	n ≥ 2000

The Tier I emission limits are identical with the existing emission limits from MARPOL Annex VI.

Also to be agreed by IMO in October 2008, the NO_x Tier I limits are to be applied for existing engines with a power output higher than 5000 kW and a displacement pr cylinder at or above 90 litres, installed on a ship constructed on or after 1 January 1990 but prior to 1 January 2000.

In relation to the sulphur content in heavy fuel and marine gas oil used by ship engines, Table 3.3.16 shows the current legislation in force, and the amendment of MARPOL Annex VI to be agreed by IMO in October 2008.

[13] For ships operating in a designated Emission Control Area. Outside a designated Emission Control Area, Tier II limits apply.

Table 3.3.16 Current legislation in relation to marine fuel quality.

Legislation		Heavy fuel oil		Gas oil	
		S- %	Impl. date (day/month/year)	S- %	Impl. date
EU-directive 93/12		None		0.2[1]	1.10.1994
EU-directive 1999/32		None		0.2	1.1.2000
EU-directive 2005/33[2]	SECA - Baltic sea	1.5	11.08.2006	0.1	1.1.2008
	SECA - North sea	1.5	11.08.2007	0.1	1.1.2008
	Outside SECA's	None		0.1	1.1.2008
MARPOL Annex VI	SECA – Baltic sea	1.5	19.05.2006		
	SECA – North sea	1.5	21.11.2007		
	Outside SECA	4.5	19.05.2006		
MARPOL Annex VI amendments	SECA's	1	01.03.2010		
	SECA's	0.1	01.01.2015		
	Outside SECA's	3.5	01.01.2012		
	Outside SECA's	0.5	01.01.2020[3]		

[1] Sulphur content limit for fuel sold inside EU.

[2] From 1.1.2010 fuel with a sulphur content higher than 0.1 % must not be used in EU ports for ships at berth exceeding two hours

[3] Subject to a feasibility review to be completed no later than 2018. If the conclusion of such a review becomes negative the effective date would default 1 January 2025.

For non road machinery, the EU directive 2003/17/EC gives a limit value of 50 ppm sulphur in diesel (from 2005).

Emission factors

The CO_2 emission factors are country-specific and come from the DEA. The N_2O emission factors are taken from the EMEP/EEA guidebook (EMEP/EEA, 2009).

For military ground material, aggregated CH_4 emission factors for gasoline and diesel are derived from the road traffic emission simulations. The CH_4 emission factors for railways are derived from specific Danish VOC measurements from the Danish State Railways (Delvig, 2009) and a NMVOC/CH_4 split, based on own judgment.

For agriculture, forestry, industry, household gardening and inland waterways, the VOC emission factors are derived from various European measurement programmes and the current EU emission legislation; see IFEU (2004) and Winther et al. (2006). The NMVOC/CH_4 split is taken from USEPA (2004). The baseline emission factors are shown in Annex 3.B.9.

For national sea transport and fisheries, the VOC emission factors come from Trafikministeriet (2000), for the ferries used by Mols Linjen, however, new VOC emission factors are provided by Kristensen (2008). The latter data originate from measurement results by Hansen et al. (2004), Wismann (1999) and PHP (1996).

For ship engines VOC/CH_4 splits are taken from EMEP/EEA (2009), and all emission factors are shown in Annex 3.B.12.

The CH_4 emission factors for domestic aviation come from the EMEP/EEA (2009).

For all sectors, emission factors for the years 1990 and 2006 are given in CollectER format in Annex 3.B.14.

Table 3.3.17 shows the aggregated emission factors for CO_2, CH_4 and N_2O in 2008 used to calculate the emissions from other mobile sources in Denmark.

Table 3.3.17 Fuel-specific emission factors for CO_2, CH_4 and N_2O for other mobile sources in Denmark.

SNAP ID	CRF ID	Category		Fuel type	Emission factors[14] CH_4 g pr GJ	CO_2 g pr GJ	N_2O g pr GJ
080100	1A5	Military		Diesel	3.84	74.00	2.71
080100	1A5	Military		Jet fuel	2.65	72.00	2.30
080100	1A5	Military		Gasoline	8.94	73.00	1.71
080100	1A5	Military		AvGas	21.90	73.00	2.00
080200	1A3c	Railways		Diesel	2.46	74.00	2.04
080300	1A3d	Inland waterways		Diesel	2.67	74.00	2.97
080300	1A3d	Inland waterways		Gasoline	60.27	73.00	1.34
080402	1A3d	National sea traffic		Residual oil	1.92	78.00	4.89
080402	1A3d	National sea traffic		Diesel	1.49	74.00	4.68
080403	1A4c	Fishing		Diesel	1.76	74.00	4.68
080403	1A4c	Fishing		Kerosene	7.00	72.00	0.00
080403	1A4c	Fishing		LPG	20.26	65.00	0.00
080404	Memo item	International sea traffic		Residual oil	1.91	78.00	4.89
080404	Memo item	International sea traffic		Diesel	1.74	74.00	4.68
080501	1A3a	Air traffic, Dom. < 3000 ft.	Other airports	Jet fuel	2.40	72.00	11.93
080501	1A3a	Air traffic, Dom. < 3000 ft.	Other airports	AvGas	21.90	73.00	2.00
080502	Memo item	Air traffic, Int. < 3000 ft.	Other airports	Jet fuel	3.04	72.00	7.97
080502	Memo item	Air traffic, Int. < 3000 ft.	Other airports	AvGas	21.90	73.00	2.00
080503	1A3a	Air traffic, Dom. > 3000 ft.	Other airports	Jet fuel	1.66	72.00	2.30
080504	Memo item	Air traffic, Int. > 3000 ft.	Other airports	Jet fuel	0.77	72.00	2.30
080600	1A4c	Agriculture		Diesel	1.08	74.00	3.16
080600	1A4c	Agriculture		Gasoline	152.40	73.00	1.68
080700	1A4c	Forestry		Diesel	0.63	74.00	3.21
080700	1A4c	Forestry		Gasoline	57.62	73.00	0.43
080800	1A2f	Industry		Diesel	1.14	74.00	3.10
080800	1A2f	Industry		Gasoline	107.34	73.00	1.46
080800	1A2f	Industry		LPG	7.69	65.00	3.50
080900	1A4b	Household and gardening		Gasoline	73.44	73.00	1.14
080501	1A3a	Air traffic, Dom. < 3000 ft.	Copenhagen	Jet fuel	3.03	72.00	7.10
080501	1A3a	Air traffic, Dom. < 3000 ft.	Copenhagen	AvGas	21.90	73.00	2.00
080502	Memo item	Air traffic, Int. < 3000 ft.	Copenhagen	Jet fuel	4.53	72.00	3.82
080502	Memo item	Air traffic, Int. < 3000 ft.	Copenhagen	AvGas	21.90	73.00	2.00
080503	1A3a	Air traffic, Dom. > 3000 ft.	Copenhagen	Jet fuel	1.64	72.00	2.30
080504	Memo item	Air traffic, Int. > 3000 ft.	Copenhagen	Jet fuel	1.12	72.00	2.30

Factors for deterioration, transient loads and gasoline evaporation for non road machinery

The emission effects of engine wear are taken into account for diesel and gasoline engines by using the so-called deterioration factors. For diesel engines alone, transient factors are used in the calculations, to account for the emission changes caused by varying engine loads. The evapora-

[14] References. CO_2: Country-specific. N_2O: EMEP/CORINAIR. CH_4: Railways: DSB/NERI; Agriculture/Forestry/Industry/Household-Gardening: IFEU/USEPA; National sea traffic/Fishing/International sea traffic: Trafikministeriet/EMEP-CORINAIR; domestic and international aviation: EMEP/CORINAIR.

tive emissions of NMVOC are estimated for gasoline fuelling and tank evaporation. The factors for deterioration, transient loads and gasoline evaporation are taken from IFEU (2004), and are shown in Annex 3.B.9. For more details regarding the use of these factors, please refer to paragraph 3.1.4 or Winther et al. (2006).

3.3.4 Calculation method

Air traffic

For aviation, the domestic and international estimates are made separately for landing and take-off (LTOs < 3000 ft), and cruising (> 3000 ft).

The fuel consumption for one LTO cycle is calculated according to the following sum formula:

$$FC_{LTO}^{a} = \sum_{m=1}^{4} t_m \cdot ff_{a,m} \quad (13)$$

Where FC = fuel consumption (kg), m = LTO mode (approach/landing, taxiing, take off, climb out), t = times in mode (s), ff = fuel flow (kg pr s), a = representative aircraft type.

The emissions for one LTO cycle are estimated as follows:

$$E_{LTO}^{a} = \sum_{m=1}^{4} FC_{a,m} \cdot EI_{a,m} \quad (14)$$

Due to lack of specific airport data, for approach/descent, take off and climb out, standardised times-in-modes of 4, 0.7 and 2.2 mins are used as defined by ICAO (ICAO, 1995), whereas for taxiing the appropriate time interval is 13 mins in Copenhagen Airport and 5 mins in other airports present in the Danish inventory.

To estimate cruise results, fuel consumption and emissions for standard flying distances from EMEP/EEA (2009) are interpolated or extrapolated – in each case determined by the great circle distance between the origin and the destination airports.

If the great circle distance, y, is smaller than the maximum distance for which fuel consumption and emission data are given in the EMEP/EEA data bank the fuel consumption or emission E (y) becomes:

$$E(y) = E_{x_i} + \frac{(y - x_i)}{x_{i+1} - x_i} \cdot (E_{x_{i+1}} - E_{x_i}) \quad y<x_{max},\ i = 0,1,2\ldots max-1 \quad (15)$$

In (5.3) x_i and x_{max} denominate the separate distances and the maximum distance, respectively, with known fuel use and emissions. If the flight distance y exceeds x_{max} the maximum figures for fuel use and emissions must be extrapolated and the equation then becomes:

$$E(y) = E_{x_{max}} + \frac{(y - x_{max})}{x_{max} - x_{max-1}} \cdot (E_{x_{max}} - E_{x_{max-1}}) \quad y>x_{max} \quad (16)$$

Total results are summed up and categorised according to each flight's airport and country codes.

The overall fuel precision in the model is around 0.8, derived as the fuel ratio between model estimates and statistical sales. The fuel difference is accounted for by adjusting cruising fuel use and emissions in the model according to domestic and international cruising fuel shares.

Prior to 2001, the calculation procedure was first to estimate each year's fuel use and emissions for LTO. Secondly, total cruising fuel use was found year by year as the statistical fuel use total minus the calculated fuel use for LTO. Lastly, the cruising fuel use was split into a domestic and international part by using the results from a Danish city-pair emission inventory in 1998 (Winther, 2001a). For more details of this latter fuel allocation procedure, see Winther (2001b).

Non-road working machinery and recreational craft

Prior to adjustments for deterioration effects and transient engine operations, the fuel use and emissions in year X, for a given machinery type, engine size and engine age, are calculated as:

$$E_{Basis}(X)_{i,j,k} = N_{i,j,k} \cdot HRS_{i,j,k} \cdot P \cdot LF_i \cdot EF_{y,z} \quad (17)$$

where E_{Basis} = fuel use/emissions in the basic situation, N = number of engines, HRS = annual working hours, P = average rated engine size in kW, LF = load factor, EF = fuel use/emission factor in g pr kWh, i = machinery type, j = engine size, k = engine age, y = engine-size class and z = emission level. The basic fuel use and emission factors are shown in Annex 2.B.9.

The deterioration factor for a given machinery type, engine size and engine age in year X depends on the engine-size class (only for gasoline), y, and the emission level, z. The deterioration factors for diesel and gasoline 2-stroke engines are found from:

$$DF_{i,j,k}(X) = \frac{K_{i,j,k}}{LT_i} \cdot DF_{y,z} \quad (18)$$

where DF = deterioration factor, K = engine age, LT = lifetime, i = machinery type, j = engine size, k = engine age, y = engine-size class and z = emission level.

For gasoline 4-stroke engines the deterioration factors are calculated as:

$$DF_{i,j,k}(X) = \sqrt{\frac{K_{i,j,k}}{LT_i}} \cdot DF_{y,z} \quad (19)$$

The deterioration factors inserted in (18) and (19) are shown in Annex 2.B.9. No deterioration is assumed for fuel use (all fuel types) or for LPG engine emissions and, hence, DF = 1 in these situations.

The transient factor for a given machinery type, engine size and engine age in year X, relies only on emission level and load factor, and is denominated as:

$$TF_{i,j,k}(X) = TF_z \quad (20)$$

Where i = machinery type, j = engine size, k = engine age and z = emission level.

The transient factors inserted in (20) are shown in Annex 2.B.9. No transient corrections are made for gasoline and LPG engines and, hence, TF_z = 1 for these fuel types.

The final calculation of fuel use and emissions in year X for a given machinery type, engine size and engine age, is the product of the expressions 17-20:

$$E(X)_{i,j,k} = E_{Basis}(X)_{i,j,k} \cdot TF(X)_{i,j,k} \cdot (1 + DF(X)_{i,j,k}) \quad (21)$$

The evaporative hydrocarbon emissions from fuelling are calculated as:

$$E_{Evap,fueling,i} = FC_i \cdot EF_{Evap,fueling} \quad (22)$$

Where $E_{Evap,fueling}$, = hydrocarbon emissions from fuelling, i = machinery type, FC = fuel consumption in kg, $EF_{Evap,fueling}$ = emission factor in g NMVOC pr kg fuel.

For tank evaporation, the hydrocarbon emissions are found from:

$$E_{Evap,\tan k,i} = N_i \cdot EF_{Evap,\tan k,i} \quad (23)$$

Where $E_{Evap,tank,i}$ = hydrocarbon emissions from tank evaporation, N = number of engines, i = machinery type and $EF_{Evap,fueling}$ = emission factor in g NMVOC pr year.

Ferries, other national sea transport and fisheries

The fuel use and emissions in year X, for regional ferries are calculated as:

$$E(X) = \sum_i N_i \cdot T_i \cdot S_{i,j} \cdot P_i \cdot LF_j \cdot EF_{k,l,y} \quad (24)$$

Where E = fuel use/emissions, N = number of round trips, T = sailing time pr round trip in hours, S = ferry share of ferry service round trips, P = engine size in kW, LF = engine load factor, EF = fuel use/emission factor in g pr kWh, i = ferry service, j = ferry, k = fuel type, l = engine type, y = engine year.

For the remaining navigation categories, the emissions are calculated using a simplified approach:

$$E(X) = \sum_i EC_{i,k} EF_{k,l,y} \quad (25)$$

Where E = fuel use/emissions, EC = energy consumption, EF = fuel use/emission factor in g pr kg fuel, i = category (local ferries, other national sea, fishery, international sea), k = fuel type, l = engine type, y = average engine year.

The emission factor inserted in (25) is found as an average of the emission factors representing the engine ages which are comprised by the average lifetime in a given calculation year, X:

$$EF_{k,l,y} = \frac{\sum_{year=X}^{year=X-LT} EF_{k,l}}{LT_{k,l}} \quad (26)$$

Other sectors

For military and railways, the emissions are estimated with the simple method using fuel-related emission factors and fuel use from the DEA:

$$E = FC \cdot EF \quad (27)$$

where E = emission, FC = fuel consumption and EF = emission factor. The calculated emissions for other mobile sources are shown in CollectER format in Annex 3.B.14 for the years 1990 and 2007 and as time-series 1990-2007 in Annex 3.B.15 (CRF format).

Energy balance: DEA statistics and NERI estimates

Following convention rules, the DEA statistical fuel sales figures are behind the full Danish inventory. However, in some cases for mobile sources the DEA statistical sectors do not fully match the inventory sectors. This is the case for non road machinery, where relevant DEA statistical sectors also include fuel consumed by stationary sources.

In other situations, fuel consumption figures estimated by NERI from specific bottom-up calculations are regarded as more reliable than DEA reported sales. This is the case for national sea transport.

In the following the transferral of fuel consumption data from DEA statistics into inventory relevant categories is explained for national sea transport and fisheries, non road machinery and recreational craft, and road transport. A full list of all fuel consumption data, DEA figures as well as intermediate fuel consumption data, and final inventory input figures is shown in Annex 3.B.13.

National sea transport and fisheries

For national sea transport in Denmark, the new fuel consumption estimates obtained by NERI (Winther, 2008a) are regarded as much more accurate than the DEA fuel sales data, since the large fluctuations in reported fuel sales cannot be explained by the actual development in the traffic between different national ports. As a consequence, the new bottom-up estimates replace the previous fuel based figures for national sea transport.

There are different potential reasons for the differences between estimated fuel consumption and reported sales for national sea transport in Denmark. According to the DEA, the latter fuel differences are most likely explained by inaccurate costumer specifications made by the oil suppliers. This inaccuracy can be caused by a sector misallocation in the sales statistics between national sea transport and fisheries for gas oil, and between national sea transport and industry for heavy fuel oil (Peter Dal, DEA, personal communication, 2007).

Following this, for fisheries and industry the updated fuel consumption time-series for national sea transport lead, in turn, to changes in the fuel activity data for fisheries (gas oil) and industry (heavy fuel oil), so the national energy balance can remain unchanged.

For fisheries, fuel investigations made prior to the initiation of the work made by Winther (2008a) have actually pointed out a certain area of inaccuracy in the DEA statistics. No engines installed in fishing vessels use heavy fuel oil, even though a certain amount of heavy fuel oil is listed in the DEA numbers for some statistical years (H. Amdissen, Danish Fishermen's Association, personal communication, 2006). Hence, for fisheries small amounts of fuel oil are transferred to national sea transport, and in addition small amounts of gasoline and diesel are transferred to recreational craft.

Non road machinery and recreational craft

For diesel and LPG, the non-road fuel consumption estimated by NERI is partly covered by the fuel-use amounts in the following DEA sectors: agriculture and forestry, market gardening, and building and construction. The remaining quantity of non-road diesel and LPG is taken from the DEA industry sector.

For gasoline, the DEA residential sector, together with the DEA sectors mentioned for diesel and LPG, contribute to the non-road fuel consumption total. In addition, a certain amount of fuel from road transport is needed to reach the fuel-use goal.

The amount of diesel and LPG in DEA industry not being used by non-road machinery is included in the sectors, "Combustion in manufacturing industry" (0301) and "Non-industrial combustion plants" (0203) in the Danish emission inventory.

For recreational craft, the calculated fuel-use totals for diesel and gasoline are subsequently subtracted from the DEA fishery sector. For gasoline, the DEA reported fuel consumption for fisheries is far too small to fill the fuel gap, and hence the missing fuel amount is taken from the DEA road transport sector.

Bunkers

The distinction between domestic and international emissions from aviation and navigation should be in accordance with the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. For the national emission inventory, this, in principle, means that fuel sold (and associated emissions) for flights/sea transportation starting from a seaport/airport in the Kingdom of Denmark, with destinations inside or outside the Kingdom of Denmark, are regarded as domestic or international, respectively.

Aviation

For aviation, the emissions associated with flights inside the Kingdom of Denmark are counted as domestic. The flights from Denmark to Greenland and the Faroe Islands are classified as domestic flights in the inventory background data. In Greenland and in the Faroe Islands, the jet fuel sold is treated as domestic. This decision becomes reasonable when considering that almost no fuel is bunkered in Greenland/the Faroe Islands by flights other than those going to Denmark.

Navigation

In DEA statistics, the domestic fuel total consists of fuel sold to Danish ferries and other ships sailing between two Danish ports. The DEA international fuel total consists of the fuel sold in Denmark to international ferries, international warships, other ships with foreign destinations, transport to Greenland and the Faroe Islands, tank vessels and foreign fishing boats.

In Greenland, all marine fuel sales are treated as domestic. In the Faroe Islands, the fuel sold in Faroese ports for Faroese fishing vessels and other Faroese ships is treated as domestic. The fuel sold to Faroese ships bunkering outside Faroese waters and the fuel sold to foreign ships in Faroese ports or outside Faroese waters is classified as international (Lastein and Winther, 2003).

To comply with the IPCC classification rules, the fuel consumed by vessels sailing to Greenland and the Faroe Islands should be a part of the domestic total. To improve the fuel data quality for Greenland and the Faroe Islands, the fuel sales should be grouped according to vessel destination and IPCC classification, subsequently.

In conclusion, the domestic/international fuel split (and associated emissions) for navigation is not determined with the same degree of precision as for aviation. It is considered, however, that the potential of incorrectly allocated fuel quantities is only a small part of the total fuel sold for navigational purposes in the Kingdom of Denmark.

3.3.5 Uncertainties and time-series consistency

Uncertainty estimates for greenhouse gases on Tier 1 and Tier 2 levels, are made for road transport and other mobile sources using the guidelines formulated in the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000). For road transport, railways and fisheries, these guidelines provide uncertainty factors for activity data that are used in the Danish situation. For other sectors, the factors reflect specific national knowledge (Winther et al., 2006 and Winther, 2008a). These sectors are (SNAP categories): Inland Waterways (a part of 1A3d: Navigation), Agriculture and Forestry (parts of 1A4c: Agriculture-/forestry/fisheries), Industry (mobile part of (1A2f: Industry-other), Residential (1A4b) and National sea transport (a part of 1A3d: Navigation).

The activity data uncertainty factor for civil aviation is based on own judgement.

The uncertainty estimates should be regarded as preliminary, only, and may be subject to changes in future inventory documentation. The calculations for Tier 1 are shown in Annex 3.B.16 for all emission components. Please refer to the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000) for further information regarding the calculation procedure for Tier 2 uncertainty calculations.

Table 3.3.18 Tier 1 Uncertainties for activity data, emission factors and total emissions in 2008 and as a trend.

Category	Activity data %	CO_2 %	CH_4 %	N_2O %
Road transport	2	5	40	50
Military	2	5	100	1000
Railways	2	5	100	1000
Navigation (small boats)	41	5	100	1000
Navigation (large vessels)	11	5	100	1000
Fisheries	2	5	100	1000
Agriculture	24	5	100	1000
Forestry	30	5	100	1000
Industry (mobile)	41	5	100	1000
Residential	35	5	100	1000
Civil aviation	10	5	100	1000
Overall uncertainty in 2008		5,3	34,0	142,0
Trend uncertainty		6,4	7,7	64,3

Table 3.3.19 Tier 2 Uncertainty factors for activity data and emission factors in 2008.

Category	Activity data %	CO_2 %	CH_4 %	N_2O %
Road transport	1	2.5	20	250
Military	1	2.5	50	500
Railways	1	2.5	50	500
Navigation (small boats)	20.5	2.5	50	500
Navigation (large vessels)	5.5	2.5	50	500
Fisheries	1	2.5	50	500
Agriculture	12	2.5	50	500
Forestry	15	2.5	50	500
Industry (mobile)	20.5	2.5	50	500
Residential	17.5	2.5	50	500
Civil aviation	5	2.5	50	500

Table 3.3.20 Tier 2 Uncertainty estimates for CO_2, CH_4, N_2O and CO_2-eq. in 2008.

Year		Component	95 % confidence ratio Median	Lower limit < 2.5 %	Upper limit > 97.5 %
	2008	CO_2		-4.8	5.2
	2008	CH_4		-25.5	35.0
	2008	N_2O		-48.9	381.2
	2008	CO_2-eq		-5.0	7.2
Trend	1990-2008	CO_2	26	27	24
	1990-2008	CH_4	-51	-35	-73
	1990-2008	N_2O	9	68	-83
	1990-2008	CO_2-eq	25	27	23

For 2008 the emissions of CO_2-eq. are estimated with an uncertainty range of [-5.0 %;7.2 %] for the 95 % confidence ratio. The 1990-2008 median trend of CO_2-eq. emissions are +25 %, and the uncertainty range is [23 %;27 %] for the 95 % confidence ratio.

As regards time-series consistency, background flight data cannot be made available on a city-pair level prior to 2000. However, aided by LTO/aircraft statistics for these years and the use of proper assumptions, a sound level of consistency is, in any case, obtained for this part of the transport inventory.

The time-series of emissions for mobile machinery in the agriculture, forestry, industry, household and gardening (residential) and inland waterways (part of navigation) sectors are less certain than time-series for other sectors, since DEA statistical figures do not explicitly provide fuel consumption information for working equipment and machinery.

3.3.6 Quality assurance/quality control (QA/QC)

The intention is to publish every second year a sector report for road transport and other mobile sources. The last sector report prepared concerned the 2006 inventory (Winther, 2008).

The QA/QC descriptions of the Danish emission inventories for transport follow the general QA/QC description for NERI in Section 1.6, based on the prescriptions given in the IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000).

An overview diagram of the Danish emission inventory system is presented in Figure 1.2 (Data storage and processing levels), and the exact definitions of Critical Control Points (CCP) and Points of Measurements (PM) are given in Section 1.6. The status for the PMs relevant for the mobile sector are given in the following text and the result of this investigation indicates a need for future QA/QC activities in order to fulfil the QA/QC requirements from the IPCC GPG.

Data storage level 1

Data Storage level 1	3.Completeness	DS.1.3.1	Documentation showing that all possible national data sources are included by setting down the reasoning behind the selection of datasets.

The following external data sources are used in the mobile part of the Danish emission inventories for activity data and supplementary information:

- Danish Energy Authority: Official Danish energy statistics
- Danish Road Directorate: Road traffic vehicle fleet and mileage data
- Civil Aviation Agency of Denmark: Flight statistics
- Non-road machinery: Information from statistical sources, research organisations, different professional organisations and machinery manufacturers
- Ferries (Statistics Denmark): Data for annual return trips for Danish ferry routes

- Ferries (Danish Ferry Historical Society): Detailed technical and operational data for specific ferries
- Ferries (Mols Linjen and Bornholmstrafikken): Detailed technical and operational data for specific ferries
- Danish Meteorological Institute (DMI): Temperature data
- The National Motorcycle Association: 2-wheeler data

The emission factors come from various sources:
- Danish Energy Authority: CO_2 emission factors and lower heating values (all fuel types)
- COPERT IV: Road transport (all exhaust components, except CO_2, SO_2)
- Danish State Railways: Diesel locomotives (NO_X, VOC, CO and TSP)
- EMEP/EEA guidebook: Civil aviation and supplementary
- Non road machinery: References given in NERI reports
- National sea transport and fisheries: TEMA2000 (NO_X, VOC, CO and TSP) and MAN Diesel (sfc, NO_X)

Table 3.3.21 to follow contains Id, File/Directory/Report name, Description, Reference and Contacts. As regards File/Directory/Report name, this field refers to a file name for Id when all external data (time-series for the existing inventory) are stored in one file. In other cases, a computer directory name is given when the external data used are stored in several files, e.g. each file contains one inventory year's external data or each file contains time-series of external data for sub-categories of machinery. A third situation occurs when the external data are published in publicly available reports; here the aim is to obtain electronic copies for internal archiving.

Table 3.3.21 Overview table of external data for transport.

Id no	File/-Directory/-Report name	Description	Activity data or emission factor	Reference	Contacts	Data agreement
T1	Transport energy[1]	Dataset for all transport energy use	Activity data	The Danish Energy Authority (DEA)	Peter Dal	Yes
T2	Fleet and mileage data[1]	Road transport fleet and mileage data	Activity data	The Danish Road Directorate	Inger Foldager	Yes
T3	Flight statistics[2]	Data records for all flights	Activity data	Civil Aviation Agency of Denmark	Henrik Gravesen	Yes
T4	Non road machinery[2]	Stock and operational data for non-road machinery	Activity data	Non road Documentation report	Morten Winther	No
T5	Emissions from ships[3]	Data for ferry traffic	Activity data	Statistics Denmark	Sonja Merkelsen	No
T6	Emissions from ships[3]	Technical and operational data for Danish ferries	Activity data	Navigation emission documentation report	Hans Otto Kristensen	No
T7	Temperature data[3]	Monthly avg of daily max/min temperatures	Other data	Danish Meteorological Institute	Danish Meteorological Institute	No
T8	Fleet and mileage data[1]	Stock data for mopeds and motorcycles	Activity data	The National Motorcycle Association	Henrik Markamp	No
T9	CO_2 emission factors[1]	DEA CO_2 emission factors (all fuel types)	Emission factor	The Danish Energy Authority (DEA)	Peter Dal	No
T10	COPERT IV emission factors[3]	Road transport emission factors	Emission factor	Laboratory of applied thermodynamics Aristotle University Thessaloniki	Leonidas Ntziachristos	No
T11	Railways emission factors[1]	Emission factors for diesel locomotives	Emission factor	Danish State Railways	Per Delvig	Yes
T12	EMEP/EEA guidebook[3]	Emission factors for navigation, civil aviation and supplementary	Emission factor	European Environment Agency	European Environment Agency	No
T13	Non road emission factors[3]	Emission factors for agriculture, forestry, industry and household/gardening	Emission factor	Non road Documentation report	Morten Winther	No
T14	Emissions from ships[3]	Emission factors for national sea transport and fisheries	Emission factor	Navigation emission documentation report	Morten Winther	No

1) File name; 2) Directory in the NERI data library structure; 3) Reports available on the internet.

Danish Energy Authority (energy statistics)

The official Danish energy statistics are provided by the Danish Energy Authority (DEA) and are regarded as complete on a national level. For most transport sectors, the DEA subsector classifications fit the SNAP classifications used by NERI.

For non-road machinery, this is however not the case, since DEA do not distinguish between mobile and stationary fuel consumption in the sub-sectors relevant for non-road mobile fuel consumption.

Here, NERI calculates a bottom-up non-road fuel consumption estimate and for diesel (land based machinery only) and LPG, the residual fuel quantities are allocated to stationary consumption. For gasoline (land-based machinery) the relevant fuel consumption quantities for the DEA are smaller than the NERI estimates, and the amount of fuel consumption missing is subtracted from the DEA road transport total to account for all fuel sold. For recreational craft, no specific DEA category exists and, in this case, the gasoline and diesel fuel consumption is taken from road transport and fisheries, respectively.

In the case of Danish national sea transport, fuel consumption estimates are obtained by NERI (Winther, 2008a), since they are regarded as much more accurate than the DEA fuel sales data. For the latter source, the large fluctuations in reported fuel sales cannot be explained by the actual development in the traffic between different national ports.

In order to maintain the national energy balance, the updated fuel consumption time-series for national sea transport lead, in turn, to changes in the fuel activity data for fisheries (gas oil) and industry (heavy fuel oil).

The NERI fuel modifications, thus, give DEA-SNAP differences for road transport, national sea transport and fisheries.

A special note must be made for the DEA civil aviation statistical figures. The domestic/international fuel consumption division derives from bottom-up fuel consumption calculations made by NERI.

Danish Road Directorate

Figures for fleet numbers and mileage data are provided by the Danish Road Directorate. Being a sector institution under the Ministry of Transport, it is a basic task for the Danish Road Directorate to possess comprehensive information on Danish road traffic. The fleet figures are based on data from the Car Register, kept by Statistics Denmark and are, therefore, regarded as very precise. In some cases, stock data are split into vehicle subcategories (COPERT III format), based on expert judgement. Annual mileage information comes from the Danish Vehicle Inspection and Maintenance Programme.

Civil Aviation Agency of Denmark

The Civil Aviation Agency of Denmark (CAA-DK) monitors all aircraft movements in Danish airspace and, in this connection, possesses data records for all take-offs and landings at Danish airports. The dataset from 2001 onwards, among others consisting of aircraft type and origin and destination airports for all flights leaving major Danish airports, are, therefore, regarded as very complete. For inventory years before 2001, the most accurate data contain CAA-DK total movements from major Danish airports and detailed aircraft type distributions for aircraft using Copenhagen Airport, provided by the airport itself.

Non-road machinery (stock and operational data)

A great deal of new stock and operational data for non road machinery was obtained in a research project carried out by Winther et al. (2006) for the 2004 inventory. The source for the agricultural machinery stock of tractors and harvesters is Statistics Denmark. Sales figures for tractors, harvesters and construction machinery, together with operational data and supplementary information, are obtained from The Association of Danish Agricultural Machinery Dealers. IFAG (The Association of Producers and Distributors of Fork Lifts in Denmark) provides fork-lift sale figures, whereas total stock numbers for gasoline equipment are obtained from machinery manufacturers with large Danish market shares, with figures validated through discussions with KVL. Stock information disaggregated into vessel types for recreational craft was obtained from the Danish Sailing Association. A certain part of the operational data comes from previous Danish non-road research projects (Dansk Teknologisk Institut, 1992 and 1993; Bak et al., 2003).

No statistical register exists for non-road machinery types and this affects the accuracy of stock and operational data. For tractors and harvesters, Statistics Denmark provide total stock data based on information from questionnaires and the registers of crop subsidy applications kept by the Ministry of Food, Agriculture and Fishery. In combination with new sales figures pr engine size from The Association of Danish Agricultural Machinery Dealers, the best available stock data are obtained. In addition, using the sources for construction machinery and fork lift sale figures are regarded as the only realistic approach for consolidated stock information for these machinery types. Use of this source-type also applies in the case of machinery types (gasoline equipment, recreational craft) where data is even scarcer.

To support the 2008 inventory, new 2008 stock data for tractors, harvesters, fork lifts and construction machinery was obtained from the same sources as in Winther et al. (2006). For non-road machinery in general, it is, however, uncertain if data in such a level can be provided annually in the future.

Ferries (Statistics Denmark)

Statistics Denmark provides information of annual return trips for all Danish ferry routes from 1990 onwards. The data are based on monthly reports from passenger and ferry shipping companies in terms of transported vehicles passengers and goods. Thus, the data from Statistics Denmark are regarded as complete. Most likely the data can be provided annually in the future.

Ferries (Danish Ferry Historical Society, DFS)

No central registration of technical and operational data for Danish ferries and ferry routes is available from official statistics. However, one valuable reference to obtain data and facts about construction and operation of Danish ferries, especially in the recent 20 - 30 years is the archives of Danish Ferry Historical Society. Pure technical data has not only been obtained from this society´s archives, but some of the knowledge has been obtained through the personal insight about ferries from some of the members of the society, which have been directly involved in the ferry business for example consultants, naval architects, marine engineers, captains and superintendents. However, until recently no documentation of the detailed DFS knowledge was established in terms of written reports or a central database system.

To make use of all the ferry specific data for the Danish inventories, DSF made a data documentation for the years 1990-2005 as a specific task of the research project carried out by Winther (2008a).

Ferries (Mols Linjen and Bornholmstrafikken)

For the years 2006+, the major Danish ferry companies are contacted each year in order to obtain ferry technical data, relating to specific ferries in service, annual share of total round trips and other technical information. The relevant annual information is given as personal communication, a method which can be repeated in the future.

Danish Meteorological Institute

The monthly average max/min temperature for Denmark comes from DMI. This source is self explanatory in terms of meteorological data. Data are publicly available for each year on the internet.

The National Motorcycle Association

Road transport: 2-wheeler stock information (The National Motorcycle Association). Given that no consistent national data are available for mopeds in terms of fleet numbers and distributions according to new sales pr year, The National Motorcycle Association is considered to be the professional organisation, where most expert knowledge is available. The relevant annual information is given as personal communication, a method which can be repeated in the future.

Danish Energy Authority (CO_2 emission factors and lower heating values)

The CO_2 emission factors and lower heating values (LHV) are fuel-specific constants. The country-specific values from the DEA are used for all inventory years.

COPERT IV

COPERT IV provides factors for fuel consumption and for all exhaust emission components which are included in the national inventory. For several reasons, COPERT IV is regarded as the most appropriate source of road traffic fuel consumption and emission factors. First of all, very few Danish emission measurements exist, so data are too scarce to support emission calculations on a national level. Secondly, most of the fuel-use and emission information behind the COPERT model are derived from the European 5th framework research projects ARTEMIS and Particulates, and the formulation of fuel-use and emission factors for all single vehicle categories has been made by a group of road traffic emission experts. A large degree of internal consistency is, therefore, achieved. Finally, the COPERT model is regularly updated with new experimental findings from European research programmes and, apart from updated fuel-use and emission factors, the use of COPERT IV by many European countries ensures a large degree of cross-national consistency in reported emission results.

Danish State Railways

Aggregated emission factors of NO_x, VOC, CO and TSP for diesel locomotives are provided annually by the Danish State Railways. Taking into account available time resources for subsector emission calculations, the use of data from Danish State Railways is sensible. This operator accounts for around 90 % of all diesel fuel consumed by railway locomotives in Denmark and the remaining diesel fuel is used by various private railways companies. Setting up contacts with the private transport operators is considered to be a rather time consuming experience taking time away from inventory work in areas of greater emission importance.

EMEP/EEA guidebook

Fuel-use and emission data from the EMEP/EEA guidebook is the prime and basic source for the aviation and navigation part of the Danish emission inventories. For aviation, the guidebook contains the most comprehensive list of representative aircraft types available for city-pair fuel consumption and emission calculations. The data have been evaluated specifically for detailed national inventory use by a group of experts representing civil aviation administration, air traffic management, emission modellers and inventory workers.

In addition, the EMEP/EEA guidebook is the source of non-exhaust TSP, PM_{10} and $PM_{2.5}$ emission factors for road transport, and the primary source of emission factors for some emission components – typically N_2O, NH_3, heavy metals and PAH – for other mobile sources.

Non-road machinery (fuel consumption and emission factors)

The references for non-road machinery fuel-use and emission factors are listed in Winther et al. (2006). The fuel-use and emission data is regarded as the most comprehensive data collection on a European level, having been thoroughly evaluated by German emission measurement and non-road experts within the framework of a German non-road inventory project.

National sea transport and fisheries

Emission factors for NO_X, VOC, CO and TSP are taken from the TEMA2000 model developed for the Ministry of Transport. To a large extent the emission factors originate from the exhaust emission measurement programme carried out by Lloyd's (1995). For NO_X, additional information of emission factors in a time-series going back to 1949, and PM_{10} and $PM_{2.5}$ fractions of total TSP was provided by the engine manufacturer MAN Diesel.

Specifically for the ferries used by Mols Linjen new NO_x , VO and CO emission factors are provided by Kristensen (2008), originating from measurement results by Hansen et al. (2004), Wismann (1999) and PHP (1996).

The experimental work by Lloyd's is still regarded as the most comprehensive measurement campaign with results publicly available. The additional NO_X and $PM_{10}/PM_{2.5}$ information comes from the world's largest ship engine manufacturer and data from this source is consistent with data from Lloyd's. Consequently the data used in the Danish inventories for national sea transport is regarded as the best available for emission calculations.

Data Storage level 1	1. Accuracy	DS.1.1.1	General level of uncertainty for every dataset, including the reasoning for the specific values

The uncertainty involved in the DEA fuel-use information (except civil aviation) and the CAA-DK flight statistics is negligible, as such, and this is also true for DMI temperature data. For civil aviation, some uncertainty prevails, since the domestic fuel-use figures originate from a division of total jet-fuel sales figures into domestic and international fuel quantities, derived from bottom-up calculations. A part of the fuel-use uncertainties for non-road machines is due to the varying levels of stock and operational data uncertainties, as explained in DS 1.3.1. The road transport fleet totals from the Danish Road Directorate and The National Motorcycle Association in the main vehicle categories are accurate. Uncertainties, however, are introduced when the stock data are split into vehicle subcategories. The mileage figures from the Danish Road Directorate are generally less certain and uncertainties tend to increase for disaggregated mileage figures on subcategory levels.

As regards emission factors, the CO_2 factors (and LHVs) from the DEA are considered to be very precise, since they relate only to fuel. For the remaining emission factor sources, the SO_2 (based on fuel sulphur content), NO_X, NMVOC, CH_4, CO, TSP, PM_{10} and $PM_{2.5}$ emission factors are less accurate. Though many measurements have been made, the experimental data rely on the individual measurement and combustion conditions. The uncertainties for N_2O and NH_3 emission factors increase even further due to the small number of measurements available. For heavy metals and PAH, experimental data are so scarce that uncertainty becomes very high.

A special note, however, must be made for energy. The uncertainties due to the subsequent treatment of DEA data for road transport, fisheries and the non-road relevant sectors, explained in DS 1.3.1, trigger some uncertainties in the fuel-use figures for these sectors. This point is, though, more relevant for QA/QC description for data processing, Level 1.

Data Storage level 1	1. Accuracy	DS.1.1.2	Quantification of the uncertainty level of every single data value including the reasoning for the specific values.

The general uncertainties of the DEA fuel-use information, DMI temperature data, road transport stock totals and the CAA-DK flight statistics are zero. For domestic aviation fuel consumption, the uncertainty is based on own judgement. For road transport, military and railways the fuel consumption uncertainties are taken from the IPCC Good Practice Guidance manual. It is noted that for road transport, it is not possible to quantify in-depth the uncertainties (1) of stock distribution into COPERT IV-relevant vehicle subsectors and (2) of the national mileage figures, as such.

For non-road machinery stock and operational data, the uncertainty figures are given in Winther et al. (2006). For navigation, the uncertainty figures are given in Winther (2008b).

For emission factors, the uncertainties for mobile sources are determined as suggested in the IPCC and UNECE guidelines. The uncertainty figures are listed in Paragraph 1.1.5 for greenhouse gases, and in Nielsen et al. (2009), Winther et al. (2006) and Winther (2008b) for the remaining emission components.

Data Storage level 1	2.Comparability	DS.1.2.1	Comparability of the data values with similar data from other countries, which are comparable with Denmark, and evaluation of discrepancy.

Work has been carried out to compare Danish figures with corresponding data from other countries in order to evaluate discrepancies. The comparisons have been made on a CRF level, mostly for implied emission factors (Fauser et al., 2007).

Data Storage level 1	4.Consistency	DS.1.4.1	The origin of external data has to be preserved whenever possible without explicit arguments (referring to other PMs)

It is ensured that the original files from external data sources are archived internally at NERI. Subsequent raw data processing is carried out either in the NERI database models or in spreadsheets (data processing level 1).

Data Storage level 1	6.Robustness	DS.1.6.1	Explicit agreements between the external institution holding the data and NERI about the condition of delivery

For transport, NERI has made formal agreements with regard to external data deliverance with (Table 3.3.21 external data source Id's in brackets): DEA (T1), CAA-DK (T3), Danish State Railways (T9) and the Danish Road Directorate (T2).

Data Storage level 1	7.Transparency	DS.1.7.1	Summary of each dataset, including the reasoning for selecting the specific dataset

Please refer to DS 1.1.1. In this measurement point, the reason for external data selections in different inventory areas is given.

Data Storage level 1	7.Transparency	DS.1.7.3	References for citation for any external dataset have to be available for any single value in any dataset.

The references for external datasets are provided in the present report.

Data Storage level 1	7.Transparency	DS.1.7.4	Listing of external contacts for every dataset

The following list shows the external data source (source Id in brackets), the responsible person and contact information for each area where formal data deliverance agreements have been made.

- Danish Energy Authority (T1): Peter Dal (pd@ens.dk)
- Danish Road Directorate (T2): Inger Foldager ((ifo@vd.dk)
- Civil Aviation Agency of Denmark (T3): Henrik Gravesen (hgr@slv.dk)
- Danish State Railways (T9): Per Delvig (pede@dsb.dk)

Data Processing Level 1

Data Processing level 1	1. Accuracy	DP.1.1.1	Uncertainty assessment for every data source as input to Data Storage level 2 in relation to type of variability. (Distribution as: normal, log normal or other type of variability)

In the mobile part of the Danish emission inventories, uncertainty assessments are made at Data Processing Level 1 for non-road machinery, recreational craft and national sea transport. For these types of mobile machinery, the stock and operational data variations are assumed to be normally distributed (Winther et al., 2006; Winther, 2008a). Tier 1 uncertainty calculations produce final fuel-use uncertainties ready for Data Storage Level 2 (SNAP level 2: Inland waterways, agriculture, forestry, industry and household-gardening).

Data Processing level 1	1. Accuracy	DP.1.1.2	Uncertainty assessment for every data source as input to Data Storage level 2 in relation to scale of variability (size of variation intervals)

For non-road machinery, recreational craft and national sea transport, uncertainty assessments are made by Winther et al. (2006) and Winther (2008a), and the sizes of the variation intervals are given for activity data and emission factors.

Data Processing level 1	1. Accuracy	DP.1.1.3	Evaluation of the methodological approach using international guidelines

An evaluation of the methodological inventory approach has been made, which proves that the emission inventories for transport are made according to the international guidelines (Winther, 2005: Kyoto notat, in Danish). This paper will be translated into English and the conclusions will be implemented in the future national inventory reports.

Data Processing level 1	1. Accuracy	DP.1.1.4	Verification of calculation results using guideline values

It has been checked that the greenhouse gas emission factors used in the Danish inventory are within margin of the IPCC guideline values.

Data Processing level 1	2.Comparability	DP.1.2.1	The inventory calculation has to follow the international guidelines suggested by UNFCCC and IPCC.

See DP 1.1.3.

Data Processing level 1	3.Completeness	DP.1.3.1	Assessment of the most important quantitative knowledge which is lacking.

Data Processing level 1	3.Completeness	DP.1.3.2	Assessment of the most important cases where access is lacking with regard to critical data sources that could improve quantitative knowledge.

The most important area where the accessibility to critical data is lacking is road transport. More accurate national vehicle fleet and mileage data is available from the Danish Vehicle Inspection Programme, and new fuel consumption and emission information is available in a new version of COPERT- COPERT IV. It is, however, not straight forward to combine the new traffic and emission data, due to different formats. Instead the new data are transformed into COPERT III input formats by using different assumptions. Work has been made recently by the Ministry of Transport to transform the new fleet and mileage traffic data into COPERT IV format, and the next inventory will be fully based on the COPERT IV format.

Data Processing level 1	4.Consistency	DP.1.4.1	In order to keep consistency at a high level, an explicit description of the activities needs to accompany any change in the calculation procedure.

Se DP 1.7.5.

Data Processing level 1	5.Correctness	DP.1.5.1	Show at least once, by independent calculation, the correctness of every data manipulation.

During model development it has been checked that all mathematical model relations give exactly the same results as independent calculations.

Data Processing level 1	5.Correctness	DP.1.5.2	Verification of calculation results using time-series

Data Processing level 1	5.Correctness	DP.1.5.3	Verification of calculation results using other measures

When NERI transport model changes are made relating to fuel consumption, it is checked that the calculated fuel-use sums correspond to the expected fuel-use levels in the time-series. The fuel-use check also includes a time-series comparison with fuel-use totals calculated in the previous model version. The checks are performed on a SNAP level and, if appropriate, detailed checks are made for vehicle/machinery technology splits.

As regards model changes in relation to derived emission factors (and calculated emissions), the time-series of emission factors (and emissions) are compared to previous model figures. A part of this evaluation includes an assessment, if the development corresponds to the underlying assumptions given by detailed input parameters. Among other things, the latter parameters depend on emission legislation, new technology phase-in, deterioration factors, engine operational conditions/driving modes, gasoline evaporation (hydrocarbons) and cold starts. For methodological issues, please refer to Section 3.3.2.

Data Processing level 1	5.Correctness	DP.1.5.4	Show one-to-one correctness between external data sources and the data bases at Data Storage level 2

For road transport, aviation and non-road machinery, whether all external data are correctly put into the NERI transport models is checked.

This is facilitated by the use of sum queries which sum up stock data (and mileages for road transport) to input aggregation levels. However, spreadsheet or database manipulations of external data are, in some cases, included in a step prior to this check.

This is carried out in order to produce homogenous input tables for the NERI transport models (road, civil aviation, non-road machinery/recreational craft, navigation/fisheries). The sub-routines perform operations, such as the aggregation/disaggregation of data into first sales year (Examples: Fleet numbers and mileage for road transport, stock numbers for tractors, harvesters, fork lifts) or simple lists of total stock pr year (per machinery type for e.g. household equipment and for recreational craft). For civil aviation, additional databases control the allocation of representative aircraft to real aircraft types and the cruise distance between airports. A more formal description of the sub-routines will be made.

Regarding fuel data, it is checked for road transport and civil aviation that DEA totals (modified for road) match the input values in the NERI models. For the transport modes military and railways, the DEA fuel-use figures go directly into Data Storage Level 2. This is also the case for the railway emission factors obtained from Danish State Railways and, generally, for the emission factors which are kept constant over the years.

The NERI model simulations of fuel-use and emission factors for road transport, civil aviation and non-road machinery refer to Data Processing Level 1.

Data Processing level 1	7.Transparency	DP.1.7.1	The calculation principle and equations used must be described
Data Processing level 1	7.Transparency	DP.1.7.2	The theoretical reasoning for all methods must be described
Data Processing level 1	7.Transparency	DP.1.7.3	Explicit listing of assumptions behind all methods

The NERI model calculation principles and basic equations are thoroughly described in the present report, together with the theoretical model reasoning and assumptions. Documentation is also given e.g. in Nielsen et al. (2009), Winther (2001, 2007, 2008) and Winther et al. (2006). Further formal descriptions of NERI model sub routines are given in internal notes, and flow maps show the interrelations between tables and calculation queries in the models.

Data Processing level 1	7.Transparency	DP.1.7.4	Clear reference to dataset at Data Storage level 1.

In the different documentation reports for transport in the Danish emission inventories, there are explicit references for the different external data used.

Data Processing level 1	7.Transparency	DP.1.7.5	A manual log to collect information about recalculations

Recalculation changes in the emission inventories are described in the NIR and ECE reports as a standard. These descriptions take into account changes in emission factors, activity data and calculation methods.

Data Storage Level 2

Data Storage level 2	5.Correctness	DS.2.5.1	Documentation of a correct connection between all data types at level 2 to data at level 1

In the various documentation reports behind the transport part of the Danish emission inventories there is a thorough documentation of the SNAP aggregated fuel consumption figures and emission factors, based on the original external data derived from external sources.

Data Storage level 2	5.Correctness	DS.2.5.2	Check if a correct data import to level 2 has been made.

At present, a NERI software programme imports data from prepared input data tables (SNAP fuel-use figures and emission factors) into the CollectER database.

Tables for CollectER fuel consumption and emission results are prepared by a special NERI database (NERIrep.mdb). The results relevant for mobile sources are copied into a database containing all the official inventory results for mobile sources (Data2008 NIR-UNECE.mdb). By the use of database queries, the results from this latter database are aggregated into the same formats as being used by the relevant NERI transport models in their results calculation part. The final comparison between CollectER and NERI transport model results are set up in a spreadsheet.

Suggested QA/QC plan for mobile sources

The following points make up the list of QA/QC tasks to be carried out directly in relation to the mobile part of the Danish emission inventories. The time plan for the individual tasks has not yet been prepared.

Data storage level 1

- An elaboration of the PAH and heavy metal part of the inventory for mobile sources. Review of existing emission factors and inclusion of new sources.

Data processing level 1

- Inclusion of new Danish fleet and mileage data (source: Ministry of Transport and Energy) fully correspondent with COPERT IV

3.3.7 Recalculations and improvements

The following recalculations and improvements of the emission inventories have been made since the emission reporting in 2009.

Road transport

The total mileage pr vehicle category from 2005-2008 have been updated based on the traffic index development (derived from traffic counts on selected roads) from the Danish Road Directorate. In addition new data prepared by DTU Transport for the Danish Infrastructure Commission has given information of the total mileage driven by foreign trucks on Danish roads. This mileage contribution has been added to the total mileage for Danish trucks on Danish roads, for trucks > 16 tonnes of gross vehicle weight. The data from DTU Transport was estimated for 2005, and by using appropriate assumptions the mileage have been backcasted to 1985 and forecasted to 2008.

For passenger cars the new division of total mileage into gasoline and diesel made by the Danish Road Directorate is regarded as very broad. Hence in the subsequent model calculations, the fuel and emission results for diesel passenger cars are adjusted with the overall sales/calculated fuel ratio, being applied to the estimates for the other diesel vehicle categories as well. This is a change compared to previous year's inventory submissions for which the diesel passenger car results remain unadjusted.

For heavy duty vehicles an error for the NMVOC emission factors for Euro 0-III trucks and buses has been corrected giving somewhat smaller emission factors.

For mopeds and motorcycles, updated first registration year information for 2005+ and 2000+, respectively, has caused some changes in the fleet/technology mix and the resulting emissions.

The minimum and maximum percentage difference and year of numeric maximum differences (min %, max %, year of max %) for the different emission components are: CO_2 (0 %, -0.1 %, 2007), CH_4 (0.1 %, 1.9 %, 2006) and N_2O (0.4 %, 3 %, 2007).

Biofuel consumption and CH4 and N2O emissions from road transport have been allocated to biomass under 1A3b following the recommendation of the ERT.

National sea transport
No changes have been made.

Fishery
No changes have been made.

Military
Emission factors derived from the new road transport simulations have caused some emission changes from 1985-2007. The minimum and maximum emission differences (min %, max %) for the different emission components are: CH_4 (0 %, 4 %) and N_2O (0 %, 2 %).

Residential
The number of riders has been updated for 2007. Thus, the emission increases are 2 % for CH_4 and CO_2 (and fuel consumption), and 3 % for N_2O.

Industrial non road machinery
The number of wheel type excavators has been updated for 2007. The fuel consumption and emission increases are insignificant.

Agricultural non road machinery
The number of machine pool tractors, harvesters and self-propelled vehicles has been updated for 2007. The fuel consumption and emission increases are less than 1 %.

Railways
No changes have been made.

Aviation
En error for 2007 has been corrected. Erroneously, the flights between Denmark and Greenland/Faroe Islands were treated as international flights. As a result of this correction the fuel consumption and emissions change substantially. The fuel consumption and CO_2 emission increases are 51%, whereas CH_4 and N_2O emissions increase by 22 % and 26 %, respectively.

Very small emission changes between 0 % and 2 % occur for the years 2001-2006, due to inclusion of new representative aircraft types.

3.3.8 Planned improvements
The ongoing aspiration is to fulfil the requirements from UNECE and UNFCCC for good practice in inventory preparation for transport. A study has been completed for transport, reviewing the different issues of choices relating to methods (methods used, emission factors, activity data, completeness, time-series consistency, uncertainty assessment) reporting and documentation, and inventory quality assurance/quality control. This work and the overall priorities of NERI, taking into account emission source importance (from the Danish 2008 key source analysis), background data available and time resources, lay down the following list of improvements to be made in future.

Emission factors
The Danish greenhouse gas emission factors will be compared with the factors suggested by IPCC.

QA/QC
Future improvements regarding this issue are dealt with in Section 3.1.4.

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3.4 Additional information, CRF sector 1A Fuel combustion

3.4.1 Reference approach, feedstocks and non-energy use of fuels

In addition to the sector-specific CO_2 emission inventories (the national approach), the CO_2 emission is also estimated using the reference approach described in the IPCC Reference Manual (IPCC, 1997). The reference approach is based on data for fuel production, import, export and stock change. The CO_2 emission inventory based on the reference approach is reported to the Climate Convention and used for verification of the official data in the national approach.

Data for import, export and stock change used in the reference approach originate from the annual "basic data" table prepared by the Danish Energy Authority and published on their home page (Danish Energy Authority, 2009b). The fraction of carbon oxidised has been assumed to be 1.00. The carbon emission factors are default factors originating from the IPCC Reference Manual (IPCC, 1997). The country-specific emission factors are not used in the reference approach, the approach being for the purposes of verification.

The Climate Convention reporting tables include a comparison of the national approach and the reference approach estimates. To make results comparable, the CO_2 emission from incineration of the plastic content of municipal waste is added in the reference approach while the fuel consumption is subtracted.

Three fuels are used for non-energy purposes: lube oil, bitumen and white spirit. The total consumption for non-energy purposes is relatively low – 11.1 PJ in 2008.

In 2008 the fuel consumption rates in the two approaches differ by -0.80 % and the CO_2 emission differs by -0.51%. In the period 1990-2008 both the fuel consumption and the CO_2 emission differ by less than 1.6%. The differences are below 1 % for all years except 1998 and 2006. According to IPCC Good Practice Guidance (IPCC 2000) the difference should be within 2 %. A comparison of the national approach and the reference approach is illustrated in Figure 3.4.1.

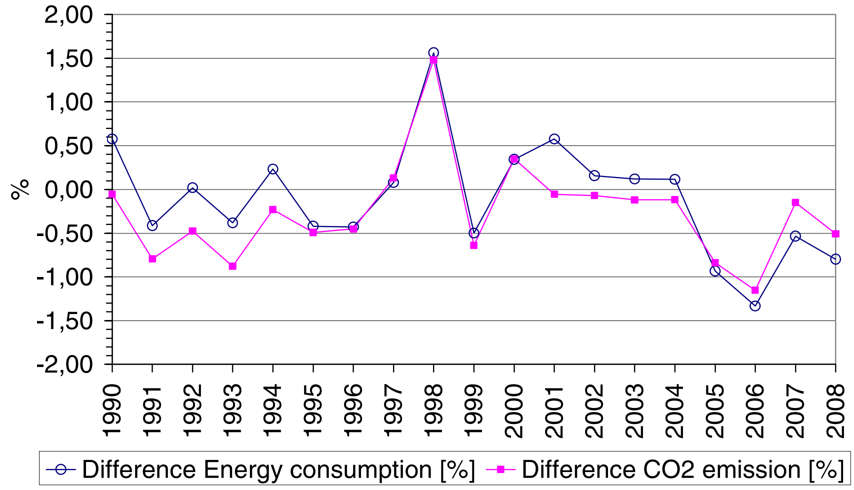


Figure 3.4.1 Comparison of the reference approach and the national approach.

3.5 Fugitive emissions (CRF sector 1B)

This chapter includes fugitive emissions in the CRF sector 1B.

3.5.1 Source category description

According to the IPCC sector definitions the category *fugitive emissions* is a sub-category under the main-category Energy (Sector 1). The category *fugitive emissions* (Sector 1B) is segmented into sub-categories covering emissions from solid fuels (coal mining and handling (1B1a), solid fuel transformation (1B1b), other (1B1c)) and from oil and natural gas (oil (1B2a), natural gas (1B2b), venting and flaring (1B2c) and other (1B2d)). The sub-sectors relevant for the Danish emission inventory are shortly described below according to Danish conditions:

- 1B1c: Fugitive emission from solid fuels: Emissions from solid fuels are only relevant for the Danish national emission inventories in the case of particulate emissions from storage and handling of coal. Other components are not occurring, as these emissions should be included in the inventory for the nation housing the coalmines.

- 1B2a: Fugitive emissions from oil include emissions from offshore activities and refineries.
- 1B2b: Fugitive emissions from natural gas include emissions from transmission and distribution of natural gas. Emissions from gas storage are included in the transmission.
- 1B2c: Venting and flaring includes both offshore flaring, flaring in gas storage and treatment plants and in refineries. In Denmark venting of gas is assumed to be negligible as controlled venting enters the gas flare system.

Activity data, emission factors and emissions are stored in the Danish emission database on SNAP sector categories (Selected Nomenclature for Air Pollution). In Table 3.5.1 the corresponding SNAP codes and IPCC sectors relevant to fugitive emissions are shown. Further, the table holds the SNAP names for the SNAP codes and the overall activity (e.g. oil and natural gas).

Table 3.5.1 List of the IPCC sectors and corresponding SNAP codes for the categories included in the Danish emission inventory model.

IPCC sectors	SNAP code	SNAP name	Activity
	04	Production processes	
1 B 2 a 4	040101	Petroleum products processing	Oil
1 B 2 a 4	040103	Other	Oil
	05	Extraction and distribution of fossil fuels and geothermal energy	
1 B 1 a	050103 *	Storage of solid fuel	Coal mining and handling
1 B 2 a 2	050201	Land-based activities	Oil
1 B 2 a 2	050202 **	Off-shore activities	Oil
1 B 2 a 5	050503	Service stations (including refuelling of cars)	Oil
1 B 2 b / 1 B 2 b 3	050601	Pipelines	Natural gas / Transmission
1 B 2 b / 1 B 2 b 4	050602	Distribution networks	Natural gas / Distribution
	09	Waste treatment and disposal	
1 B 2 c 2 1	090203	Flaring in oil refinery	Venting and flaring
1 B 2 c 2 2	090206	Flaring in oil and gas extraction	Venting and flaring

*Only relevant for emissions of particulate matter from storage and handling of coal.

**In the Danish inventory emissions from extraction of gas are united under "Extraction, 1st treatment and loading of liquid fossil fuels/off-shore activities" (IPCC 1B2a / SNAP 050202).

Table 3.5.2 summarizes the Danish fugitive emissions in 2008. The methodologies, activity data and emission factors used for calculation are described in the following chapters.

Table 3.5.2 Summary of the Danish fugitive emissions 2008. P refers to point source and A to area source.

IPCC code	SNAP code	Source	Pollutant	Emission	Unit
1B2a i	050201	A	NMVOC	5551	Mg
1B2a i	050201	A	CH_4	1744	Mg
1B2a i	050202	A	NMVOC	2437	Mg
1B2a i	050202	A	CH_4	1837	Mg
1B2a iv	040101	P	SO_2	0*	Mg
1B2a iv	040101	P	NMVOC	3784	Mg
1B2a iv	040101	P	CH_4	2184	Mg
1B2a iv	040103	P	SO_2	794	Mg
1B2a v	050503	A	NMVOC	1210	Mg
1B2b	050601	A	NMVOC	4	Mg
1B2b	050601	A	CH_4	16	Mg
1B2b	050601	P	NMVOC	27	Mg
1B2b	050601	P	CH_4	115	Mg
1B2b	050603	A	NMVOC	42	Mg
1B2b	050603	A	CH_4	174	Mg
1B2c	090203	P	SO_2	380	Mg
1B2c	090203	P	NO_x	30	Mg
1B2c	090203	P	NMVOC	38	Mg
1B2c	090203	P	CH_4	9	Mg
1B2c	090203	P	CO	88	Mg
1B2c	090203	P	CO_2	28	Gg
1B2c	090203	P	N_2O	0.2	Mg
1B2c	090206	A	SO_2	2	Mg
1B2c	090206	A	NO_x	158	Mg
1B2c	090206	A	NMVOC	13	Mg
1B2c	090206	A	CH_4	25	Mg
1B2c	090206	A	CO	129	Mg
1B2c	090206	A	CO_2	344	Gg
1B2c	090206	A	N_2O	2	Mg
1B2c	090206	P	SO_2	<0.1	Mg
1B2c	090206	P	NO_x	6	Mg
1B2c	090206	P	NMVOC	4	Mg
1B2c	090206	P	CH_4	13	Mg
1B2c	090206	P	CO	1	Mg
1B2c	090206	P	CO_2	3	Gg
1B2c	090206	P	N_2O	<0.1	Mg

* From 2001 SO_2 emissions from oil refining are included in stationary combustion.

3.5.2 Methodological issues

The following chapters give descriptions on the methods of calculation used in the Danish emission inventory. Further, the activity data and emission factors that form the basis for the calculations are described according to data source and values.

Fugitive emissions from oil (1B2a)

The emissions from oil derive from offshore activities, service stations and refineries. Emissions from offshore activities include emissions from extraction, onshore oil tanks and onshore and offshore loading of ships.

In the case of service stations emissions from reloading of tankers and re-fuelling of vehicles are included. The emissions from refineries derive from petroleum products processing (oil refining). Emissions from flaring in refineries are included in the chapters concerning flaring.

Offshore activities

Fugitive emissions from oil include emissions from extraction, from on-shore oil tanks and from onshore and offshore loading of ships.

The total emission can be expressed as:

$$E_{total} = E_{extraction} + E_{ship} + E_{oil\ tanks} \quad \text{(Eq. 3.5.1)}$$

Fugitive emissions from extraction

According to the EMEP/EEA Guidebook (EMEP/EEA, 2009) the total fugitive emissions of volatile organic components (VOC) from extraction of oil and gas can be estimated by means of equation 3.5.2.

$$E_{extraction,VOC} = 40.2 \cdot N_P + 1.1 \cdot 10^{-2} P_{gas} + 8.5 \cdot 10^{-6} \cdot P_{oil} \quad \text{(Eq. 3.5.2)}$$

where $E_{extraction,VOC}$ is the emission of VOC in Mg pr year, N_P is the number of platforms, P_{gas} is the production of gas, 10^6 Nm^3 and P_{oil} is the production of oil, 10^6 tonnes.

It is assumed that the VOC contains 75 % methane (CH_4) and 25 % NMVOC and in consequence the total emission of CH_4 and NMVOC for extraction of oil and gas can be calculated as:

$$E_{extraction,CH_4} = 0.75 \cdot E_{extraction,VOC} \quad \text{(Eq. 3.5.3)}$$

$$E_{extraction,NMVOC} = 0.25 \cdot E_{extraction,VOC} \quad \text{(Eq. 3.5.4)}$$

Loading of ships

Fugitive emissions of CH_4 and NMVOC from loading of ships include the transfer of oil from storage tanks or directly from the well into ships. The activity also includes losses during transport. When oil is loaded hydrocarbon vapour will be displaced by oil and new vapour will be formed, both leading to emissions. The emissions from ships are calculated by equation 3.5.5.

$$E_{ships} = EMF_{ships,onshore} \cdot L_{oil,onshore} + EMF_{ships,offshore} \cdot L_{oil,ofshore} \quad \text{(Eq. 3.5.5)}$$

where EMF_{ships} is the emission factor for loading of ships off-shore and on-shore and L_{oil} is the amount of oil loaded.

Oil tanks

The CH_4 and NMVOC emissions from storage of oil are given in the environmental reports from DONG Energy for 2008 (DONG Energy, 2009). An implied emission factor is calculated for use in the reporting template on the basis of the amount of oil transported in pipelines according to equation 3.5.6.

$$IEF_{tanks} = \frac{E_{tanks}}{T_{oil}} \quad \text{(Eq. 3.5.6)}$$

where IMF_{tanks} is the implied emission factor for storage of raw oil in tanks, E_{tanks} is the emission and T_{oil} is the amount of oil transported in pipelines.

Service stations

NMVOC emissions from service stations are estimated as outlined in equation 3.5.7.

$$E_{service\ stations} = \left(EMF_{reloading} \cdot T_{fuel}\right) + \left(EMF_{refuelling} \cdot T_{fuel}\right) \quad \text{(Eq.3.5.7)}$$

where $EMF_{reloading}$ is the emission factor for reloading of tankers to underground storage tanks at the service stations, $EMF_{refuelling}$ is the emission factor for refuelling of vehicles and T_{fuel} is the amount of gasoline used for road transport.

Oil refining

When oil is processed in the refineries, part of the volatile organic components (VOC) is emitted to the atmosphere. The VOC emissions from the petroleum refinery process include non-combustion emissions from handling and storage of feedstock (raw oil), from the petroleum product processing and from handling and storage of products. Emissions from flaring in refineries are included under "Flaring". Emissions related to process furnaces in refineries are included in stationary combustion with the relevant emission factors. In cases where only the total VOC emission is given by the refinery the emission of CH_4 and NMVOC is estimated due to the assumption that 1 % of VOC is CH_4 and the remaining 99 % is NMVOC.

Both the non-combustion processes including product processing and sulphur recovery plants emit SO_2. The SO_2 emissions are calculated by the refineries and implemented in the emission inventory without further calculation.

Fugitive emissions from gas (1B2b)

Transmission and distribution of gas

The fugitive emission from transmission, storage and distribution is based on information from the gas companies. The transmission and distribution companies give data on the transported amount and length and material of the pipeline systems. The fugitive losses from pipelines are only given for some companies, here among the transmission company. The available distribution data are used for the remaining companies too. From the fugitive losses from transmission and distribution pipelines the emissions of CH_4 and NMVOC are calculated due to the gas quality measured by Energinet.dk.

Flaring

Emissions from flaring are estimated from the amount of gas flared offshore, in gas treatment/storage plants and in refineries and from the corresponding emission factors. From 2006 data on offshore flaring (flared amounts, calorific values and CO_2 emission factors) is given in the reports for the European Union Greenhouse Gas Emission Trading System

(EU ETS) and thereby flaring can be split to the individual production units. Before 2006 only the summarized flared amount are available.

3.5.3 Activity data

Extraction of oil and gas and loading of ships

Activity data used in the calculations of the emissions from oil and gas production and loading of ships are shown in Table 3.5.3. Data are based on information from the Danish Energy Agency (2009a) and from the environmental reports from DONG Energy (DONG Energy, 2009).

Table 3.5.3 Activity data for 2008.

Activity	Symbols	Amounts	Data source
Number of platforms	N_p	55	Danish Energy Agency, 2009a
Produced gas, 10^6 Nm^3	P_{gas}	9 879	Danish Energy Agency, 2009a
Produced oil, 10^3 m^3	$P_{oil,vol}$	16 672	Danish Energy Agency, 2009a
Produced oil, 10^3 tonnes	P_{oil}	14 338	Danish Energy Agency, 2009a
Oil loaded, 10^3 m^3	$L_{oil\ off\text{-}shore}$	2 158	Danish Energy Agency, 2009a
Oil loaded, 10^3 tonnes	$L_{oil\ off\text{-}shore}$	1 856	Danish Energy Agency, 2009a
Oil loaded, 10^3 m^3	$L_{oil\ on\text{-}shore}$	11 200	DONG Energy, 2009
Oil loaded, 10^3 tonnes	$L_{oil\ on\text{-}shore}$	9 632	DONG Energy, 2009

Mass weight raw oil = 0.86 tonnes pr m^3

As seen in Figure 3.5.1 the production of oil and gas in the North Sea has generally increased in the years 1990-2004. Since 2004 the production has decreased. The number of platforms is yet still increasing (Figure 3.5.2). Five major platforms were completed in 1997-1999 which is the main reason for the great increase in the oil production in the years 1998-2000.

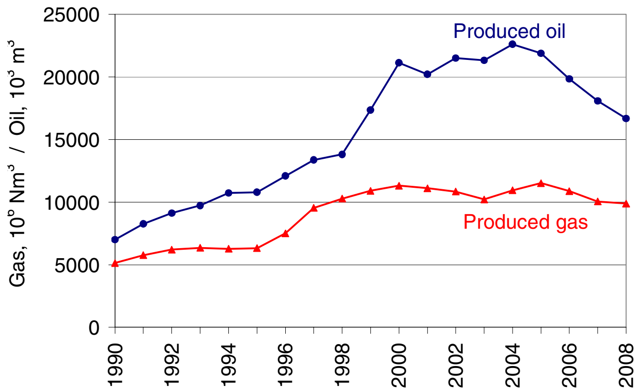


Figure 3.5.1 Production of oil and gas in the Danish part of the North Sea.

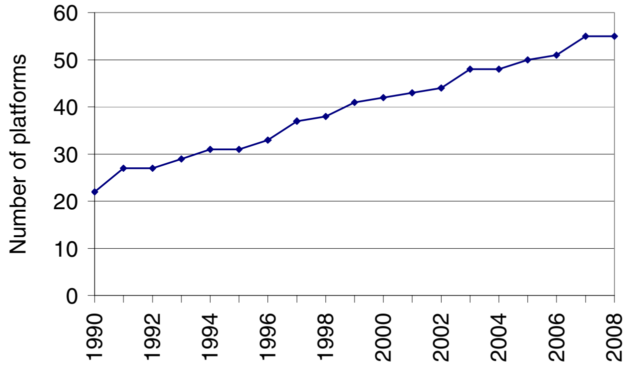


Figure 3.5.2. The number of platforms in the Danish part of the North Sea.

The amounts of oil loaded offshore on ships roughly follow the trend of the oil and gas production (Figure 3.5.3). In case of onshore loading of ships the trend is more smoothed.

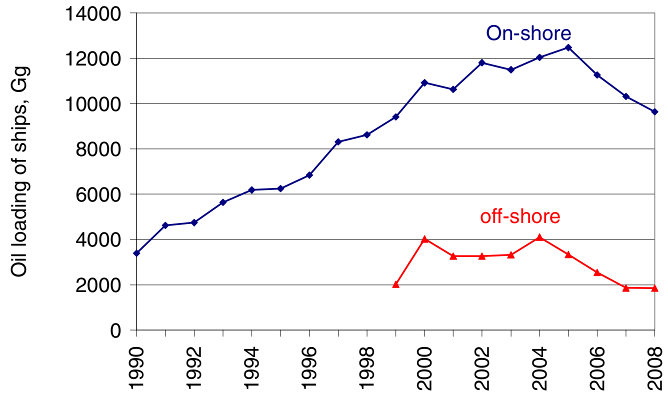


Figure 3.5.3 Onshore and offshore loading of ships.

Oil refining

Data on the amount of crude oil processed in the two Danish refineries are given by the refineries in their annual environmental report (A/S Dansk Shell, 2009 and Statoil A/S, 2009a). Data are shown in Table 3.5.4. In the last years the amount of crude oil being processed has been slightly decreasing to 7 933 Gg in 2008.

Table 3.5.4 Oil refineries. Processed crude oil in the two Danish refineries.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Crude oil, 1000 Mg	7 263	7 798	8 324	8 356	8 910	9 802	10 522	7 910	7 906	8 252
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
Crude oil, 1000 Mg	8 508	8 284	8 045	8 350	8 264	8 033	8 179	7 963	7 933	

Service stations

The Danish Energy statistics holds data on the sale of gasoline that is the basis for estimating emissions of NMVOC from service stations. The gasoline sales show an increase from 1990-1998 and a slightly decreasing trend from 1999-2008 as shown in Figure 3.5.4. In 2008 the gasoline sale was 1 748 516 Mg.

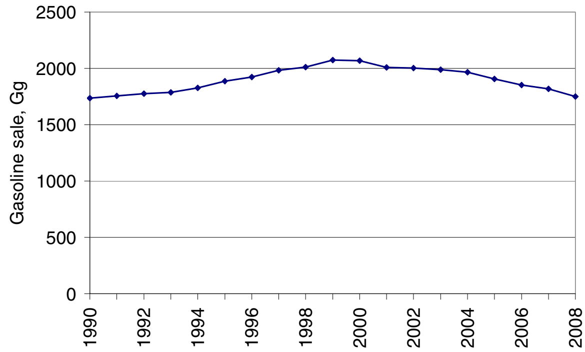


Figure 3.5.4 Gasoline sales in Denmark 1990-2008.

Transmission, storage and distribution of gas

The activity data used in the calculation of the emissions from natural gas is shown in Table 3.5.5. Transmissions rates for 1990-1997 refer to the Danish energy statistics and to the annual environmental report of DONG Energy for 1998. The distribution rates for 1990-1998 are estimated according to the transmission rates. Transmissions and distribution rates for 1999-2006 refers to Dong Energy, Danish Gas Technology Centre and the Danish gas distribution companies. In 2007-2008 the transmission rate stems from the annual environmental report by Energinet.dk. The distribution rates for 2007-2008 are given by the distribution companies, either in their annual reports or through personal communication.

Table 3.5.5 Activity data on transmission and distribution of gas. Town gas is included in distribution.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Transmission, Mm^3 *	2 739	3 496	3 616	3 992	4 321	4 689	5 705	6 956	6 641	6 795
Distribution, Mm^3 **	1905	2145	2252	2516	2693	3089	3585	3607	3734	3627
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
Transmission, Mm^3 *	7 079	7 289	7 287	7 275	7 384	7 600	7 600	6 400	7 565	
Distribution, Mm^3 **	3511	4005	3749	3749	3579	3297	3593	3388	3355	

* In 1990-1997 transmission rates refer to Danish energy statistics, in 1998 the transmission rate refers to the annual environmental report of DONG Energy, in 1999-2006 emissions refer to DONG/Danish Gas Technology Centre (Karll 2003, Karll 2005, Oertenblad 2006, Oertenblad 2007). Since 2007 transmission data refer to the annual environmental report by Energinet.dk.

**) In 1990-98 distribution rates are estimated from the Danish energy statistics. Distribution rates are assumed to equal total Danish consumption rate minus the consumption rates of sectors that receive the gas at high pressure. The following consumers are assumed to receive high pressure gas: town gas production companies, production platforms and power plants. In 1999-2006 distribution rates refer to DONG Energy / Danish Gas Technology Centre / Danish gas distribution companies (Karll 2003, Karll 2005, Oertenblad 2006, Oertenblad 2007). Since 2007 the distribution rates are given by the companies. The distribution of town gas is based on the available data from the Danish town gas distribution companies of which more are closed down today.

In 2008 the gas transmission was 7 565 Mm_n^3 and the distribution rate is 3 355 Mm_n^3, hereof 22 Mm_n^3 town gas (Figure 3.5.5). The increase compared to 2007 owes to a mild winter and because Denmark had import of electricity from Norway and Sweden in 2007.

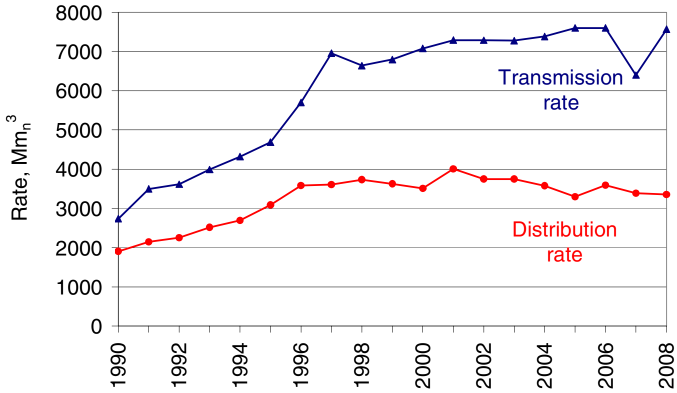


Figure 3.5.5 Rates for transmission and distribution of gas. Distribution cower both natural gas and town gas.

Data on the transmission pipelines excluding offshore pipelines and on the distribution network are given by Energinet.dk, DGC and the distribution companies concerning length and material. In 2008 the length of the transmission pipelines was 860 km. Because the distribution system in Denmark is relatively new most of the distribution network is made of PE. In 2008 the length of the distribution network was 16 618 km. The major part is made of plastic (approximately 90 %) and the remaining part is made of steel. For this reason the fugitive emission is negligible under normal circumstances as the PE distribution system is basically tight with only minimal fugitive losses. However, the PE pipes are vulnerable and therefore most of the fugitive emissions from the pipes are caused by losses due to excavation damages and construction and maintenance activities performed by the gas companies. These losses are either measured or estimated by calculation in each case by the gas companies. About 6 % of the distribution network is used for town gas distribution. This part of the network is older and the fugitive losses are greater. The fugitive losses from this network are associated with more uncertainty as the losses are estimated as a percentage (15 %) of the meter differential. This assumption is based on expert judgement from one of the town gas companies. It must be noted that more town gas distribution companies are now closed (one in 2004 and another in 2006), and therefore the data availability is scarce.

In Denmark there are two natural gas storage facilities. Both are obligated to make an environmental report on annual basis. Data on gas input and withdrawal are included and were 740 Mm^3 and 725 Mm^3 in 2008, respectively. Until 2000 emissions from storage of gas were included in transmission in the inventories.

Flaring

Offshore flaring amounts are given in Denmark's oil and gas production (Danish Energy Agency, 2009a) while flaring in treatment/storage plants are given in DONG Energy's environmental reports (Dong Energy, 2009). Flaring rates for the two Danish refineries are given in their environmental reports and additional data. From 2006 flaring amounts are given in the EU ETS reporting.

The flaring rates are shown in figure 3.5.6 and figure 3.5.7. Flaring rates in gas treatment and gas storage plants are not available until 1995. The mean value for the following ten years (1995 to 2004) has been adopted as basis for the emission calculation for the years 1990-1994.

The amount of flared gas is high in 2007 because of larger maintenance work at the gas treatment plant. In 2008 there has also been one situation with flaring of a larger amount of gas.

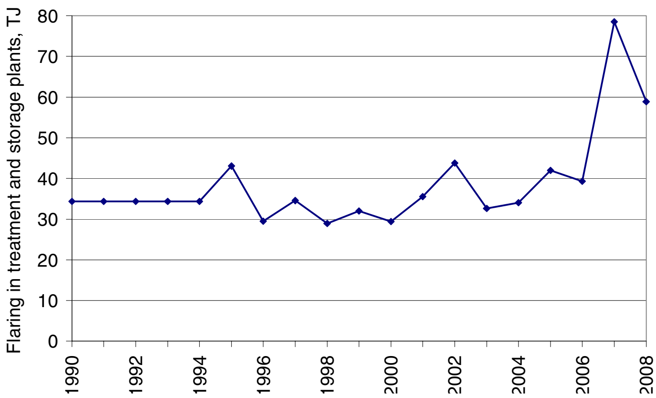


Figure 3.5.6 Amount flared in gas treatment and storage plants (DONG Energy, 2009).

The offshore flaring amounts have been decreasing over the last four years in accordance with the decrease in production as seen in Figure 3.5.7. Further, there is focus on reduction of the amount being flared for environmental reasons.

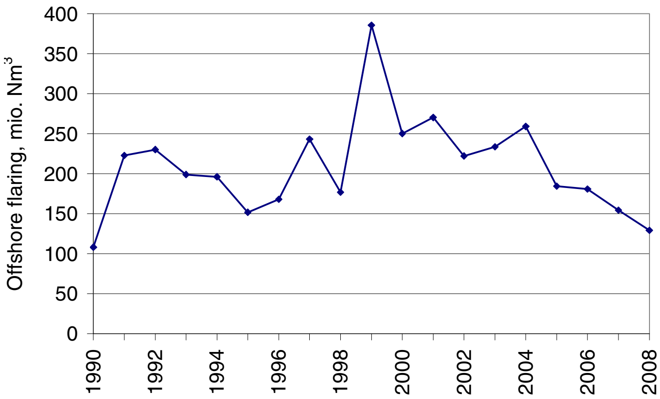


Figure 3.5.7 Amounts of gas flared offshore at exploration facilities (Danish Energy Agency, 2009b).

3.5.4 Emission factors

Loading of ships

In the EMEP/EEA Guidebook standard emission factors for different countries are given. In the Danish emission inventory the Norwegian emission factors are used for estimation of fugitive emissions from loading of ships onshore and offshore (EMEP/EEA, 2009). The emission factors are listed in Table 3.5.6.

Table 3.5.6 Emission factors for loading of ships onshore and offshore.

	NMVOC, fraction of loaded	CH_4, fraction of loaded	Reference
Ships off-shore	0.001	0.00005	EMEP/EEA, 2009
Ships on-shore	0.0002	0.00001	EMEP/EEA, 2009

Oil refining

The refineries deliver information on consumption of fuel gas and fuel oil. The calorific values are given by the refineries in the reporting for EU

ETS from 2006. Before 2006 the calorific values given by the refineries were used when available. When not available standard calorific values given in the basic data tables from the Danish Energy Agency combined with the conversion factor between fuel gas and fuel oil given by the refinery were used for calculation. The emissions are given by the refineries for SO_2, NO_x and VOC. Only one of the two refineries has made a split between NMVOC and CH_4. For the other refinery it is assumed that 1 % of the VOC emission is CH_4 and the remaining 99 % is NMVOC.

Service stations

NMVOC from service stations is calculated by use of different emission factors for the time series as shown in Table 3.5.7. In 1994 the emission factors for NMVOC from service stations were investigated by Fenhann and Kilde (1994) for the years 1990 1991 and 1992, individually. The emission factors reported for reloading and refuelling for 1990 were used for the years 1985-1990, while the emission factors for 1991 was used for that year only. For the years 1992-1995 only emission factor for refuelling reported by Fenhann and Kilde (1994) was used in the Danish emission inventory. For reloading of tankers the British emission factor - as given in the UK Emission Factor Database - was adopted for the years 1992-2000. For 2008 the emission factors from the EMEP/EEA guidebook (2009) are used for reloading and refuelling. For the years 2001-2007 and 1996-2007 the emission factors for reloading and refuelling, respectively, are estimated by using interpolation.

Table 3.5.7 Emission factors used for estimating NMVOC from service stations.

	Reloading of tankers, kg NMVOC pr tonnes gasoline	Refuelling of vehicles, kg NMVOC pr tonnes gasoline	Sum of reloading and refuelling, kg NMVOC pr tonnes gasoline	Source
1985-1990	1.28	1.52	2.80	Fenhann & Kilde,1994
1991	0.64	1.52	2.16	Fenhann & Kilde,1994
1992-1995	0.08	1.52	1.60	UK emf. database / Fenhann & Kilde,1994
1996	0.08	1.45	1.53	UK emf. database / interpolation 1995-2008
1997	0.08	1.39	1.47	UK emf. database / interpolation 1995-2008
1998	0.08	1.32	1.40	UK emf. database / interpolation 1995-2008
1999	0.08	1.25	1.33	UK emf. database / interpolation 1995-2008
2000	0.08	1.19	1.27	UK emf. database / interpolation 1995-2008
2001	0.077	1.12	1.20	Interpolation 2000-2008 / 1995-2008
2002	0.073	1.05	1.13	Interpolation 2000-2008 / 1995-2008
2003	0.070	0.99	1.05	Interpolation 2000-2008 / 1995-2008
2004	0.067	0.92	0.98	Interpolation 2000-2008 / 1995-2008
2005	0.063	0.85	0.91	Interpolation 2000-2008 / 1995-2008
2006	0.060	0.78	0.84	Interpolation 2000-2008 / 1995-2008
2007	0.056	0.72	0.77	Interpolation 2000-2008 / 1995-2008
2008	0.053	0.65	0.70	EMEP/EEA 2009

Transmission, storage and distribution of gas

The fugitive emissions from transmission, storage and distribution of natural gas are based on data on gas losses from the companies and on the average yearly natural gas composition given by Energinet.dk.

Flaring

Flaring in refineries

The composition of fuel gas is given for 2008 by one of the two refineries. As the composition for fuel gas is marked different than the composition of natural gas, which has been used in earlier year's calculations, the new composition data are adopted in the calculations. The same fuel gas composition is used in calculations for the other Danish refinery. The new emission factors for CH_4 and NMVOC have been included in the inventory for all years (1990-2008) as the 2008 fuel gas composition is assumed to be more accurate for the emission calculation than the yearly composition for natural gas being distributed in Denmark used in previous emission inventories. The CO_2 emission factor is based on the refineries reporting to the EU ETS for the years 2006-2008. Before 2006 corresponding data are not available and the CO_2 emission factors are calculated from the yearly natural gas composition given by Energinet.dk. For NO_x, CO and N_2O the emission factors from the EMEP/EEA guidebook 2009 are used. For trace metals, dioxin and PAHs the emission factors given in the guidebook (EMEP/EEA, 2009) for stationary combustion, Tier 1, are adopted for flaring in refineries. The emission factors are listed in table 3.5.8.

Table 3.5.8 Emission factors for flaring in refineries.

Pollutant	Emission factor	Unit
NO_x *	32.2	g pr GJ
NMVOC	76.5	g pr GJ
CH_4	18.5	g pr GJ
CO	177	g pr GJ
CO_2 **	56.74 / 57.08	kg pr GJ
N_2O	0.47	g pr GJ
TSP	0.90	g pr GJ
PM_{10}	0.90	g pr GJ
$PM_{2.5}$	0.90	g pr GJ
As	0.09	mg pr GJ
Cd	0.50	mg pr GJ
Cr	0.70	mg pr GJ
Cu	0.40	mg pr GJ
Hg	0.10	mg pr GJ
Ni	1.00	mg pr GJ
Pb	0.20	mg pr GJ
Se	0.01	mg pr GJ
Zn	14.0	mg pr GJ
Dioxin	0.05	ng pr GJ
Benzo(b)fluoranthene	0.08	µg pr GJ
Benzo(k)fluoranthene	0.08	µg pr GJ
Benzo(a)pyrene	0.06	µg pr GJ
Indeno(1,2,3-c,d)pyrene	0.08	µg pr GJ

*The emission of NO_x is given for one refinery why the emission factor is used for one refinery only.

** The CO_2 emission is based on the refineries reports for ETS and is source specific.

Flaring offshore

The emission factors for offshore flaring are shown in Table 3.5.9. For the years 2006-2008 the CO_2 emission factor is calculated according to the reporting for EU ETS. Corresponding data are not available for earlier years and therefore the CO_2 emission factor is assumed to follow the same time-series as for natural gas combusted in stationary combustion plants. The dioxin emission factor originates from a Danish study by Henriksen et al. (2006) and is, like emission factors for PM and SO_2, the same as the emission factors used for combustion of natural gas in Danish public power plants.

The NO_x emission factor is based on the conclusion in a Danish study of NO_x emissions from offshore flaring carried out by the Danish Environmental Protection Agency (2008). The recommended NO_x emission factor (31 008 g pr GJ or 0.0015 tonnes NO_x pr tonnes gas) corresponds well with the emission factors used to estimate NO_x emission in other countries with oil production in the North Sea (Netherlands: approximately 0.0014 tonnes NO_x pr tonnes gas and United Kingdom: approximately 0.0013 tonnes NO_x pr tonnes gas). Emission factors for NMVOC, CH_4, CO and N_2O are based on the EMEP/EEA Guidebook. For trace metals, dioxin and PAH's the emission factors given in the guidebook (EMEP/EEA, 2009) for stationary combustion Tier 1 are adopted for flaring in refineries.

Emissions from flaring in gas treatment and storage plants are calculated from the same emission factors which are used for offshore flaring. Only difference is the CO_2 emission factor for the years 2006-2008. The emission factor used for the plants are based on the same data source, the reporting for EU ETS, but the values are different than for offshore flaring. The gas that are flared in the treatment and storage plants are natural gas with the same composition as natural gas distributed in Denmark. Therefore, the emission factors in the EU ETS reports are the same as the one calculated on basis of the gas composition given by Energinet.dk (56.77 g pr GJ in 2008).

Table 3.5.9 Emission factors for offshore flaring.

Pollutant	Emission factor	Unit
SO_2	0.014	g pr Nm3
NO_x	1.227	g pr Nm3
NMVOC	0.100	g pr Nm3
CH_4	0.190	g pr Nm3
CO	1.000	g pr Nm3
CO_2	2.670	kg pr Nm3
N_2O	0.019	g pr Nm3
TSP	0.041	g pr Nm3
PM_{10}	0.041	g pr Nm3
$PM_{2.5}$	0.041	g pr Nm3
As	0.004	mg pr Nm3
Cd	0.023	mg pr Nm3
Cr	0.032	mg pr Nm3
Cu	0.018	mg pr Nm3
Hg	0.005	mg pr Nm3
Ni	0.046	mg pr Nm3
Pb	0.009	mg pr Nm3
Se	0.0005	mg pr Nm3
Zn	0.639	mg pr Nm3
Dioxin	0.023	ng pr Nm3
Benzo(b)fluoranthene	0.037	µg pr Nm3
Benzo(k)fluoranthene	0.037	µg pr Nm3
Benzo(a)pyrene	0.027	µg pr Nm3
Indeno(1,2,3-c,d)pyrene	0.037	µg pr Nm3

3.5.5 Emissions

Extraction of oil and gas and loading of ships

From the activity data in Table 3.5.3, equation 3.5.3 and equation 3.5.4 the fugitive emissions of CH_4 and NMVOC from extraction are calculated. Corresponding emissions from loading of ships can be estimated by Table 3.5.3, Table 3.5.6 and equation 3.5.5. The emissions are listed in Table 3.5.10 along with the emissions from storage of oil given in the environmental reports from DONG Energy (2009).

Table 3.5.10 CH_4 and NMVOC emissions for 2008.

	CH_4, Mg	NMVOC, Mg
Onshore loading of ships	96	1 926
Oil tanks	1 648	3 625
Fugitive emissions from extraction	1 744	581
Offshore loading of ships	93	1 856
Total	3 581	7 988

The emissions from extraction of oil and gas are aggregated in two sources; emissions related to onshore and offshore activities, respectively. The time-series for onshore and offshore activities related to extraction of oil and natural gas are shown in table 3.5.11 and table 3.5.12.

Tabel 3.5.11 CH_4 and NMVOC from onshore activities related to extraction of oil and natural gas (onshore loading of ships and oil tanks).

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
NMVOC, Mg	2404	2961	3199	3520	3876	3913	4304	4918	5078	5582	6183
CH4, Mg	817	970	1069	1142	1259	1271	1400	1560	1608	1794	1809
continued	2000	2001	2002	2003	2004	2005	2006	2007	2008		
NMVOC, Mg	6183	6126	6761	6698	6908	6994	6403	5981	5551		
CH4, Mg	1809	2006	2118	2115	2220	2225	2013	1883	1744		

The major increase for NMVOC emission from offshore activities in 1999 owe to offshore loading as there were no offshore loading in the years 1990-1998. A similar increase is not seen for CH_4 as emissions from extraction is the dominating source.

Tabel 3.5.12 CH_4 and NMVOC from offshore activities related to extraction of oil and natural gas (offshore loading of ships and extraction).

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
NMVOC, Mg	236	288	289	310	330	330	353	400	412	2465	4476
CH_4, Mg	708	864	868	930	989	990	1060	1199	1235	1432	1566
continued	2000	2001	2002	2003	2004	2005	2006	2007	2008		
NMVOC, Mg	4476	3726	3742	3836	4620	3873	3087	2442	2437		
CH_4, Mg	1566	1556	1584	1702	1748	1775	1759	1839	1837		

Oil refining

In Table 3.5.13 the activity data and emissions of CH_4 and NMVOC from the Danish refineries are listed for the years 1990-2008. Further, the emissions of SO_2 from oil refining and sulphur recovery in refineries are shown. In cases where only VOC emissions are given, 1 % of the VOC emission is assumed to be CH_4 and 99 % NMVOC. The emission of SO_2 has shown a pronounced decrease since 1990 because of technical improvements at the refineries. Note that SO_2 from refining and recovery prior to 1994 was summarized and reported as an area source in the IPCC category 1B2a vi. Note also that SO_2 from oil refining from 2001 are included in stationary combustion.

Table 3.5.13 Oil Refineries. Emissions of NMVOC and SO_2 from oil refining and SO_2 from sulphur recovery.

	1990[1]	1991[1]	1992[1]	1993[1]	1994	1995	1996	1997	1998	1999
NMVOC, Mg	3 667	3 937	4 203	4 219	5 855	4 546	5 875	4 547	4 558	4 558
SO_2, oil refining, Mg	3 335	2 713	3 147	2 526	934	585	167	216	253	234
SO_2, sulphur recovery, Mg					3 332	2 437	2 447	1 766	1 188	1 125
Continued	2000	2001[2]	2002[2]	2003[2]	2004[2]	2005[2]	2006[2]	2007[2]	2008[2]	
NMVOC, Mg	4 983	4 338	4 302	3 708	3 732	3 550	3 837	3 761	3 784	
SO_2, oil refining Mg	178									
SO_2, sulphur recovery Mg	803	672	332	246	119	255	679	610	794	

1) Prior to 1994 SO_2 emissions from oil refining and sulphur recovery are reported as area sources in category 1B2a vi.

2) From 2001 SO_2 emissions from oil refining are included in stationary combustion.

Service stations

Emissions from service stations are calculated using the emission factors in Table 3.5.7 and the sold amounts of gasoline given by the Danish Energy statistics (Danish Energy Agency, 2009b). The NMVOC emissions are listed in Table 3.5.14.

Table 3.5.14 Emissions of NMVOC from service stations 1985-2007.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
NMVOC, Mg	4 856	3 792	2 832	2 854	2 916	3 016	2 949	2 906	2 813	2 760
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
NMVOC, Mg	2 616	2 399	2 252	2 094	1 933	1 742	1 563	1 405	1 210	

Transmission, storage and distribution of gas

The gas transmission company gives emissions of CH_4. The CH_4 emissions for transmission are estimated on the basis of registered loss in the transmission grid and the emission from the natural gas consumption in the pressure regulating stations (Oertenblad, 2007). The distribution companies give data on fugitive losses, and the CH_4 emissions are estimated due to the gas quality given by Energinet.dk.

The emissions of NMVOC are calculated on the basis of the CH_4 emission according to the gas quality measured by Energinet.dk (equation 3.5.8).

$$E_{NMVOC} = E_{CH_4} \times \left(w_{NMVOC} / w_{CH_4} \right) \text{ (Eq.3.5.8)}$$

where w_{NMVOC} is the weight-% NMVOC and w_{CH_4} is the weight-% CH_4 according to the gas quality of the current year.

Emissions of CH_4 and NMVOC from transmission, storage and distribution of gas are shown in table 3.5.15 and table 3.5.16, respectively. For the years before 2000 emissions from transmission and storage have not been estimated separately and storage is included in the transmission category. As the pipelines in Denmark are relatively new, most emissions are due to construction and maintenance. The decrease in emission from transmission in 2007 is caused by the completion of a greater construction work and rerouting of a major pipeline. There have been no significant construction or renovation work in 2007 and therefore a low emission. The increase in 2008 owe to a minor increase in these work activities.

The increased emission from distribution in 2004 owes to venting of the distribution network. The reason for the increase in 2007 is not explained by the given company.

Table 3.5.15 CH_4 emission from transmission, storage and distribution.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Transmission Mg*	243	310	93	186	151	536	205	235	156	191
Storage Mg**										
Distribution Mg***	226	247	246	242	242	298	302	225	228	243
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
Transmission Mg*	86	157	78	88	85	141	152	7	16	
Storage Mg**	84	73	67	68	83	54	66	71	115	
Distribution Mg***	231	246	227	211	294	239	260	287	174	

Table 3.5.16 NMVOC emission from transmission, storage and distribution. NMVOC emissions are estimated from the CH_4 emission according to the gas quality given by Energinet.dk.

NMVOC emission	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Transmission, Mg*	74	94	28	57	46	163	63	72	45	56
Storage, Mg**										
Distribution, Mg***	57	62	62	61	61	71	72	55	56	61
Continued	2000	2001	2002	2003[1]	2004	2005	2006	2007	2008	
Transmission, Mg*	26	45	23	25	23	36	37	2	4	
Storage, Mg**	25	21	20	19	23	14	18	18	27	
Distribution, Mg***	59	62	57	53	75	59	63	70	42	

Flaring

As shown in Figure 3.5.8 there was a marked increase in the amount of offshore flaring in 1997 and especially in 1999. The increase in 1997 was due to the new Dan field and the completion of the Harald field. The increase in 1999 was due to the opening of the three new fields Halfdan, Siri and Syd Arne.

The time-series for the emission of CO_2 from offshore flaring fluctuates due to the fluctuations in the fuel rate and to a minor degree due to the CO_2 emission factor. The latter rests on gas quality measurements. From 2006 the calorific values for flaring are given at installation level in the EU ETS. This information is incorporated in the inventory for the years 2006-2008. This has lead to an increase of the CO_2 emission factor. The average of the emission factors for 2006-2008 is adopted for 1990-2005. Fuel rate and CO_2 emission are shown in Figure 3.5.8.

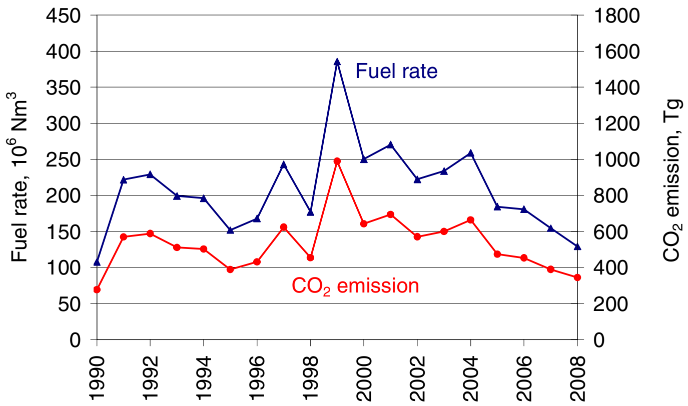


Figure 3.5.8 Fuel rate and CO2 emission from offshore flaring of gas 1990-2008.

The emissions from offshore flaring are estimated from the same emission factors for all years and the variations reflect only the variations in the flared amounts. The only exception is CO_2 where the emission factors from the EU ETS reports are used for 2006-2008. Emissions of selected components are shown in table 3.5.17.

Table 3.5.17 Emissions from flaring offshore and in gas treatment/storage plants.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes
SO_2	2	3	3	3	3	2	2	3	2	5
NO_x	132	272	281	244	240	199	211	303	217	476
NMVOC	11	22	23	20	20	19	19	27	20	41
CO	108	222	229	199	196	160	174	250	183	392
CO_2	276	569	587	510	502	391	432	625	455	991
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes	
SO_2	4	4	3	3	4	3	3	2	2	
NO_x	310	336	277	291	322	231	226	197	165	
NMVOC	28	30	26	27	29	22	21	22	17	
CO	256	277	231	240	266	193	189	170	130	
CO_2	643	700	572	601	666	475	455	394	348	

Besides in the offshore sector flaring also takes place in refineries and gas treatment/storage plants. Flaring in refineries is a significant fugitive emission source for SO_2. In 1990-1993 emissions from petroleum product processing were included in emissions from flaring in refineries (1B2c). From 1994 the data delivery format was changed, which made it possible to split the emissions into contributions from flaring and processing, respectively. Emissions from processing are from 1994 included in 1B2a iv.

The decreasing emissions of SO_2 from 1995 to 1998 are due to technical improvements of the sulphur recovery system at one of the two Danish refineries (Table 3.5.18). The increase in SO_2 from flaring in refineries in 2005 and 2007 was due to planned shutdowns due to inspection and maintenance at one of the two refineries. Further, in 2007 the same refinery had problems with the ATS system leading to an increased SO_2 emission from flaring.

Table 3.5.18 Emissions from flaring in refineries.

	1990*	1991*	1992*	1993*	1994	1995	1996	1997	1998	1999
	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes
SO_2 *	943	926	935	1 190	520	203	218	138	70	50
NO_x	41	41	41	41	230	21	36	18	25	31
NMVOC	34	34	34	34	32	32	32	20	26	25
CO	5	5	5	5	49	49	49	47	60	57
CO_2	23	23	23	23	29	23	23	15	19	18
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes	Tonnes	
SO_2	51	46	68	96	53	296	257	526	380	
NO_x	32	21	39	23	30	26	22	24	30	
NMVOC	26	17	31	19	24	32	31	33	38	
CO	60	39	72	44	56	73	73	77	88	
CO_2	19	13	23	14	18	24	23	25	28	

*In 1990-1993 emissions from petroleum product processing were included in flaring in refineries due to the data delivery form. From 1994 emissions from petroleum product processing were given in 1B2a iv.

3.5.6 Uncertainties and time-series consistency

Two set of uncertainty estimates are made for the Danish emission inventory for greenhouse gases based on Tier 1 and Tier 2 methodology, respectively. The uncertainty models follow the methodology in IPCC

Good Practise Guidance (IPCC, 2000). Tier 1 is based on the simplified uncertainty analysis and Tier 2 is based on Monte Carlo simulations.

Uncertainty estimates are made for total emissions in the base year (only Tier 2), in the latest inventory year and for the emission trend for the corresponding time series. Uncertainty estimates are made for the GHGs separately and summarized.

Input data

The Tier 1 uncertainty model is based on emission data, uncertainty levels for activity data and uncertainty levels for emission factors for base year and latest inventory year. The Tier 2 model is based on activity data and emission factors for the same years and the same uncertainty levels as in Tier 1. Emission data, activity data and emission factors are described in chapter 3.5.3, 3.5.4 and 3.5.5.

The uncertainty levels used in the uncertainty models are based on different sources, e.g. IPCC Good Practice Guidance, EMEP/EEA Guidebook and reports for the EU ETS. Further, a number of the uncertainty levels are given as NERI assumptions in Table 3.5.19 and 3.5.21. NERI assumptions are based on source and/or plant specific uncertainty levels for part of the SNAP category and assumptions for the remaining sources and/or plants in the category.

Input data are aggregated on SNAP level. Estimates are made for the greenhouse gases CO_2, CH_4 and N_2O both separately and summarized (GHG). The Tier 1 uncertainty levels for activity data and emission factors are listed in table 3.5.19. Uncertainty levels are given in percentage related to the 95 % confidence interval assuming a normal distribution.

Table 3.5.19 Uncertainty levels for activity rates and emission factors included in the Tier 1 uncertainty model.

	Activity data uncertainty level, %		Emission factor uncertainty level, %	
CO2_090203	11	N	5	N
CO2_090206	8	I	5	S
CH4_040101	1	I	125	N
CH4_050201	2	I	40	G
CH4_050202	2	N	30	N
CH4_050601	15	N	5	N
CH4_050603	25	N	10	E
CH4_090203	11	N	15	G
CH4_090206	8	E	5	G
N2O_090203	11	E	500	E
N2O_090206	8	E	500	G

N: NERI assumption.

I: IPCC Good Practice Guidance (default value).

S: Statistisk Sentralbyrå, Statistics Norway, 2008.

E: EU Emission Trading Scheme (EU ETS).

G: EMEP/EEA Guidebook, 2009.

The CO_2 emission factors are the most accurate as they are calculated on basis of gas quality analysis. Detailed CO_2 emission factors are available for flaring offshore and in refineries in the reports for EU ETS. For the remaining sources the gas quality for the distributed natural gas in

Denmark are used. The IPCC Good Practice Guidance (IPCC, 2000) suggests that the accuracy for gas composition is usually ±5 %, which is adopted in the Danish emission inventories.

The EMEP/CORINAIR Guidebook (2007) suggests an error of 65 % for the standard equation used to estimate fugitive emissions of VOC from extraction noting that the error could be much higher when the equation is used for other fields than the ones in USA, which it has been based on. It is expected in the EMEP/EEA Guidebook (2009) that it seems to be in reasonable agreement with estimates for Norway and UK. Data from the Danish operators (one year only) indicate that the VOC emissions in the Danish inventory have an uncertainty around 30 %.

The uncertainty level for the emission factor for fugitive CH_4 from refineries is dominated by a large uncertainty for one refinery. Further, measurements of fugitive emissions from the refineries are only available for one and two years, respectively, and these measurements indicate larger emissions than earlier estimates. As more measurements become available the uncertainty level is expected to decrease significantly.

According to IPCC (2000) the emission factor for N_2O is the least reliable. An uncertainty level of 500 % is adopted in the Danish uncertainty model.

The Tier 2 uncertainty model is based on Monte Carlo simulations and the input uncertainty levels are given for one standard deviation corresponding to the 68 % confidence interval assuming a log-normal distribution. The uncertainty levels corresponds to those used in the Tier 1 uncertainty model (table 3.5.19) only recalculated to represent the 68 % confidence interval in stead of the 95 % confidence interval used in the Tier 1 model. Recalculation is carried out as stated in equation 3.5.9.

$$U_{68} = U_{95} / 1.96 \quad \text{(Eq.3.5.9)}$$

Results

The results of the Tier 1 uncertainty model for 2008 are shown in table 3.5.20. In 2008 N_2O has the largest uncertainty for the total emission followed by CH_4 and CO_2. Due to the emission trend CH_4 has the largest uncertainty followed by N_2O and CO_2. The estimated uncertainty for the total GHG emission is 13 % and the GHG emission trend is 47 % ± 20 %-point.

Table 3.5.20 Uncertainty estimates for total emissions and emission trends from the Tier 1 uncertainty model.

	Emission Gg CO_2-eqv	Uncertainty, % Lower and upper (±)	Trend, %	Uncertainty, % Lower and upper (±)
1B2_CO2	376	9	25	13
1B2_CH4	128	47	196	126
1B2_N2O	1	459	10	64
1B2_GHG	505	13	47	20

Table 3.5.21 show the results from the Tier 2 uncertainty model for 1990 and 2008. The overall emission uncertainty in 2008 is -9 %/+16 %. The Tier 2 trend estimate is 40 % -40/52 %-point.

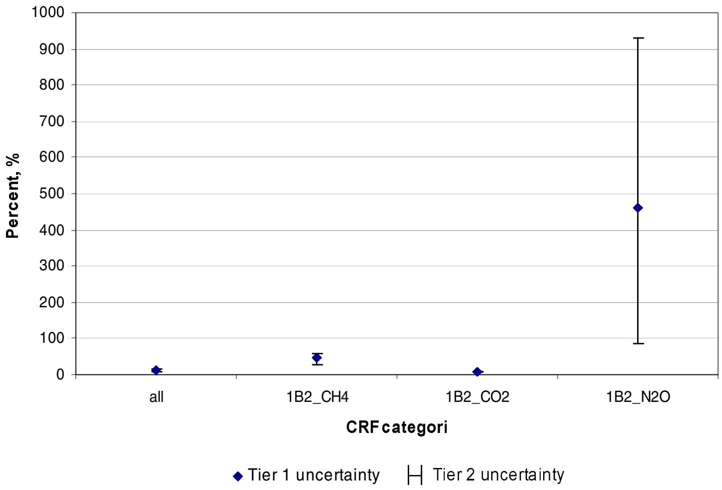
Table 3.5.21 Uncertainty estimates for total emissions in 1990 and 2008 and for the emission trends from the Tier 2 uncertainty model.

	1990			2008			1990-2008		
	Median emission Gg CO_2-eqv	Uncertainty, %		Median emission Gg CO_2-eqv	Uncertainty, %		Median trend, %	Uncertainty, %	
		Lower (-)	Upper (+)		Lower (-)	Upper (+)		Lower (-)	Upper (+)
1B2_CO2	299	15	18	377	8	8	26	27	30
1B2_CH4	44	18	24	130	27	58	92	75	65
1B2_N2O	1	85	757	1	87	929	1	1 150	3 149
1B2_GHG	346	13	15	510	9	16	47	40	52

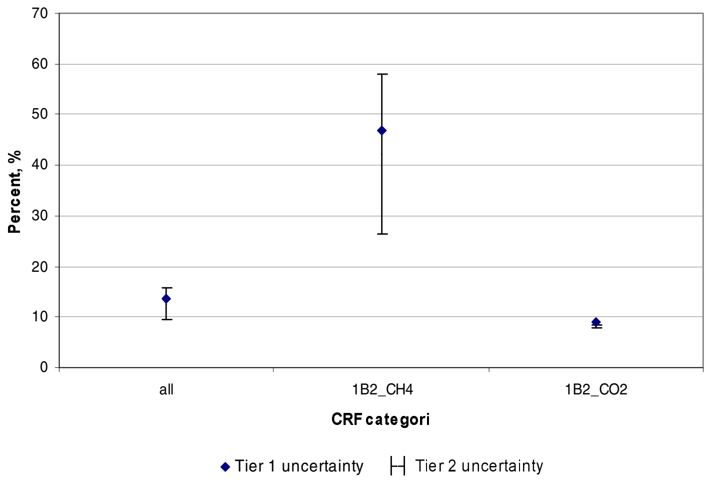
Tier 1 and Tier 2 emission uncertainties are shown together in Figure 3.5.9. It is seen that the uncertainty estimates are in the same range for Tier 1 and Tier 2. The N_2O uncertainty is leaved out in Figure 3.5.9 b as the N_2O uncertainties are much higher than for the other greenhouse gases. It must be noted that the uncertainty models are not suitable for very large uncertainty levels and therefore the uncertainty estimates for N_2O may only be seen as an indicator for a large uncertainties while the values are less accurate.

Figure 3.5.9 Emission uncertainty estimates from the Tier 1 and Tier 2 models; a) GHG, CH_4, CO_2 and N_2O, b) as figure a, but without N_2O.

a)



b)



3.5.7 Source specific QA/QC and verification

The elaboration of a formal QA/QC plan started in 2004 and the first version is available (Sørensen et al., 2005). The plan describes the concepts of quality work and definitions of sufficient quality, critical control points and a list of Points of Measuring, PM (Figure 3.5.9). Please refer to the general chapter on QA/QC.

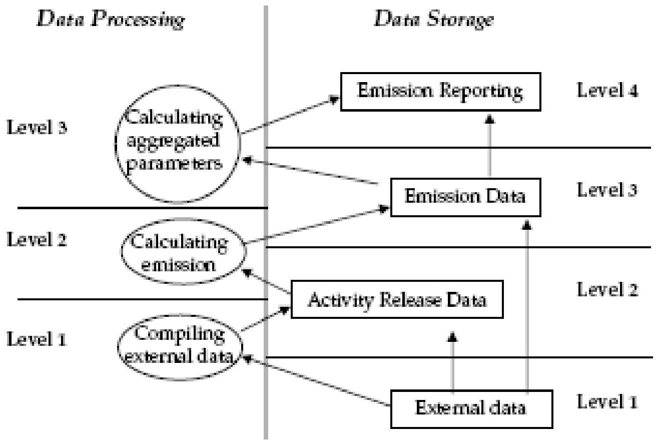


Figure 3.5.9 The general data structure for the Danish emission inventory (Sørensen et al., 2005).

Data storage level 1

Data storage level 1 refers to the data collected by NERI before any processing or preparing. Table 3.5.21 lists the external data deliveries used for the inventory of fugitive emissions. Further the table holds information on the contacts at the data delivery companies.

Table 3.5.23 List of external data sources.

Source	Data description	Activity data, emission factors or emissions	Reference	Contact(s)	Data agreement/ Comment
Offshore extraction	Gas and oil production. Dataset for production of oil, gas and number of platforms. CRF 1B2a	Activity data	The Danish Energy Agency (DEA)	Jan H. Andersen	No formal data agreement.
Offshore flaring	Flaring offshore in oil and gas extraction	Activity data	The Danish Energy Agency	Peter Dal	Data agreement
Service stations	Data on gasoline sales from the Danish energy statistics.	Activity data	The Danish Energy Agency (DEA)	Peter Dal	Data agreement
Gas transmission	Natural gas from the transmission company, sales and losses (meter differences)	Activity data	Energinet.dk	Christian Friberg B. Nielsen	Not necessary due to obligation by law
Environmental report from DONG Energy	Environmental report from DONG Energy. Oil and gas production. The amount of oil loaded onshore and emissions from raw oil tanks. CRF 1B2a	Activity data and emission data	DONG Energy		Not necessary due to obligation by law
Gas distribution	Natural gas from the distribution company, sales and losses (meter differences)	Activity data	Naturgas Fyn, DONG Energy, HNG and MN	Gert Nielsen, Ida Pernille Schou	No formal data agreement.
Air emissions from refinery	Fuel consumption and emission data. CRF 1B2a.	Activity data and emission data	Statoil A/S, A/S Danish Shell	Anette Holst, Lis Rønnow Rasmussen	No formal data agreement.
Storage and treatment of gas	Environmental reports from plants defined as large point sources (Lille Torup, Stenlille, Nybro)	Activity data	Various plants		Not necessary due to obligation by law
CO_2 emission factors for different sources	Reports according to the CO_2 emission trading scheme (ETS)	Activity data	Various plants		Not necessary due to obligation by law
Emission factors	Emission factors origin from a large number of sources	Emission factors	See chapter regarding emission factors		

Data Storage level 1	1. Accuracy	DS.1.1.1	General level of uncertainty for every dataset including the reasoning for the specific values.

The DEA is responsible for the official Danish energy statistics as well as reporting to the IEA. NERI regards the data as being complete and in accordance with the official Danish energy statistics and IEA reporting. The uncertainties connected with estimating fuel consumption do not, therefore, influence the accordance between IEA data, the energy statistics and the dataset on SNAP level utilised by NERI. For the remaining datasets, it is assumed that the level of uncertainty is relatively small, except for the emissions from refineries. For further comments regarding uncertainties, see Chapter 3.5.6.

Data Storage level 1	1. Accuracy	DS.1.1.2	Quantification of the uncertainty level of every single data value including the reasoning for the specific values.

The uncertainty for external data is not quantified. The uncertainties of activity data and emission factors are quantified see Chapter 3.5.6.

Data Storage level 1	2.Comparability	DS.1.2.1	Comparability of the data values with similar data from other countries, which are comparable with Denmark, and evaluation of discrepancy.

Systematic inter-country comparison has only been made on Data Storage Level 4. Refer to DS 4.3.2.

Data Storage level 1	3.Completeness	DS.1.3.1	Documentation showing that all possible national data sources are included, by setting down the reasoning behind the selection of datasets.

External data sources are the Danish Energy Authority and annual environmental reports from plants which are obligated to publish environmental reports. Further, annual reports from the gas companies are used. Some environmental reports and annual reports are supplemented with data and information from the given companies.

Energy statistics
The Danish Energy Authority reports fuel consumption statistics on the SNAP level based on a correspondence table developed in co-operation with NERI. Both traded and non-traded fuels are included in the Danish energy statistics. Data on offshore extraction, offshore flaring and gasoline sales are used for estimation of fugitive emissions.

Environmental reports
A large number of plants are obligated by law to publish an environmental report annually with information on fuel consumption and emissions, among other things. NERI compares data with those from previous years and discrepancies are checked.

Annual reports
The gas distribution companies are not obligated to publish environmental reports. Instead the annual reports and additional data and information are used when available. All information is compared with previous years.

Reports for the European Union Greenhouse Gas Emission Trading System (EU ETS)
CO_2 emission factors for flaring offshore and in refineries are taken from the EU ETS reports since 2006 when the EU ETS reports became available. EU ETS reports are available for the individual Danish oil/gas production fields and for the refineries.

Emission factors from a wide range of sources
For specific references, see chapter regarding emission factors.

Data Storage level 1	4.Consistency	DS.1.4.1	The origin of external data has to be preserved whenever possible without explicit arguments (referring to other PMs)

All external data are stored in the inventory file system and are accessible for all inventory staff members. Data processing is carried out in other spreadsheets or databases so that the data are always available in the original form. Refer to Section 1.3.

Data Storage level 1	6.Robustness	DS.1.6.1	Explicit agreements between the external institution holding the data and NERI about the condition of delivery

Formal agreements are made with the Danish Energy Authority. Most of the other external data sources are available due to legal requirements in this regard. See Table. 3.5.23

Data Storage level 1	7.Transparency	DS.1.7.1	Summary of each dataset including the reasoning for selecting the specific dataset

See DS 1.3.1

Data Storage level 1	7.Transparency	DS.1.7.3	References for citation for any external data set have to be available for any single value in any dataset.

Refer to Table 3.5.23 for general references. The references are available in the inventory file system. Refer to Section 1.3.

Data Storage level 1	7.Transparency	DS.1.7.4	Listing of external contacts for every dataset.

Refer to Table 3.5.23

Data Processing Level 1

Data Processing level 1	1. Accuracy	DP.1.1.1	Uncertainty assessment for every data source as input to Data Storage Level 2 in relation to type of variability (distribution as: normal, log normal or other type of variability)

Refer to Section 1.7 in the Danish NIR and the QA/QC Section 3.5.7.

Data Processing level 1	1. Accuracy	DP.1.1.2	Uncertainty assessment for every data source as input to Data Storage level 2 in relation to scale of variability (size of variation intervals)

The uncertainty assessment of activity data and emission factors are discussed in Section 1.7 concerning uncertainties.

Data Processing level 1	1. Accuracy	DP.1.1.3	Evaluation of the methodological approach using international guidelines

The methodological approach is consistent with international guidelines and described in Section 3.5.2.

Data Processing level 1	1. Accuracy	DP.1.1.4	Verification of calculation results using guideline values.

This PM has only been carried out for some of the sources, but will be completed for the key categories.

Data Processing level 1	2.Comparability	DP.1.2.1	The inventory calculation has to follow the international guidelines suggested by UNFCCC and IPCC.

The calculations follow the principles in international guidelines.

Data Processing level 1	3.Completeness	DP.1.3.1	Assessment of the most important quantitative knowledge which is lacking.

Regarding the emissions from refineries and gas distribution, more detailed data material would be preferred. Further, more detailed data on emissions from exploration of oil and gas would be preferred.

Data Processing level 1	3.Completeness	DP.1.3.2	Assessment of the most important cases where access is lacking with regard to critical data sources that could improve quantitative knowledge.

No accessibility to critical data sources is lacking.

Data Processing level 1	4.Consistency	DP.1.4.1	In order to keep consistency at a high level, an explicit description of the activities needs to accompany any change in the calculation procedure.

A change in calculating procedure would entail that an updated description would be elaborated.

Data Processing level 1	5.Correctness	DP.1.5.1	Show at least once, by independent calculation, the correctness of every data manipulation.

During data processing it is checked that calculations are performed correctly. Documentation needs to be elaborated, however.

Data Processing level 1	5.Correctness	DP.1.5.2	Verification of calculation results using time-series.

A time-series for activity data on SNAP level as well as emission factors is used to identify possible errors in the calculation procedure.

Data Processing level 1	5.Correctness	DP.1.5.3	Verification of calculation results using other measures.

This PM has only been carried out for some of the sources.

Data Processing level 1	5.Correctness	DP.1.5.4	Shows one-to-one correctness between external data sources and the databases at Data Storage level 2.

There is a direct line between the external datasets, the calculation process and the input data used on Data Storage level 2. During the calculation process, numerous controls are in place to ensure correctness, e.g. sum checks of the various stages in the calculation procedure.

Data Processing level 1	7.Transparency	DP.1.7.1	The calculation principle and equations used must be described.
Data Processing level 1	7.Transparency	DP.1.7.2	The theoretical reasoning for all methods must be described.
Data Processing level 1	7.Transparency	DP.1.7.3	Explicit listing of assumptions behind all methods.

Where appropriate this is included in the NIR in chapter 3.5.

Data Processing level 1	7.Transparency	DP.1.7.4	Clear reference to data set at Data Storage level 1.

References to external data sets are in most cases incorporated in the data storage and calculation systems. References will be worked out for the remaining sources.

Data Processing level 1	7.Transparency	DP.1.7.5	A manual log to collect information on recalculations.

At present, a manual log table is not in place on this level. However, this feature will be implemented in the future. A manual log table is incorporated in the national emissions database, Data Storage level 2.

Data storage level 2

Data Storage level 2	5.Correctness	DS.2.5.1	Documentation of a correct connection between all data types at level 2 to data at level 1

To ensure a correct connection between data on level 2 to data on level 1, different controls are in place, e.g. control of sums and random tests.

Data Storage level 2	5.Correctness	DS.2.5.2	Check if a correct data import to level 2 has been made.

Data import is checked by use of sum control and random testing. The same procedure is applied every year in order to minimise the risk of data import errors.

Other QC procedures

A list of QA/QC tasks are performed directly in relation to the fugitive emission part of the Danish emission inventories. The following procedures are carried out to ensure the data quality:

- Checking of time-series in the IPCC and SNAP source categories. Considerable changes are controlled and explained.
- Comparison with the inventory of the previous year. Any major changes are verified.
- Total emission, when aggregated to IPCC and LRTAP reporting tables, is compared with totals based on SNAP source categories (control of data transfer).
- A manual log table in the emission databases is applied to collect information about recalculations.

- The emission from the large point sources (refineries, gas treatment and storage plants) are compared with the emission reported the previous year.
- Some automated checks have been prepared for the emission databases:
  - Check of units for fuel rate, emission factor and plant-specific emissions.
  - Check of emission factors for large point sources. Emission factors for pollutants that are not plant-specific should be the same as those defined for area sources.
  - Additional checks on database consistency.
- Most emission factor references are now incorporated in the emission database, itself.
- Most data sources are implemented in the fugitive emission model.
- Annual environmental reports are kept for subsequent control of plant-specific emission data.

The QC work will continue in future years.

3.5.8 Recalculations

In the emission inventory for 2008 there have been some recalculations as listed below.

Service stations: The amounts of gasoline sales used for calculation of fugitive emissions from service stations (SNAP 050503) have been updated according to the Energy Statistics for 2008 1983-2007. The emission factors for NMVOC from service stations have been updated for both reloading of tankers and refuelling of vehicles for the years 2000-2008.

Oil exploration, production and transport: This year the data storage Level 2 has been improved for 1B2a (SNAP 050201 – Land-based activities and SNAP 050202 – offshore activities). Data at SNAP-level have been split into two sources for each snap category; "Oil loading and transport", and "Pipelines" for land-based activities (SNAP 050201) and Extraction of oil and natural gas" and "Oil loading and transport" for offshore activities. Thereby the implied emission factors now refer to the sources separately instead of referring to a mix of sources. Implied emission factors for the four sources are calculated on basis of the same activity data; Mg crude oil produced. This does not change the emissions but only the activity data and the implied emission factors in the CRF tables.

Gas distribution: Emissions from distribution of town gas have been included in the emission inventory for the years 1985-2008. The input data are sparse as more of the distribution companies have been closed down. Only in the cities of Copenhagen and Aalborg town gas is still being distributed. Another two distribution companies are included in the inventory. Those were closed in 2004 and 2006, respectively. To complete the time-series interpolation and extrapolation has been used on basis of the available data. The uncertainties are expected to be large both regarding the distribution for years without data, the distribution loss and the gas composition.

Offshore flaring: The amounts of offshore flaring for the time-series have been reviewed and some changes have been carried out. As the calorific values and gas composition is not known for years before 2006 the emission calculations are changed so that they are now based on the flared amounts given in Nm3 instead of GJ as used in earlier year's emission calculations. The emission factors are still based on the EMEP/EEA guidebook, but contrary to earlier years the emission factors are not converted according to the gas quality data for Danish natural gas, which has been the best obtainable conversion factor. For SO_2 the TIER 1 emission factor for stationary combustion from the EMEP/EEA guidebook (2009) is used. As this factor is given pr energy units it has to be converted to emissions pr volume gas. This conversion is based on the average calorific value of the gas flared offshore in 2006-2008 which again is based on data from the ETS reports. For the components SO_2, NO_x, CO and N_2O the same emission factors are adopted for flaring in storage and treatment plants as for offshore flaring. The CO_2 emission is calculated using the emission factor for natural gas given by Energinet.dk.

Flaring at refineries: The emission factors for flaring in refineries have been updated. The emission factors for NMVOC and CH_4 are based on new information on the fuel gas composition from one of the two Danish refineries. The same emission factors are adopted for the second Danish refinery. Emission factors from the EMEP/EEA guidebook (2009) are used to calculate emissions of NO_x, CO and N_2O. CO_2 emission factors are based on data from the ETS reports for 2006-2008 and the calorific values for fuel gas for one refinery. For SO_2 the TIER 1 emission factors for stationary combustion from the EMEP/EEA guidebook (2009) are used.

3.5.9 Source-specific planned improvements

The following future improvements are suggested.

- **Emissions from storage of fuels in tank facilities:** The recent edition of the Danish emission inventory holds emissions from extraction of fuels, combustion of fuels and from service stations. To make the inventory complete emissions from storage of fuels in tank facilities should be included in the future if data is available. Work is going on to locate greater tank facilities in Denmark and collect the available data. In cases where no emission estimates or measurements are available a set of emission factors have to be set up.
- **Emissions from offshore extraction of oil and gas:** The fugitive emissions from extraction of oil and gas are based on a standard formula. If better estimates become available those will be implemented.

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4 Industrial processes (CRF sector 2)

4.1 Overview of the sector

The aim of this chapter is to present industrial emissions of greenhouse gases, not related to generation of energy. An overview of the sources identified is presented in Table 4.1 with an indication of the contribution to the industrial part of the emission of greenhouse gases in 2008. The emissions are extracted from the CRF tables.

Table 4.1 Overview of industrial greenhouse gas sources (2008).

Process	IPCC Code	Substance	Emission ktonneCO_2-eq.	%
Cement	2A		1 155	51.2
Refrigeration	2F	HFCs+PFCs	739	32.8
Foam blowing	2F	HFCs	103	4.55
Lime	2A		65.6	2.91
Limestone and dolomite use	2A		38.7	1.71
Other (lubricants)	2G		34.0	1.51
Other (yellow bricks)	2A		28.4	1.26
Aerosols / Metered dose inhalers	2F	HFCs	18.6	0.82
Electrical equipment	2F	SF_6	16.2	0.72
Other (expanded clay products)	2A		16.1	0.71
Other (laboratories, double glaze windows)	2F	SF_6	15.4	0.68
Other (container glass, glass wool)	2A		15.1	0.67
Other (fibre optics)	2F	HFCs+PFCs	5.15	0.23
Food and Drink	2D		2.67	0.12
Catalysts / fertilisers	2B		2.40	0.11
Road paving	2A		1.92	0.085
Asphalt roofing	2A		0.024	0.0011
Metal production	2C		0	0
Nitric acid	2B	N_2O	0	0
Total			2 257	100

The subsectors *Mineral products* (2A) constitutes 59 %, *Chemical industry* (2B) constitutes below 1 %, *Metal production* (2C) constitutes 0 %, *Consumption of halocarbons and SF_6* (2F) constitutes 40 %, *Other, Food and Drink* (2D), and *Other, Lubricants* (2G) constitutes 1.5 % of the industrial emission of greenhouse gases. The total emission of greenhouse gases (excl. LUCF) in Denmark is estimated to 63.9 Mt CO_2-eq., of which industrial processes contribute with 2.27 Mt CO_2-eq. (3.5 %). The emission of greenhouse gases from industrial processes from 1990-2008 are presented in Figure 4.1.

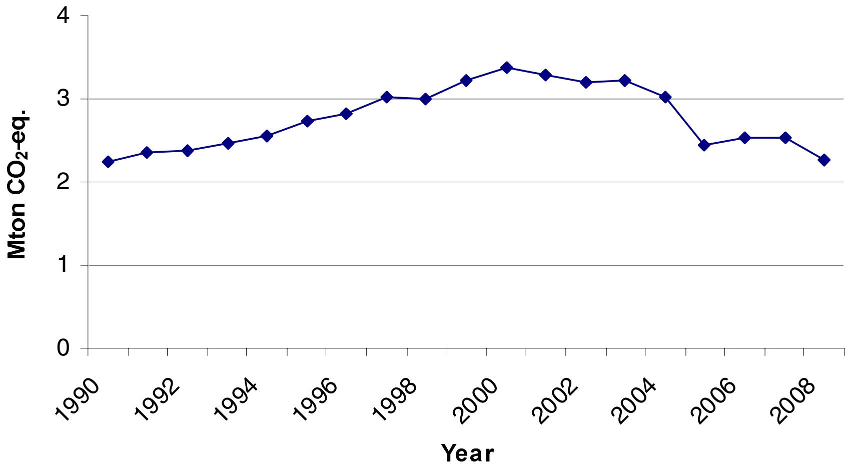

Figure 4.1 Emission of greenhouse gases from industrial processes (CRF Sector 2) from 1990-2008.

The key categories in the industrial sector constitute 2.1 and 1.1 % of the total emission of greenhouse gases. The trends in greenhouse gases from the industrial sector/subsectors are presented in Table 4.2 and they will be discussed subsector by subsector below. The emissions are extracted from the CRF tables.

Table 4.2 Emission of greenhouse gases from industrial processes in different subsectors from 1990-2007.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
CO_2 (kt CO_2)										
A. Mineral Products	1 069	1 246	1 366	1 383	1 406	1 405	1 512	1 681	1 615	1 595
B. Chemical Industry	0.80	0.80	0.80	0.80	0.80	0.80	1.45	0.87	0.56	0.58
C. Metal Production	28.4	28.4	28.4	31.0	33.5	38.6	35.2	35.0	42.2	43.0
D. Food and Drink	4.45	4.49	4.14	4.26	4.36	3.91	3.80	4.29	4.90	4.71
G. Other	49.7	48.9	48.1	47.6	46.9	48.8	48.9	47.1	44.9	42.7
Total	1 152	1 329	1 447	1 466	1 492	1 497	1 601	1 768	1 708	1 686
CH_4	-	-	-	-	-	-	-	-	-	-
N_2O (kt N_2O)										
B. Chemical Industry	3.36	3.08	2.72	2.56	2.60	2.92	2.69	2.74	2.60	3.07
HFCs (kt CO_2 eq.)										
F. Consumption of Halocarbons and SF_6	-	-	3.44	93.9	135	218	329	324	411	504
PFCs (kt CO_2 eq.)										
F. Consumption of Halocarbons and SF_6	-	-	-	-	0.053	0.50	1.66	4.12	9.10	12.5
SF_6 (kt CO_2 eq.)										
F. Consumption of Halocarbons and SF_6	44.5	63.5	89.2	101	122	107	61.0	73.1	59.4	65.4

Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008
CO_2 (kt CO_2)									
A. Mineral Products	1 616	1 612	1 656	1 527	1 644	1 544	1 607	1 606	1 320
B. Chemical Industry	0.65	0.83	0.55	1.05	3.01	3.01	2.18	2.16	2.40
C. Metal Production	40.7	46.7	NA,NO	NA,NO	NA,NO	15.6	NA,NO	NA,NO	NA,NO
Food and Drink	3.90	4.95	4.47	4.49	3.97	4.46	2.17	1.72	2.67
G. Other	39.7	38.5	39.9	37.0	37.7	37.6	37.5	37.9	34.0
Total	1 701	1 703	1 701	1 569	1 688	1 604	1 649	1 647	1 360
CH_4									
N_2O (kt N_2O)									
B. Chemical Industry	3.24	2.86	2.50	2.89	1.71	0.00	0.00	0.00	0.00
HFCs (kt CO_2 eq.)									
F. Consumption of Halocarbons and SF_6	607	650	676	701	755	802	823	850	853
PFCs (kt CO_2 eq.)									
F. Consumption of Halocarbons and SF_6	17.9	22.1	22.2	19.3	15.9	13.9	15.7	15.4	12.8
SF_6 (kt CO_2 eq.)									
F. Consumption of Halocarbons and SF_6	59.2	30.4	25.0	31.4	33.1	21.8	36.0	30.3	31.6

A number of improvements have been planned and are in progress, e.g. inclusion of iron foundries.

4.2 Mineral products (2A)

4.2.1 Source category description

The subsector *Mineral products* (2A) cover the following processes:

- Production of cement.
- Production of lime (quicklime).
- Production of bricks, tiles and expanded clay products.
- Limestone and dolomite use.
- Roof covering with asphalt materials.
- Road paving with asphalt.
- Production of container glass/glass wool.

Production of cement is identified as a key category; see *Annex 1: Key Category Analyses*.

The time-series for the emission of CO_2 from *Mineral products* (2A) are presented in Table 4.3. The emissions are extracted from the CRF tables and the values are rounded.

Table 4.3 Time-series for emission of CO_2 (kt) from Mineral products (2A).

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1. Production of Cement	882	1 088	1 192	1 206	1 192	1 204	1 282	1 441	1 390	1 355
2. Production of Lime	116	82.7	95.0	93.2	96.1	87.7	82.0	87.4	74.4	78.9
3. Limestone and dolomite use	13.7	23.2	25.2	32.6	53.1	53.7	85.5	85.3	86.3	94.5
5. Asphalt roofing	0.019	0.014	0.012	0.018	0.021	0.020	0.024	0.019	0.026	0.026
6. Road paving	1.76	1.76	1.79	1.81	1.75	1.77	1.77	1.77	1.70	1.75
7. Other										
Glass and Glass wool	17.4	15.6	14.5	14.1	14.9	14.1	13.9	14.0	15.0	18.1
Yellow Bricks	23.0	23.0	24.0	22.0	30.8	28.7	29.8	33.1	33.4	32.0
Expanded Clay	14.9	12.1	12.7	13.0	17.3	15.3	16.6	18.3	14.6	14.8
Total	1 069	1 246	1 366	1 383	1 406	1 405	1 512	1 681	1 615	1 595
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
1. Production of Cement	1 385	1 388	1 416	1 330	1 459	1 363	1 395	1 407	1 155	
2. Production of Lime	76.7	80.7	103	75.1	67.9	63.5	69.2	66.9	65.6	
3. Limestone and dolomite use	89.7	87.2	80.9	70.0	60.2	56.2	71.7	49.6	38.7	
5. Asphalt roofing	0.032	0.025	0.017	0.018	0.020	0.024	0.024	0.025	0.024	
6. Road paving	1.72	1.66	1.66	1.67	1.85	1.84	1.84	2.00	1.92	
7. Other										
Glass and Glass wool	15.9	16.0	16.3	13.5	13.3	12.6	13.5	15.0	15.1	
Yellow Bricks	32.8	27.8	27.0	27.0	28.9	32.2	34.8	38.0	28.4	
Expanded Clay	14.2	10.5	10.8	9.53	12.7	14.0	20.9	26.9	16.1	
Total	1 616	1 612	1 656	1 527	1 644	1 544	1 607	1 606	1 320	

The increase in CO_2 emission is most significant for the production of cement. From 1990 to 2008, the CO_2 emission increased from 882 to 1 155 kt CO_2, i.e. by 31 %. The maximum emission occurred in 2004 and constituted 1 459 kt CO_2; see Figure 4.2.

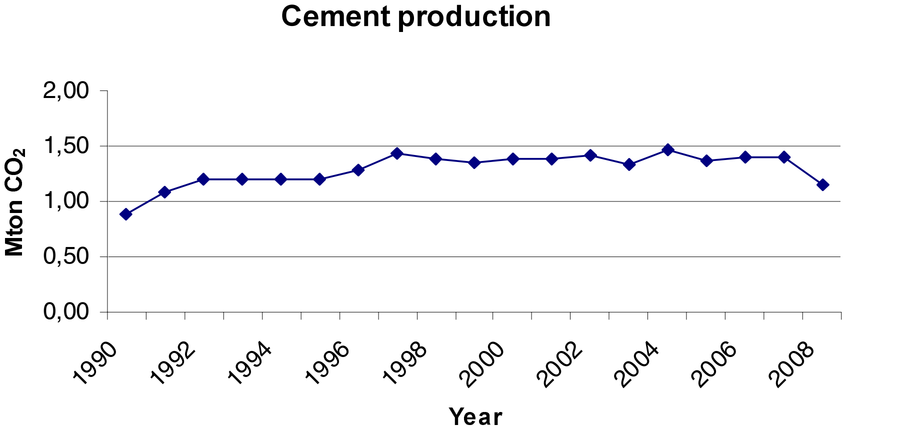

Figure 4.2 Emission of CO_2 from cement production.

The increase can be explained by the increase in the annual cement production. The emission factor has only changed slightly as the distribution between types of cement especially grey/white cement has been almost constant from 1990-1997.

4.2.2 Methodological issues

General

The CO_2 emission from the production of cement has been estimated from the annual production of cement expressed as TCE (total cement equivalents[15]) and an emission factor estimated by the company (Aalborg Portland, 2009a; 2009b; 2008c). The emission factor has been estimated from the loss of ignition determined for the different kinds of clinkers produced, combined with the volumes of grey and white cements produced. Determination of loss of ignition takes into account all the potential raw materials leading to release of CO_2 and omits the Ca-sources leading to generation of CaO in cement clinker without CO_2 release. The applied methodology is in accordance with EU guidelines in calculation of CO_2 emissions (Aalborg Portland, 2008c). However, from the year 2005 the CO_2 emission compiled by Aalborg Portland for EU-ETS is used in the inventory (Aalborg Portland, 2009a). Activity data and emission factors for cement production are presented in Table 4.4.

[15] TCE (total cement equivalent) expresses the total amount of cement produced for sale and the theoretical amount of cement from the amount of clinkers produced for sale.

Table 4.4 Activity data, emission factors, and CO_2 emission for cement production.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Tonnes TCE	1 619 976	1 998 674	2 214 104	2 244 329	2 242 409	2 273 775	2 418 988	2 718 923	2 754 405	2 559 575
Tonnes clinker	NI	NI	NI	NI	NI	NI	NI	NI	2 462 249	2 387 282
Tonnes clinker + white cement[1]	1 406 212	1 811 958	2 089 393	2 117 895	2 192 402	2 353 123	2 481 792	2 486 475	-	-
EF tonnes CO_2 pr tonnes TCE[2]	0.545	0.544	0.539	0.537	0.532	0.529	0.530	0.530	0.505	-
EF tonnes CO_2 pr tonnes TCE[3]	-	-	-	-	-	-	-	-	0.505	0.529
EF tonnes CO_2 pr tonnes TCE[4]	-	-	-	-	-	-	-	-	-	-
EF tonnes CO_2 pr tonnes clinker[5]	*0.628*	*0.600*	*0.571*	*0.569*	*0.544*	*0.512*	*0.517*	*0.580*	0.564	0.568
Tonnes CO_2	882 402	1 087 816	1 192 336	1 206 093	1 192 196	1 203 777	1 282 064	1 441 029	1 390 975	1 354 015

Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008
Tonnes TCE	2 612 721	2 660 972	2 698 459	2 546 295	2 861 471	2 706 371	2 842 282	2 946 294	2 551 346
Tonnes clinker	2 452 394	2 486 146	2 508 415	2 363 610	2 611 617	2 520 788	2 632 112	2 706 048	2 269 687
Tonnes clinker + white cement[1]	-	-	-	-	-	-	-	-	-
EF tonnes CO_2 pr tonnes TCE[2]	-	-	-	-	-	-	-	-	-
EF tonnes CO_2 pr tonnes TCE[3]	0.530	0.517	0.529	0.532	0.510	-	-	-	-
EF tonnes CO_2 pr tonnes TCE[4]	-	-	-	-	-	0.504	0.491	0.478	-
EF tonnes CO_2 pr tonnes clinker[5]	0.565	0.553	0.569	0.573	0.559	0.541	0.530	0.520	0.509
Tonnes CO_2	1 384 742	1 375 723	1 427 485	1 354 629	1 459 350	1 363 000	1 395 466	1 408 329	1 154 749

1. 1990-1997: Amount of clinker produced has not been measured as from 1998-2008. Therefore, the amount of GLK-, FHK-, SKL-/RKL-clinker and white cement is used as estimate of total clinker production.
2. 1990-1997: EF based on information provided by Aalborg Portland.
3. 1998-2004: EF based on information provided by Aalborg Portland (Aalborg Portland, 2008c).
4. 2005-2008: EF based on emissions reported to EU-ETS (Aalborg Portland, 2009a).
5. 1998-2008: EF based on clinker production statistics provided by Aalborg Portland (Aalborg Portland, 2009, 2010).

NI No information.

The EF depends on the ratio: white/grey cement and the ratio between three types of clinker for grey cement: GKL-clinker/FHK-clinker/SKL-RKL-clinker. The ratio white/grey cement is known from 1990-1997 with maximum in 1990 and thereafter decreasing. The ratio: GKL-clinker/FHK-clinker/SKL-RKL-clinker is known from 1990-1997. The individual EF for the different clinker types are respectively: 0,477, 0,459, and 0,610 ton CO_2 pr ton. Production of SKL/RKL-clinker peaks in 1991 and decrease hereafter. FKH-clinker is introduced in 1992 and increase to 35% in 1997.

When estimating the activity for 1990-1997 the amount of white cement is summed with the amount of clinker for grey cement as an estimate for total clinker prodduction. Information on the total production of clinker from 1998-2008 has been provided by the company recently (Aalborg Portland 2008c, 2009a, 2009b).

The company has at the same time stated that data until 1997 can not be improved as they are not available anymore.

The CO_2 emission from the production of burnt lime (quicklime) as well as hydrated lime (slaked lime) has been estimated from the annual production figures, registered by Statistics Denmark – see Table 4.5 and emission factors.

Table 4.5 Statistics for production of lime and slaked lime (tonnes) (Statistics Denmark, 2008).

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Lime	127 978	86 222	104 526	106 587	112 480	100 789	95 028	102 587	88 922	95 177
Slaked lime	27 686	27 561	23 821	17 559	14 233	15 804	13 600	12 542	8 445	7 654
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
Lime	92 002	96 486	122 641	87 549	77 844	71 239	78 652	75 504	74 981	
Slaked lime	8 159	9 012	12 006	11 721	12 532	13 839	13 731	14 028	12 326	

The emission factors applied are 0.785 kg CO_2 pr kg CaO as recommended by IPCC (IPCC, 1997, vol. 3, p. 2.8) and 0.541 kg CO_2 pr kg hydrated lime (calculated from company information on composition of hydrated lime (Faxe Kalk, 2003)).

The CO_2 emission from the production of bricks and tiles has been estimated from information on annual production registered by Statistics Denmark, corrected for amount of yellow bricks and tiles. This amount is unknown and, therefore, is assumed to be 50 %; see Table 4.6.

Table 4.6 Statistics for production of yellow bricks and expanded clay products (tonnes) (Statistics Denmark, 2007).

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Yellow bricks	291 348	291 497	303 629	278 534	389 803	362 711	377 652	419 431	423 254	405 241
Expanded clay products	331 760	268 871	282 920	288 310	383 768	340 881	368 080	406 716	324 413	329 393
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
Yellow bricks	414 791	351 955	342 179	341 981	365 388	407 940	465 504	348 928	322 137	
Expanded clay products	316 174	232 289	239 664	211 794	281 828	310 901	411 869	504 925	303 948	

The content of $CaCO_3$ and a number of other factors determine the colour of bricks and tiles and, in the present estimate, the average content of $CaCO_3$ in clay has been assumed to be 18 %. The emission factor lime (0.44 kg CO_2 pr kg $CaCO_3$) has been used to calculate the emission factor for yellow bricks: 0.079 tonne CO_2 pr tonne yellow bricks.

For verification of this approach see Figure 4.3. For 2006-2008 emission factors have been derived from CO_2 emissions reported by the brickworks to EU-ETS (confidential reports from approximately 20 brickworks) and production statistics (Statistics Denmark, 2009). The emission factors are calculated to 0.0747-0.0881 tonne CO_2 pr tonne yellow bricks.

The CO_2 emission from the production of container glass/glass wool has been estimated from production statistics published in environmental reports from the producers (Rexam Glass Holmegaard, 2007; Ardagh Glass Holmegaard, 2009; Saint-Gobain Isover, 2009) and emission factors based on release of CO_2 from specific raw materials (stoichiometric determination).

The CO_2 emission from consumption of limestone for flue gas cleaning has been estimated from statistics on generation of gypsum (wet flue gas cleaning processes) and the stoichiometric relations between gypsum and release of CO_2:

SO_2 (g) + ½O_2 (g) + $CaCO_3$ (s) + 2H_2O → $CaSO_4$,2H_2O (s) + CO_2 (g)

and the emission factor is: 0.2325 tonnes CO_2 pr tonne gypsum.

Statistics on the generation of gypsum from power plants are compiled by Energinet.dk (2008). However, for 2006 - 2008 information on consumption of $CaCO_3$ at the relevant power plants has been compiled (from environmental reports) and used in the calculation of CO_2-emission from flue gas cleaning.

Information on the generation of gypsum at waste incineration plants does not explicitly appear in the Danish waste statistics (Miljøstyrelsen, 2010). However, the total amount of waste products generated can be found in the statistics. The amount of gypsum is calculated by using information on flue gas cleaning systems at Danish waste incineration plants (Illerup et al., 1999; Nielsen & Illerup, 2002) and waste generation from the different flue gas cleaning systems (Hjelmar & Hansen, 2002).

The CO_2 emission from the production of expanded clay products has been estimated from production statistics compiled by Statistics Denmark and an emission factor of 0.045 tonne CO_2 pr tonne product. For 2006-2008 emission factors have been derived from CO_2 emissions reported to EU-ETS (Damolin, 2009; Maxit, 2009) and production statistics (Statistics Denmark, 2009). The emission factors are calculated to 0.0507 and 0.0529 tonne CO_2 pr tonne product.

The indirect emission of CO_2 from asphalt roofing and road paving has been estimated from production statistics compiled by Statistics Denmark and default emission factors presented by IPCC (1997) and EMEP/CORINAIR (2004). The default emission factors, together with the calculated emission factor for CO_2, are presented in Table 4.7.

Table 4.7 Default emission factors for application of asphalt products.

		Road paving with asphalt	Use of cutback asphalt	Asphalt roofing
CH_4	g pr tonnes	5	0	0
CO	g pr tonnes	75	0	10
NMVOC	g pr tonnes	15	64 935	80
Carbon content fraction of NMVOC	%	0.667	0.667	0.8
Indirect CO_2	Kg pr tonnes	0.168	159	0.250

EU-ETS (EU Emission Trading Scheme)

Guidelines for calculating company specific CO_2 emissions are developed by EU (EU, 2007). The guidelines present standard methods for minor companies and methods for developing individual plans for major companies. The standard methods include default emission factors similar to the default emission factors presented by IPCC (e.g. for limestone), whereas, the major companies has to use individual methods to determine the actual composition of raw materials (e.g. purity of limestone or Ca pr Mg ratio in dolomite) or the actual CO_2 emission from the specific process.

4.2.3 Uncertainties and time-series consistency

The time-series are presented in Table 4.4. The methodology applied for the years 1990-2008 is considered to be consistent as the emission factor has been determined by the same approach for all years. The emission factor has only changed slightly as the distribution between types of cement, especially grey/white cement, has been almost constant from 1990-1997. Furthermore, the activity data originates from the same company for all years.

For the production of lime and bricks, as well as container glass and glass wool, the same methodology has also been applied for all years. The emission factors are based either on stoichiometric relations or on a standard assumption of $CaCO_3$-content of clay used for bricks. The source for the activity data is, for all years, Statistics Denmark.

The source-specific uncertainties for mineral products are presented in Section 4.9. The overall uncertainty estimate is presented in Chapter 1.7.

4.2.4 Verification

The estimation of CO_2 release from the production of bricks based on an assumption of 50 % yellow bricks has been verified by comparing the estimate with actual information on emission of CO_2 from calcination of lime compiled by the Danish Energy Authority (DEA) (DEA, 2004). The information from the companies (tile-/brickworks; based on measurements of $CaCO_3$ content of raw material) has been compiled by DEA in order to allocate a CO_2 quota to Danish companies with the purpose of future reductions. The result of the comparison is presented in Figure 4.3.

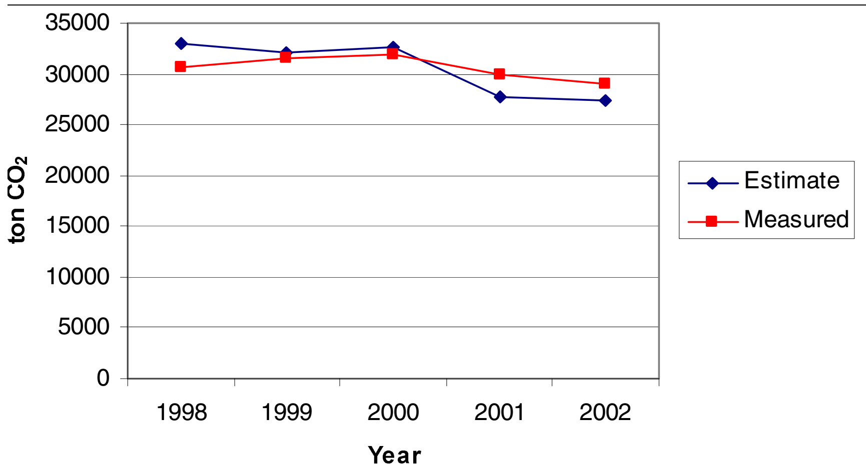

Figure 4.3 Estimated and "measured" CO_2 emission from tile-/brickworks; "measured" means information provided to the Danish Energy Authority by the individual companies (DEA, 2004).

Figure 4.3 shows a reasonable correlation between the estimated and measured CO_2 emission.

4.2.5 Recalculations

The emission of CO_2 from production of cement has been revised for the years 1998-2005 based on new information from the company; see Table 4.4.

For yellow bricks and expanded clay products the CO_2 emission has been adapted from the company reports to EU-ETS as the emission factors calculated previously and used until 2005 were found not to be in line with the actual emission.

4.2.6 Source-specific planned improvements

Production statistics for glass and glass wool as well as information on consumption of raw materials will be completed for 1990-1995.

4.3 Chemical industry (2B)

4.3.1 Source category description

The subsector *Chemical industry* (2B) covers the following processes:

- Production of nitric acid/fertiliser.
- Production of catalysts/fertilisers.

Production of nitric acid is identified as a key category.

The time-series for emission of CO_2 and N_2O from *Chemical industry* (2B) are presented in Table 4.8.

Table 4.8 Time-series for emission of greenhouse gasses from Chemical industry (2B).

2B	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
2. Nitric acid production (kt N_2O)	3.36	3.08	2.72	2.56	2.60	2.92	2.69	2.74	2.60	3.07
2. Nitric acid production (kt CO_2 eq.)	1 043	955	844	795	807	904	834	848	807	950
5. Other (kt CO_2)	0.80	0.80	0.80	0.80	0.80	0.80	1.45	0.87	0.56	0.58
Total (kt CO_2 eq.)	1 044	956	844	796	807	905	836	849	807	951
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
2. Nitric acid production (kt N_2O)	3.24	2.86	2.50	2.89	1.71	0	0	0	0	
2. Nitric acid production (kt CO_2 eq.)	1 004	885	774	895	531	0	0	0	0	
5. Other (kt CO_2)	0.65	0.83	0.55	1.05	3.01	3.01	2.18	2.16	2.40	
Total (kt CO_2 eq.)	1 004	886	775	896	534	3.01	2.18	2.16	2.40	

The emissions are extracted from the CRF tables and the values are rounded.

The emission of N_2O from nitric acid production is the most considerable source of GHG from the chemical industry. The trend for N_2O from 1990 to 2003 shows a decrease from 3.36 to 2.89 kt, i.e. -14 %, and a 40 % decrease from 2003 to 2004. However, the activity and the corresponding emission show considerable fluctuations in the period considered and the decrease from 2003 to 2004 can be explained by the closing of the plant in the middle of 2004.

From 1990 to 2008, the emission of CO_2 from the production of catalysts/fertilisers has increased from 0.80 to 2.40 kt with maximum in

2004-5, due to an increase in the activity as well as changes in raw material consumption.

4.3.2 Methodological issues

The N_2O emission from the production of nitric acid/fertiliser is based on measurement for 2002. For the previous years, the N_2O emission has been estimated from annual production statistics from the company and an emission factor of 7.5 kg N_2O pr tonne nitric acid, based on the 2002 emission measured (Kemira Growhow, 2004). The production of nitric acid ceased in the middle of 2004.

The CO_2 emission from the production of catalysts/fertilisers is based on information in an environmental report from the company (Haldor Topsøe, 2009), combined with personal contacts. In the environmental report, the company has estimated the amount of CO_2 from the process and the amount from energy conversion. Based on information from the company, the emission of CO_2 has been calculated from the composition of raw materials used in the production (for the years 1990 and 1996-2004) and for 2006 to 2008 assumed to be the same as in 2004 based on the same activity (produced amount). For the years 1991-1995, the production, as well as the CO_2 emission, has been assumed to remain the same as in 1990.

4.3.3 Uncertainties and time-series consistency

The time-series are presented in Table 4.8. The applied methodology regarding N_2O is considered to be consistent. The activity data is based on information from the specific company. The emission factor applied has been constant from 1990 to 2001 and is based on measurements in 2002. The production equipment has not been changed during the period.

The estimated CO_2 emissions are considered to be consistent as they are based on stoichiometric relations combined with company assumptions for the years 1991-1995.

The source-specific uncertainties for the chemical industry are presented in Section 4.9. The overall uncertainty estimate is presented in Chapter 1.7..

4.3.4 Recalculations

No source-specific recalculations have been performed regarding emissions from the chemical industry.

4.3.5 Source-specific planned improvements

No improvements are planned for this sector.

4.4 Metal production (2C)

4.4.1 Source category description

The subsector *Metal production* (2C) covers the following process:

- Steelwork

The time-series for emission of CO_2 from *Metal production* (2C) is presented in Table 4.9. The emissions are extracted from the CRF tables and the values presented are rounded.

Table 4.9 Time-series for emission of CO_2 (kt) from Metal production (2C).

2C	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1. Iron and steel production	28.4	28.4	28.4	31.0	33.5	38.6	35.2	35.0	42.2	43.0
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
1. Iron and steel production	40.7	46.7	NE,NO	NE,NO	NE,NO	15.6	NE,NO	NE,NO	NE,NO	

From 1990 to 2001, the CO_2 emission from the electro-steelwork has increased from 28 to 47 kt, i.e. by 68 %. The increase in CO_2 emission is similar to the increase in the activity as the consumption of metallurgical coke pr amount of steel sheets and bars produced has almost been constant during the period. The electro-steelwork reopened and closed down again in 2005.

4.4.2 Methodological issues

The CO_2 emission from the consumption of metallurgical coke at steelworks has been estimated from the annual production of steel sheets and steel bars combined with the consumption of metallurgical coke pr produced amount (Stålvalseværket, 2002). The carbon source is assumed to be coke and all the carbon is assumed to be converted to CO_2 as the carbon content in the products is assumed to be the same as in the iron scrap. The emission factor (3.6 tonnes CO_2 pr tonne metallurgical coke) is based on values in the IPCC-guidelines (IPCC (1997), vol. 3, p. 2.26). Emissions of CO_2 for 1990-1991 and for 1993 have been determined with extrapolation and interpolation, respectively.

4.4.3 Uncertainties and time-series consistency

The time-series (see Table 4.9) is considered to be consistent as the same methodology has been applied for the whole period. The activity, i.e. amount of steel sheets and bars produced as well as consumption of metallurgical coke, has been published in environmental reports. The emission factor (consumption of metallurgical coke pr tonnes of product) has been almost constant from 1994 to 2001. For the remaining years, the same emission factor has been applied. In 2002, production stopped. For 2005 the production has been assumed to be one third the production in 2001 as the steelwork was operating between 4 and 6 months in 2005.

The source-specific uncertainties for the metal production are presented in Section 4.9. The overall uncertainty estimate is presented in Chapter 1.7.

4.4.4 Recalculations

No source-specific recalculations have been performed regarding emissions from the metal production.

4.4.5 Source-specific planned improvements

The emission of CO_2 from consumption of metallurgical carbon in iron foundries is not included at the moment. However, this source will be investigated and included.

4.5 Other production (2D)

4.5.1 Source category description

The subsector *Other production*, Food and Drink (2D2) cover the following process:

- Production of sugar

The time-series for emission of CO_2 from *Other production, Food and Drink* (2D) is presented in Table xx.

Table xx Time-series for emission of CO_2 (kt) from Other production, Food and Drink (2D).

2D	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
2. Food and Drink	4.45	4.49	4.14	4.26	4.36	3.91	3.80	4.29	4.90	4.71
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
2. Food and Drink	3.90	4.95	4.47	4.49	3.97	4.46	2.17	1.72	2.67	

The emissions are extracted from The CRF tables and the values are rounded.

4.5.2 Methodological issues

The CO_2 emission from the refining of sugar is estimated from production statistics for sugar and a number of assumptions: consumption of 0.02 tonne $CaCO_3$ pr tonne sugar and precipitation of 90 % CaO resulting in an emission factor at 0.0088 tonne CO_2 pr tonne sugar. However, from the year 2006-2008 the CO_2 emission compiled by the company for EU-ETS is used in the inventory (Danisco, 2009).

4.5.3 Uncertainties and time-series consistency

The time-series is presented in table xx. The same methodology has been applied for 1990-2005. From 2006-2008 data from EU-ETS has been available and therefore included in the inventory.

4.5.4 Recalculations

No source-specific recalculations have been performed regarding emissions from production of sugar. However, the emissions have been allocated to 2D instead of 2A. Emission of NMVOC from other processes within the sector Food and Drink (2D2) has also been included.

4.5.5 Source-specific planned improvements

No improvements are planned for this sector.

4.6 Production of Halocarbons and SF_6 (2E)

There is no production of Halocarbons or SF_6 in Denmark.

4.7 Metal Production (2C) and Consumption of Halocarbons and SF_6 (2F)

4.7.1 Source category description

The sub-sector *Consumption of halocarbons and SF_6* (2F) includes the following source categories and the following F-gases of relevance for Danish emissions:

- 2C4: SF_6 used in Magnesium Foundries: SF_6; see Table 4.10.
- 2F1: Refrigeration: HFC32, 125, 134a, 152a, 143a, PFC (C_3F_8); see Table 4.11.
- 2F2: Foam blowing: HFC134a, 152a; see Table 4.12.
- 2F4: Aerosols/Metered dose inhalers: HFC134a; see Table 4.13.
- 2F8: Production of electrical equipment: SF_6; see Table 4.14.
- 2F9: Other processes (laboratories, double glaze windows, fibre optics): SF_6, HFC23, CF_4, C_3F_8, C_4F_8; see Table 4.15.

A quantitative overview is given below for each of these source categories and each F-gas, showing their emissions in tonnes through the times-series. The data is extracted from the CRF tables that form part of this submission and the data presented is rounded values. It must be noticed that the inventories for the years 1990-1993 (1994) might not cover emissions of these gases in full. The choice of base-year for these gases is 1995 for Denmark.

Table 4.10 SF_6 used in magnesium foundries (t).

2C4	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
SF_6 used in magnesium foundries	1.30	1.30	1.30	1.50	1.90	1.50	0.40	0.60	0.70	0.70
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
SF_6 used in magnesium foundries	0.89	NO	NO	NO	NO	NO	NO	NO	NO	

Table 4.11 Consumption of HFCs and PFC in refrigeration and air condition systems (t).

2F1 Refrigeration	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
HFC32	NE	NE	NE	NA	NA	0.11	0.84	1.77	2.72	3.77
HFC125	NE	NE	NE	NA	0.23	2.58	9.46	15.8	21.8	31.7
HFC134a	NE	NE	0.32	2.63	10.3	14.3	16.3	34.2	45.9	94.3
HFC152a	NE	NE	NE	NA	NA	NA	NA	0.05	0.36	0.49
HFC143a	NE	NE	NE	NA	0.22	2.43	8.65	13.7	19.3	29.1
PFC (C_3F_8)	NE	NE	NE	NA	0.0075	0.072	0.24	0.59	1.30	1.78
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
HFC32	5.75	7.33	8.44	10.1	12.0	13.7	14.5	15.4	16.8	
HFC125	43.1	45.1	48.5	54.9	59.9	67.7	70.6	73.6	75.3	
HFC134a	112	128	151	162	169	181	188	198	198	
HFC152a	0.58	0.58	0.51	0.41	0.33	0.26	0.21	0.17	0.14	
HFC143a	39.6	40.1	43.2	49.0	52.8	60.3	63.0	65.6	66.0	
PFC (C_3F_8)	2.29	2.64	2.67	2.51	2.27	1.99	1.76	1.51	1.29	

Table 4.12 Consumption of HFCs in foam blowing (t).

2F2 Foam blowing	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
HFC32	NE	NE	NE	NA	NA	NA	NA	NA	NA	NA
HFC125	NE	NE	NE	NA	NA	NA	NA	NA	NA	NA
HFC134a	NE	NE	2.00	66.4	87.1	136	187	138	164	125
HFC152a	NE	NE	3.00	30.0	46.0	43.4	32.2	15.2	9.30	37.7
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
HFC32	NA	3.72	NA	NA	NA	NO	NO	NO	NO	
HFC125	NA	3.72	NA	NA	NA	NO	NO	NO	NO	
HFC134a	127	132	122	98.8	110	91.2	81.8	78.9	78.6	
HFC152a	16.2	12.8	12.5	1.63	5.81	1.49	2.56	2.82	3.39	

Table 4.13 Consumption of HFC in aerosols/metered dose inhalers (t).

2F4 Aerosols	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
HFC134a	NE	NE	NE	NA	NA	NA	NA	NA	0.61	8.91
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
HFC134a	14.5	11.7	10.8	11.4	11.5	16.1	18.8	16.0	14.3	

Table 4.14 Consumption of SF_6 in electrical equipment (t).

2F8 Electrical equipment	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
SF_6	0.060	0.11	0.11	0.12	0.14	0.16	0.18	0.38	0.27	0.48
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
SF_6	0.47	0.53	0.37	0.40	0.43	0.52	0.54	0.63	0.68	

Table 4.15 Consumption of SF_6, HFCs, and PFCs in other processes (t).

2F9 Other	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
SF_6	0.50	1.25	2.32	2.61	3.07	2.83	1.97	2.08	1.52	1.55
HFC23	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
CF_4	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C_3F_8	NE,NO	NE,NO	NE,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
C_4F_8	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
SF_6	1.12	0.75	0.68	0.91	0.96	0.39	0.96	0.64	0.65	
HFC23	NO	NO	NO	NO	NO	NA,NO	0.08	0.24	0.12	
CF_4	NO	NO	NO	NO	NO	NA,NO	0.25	0.14	0.11	
C_3F_8	0.27	0.52	0.50	0.25	NA,NO	NO	NO	NO	NO	
C_4F_8	NO	NO	NO	NO	NO	NA,NO	0.20	0.45	0.35	

The emission of SF_6 has been decreasing in recent years due to the fact that activities under Magnesium Foundry no longer exist and due to a decrease in the use of electric equipment. Also, a decrease in "other" occurs, which for SF_6 is used in window plate production use, laboratories and in the production of running shoes.

The emission of HFCs increased rapidly in the 1990s and, thereafter, increased more modestly due to a modest increase in the use of HFCs as a refrigerant and a decrease in foam blowing. The F-gases have been regulated in two ways since 1 March 2001. For some types of use there is a ban on use of the gases in new installations and for other types of use, taxation is in place. These regulations seem to have influenced emissions so that they now only increase modestly.

The phase out of F-gasses has in particular been effective within the foam blowing sector and refrigeration installations. According to foam blowing, there was a stepwise phase-out of HFC-134a used for foam blowing in hard and soft foam production, during the period 2001-2004. In 2006, all foam productions in DK have substituted HFC. Especially the phase-out of HFCs in soft foam is significant for the GWP emission in this period.

With respect to HFC refrigeration, it is not possible to determine a stabile decreasing trend yet. Since the introduction of taxes on HFC's in 2001, the consumption decreased in 2002-2003, but then the consumption of HFCs for refrigeration purposes increased again. Especially HFC-404a and HFC-134a increased. This increase is explained with another regulatory initiatives in Danish legislation, where new refrigeration systems containing HCFC-22 (ODP) was banned from 2001. It coursed a boom in HFC refrigeration systems during 2002-2004, because the HFC technology was cheap and well proven. Thus, the consumption of HFC for refrigeration has changed after 1 January 2007, where new larger HFC installations with stocks exceeding 10 kg are banned. Alternative refrigeration technologies based on CO_2, propan/buthan and ammonia is now introduced and available for customers.

Table 4.16 and Figure 4.4 quantify an overview of the emissions of the gases in CO_2-eq. The reference is the trend table as included in the CRF table for year 2008.

Table 4.16 Time-series for emission of HFCs, PFCs and SF_6 (kt CO_2-eq.).

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
HFCs	-	-	3.44	93.9	135	218	329	324	411	503
PFCs	-	-	-	-	0.05	0.50	1.66	4.12	9.10	12.5
SF_6	44.5	63.5	89.2	101	122	107	61.0	73.1	59.4	65.4
Total	44.5	63.5	92.6	195	257	326	392	401	480	581
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
HFCs	605	647	672	695	749	795	815	840	853	
PFCs	17.9	22.1	22.2	19.3	15.9	13.9	15.7	15.4	12.8	
SF_6	59.2	30.4	25.0	31.4	33.1	21.8	36.0	30.3	31.6	
Total	682	700	719	746	798	831	867	886	897	

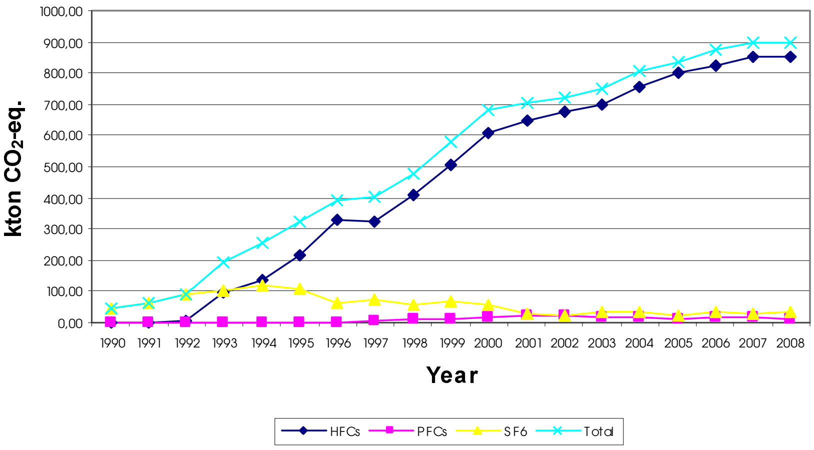

Figure 4.4 Time-series for emission of HFCs, PFCs and SF_6 (kt CO_2-eq.).

The decrease in the SF_6 emission has brought its emissions in CO_2-eq. down to the level of PFC. Overall, and for all uses, the most dominant group by far is HFCs. In this grouping, HFCs constitute a key category, both with regard to the key category level and trend analysis.

4.7.2 Methodological issues

The data for emissions of HFCs, PFCs, and SF_6 has been obtained in continuation on work on inventories for previous years. The determination includes the quantification and determination of any import and export of HFCs, PFCs, and SF_6 contained in products and substances in stock form. This is in accordance with the IPCC guidelines (IPCC (1997), vol. 3, p. 2.43ff), as well as the relevant decision trees from the IPCC Good Practice Guidance (IPCC, 2000) p. 3.53ff).

For the Danish inventories of F-gases, a Tier 2 bottom-up approach is basically used. As for verification using import/export data, a Tier 2 top-down approach is applied. In an annex to the F-gas inventory report 2008 (DEPA, 2010), there is a specification of the approach applied for each sub-source category.

The following sources of information have been used:

- Importers, agency enterprises, wholesalers and suppliers.
- Consuming enterprises, and trade and industry associations.
- Recycling enterprises and chemical waste recycling plants.
- Statistics Denmark.

- Danish Refrigeration Installers' Environmental Scheme (KMO).
- Previous evaluations of HFCs, PFCs and SF_6.

Suppliers and/or producers provide consumption data of F-gases. Emission factors are primarily defaults from the GPG, which are assessed to be applicable in a national context. In case of commercial refrigerants and Mobile Air Condition (MAC), national emission factors are defined and used.

Import/export data for sub-source categories where import/export is relevant (MAC, fridge/freezers for household) are quantified on estimates from import/export statistics of products + default values of the amount of gas in the product. The estimates are transparent and described in the annex to the report referred to above.

The Tier 2 bottom-up analysis used for determination of emissions from HFCs, PFCs, and SF_6 covers the following activities:

- Screening of the market for products in which F-gases are used.
- Determination of averages for the content of F-gases pr product unit.
- Determination of emissions during the lifetime of products and disposal.
- Identification of technological development trends that have significance for the emission of F-gases.
- Calculation of import and export on the basis of defined key figures, and information from Statistics Denmark on foreign trade and industry information.

The determination of emissions of F-gases is based on a calculation of the actual emission. The actual emission is the emission in the evaluation year, accounting for the time lapse between consumption and emission. The actual emission includes Danish emissions from production, from products during their lifetimes and from waste products.

Consumption and emissions of F-gases are, whenever possible, determined for individual substances, even though the consumption of certain HFCs has been very limited. This has been carried out to ensure transparency of evaluation in the determination of GWP values. However, the continued use of a category for *Other HFCs* has been necessary since not all importers and suppliers have specified records of sales for individual substances.

The potential emissions have been calculated as follows:

Potential emission = import + production - export - destruction/treatment.

Table 4.17 Content (w/w%) of "pure" HFC in HFC-mixtures, used as trade names.

HFC mixtures	HFC-32	HFC-125	HFC-134a	HFC-143a	HFC-152a	HFC-227ea
	%	%	%	%	%	%
HFC-365						8
HFC-401a					13	
HFC-402a		60				
HFC-404a		44	4	52		
HFC-407a	23	25	52			
HFC-410a	50	50				
HFC-507a		50		50		

The substances have been accounted for in the survey according to their trade names, which are mixtures of HFCs used in the CRF, etc. In the transfer to the "pure" substances used in the CRF reporting schemes, the following ratios have been used; see Table 4.17.

The national inventories for F-gases are provided and documented in a yearly report (DEPA, 2010). Furthermore, detailed data and calculations are available and archived in an electronic version. The report contains summaries of methods used and information on sources as well as further details on methodologies.

Activity data is described in a spreadsheet for the current year.

4.7.3 Uncertainties and time-series consistency

The time-series for emission of Halocarbons and SF_6 are presented in Section 4.7.1. The time-series are consistent as regards methodology. No potential emission estimates are included as emissions in the time-series and the same emission factors are used for all years.

No appropriate measures of uncertainties have been established and no uncertainty estimates following the GPG procedures have been developed for the F-gas calculations, to date.

In general, uncertainty in inventories will arise through at least three different processes:

1. Uncertainties from definitions (e.g. incomplete, unclear, or faulty definition of an emission or uptake);
2. Uncertainties from natural variability of the process that produces an emission or uptake;
3. Uncertainties resulting from the assessment of the process or quantity depending on the method used: (i) uncertainties from measuring; (ii) uncertainties from sampling; (iii) uncertainties from reference data that may be incompletely described, and (iv) uncertainties from expert judgement.

Uncertainties due to poor definitions are not expected to be an issue in the F-gas inventory. The definitions of chemicals, the factors, sub-source categories in industries etc. are well defined.

Uncertainties from natural variability are likely to occur over the short-term while estimating emissions in individual years. But over a longer time period, 10-15 years, these variabilities level out in the total emission. This is due to that input data (consumption of F-gases) is known and is valid data, and has no natural variability due to the chemicals stabile nature.

Uncertainties that arise due to imperfect measurement and assessment are probably an issue for the:

- Emission from MAC (HFC-134a).
- Emission from commercial refrigerants (HFC-134a).

Due to the limited knowledge for these sources, the expert assessment of consumption of F-gases can lead to inexact values of the specific consumption of F-gases.

The uncertainty varies from substance to substance. Uncertainty is greatest for HFC-134a due to its widespread application in products that are imported and exported. The greatest uncertainty in application is expected to arise from consumption of HFC-404a and HFC-134a in commercial refrigerators and mobile refrigerators. The uncertainty involved in year-to-year data is influenced by the uncertainty associated with the rates at which the substances are released. This results in significant differences in the emission determinations in the short-term (approx. five years); differences that balance in the long-term.

The source-specific uncertainties for consumption of halocarbons and SF_6 are presented in Chapter 4.9. The overall uncertainty estimate is presented in Chapter 1.7.

4.7.4 QA/QC and verification

Comparison of emissions estimates using different approaches

Inventory agencies should use the Tier 1 potential emissions method for a check on the Tier 2 actual emission estimates. Inventory agencies may consider developing accounting models that can reconcile potential and actual emission estimates and which may improve the determination of emission factors over time.

This comparison was carried out in 1995-1997 and, for all three years, it shows a difference of approx. factor 3 higher emission by using potential emission estimates.

Inventory agencies should compare bottom-up estimates with the top-down Tier 2 approach, since bottom-up emission factors have the highest associated uncertainty. This technique will also minimise the possibility that certain end-uses are not accounted for in the bottom-up approach.

This comparison has not been developed.

National activity data check

For the Tier 2a (bottom-up) method, inventory agencies should evaluate the QA/QC procedures associated with estimating equipment and product inventories to ensure that they meet the general procedures outlined in the QA/QC plan and that representative sampling procedures are used. This is particularly important for the ODS (Ozone Depleting Substances)-substitute subsectors because of the large populations of equipment and products.

The spreadsheets containing activity data have incorporated several data-control mechanisms, which ensure that data estimates do not contain calculation failures. A very comprehensive QC procedure on the data in the model for the whole time-series has been carried for the present submission in connection with the process which provided, (1) data for the CRF background tables 2(II).F. for the years (1993)-2008 and (2) data for potential emissions in CRF tables 2(I). This procedure consisted of a check of the input data for the model for each substance. As regards the HFCs, this checking was carried out in relation to their trade names. Conversion was made to the HFC substances used in the CRF tables, etc. A QC was that emission of the substances could be calculated and checked comparing results from the substances as trade names and as the "no-mixture" substances used in the CRF.

Emission factors check

Emission factors used for the Tier 2a (bottom-up) method should be based on country-specific studies. Inventory agencies should compare these factors with the default values. They should determine if the country-specific values are reasonable, given similarities or differences between the national source category and the source represented by the defaults. Any differences between country-specific factors and default factors should be explained and documented.

Country-specific emission factors are explained and documented for MAC and commercial refrigerants and SF_6 in electric equipment. Separate studies have been carried out and reported. For other sub-source categories, the country-specific emission factors are assessed to be the same as the IPCC default emission factors.

Emission check

As the F-gas inventory is developed and made available in full in spreadsheets, where HFCs data relate to trade names, special procedures are performed to check the full possible correctness of the transformation to the CRF-format through Access databases.

Recalculations

In the group 2F4 *Aerosols/Metered Dose Inhalers* metered dose inhalers has been included for 2008 and the emissions has also been recalculated from 1998 - 2007.

4.7.5 Planned improvements

It is planned to improve uncertainty estimates as well as the information on the choice of EFs and the specific approaches applied.

4.8 Other (2G)

4.8.1 Source category description

The subsector *Other* (2G) covers the following process:

- Consumption of lubricant oil.

The time-series for emission of CO_2 from *Other* (2G) is presented in Table 4.18.

Table 4.18 Time-series for emission of CO_2 (kt) from Other (2G).

2G	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1. Consumption of lubricant oil	49.7	48.9	48.1	47.6	46.9	48.8	48.9	47.1	44.9	42.7
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
1. Consumption of lubricant oil	39.7	38.5	39.9	37.0	37.7	37.6	37.5	37.9	34.0	

The emissions are extracted from The CRF tables and the values are rounded.

The emission of CO_2 from consumption of lubricants is decreasing from 49.7 kt in 1990 to 34.0 kt in 2008.

4.8.2 Methodological issues

The emission of CO_2 from consumption of lubricant oil is calculated according to the following formula:

$$E_{CO2} = LC \bullet CC_{\text{lub}\,ricant} \bullet ODU_{\text{lub}\,ricant} \bullet 44/12$$

where:

E_{CO2} = emission of CO_2

LC = consumption of lubricants

CC = carbon content of lubricant

ODU = amount of lubricant oxidised during use

In the calculation the following default values have been applied: CC = 20.1 kg C pr kg lubricant and ODU = 0.2. The activity data applied is presented in Table 4.19.

Table 4.19 Consumption of lubricant oil (TJ) (Danish Energy Authority).

2G	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1. Consumption of lubricant oil	3 372	3 315	3 265	3 226	3 185	3 314	3 317	3 199	3 043	2 898
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
1. Consumption of lubricant oil	2 693	2 611	2 704	2 512	2 560	2 550	2 544	2 574	2 307	

4.8.3 Uncertainties and time-series consistency

The time-series is presented in Table 4.18. The applied methodology has been the same during all the years and is therefore considered to be consistent. The activity data is based on information from Danish Energy Authority. The same emission factor has been used for all the years from 1990 to 2008.

4.8.4 Recalculations

No source-specific recalculations have been performed regarding emissions from the consumption of lubricants.

4.8.5 Source-specific planned improvements

No improvements are planned for this sector.

4.9 Uncertainty

4.9.1 Tier 1 uncertainty

The source-specific uncertainties for industrial processes are presented in Table 4.20. The uncertainties are based on IPCC guidelines combined with assessment of the individual processes.

The producer has delivered the activity data for production of cement as well as calculated the emission factor based on quality measurements. The uncertainties on activity data and emission factors are assumed to be 1 % and 2 %, respectively.

The activity data for production of lime and bricks are based on information compiled by Statistics Denmark. Due to the many producers and the variety of products, the uncertainty is assumed to be 5 %. The emission factor is partly based on stoichiometric relations and partly on an assumption of the number of yellow bricks. The last assumption has been verified (see Table 4.20). The combined uncertainty is assumed to be 5 %.

The producers of glass and glass wool have registered the consumption of - raw materials containing carbonate. The uncertainty is assumed to be 5 %. The emission factors are based on stoichiometric relations and, therefore, uncertainty is assumed to be 2 %.

The producers have registered the production of nitric acid during many years and, therefore, the uncertainty is assumed to be 2 %. The measurement of N_2O is problematic and is only carried out for one year. Therefore, uncertainty is assumed to be 25 %.

The uncertainty for the activity data as well as for the emission factor is assumed to be 5 % for production of catalysts/fertilisers and iron and steel production.

The emission of F-gases is dominated by emissions from refrigeration equipment and, therefore, the uncertainties assumed for this sector will be used for all the F-gases. The IPCC propose an uncertainty at 30-40 % for regional estimates. However, Danish statistics have been developed over many years and, therefore the uncertainty on activity data is assumed to be 10 %. The uncertainty on the emission factor is, on the other hand, assumed to be 50 %. The base year for F-gases for Denmark is 1995.

Table 4.20 Uncertainties on activity data and emission factors as well as overall trend uncertainties for the different greenhouse gases.

	Activity data uncertainty	Emission factor uncertainty				
		CO_2	N_2O	HFCs[3]	PFCs[3]	SF_6[3]
Greenhouse gases	%	%	%	%	%	%
2A1. Production of Cement	1	2				
2A2. Production of Lime and Bricks	5	5				
2A3. Limestone and dolomite use	5	5				
2A5. Asphalt roofing	5	25				
2A6. Road paving with asphalt	5	25				
2A7. Other[1]	5	2				
2B2. Nitric acid production	2		25			
2B5. Other[2]	5	5				
2C1. Iron and Steel production	5	5				
2D. Food and Drink	5	5				
2F. Consumption of HFC	10			50		
2F. Consumption of PFC	10				50	
2F. Consumption of SF_6	10					50
2G. Other: Lubricants	2	5				
Overall uncertainty in 2008		1.949	25.08[4]	50.99	50.99	50.99
Trend uncertainty		1.574	1.439[4]	55.28	360.2	4.163

1) Production of yellow bricks, expanded clay products, container glass and glass wool.

2) Production of catalysts/fertilisers.

3) The base year for F-gases is for Denmark 1995.

4) 2004. The production closed down in the middle of 2004.

4.9.2 Tier 2 uncertainty

The first attempt on calculating tier 2 uncertainty for CO_2 emission from industrial processes is presented in Table 4.1.

Table 4.1. Tier 2 uncertainty for CO_2 emission from industrial processes.

Category (CRF)	Parameter (activity)	Median	Below 2.5%	Above 97.5%
2A1	Cement production	1 155	1 130	1 180
2A2	Lime production	65.58	62.20	69.07
2A3	Limestone and dolomit use	38.67	34.75	42.94
2A5	Asphalt roofing	0.025	0.019	0.031
2A6	Road paving with asphalt	1.919	1.494	2.456
2A7	Glass production	15.08	14.65	15.50
2A7	Yellow bricks	28.39	27.60	29.19
2A7	Expanded clay	16.08	15.64	16.54
2B5	Other, catalysts	2.398	2.089	2.747
2C1	Steel	0	0	0
2D2	Other, food and drink	2.664	2.325	3.049
2G	Other, lubricants	34.04	30.83	37.56
	Total	1 360	1 334	1 386

4.10 Quality assurance/quality control (QA/QC)

4.10.1 Internal QA/QC

The approach used for quality assurance/quality control (QA/QC) is presented in Chapter 1.6. The present chapter presents QA/QC considerations for industrial processes based on a series of Points of Measuring (PMs); see Chapter 1.6.

Data Storage level 1	1. Accuracy	DS.1.1.1	General level of uncertainty for every dataset including the reasoning for the specific values.

The uncertainty assessment has been performed on Tier 1 level by using default uncertainty factors. The applied uncertainty factors are presented in Table 4.17.

Data Storage level 1	1. Accuracy	DS.1.1.2	Quantification of the uncertainty level of every single data value including the reasoning for the specific values.

See DS.1.1.1. As Tier 1 and default uncertainty factors are applied, the individual datasets have not been assessed.

Data Storage level 1	2.Comparability	DS.1.2.1	Comparability of the data values with similar data from other countries, which are comparable with Denmark, and evaluation of discrepancy.

Comparability of the data has not been performed at "Data Storage level 1". However, investigation of comparability at CRF level is in progress.

The applied data sets are presented in Table 4.21.

Data Storage level 1	3.Completeness	DS.1.3.1	Documentation showing that all possible national data sources are included setting down the reasoning behind the selection of datasets.

Table 4.21 Applied data sets.

File or folder name	Description	AD or E	Reference	Contact(s)	Comment
Ardagh Glass Holmegaard gr2008.pdf		E	www.cvr.dk		
Damolin Fur gr2008.pdf			www.cvr.dk		
Damolin Mors gr2008.pdf			www.cvr.dk		
Danisco Assens gr2007-2008.pdf		AD	www.danisco.dk www.cvr.dk		AD used for estimation of production at three different locations 1990-1995.
Danisco Nakskov gr2007-2008.pdf		AD	www.danisco.dk www.cvr.dk		AD used for estimation of production at three different locations 1990-1995.
Danisco Nykøbing gr2007-2008.pdf		AD	www.danisco.dk www.cvr.dk		AD used for estimation of production at three different locations 1990-1995.
Faxe_Kalk-brandt_kalk.pdf	Chemical composition of product.		www.faxekalk.dk		
Faxe_Kalk-hydratkalk_191103.pdf	Chemical composition of product.		www.faxekalk.dk		
Haldor Topsoe gr2008.pdf		AD, E	www.cvr.dk		
Haldor Topsoe 1990.xls		E	Haldor Topsøe	Allan Willumsen	
Haldor Topsoe – emissioner 1996 – 2004.xls		E	Haldor Topsøe	Allan Willumsen	
Kemira GR2003.pdf		AD, E	www.kemira-growhow.com		
Maxit Hinge\			www.cvr.dk		
Rockwool gr2008.pdf		AD	www.cvr.dk		
Saint Gobain gr2008.pdf		AD,E	Saint-Gobain Isover www.isover.dk	Anette Åkesson	
Stålvalseværket (2002) – paper version.		AD, E	Stålvalseværket		
Aalborg Portland miljoredegorelse_2008.pdf		AD, E	www.aalborg-portland.dk		
Aalborg Portland energy 2000-2004 answer.xls		AD	Aalborg Portland	Henrik Møller Thomsen, Torben Ahlmann-Laursen	
DS produktion af klinker + letbeton.xls		AD	Danmarks Statistik; www.statistikbanken.dk		
DS produktion af sukker.xls		AD	Danmarks Statistik; www.statistikbanken.dk		
DS produktion af øl.xls		AD	Danmarks Statistik; www.statistikbanken.dk		

The data sources - in general - can be grouped as follows:

- Company specific environmental reports.
- Personal communication with individual companies.
- Company specific information compiled by Danish Energy Authority in relation to the EU-ETS.
- Industrial organisations.
- Statistics Denmark.
- Secondary literature.
- IPCC guidelines.

The environmental reports contribute with company-specific emission factors, technical information and, in some cases, activity data. The environmental reports are primarily used for large companies and, for some companies, are supplemented with information from personal contacts, especially for completion of the time-series for the years before the legal requirement to prepare environmental reports (i.e. prior to 1996).

Statistics Denmark is used as source for activity data as they are able to provide consistent data for the period 1990-2007. In the cases where the statistics do not contain transparent data, statistics from industrial organisations are used to generate to required activity data.

For many of the processes, the default emission factors are based on chemical equations and are, therefore, the best choice. In some cases, the default EF has been modified in order to reflect local conditions.

Secondary literature may be used in the interpretation or in disaggregation of the public statistics.

Data Storage level 1	4.Consistency	DS.1.4.1	The origin of external data has to be preserved whenever possible without explicit arguments (referring to other PMs).

See DS.1.4.1. Consistency is secured by application of the same data source over the period in question, e.g. activity data from Statistics Denmark, or by using personal contacts in the individual companies to obtain activity data for the period when environmental reports were not mandatory. For some activities, statistics compiled by industrial organisations were applied.

Data Storage level 1	6.Robustness	DS.1.6.1	Explicit agreements between the external institution holding the data and NERI about the condition of delivery.

An agreement regarding inclusion of information - compiled by Danish Energy Authority for EU-ETS - in the Danish GHG-inventory has been signed. The implementation of this information has been introduced for production of cement as well as sugar refining.

Data Storage level 1	7.Transparency	DS.1.7.1	Summary of each dataset including the reasoning for selecting the specific dataset.

The datasets applied are presented in Table 4.21. For the reasoning behind their selection, see DS.1.3.1.

Data Storage level 1	7.Transparency	DS.1.7.3	References for citation for any external dataset have to be available for any single value in any dataset.

The data applied, including references for citation, are presented in Table 4.21.

Data Storage level 1	7.Transparency	DS.1.7.4	Listing of external contacts for every dataset.

The applied data including external contacts are presented in Table 4.21.

Data Processing level 1	1. Accuracy	DP.1.1.1	Uncertainty assessment for every data source as input to Data Storage level 2 in relation to type of variability (distribution as: normal, log normal or other type of variability).

The uncertainty assessment has been performed on Tier 1 level, assuming a normal distribution of activity data as well as emission data, by application of default uncertainty factors. Therefore, no considerations regarding distribution or type of variability have been performed.

Data Processing level 1	1. Accuracy	DP.1.1.2	Uncertainty assessment for every data source as input to Data Storage level 2 in relation to scale of variability (size of variation intervals).

See DP.1.1.2.

Data Processing level 1	1. Accuracy	DP.1.1.3	Evaluation of the methodological approach using international guidelines.

The applied methodologies are in line with the international guidelines issued by the IPCC combined with national adjustments. The degree of fulfilment of the required methodology has been documented in an internal note (Kyoto note).

Data Processing level 1	1. Accuracy	DP.1.1.4	Verification of calculation results using guideline values.

The emission factors applied are mostly based on chemical equations and are, therefore, in accordance with the default EFs. E.g. for production of nitric acid, where the emission factor is dependent on process conditions, a comparison has been made to the default EF listed in the guideline. E.g. for the deviation of the emission factor for calcination in the cement process, an explanation has been developed in cooperation with the company.

Data Processing level 1	2.Comparability	DP.1.2.1	The inventory calculation has to follow the international guidelines suggested by UNFCCC and IPCC.

See DP.1.1.3

Data Processing level 1	3.Completeness	DP.1.3.1	Assessment of the most important quantitative knowledge which is which is lacking.

This issue will be investigated further.

Data Processing level 1	3.Completeness	DP.1.3.2	Assessment of the most important cases where access is lacking with regard to critical data sources that could improve quantitative knowledge.

Accessibility to critical company-specific information will be established as a consequence of the formal agreement with the Danish Energy Authority concerning data compiled in relation to the EU-ETS.

Data Processing level 1	4.Consistency	DP.1.4.1	In order to keep consistency at a high level, an explicit description of the activities needs to accompany any change in the calculation procedure.

Recalculations are described in the NIR. A manual log is included in the tool used for data processing at Data Processing level 2. This log also includes changes on Data Processing level 1.

Data Processing level 1	5.Correctness	DP.1.5.1	Show at least once, by independent calculation, the correctness of every data manipulation.

The sector report for industry (in prep.) presents an independent example of the calculations to ensure the correctness of every data manipulation.

Data Processing level 1	5.Correctness	DP.1.5.2	Verification of calculation results using time-series.

The calculations are verified by checking the time-series.

Data Processing level 1	5.Correctness	DP.1.5.3	Verification of calculation results using other measures.

A methodology to verify calculation of results using other measures will be developed.

Data Processing level 1	5.Correctness	DP.1.5.4	Shows one-to-one correctness between external data sources and the databases at Data Storage level 2.

A methodology to check the correctness between external data sources and the databases at storage level 2 will be developed.

Data Processing level 1	7.Transparency	DP.1.7.1	The calculation principle and equations used must be described.

The calculation principles and equations are based on the methodology presented by the IPCC. A detailed description can be found in the sector report for industry (in prep.).

Data Processing level 1	7.Transparency	DP.1.7.2	The theoretical reasoning for all methods must be described.

The theoretical reasoning for choice or development of methods is described in detail in the sector report for industry (in prep.).

Data Processing level 1	7.Transparency	DP.1.7.3	Explicit listing of assumptions behind all methods.

The assumptions used in the different methods are described in the sector report for industry (in prep.) and also included in the present report. An explicit list of assumptions will be developed in the coming sector report.

Data Processing level 1	7.Transparency	DP.1.7.4	Clear reference to data set at Data Storage level 1.

Explicit references from the data processing to each dataset can be found in the sector report for industry (in prep.).

Data Processing level 1	7.Transparency	DP.1.7.5	A manual log to collect information about recalculations.

A manual log is included in the tool used for data processing at data level 2. This log also includes changes on Data Processing level 2. A detailed log will be developed in the sector report for industry (in prep.).

Data Processing level 2	5.Correctness	DS.2.5.1	Documentation of a correct connection between all data types at level 2 to data at level 1.

The sector report for industry (in prep.) presents the connection between the datasets on Data Storage level 1 and Data Processing level 2. Individual calculations are used to check the output of the data processing tool used at Data Processing level 2.

Data Processing level 2	5.Correctness	DS.2.5.2	Check if a correct data import to level 2 has been made.

See DS.2.5.2.

4.10.2 External QA/QC

External QA/QC is described for one source: cement production.

Cement production

Aalborg Portland has an environmental management system that meets the requirements in DS/ISO 14001, EMAS etc. (Aalborg Portland, 2009b). The environmental management system is part of an integrated process management system. The system is certified according to the standards by the accredited body: Danish Standards. Information on raw material consumption as well as internal recycling is compiled in an environmental database. Some pollutants (NO_x, SO_2, CO and TSP) are measured continuously. Emission of CO_2 is calculated based on (fuel and) raw material consumption and raw material flow according to an approved CO_2 emission plan (EU-ETS). The CO_2 emission plan has to fulfil the requirements in the guidelines developed by EU (EU, 2007).

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5 Solvents and other product use (CRF sector 3)

5.1 Overview of the sector

This report presents the Danish methodology used for calculating CO_2, N_2O and NMVOC emissions from use of solvents in industrial processes and households that are related the source categories Paint application (CRF sector 3A), Degreasing and dry cleaning (CRF sector 3B), Chemical products, manufacture and processing (CRF sector 3C) and Other (CRF sector 3D). NMVOCs are not considered direct greenhouse gases but once emitted in the atmosphere they will over a period of time oxidise to CO_2.

Solvents are chemical compounds that are used on a global scale in industrial processes and as constituents in final products to dissolve e.g. paint, cosmetics, adhesives, ink, rubber, plastic, pesticides, aerosols or are used for cleaning purposes, i.e. degreasing. NMVOCs are main components in solvents - and solvent use in industries and households is typically the dominant source of anthropogenic NMVOC emissions (UNFCCC, 2008; Pärt, 2005; Karjalainen, 2005). In industrial processes where solvents are produced or used NMVOC emissions to air and as liquid can be recaptured and either used or destroyed. Solvent containing products are used indoor and outdoor and the majority of solvent sooner or later evaporate. A small fraction of the solvent ends up in waste or as emissions to water and may finally also contribute to air pollution by evaporation from these compartments. Emission inventories for solvents are based on model estimates, as direct and continuous emissions are only measured from a limited number of pollutants and sources, e.g. SO_2 and NOx from central power plants.

In this section the methodology for the Danish NMVOC emission inventory for solvent use is presented and the results for the period 1995 – 2008 are summarised. The method is based on the detailed approach described in EMEP/CORINAIR (2004) and emissions are calculated for industrial sectors, households in the CRF sectors mentioned above, as well as for individual chemicals.

5.2 Source category emissions

Table 5.1 and Figure 5.1 show the emissions of chemicals from 1985 to 2008, where the used amounts of single chemicals have been assigned to specific products and CRF categories. The methodological approach for finding emissions in the period 1995 - 2008 is described in the following section. A linear extrapolation is made for the period 1985 – 1994. A general decrease is seen throughout the sectors. Table 5.2 shows the used amounts of chemicals for the same period. Table 5.1 is derived from Table 5.2 by applying emission factors relevant to individual chemicals and production or use activities. Table 5.3 showing the used amount of products is derived from Table 5.2, by assessing the amount of chemicals that is comprised within products belonging to each of the four source categories. The CO_2 conversion factor for each chemical is shown in Table 5.4.

In Table 5.4 the emission for 2008 is split into individual chemicals. The most abundantly used solvents are ethanol, turpentine, or white spirit defined as a mixture of stoddard solvent and solvent naphtha and propylalcohol. Ethanol is used as solvent in the chemical industry and as windscreen washing agent. Turpentine is used as thinner for paints, lacquers and adhesives. Propylalcohol is used in cleaning agents in the manufacture of electrical equipment, flux agents for soldering, as solvent and thinner and as windscreen washing agent. Household emissions are dominated by propane and butane, which are used as aerosols in spray cans, primarily in cosmetics. For some chemicals the emission factors are precise but for others they are rough estimates. Emission factors are divided into four categories: 1) chemical industry (lowest EF), 2) other industry, 3) non-industrial activities, 4) domestic and other diffuse use (highest EF). This implies that high emission factors are applicable for use of solvent containing products and lower emission factors are applicable for use in industrial processes.

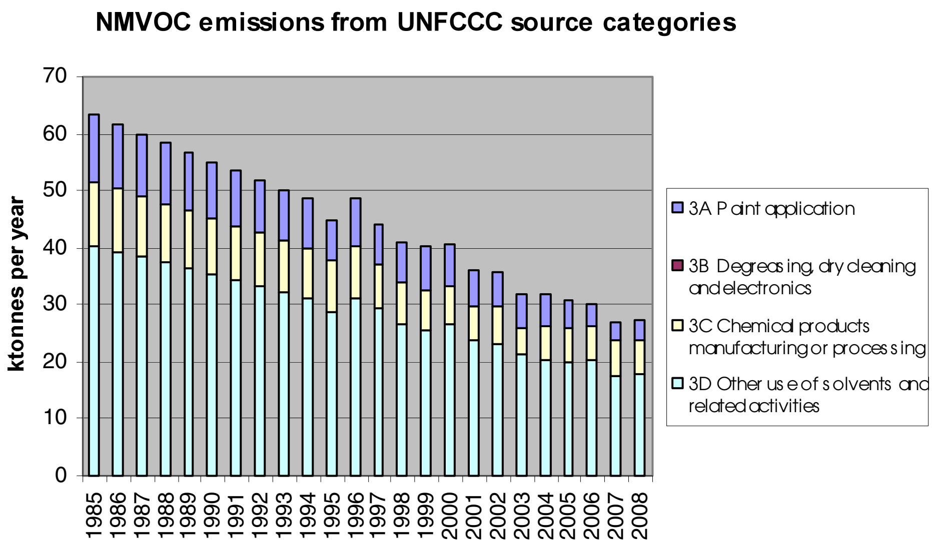

Figure 5.1 Emissions of chemicals in ktonnes pr year (equal to Gg pr year). The methodological approach for finding emissions in the period 1995 – 2008 is described in the text, and a linear extrapolation is made for 1985 – 1994. Figures can be seen in Table 5.1.

Table 5.1 Emission of chemicals in Gg pr year.

Total emissions Gg pr year	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Paint application (3A)	11.6	11.3	11.0	10.6	10.3	9.93	9.59	9.24	8.90	8.56	6.89	8.46
Degreasing and dry cleaning (3B)	1.0E-04	1.0E-04	9.6E-05	9.1E-05	8.7E-05	8.3E-05	7.9E-05	7.4E-05	7.0E-05	6.6E-05	7.7E-05	7.4E-05
Chemical products, manufacturing and processing (3C)	11.2	11.0	10.7	10.4	10.1	9.83	9.55	9.26	8.98	8.70	9.11	9.20
Other (3D)	40.4	39.4	38.4	37.3	36.3	35.3	34.3	33.3	32.3	31.3	28.7	31.2
Total NMVOC	63.3	61.6	60.0	58.4	56.7	55.1	53.5	51.8	50.2	48.6	44.7	48.8
Total CO_2	155	151	147	143	139	135	131	126	122	118	107	119
Continued	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Paint application (3A)	7.16	6.99	7.55	7.44	6.08	6.08	5.95	5.40	4.89	4.07	3.39	3.67
Degreasing and dry cleaning (3B)	4.5E-05	5.5E-05	3.4E-05	2.9E-05	1.3E-05	3.0E-05	2.9E-05	2.4E-05	1.8E-05	1.5E-05	2.2E-05	1.5E-05
Chemical products, manufacturing and processing (3C)	7.82	7.45	7.07	6.74	6.10	6.39	4.76	5.90	6.12	5.94	6.07	5.85
Other (3D)	29.3	26.6	25.6	26.5	23.7	23.3	21.3	20.5	19.9	20.2	17.6	17.9
Total NMVOC	44.2	41.0	40.2	40.6	35.9	35.7	32.0	31.8	31.0	30.2	27.0	27.4
Total CO_2	107	99.8	98.8	98.8	86.9	87.1	78.9	77.0	74.4	70.6	63.2	64.8

Table 5.2 Used amounts of chemicals in Gg pr year.

Used amounts of chemical Gg pr year	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Paint application (3A)	24.8	24.1	23.5	22.8	22.1	21.5	20.8	20.2	19.5	18.9	15.3	18.5
Degreasing and dry cleaning (3B)	1.04	1.00	0.959	0.917	0.874	0.832	0.789	0.746	0.704	0.661	0.767	0.738
Chemical products, manufacturing and processing (3C)	53.4	57.2	60.9	64.6	68.4	72.1	75.9	79.6	83.3	87.1	101	105
Other (3D)	63.0	61.6	60.3	58.9	57.58482	56.2	54.9	53.6	52.2	50.9	47.8	50.0
Total NMVOC	142	144	146	147	149	151	152	154	156	157	165	174
Continued	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Paint application (3A)	16.0	16.2	16.8	17.3	14.2	14.3	13.4	12.8	12.1	10.2	8.76	9.19
Degreasing and dry cleaning (3B)	0.446	0.548	0.345	0.293	0.125	0.298	0.289	0.240	0.183	0.146	0.217	0.150
Chemical products, manufacturing and processing (3C)	104	106	97.7	114	110	108	103	127	148	150	163	155
Other (3D)	48.0	45.1	43.4	44.4	39.8	42.3	35.5	35.2	39.7	35.1	31.8	33.0
Total NMVOC	168	167	158	175	165	165	152	175	200	196	204	197

Table 5.3 Used amounts of products in Gg pr year.

Used amounts of products Gg pr year	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Paint application (3A)	165	161	156	152	148	143	139	135	130	126	102	123
Degreasing and dry cleaning (3B)	2.09	2.00	1.92	1.83	1.75	1.66	1.58	1.49	1.41	1.32	1.53	1.48
Chemical products, manufacturing and processing (3C)	267	286	305	323	342	361	379	398	417	435	505	524
Other (3D)	315	308	301	295	288	281	274	268	261	254	239	250
Total products	749	757	764	772	779	787	794	802	809	817	848	898
Continued	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Paint application (3A)	107	108	112	115	94.7	95.4	89.5	85.2	80.9	67.7	58.4	61.2
Degreasing and dry cleaning (3B)	0.892	1.10	0.690	0.586	0.251	0.597	0.578	0.481	0.366	0.292	0.433	0.299
Chemical products, manufacturing and processing (3C)	519	528	488	568	552	541	514	635	742	751	816	774
Other (3D)	240	225	217	222	199	211	178	176	199	176	159	165
Total products	867	863	818	905	846	848	781	896	1022	995	1035	1001

Table 5.4 Chemicals with highest emissions 2008, and CO_2 conversion factors assuming that all carbon molecules in the NMVOC molecule are converted to CO_2.

Chemical	CAS no	Emissions 2008 (tonnes)	CO_2-conversion factor (g CO_2 pr g NMVOC)
ethanol	64-17-5	5865	1.91
turpentine (white spirit: stoddard solvent and solvent naphtha)	64742-88-7 8052-41-3	5653	2.79
propylalcohol	67-63-0	4377	2.20
pentane	109-66-0	2134	3.06
methanol	67-56-1	1327	1.38
propylenglycol	57-55-6	1183	1.74
cyanates	79-10-7	891	1.83
xylene	1330-20-7 95-47-6 108-38-3 106-42-3	890	3.32
acetone	67-64-1	822	2.28
glycolethers	110-80-5 107-98-2 108-65-6 34590-94-8 112-34-5 and others	688	1.95
butanone	78-93-3	671	2.45
propane	74-98-6	654	2.86
butane	106-97-8	654	2.93
formaldehyde	50-00-0	263	1.47
phenol	108-95-2	263	2.81
toluene	108-88-3	214	3.35
ethylenglycol	107-21-1	148	1.42
cyclohexanones	108-94-1	148	2.69
1-butanol	71-36-3	146	2.38
acyclic aldehydes	78-84-2 111-30-8 and others	116	2.31
methyl methacrylate	80-62-6	103	2.20
styrene	100-42-5	48.4	3.39
ethylacetate	141-78-6	43.8	2.00
butanoles	78-92-2 2517-43-3 and others	43.2	2.24
butylacetate	123-86-4	33.9	2.28
triethylamine	121-44-8	20.3	2.61
naphthalene	91-20-3	16.0	3.44
acyclic monoamines	75-31-0 and others	7.45	2.24
tetrachloroethylene	127-18-4	2.46	0.531
Total 2007		27426	

5.3 Other use (N2O)

Five companies sell N_2O in Denmark and only one company produces N_2O. N_2O is primarily used in anaesthesia by dentists, veterinarians and in hospitals and in minor use as propellant in spray cans and in the production of electronics. Due to confidentiality no data on produced amount are available and thus the emissions related to N_2O production are unknown. An emission factor of 1 is assumed for all uses, which equals the sold amount to the emitted amount. Sold amounts are obtained from the respective companies and the produced amount is estimated from communication with the company.

Total sold and estimated produced NO_2 for sale in Denmark, which equals the emissions, is shown in Table 5.5.

Table 5.5 N2O emissions. EF = 1, i.e. sale in Denmark equals emissions

	2005	2006	2007	2008
N_2O sale = emissions (Gg)	0.0453	0.122	0.119	0.0881

5.4 Uncertainties and time-trends

Tier 1 uncertainty analysis:

Overall uncertainty in 2008: 8.3%

Trend uncertainty 1990 – 2008: 3.9%

Tier 2 uncertainty analysis:

Overall uncertainty in 2008: 28% (-24%, +34%)

Trend uncertainty 1990 – 2008: 30% (-3.6%, +0.25%)

5.5 Methodology

Until 2002 the Danish solvent emission inventory was based on questionnaires, which were sent to selected industries and sectors requiring information on solvent use. In 2003 it was decided to implement a method that is more complete, accurate and transparent with respect to including the total amount of used solvent, attributing emissions to industrial sectors and households and establishing a reliable model that is readily updated on a yearly basis.

Emission modelling of solvents can basically be done in two ways: 1) By estimating the amount of (pure) solvents consumed, or 2) By estimating the amount of solvent containing products consumed, taking account of their solvent content (EMEP/CORINAIR, 2004).

In 1) all relevant solvents must be estimated, or at least those together representing more than 90 % of the total NMVOC emission, and in 2) all relevant source categories must be inventoried or at least those together contributing more than 90 % of the total NMVOC emission. A simple approach is to use a pr capita emission for each category, whereas a detailed approach is to get all relevant consumption data (EMEP/CORINAIR, 2004).

The detailed method 1) is used in the Danish emission inventory for solvent use, thus representing a chemicals approach, where each chemical

(NMVOC) is estimated separately. The sum of emissions of all estimated NMVOCs used as solvents equals the NMVOC emission from solvent use. See Figure 1 for methodological overview.

5.5.1 Chemical list

NMVOC is the most important chemical group especially in relation to the CLRTAP. There is also some use of N_2O and due to the high greenhouse warming potential (GWP) of N_2O, yielding a CO_2-equivalent of 1 g N_2O = 310 g CO_2 (IPCC 2000). Only NMVOC, N_2O and CO_2 are considered in the present reporting to the Climate Convention. However, minor emissions may apply to use of other chemicals and e.g. mercury, PAHs, dioxins and PCBs will be assessed in coming inventories.

The definitions of solvents and VOC that are used in the Danish inventory (Nielsen et al., 2009) are as defined in the solvent directive (Directive 1999/13/EC) of the EU legislation: "Organic solvent shall mean any VOC which is used alone or in combination with other agents, and without undergoing a chemical change, to dissolve raw materials, products or waste materials, or is used as a cleaning agent to dissolve contaminants, or as a dissolver, or as a dispersion medium, or as a viscosity adjuster, or as a surface tension adjuster, or a plasticiser, or as a preservative". VOCs are defined as follows: "Volatile organic compound shall mean any organic compound having at 293,15 K a vapour pressure of 0,01 kPa or more, or having a corresponding volatility under the particular condition of use".

This implies that some chemicals, e.g. ethylenglycol, that have vapour pressures just around 0.01 kPa at 20 ^oC, may only be defined as VOCs at use conditions with higher temperature. However, use conditions under elevated temperature are typically found in industrial processes. Here the capture of solvent fumes is often efficient, thus resulting in small emissions (communication with industries).

The Danish list of chemicals comprises 33 chemicals or chemical groups representing more than 95 % of the total NMVOC emission from solvent use of the known NMVOCs, cf. Table 6. CO_2 conversion factors, where all C-molecules in a NMVOC molecule are converted to CO_2, are also listed in Table 6.

5.5.2 Activity data

For each chemical a mass balance is formulated:

Consumption = (production + import) – (export + destruction/disposal + hold-up) (Eq. 1)

Data concerning production, import and export amounts of solvents and solvent containing products are collected from StatBank DK (2008), which contains detailed statistical information on the Danish society. Manufacturing and trading industries are committed to reporting production and trade figures to the Danish Customs & Tax Authorities in accordance with the Combined Nomenclature. Import and export figures are available on a monthly basis from 1995 to present and contain trade information from 272 countries world-wide. Production figures are reported quarterly as "industrial commodity statistics by commodity group and unit" from 1995 to present.

Destruction and disposal of solvents lower the NMVOC emissions. In principle this amount must be estimated for each NMVOC in all industrial activity and for all uses of NMVOC containing products. At present the solvent inventory only considers destruction and disposal for a limited number of NMVOCs. For some NMVOCs it is inherent in the emission factor, and for others the reduction is specifically calculated from information obtained from the industry or literature.

Hold-up is the difference in the amount in stock in the beginning and at the end of the year of the inventory. No information on solvents in stock has been obtained from industries. Furthermore, the inventory spans over several years so there will be an offset in the use and production, import and export balance over time.

In some industries the solvents are consumed in the process, e.g. in the graphics and plastic industry, whereas in the production of paints and lacquers the solvents are still present in the final product. These products can either be exported or used in the country. In order not to double count consumption amounts of NMVOCs it is important to keep track of total solvent use, solvents not used in products and use of solvent containing products. Furthermore some chemicals may be represented as individual chemicals and also in chemical groups, e.g. "o-xylene", "mixture of xylenes" and "xylene". Some chemicals are better inventoried as a group of NMVOCs rather than individual NMVOCs, due to missing information on use or emission for the individual NMVOCs. The Danish inventory considers single NMVOCs, with a few exceptions.

Activity data for chemicals are thus primarily calculated from Equation 1 with input from StatBank DK (2008). When StatBank (2008) holds no information on production, import and export or when more reliable information is available from industries, scientific reports or expert judgements the data can be adjusted or even replaced.

5.5.3 Emission factors

For each chemical the emission is calculated by multiplying the consumption with the fraction emitted (emission factor), according to:

Emission = consumption * emission factor

The present Danish method uses emission factors that represent specific industrial activities, such as processing of polystyrene, dry cleaning etc. or that represent use categories, such as paints and detergents. Some chemicals have been assigned emission factors according to their water solubility. Higher hydrophobicity yields higher emission factors, since a lower amount ends in waste water, e.g. ethanol (hydrophilic) and turpentine (hydrophobic).

Emission factors are categorised in four groups in ascending order: (1) Lowest emission factors in the chemical industry, e.g. lacquer and paint manufacturing, due to emission reducing abatement techniques and destruction of solvent containing waste, (2) Other industrial processes, e.g.

graphic industry, have higher emission factors, (3) Non-industrial use, e.g. auto repair and construction, have even higher emission factors, (4) Diffuse use of solvent containing products, e.g. painting, where practically all the NMVOC present in the products will be released during or after use.

For a given chemical the consumed amount can thus be attributed with two or more emission factors; one emission factor representing the emissions occurring at a production or processing plant and one emission factor representing the emissions during use of a solvent containing product. If the chemical is used in more processes and/or is present in several products more emission factors are assigned to the respective chemical amounts.

Emission factors can be defined from surveys of specific industrial activities or as aggregated factors from industrial branches or sectors. Furthermore, emission factors may be characteristic for the use pattern of certain products. The emission factors used in the Danish inventory also rely on the work done in the joint Nordic project (Fauser et al. 2009).

5.5.4 Source allocation

The Danish Working Environment Authority (WEA) is administrating the registrations of chemicals and products to the Danish product register. All manufacturers and importers of products for occupational and commercial use are obliged to register. The following products are comprised in the registration agreement:

- Chemicals and materials that are classified as dangerous according to the regulations set up by the Danish Environmental Protection Agency (EPA).
- Chemicals and materials that are listed with a limit value on the WEA “limit value list”.
- Materials, containing 1 % or more of a chemical, which is listed on the WEA “limit value list”.
- Materials, containing 1 % or more of a chemical, which are classified as hazardous to humans or the environment according to the EPA rules on classification.

There are the following important exceptions for products, which does not need to be registered:

- Products exclusively for private use.
- Pharmaceuticals ready for use.
- Cosmetic products.

The Danish product register does therefore not comprise a complete account of used chemicals. Source allocations of exceptions from the duty of declaration are done based on information from trade organisations, industries, scientific reports and information from the internet.

Outputs from the inventory are

- a list where the 34 most predominant NMVOCs are ranked according to emissions to air,

- specification of emissions from industrial sectors and from households,
- contribution from each NMVOC to emissions from industrial sectors and households,
- yearly trend in NMVOC emissions, expressed as total NMVOC and single chemical, and specified in industrial sectors and households.

5.6 Uncertainties and time-series consistency

An estimate of the overall uncertainty in EMEP/CORINAIR of 165 % is used. A full tier 1 and tier 2 (Monte Carlo) uncertainty analysis is currently being made for the solvent sector.

Important uncertainty issues related to the mass-balance approach are

(i) Identification of chemicals that qualify as NMVOCs. Although a tentative list of 650 chemicals from NAI (2000) has been used, it is possible that relevant chemicals are not included, e.g. chemicals that are not listed with their name in Statistics Denmark (StatBank DK, 2008) but as a product.

(ii) Collection of data for quantifying production, import and export of single chemicals and products where the chemicals are comprised. For some chemicals no data are available in StatBank DK (2008). This can be due to confidentiality or that the amount of chemicals must be derived from products wherein they are comprised. For other chemicals the amount is the sum of the single chemicals *and* product(s) where they are included. The data available in StatBank DK (2008) is obtained from Danish Customs & Tax Authorities and they have not been verified in this assessment.

(iii) Distribution of chemicals on products, activities, sectors and households. The present approach is based on amounts of single chemicals. To differentiate the amounts into industrial sectors it is necessary to identify and quantify the associated products and activities and assign these to the industrial sectors and households. No direct link is available between the amounts of chemicals and products or activities. From the Nordic SPIN database it is possible to make a relative quantification of products and activities used in industry, and combined with estimates and expert judgement these products and activities are differentiated into sectors. The contribution from households is also based on estimates. If the household contribution is set too low, the emission from industrial sectors will be too high and vice versa. This is due to the fact that the total amount of chemical is constant. A change in distribution of chemicals between industrial sectors and households will, however, affect the total emissions, as different emission factors are applied in industry and households, respectively.

A number of activities are assigned as "other", i.e. activities that can not be related to the comprised source categories. This assignment is based on expert judgement but it is possible that the assigned amount of chemicals may more correctly be included in other sectors. More detailed information from the industrial sectors is continuously being implemented.

(iv) Rough estimates and assumed emission factors are used for some chemicals. For some chemicals more reliable information has been obtained from the literature and from communication with industrial sectors. In some cases it is more appropriate to define emission factors for sector specific activities rather than for the individual chemicals.

A quantitative measure of the uncertainty has not been assessed. Single values have been used for emission factors and activity distribution ratios etc. A Tier 2 Monte Carlo assessment is currently being implemented in the Danish inventory.

5.7 QA/QC and verification

Table 5.6 External and internal data.

File or folder name	Description	AD or Emf.	Reference	Contact(s)	Data agreement/ Comment
"Emissioner NMVOC" folder	Production, import and export data from Statistics Denmark	Activity data	Statistics Denmark	Patrik Fauser	
NMVOC emissions.xls	Calculations, emissionfactors, SPIN data. For industrial branches (NACE)	Activity data and emissionfactors	Statistics Denmark, SPIN, reports, personal communication	Patrik Fauser	
Use Category National.xls	Calculations, emissionfactors, SPIN data (UCN and NACE) and use amounts from Statbank.	Activity data and emissionfactors	Statistics Denmark, SPIN, reports, personal communication	Patrik Fauser	
Emission factors solvent use.xls	Emission factors for chemicals in CRF and SNAP sub-categories. CO_2 conversion factors.	Emission factors and CO_2 conversion factors	Scientific reports, personal communication and expert judgement	Patrik Fauser	

The QA/QC procedure is outlined in section 1.6?. In general, Critical Control Points (CCP) have been defined as elements or actions, which need to be addressed in order to fulfil the quality objectives. The CCPs have to be based on clear measurable factors, expressed through a number of Points for Measuring (PM). The list of PMs are listed in Nielsen et al. (2009).

Data Storage level 1	1. Accuracy	DS.1.1.1	General level of uncertainty for every data set including the reasoning for the specific values

The sources of data described in the methodology section and in DS.1.2.1 and DS.1.3.1 are used in this inventory. It is the accuracy of these data that define the uncertainty of the inventory calculations. Any data value obtained from StatBank DK (2008) and SPIN are given as a single point estimate and no probability range or uncertainty is associated with this value. Information from reports is sometimes given in ranges. However, a Tier 2 (Monte Carlo) uncertainty assessment is currently being implemented in the Danish inventory, and a Tier 2 uncertainty estimate will be given for the solvent sector in the coming inventories. In the following list the current state of QA/QC and uncertainty assessment are stated.

Data Storage level 1	1. Accuracy	DS.1.1.2	Quantification of the uncertainty level of every single data value including the reasoning for the specific values.

No uncertainty levels are quantified for the external data.

Data Storage level 1	2. Comparability	DS.1.2.1	Comparability of the data values with similar data from other countries, which are comparable with Denmark and evaluation of the discrepancy.

1) Production and import/export data from StatBank DK (2008) for single chemicals can be directly compared with data from Eurostat (2008) for other countries. This has been done for a few chosen chemicals and countries. Furthermore, chosen Danish data from Eurostat (2008) have been validated with data from StatBank DK (2008) in order to check the consistency in data transfer from national to international databases.

2) Use categories for chemicals in products are found from the Nordic SPIN database. Data for all Nordic countries are available and reported uniformly. For chosen chemicals a comparison of chemical amounts and use has been made between countries.

3) A joint Nordic project funded by the Nordic Council of Ministers has been used on methodological issues and for emission factors.

Data Storage level 1	3.Completeness	DS.1.3.1	Documentation showing that all possible national data sources are included by setting up the reasoning for the selection of data sets

A number of external data sources form the basis for calculating emissions of single chemicals. The general methodology in the emission inventory is described above.

1) StatBank DK (2008) is used as the main database for collecting data on production, import and export of single chemicals, chemical groups and for some products. In order to obtain a uniform and unique set of data it is important that the data for e.g. production of single chemicals is in the same reporting format and from the same source. The amount of data is very comprehensive and is linked with the data present in Eurostat. The database covers all sectors and is regarded as complete on a national level.

2) Nordic SPIN database provides data on the use of chemicals in Norway, Sweden, Denmark and Finland. It is financed by the Nordic Council of Ministers, Chemical group, and the data is supplied by the product registries of the contributing countries. The Danish product register (PROBAS) is a joint register for the WEA and the EPA and comprises a large number of chemicals and products. The information is obtained from registration according to the EPA rules and from scientific studies and surveys and other relevant sources. The product register is the most comprehensive collection of chemical data in products for Denmark and with the availability of data from the other Nordic coun-

tries it enables an inter-country comparison. For each chemical the data is reported in a uniform way, which enhances comparability, transparency and consistency.

3) Reports from and personal contacts with industrial branches. It is fundamental to have information from the industrial branches that have direct contact with the activities, i.e. chemicals and products of interest. The information can be in the form of personal communication, but also reported surveys are of great importance. In contrast to the more generic approach of collecting information from large databases, the expert information from industrial branches may give valuable information on specific chemicals and/or products and industrial activities. By considering both sources a verification as well as optimum reliability and accuracy is obtained.

4) The present inventory procedure builds partly on information from the previous Danish solvent emission inventory, which is based on questionnaires to industrial branches. Furthermore a joint Nordic collaboration on solvent inventories has given important information on methods and data.

Data Storage level 1	4.Consistency	DS.1.4.1	The origin of external data has to be preserved whenever possible without explicit arguments (referring to other PM's)

Data are predominantly extracted from the internet (StatBank 2008 and SPIN). These are saved as original copies in their original form. Specific information from industries and experts are saved as e-mails and reports.

Data Storage level 1	6.Robustness	DS.1.6.1	Explicit agreements between the external institution of data delivery and NERI about the condition of delivery

As stated in DS.1.4.1 most data are obtained from the internet. No explicit agreements have been made with external institutions.

Data Storage level 1	7.Transparency	DS.1.7.1	Summary of each data set including the reasoning for selecting the specific data set

See DS.1.3.1.

Data Storage level 1	7.Transparency	DS.1.7.3	References for citation for any external data set have to be available for any single number in any data set.

See Table 5.6.

Data Storage level 1	7.Transparency	DS.1.7.4	Listing of external contacts to every data set

See Table 5.6.

Data Processing level 1	1. Accuracy	DP.1.1.1	Uncertainty assessment for every data source as input to Data Storage level 2 in relation to type of variability (Distribution as: normal, log normal or other type of variability)

Tier1 assumes normal distribution of activity data and emission factors.

Data Processing level 1	1. Accuracy	DP.1.1.2	Uncertainty assessment for every data source as input to Data Storage level 2 in relation to scale of variability (size of variation intervals)

In the Emission Inventory Guidebook uncertainty estimates for the final emission calculations are given for the associated SNAP codes.

Data Processing level 1	1. Accuracy	DP.1.1.3	Evaluation of the methodological approach using international guidelines

The methodological approach is based on the detailed methodology as outlined in the Emission Inventory Guidebook.

Data Processing level 1	1. Accuracy	DP.1.1.4	Verification of calculation results using guideline values

No guideline values are stated for Denmark in the Emission Inventory Guidebook.

Data Processing level 1	2.Comparability	DP.1.2.1	The inventory calculation has to follow the international guidelines suggested by UNFCCC and IPCC.

See DP.1.1.3 and DS.1.3.1.

Data Processing level 1	3.Completeness	DP.1.3.1	Assessment of the most important missing quantitative knowledge

In "Uncertainties and time-series consistency" important uncertainty issues related to missing quantitative knowledge is stated. To summarise; (i) identification and inclusion of all relevant chemicals (and products). (ii) Collection of data for quantifying production, import and export of single chemicals. (iii) Distribution of chemicals on products, activities, sectors and households. (iv) Emission factors for single chemicals, products and industrial and household activities.

Data Processing level 1	3.Completeness	DP.1.3.2	Assessment of the most important missing accessibility to critical data sources that could improve quantitative knowledge

The issues are referring to DP.1.3.1: (i) Identification of chemicals that qualify as NMVOCs. The definition in the solvent directive (Directive 1999/13/EC) is used. Here VOCs are defined as follows: "Volatile organic compound shall mean any organic compound having at 293,15 K a vapour pressure of 0,01 kPa or more, or having a corresponding volatility under the particular condition of use". A tentative list of 650 chemicals from the "National Atmospheric Emission Inventory" (NAI 2000) has been used, it is possible that relevant chemicals are not included. (ii) For some chemicals no data are available in StatBank DK (2008). This can be due to confidentiality or that the amount of chemicals must be derived from products wherein they are comprised. (iii) No direct link is available between the amounts of chemicals and products or activities. From the Nordic SPIN database it is possible to make a relative quantification of products and activities used in industry, and combined with estimates and expert judgement these products and activities are differentiated into sectors. More detailed information from the industrial sectors may still be required. (iv) For many industrial and household activities involving solvent containing products no estimates on emission factors are available. Large variations occur between industry and product groups. And given the large number of chemicals more specific knowledge regarding industrial processes and consumption is needed.

Data Processing level 1	4.Consistency	DP.1.4.1	In order to keep consistency at a higher level an explicit description of the activities needs to accompany any change in the calculation procedure

Any changes in calculation procedures are noted for each year's inventory.

Data Processing level 1	5.Correctness	DP.1.5.1	Shows at least once by independent calculation the correctness of every data manipulation

Calculations performed by IIASA using RAINS codes, which are based on a different methodological approach gives total emission values that are similar to the emissions found in the present approach.

Data Processing level 1	5.Correctness	DP.1.5.2	Verification of calculation results using time-series

No detailed guidelines or calculations are accessible for time-series. These are therefore not used for verification.

Data Processing level 1	5.Correctness	DP.1.5.3	Verification of calculation results using other measures

No other measures are used for verification.

Data Processing level 1	5.Correctness	DP.1.5.4	Shows one to one correctness between external data sources and the data bases at Data Storage level 2

The transfer of emission data from level 1, storage and processing, to data storage level 2 is manually checked.

Data Processing level 1	7.Transparency	DP.1.7.1	The calculation principle and equations used must be described

See methodological approach previously described.

Data Processing level 1	7.Transparency	DP.1.7.2	The theoretical reasoning for all methods must be described

See methodological approach previously described.

Data Processing level 1	7.Transparency	DP.1.7.3	Explicit listing of assumptions behind all methods

See methodological approach previously described.

Data Processing level 1	7.Transparency	DP.1.7.4	Clear reference to data set at Data Storage level 1

See Table 7?.

Data Processing level 1	7.Transparency	DP.1.7.5	A manual log to collect information about recalculations

Any changes in calculation procedures and methods are noted for each year's inventory.

Data Storage level 2	5.Correctness	DS.2.5.1	Documentation of a correct connection between all data type at level 2 to data at level 1

See DP.1.5.4.

Data Storage level 2	5.Correctness	DS.2.5.2	Check if a correct data import to level 2 has been made

See DP.1.5.4.

5.8 Recalculations

Improvements and additions are continuously being implemented due to the comprehensiveness and complexity of the use and application of solvents in industries and households. The main improvements in the 2008 reporting include the following:

- An improved and more detailed source allocation method has been implemented, which enables emission calculation on SNAP sub-category level.
- Emission factors (EFs) have been improved for some chemicals.
- EFs have been attributed to all chemicals on SNAP sub-category level.
- CO_2 conversion factors have been implemented for all chemicals.

5.9 Planned improvements

N_2O emissions from fire extinguishers will be assessed in the coming inventory. In a joint Nordic project in 2010 PAH, PCB, dioxin and mercury use and emissions will be investigated. Furthermore chemicals that are listed as products in Statistics Denmark, e.g. cosmetics, will be included in the inventory.

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6 Agriculture (CRF sector 4)

The emission of greenhouse gases from agricultural activities includes:

- CH_4 emission from enteric fermentation and manure management
- N_2O emission from manure management and agricultural soils
- NMVOC emission from agricultural soils
- Emission of CH_4, N_2O, NMVOC, CO and NOx from burning of straw on field

The emissions are reported in CRF Tables 4.A, 4.B(a), 4.B(b), 4.D and 4.F. Furthermore, the emission of NMVOC, CO and NO_x from field burning is given in CRF Table 4s2. CO_2 emissions from agricultural soils are included in the LULUCF sector.

Emission from rice production and burning of savannas does not occur in Denmark and the CRF Tables 4.C and 4E have, consequently, not been completed.

6.1 Overview

In CO_2 equivalents, the agricultural sector (without LULUCF) contributes with 16 % of the overall greenhouse gas emission (GHG) in 2008. Next to the energy sector, the agricultural sector is the largest source of GHG emission in Denmark. The major part of the emission is related to livestock production, which in Denmark is dominated by the production of cattle and pigs. Given in CO_2 equivalents, the N_2O emission contributed with 61 % of the total GHG emission from the agricultural sector and CH_4 contributed with the remaining 39 % in 2008.

From 1990 to 2008, the emissions decreased from 13.1 Mt CO_2 eqv. to 10.0 Mt CO_2 eqv., which corresponds to a 24 % reduction (Table 6.1). Since the previous reporting, there have been some changes. These changes reflect increased emissions in the years 1990-2002 and 2006 up to 2% and decreased emissions in the years 2004, 2005 and 2007 up to 3% compared to the total CO_2-equivalent emission from the agricultural sector (Section 6.8).

Table 6.1 Emission of GHG in the agricultural sector in Denmark 1990 – 2008

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
CH_4, Gg CO_2-eqv.	4 132	4 147	4 126	4 192	4 088	4 070	4 068	3 964	3 985	3 839
N_2O, Gg CO_2-eqv.	8 977	8 821	8 520	8 313	8 106	7 905	7 681	7 491	7 441	7 110
Total, Gg CO_2-eqv.	13 109	12 969	12 646	12 505	12 194	11 975	11 749	11 454	11 426	10 949
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
CH_4, Gg CO_2-eqv.	3 865	3 938	3 900	3 861	3 790	3 749	3 755	3 859	3 872	
N_2O, Gg CO_2-eqv.	6 833	6 585	6 360	6 137	6 114	6 153	5 987	5 900	6 154	
Total, Gg CO_2-eqv.	10 698	10 523	10 261	9 998	9 904	9 901	9 742	9 759	10 025	

Figure 6.1 shows the distribution of the greenhouse gas emission across the main agricultural sources. The total N_2O emission from 1990-2008 has decreased by 31 %. The decrease in national emissions can largely be

attributed to the decrease in N_2O emissions from agricultural soils. This reduction is due to a proactive national environmental policy over the last twenty years. The environmental policy has introduced a series of measures to prevent loss of nitrogen from agricultural soil to the aquatic environment. The measures include improvements to the utilisation of nitrogen in manure, a ban on manure application during autumn and winter, increasing area with winter-green fields to catch nitrogen, a maximum number of animals pr hectare (ha) and maximum nitrogen application rates for agricultural crops.

The main part of the emission from the agricultural sector is related to livestock production. The agricultural development has brought about a decrease in the N-excretion, a decrease of emission pr produced animal, because of more efficient feeding and a fall in use of synthetic fertilizer, which all has reduced the overall GHG emission.

From 1990 to 2008, only a slight reduction in the total CH_4 emission has occurred. The emission from enteric fermentation has increased from 2005-2008 due to an adjustment of feed intake for non dairy cattle. But from 1990 to 2008 the enteric fermentation has decreased mainly due to decrease in the number of cattle. The emission from manure management has increased due to a change towards greater use of slurry-based stable systems, which have a higher emission factor than systems with solid manure. By coincidence, the decrease and the increase almost balance each other out and the total CH_4 emission from 1990 to 2008 has decreased by 6 %.

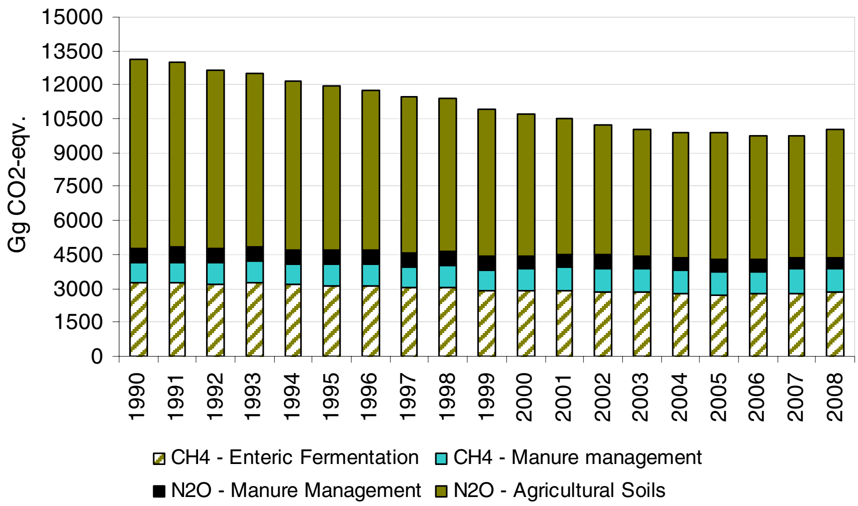

Figure 6.1 Danish greenhouse gas emissions 1990 – 2008.

6.1.1 References – sources of information

The calculations of the emissions are based on methods described in the IPCC Reference Manual (IPCC, 1997) and the Good Practice Guidance (IPCC, 2000).

Activity data and emission factors are collected and discussed in cooperation with specialists and researchers in various institutes, such as the Faculty of Agricultural Sciences – Aarhus University, Statistics Denmark, the Danish Agricultural Advisory Centre, the Danish Plant Directorate and the Danish Environmental Protection Agency. In this way, both data and methods will be evaluated continually, according to the latest knowledge and information. National Environmental Research Institute has established data agreements with the institutes and organisations to assure that the necessary data is available to prepare the emission inventory on time.

Table 6.2 List of institutes involved in the emission inventory for the agricultural sector.

References	Link	Abbreviation	Data/information
National Environmental Research Institute, University of Aarhus	www.dmu.dk	NERI	- reporting - data collecting
Statistics Denmark – Agricultural Statistics	www.dst.dk	DSt	- No. of animal - milk yield - slaughter data - land use - crop production - crop yield
Faculty of Agricultural Sciences, University of Aarhus	www.agrsci.dk	FAS	- N-excretion - feeding situation - animal growth - N-fixed crops - crop residue - N-leaching/runoff - NH_3 emissions factor
The Danish Agricultural Advisory Centre	www.lr.dk	DAAC	- stable type (until 2004) - grassing situation - manure application time and methods - field burning of agricultural residue
Danish Environmental Protection Agency	www.mst.dk	EPA	- sewage sludge used as fertiliser - industrial waste used as fertiliser
The Danish Plant Directorate	www.pdir.dk	PD	- synthetic fertiliser (consumption and type) - stable type (from 2005)
The Danish Energy Authority	www.ens.dk	DEA	- manure used in biogas plants

The emissions from the agricultural sector are calculated in a comprehensive agricultural model complex called IAD (Inventory Agriculture Data). This model complex, as shown in Figure 6.2, is implemented in great detail and is used to cover emissions of ammonia, particulate matter and greenhouse gases. Thus, there is a direct coherence between the ammonia emission and the emission of N_2O. A more detailed description has been published (Mikkelsen et al. 2006). New version with updated data and descriptions is planned to be published in 2010.

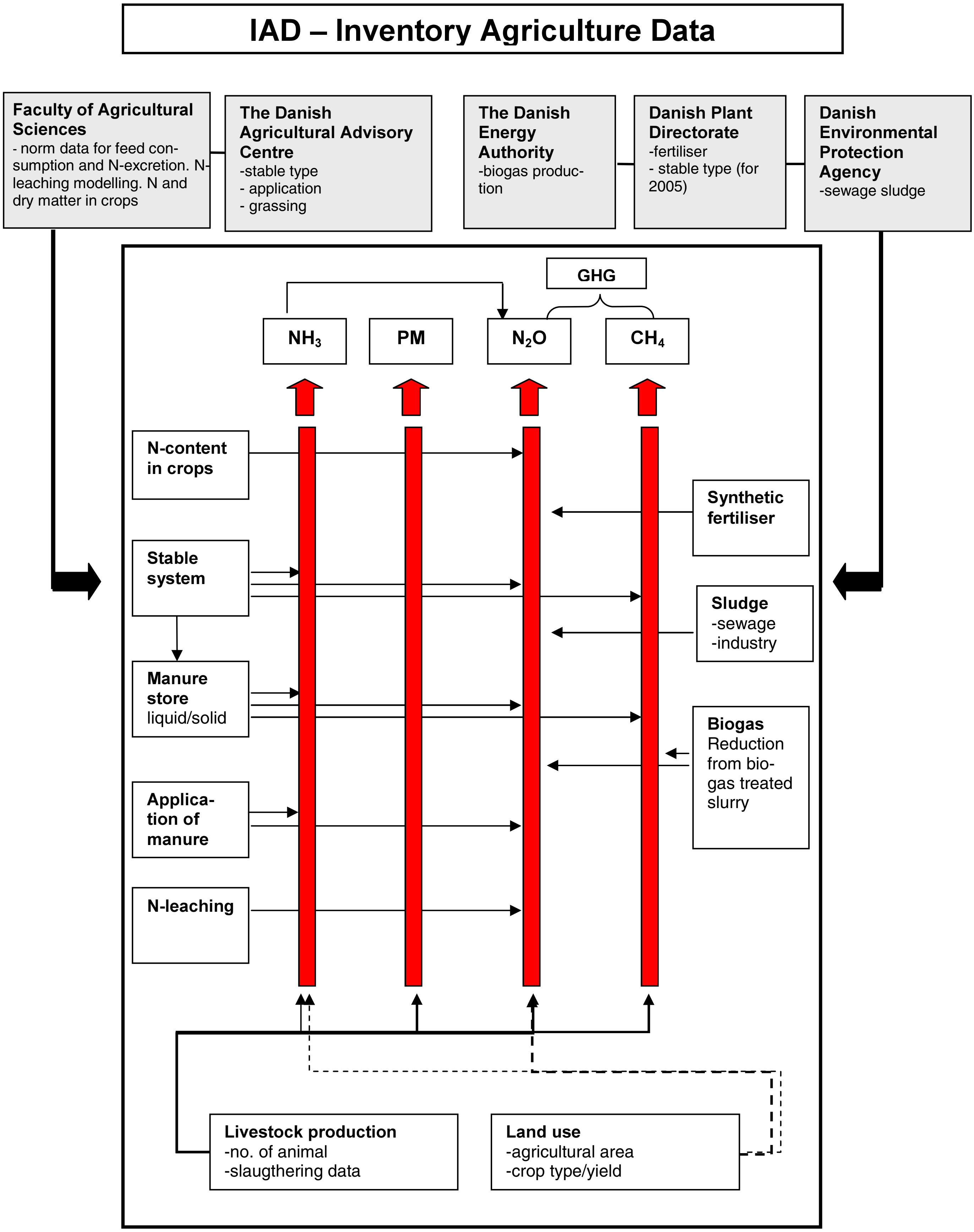

Figure 6.2 IAD – Inventory Agriculture Data.

The IAD model complex is build up as a database, where activity data is stored in one database and the calculations in another linked to the activity database. The main part of the emission is related to livestock production. In short, the emission from livestock production is based on information concerning the number of animals, the distribution of animals according to stable type and final information on feed consumption and excretion.

IAD operates with 38 different livestock categories, according to livestock category, weight class and age. These categories are subdivided into stable type and manure type, which results in around 200 different combinations of livestock subcategories and stable types (see appendix 3D table 6). For each of these combinations, information on e.g. feed intake, digestibility, excretion and methane conversion factors is attached. The emission is calculated from each of these subcategories and then aggregated in accordance with the IPCC livestock categories given in the CRF.

Table 6.3 shows an example of subcategories for cattle and swine.

Table 6.3 Livestock categories and subcategories.

CRF 4B	Aggregated livestock categories as given in IPCC	Includes	No. of subcategories in IAD, animal type/stable system
4B 1a	Dairy Cattle[1]	Dairy Cattle	12
4B 1b	Non-dairy Cattle[1]	Calves (<½ yr), heifers, bulls, suckling cattle	35
4B 3	Sheep	including lambs	1
4B 4	Goats	Including kids (meet, dairy and mohair)	3
4B 6	Horses	200 kg, 400 kg, 600 kg, 800 kg	4
4B 8	Swine	Sows, piglets, slaughtering pigs	24
4B 9	Poultry	Hens, pullet, broilers, turkey, geese, ducks	21
4B 13	Other	Fur farming, deer, Ostrich, pheasant	9

[1)] For all subcategories, large breed and jersey cattle are distinguished from each other.

It is important to point out that changes over the years, both to the national emission and the implied emission factor, are not only a result of changes in the numbers of animals, but also depend on changes in the allocation of subcategories, changes in feed consumption and changes in stable type.

Number of animals: Livestock production is primarily based on the agricultural census from Statistics Denmark (DSt). The emission from slaughter pigs and poultry is based on slaughter data. Approximate numbers of horses, goats and sheep on small farms are added to the number in DSt, in agreement with the Danish Agricultural Advisory Centre (DAAC) because Statistics Denmark does not include farms less than 5 ha. Statistics Denmark is the source for the database kept by FAO (Food and Agriculture Organization of the United Nations). This explains why the number of sheep, goats and horses in FAO and the Danish emission inventory disagree. The largest difference is found for horses. In the agricultural census, for 2008 the number of horses is estimated to be 60 029. Including horses on small farms and riding schools, however, the number of horses rises to approximately 190 000. As recommended by the ERT improvements to the documentation of the number of sheep and goats on small farms are made. Data on the number of sheep and goats is based on the Central House-animal farm Register (CHR) which is the central register of farms and animal of the Ministry of Food, Agriculture and Fisheries.

This year the inventory furthermore includes emission from deer, ostriches and pheasants. These animal categories are not included in Statistics Denmark and the number of deer and ostriches are based on information delivered from CHR. The number of pheasants is based on expert judgement from NERI and the pheasant breeding association.

Stable type: From 2005, all farmers have to report to the Danish Plant Directorate information concerning the use of stable type. Annex 3D Table 5 shows the stable type for each livestock category 1990 – 2008.

Before 2005 there exist no official statistics concerning the distribution of animals according to stable type. The distribution is, therefore, based on an expert judgement from the Danish Agricultural Advisory Centre (DAAC) and Faculty of Agricultural Sciences (FAS). Approximately 90-95 % of Danish farmers are members of DAAC, which regularly collects statistical data from the farmers on different issues, as well as making recommendations with regard to farm buildings. Hence, DAAC have a very good feeling of which stable types are currently in use.

Feed consumption and excretion: The Faculty of Agricultural Sciences (FAS) delivers Danish standards related to feed consumption, contribution of different manure type in different stable types, nitrogen content in manure, etc. The Danish Normative System for animal excretions is based on data from the Danish Agricultural Advisory Centre (DAAC). DAAC is the central office for all Danish agricultural advisory services. DAAC carries out a considerable amount of research itself, as well as collecting efficacy reports from the Danish farmers for dairy production, meat production, pig production, etc., to optimise productivity in Danish agriculture. In total, feed plans from 15-18 % of the Danish dairy production, 25-30 % of the pig production, 80-90 % of the poultry production and approximately 100 % of the fur production are collected. These basic feeding plans are used to develop the Danish Normative System. For dairy cows, approximately 800 feeding plans are used to develop the norm figures. Previously, the standards were updated and published every third or fourth year – the last one is Poulsen et al. from 2001. These standards have been described and published in English in Poulsen & Kristensen (1998). From 2001, NERI receives updated data annually directly from FAS and the data is available at the homepage of FAS http://www.agrsci.au.dk/ny_navigation/institutter/institut_for_husdyrbiologi_og_sundhed/husdyrernaering_og_miljoe/normtal.

6.1.2 Key category identification

In the key category analysis the agriculture emissions are divided into 13 categories, refer Annex 1. In the tier 1 KCA including LULUCF 8 of these categories are in 2008 key categories according to level and 7 of these are key categories for level and trend; a further category is key to trend only, Table 6.4. All of these 9 categories are identified as level key categories for the base year 1990.

The 3 most important agriculture key categories are CH_4 from enteric fermentation and N_2O emission from agricultural soils – nitrogen leaching and run-off and synthetic fertilizers, contributing according to the level analysis for 2008 4.2, 3.0 and 2.0 %, respectively, of the total national GHG emission.

Table 6.4 Key category identification from the agricultural sector 1990 and 2008.

CRF table	Compounds	Emission source	Key category identification
2008			
4.A	CH_4	Enteric fermentation	Level/trend
4.B(a)	CH_4	Manure management	Level/trend
4.B(b)	N_2O	Manure management	Level/trend
4.D	N_2O	Agriculture soils, Crop Residue	Level
4.D	N_2O	Agriculture soils, Atmospheric Deposition	Level/trend
4.D	N_2O	Agriculture soils, Nitrogen Leaching and Run-off	Level/trend
4.D	N_2O	Agriculture soils, Synthetic Fertilizers	Level/trend
4.D	N_2O	Agriculture soils, Animal Manure Applied to Soils	Level/trend
4.D	N_2O	Agriculture soils, Pasture, range and paddock	/trend
1990			
4.A	CH_4	Enteric fermentation	Level
4.B(a)	CH_4	Manure management	Level
4.B(b)	N_2O	Manure management	Level
4.D	N_2O	Agriculture soils, Crop Residue	Level
4.D	N_2O	Agriculture soils, Atmospheric Deposition	Level
4.D	N_2O	Agriculture soils, Nitrogen Leaching and Run-off	Level
4.D	N_2O	Agriculture soils, Synthetic Fertilizers	Level
4.D	N_2O	Agriculture soils, Animal Manure Applied to Soils	Level
4.D	N_2O	Agriculture soils, Pasture, range and paddock	Level

6.2 CH_4 emission from Enteric Fermentation (CRF Sector 4A)

6.2.1 Description

The major part of the agricultural CH_4 emission originates from digestive processes. In 2008, this source accounts for 28 % of the total GHG emission from agricultural activities. The emission is primarily related to ruminants and, in Denmark, particularly to cattle, which, in 2008, contributed with 84 % of the emission from enteric fermentation. The emission from pig production is the second largest source and covers 11 % of the national emission from enteric fermentation, followed by horses (3 %) and sheep, goats and deer (2 %).

6.2.2 Methodological issues

The implied emission factors for all animal categories are based on the Tier 2/Country Specific (CS) approach. Feed consumption for all animal categories is based on the Danish normative figures. Default values for the methane conversion rate (Y_m) given by the IPCC are used for all livestock categories, except for dairy cattle and heifers, where a national Y_m is used for all years (Annex 3D Table 3a).

Table 6.5 CH_4 - Enteric fermentation – use of national parameters and IPCC default values.

CH_4 - Enteric fermentation	National parameters	IPCC default value
Gross energy intake (GE)	Based on feed units (Annex 3D, Table 2a + 2b)	
Methane conversion rates (Y_m)	Dairy cattle and heifer (Annex 3D, table 3a)	Other animal categories

The Tier 2/CS equation for EF of enteric fermentation is given below. It is only dairy cattle and heifers which have sugar beets in the feed, therefore will the parts of the equation concerning sugar beet be left out for the remaining animal categories.

$$EF = EF_{winter} + EF_{summer}$$

$$EF_{winter} = FE \cdot ((GE_{FE\,winter}/55.65) \cdot Y_{m\,excl\,sugar\,beet} \cdot (1 - grazing\,days/365 - days\,with\,sugar\,beet/365) + (GE_{FE\,winter}/55.65) \cdot Y_{m\,incl\,sugar\,beet} \cdot days\,with\,sugar\,beet/365)$$

$$EF_{summer} = FE \cdot (GE_{FE\,summer} / 55.65) \cdot Y_{m\,grazing} \cdot grazing\,days/365$$

Where:

FE = feeding units
GE_{FE} = gross energy pr feeding unit, MJ pr FE

The Tier2/CS for enteric fermentation differs mainly from the IPCC Tier 2 in the calculation of GE. A comparison between these two methods is shown in chapter 6.2.4.

Gross energy intake (GE)

In Annex 3D Table 2a, the annual average feed intake (GE) is shown, from 1990 to 2008, for each CRF livestock category. Table 2b shows the GE for each subcategory for non-dairy cattle and swine.

The normative data are based on actual efficacy feeding controls or actual feeding plans at farm level, collected by DAAC or FAS. For cattle, approximately 20 % of the herd is included and for pigs, approximately 35 % are included. The data is given in Danish feed units or kg feedstuff and is converted to mega joule (MJ). A more detailed description is given in Mikkelsen et al (2006). For grassing animals the energy content in the winter periods feed plan and the energy plan in grass are distinguished between. Annex 3D, Table 1 provides additional information about grassing days for each livestock category.

Methane conversion rate (Y_m)

New investigations from FAS have shown a change in fodder practice from use of sugar beet to maize (whole cereal). Sugar beet feeding gives a higher methane production rate compared to grass and maize due to the high content of easily convertible sugar. The development in fodder practice reflects the change in the average Y_m for dairy cattle and heifer from 6.39 in 1990 to 5.94 in 2008.

The estimation of the national values of Y_m is based on model "Karoline" developed by FAS based on average feeding plan for 20 % of all dairy cows in Denmark obtained from the Danish Agricultural Advisory Centre DAAC (Olesen et al.; 2005). FAS have estimated the CH_4 emission for a winter feeding plan for two years, 1991 (Y_m=6.7) and 2002 (Y_m=6.0). Y_m for the years between 1991 and 2002 are estimated by interpolation and for 1990 and 2003 to 2008 by extrapolation where the actual sugar beet area is taken into account. Data for actual sugar beet area are in Annex 3D table 3b. Sugar beet is only included in the winter feeding plan and the Y_m is therefore also adjusted for days on winter and summer feeding plan. It is assumed that winter feeding plan covers 200 days. The value of the estimated Y_m for 1991 and 2002 are, when adjusted for winter/summer, 6.35 and 5.96, respectively.

Implied emission factor

Table 6.6 shows the implied emission factors for all IPCC livestock categories. No default values are recommended in the IPCC Reference Manual or Good Practice Guidance for poultry, fur farming, ostrich and pheasants.

The implied emission factor (IEF) vary across the years for dairy cattle, other cattle and swine due to changes for feed consumption, allocation of subcategories and number of grassing days. For goats and horses new subcategories are introduced in 2007 and therefore the IEF differs from the other years. For sheep and deer the IEF is constant.

Table 6.6 Implied emission factor – Enteric Fermentation 1990 – 2008, kg CH_4 pr head pr yr.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1. Cattle										
a. Dairy	116.59	117.59	118.29	119.17	120.01	119.46	118.50	118.21	118.52	117.66
b. Non-Dairy	35.45	35.49	35.42	35.45	35.17	35.18	35.02	35.36	35.14	35.42
3. Sheep	17.17	17.17	17.17	17.17	17.17	17.17	17.17	17.17	17.17	17.17
4. Goats	13.15	13.15	13.15	13.15	13.15	13.15	13.15	13.15	13.15	13.15
6. Horses	21.34	21.34	21.34	21.34	21.34	21.34	21.34	21.34	21.34	21.34
8. Swine	1.07	1.08	1.10	1.07	1.10	1.07	1.11	1.10	1.10	1.13
9. Poultry	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
10. Other										
Fur farming	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Deer	11.30	11.30	11.30	11.30	11.30	11.30	11.30	11.30	11.30	11.30
Ostrich	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Pheasant	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE

Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008
1. Cattle									
a. Dairy	117.21	119.31	122.01	124.12	126.18	128.08	129.24	130.27	130.43
b. Non-Dairy	35.60	35.79	35.90	36.00	35.58	36.93	38.74	40.13	40.41
3. Sheep	17.17	17.17	17.17	17.17	17.17	17.17	17.17	17.17	17.17
4. Goats	13.15	13.15	13.15	13.15	13.15	13.15	13.15	12.80	13.05
6. Horses	21.34	21.34	21.34	21.34	21.34	21.34	21.34	21.81	21.81
8. Swine	1.11	1.09	1.09	1.09	1.11	1.05	1.10	1.08	1.13
9. Poultry	NE	NE	NE	NE	NE	NE	NE	NE	NE
10. Other									
Fur farming	NE	NE	NE	NE	NE	NE	NE	NE	NE
Deer	11.30	11.30	11.30	11.30	11.30	11.30	11.30	11.30	11.30
Ostrich	NE	NE	NE	NE	NE	NE	NE	NE	NE
Pheasant	NE	NE	NE	NE	NE	NE	NE	NE	NE

The increase in the IEF for dairy cattle from 1990-2008 is the result of increasing feed consumption due to rising milk yields. On average, the milk yield has increased from 6200 litre pr cow pr yr in 1990 to approximately 8200 litre pr cow pr yr in 2008 (Statistics Denmark). A comparison with IPCC Tier 2 calculation in chapter 6.2.4 shows that the IEF used in the Danish inventory are lower. However, the national IEF can be considered as reasonable because this can be explained by the improvement in feed efficiency which has taken place in the Danish agriculture from 2000.

The category "Non-Dairy Cattle" includes calves, heifers, bulls and suckle cows and the implied emission factor is a weighted average of these different subcategories. The development 1990 - 2004 in IEF shows a slight increase, which is due to changes in allocation of the subcategories. From 2005 to 2008 the IEF increases due to a higher feed consumption for heifers and these are interpolated in 2005 and 2006 as recommended by ERT.

The Danish IEF for non-dairy cattle is lower compared with the Tier 1 default value given in the IPCC Reference Manual (IPCC, 1997). This is due to a combination of lower Y_m value for heifer and lower weight/lower feed intake (Table 6.7). In chapter 6.2.4 the national IEF is compared with IPCC Tier 2 calculation and the result shows a good correlation which indicates the national estimate is reasonable.

Table 6.7 Subcategories for Non Dairy Cattle 2008 – enteric fermentation.

Non Dairy Cattle – subcategories (Based on an one year production)		Energy intake, MJ pr day	Methane conversion rate (Y_m), %	IEF, kg CH_4 pr head pr yr
Calves, bull (0-6 month)	200 kg	61.67	4.00	16.18
Calves, heifer (0-6 month)	150 kg	102.44	6.00	39.78
Bull (6 month to slaughter)	large breed: 440 kg sl. weight jersey: 330 kg sl. weight	116.01	4.00	30.44
Heifer (6 month to calving)	325 kg	130.47	5.94 (CS)	50.77
Suckling cattle	Up to 800 kg	163.56	6.00	63.51
Average - Non-Dairy Cattle				40.41
IPCC – default value				48.00

The yearly changes for pigs primarily reflect the changes in the allocation of the subcategories (sows, piglets and slaughter pigs). The feed intake for sows and piglets has overall increased while the feed intake for slaughtering pigs has decreased as a result of improved fodder efficacy (Annex 3D Table 2b). The feed consumption for piglets has, as recommended by ERT, been interpolated in 1991-1993.

In Table 6.8 the IEF for swine subcategories is shown. The lower IEF for swine compared to the IPCC default values is due a very high efficiency production in the Danish production. The majority of the pork meat is exported and an improvement in the genetic development and the production managements has results in high fodder efficiency especially for the production of slaughter pigs.

Table 6.8 Subcategories for Swine 2008 – enteric fermentation.

Swine – subcategories (Based on an one year production)	Energy intake, MJ pr day	Methane conversion rate (Y_m), %	IEF, kg CH_4 pr head pr yr
Sows (incl. piglets until 7.5 kg)	71.13	0.60	2.74
Piglets (7.5 – 30 kg)	15.22	0.60	0.60
Slaugther pigs (30 – 105 kg)	39.87	0.60	1.57
Average - Swine			1.13
IPCC – default value	38	0.60	1.5

It is important to point out that the IEF for sheep and goats includes emission from lambs and kids, which corresponds to the Danish normative data. This explains why the Danish IEF is nearly twice as high as the IPCC default value. A comparison with IPCC Tier 2 calculation (see chapter 6.2.4) which includes lamb indicates that the national IEF are reasonable.

Activity data

In Table 6.9, the development in the number of animals from the agricultural statistics (Statistics Denmark), DAAC and CHR from 1990 to 2008 is presented. The agricultural census does not include farms less than 5 ha. In the Danish emission inventory, the decision has been made to add number of sheep, goats and horses on small farms and deer, pheasants and ostriches based on information from DAAC and CHR (see chapter 6.1.1 – number of animals).

Since 1990, the number of swine and poultry has increased, in contrast to the number of cattle, which has decreased due to an increasing milk yield. Buffalo, camels and llamas, mules and donkeys are not relevant for Denmark.

Table 6.9 Number of animals from 1990 to 2008, 1000 head.

CRF Table 4.A, 4.B (a) and 4.B (b)	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
IPCC livestock categories:										
Dairy Cattle	753	742	712	714	700	702	701	670	669	640
Non-Dairy Cattle	1 486	1 480	1 478	1 481	1 405	1 388	1 393	1 334	1 308	1 247
Sheep*	92	107	102	88	80	81	94	96	101	106
Goats*	7	7	7	7	7	7	7	7	8	8
Horses*	135	137	138	140	141	143	144	146	147	149
Swine	9 497	9 783	10 455	11 568	10 923	11 084	10 842	11 383	12 095	11 626
Poultry	16 249	15 933	19 041	19 898	19 852	19 619	19 888	18 994	18 674	21 010
Other;										
Fur farming	2 264	2 112	2 283	1 537	1 828	1 850	1 918	2 212	2 345	2 089
Pheasant**	1 063	1 063	1 063	1 063	1 063	1 063	1 063	1 063	1 063	1 063
Deer**	10	10	10	10	10	10	10	10	10	10
Ostrich**	0	0	0	1	2	3	4	6	7	8
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
IPCC livestock categories:										
Dairy Cattle	636	623	610	596	563	564	550	545	558	
Non-Dairy Cattle	1 232	1 284	1 187	1 128	1 082	1 006	984	1 021	1006	
Sheep*	112	119	117	121	124	126	128	124	117	
Goats*	8	9	9	10	11	11	12	13	14	
Horses*	150	155	160	165	170	175	180	185	190	
Swine	11 922	12 608	12 732	12 949	13 233	13 534	13 361	13 723	12 738	
Poultry	21 830	21 236	20 580	17 844	16 649	17 632	17 425	16 741	15 406	
Other;										
Fur farming	2 199	2 304	2 422	2 361	2 471	2 552	2 708	2 837	2 747	
Pheasant**	1 063	1 063	1 063	1 063	1 063	1 063	1 063	1 063	1 063	
Deer**	10	11	10	10	10	10	10	10	10	
Ostrich**	9	10	7	5	4	4	4	1	0.5	

* Including animals on small farms (less than 5 ha), which are not covered by the Statistics Denmark.
** Not included in DSt

6.2.3 Time-series consistency

The national emission from enteric fermentation is given in Table 6.10. From 1990 to 2008, the emission has decreased by 14 %, which is primarily related to a decrease in the number of dairy cattle from 753 000 in 1990 to 558 000 in 2008. The number of pigs has increased from 9.5 M in 1990 to 12.7 M in 2008, but this increase is only of minor importance in relation to the total CH_4 emission from enteric fermentation.

Table 6.10 Emission of CH_4 from Enteric Fermentation 1990 – 2008, Gg CH_4.

CRF 4.A	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Dairy Cattle	87.81	87.21	84.22	85.10	83.95	83.91	83.02	79.24	79.30	75.33
Non-Dairy Cattle	52.68	52.53	52.35	52.51	49.42	48.82	48.76	47.17	45.97	44.17
Sheep	1.58	1.83	1.76	1.52	1.37	1.39	1.62	1.65	1.73	1.82
Goats	0.10	0.10	0.10	0.09	0.09	0.09	0.09	0.09	0.10	0.11
Horses	2.88	2.91	2.94	2.98	3.01	3.04	3.07	3.10	3.14	3.17
Swine	10.14	10.61	11.51	12.40	12.03	11.91	12.03	12.53	13.28	13.09
Poultry	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Other;										
Fur farming	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Deer	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
Ostrich	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Pheasant	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Total, Gg CH_4	155.29	155.29	152.99	154.70	150.00	149.28	148.71	143.90	143.63	137.78
Total, Gg CO_2 eqv.	3 261	3 261	3 213	3 249	3 150	3 135	3 123	3 022	3 016	2 893
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
Dairy Cattle	74.49	74.38	74.38	73.98	71.10	72.27	71.12	71.05	72.78	
Non-Dairy Cattle	43.88	45.93	42.60	40.62	38.50	37.15	38.13	40.96	40.67	
Sheep	1.92	2.04	2.02	2.08	2.13	2.17	2.19	2.13	2.02	
Goats	0.11	0.12	0.12	0.13	0.14	0.15	0.16	0.16	0.18	
Horses	3.20	3.31	3.41	3.52	3.63	3.73	3.84	4.03	4.14	
Swine	13.26	13.69	13.94	14.05	14.62	14.16	14.69	14.85	14.36	
Poultry	NE	NE	NE	NE	NE	NE	NE	NE	NE	
Other;										
Fur farming	NE	NE	NE	NE	NE	NE	NE	NE	NE	
Deer	0.11	0.12	0.11	0.11	0.11	0.11	0.11	0.11	0.11	
Ostrich	NE	NE	NE	NE	NE	NE	NE	NE	NE	
Pheasant	NE	NE	NE	NE	NE	NE	NE	NE	NE	
Total, Gg CH_4	136.96	139.58	136.58	134.49	130.24	129.74	130.25	133.30	134.26	
Total, Gg CO_2 eqv.	2 876	2 931	2 868	2 824	2 735	2 724	2 735	2 799	2 819	

NE = Not estimated.

6.2.4 Tier 2/Country Specific compared to IPCC Tier 2 method

As recommended by ERT a comparison between IPCC Tier 2 and Denmark's Tier2/Country Specific (CS) calculation method for enteric fermentation is made. In IPCC default values are given for dairy cattle, non-dairy cattle and sheep therefore is a comparison made for these three groups.

Calculations of IEF are made by IPCC Tier 2, with both default and national values for Y_m, and Denmark's Tier 2/CS method. A comparison between IEF (Table 6.11) shows that the Danish method gives a value for dairy cattle there is up to 7 % lower than the IPCC Tier 2 and for non-dairy cattle a value up to 5 % higher. To compare the IEF for sheep the calculation includes lamb. The Danish method gives a 7 % lower value than IPCC with default values for Y_m, but a 9 % higher value than IPCC with national values for Y_m.

Table 6.11 EF for enteric fermentation calculated by to methods, 2008.

IEF, kg CH_4 pr animal pr year	Tier 2 (IPCC Y_m)	Tier 2 (DK Y_m)	Tier 2/CS
Dairy Cattle	140.3	137.9	130.4
Non-Dairy Cattle	38.8	38.3	40.4
Sheep (incl. lambs)	18.4	15.8	17.2

The three different Tier 2 calculations for Non-dairy cattle all shows an IEF between 38-41 kg pr head pr yr, which indicate that the Tier 2/CS used in the Danish inventor seems to be reasonable. However, these values are particularly higher compared to the Tier 1 default value at 48 kg pr head pr yr given in the Reference manual (IPCC, 1997) (Table 4.-4) which properly can be explained by combination of lower Y_m for heifers and lower animal weight/lower feed intake.

The calculations of IEF for sheep indicate that the value used in the Danish inventor are reasonable. A Tier 2 calculation, where the productions of lamb are included, based on IPCC Y_m shows an IEF at the same level.

The lower value for IEF for dairy cattle is mainly due to a lower value for gross energy (GE) (Table 6.12). The Danish values for feed consumption is based on the Danish normative figures and the normative data are based on actual efficacy feeding controls or actual feeding plans at farm level, more info on GE calculations in chapter 6.2.2.

Table 6.12 Gross energy for dairy cattle calculated by to methods, 2008

GE, MJ pr animal pr day	Tier 2 (IPCC Y_m)	Tier 2/CS
Dairy cattle	356.4	335.3

In Statistic Denmark is given that in average dairy cattle produce 22.5 kg milk pr animal pr day in 2008. In table 6.13 shows the need of energy intake to produce this milk production calculated by two different methods. By using the Tier 2 calculation given in the Reference manual (IPCC, 1997) 15.8 MJ is needed to produce 22.5 kg milk/animal/day. National data for feed intake which reflect the actual Danish agricultural conditions shows a lower need of energy intake corresponding to 14.9 MJ. This is a result of improved feeding efficiency.

Table 6.13 MJ pr kg milk produced 2008

	Kg milk pr animal pr day	MJ pr kg milk Tier 2	MJ pr kg milk Tier 2/CS
Dairy cattle	22.5	15.8	14.9

In Figure 6.3 is shown the Danish trend of MJ pr kg milk for dairy cattle. It is seen that the energy intake pr kg milk have overall decreased from 1996 up till now. Around 1999 the Danish level of MJ pr kg milk was at the same level as given in the IPCC Tier 2 method. Since then have feeding efficiency continued to rice due to the structural development – bigger farms and more intensive production. This can an explanation of the lower IEF for dairy cattle used in the Danish inventory.

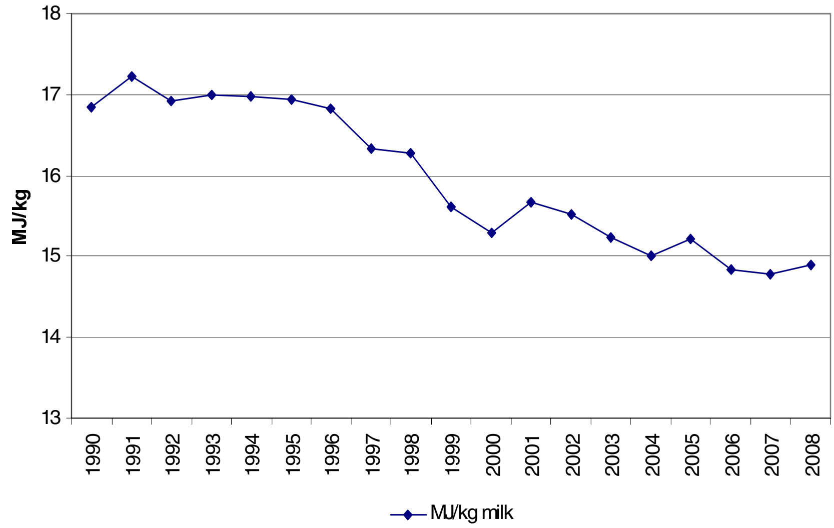

Figure 6.3 The Danish trend for MJ pr kg milk produced for dairy cattle, 1990-2008.

6.3 CH_4 and N_2O emission from Manure Management (CRF Sector 4B)

6.3.1 Description

The emissions of CH_4 and N_2O from manure management are given in CRF Table 4.B (a) and 4.B (b). This source contributes with 16 % of the national emission from the agricultural sector in 2008 and the major part of the emission originates from the production of cattle (45 %) followed by swine production (40 %). The remaining part is mainly from poultry (14 %).

6.3.2 Methodological issues

CH_4 emission

The IPCC Tier 2/CS methodology is used for the estimation of the CH_4 emission from manure management. This year some changes have been made. The calculation is based on manure excretion instead of feed intake as described in IPCC Reference manual (IPCC, 1997). Default values for maximum methane producing capacity, B_0 and methane conversion factor, MCF given by the IPCC are used. Calculation of volatile solids, VS is based on national data.

Table 6.14 CH_4 – Manure management – use of national parameters and IPCC default values.

CH_4 – Manure management	National parameters	IPCC default value
Volatile solids, VS	Based on amount of manure (Annex 3D table 4a and 4b)	
Maximum methane producing capacity, B_0		IPCC 1997
Methane conversion factor, MCF		IPCC 1997

The amount of manure is calculated for each combination of livestock subcategory and stable type and then aggregated to the IPCC livestock categories. In the calculation grazing days and use of straw in the stable is taken into account. Equation for CH_4 calculation:

$$CH_{4_{Manure}} = CH_4 \text{ stable} + CH_4 \text{ grazing}$$

$$CH_4 \text{ stable} = VS_{stable} \cdot MCF \cdot 0.67 \cdot B_0$$

$$CH_4 \text{ grazing} = VS_{grazing} \cdot MCF \cdot 0.67 \cdot B_0$$

VS is calculated from data concerning amount of manure, dry matter content, share of VS in dry matter, amount of bedding and grazing days. Except from grazing days, all these parameters are based on Danish Normative data.

MCF used for slurrey

Default values provided in the IPCC guidelines for the methane production B_o and MCF are used. For liquid systems, the MCF of 10 % in the Reference Manual (IPCC, 1997) is used.

The revised 1996 IPCC guidelines use a default MCF of 10% for liquid//slurry, which is based on research of Hashimoto, A. and J. Steed (1993) and Woodbury, J.W. and A. Hashimoto (1993). This MCF value was changed to 39% in the revised guidelines IPCC 2000 - the Good Practice Guidance, without any scientific argumentation, documentation or specific references. It has to be remarked that the new IPCC 2006 guidelines return to a MCF value of 10 % for Danish conditions referred to Judgement of IPCC Expert Group in combination with Mangino *et al.* (2001) and Sommer et al. (2000).

The methane emission from liquid systems is very sensitive to temperature effects. Basically most of the manure is stored in Denmark under cold conditions (<5-10 degrees) .The CH4 formation practically stops at 4° and therefore there are no plausible arguments that 39% of total CH4 capacity should be released under Danish conditions. Danish studies confirm this assumption (Husted, 1994 and Sommer et al. 2000). Furthermore, investigations based on measurements in Canada, which conditions are similar to Denmark, support this value (Massé et al. 2003). Support of this value is also found from a Swedish review (Dustan, 2002), taking both the cold climate and the fact that the slurry containers usually have a surface cover, in to account and which also argues for a liquid MCF at 10 %.

Considering the agricultural conditions in Denmark and the present scientific knowledge as described above a MCF of 10 % for liquid/slurry is more appropriate under the Danish conditions. The Danish decision of using a MCF of 10 % is as demonstrated above backed by several scientific papers as well as both the revised 1996 IPCC Guidelines and the IPCC 2006 Guidelines. Therefore Denmark intends to continue using a MCF value of 10 % until scientific knowledge become available

It has to be remarked that countries with comparable climate use a MCF for liquid/slurry at the same level as default recommended in the revised IPCC 1996 guidelines. Sweden, Finland and Germany use the same value as Denmark, which mean a MCF at 10 %, Belgium use 19 % and Norway and Netherland use a MCF below 10 %.

Reduction from biogas treated slurry

Animal slurry treated in biogas plants reduce the emission of CH_4 and N_2O (Sommer et al. 2001) and this reduction is included in the emission inventory as reduced emission from dairy cattle and pigs for slaughter, which is the main sources of the production of slurry.

In 2008, approximately 8 % (0.98 Mt of cattle slurry and 1.20 Mt of pig slurry) were treated in biogas plants (DEA 2008) (Annex 3D Table 7). The reduction in the CH_4 emission is based on model calculations for an average size biogas plant with a capacity of 550 m^3 pr day. The reduced CH_4 emission is calculated as:

$$\mathrm{CH4}_{reduction,i} = \mathrm{VS}_{treatedslurry,i} \cdot \mathrm{B}_{\mathrm{o,i}} \cdot \mathrm{MCF} \cdot 0.67 \cdot \mathrm{R}_{CH4-potetial,i}$$

Where; $CH_{4\ reduction}$ is the reduction in the amount of methane from livestock type *i*, VS treated slurry is the total amount of treated slurry, B_0 is the maximum methane forming capacity, MCF is the methane conversion factor and $R_{CH4\text{-}potential}$ is the reduction potential (Table 6.15). A reduction potential of 30 % for cattle slurry and 50 % for pig slurry is obtained (Nielsen et al. 2002, Sommer et al. 2001).

Tabel 6.15 Key model parameters for reduction in CH_4 emission due to biogas plants.

	Dry matter (dm),[a] %	VS of dm,[b] %	$R_{CH4\text{-}potential}$,[c] %	MCF[d]	B_0[d]
Cattle	10.3	80	30	10	0.24
Swine	6.1	80	50	10	0.45

[a] FAS.

[b] Henrik.B. Møller, DIAS (pers. comm. 2003), Husted 1994 and Massé et al. 2003.

[c] Nielsen et al. 2002, Sommer et al. 2001.

[d] IPCC default.

Due to the biogas plants, the national emission of CH_4 is reduced by 1.28 Gg CH_4 (Table 6.16), which correspond a 3 % reduction of the CH_4 emission from manure management in 2008.

Table 6.16 Reduced CH_4 emissions from biogas treated slurry 1990 – 2008.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Amount of treated slurry, Mt										
- cattle	0.09	0.14	0.18	0.21	0.24	0.29	0.31	0.37	0.45	0.47
- swine	0.10	0.18	0.21	0.25	0.30	0.35	0.38	0.46	0.56	0.57
VS total in treated slurry										
- cattle	0.01	0.01	0.01	0.02	0.02	0.02	0.03	0.03	0.04	0.04
- swine	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.03	0.03
Total reduced emission, Gg CH_4	0.11	0.19	0.23	0.27	0.32	0.37	0.40	0.48	0.59	0.61
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
Amount of treated slurry, Mt										
- cattle	0.52	0.57	0.65	0.79	0.85	0.87	0.96	0.97	0.98	
- swine	0.64	0.69	0.79	0.97	1.03	1.06	1.18	1.18	1.20	
VS total in treated slurry										
- cattle	0.04	0.05	0.05	0.07	0.07	0.07	0.08	0.08	0.08	
- swine	0.03	0.03	0.04	0.05	0.05	0.05	0.06	0.06	0.06	
Total reduced emission, Gg CH_4	0.68	0.74	0.84	1.03	1.10	1.13	1.25	1.26	1.28	

CH_4–implied emission factor

Table 6.17 shows the development in the implied emission factors from 1990 to 2008. Variations between the years for dairy cattle, other cattle, poultry, swine and fur farming reflect changes in feed intake, allocation of subcategories, grassing situation and changes in stable type system.

The IEF for sheep, goats and deer is unaltered because of very few changes in feed intake and grassing days. A more detailed division in subcategories for goats and horses is from 2007 implemented and can explain the small change for horses.

Table 6.17 Implied emission factor – Manure Management 1990 – 2008, kg CH_4 pr head pr yr.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1a. Dairy Cattle	21.87	22.04	22.21	22.38	22.55	22.73	22.89	22.52	22.15	22.14
1b. Non-Dairy Cattle	4.85	4.75	4.69	4.63	4.56	4.50	4.43	4.40	4.42	4.44
3. Sheep	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52
4. Goats	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44
6. Horses	3.17	3.17	3.17	3.17	3.17	3.17	3.17	3.17	3.17	3.17
8. Swine	1.62	1.69	1.75	1.73	1.85	1.81	1.88	1.88	1.89	1.96
9. Poultry	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02
10. Other										
Fur farming	0.58	0.58	0.58	0.59	0.60	0.60	0.61	0.61	0.62	0.62
Deer	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Ostrich	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Pheasant	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
1a. Dairy Cattle	24.86	25.62	27.40	29.05	30.13	29.22	28.71	28.80	28.82	
1b. Non-Dairy Cattle	4.44	4.52	4.53	4.16	4.08	4.17	4.23	4.53	4.31	
3. Sheep	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	
4. Goats	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	
6. Horses	3.17	3.17	3.17	3.17	3.17	3.17	3.17	2.95	2.95	
8. Swine	1.94	1.85	1.91	1.89	1.95	1.83	1.89	1.92	2.02	
9. Poultry	0.02	0.02	0.02	0.03	0.03	0.03	0.02	0.03	0.04	
10. Other										
Fur farming	0.67	0.70	0.64	0.68	0.71	0.78	0.78	0.91	0.92	
Deer	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	
Ostrich	NE	NE	NE	NE	NE	NE	NE	NE	NE	
Pheasant	NE	NE	NE	NE	NE	NE	NE	NE	NE	

NE = Not estimated.

IEF for dairy cattle has increased as a result of an increasing milk yield, but also because of change in stable types. In Annex 3D, Table 5 shows the changes in stable types from 1990 to 2008. Old-style tethering systems with solid manure have been replaced by loose-housing with slurry-based systems. The MCF for liquid manure is ten times higher than that for solid manure. For non-dairy cattle, the opposite development has taken place. An increasing proportion of bull-calves are raised in stables with deep litter, where the MCF is lower than for liquid manure.

For pigs and fur farming, there has been a similar development as for dairy cattle with a move from solid manure to slurry-based systems.

The IEF for sheep and goats includes lambs and kids, which correspond to the Danish normative data. This explains why the Danish IEF is nearly twice as high as the IPCC default value.

The implied emission factor based on Tier 2/CS compared to IPCC default values shows some differences and can be explained by looking at the values for the most important parameters as volatile solids (VS), feed consumption and the part of animal placed on slurry based system.

As shown in table 6.18 the national IEF for dairy cattle is particularly higher, which is mainly due to the fact that more cattle are stabled on slurry based system than given in the IPCC assumptions. Furthermore VS used for Danish dairy cattle are higher due to higher milk yield.

For the category non dairy cattle a lower national IEF is seen. The national VS value is nearly the same as the default, but the lower feed consumption and a lower share of animals on liquid stable systems result in a lower IEF.

Table 6.18 Cattle – important parameters for calculation of the average implied emission factor for manure management 2008.

	IPCC			DK - 2008		
	VS kg dm pr hd pr day	Liquid/slurry %	IEF kg CH_4 pr hd pr yr	VS kg dm pr hd pr day	Liquid/slurry %	IEF kg CH_4 pr hd pr yr
Dairy	5.1	40	14	6.3	86	29
Non-dairy (average)	2.7	50	6	2.8	31	4
Calves, bull				1.5	0	0.6
Calves, heifer				1.8	0	0.8
Bulls > ½ yr				3.8	35	2.5
Heifer > ½ yr				3.0	44	5.8
Suckling cattle				4.1	9	2.5

The category of swine operates with three subcategories. The IEF is lower compared with the IPCC default value due to particularly lower VS value. In Reference manual (IPCC, 1997) is used 38 MJ pr head pr day which is significantly higher than the average feed intake for Danish piglets and slaughter pigs.

Table 6.19 Swine – important parameters for calculation of the average implied emission factor for manure management 2008.

	IPCC				DK - 2008			
	VS kg dm pr hd pr day	Feed intake MJ pr hd pr day	Pit > 1 month %	IEF Kg CH_4 pr hd pr yr	VS kg dm pr hd pr day	Feed intake MJ pr hd pr day	Liquid/slurry %	IEF kg CH_4 pr hd pr yr
Swine	0.5	38	73	3.0	0.2		94	2.0
Sows (incl. piglets until 7 kg)					0.3	71		
Piglets (7-30 kg)					0.1	2		
Slaugther pigs (30-104kg)					0.3	10		

Table 6.20 Emission of CH_4 from Manure Management 1990 – 2008, Gg CH_4.

CRF 4.A	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Dairy Cattle	16.47	16.35	15.81	15.98	15.78	15.96	16.04	15.10	14.82	14.18
Non-Dairy Cattle	7.21	7.02	6.93	6.87	6.41	6.25	6.16	5.87	5.78	5.53
Sheep	0.05	0.06	0.05	0.05	0.04	0.04	0.05	0.05	0.05	0.05
Goats	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Horses	0.43	0.43	0.44	0.44	0.45	0.45	0.46	0.46	0.47	0.47
Swine	15.40	16.52	18.33	20.03	20.16	20.04	20.41	21.37	22.92	22.80
Poultry	0.49	0.47	0.49	0.53	0.61	0.54	0.55	0.51	0.49	0.51
Other;										
Fur farming	1.31	1.23	1.33	0.91	1.09	1.12	1.17	1.36	1.45	1.30
Deer	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Ostrich	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Pheasant	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Total, Gg CH_4	41.39	42.11	43.42	44.83	44.57	44.43	44.88	44.75	46.00	44.87
Total, Gg CO_2 eqv.	869	884	912	941	936	933	942	940	966	942
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
Dairy Cattle	15.80	15.97	16.70	17.31	16.98	16.49	15.80	15.71	16.08	
Non-Dairy Cattle	5.47	5.80	5.37	4.69	4.41	4.19	4.16	4.63	4.34	
Sheep	0.06	0.06	0.06	0.06	0.06	0.07	0.07	0.06	0.06	
Goats	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	
Horses	0.48	0.49	0.51	0.52	0.54	0.56	0.57	0.55	0.56	
Swine	23.11	23.30	24.30	24.47	25.77	24.81	25.27	26.30	25.76	
Poultry	0.51	0.52	0.51	0.52	0.55	0.49	0.40	0.46	0.62	
Other;										
Fur farming	1.47	1.62	1.55	1.62	1.76	1.99	2.11	2.58	2.54	
Deer	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	
Ostrich	NE	NE	NE	NE	NE	NE	NE	NE	NE	
Pheasant	NE	NE	NE	NE	NE	NE	NE	NE	NE	
Total, Gg CH_4	46.94	47.80	49.04	49.23	50.11	48.62	48.41	50.32	49.99	
Total, Gg CO_2 eqv.	986	1 004	1 030	1 034	1 052	1 021	1 017	1 057	1 050	

NE = Not estimated.

N_2O emission

The N_2O emission from manure management is based on the amount of nitrogen in the manure in stables. The emission from manure deposits on grass is included in "Animal Production" (Section 6.4.2.2). The IPCC default emission values are applied, i.e. 2.0 % of the N-excretion for solid manure, 0.1 % for liquid manure and 0.5 % from poultry in stable systems without bedding. Nitrogen from poultry, without bedding, contributes less than 1 % to the total amount of nitrogen in manure.

The total amount of nitrogen in manure has decreased by 8 % from 1990 to 2008 (Table 6.21), despite the increasing production of pigs and poultry. This reduction is particularly due to an improvement in fodder efficiency, especially for slaughter pigs. A decrease in total amount of nitrogen means also a decrease for the N_2O emission. Another reason for the decreased N_2O emission is the lower emission factor for liquid manure than for solid manure. The development from the previous more traditional tethering systems with solid manure to slurry based system leads to a reduction in the emission of N_2O.

It is important to point out that the N-excretion rates shown in Table 6.21 are values weighted for the subcategories (Table 6.3). N-excretion reflects nitrogen excreted pr animal pr year. The variations in N-excretion in the time-series reflect changes in feed intake, fodder efficiency and allocation of subcategories.

Table 6.21 Nitrogen excretion, annual average 1990 – 2008, kg N pr head pr yr.

CRF table 4.B(b)	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Livestock category										
Non-dairy	36.57	36.68	36.80	36.92	36.64	36.56	36.62	36.81	36.71	36.98
Dairy cattle	129.49	128.63	127.76	126.89	126.06	125.22	125.09	124.94	124.82	124.60
Sheep	21.18	21.33	21.47	21.61	21.76	21.90	20.11	18.32	16.53	14.75
Goats	21.18	21.33	21.47	21.61	21.76	21.90	20.11	18.32	16.53	14.75
Swine	10.48	10.32	10.07	9.39	9.39	8.64	8.89	8.73	8.67	8.85
Poultry	0.70	0.70	0.62	0.64	0.71	0.66	0.65	0.66	0.65	0.60
Horses	48.89	47.77	46.66	45.54	44.42	43.31	43.31	43.31	43.31	43.31
Fur farming	4.90	4.83	4.80	4.75	4.70	4.65	4.66	4.65	4.64	4.63
Deer	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00
Ostrich	0	0	0	15.60	15.60	15.60	15.60	15.60	15.60	15.60
Pheasant	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
N-excretion, total, Gg N pr yr	283	281	282	283	273	264	265	264	268	259
N-excretion, stable, Gg N pr yr	248	246	247	246	238	229	229	228	233	225
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
Livestock category										
Non-dairy	37.20	37.61	37.59	37.44	38.39	40.79	43.05	44.93	45.01	
Dairy cattle	125.31	125.31	127.74	129.79	131.56	133.30	134.66	137.58	137.98	
Sheep	16.95	16.95	16.95	16.95	16.95	16.95	16.95	16.95	16.95	
Goats	16.95	16.95	16.36	16.36	16.36	16.36	16.36	15.61	16.32	
Swine	8.69	8.27	8.59	8.25	8.50	8.07	7.68	7.61	7.85	
Poultry	0.57	0.60	0.61	0.69	0.79	0.75	0.64	0.63	0.79	
Horses	43.31	43.31	43.31	43.31	43.31	43.31	43.31	39.56	39.56	
Fur farming	4.63	4.62	4.61	4.61	5.09	5.38	5.18	5.18	5.29	
Deer	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	
Ostrich	15.60	15.60	15.60	15.60	15.60	15.60	15.60	15.60	15.60	
Pheasant	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	
N-excretion, total, Gg N pr yr	261	263	265	259	264	263	255	260	259	
N-excretion, stable, Gg N pr yr	226	228	231	229	236	236	230	237	235	

The reduced effects from biogas-treated slurry are included in the N_2O-emission from manure management. No description in IPCC Reference Manual or GPG refers how to provide this reduction, why this estimation is based on Danish studies (Nielsen et al. 2002, Sommer et al. 2001). The reduced N2O emission is calculated as:

$$N_2O - N_{reduction} = N_{i,slurry,treated} \cdot N_{content} \cdot R_{N_2O,potential} \cdot EF_{N_2O}$$

Where; N_2O-N $_{reduction}$ is the reduction in the amount of N_2O, N $_{i, slurry, treated}$ is the total amounts of N in treated slurry from livestock type i, R $_{N20, potential}$ is the reduction potential (Table 6.22). For the emission factor for N_2O emission EF_{N2O} IPCC default is used (1.25 percent).

Tabel 6.22 Key model parameters for reduction in N_2O emission due to biogas plants.

	Total N in treated slurry, %[a]	$R_{N2O, potential}$, %[b]
Cattle	0.538	36
Swine	0.541	40

[a] Poulsen et al. 2001

[b] Nielsen et al. 2002, Sommer et al. 2001

Due to the biogas plants, the national emission of N_2O is reduced by 0.06 Gg N_2O (Table 6.23 and Annex 3D Table 7), which correspond a 4 % reduction of the N_2O emission from manure management in 2008.

Table 6.23 Reduced N_2O emissions from biogas-treated slurry 1990 – 2008.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Amount of treated slurry, Mt										
- cattle	0.09	0.14	0.18	0.21	0.24	0.29	0.31	0.37	0.45	0.47
- swine	0.10	0.18	0.21	0.25	0.30	0.35	0.38	0.46	0.56	0.57
Total reduced emission, Gg N_2O	0.00	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.03	0.03
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
Amount of treated slurry, Mt										
- cattle	0.52	0.57	0.65	0.79	0.85	0.87	0.96	0.97	0.98	
- swine	0.64	0.69	0.79	0.97	1.03	1.06	1.18	1.18	1.20	
Total reduced emission, Gg N_2O	0.03	0.03	0.04	0.05	0.05	0.05	0.06	0.06	0.06	

6.3.3 Time-series consistency

In Table 6.24, the national emission from manure management from 1990 to 2008 is shown. The N_2O emission has decreased by 24 %. The national emission from manure management has, nevertheless, increased by 1 % in CO_2 equivalents due to the increase in the CH_4 emission.

Table 6.24 Emissions of N_2O and CH_4 from Manure Management 1990 – 2008.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
N_2O emission										
Liquid manure, Gg N_2O	0.29	0.28	0.28	0.28	0.27	0.25	0.25	0.25	0.25	0.24
Solid manure, Gg N_2O	1.86	1.86	1.86	1.86	1.81	1.76	1.76	1.77	1.80	1.74
Total, Gg N_2O	2.15	2.14	2.15	2.14	2.08	2.01	2.01	2.02	2.04	1.98
Total, Gg CO_2 eqv.	667	663	665	663	644	622	623	625	634	612
CH_4 emission										
Total, Gg CH_4	41.39	42.11	43.42	44.83	44.57	44.43	44.88	44.75	46.00	44.87
Total, Gg CO_2 eqv.	869	884	912	941	936	933	942	940	966	942
Total Manure Management, Gg CO_2 eqv.*	1 536	1 547	1 577	1 604	1 580	1 556	1 566	1 565	1 600	1 555
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
N_2O emission										
Liquid manure, Gg N_2O	0.24	0.24	0.24	0.24	0.24	0.24	0.23	0.25	0.24	
Solid manure, Gg N_2O	1.64	1.64	1.59	1.52	1.55	1.59	1.52	1.38	1.39	
Total, Gg N_2O	1.88	1.88	1.83	1.76	1.79	1.83	1.75	1.63	1.63	
Total, Gg CO_2 eqv.	582	583	569	546	554	566	543	505	505	
CH_4 emission										
Total, Gg CH_4	46.94	47.80	49.04	49.23	50.11	48.62	48.41	50.32	49.99	
Total, Gg CO_2 eqv.	986	1 004	1 030	1 034	1 052	1 021	1 017	1 057	1 050	
Total Manure Management, Gg CO_2 eqv.*	1 567	1 587	1 598	1 580	1 607	1 587	1 560	1 562	1 555	

* Incl. the reduction from biogas treated slurry.

6.4 N_2O emission from Agricultural Soils (CRF Sector 4D)

6.4.1 Description

The N_2O emissions from agricultural soils, CRF Table 4.D, contribute, in 2008 with 56 % of the national emission from the agricultural sector. Figure 6.4 shows the distribution and the development from 1990 to 2008 according to different sources. The emission has overall decreased 33 %. The increase from 2007 to 2008 is due to a rise in the use of fertiliser, which can mainly be explained by expectations of rising prices.

The main part of the emission originates as direct emission. The largest sources here are manure and fertiliser applied on agricultural soils. Another large source is the indirect N_2O emission, of which the emission from nitrogen leaching is an essential part.

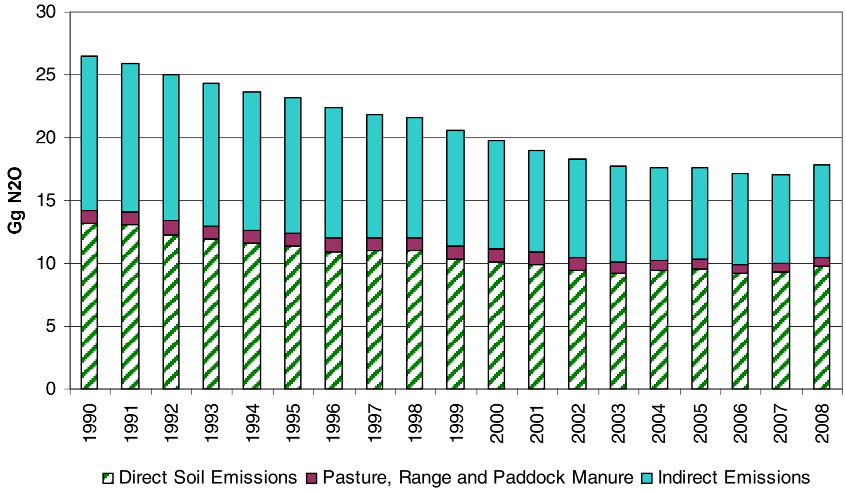

Figure 6.4 N_2O emissions from agricultural soils 1990 - 2008.

6.4.2 Methodological issues

To calculate the N_2O emission IPCC Tier 1b is used in combination with a country specific method (CS). Tier 1 b is use in calculation of emission from N-fixing crops, crops residue and atmospheric deposition.

Emissions of N_2O are closely related to the nitrogen balance and all data concerning the evaporation of ammonia and data for manure condition is applied from the national ammonia emission inventory. This is in more detailed described in Mikkelsen et al. 2006 and Denmark's annual inventory report, due to the UNECE-Convention on Longe-Range Transboundary Air Pollution (Nielsen et al., 2009) and are available on the internet. Specific for calculation of emission from nitrogen leaching and runoff a national model is used.

In connection to calculation of from The N_2O emission factors for all sources are based on the default values given in IPCC (2000), except from cultivation of histosols, which is based on a national factor. A NH3 and N_2O emission factor survey is presented in Table 6.25 and shows that except from histosols all N_2O emission factor is based on IPCC default values. The estimated emissions from the different sub-sources are described in the text which follows.

Table 6.25 Emissions factor - N_2O emission from the Agricultural Soils 1990 – 2008.

Agricultural soils – emission sources CRF Table 4.D	Ammonia emission factor (national data)	N_2O emission factor (national value)	N_2O emission factor (IPCC default value)
	Kg NH_3-N pr kg N	kg N_2O-N pr ha	kg N_2O -N pr kg N
1. Direct Soil Emissions			
Synthetic Fertiliser Applied to Soils	0.02		0.0125
Animal Wastes Applied to Soils	0.31 – 0.25		0.0125
N-fixing Crops			0.0125
Crop Residue			0.0125
Cultivation of Histosols		2.8 – 3.1	
2. Animal Production	0.07		0.02
3. Indirect Soil Emissions			
Atmospheric Deposition			0.01
Nitrogen Leaching and Runoff			0.025
4. Other			
Industrial Waste Used as Fertiliser			0.0125
Sewage Sludge Used as Fertiliser	0.02		0.0125

Direct emissions

Synthetic fertiliser

The amount of nitrogen (N) applied to soil via use of synthetic fertiliser is estimated from sales estimates from the Danish Plant Directorate, the source for the FAO database. Table 6.26 shows the consumption of each fertiliser type. Furthermore, the ammonia emission factor for each fertiliser is given, based on the values given in EMEP/EEA (2009). The Danish value for the FracGASF is estimated at 0.02 and is considerably lower than the recommended default value in IPCC, i.e. 0.10. The ammonia emission depends on fertiliser type and the major part of the Danish emission is related to the use of calcium ammonium nitrate and NPK fertiliser, where the emission factor is 0.01 kg NH_3-N pr kg N. The low Danish FracGASF is also due to the small consumption of urea (<1%), which has a high emission factor.

Table 6.26 Synthetic fertiliser consumption 2008 and the NH_3 emission factors.

Synthetic fertiliser year 2008	NH_3 Emission factor[1] kg NH_3-N pr kg N	Consumption[2] t N
Fertiliser type		
Calcium and boron calcium nitrate	0.01	0.1
Ammonium sulphate	0.02	6.2
Calcium ammonium nitrate and other nitrate types	0.01	104.9
Ammonium nitrate	0.01	9.7
Liquid ammonia	0.02	4.1
Urea	0.13	0.1
Other nitrogen fertiliser	0.06	18.1
Magnesium fertiliser	0.01	0.0
NPK-fertiliser	0.01	66.2
Diammonphosphate	0.01	0.4
Other NP fertiliser types	0.01	4.3
NK fertiliser	0.01	6.2
Total consumption of N in synthetic fertiliser		220.4
National emission of NH_3-N, M kg	4.00	
Average NH_3-N emission (FracGASF)	0.02	

[1]) EMEP/EEA (2009).

[2]) The Danish Plant Directorate.

The use of synthetic fertiliser includes fertiliser used in parks, golf courses and private gardens. 1 % of the synthetic fertiliser can be related to these uses outside the agricultural area.

As a result of increasing requirements for improved use of nitrogen in livestock manure and reduce the nitrogen loss to the environment, the consumption of nitrogen in synthetic fertiliser has more than halved from 1990 to 2008 (Table 6.27). From 2007 to 2008 the consumption is increased which is due to an expectation of rising prices and therefore the consumption is expected to decrease again in 2009.

Table 6.27 Nitrogen applied as fertiliser to agricultural soils 1990 – 2008.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
N content in synthetic fertiliser, Gg N	400	395	370	333	326	316	291	288	283	263
NH_3-N emission, Gg NH_3-N	7	7	6	6	6	6	5	5	5	4
N in fertiliser applied on soil, Gg N	393	388	363	327	320	310	286	283	279	258
N_2O emission, Gg N_2O	7.72	7.62	7.13	6.42	6.28	6.09	5.61	5.56	5.47	5.08
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
N content in synthetic fertiliser, Gg N	251	234	211	201	207	206	192	195	220	
NH_3-N emission, Gg NH_3-N	4	4	3	3	4	4	4	4	4	
N in fertiliser applied on soil, Gg N	247	230	207	198	203	203	188	191	216	
N_2O emission, Gg N_2O	4.86	4.51	4.07	3.89	3.99	3.98	3.70	3.75	4.25	

Manure applied to soil

The amount of nitrogen applied to soil is estimated as the N-excretion in stables minus the ammonia emission, which occur in stables, under storage and in relation to the application of manure. These values are based on national estimations and are calculated in the ammonia emission inventory (Table 6.28). The total N-excretion in stables from 1990 to 2008 has decreased by 5 %. Despite this reduction in N-excretion, the amount of nitrogen applied to soil remains almost unaltered, due to the reduction in the ammonia emission.

Table 6.28 Nitrogen applied as manure to agricultural soils 1990 – 2008.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
N-excretion, stable, Gg N	248	246	247	246	238	229	229	228	233	225
N ab Storage, Gg N	206	205	205	207	199	192	193	191	194	191
NH_3-N emission from application, Gg NH_3-N	34	32	31	30	28	25	24	24	24	23
N in manure applied on soil, Gg N	172	173	174	177	172	167	169	167	170	167
N_2O emission, Gg N_2O	3.39	3.39	3.42	3.48	3.37	3.27	3.31	3.28	3.34	3.29
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
N-excretion, stable, Gg N	226	228	231	229	236	236	230	237	235	
N ab Storage, Gg N	189	191	194	193	197	199	194	199	201	
NH_3-N emission from application, Gg NH_3-N	23	23	21	18	16	16	16	17	16	
N in manure applied on soil, Gg N	166	169	172	175	181	182	178	182	185	
N_2O emission, Gg N_2O	3.26	3.31	3.39	3.44	3.55	3.58	3.49	3.58	3.62	

The FracGASM express the fraction of total N-excretion (N ab animal) that is volatilised as ammonia emission in stables, storage and application. The FracGASM has decreased from 0.24 in 1990 to 0.19 in 2008 (Table 6.29). This is the result of an active strategy to improve the utilisation of the nitrogen in manure.

Table 6.29 FracGASM 1990 – 2008.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Total N-excretion, Gg N	283	281	282	283	273	264	265	264	268	259
NH_3-N emission from manure, Gg NH_3-N	76	74	74	72	69	64	63	64	65	63
FracGASM	0.24	0.24	0.23	0.23	0.23	0.22	0.22	0.22	0.22	0.22
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
Total N-excretion, Gg N	261	263	265	259	264	263	255	260	259	
NH_3-N emission from manure, Gg NH_3-N	63	63	61	57	57	54	52	54	53	
FracGASM	0.22	0.21	0.21	0.20	0.20	0.19	0.19	0.19	0.19	

N-fixing crops

To estimate the emission from N-fixing crops, IPCC Tier 1b is applied. The emission calculated is based on nitrogen content, the fraction of dry matter and the content of protein for each harvest crop type. Data for crop yield is based on data from Statistics Denmark. For nitrogen content in the plants, the data is taken from Danish feedstuff tables (Danish Agricultural Advisory Centre). The estimates for the amount of nitrogen fixed in crops are made by the Danish Institute of Agricultural Science (Kristensen 2003, Høgh-Jensen et al. 1998, Kyllingsbæk 2000).

$$N_2O\text{ - }N_{N\text{-fix}} = \sum (Ts_{i,\text{ yield}} \cdot N_{i,\text{ pct}} \cdot (1 + N_{i,\text{ pct in root and stubble}}) \cdot A_{\text{pct fix}}) \cdot EF_{N2O}$$

Where; N_2O-N is the nitrous oxide emission, Ts_{iyield} is the dry matter, yield, kg pr ha for croptype *i*, $N_{i,pc}$ is the nitrogen percentage in dry matter, $N_{i,pct\ root\ +\ stubble}$ is the nitrogen percentage in root and stubble, $A_{pct\ fix}$ is the percentage of nitrogen which is fixed and for the emission factor for N_2O emission EF_{N2O} the IPCC standard value of 1.25 percent is used.

The Danish inventory includes emissions from clover-grass, despite the fact that this source is not mentioned in the IPCC GPG. Area with grass and clover covered approximately 18 % of the total agricultural area in 2008 and, for this reason, represents an important contributor to the national emission from N-fixing crops.

In Table 6.30 the background data for estimating the N-fixing is listed. The emission from N-fixing crops decreases from 1990-2008, largely due to a reduction in agricultural area.

Table 6.30 Emissions from N-fixing crops 2008.

N_2O emission from nitrogen fixing crops	Dry matter Fraction, %	N-Fraction, % of DM	N-fixing variations 1990-2008, kg N pr ha	N-fixing 2008, kg N pr ha	N-fixing total 2008, kg N fix	N_2O Emission, Gg N_2O
Pulses*	0.85	0.0337	96-179	106	522	0.010
Lucerne	0.21	0.0064	302-517	390	1 465	0.029
Cereals and pulses for green fodder	0.23	0.0061	14-38	17	1 019	0.020
Pulses, fodder cabbage etc.	0.23	0.0061	0-1	NO	NO	NO
Peas for canning*	0.85	0.0337	76-144	85	305	0.006
Seeds for sowing	NE	NE	181-186**	182	812	0.016
Grass and clover field in rotation	0.13	0.0052	40-102	94	28 165	0.553
Grass and clover outside rotation	0.13	0.0052	6-11	7	1 355	0.027
Aftermath	0.13	0.0052	6-16	11	1 289	0.025
Total N-fix					34 931	
Total N_2O emission						0.686

* Dry matter content for straw is 0.87 and the N-fraction is 0.010.

** Average - assumed that N-fix for red clover is 200 kg N pr ha and 180 kg N pr ha for white clover (Kyllingsbæk 2000).

Crop residue

To estimate the emission from N-fixing crops, IPCC Tier 1b is applied. N_2O emissions from crop residues are calculated as the total above-ground quantity of crop residue returned to soil. For cereals, the above-ground residues are calculated as the amount of straw plus stubble and husks. The total amount of straw is given in the annual census and reduced by the amount used for feeding, bedding and bio fuel in power plants. Straw for feed and bedding is subtracted because this quantity of removed nitrogen returns to the soil via manure.

$$N_2O - N_{crop\ residue,j} = \sum_{1}^{N} ha_{i,j} \cdot \left(\left(\frac{N_{i,stubble}}{N_{i,ploughing\ frequency.}}\right) + N_{husks} + N_{i,tops} + N_{i,leafs}\right) \cdot EF_{N2O}$$

Where; *i* is the crop type, *j* is the year, *ha* is the area on which the crop is grown, N_i is nitrogen derived from husks, stubble, plant tops and leaf debris in kg ha^{-1}, $N_{i,\ plouging\ frequency}$ is the number of years between ploughing and EF_{N2O} is the IPCC standard emission factor 1.25 %.

National values for nitrogen content are used provided by the Faculty of Agricultural Sciences (Djurhuus and Hansen 2003). It is calculated based on relatively few observations, but is at present the best available data. Data for yield and area cultivated are collected from Statistic Denmark. Background data is given in Annex 3D, Table 6.

The national emission from crop residues has decreased 16 % from 1990 to 2008 (Table 6.31). This decrease is a result of a fall in cultivated area of beets for feeding, which has been replaced by cultivation of green maize. Another reason is a fall in the agricultural area and a greater part of the straw is harvest – 52 % in 1990 and 60 % in 2008.

Table 6.31 Emissions from crop residue 1990 – 2008.

Crop residue	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Stubble	18.9	18.5	19.0	19.1	18.3	18.2	18.7	18.8	18.9	18.7
Husks	11.4	11.1	11.8	11.4	11.5	11.6	12.3	12.5	12.6	11.8
Top of beets and potatoes	7.1	7.1	6.7	7.2	6.1	5.8	5.9	5.5	5.7	5.4
Leafs	6.8	6.7	6.7	10.1	10.4	10.3	9.7	8.1	7.9	8.7
Straw	15.1	14.3	6.1	3.9	5.4	10.4	10.7	11.6	11.4	10.1
Crop residue, total, Gg N	59.3	57.7	50.3	51.7	51.7	56.3	57.3	56.5	56.5	54.7
N_2O emission, Gg	1.17	1.13	0.99	1.01	1.02	1.10	1.12	1.11	1.11	1.07
$Frac_R$	0.69	0.69	0.71	0.71	0.70	0.70	0.70	0.70	0.70	0.71
$Frac_{NCRO}$	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.017	0.017
$Frac_{NCRBF}$	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
Stubble	18.6	18.6	18.3	17.6	17.0	17.6	17.8	17.4	17.9	
Husks	12.0	12.3	11.5	12.0	12.0	12.3	12.4	12.1	11.9	
Top of beets and potatoes	5.3	5.2	5.5	4.9	5.0	4.9	4.4	4.5	4.4	
Leafs	9.0	9.2	9.1	9.1	8.5	9.4	9.4	9.3	7.9	
Straw	10.8	11.6	9.0	9.0	10.7	10.2	10.0	9.3	8.1	
Crop residue, total, Gg N	55.7	56.9	53.4	52.6	53.2	54.4	54.0	52.6	50.2	
N_2O emission, Gg	1.09	1.12	1.05	1.03	1.05	1.07	1.06	1.03	0.98	
$Frac_R$	0.71	0.71	0.71	0.72	0.72	0.73	0.73	0.73	0.73	
$Frac_{NCRO}$	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017	
$Frac_{NCRBF}$	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	

Frac vaules

The Fraction value $Frac_{NCRO}$ and $Frac_{NCRBF}$ is now calculated and $Frac_R$ is recalcultated for all years by using the definitions as given in IPCC Reference Manual pp 4.92 – 4.94.

The $Frac_{NCRO}$ and $Frac_{NCBRF}$ are calculated as the N-content in harvest crops divided with the total amount of dry matter in harvest crops. $Frac_{NCBRF}$ covers all crops which is N-fixing crops and $Frac_{NCRO}$ all the non N-fixing crops. The national values are differ slightly during the years and are a bit higher than the IPCC default values. For N-fixing crops the explanation could be that DK includes fields with clover grass, which has a high N-content. The higher national $Frac_{NCRO}$ could be a consequence of the relatively great part of straw is harvest and used for feeding, bedding and heating. As provided in Statistics Denmark nearly 70 % of the straw in 2008 is harvest.

By calculation of $Frac_R$ the fractions are given in kg dry matter pr kg dry matter instead of kg N pr kg crop-N as given in the Reference Manual. The fraction is calculated as dry matter content in harvest crops divided with total dry matter content in all parts of plants above ground.

In table 6.32 the national calculated frac values are compared to default values given in the Reference Manual. The national frac $Frac_{NCRO}$ and $Frac_{NCBRF}$ differ slightly during the years and are a bit higher than the IPCC default values. For N-fixing crops the explanation could be that DK includes fields with clover grass, which has a high N-content. The higher national $Frac_{NCRO}$ could be a consequence of the relatively great part of straw is harvest and used for feeding, bedding and heating. As provided in Statistics Denmark nearly 70 % of the straw in 2008 is harvest.

The national $Frac_R$ is particularly higher than IPCC default. The national value express that 69 % to 73 % of the total dry matter content in crops is removed from the field. The remaining 29 % to 31 % are dm content in straw and tops from beets and potatoes which are left on the field. From 1990 to 2008 the $Frac_R$ is increased as a consequence of a fall in cultivated area of feeding beets.

Table 6.32 Frac values.

Fractions	Text in CRF Table 4.Ds2 – additional information	Unit	IPCC default values	National Values 1990-2008
$Frac_{NCRO}$	Fraction of residue dry biomass that is N (all other crops than N-fixing crop)	Kg N pr kg dm	0.015	0.017-0.018
$Frac_{NCRBF}$	Fraction of total above-ground biomass of N-fixing crop that is N	Kg N pr kg dm	0.03	0.04
$Frac_R$	Fraction of total above-ground crop biomass that is removed from the field as a crop product	Kg dm pr kg dm	0.45*	0.69-0.73

*The IPCC default values of $Frac_R$ refer to the unit kg N pr kg crop-N.

Cultivation of histosols

N_2O emissions from histosols are based on the area with organic soils multiplied by the emission factor for C, the C:N relationship for the organic matter in the histosols and an emission factor of 1.25 of the total amount of released N. See the LULUCF section for further description.

Table 6.33 Activity data – cultivation of histosols, ha.

CRF – Table 4.D	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Cultivated histosols	77 987	77 371	77 100	82 211	84 818	83 003	81 594	77 010	76 827	77 346
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
Cultivated histosols	78 412	79 665	78 688	78 992	77 420	82 187	82 309	81 099	79 482	

Other Direct Emissions

The category, "Other", includes emission from sewage sludge and sludge from the industrial production applied to agricultural soils as fertiliser. Information about industrial waste, sewage sludge applied on agricultural soil and the content of nitrogen is provided by the Danish Environmental Protection Agency. It is assumed that 1.9 % of N-input applied to soil volatises as ammonia.

Table 6.34 Emission from sludge applied on agricultural soils 1990 – 2008.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Nitrogen in sewage sludge, t N	3 115	3 207	3 847	4 935	4 446	4 635	4 545	3 973	3 750	3 669
Nitrogen in industrial waste, t N	1 529	2 732	3 023	4 519	4 500	4 500	4 630	4 514	5 110	4 364
NH_3-N emission, t NH_3-N	58	60	72	93	83	87	85	74	70	69
N applied as fertiliser to the soil, t N	4 586	5 879	6 797	9 362	8 863	9 048	9 090	8 413	8 790	7 965
N_2O emission, Gg N_2O	0.09	0.12	0.13	0.18	0.17	0.18	0.18	0.17	0.17	0.16
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
Nitrogen in sewage sludge, t N	3 625	3 518	3 600	3 151	2 675	2 173	2 158	2 167	1 900	
Nitrogen in industrial waste, t N	5 147	7 274	8 000	8 000	10 000	10 000	11 000	11 000	11 000	
NH_3-N emission, t NH_3-N	68	66	67	59	50	41	40	41	36	
N applied as fertiliser to the soil, t N	8 705	10 726	11 532	11 092	12 625	12 132	13 117	13 126	12 864	
N_2O emission, Gg N_2O	0.17	0.21	0.23	0.22	0.26	0.24	0.26	0.26	0.25	

Pasture, Range and Paddock Manure

The amount of nitrogen deposited on grass is based on estimations from the ammonia inventory. It is assumed that 5 %, on average, of the nitrogen from dairy cattle and heifers is excreted on grass (expert judgement from the Danish Agricultural Advisory Centre – Aaes, O.). N-excretion on grass has decreased due to a reduction in the number of dairy cattle. An ammonia emission factor of 7 % is used for all animal categories based on investigations from the Netherlands and the United Kingdom (Jarvis et al. 1989a, Jarvis et al., 1989b and Bussink 1994).

Table 6.35 Nitrogen excreted on grass 1990 – 2008.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
N-excretion, grass, Gg N	35	35	35	36	35	36	36	35	35	34
NH_3-N emission, Gg NH_3-N	2	2	2	3	2	3	3	2	2	2
N deposited on grass, Gg N	32	33	33	34	33	33	34	33	33	32
N_2O emission, Gg	1.01	1.04	1.04	1.05	1.03	1.05	1.06	1.03	1.03	1.01
FracGRAZ	0.12	0.13	0.13	0.13	0.13	0.14	0.14	0.13	0.13	0.13
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
N-excretion, grass, Gg N	35	35	34	30	28	26	25	24	24	
NH_3-N emission, Gg NH_3-N	2	2	2	2	2	2	2	2	2	
N deposited on grass, Gg N	32	33	32	28	26	24	23	22	22	
N_2O emission, Gg	1.01	1.03	1.00	0.89	0.82	0.77	0.73	0.69	0.69	
FracGRAZ	0.13	0.13	0.13	0.12	0.11	0.10	0.10	0.09	0.09	

$Frac_{GRAZ}$ is estimated as the volatile fraction from grazing animals compared with the total excreted nitrogen (N ab animal) (Table 6.35). The decrease in $Frac_{GRAZ}$ is due to fall in the production of grassing animals e.g. cattle.

Indirect emissions

Atmospheric deposition

To estimate the emission from N-fixing crops, IPCC Tier 1b is applied. Atmospheric deposition includes all ammonia emissions sources included in the Danish ammonia emission inventory (Nielsen et al. 2008). This includes the emission from livestock manure, use of synthetic fertiliser, crops, ammonia-treated straw used as feed, field burning of crop residue and sewage sludge plus sludge from industrial production applied to agricultural soils.

The emission from atmospheric deposition has decreased from 1990 – 2008 as a result of the reduction in the total ammonia emission, from 90618 tonnes of NH_3-N in 1990 to 54757 in 2008.

Table 6.36 Ammonia emission 2008.

Ammonia emission	2008
	t NH_3-N
Manure	50 178
Synthetic fertiliser	3 999
Crops	4 459
NH_3 treated straw*	NO
Burning of agricultural residue	85
Sewage sludge and sludge from the industrial production	36
Emission total	58 757
N_2O emission, Gg	0.92

*Ammonia treated straw has been prohibited from 2006.

Nitrogen leaching and Run-off

The amount of nitrogen lost by leaching and run-off from 1986 to 2002 has been calculated by FAS. The calculation is based on two different model predictions, SKEP/Daisy and N-Les2 (Børgesen and Grant, 2003), and for both models measurements from field studies are taken into account. SKEP/DAISY is a dynamical crop growth model taking into account the growth factors (Annex 3D 1.4), where as N-Les2 is an empirical leaching model based on more than 1200 leaching studies performed in Denmark from the middle of the 1980'th to 2002 (Annex 3D 1.4). The results of the two models differ only marginally. The average of the two model predictions is used in the emission inventory.

Figure 6.5 shows leaching estimated in relation to the nitrogen applied to agricultural soils as livestock manure, synthetic fertiliser and sludge. The average proportion of nitrogen leaching and runoff has decreased from around 40 % in the middle of the nineties to around 34 % in 2008. The decline is due to an improvement in the utilisation of nitrogen in manure. The reduction in nitrogen applied is particularly due to the fall in the use of synthetic fertiliser, which has reduced by 45 % from 1990 to 2008.

The proportion of N input to soils lost through leaching and runoff ($Frac_{LEACH}$) used in the Danish emission inventory is higher than the default value of the IPCC (30 %). The high values are partly due to the humid Danish climate, with the precipitation surplus during winter causing a downward movement of dissolved nitrogen. $Frac_{LEACH}$ has decreased from 1990 and onwards. At the beginning of 1990s, manure was often applied in autumn. Now the main part of manure application takes place in the spring and early summer, where there are nearly now downward movements of soil water. The decrease in $Frac_{LEACH}$ over time is due to increasing environmental requirements and banning manure application after harvest. The data based on model estimates from FAS and NERI reflects the Danish conditions and is considered as a best estimate.

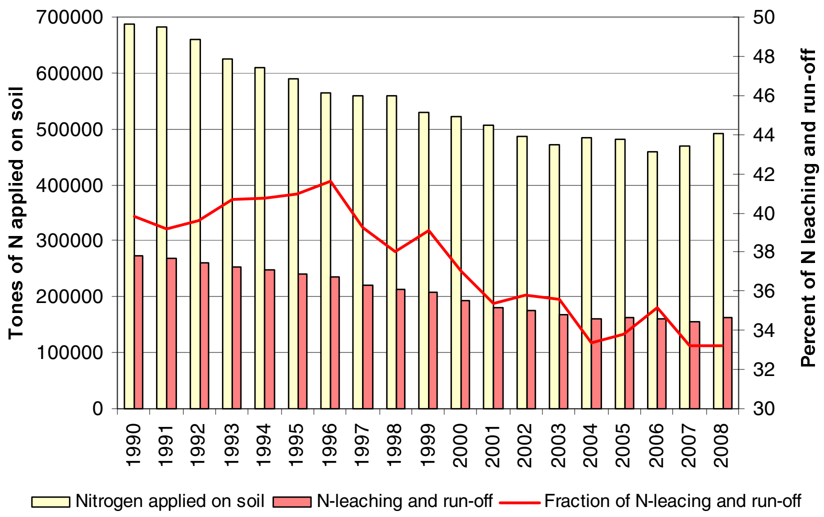

Figure 6.5 Nitrogen applied to agricultural soils and N-leaching from 1990 to 2008.

6.4.3 Activity data

Table 6.37 provides an overview on activity data from 1990 to 2008 used in relation to the estimation of N_2O emission from agricultural soils. The amount of nitrogen applied to agricultural soil has decreased from 1071 Gg N to 743 Gg N, corresponding to a 31 % reduction, which results in a lower N_2O emission.

Table 6.37 Activity data - agricultural soils 1990 – 2008, Gg N.

CRF – Table 4.D	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Total amount of nitrogen applied on soil	1 071	1 051	1 007	980	955	931	900	885	882	836
1. Direct Emissions										
Synthetic Fertiliser	393	388	363	327	320	310	286	283	279	258
Animal Waste Applied	172	173	174	177	172	167	169	167	170	167
N-fixing Crops	44	39	33	42	40	37	36	43	48	39
Crop Residue	59	58	50	52	52	56	57	56	56	55
2. Animal Production	32	33	33	34	33	33	34	33	33	32
3. Indirect Emissions										
Atmospheric Deposition	91	88	86	85	82	77	75	74	74	70
N-leaching and Runoff	274	267	261	254	248	242	235	220	213	207
4. Other										
Industrial Waste	2	3	3	5	5	5	5	5	5	4
Sewage Sludge	3	3	4	5	4	5	5	4	4	4
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
Total amount of nitrogen applied on soil	810	781	753	728	731	733	711	710	743	
1. Direct Emissions										
Synthetic Fertiliser	247	230	207	198	203	203	188	191	216	
Animal Waste Applied	166	169	172	175	181	182	178	182	185	
N-fixing Crops	38	36	36	31	30	34	35	35	35	
Crop Residue	56	57	53	53	53	54	54	53	50	
2. Animal Production	32	33	32	28	26	24	23	22	22	
3. Indirect Emissions										
Atmospheric Deposition	69	67	65	64	63	60	59	59	59	
N-leaching and Runoff	193	180	174	168	161	163	162	156	164	
4. Other										
Industrial Waste	5	7	8	8	10	10	11	11	11	
Sewage Sludge	4	4	4	3	3	2	2	2	2	

6.4.4 Time-series consistency

The N_2O emissions from agricultural soils have reduced by 32 % from 1990 to 2008. This is largely due to a decrease in the use of synthetic fertiliser and a decrease in N-leaching as a result of national environmental policy, where action plans have focused on decreasing the nitrogen losses and on improving the nitrogen utilisation in manure.

Table 6.38 Emissions of N_2O from Agricultural Soils 1990 – 2008, Gg N_2O.

CRF – Table 4.D	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Total N_2O emission	26.80	26.32	25.34	24.67	24.07	23.49	22.77	22.14	21.96	20.96
1. Direct Emissions	13.52	13.28	12.56	12.11	11.83	11.56	11.12	11.16	11.23	10.56
Synthetic Fertiliser	7.72	7.62	7.13	6.42	6.28	6.09	5.61	5.56	5.47	5.08
Animal Waste Applied	3.39	3.39	3.42	3.48	3.37	3.27	3.31	3.28	3.34	3.29
N-fixing Crops	0.87	0.76	0.64	0.83	0.78	0.73	0.70	0.85	0.94	0.76
Crop Residue	1.17	1.13	0.99	1.01	1.02	1.10	1.12	1.11	1.11	1.07
Cultivation of Histosols	0.38	0.37	0.37	0.37	0.38	0.36	0.36	0.36	0.36	0.36
2. Animal Production	1.01	1.04	1.04	1.05	1.03	1.05	1.06	1.03	1.03	1.01
3. Indirect Emissions	12.18	11.88	11.61	11.32	11.04	10.70	10.41	9.79	9.53	9.24
Atmospheric Deposition	1.42	1.38	1.36	1.33	1.30	1.22	1.18	1.16	1.16	1.09
N-leaching and Runoff	10.75	10.50	10.25	9.99	9.74	9.49	9.24	8.63	8.36	8.14
4. Other	0.09	0.12	0.13	0.18	0.17	0.18	0.18	0.17	0.17	0.16
Industrial Waste	0.03	0.05	0.06	0.09	0.09	0.09	0.09	0.09	0.10	0.09
Sewage Sludge	0.06	0.06	0.07	0.10	0.09	0.09	0.09	0.08	0.07	0.07
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
Total N_2O emission	20.16	19.36	18.68	18.03	17.93	18.02	17.56	17.40	18.22	
1. Direct Emissions	10.32	10.00	9.58	9.33	9.53	9.67	9.30	9.41	9.92	
Synthetic Fertiliser	4.86	4.51	4.07	3.89	3.99	3.98	3.70	3.75	4.25	
Animal Waste Applied	3.26	3.31	3.39	3.44	3.55	3.58	3.49	3.58	3.62	
N-fixing Crops	0.75	0.70	0.72	0.62	0.59	0.67	0.68	0.68	0.69	
Crop Residue	1.09	1.12	1.05	1.03	1.05	1.07	1.06	1.03	0.98	
Cultivation of Histosols	0.36	0.36	0.35	0.35	0.35	0.37	0.37	0.36	0.38	
2. Animal Production	1.01	1.03	1.00	0.89	0.82	0.77	0.73	0.69	0.69	
3. Indirect Emissions	8.66	8.12	7.88	7.60	7.33	7.34	7.27	7.04	7.35	
Atmospheric Deposition	1.09	1.06	1.03	1.00	1.00	0.95	0.92	0.93	0.92	
N-leaching and Runoff	7.57	7.06	6.85	6.60	6.34	6.39	6.34	6.11	6.43	
4. Other	0.17	0.21	0.23	0.22	0.25	0.24	0.26	0.26	0.25	
Industrial Waste	0.10	0.14	0.16	0.16	0.20	0.20	0.22	0.22	0.22	
Sewage Sludge	0.07	0.07	0.07	0.06	0.05	0.04	0.04	0.04	0.04	

6.5 Field Burning of Agricultural Residue (CRF Sector 4F)

Field burning of agricultural residue has in Denmark been prohibited since 1990 and may only take place in connection to production of grass seeds on fields with repeated production and in cases of wet or broken bales of straw. The amount of burnt straw from the grass seed production is estimated as 15 % of the total amount produced. The amount of burnt bales of or wet straw is estimated as 0.1 % of total amount of straw. Both estimates are based on an expert judgement by the Danish Agricultural Advisory Service. The total amounts are based on data from Statistics Denmark.

From field burning is seen emissions of a series of different compounds and related to GHG emissions of the following compounds are estimated CH_4, N_2O, NO_x, CO, CO_2, SO_2 and NMVOC. For emission of NMVOC see chapter 6.6. The emission of NO_x and CO is given CRF table 4s2. Emission of CO_2 and SO_2 is estimated, but not reported because this is not possible in CRF tables in present format. Equation for calculating emission of various compounds:

$$Emi = BB \cdot \frac{EF}{1\,000\,000} \cdot FO$$

$$BB = CP \cdot FB \cdot FR_{dm}$$

Emi = emission of compounds, Gg
BB = total burned biomass, Gg dm
CP = crop production, t
FB = fraction burned in fields
FR_{dm} = dry matter fraction of residue
EF = emission factor, g pr kg dm
FO = fraction oxidized

Table 6.39 Factors for estimating emissions of CH_4 and N_2O, 2008.

2008		Crop production	Fraction burned in fields	Dry matter (dm) fraction of residue	Total biomass burned	EF	Fraction oxidized	Emission
		t			Gg dm	g pr kg dm		Gg
CH_4	Mixed cereals	5 662 000	0.001	0.85	4 813	2.7	0.90	0.012
CH_4	Straw from seeds of grass	337 010	0.15	0.85	42 969	2.7	0.90	0.104
N_2O	Mixed cereals	5 662 000	0.001	0.85	4 813	0.07	0.90	0.0003
N_2O	Straw from seeds of grass	337 010	0.15	0.85	42 969	0.07	0.90	0.003
Total CO_2-eqv								3.37

The emission of CH_4, N_2O, NO_x, CO, CO_2 and SO_2 from field burning contributes with less than 1 % of the national emission.

The Fraction value $Frac_{BURN}$ is now calculated by using the definitions as given in IPCC Reference Manual pp 4.92 – 4.94. $Frac_{BURN}$ is calculated as the amount of burned straw divided with the total amount of straw produced and the fractions are given in kg dry matter pr kg dry matter instead of kg N pr kg crop-N. For all years the value of $Frac_{BURN}$ is around 0.01 kg dm pr kg dm, which is low compared to IPCC default value. This is due to the prohibition of field burning in Denmark.

6.6 NMVOC emission

Around 2 % of the total NMVOC emission originates from the agricultural sector, which, in the Danish emission inventory, includes emission from agricultural soils, such as arable land crops and grassland, and field burning of agricultural residue. Activity data is obtained from Statistics Denmark. The emission factor for agricultural soils is for land with arable crops is 393 g NMVOC pr ha and for grassland, 2120 g NMVOC pr ha (Fenhann and Kilde 1994), (Priemé and Christensen 1991). IPCC default value for the emission factors for field burning of agricultural residue is used. The emission from agricultural soils contributes with 88 % and field burning with 12 % of the agricultural emission.

Table 6.40 NMVOC emission from agricultural soils 1990 – 2008.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Arable crops, 1000 ha	2 322	2 307	2 293	2 254	2 044	2 064	2 075	2 138	2 125	2 064
Grassland, 1000 ha	466	462	463	484	647	446	450	403	405	398
NMVOC emission, Gg	1.90	1.89	1.88	1.91	2.18	1.76	1.77	1.69	1.69	1.65
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
Arable crops, 1000 ha	2043	2 060	2 065	2 062	2 079	2 086	2 083	2 050	2 107	
Grassland, 1000 ha	413	414	396	390	369	446	460	459	490	
NMVOC emission, Gg	1.68	1.69	1.65	1.64	1.60	1.77	1.79	1.78	1.87	

Table 6.41 NMVOC emission from field burning of agricultural residue 1990 – 2008.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
NMVOC emission, Gg	0.20	0.21	0.20	0.22	0.21	0.24	0.24	0.25	0.32	0.30
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
NMVOC emission, Gg	0.30	0.31	0.26	0.31	0.33	0.33	0.34	0.29	0.27	

6.7 Uncertainties

Uncertainties are calculated by using both a Tier 1 and a Tier 2 approach, see chapter 1.7 for description of the Tier 2 calculation. The same uncertainties values for activity data and emission factor are used for both Tier 1 and Tier 2.

6.7.1 Uncertainty values

Uncertainty values are based on expert judgement (Olesen et al. 2001, Gyldenkærne, pers. comm., 2005).

Uncertainties regarding animal production, such as number of animals, feeding consumption, normative figures ect. are very small. Number of animals is estimated by Statistic Denmark and all cattle, sheep and goats have their own ID-number (ear tags) and, hence, uncertainty with regard to their numbers is almost absent. Statistics Denmark has estimated the uncertainty in the number of pigs to be less than 1 %.

The Danish Normative System for animal excretions is based on data from the Danish Agricultural Advisory Centre (DAAC), which is the central office for all Danish agricultural advisory services. DAAC engages in a great deal of research as well as the collection of efficacy reports from Danish farmers for dairy production, meat production, swine production, etc to optimise productivity in Danish agriculture. In total, feeding plans from 15-18 % of Danish dairy production, 25-30 % of pig production. 80-90 % of poultry production and approximately 100 % of fur production are collected annually. These basic feeding plans are used to develop the standard values of the “Danish Normative System”.

The normative figures (Poulsen et al. 2001) are comprised of arithmetic means. Based on feeding plans, the standard deviation in N-excretion rates between farms can be estimated to ±20 % for all animal types (Hanne D. Poulsen. FAS. Pers, comm). However, due to the large number of farms included in the norm figures the arithmetic mean, it can be assumed as a very good estimate with a low uncertainty.

Data for hectares under cultivation is estimated by Statistic Denmark and the uncertainties is based on there calculations. For the most common crops the uncertainties are below 5%.

The combined effect of low uncertainty in actual animal numbers, relatively low uncertainty for feed consumption and excretion rates gives a relatively low uncertainty in the activity data as a whole – between 3% and 20%. The major uncertainties are related to the emission factors.

The highest uncertainty is connected with manure management. Until further investigation provide new data an uncertainty value of 100% is used. Uncertainties related to the N_2O emission factor is based on Good Practice Guidance. See table 6.42 for uncertainty values for the agricultural sector.

Table 6.42 Uncertainties values for activity data and emission factors for CH_4 and N_2O.

CRF category		Emission factor	Uncertainties value for activity data, %	Uncertainties value for emission factor, %
4.A Enteric Fermentation		CH_4	10	8
4.B Manure Management		CH_4	10	100
		N_2O	10	100
4.D Agricultural Soils				
4.D1 Direct soil emissions				
	Synthetic Fertiliser	N_2O	3	50
	Animal Waste Applied to Soils	N_2O	10	50
	N-fixing Crops	N_2O	20	50
	Crop Residue	N_2O	20	50
	Cultivation of Histosols	N_2O	20	50
	Sewage N	N_2O	20	50
	Industrial Waste Used as Fertiliser	N_2O	20	50
4.D2 Animal Production		N_2O	20	25
4.D3 Indirect soil emissions				
	Atmospheric Deposition	N_2O	10	50
	N-Leaching and Runoff	N_2O	20	50
4.F Field Burning of Agricultural Residue				
		CH_4	10	50
		N_2O	10	50

6.7.2 Result of the uncertainty calculation

Table 6.43 shows the result of the Tier 1 and Tier 2 uncertainty calculation for 2008. A calculation of 1990 gives nearly the same uncertainty values for all emission sources. The overall uncertainty calculation for the agricultural sector based on Tier 1 is estimated to ±19%. Tier 2 calculation shows an uncertainty interval from -12% to +16%, which is a bit lower. For most of the emission sources the uncertainty level based on Tier 2 are lower, but still nearly at the same level, see figure 6.6. The two calculations can be considered as consistent. The lowest uncertainties are seen for CH_4 emission from enteric fermentation and the highest for emission form manure management and this pattern is reflected in both calculations.

The biggest difference between the Tier 1 and Tier 2 uncertainty calculations is seen for CH_4 and N_2O from manure management. It is also these categories which have the highest uncertainties, which could indicate that Tier 2 in a better way can handle high uncertainties.

Table 6.43 Comparison between Tier 1 and Tier 2 uncertainty calculation, 2008.

Uncertainty		Tier 1		Tier 2		
2008		Emission, Gg CO_2-eqv	Uncertainty, %	Median emission, Gg CO_2-eqv	Uncertainty, %	
			Lower and upper (±)		Lower (-)	Upper (+)
4 Agriculture total	CH_4 and N_2O	10 043	19	10 275	12	16
4.A Enteric Fermentation	CH_4	2 819	13	2 823	5	4
4.B Manure Management	CH_4 and N_2O					
	CH_4	1 050	100	1 082	38	70
	N_2O	523	100	555	33	50
4.D Agricultural soil:	N_2O					
4.D1 Direct soil emissions	N_2O	3 154	29	3 176	20	33
4.D2 Grassing animals	N_2O	214	32	215	30	27
4.D3 Indirect soil emissions	N_2O	2 279	48	2 287	34	47
4.F Field Burning of Agricultural Residues	CH_4 and N_2O					
	CH_4	2	51	2	40	65
	N_2O	1	51	1	43	63

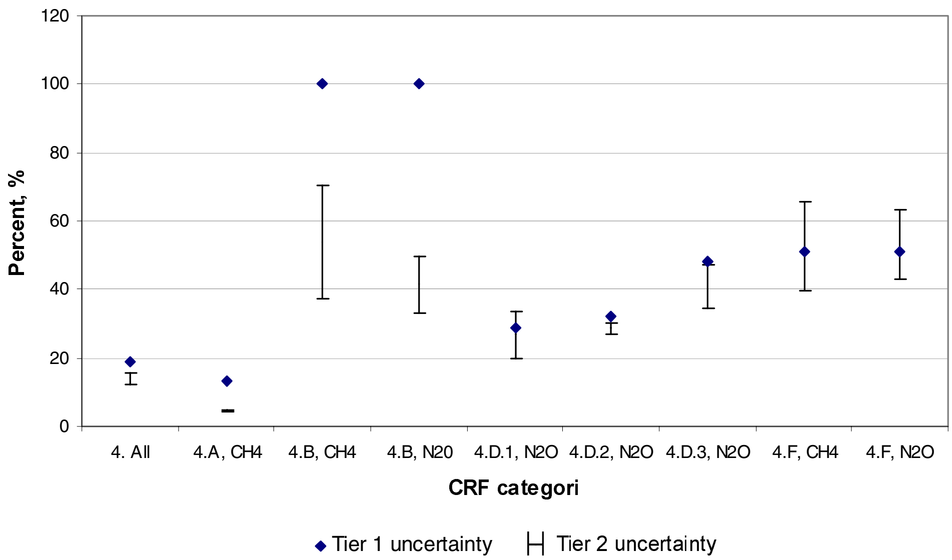

Figure 6.6: Tier 1 and Tier 2 uncertainties for the agricultural sector, 2008.

6.8 Quality assurance and quality control - QA/QC

A first step of development and implementation of a general QA/QC plan for all sectors started in 2004 which is described in a publicised manual (Sørensen et al., 2005). The manual describes the concepts of quality work and how to handle quality management by using Critical Control Points and a list of Point of Measurements. For more detailed information refer to the general chapter 1.6 for QA/QC.

The QA/QC work concerning the agricultural sector is still under development and improvements will be continued the following years. A complete list Points of Measures (PM) are given in table 1.2. PM related to the agricultural inventory is listed below and are primarily connected to data storage and data processing level 1. For PM not mentioned below please refer to chapter 1.6.

6.8.1 Data storage level 1

Data Storage level 1	3.Completeness	DS.1.3.1	Documentation showing that all possible national data sources are included by setting down the reasoning behind the selection of datasets.

The following external data are in used in the agricultural sector, in more details see table 6.2:

- Data from the annual agricultural census made by Statistics Denmark
- The Faculty of Agricultural Sciences, University of Aarhus (FAS)
- The Danish Plant Directorate
- Danish Agricultural Advisory Centre (DAAC)
- The Danish Energy Authority
- Danish Environmental Protection Agency

The emission factors come from various sources:

- IPCC guidelines
- The Faculty of Agricultural Sciences, University of Aarhus (FAS): NH_3 emission, CH_4 emission from enteric fermentation and manure management.

Statistics Denmark

The agricultural census made by Statistics Denmark is the main supply of basic agricultural data. In Denmark, all cattle, sheep and goats have to be registered individually and hence the uncertainty in the data is negligible. For all other animal types, farms having more than 10 animal units are registered.

The Faculty of Agricultural Sciences (FAS)

FAS are responsible for the delivery of N-excretion data for all animal and housing types. Data on feeding consumption on commercial farms are collected annually by DAAC from on-farm efficacy controls. For dairy cattle, data is collected from 15-20 % of all farms, for pigs, 25-30 % and for poultry and mink, 90-100 % of all farms. The farm data are used to calculate average N-excretion from different animal and housing types. Due to the large amount of farm data involved in the dataset, N-excretion is seen as a very good estimate for average N-excretion at the Danish livestock production.

Danish Plant Directorate

Total area with the various agricultural crops is provided to the Danish Plant Directorate via the agricultural subsidy system. For every parcel of land (via a vector-based field map with a resolution of >0.01 ha), the area planted with different crops is reported. If the total crop area within a parcel is larger than the parcel area, a manual control of the information is performed by the Plant Directorate. The area with different crops, therefore, represents a very precise estimate.

All farmers are obliged to do N-mineral accounting on a farm and field level with the N-excretion data from FAS. Data at farm level is reported annually to the Danish Plant Directorate. The N figures also include the quantities of synthetic fertilisers bought and sold. Suppliers of synthetic fertilisers are required to report all N sales to commercial farmers to the Plant Directorate. The total sold to farmers is very close to the amount imported by the suppliers, corrected for storage. The total amount of synthetic fertiliser in Denmark is, therefore, a very precise estimate for the synthetic fertiliser consumed. This is also valid for N-excretion in animal manure.

The Danish Plant Directorate, as the controlling authority, performs analysis of feed sold to farmers. On average, 1600 to 2000 samples are analysed every year. Uncertainty in the data is seen as negligible. The data are used when estimating average energy in feedstuffs for pigs, poultry, fur animals, etc.

From 2005 the Danish Plant Directorate provides data for distribution of stable type.

<u>Danish Agricultural Advisory Centre (DAAC)</u>
DAAC is the central office for all Danish agricultural advisory services. DAAC carries out a considerable amount of research itself, as well as collecting efficacy reports from the Danish farmers for dairy production, meat production, pig production, etc., to optimise productivity in Danish agriculture. From DAAC data on stable type until 2004, grassing situation and information on application of manure is received.

<u>The Danish Energy Authority</u>
The amount of slurry treated in biogas plants is received from the Danish Energy Authority.

<u>Danish Environmental Protection Agency</u>
Information on the sludge from waste water treatment and the manufacturing industry and the amount applied on agricultural soil is obtained from the Danish Environmental Protection Agency.

Data Storage level 1	1. Accuracy	DS.1.1.1	General level of uncertainty for every dataset including the reasoning for the specific values

The most important emission source is related to the animal production. Uncertainty for the animal data is very low due to the very strict environmental laws in Denmark. Standard deviation regarding the numbers of cattle and pigs has been estimated to <0.7 %. For poultry the standard deviation is <2.1 %. For all years, 25-35 % of all holdings are included in the census. The standard deviation for N-excretion between farms is reported as 25 % for dairy cattle and pigs, but due to the large numbers involved in the estimation of the average N-excretion, the average is assumed to be a precise estimate for the Danish agricultural efficacy level.

Regarding uncertainties for the remaining emission sources see chapter 6.7.

Data Storage level 1	1. Accuracy	DS.1.1.2	Quantification of the uncertainty level of every single data value including the reasoning for the specific values.

Please, refer to chapter 6.7 and Table 6.42.

Data Storage level 1	1. Comparability	DS.1.2.1	Comparability of the data values with similar data from other countries, which are comparable with Denmark, and evaluation of discrepancy.

The Danish N-excretion levels are generally lower than IPCC default values. This is due to the highly skilled, professional and trained farmers in Denmark, with access to a highly competent advisory system.

The feed consumption pr animal is in line with similar data from Sweden, although they are not quite comparable because Denmark is using feeding units (FE) which cannot easily be converted to energy content. Earlier, one feeding unit was defined as one kg of barley. Today, the calculations are more complicated and depend on animal type.

Data Storage level 1	4.Consistency	DS.1.4.1	The origin of external data has to be preserved whenever possible without explicit arguments (referring to other PMs).

External data received are stored in the original format in quality management database system.

Data Storage level 1	6.Robustness	DS.1.6.1	Explicit agreements between the external institution holding the data and NERI about the conditions of delivery.

NERI has established formal data agreements with all institutes and organisations which deliver data, to assure that the necessary data is available to prepare the inventory on time.

Data Storage level 1	6.Robustness	DS.1.6.2	At least two employees must have a detailed insight into the gathering of every external data set.

Please refer to chapter 1.7.

Data Storage level 1	7.Transparency	DS.1.7.1	Summary of each dataset including the reasoning for selecting the specific dataset.

Please refer to DS 1.1.1.

Data Storage level 1	7.Transparency	DS.1.7.2	The archiving of data sets needs to be easy accessible for any person in the emission inventory.

Please refer to chapter 1.7.

Data Storage level 1	7.Transparency	DS.1.7.3	References for citation for any external data set have to be available for any single value in any dataset.

A great deal of documentation already exists in the literature list, and also given in the quality management database system: I:/rosproj/luft_emi/inventory-/2008/4_Agriculture/level_1a_storage/

Data Storage level 1	7.Transparency	DS.1.7.4	Listing of external contacts for every dataset.

Statistics Denmark:

Mr. Ole Nielsen (oni@dst.dk)

Mr. Karsten K. Larsen (kkl@dst.dk)

Faculty of Agricultural Sciences (University of Aarhus):

Mrs. Hanne Damgaard Poulsen (hannedamgaard.poulsen@agrsci.dk)

Mr. Nick Hutchings (nick.hutchings@agrsci.dk)

Mr. Christen Duus Børgesen (Christen.Borgesen@agrsci.dk)

The Danish Agricultural Advisory Centre:

Mr. Ole Aaes (OEA@Landscentret.dk)

Mr. Eric F. Clausen (EFC@landscentret.dk)

Mr. Barthold Feidenshans'l (BAF@landscentret.dk)

Danish Plant Directorate:

Mr. Troels Knudsen (tkn@pdir.dk)

Mrs. Mette Thomsen (mth@pdir.dk)

The Danish Energy Agency:

Mr. Søren Tafdrup (st@ens.dk)

The Danish Environmental Protection Agency:

Mrs. Trine Leth Kølby (trile@mst.dk)

6.8.2 Data processing level 1

Data Processing level 1	1. Accuracy	DP.1.1.1	Uncertainty assessment for every data source as input to Data Storage level 2 in relation to type of variability. (Distribution as: normal, log normal or other type of variability).

The Tier 1 methodology is used to calculate the uncertainties for the agricultural sector. The uncertainties are based on expert judgement (Olesen et al. 2001, Poulsen et al. 2001, Gyldenkærne, pers. comm., 2005) and a normal distribution is assumed. A Tier 2 is calculation is provided, please refer to chapter 6.7.

Data Processing level 1	1. Accuracy	DP.1.1.2	Uncertainty assessment for every data source as input to Data Storage level 2 in relation to scale of variability (size of variation intervals).

Please refer to DP 1.1.1.

Data Processing level 1	1. Accuracy	DP.1.1.3	Evaluation of the methodological approach using international guidelines.

Denmark has worked out a report with a more detailed description of the methodological inventory approach (Mikkelsen et al. 2006). This report has been reviewed by the Statistics Sweden, who is responsible for the Swedish agricultural inventory. Furthermore, data sources and calculation methodology developments are discussed in cooperation with specialists and researchers in different institutes and research sections. As a consequence, both the data and methods are evaluated continually according to the latest knowledge and information.

Data Processing level 1	1. Accuracy	DP.1.1.4	Verification of calculation results using guideline values

The methodological approach is consistent with the IPCC Reference Manual and the Good Practice Guidance. For some of the calculation differences can be seen and are explanation are given in NIR.

Enteric CH_4 emissions are, in general, lower than the IPCC default values due to the professional way farms are managed in Denmark. Enteric fermentation from dairy cows is high and comparable with North American conditions. Due to the increase in milk production pr dairy cow, there has been an increase in enteric fermentation of CH_4, and it is in line with the conditions in the USA, the Netherlands and Sweden.

The CH_4 emission from manure management is, in general, higher than the default IPCC values for Western Europe because of the higher percentage handled as slurry. However, due to the high efficacy at farm level, energy intake is lower pr head and the subsequent CH_4 emission from slurry is, thereby, lower. Denmark uses an MCF factor of 10 % as provided in the 1996 guidelines and not the 39 % in the revision to the 1996 guidelines. For further explanation, see the text in the agriculture chapter (6.3.2).

$Frac_{LEACH}$ is higher than the default IPCC values. $Frac_{LEACH}$ has decreased from 1990 and onwards. In the beginning of 1990s, manure was often applied in autumn. The high values are partly due to the humid Danish climate, with the precipitation surplus during winter causing a downward moment of dissolved nitrogen. The decrease in $Frac_{LEACH}$ over time is caused by sharpened environmental requirements, banning manure application after harvest. As a result, most manure application occurs during spring and summer, where there is a precipitation deficit. The generally accepted leaching values in Denmark are 0.3 for mineral nitrogen and 0.45 for organic-bound nitrogen. These values are based on numerical leaching studies.

Data Processing level 1	2.Comparability	DP.1.2.1	The inventory calculation has to follow the international guidelines suggested by UNFCCC and IPCC.

The methodological approach is consistent with the IPCC Reference Manual and the Good Practice Guidance.

Data Processing level 1	3.Completeness	DP.1.3.1	Assessment of the most important quantitative knowledge which is lacking.

Regarding the reduction potential for biogas treated slurry, more information and investigation could be preferred. There is ongoing work to increase the accuracy of this emission source.

Data Processing level 1	3.Completeness	DP.1.3.2	Assessment of the most important missing accessibility to critical data sources

All known major sources are included in the inventory. In Denmark, only very few data are restricted (military installations). Accessibility is not a key issue; it is more lack of data.

Data Processing level 1	4.Consistency	DP.1.4.1	In order to keep consistency at a high level, an explicit description of the activities needs to accompany any change in the calculation procedure

The calculation procedure is consistent for all years.

Data Processing level 1	4.Consistency	DP.1.4.2	Identification of parameters (e.g. activity data, constants) that are common to multiple source categories and confirmation that there is consistency in the values used for these parameters in the emission calculations

Please refer to chapter 1.7.

Data Processing level 1	5.Correctness	DP.1.5.1	Show at least once, by independent calculation, the correctness of every data manipulation.

During the development of the model, thorough checks have been made by all persons involved in preparation of the agricultural section.

Data Processing level 1	5.Correctness	DP.1.5.2	Verification of calculation results using time-series.

Time-series for activity data, emission factors and national emission are performed to check consistency in the methodology, to avoid errors, to identify and explain considerable year to year variations.

Data Processing level 1	5.Correctness	DP.1.5.3	Verification of calculation results using other measures.

A comparison between IPCC Tier 2 method for enteric fermentation and Denmark's Tier 2/CS is made, see chapter 6.2.4.

Data Processing level 1	5.Correctness	DP.1.5.4	Show one-to-one correctness between external data sources and the databases at Data Storage level 2

In the database key ids is used to identify the unique data. The data on DS level 1 is linked to the key id used in the database so a clear reference from DS level 1 to higher levels of both DP and DS is secured.

Data Processing level 1	6.Robustness	DP.1.6.1	Any calculation must be anchored to two responsible persons that can replace each other in the technical issue of performing the calculations.

Please refer to chapter 1.7.

Data Processing level 1	7.Transparency	DP.1.7.1	The calculation principle and equations used must be described.

All calculation principles are described in the NIR and the documentation report (Mikkelsen et al. 2006).

Data Processing level 1	7.Transparency	DP.1.7.2	The theoretical reasoning for all methods must be described.

All theoretical reasoning is described in the NIR and the documentation report (Mikkelsen et al. 2006).

Data Processing level 1	7.Transparency	DP.1.7.3	Explicit listing of assumptions behind methods.

All theoretical reasoning is described in the NIR and the documentation report (Mikkelsen et al. 2006).

Data Processing level 1	7.Transparency	DP.1.7.4	Clear reference to dataset at Data Storage level 1.

In the database key ids is used to identify the unique data. The data on DS level 1 is linked to the key id used in the database so a clear reference from DS level 1 to higher levels of both DP and DS is secured.

Data Processing level 1	7.Transparency	DP.1.7.5	A manual log to collect information about recalculations.

Changes compared with the last emissions report are described in the NIR and the national emission changes is given in a table under the section, "Recalculation". The text describes whether the change is caused by changes in the dataset or changes in the methodology used. Furthermore a log table is filled in when data are updated or adjusted continuously.

6.8.3 Data storage and processing level 2

For point of measurements not mentioned below please refer to chapter 1.7.

Data Storage level 2	5.Correctness	DS.2.5.1	Documentation of a correct connection between all data types at level 2 to data at level 1.

A manual check-list is under development for correct connection between all data types at level 1 and 2.

Data Processing level 2	5.Correctness	DS.2.5.2	Check if a correct data import to level 2 has been made.

A manual check-list is under development for correctness of data import to level 2.

6.9 Recalculation

Improvements and recalculations since the 2009 emission inventory:

Improvements
Based on the Report of the individual review submitted in 2007 and 2008 and response to issues raised during review of the 2009 submission some improvements is done to meet the recommendations and proposal.

The new database system IAD (Inventory Agriculture Data) is now implemented and this first year some problems concerning the data extensions turned up. As recommended by ERT a quality procedure are provided which include a first step for annually check for all activity data, emission factor, IEF and other important key parameters used in the emission calculations. The description will be included in NIR for next submission.

As recommended by ERT a comparison between IPCC Tier 2 and Denmark's Tier2/Country Specific (CS) calculation method for enteric fermentation is made for dairy cattle, non-dairy cattle and sheep. The result of the calculations by using the IPCC Tier 2 approach indicates that the values used in the Danish inventory are reasonable.

As recommended by ERT improvement in documentation of number of sheep and goats has taken place. These are based on the Central House-animal farm Register (CHR) which is the central register of farms and animals of the Ministry of Food, Agriculture and Fisheries.

Emission from ostriches, deer and pheasants are now included in the inventory. The number of deer and ostriches is also based on CHR because these are not included in Statistics Denmark. The number of pheasants is based on expert judgement from NERI and pheasant breeding association.

As recommended by ERT the GE is interpolated to improve the series consistency. GE concerning heifer is interpolated for the years 2005 and 2006 and GE for piglets and slaughtering pigs is interpolated for the years 1991 – 1993.

Field burning of agricultural wastes has in Denmark been prohibited since 1990. However, burning of straw may take place in connection to continuously production of grass seeds and in cases of wet or broken bales of straw. This emission source is now included in the inventory and in relation to CRF reporting following compounds are estimated, CH_4, N_2O, NO_x, CO, CO_2, SO_2 and NMVOC.

FracNCRBF and FracNCRO are calculated for 1990 – 2008 and implemented in CRF.

A first calculation of Tier 2 uncertainties for the agricultural sector are provided.

Recalculations

Some changes for emissions from the agricultural sector have taken place. These changes reflect increased emissions in the years 1990-2002 and 2006 up to 2% and decreased emissions in the years 2004, 2005 and 2007 up to 3% compared to the total CO_2-equivalent emission from the agricultural sector (Table 6.43).

Table 6.44 Changes in GHG emission in the agricultural sector compared with the CRF reported last year.

GHG emission	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Previous inventory, Gg CO_2 eqv.	13 010	12 890	12 604	12 473	12 127	11 906	11 570	11 398	11 404	10 817
Recalculated, Gg CO_2 eqv.	13 109	12 969	12 646	12 505	12 194	11 975	11 749	11 454	11 426	10 949
Change in Gg CO_2 eqv.	100	78	42	32	67	69	179	56	22	131
Change in pct.	0,8	0,6	0,3	0,3	0,5	0,6	1,5	0,5	0,2	1,2
Continued	2000	2001	2002	2003	2004	2005	2006	2007		
Previous inventory, Gg CO_2 eqv.	10 582	10 519	10 234	9 962	10 003	9 929	9 586	10 072		
Recalculated, Gg CO_2 eqv.	10 698	10 523	10 261	9 998	9 904	9 901	9 742	9 759		
Change in Gg CO_2 eqv.	116	4	27	36	-99	-28	156	-314		
Change in pct.	1,1	0,0	0,3	0,4	-1,0	-0,3	1,6	-3,2		

The most significant inventory changes are mentioned below:

A new method – a Tier 2/CS methodology - for the calculation of CH_4 from manure management has been implemented by using national values of manure conditions. The consequences of the recalculations shows increases in the years 1990 - 2007 from 16 % to 1 % given in CO_2-equivalents with a falling tendency.

Calculations of nitrogen loss from manure have been adjusted to TAN therefore recalculations have been made. Furthermore an error in the database calculations of N_2O has been corrected. These changes decrease the emission of N_2O from manure management in the years 1990-2005 up to 4 % in CO_2-equivalents, and increase emission in 2006 by 1 % and in 2007 decrease emission by 14 %.

New data for the number of animals and the distribution on stable types have been implemented. As recommended of ERT the amount of feed and N ab animal for heifers have been interpolated in the years 2005-2006 to even out high differences. Also for dairy cattle, piglets and slaughter pigs the amount of feed has been interpolated for the amounts of cattle in 2006 and piglets and slaughter pigs in 1991-1993. Three new categories of animals are included, deer, pheasants and ostriches. New data for the use of sewage sludge as fertilizers for the years 2002, 2005 and 2007 have been implemented.

Field burning of agricultural wastes have been included and it effects the total emission by less than 1 % for all compounds.

6.10 Planned improvements

The Danish emission inventory for the agricultural sector largely meets the request as set down in the IPCC Good Practice Guidance. In the years to come and based on the ERT recommendations, some specific improvements, as mentioned below, are planned:

- In the following work to improve the inventory the calculation of reduced emission from biogas treated slurry will be highlighted as high priority. As recommended by ERT an investigation of one larger biogas plant could by a good starting point to provide specific data concerning the quantification of the reduction potential for both the CH4 and the N2O emission.
- From 2007 information on stable type are received from the Danish Plant directorate. For previously years the distribution is based on an expert judgement from the Danish Agricultural Advisory Centre. It is planned to reconsider the distribution of stable type in corporation with DAAC and identify if there is large differences which demand adjustments.
- The QA/QC plan for the agricultural sector is still under development. First step will focus on improvement of the procedure of intern quality check of both data input and output. It is planned to provide a check list of all activity data, emission factor, implied emission factor and other important key parameters. For each of these the annual change will be checked for significant differences and if necessary explain the differences. Next step includes control of the inventory data calculations. This mean to identify the possibility to compare the calculations made by other institutions or organisations e.g. calculation of total N-excretion made by the Faculty of Agricultural Science. The third step is to consider how to provide a quality assurance procedure for the entire inventory.

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7 LULUCF (CRF sector 5)

7.1 Overview of LULUCF

This Chapter covers only the territory of Denmark without the Faroe Islands and Greenland. Greenland is submitting a separate NIR and the corresponding CRF tables for the Greenlandic territory to UNFCCC. This can bee found as Annex 9 to this NIR.

Denmark (Capital: Copenhagen) is situated around 56°N and 13°E and covers 43,098 km^2. No permanent ice is occurring and only very small insignificant areas with rocks. The climate is according to IPCC GPG 2003 Cold and Wet. Denmark is an intensive agricultural country where most of the area is affected by agriculture. The average temperature in the standard 30 year, 1961-1990 was 7.7 °C with a minimum temperature in February of 0.3 °C and a maximum in July of 17.0 °C. Year 2008 was the third warmest year ever recorded since 1873, with an average mean temperature of 9.4 °C (www.dmi.dk) or 22 % above 1961-1990.

All land is classified into Forest, Cropland, Grassland, Wetlands, Settlements or Other Land.

In the following text is the abbreviations used in accordance with definitions in the IPCC guidelines:

A:	Afforestation, areas with forest established after 1990 under article 3.3
R:	Reforestation, areas which have temporarily been unstocked for less than 10 years - included under article 3.4
D:	Deforestation, areas where forests are permanently removed to allow for other land use, included under article 3.3
FF:	Forest remaining Forest, areas remaining forest after 1990
FL:	Forest Land meeting the definition of forests
CL:	Cropland
GL:	Grassland
SE:	Settlements
OL:	Other land, unclassified land
FM:	Forest Management, areas managed under article 3.4
CM:	Cropland Management, areas managed under article 3.4
GM:	Grazing land Management, areas managed under article 3.4

The LULUCF sector differs from the other sectors in that it contains both sources and sinks of carbon dioxide. LULUCF are reported in the new CRF format. Removals are given as negative figures and emissions are reported as positive figures according to the guidelines. For 2008 emissions from LULUCF were estimated to be a source of approximately 500 Gg CO_2-eqv. or 0.8 % of the total reported Danish emission. Due to that the emission estimates from agricultural soils are taking into account the actual harvest conditions and the annual climatic conditions a high variability between years is estimated.

Approximately 2/3 of the total Danish land area is cultivated and 13.2 per cent are with forest. Together with high numbers of cattle and pigs there is a high (environmental) pressure on the landscape. To reduce the impact an active policy has been adopted to protect the environment. The adopted policy aims at doubling the forested area within the next 80-100 years, restoration of former wetlands and establishment of protected national parks. In Denmark almost all natural habitats and all forests are protected. Therefore only limited conversions from forest or wetlands into cropland or grassland are occurring.

A land use/land cover map was produced for the Kyoto reference year 1990 and for the year 2005 based on EO data (23 August 1990) and other data produced from 1992-2005. In Table 7.1 is showed the overall development from 1990 to 2005. The preliminary result is an increase in the afforsted area of 31,000 hectares, but also that deforestation has taken place of approximately 6,400 ha in that period. Afforestation is mainly taking place on CL and OL not previous classified as forest. Areas which are deforestated are mainly converted to GL and to a less extend into CL. Since 1990 has more than 53,000 hectares been changed into SE and other infra structures. No FL, CL and GL are converted into OL by definition.

Table 7.1 Land Use Change from 1990 to 2005 based on EO. The figures are given in hectares.

1990\2005	Forest	Cropland	Grassland	Wetlands	Settlements	Other	Sum
Forest	533403	819	4344	29	1193	0	539788
Cropland	18095	2813870	37321	4689	49205	0	2923179
Grassland	968	4755	108565	1088	1725	0	117102
Wetlands	3	0	18	1575	0	0	1596
Settlements	0	489	255	0	384703	0	385447
Other Land	12327	2211	3877	1789	1555	320929	342688
Sum	564796	2822144	154380	9171	438382	320929	4309800
Percentage	13%	65%	4%	0%	10%	7%	100%

A detailed QA/QC process of the developed Land Use matrix will be performed during 2010, as this process has not been fully completed by May 2010.

The emission data are reported in the new CRF format under IPCC categories 5A (Forestry), 5B (Cropland), 5C (Grassland), 5D (Wetlands) and 5E (Settlements) and 5F (Other Land). Denmark is free from ice and rocks and other land therefore represent unmanaged areas.

Fertilisation of forests and other land is negligible and all fertiliser consumption is therefore reported in the agricultural sector. Drainage of forest soils are reported for the first time. All liming is reported under Cropland because only very limited amounts are used in forestry and on permanent grassland. Field burning of wooden biomass is prohibited in Denmark and therefore reported as not occurring. Wildfires are very seldom and if occurring very small in Denmark and hence reported as NO.

Table 7.2 gives an overview of the emission from the LULUCF sector in Denmark. Forests have been sinks in Denmark for the last decade, but due to the age distribution of the forests - containing a majority of mature forests - a slight decrease of the carbon stock is observed, as the old forests are regenerated with young trees. Cropland is ranging from being a net source from up to 7,700 Gg in 2006 to be a net sink of 4,700 Gg in 1993. The very high fluctuations is related to the actual crop yield that year and the climatic conditions. Low yields combined with high temperatures reduce the total amount of C in agricultural soils whereas a year with a high yield and low temperatures increase the C stock in soil. From 1990 and onwards a decrease in the emission from Cropland is estimated due to a higher incorporation of straw (ban of field burning), demands of growing of catch crops in the autumn, a change from low yielding spring barley to high yielding winter wheat, an increased C stock in hedgerows and a reduced consumption of lime. The area with restored wetlands has increased and consequently the accumulation of organic matter has also increased here.

Table 7.2 Overall emission (Gg CO_2) from the LULUCF sector in Denmark, 1990-2008.

Greenhouse gas source and sink categories	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
5. Land Use, Land-Use Change and Forestry, CO_2	-906.07	518.00	4 830.76	-5 540.73	4 782.86	1 508.47	-2 024.02	3 141.58	-2 674.09	5 055.42
A. Forest Land	-894.65	-1 013.17	-914.55	-1 121.51	-980.05	-1 112.64	-1 100.17	-1 129.86	-1 215.68	-838.57
B. Cropland	-453.03	1 196.22	5 345.05	-4 657.34	5 442.41	2 396.20	-1 201.11	4 025.37	-1 662.95	5 437.37
C. Grassland	275.56	197.74	249.00	130.51	214.74	136.61	161.29	117.73	112.99	321.89
D. Wetlands	86.45	78.11	77.70	65.19	39.59	45.88	64.65	85.90	49.13	35.69
E. Settlements	79.60	59.10	73.56	42.43	66.18	42.43	51.33	42.43	42.43	99.04
F. Other Land	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
5. Land Use, Land-Use Change and Forestry, N_2O	0.06	0.05	0.06	0.05	0.05	0.05	0.05	0.05	0.05	0.06
A. Forest Land	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.04
B. Cropland	0.01	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.01
C. Grassland	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
D. Wetlands	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E. Settlements	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO
F. Other Land	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
G. Other	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
5. Land Use, Land-Use Change and Forestry, CO_2-eqv. CO_2 and N_2O	-887.08	535.01	4 848.78	-5 525.53	4 799.84	1 523.29	-2 008.66	3 156.02	-2 659.82	5 074.00
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
5. Land Use, Land-Use Change and Forestry, CO_2	-173.41	1 314.71	4 181.09	119.52	-59.58	-2 027.86	7 340.56	876.06	1 451.38	
A. Forest Land	-899.04	-917.45	-1 073.81	-1 039.60	-1 177.02	-1 206.02	-668.99	368.01	429.94	
B. Cropland	376.15	1 882.20	5 030.70	853.15	836.51	-1 050.98	7 778.93	296.96	836.51	
C. Grassland	240.70	236.63	131.43	200.70	176.69	142.81	140.50	143.38	140.45	
D. Wetlands	32.81	39.37	47.92	41.44	46.39	40.11	38.33	15.89	-7.29	
E. Settlements	75.97	73.95	44.85	63.83	57.86	46.22	51.79	51.82	51.77	
F. Other Land	NA	NA	NA	NA	NA	NA	NA	NA	NA	
5. Land Use, Land-Use Change and Forestry, N_2O	0.06	0.05	0.04	0.05	0.05	0.04	0.04	0.04	0.04	
A. Forest Land	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	
B. Cropland	0.02	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	
C. Grassland	NA	NA	NA	NA	NA	NA	NA	NA	NA	
D. Wetlands	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
E. Settlements	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	
F. Other Land	NA	NA	NA	NA	NA	NA	NA	NA	NA	
G. Other	NE	NE	NE	NE	NE	NE	NE	NE	NE	
5. Land Use, Land-Use Change and Forestry, CO_2-eqv. CO_2 and N_2O	-153.60	1 330.84	4 194.75	134.45	-45.30	-2 014.67	7 353.69	889.01	1 464.15	

7.2 Forest remaining forest (5.A.1)

7.2.1 Forests and forest management

National Forest Inventory

In 2002, a new sample-based National Forest Inventory (NFI) was initiated (Nord-Larsen et al., 2008). This type of forest inventory is very similar to inventories used in other countries, e.g. Sweden or Norway. The NFI has replaced the National Forest Census.

The NFI is a continuous sample-based inventory with partial replacement of sample plots based on a 2 x 2 km grid covering the Danish land surface. At each grid intersection, a cluster of four circular plots (primary sampling unit, PSU) for measuring forest factors (e.g. wood volume) are placed in a 200 x 200 m grid. Each circular plot (secondary sampling unit, SSU) has a radius of 15 meters. When plots are intersected by different land-use classes or different forest stands, the individual plot is divided into tertiary sampling units (TSU).

About one third of the plots is assigned as permanent and will be remeasured in subsequent inventories every five years. Two thirds are temporary and are moved randomly within the particular 2x2 km grid cell in subsequent inventories. The sample of permanent and temporary field plots has been systematically divided into five non-overlapping, interpenetrating panels that are each measured in one year and constitute a systematic sample of the entire country. Hence all the plots are measured in a 5-year cycle.

Based on analysis of aerial photos, each sample plot (SSU) is allocated to one of three basic categories, reflecting the likelihood of forest or other wooded land (OWL) cover in the plot: (0) Unlikely to contain forest or other wooded land cover, (1) Likely to contain forest, and (2) Likely to contain other wooded land. All plots in the last two categories are inventoried in the field.

In the first years of the NFI (2002-2008) the average number of clusters (PSU) and sample plots (SSU) are 2,196 and 8,604, respectively. On average 1,627 plots (SSU) were identified as having forest or other wooded land cover based on the aerial photos and were thus selected for inventory. During the first rotation of the NFI, measurements were however not obtained for some plots. Missing plot observations were caused by a number of factors including start up problems that resulted in insufficient time to complete the measurements and prohibited access to some plots on privately owned land. In 2005, the Forest Act was revised, so forest owners are obliged to provide access. On average 322 sample plots were missing in the 2002-2008 inventories.

Each plot is divided into three concentric circles with radius 3.5, 10 and 15 m. A single calliper measurement of diameter is made at breast height for all trees in the 3.5 m circle. Trees with diameter larger than 10 cm are measured in the 10 m circle and only trees larger than 40 cm are measured in the 15 m circle. On a random sample of 2-6 trees further measurements of total height, crown height, age and diameter at stump height are made and the presence of defoliation, discoloration, mast, mosses and lichens is recorded. The presence of regeneration on the plots is registered and the species, age and height of the regeneration is recorded. Stumps from trees harvested within a year from the measurement are measured for diameter.

Deadwood is measured on the sample plots. Standing deadwood with a diameter at breast height diameter larger than 4 cm is measured according to the same principles as live trees. Lying deadwood with a diameter of more than 10 cm is measured within the 15 m radius sample plot. Length of the lying deadwood is measured as the length of the tree that exceeds 10 cm in diameter and is within the sample plot. The diameter is measured at the middle of the lying deadwood measured for length. In addition to the size measurements of deadwood the degree of decay is recorded on an ordinal scale.

Forest area mapping

Due to differences in methodologies major inconsistencies in forest area and other forest variables are observed between the different forest inventories (i.e. the 1990 and 2000 Forest Census and the 2006 National Forest Inventory). With the objective to obtain time consistent and precise estimate of forest areas to report to UNFCC and the Kyoto protocol, two projects have aimed at mapping the forest area in Denmark based on satellite images. Forest area and forest area change have been estimated for the years 1990 and 2005.

A land use / land cover map was produced for the Kyoto reference year 1990 and for the year 2005 based on EO data (23 August 1990) and other data produced from 1992-2005 and for 2005 using NFI in situ data. Forest maps are developed using Landsat imagery mainly Landsat 5 (TM) and 7 (ETM+) data to classify and estimate the area of forest cover types in Denmark. Portions of seven scenes covering the whole country were classified into forest and non-forest classes. The approach involved the integration of sampling, image processing, and estimation. Initial maps were produced by Erik Prins, Prins Enginering as part of the GMES project GSE-FM (Prins 2009). Successively a supplementary analysis is being processed. A detailed QA/QC process will be performed during 2010, as this process has not been fully completed by February 2010.

The product is specified by a Minimum Mapping Unit (MMU) of 0.5 ha, a geometric accuracy of < 15 m RMS and a thematic accuracy of 90% +/- 5% for the six major Kyoto classes: Forest, Grass, Crop, Wetland, Urban, and Other. Forest has a 0.5 ha MMU, however, is subdivided without MMU into conifer, deciduous, mixed, and temporary un-stocked forest.

Forest definition

The forest definition adopted in the NFI is identical to the FAO definition (TBFRA, 2000). It includes "wooded areas larger than 0.5 ha, that are able to form a forest with a height of at least 5 m and crown cover of at least 10%. The minimum width is 20 m." Temporarily non wooded areas, fire breaks, and other small open areas, that are an integrated part of the forest, are also included.

Methodological issues for forests

Based on analysis of aerial photos, each sample plot (SSU) is allocated to one of three forest status categories (Z), reflecting the likelihood of forest or other wooded land (OWL) in the plot: (0) Unlikely to be covered by forest or other wooded land, (1) Likely to be covered by forest, and (2) Likely to be covered by other wooded land.

On individual sample plots (j) the forest cover percentage (X) is calculated as the proportion of the forest area (A) to the total plot area of the 15 m radius circle (A15). The average forest percentage ($\bar{X}$) on plots with forest status Z=1 (and 2) is calculated as the sum of the forest percentages times an indicator variable (R) that is 1 if Z equals 1 (or 2) and 0 otherwise, divided by the number of plots with forest status Z=1 (or 2).

The overall average forest percentage ($\bar{\bar{X}}$) is calculated as the sum of: (1) observed forest cover percentages of the individual sample plots, (2) the number of unobserved sample plots with forest status Z=1 times the average forest cover percentage of sample plots with forest status 1, and (3) the number of unobserved sample plots with forest status 2 times the average forest cover percentage of observed sample plots with forest status Z=2 divided by the number of observed and unobserved sample plots. In this context sample plots with forest status 0 are regarded as observed and assumed to have a forest cover percentage of 0. Finally, the overall forest area (A_{Forest}) is calculated as the overall average forest percentage times the total land area (A_{total}).

Table 7.3 Estimation of forest percentage and forest area.

Equation	Description
$X_j = \frac{A_j}{A_{15,j}}$	The forest percentage (X) of the *j*th sample plot (SSU) is estimated as the forested area (*A*) divided by the total area of the 15 m radius sample plot ($A_{15,j}$).
$\bar{X}_Z = \frac{1}{n_Z}\sum_Z X_j R_j$	Average forest percentage ($\bar{X}$) of all inventoried plots (SSU) with forest status *Z* based on aerial photos. R_j is an indicator variable that is 1 for inventoried plots and 0 otherwise. n_Z is the number of inventoried plots identified as forest or OWL from the air photos.
$\bar{\bar{X}} = \frac{1}{n}\left(\sum_{j=1}^{n} X_j R_j + N_{21}\bar{X}_1 + N_{22}\bar{X}_2\right)$	Overall average forest percentage ($\bar{\bar{X}}$). *n* is the total number of inventoried and non-inventoried sample plots. N_{21} and N_{22} is the number of non- inventoried sample plots with forest and OWL, respectively.
$A_{Forest} = \bar{\bar{X}} \cdot A_{Total}$	Total forest area. A_{Total} is the total land area, $\bar{\bar{X}}$ is the estimated forest percentage and A_{Forest} is the total forest area.

When estimating the forest area with a specific characteristic (*k*), such as age class (i.e. forest established before or after 1990), the proportion of the plot area with the particular characteristic is found by summing the forested plot areas times an indicator variable (*R*) that is 1 if the plot has the *k*th characteristic and 0 otherwise. Subsequently the plot area with the *k*th characteristic is divided by the total forested plot area.

The total forest area with a particular characteristic (A_k) is found as the forest area percentage with the particular characteristic *k* times the total forest area. In case of species and age classes, the species is identified as the main species on the plot to resemble the management classes used in the previous National Forest Census from 2000. The age classes are 10 year intervals derived from field observations.

Table 7.4 Estimation of forest area with a specific characteristic.

Equation	Description
$\overline{X}_k = \frac{\sum_{j=1}^{n} R_{jk} A_j}{\sum_{j=1}^{n} A_j}$	Proportion of the forest area with a given characteristic ($\overline{X}_k$). R_{jk} is an indicator variable which is 1 if the the forest area on the j'th sample plots has the k'th characteristic and 0 otherwise. A_j is the sample plot area and n is the total number of inventoried sample plots with forest cover.
$A_k = \overline{X}_k \cdot A_{Forest}$	Total area with a given characteristic (A_k). $\overline{X}_k$ is the estimated proportion of the forest area with the k'th characteristic and A_{Forest} is the total forest area.

Estimation of volume, biomass and carbon pools

For estimation of volume, biomass and carbon of individual trees, we use the volume functions developed for the most common Danish forest tree species (Madsen, 1985, Madsen 1987 and Madsen and Heusèrr 1993). The functions use individual tree diameter and height as well as quadratic mean diameter of the forest stand as independent variables. For calculation of biomass and carbon

The first step is to estimate the height of trees with no height measurements. Based on the trees measured for both height and diameter, diameter-height regressions are developed for each species and growth region (Nord-Larsen et al. 2008). The functions use the observed mean height and mean diameter on each sample plot for creating localized regressions using the regression form suggested by Sloboda et al. (1993). For plots where no height measurements are available, generalized regressions are developed based on the Näslund-equation modified by Johannsen (1992).

Table 7.5 Estimation of diameter-height equations.

Equation	Description
$h_{ij} = 13 + (\overline{h}_j - 13) \cdot \exp\left(\alpha_1 \cdot \left(1 - \frac{\overline{d}_j}{d_{ij}}\right) + \alpha_2 \cdot \left(\frac{1}{\overline{d}_j} - \frac{1}{d_{ij}}\right)\right)$	Site specific dh-regression for calculating height of trees not measured for height. h_{ij} and d_{ij} is the height and diameter of the i'th tree on the j'th sample plot. $\overline{h}_j$ and $\overline{d}_j$ are the average height and diameter of trees measured for height on the jth sample plot. α_1 and α_2 are species and growth-region specific parameters
$h_{ij} = 13 + \beta_1 \cdot \exp(-\frac{\beta_2}{d_{ij}})$	General dh-regression for calculating height of trees not measured for height. h_{ij} and d_{ij} is the height and diameter of the i'th tree on the j'th sample plot. β_1 and β_2 are species and growth-region specific parameters

The next step is to estimate the quadratic mean diameter of the trees on the sample plot. As the trees are measured in different concentric circles depending on their diameter, the basal area on each sample plot is estimated by scaling the basal area of each tree (standing or felled) according to the circular area in which the tree has been measured. A similar calculation has been made for the number of stems. Finally, mean squared diameter is calculated from the basal area and stem numbers.

Table 7.6 Estimation of quadratic mean diameter.

Equation	Description
$g_{ij} = \frac{\pi}{4} d_{ij}^2$	Basal area (*g*) of the *i*th tree on the *j*th plot is calculated from the diameter at breast height (*d*) (1.3 m above ground) assuming a circular stem form.
$G_j = \sum_{i=1}^{m} \frac{1}{A_{c,ij}} g_{ij}$	Basal area per hectare (*G*) the jth sample plot is calculated as the scaled sum of individual tree basal areas. Basal area (*g*) of the *i*th tree on the *j*th sample plot is scaled according to the plot area ($A_{c,ij}$) of the *c*'th concentric circle (c=3,5; 10; 15 m).
$N_j = \sum_{i=1}^{m} \frac{1}{A_{c,ij}}$	Stem number per hectare (*N*) the *j*th sample plot is calculated as the scaled number of individual trees. The *i*th tree on the *j*th sample plot is scaled according to the plot area ($A_{c,ij}$) of the *c*'th concentric circle (c=3,5; 10; 15 m).
$D_{g,j} = \sqrt{\frac{4}{\pi} \frac{G_j}{N_J}}$	The mean squared diameter is calculated from the calculated basal area and stem number for each plot.

Based on the diameter, estimated or measured height of individual trees and the squared mean diameter before thinning, the volume of individual trees is estimated using the species specific volume functions by Madsen (1987) and Madsen and Heusèrr (1993). The volume of trees less than 3 meters tall is estimated using an alternative function. The calculated volumes are total stem volume over bark for conifers and total above ground volume over bark for deciduous species.

Using the above ground volume of the individual tree, the total volume (below and above ground) is estimated using expansion factors. For coniferous species an expansion factor model developed for Norway spruce (Skovsgaard & Bald., 2010) is applied whereas for deciduous species an expansion factor model developed for beech (Skovsgaard and Nord-Larsen, 2010) is used. Biomass of the individual tree is subsequently calculated as the total volume times the density. Species specific densities are based on Moltesen (1988).

Table 7.7 Estimation of biomass and carbon of trees.

Equation	Description
$v_{ij} = F\left(d_{ij}, h_{ij}, D_{g,j}\right)$	The volume (*v*) of the *i*'th tree on the *j*th sample plots is calculated using the existing volume functions (*F*) using the tree diameter and height and the quadratic mean diameter.
$E_{ij} = F\left(d_{ij}, h_{ij}\right)$	Expansion factor model for beech and Norway spruce
$v_{tot,ij} = v_{ij} \cdot E_{ij}$	The total above and below ground volume (v_{tot}) of the ith tree on the jth sample plot. V_{ij} is the calculated volume of the tree and *E* is the expansion factor (1.2 for deciduous species and 1.8 for conifers).
$B_{ij} = V_{tot,ij} \cdot Density_{ij}$	Biomass (*B*) of the *i*th tree on the *j*th sample plot is estimated as the total volume (V_{Tot}) times the species specific density.
$C_{ij} = B_{ij} \cdot 0.5$	Carbon of the *i*th tree on the *j*th sample plot is calculated as the biomass (*B*) times 0.5.

Total or regional volume, biomass and pools of carbon are estimated based on the estimates of individual tree volumes, biomass and carbon. First, volume, biomass or carbon per hectare is estimated for each of the concentric circles (c=3.5, 10 or 15 m radius) on each plot as the plot area depends on the diameter of the tree. Using the estimates from individual plots, the area weighted mean volume, biomass or carbon per hectare for the three concentric circles is estimated. The overall mean volume, biomass or carbon is estimated as the sum of the average volumes for the three circles. Finally, the total or regional volume, biomass or carbon is estimated as the forest area times the overall mean volume.

Table 7.8 Estimation of total biomass and carbon pools.

Equation	Description
$V_{cj} = \frac{1}{A_{cj}} \sum_{i=1}^{m} R_{c,i} v_{ij}$	Volume, biomass or carbon per hectare (*V*) of the *c*th concentric circle on the *j*th sample plot (*c*=3,5; 10; 15 m). R_c is an indicator variable that is 1 if the *i*th tree is measured on the *c*th circle and 0 otherwise. $A_{c,ij}$ is the area of the *j*th sample plot and *c*th concentric circle; *m* is the number of trees on the *jth* sample plot.
$\overline{V}_c = \frac{\sum_{j=1}^{n} A_{cj} V_{cj}}{\sum_{j=1}^{n} A_{cj}}$	The average area weighted volume, biomass or carbon per hectare ($\overline{V}$) of the *c*th concentric circle. $A_{c,ij}$ is the area of the *j*th sample plot and *c*th concentric circle; *n* is the number of sample plots.
$\overline{\overline{V}} = \overline{V}_{3,5} + \overline{V}_{10} + \overline{V}_{15}$	The overall average volume, biomass or carbon per hectare ($\overline{\overline{V}}$) is estimated as the sum of the average volume, biomass or carbon per hectare ($\overline{V}_c$) for the three concentric circles (*c*=3.5, 10 and 15)
$V = \overline{\overline{V}} \cdot A_{Skov}$	Total volume, biomass or carbon *V* is the overall average volume, biomass or carbon per hectare ($\overline{\overline{V}}$) times the forest area A_{Forest}.

The total volume, biomass or carbon pools with a given characteristic are estimated in a similar way as the total figures. First, volume, biomass or carbon per hectare with the given characteristic is estimated for each of the concentric circles (*c*=3.5, 10 or 15 m radius) on each plot. Using the estimates from individual plots, the area weighted mean volume, biomass or carbon per hectare with the given characteristic for the three concentric circles is estimated. The overall mean volume, biomass or carbon is estimated as the sum of the average volumes for the three circles. Finally, the total or regional volume, biomass or carbon with the given characteristic is estimated as the forest area times the overall mean volume.

Table 7.9 Estimation of biomass and carbon with a given characteristic.

Equation	Description
$V_{cj,k} = \frac{1}{A_{cj}} \sum_{i=1}^{m} R_{c,ij} R_{k,ij} v_{ij}$	Volume, biomass or carbon per hectare (*V*) with the *k*th characteristic of the *c*th concentric circle on the *j*th sample plot (c=3,5; 10; 15 m). R_c is an indicator variable that is 1 if the *i*th tree is measured on the *c*th circle and 0 otherwise. R_k is an indicator variable that is 1 if the tree has *k*th characteristic and 0 otherwise. $A_{c,ij}$ is the area of the *j*th sample plot and *c*th concentric circle; *m* is the number of trees on the *j*th sample plot.
$\overline{V}_{c,k} = \frac{\sum_{j=1}^{n} A_{cj} V_{cj,k}}{\sum_{j=1}^{n} A_{cj}}$	The average area weighted volume, biomass or carbon per hectare ($\overline{V}$) with the *k*th characteristic of the cth concentric circle. $A_{c,ij}$ is the area of the *j*th sample plot and *c*th concentric circle; *m* is the number of trees on the *j*th sample plot.
$\overline{\overline{V}}_k = \overline{V}_{3,5,k} + \overline{V}_{10,k} + \overline{V}_{15,k}$	The overall average volume, biomass or carbon per hectare with the *k*th characteristic ($\overline{\overline{V}}$) is estimated as the sum of the average volume, biomass or carbon per hectare ($\overline{V}_{c,k}$) for the three concentric circles (*c*=3.5, 10 and 15)
$V_k = \overline{\overline{V}}_k \cdot A_{Forest}$	Total volume, biomass or carbon with the k^{th} characteristic (V_k) is the overall average volume, biomass or carbon per hectare ($\overline{\overline{V}}_k$) times the forest area A_{Forest}.

Dead wood volume, biomass and carbon

The volume of standing dead trees is calculated similarly to the calculations for live trees. The volume of lying dead trees within the sample plot is calculated as the length of the dead wood times the cross sectional area at the middle of the dead wood. Biomass of the deadwood is calculated as the volume times the species specific density and a reduction factor according to the structural decay of the wood. Finally, carbon of each standing or lying dead tree is calculated by multiplying the dead wood biomass with 0.5.

Table 7.10 Estimation of biomass and carbon of dead wood.

Equation	Description
$v_{s,ij} = F\left(d_{s,ij}, h_{s,ij}, D_{g,j}\right)$	The volume (v_s) of the *i*th standing, dead tree on the *j*th sample plots is calculated using the existing volume functions (*F*) using the tree diameter and height and the squared mean diameter.
$v_{s,tot,ij} = v_{s,ij} \cdot E_{ij}$	The total above and below ground volume ($v_{s,tot}$) of the *i*th standing, dead tree on the *j*th sample plot. v_s is the calculated volume of the tree and *E* is the expansion factor (1.2 for deciduous species and 1.8 for conifers).
$v_{l,ij} = \frac{\pi}{4} d_{l,ij}^2 \cdot l_{l,ij}$	Volume of lying dead trees (v_l) is calculated as the length (*l*) and the ith tree on the jth sample plot times the cross sectional area. The cross sectional area is calculated from the mid-diameter (d_l) of the dead wood.
$B_{s,ij} = v_{s,ij} \cdot D_{ij} \cdot r_{k,ij}$ $B_{l,ij} = v_{l,ij} \cdot D_{ij} \cdot r_{k,ij}$	Biomass of the *i*th standing (B_s) or lying (B_l) tree on the jth sample plot is calculated as the volume (v_s or v_l) times the species specific density (*D*) and a the *k*th reduction factor according to the structural decay of the wood observed in the field.
$K_{s,ij} = B_{s,ij} \cdot 0.5$ $K_{l,ij} = B_{l,ij} \cdot 0.5$	Carbon in standing or lying dead wood (C_s or C_l) is calculated as the biomass (B_s or B_l) times 0.5.

Total or regional volume, biomass and carbon pools of deadwood are estimated based on the estimates of volumes, biomass and carbon for individual dead trees or pieces of dead wood. First, deadwood volume, biomass or carbon per hectare is estimated for each of the concentric circles (*c*=3.5, 10 or 15 m radius). Estimates for lying dead wood are made using the 15 m circle. Using the estimates from individual plots, the area weighted mean volume, biomass or carbon per hectare of deadwood for the three concentric circles is estimated. The overall mean deadwood volume, biomass or carbon is estimated as the sum of the average volumes for the three circles. Finally, the total or regional deadwood volume, biomass or carbon is estimated as the forest area times the overall mean volume.

Table 7.11 Estimation of total biomass and carbon pools of dead wood.

Equation	Description
$V_{D,cj} = \frac{1}{A_{cj}} \sum_{i=1}^{m} R_c v_{s,ij} + R_c v_{l,ij}$	Deadwood volume, biomass or carbon pools per hectare (V_D) for the *c*th circle and the *j*th sample plot. v_s and v_l is the volume of standing and lying deadwood respectively. R_c is an indicator variable that is 1 if the tree is measured in the *c*th circle and 0 otherwise. A_C is the sample plot area of the *c*th circle. *m* is the number of trees within the *j*th sample plot.
$\overline{V}_{D,c} = \frac{\sum_{j=1}^{n} A_{cj} V_{cj}}{\sum_{j=1}^{n} A_{cj}}$	The average area weighted deadwood volume, biomass or carbon per hectare ($\overline{V}_D$) of the cth concentric circle. $A_{c,ij}$ is the area of the jth sample plot and cth concentric circle; *n* is the number of sample plots.
$\overline{\overline{V}}_D = \overline{V}_{D,3,5} + \overline{V}_{D,10} + \overline{V}_{D,15}$	The overall average deadwood volume, biomass or carbon per hectare ($\overline{\overline{V}}_D$) is estimated as the sum of the average volume, biomass or carbon per hectare ($\overline{V}_{D,c}$) for the three concentric circles (c=3.5, 10 and 15)
$V_D = \overline{\overline{V}}_D \cdot A_{Forest}$	Total deadwood volume, biomass or carbon V_D is the overall average deadwood volume, biomass or carbon per hectare ($\overline{\overline{V}}_D$) times the forest area A_{Forest}.

Forest soils: forest floors and mineral soil

Introduction

Following the election of art. 3.4 it was necessary to supplement the NFI by an additional inventory in order to document that forest soils are not an overlooked source for CO_2 emissions. The monitoring of soil C stocks concerns two of the five carbon pools identified by IPCC (2003), litter (forest floor) and mineral soil to a depth of minimum 30 cm.

There is relatively good information from various soil profile databases on carbon stocks in the mineral soil to 1 m depth for well-drained Danish forest soils (Vejre et al., 2003; Krogh et al., 2003). However, there is little spatially systematic information on forest soils and therefore also limited possibility to sample new country-representative information in order to explore the development in forest soil carbon stocks over time. This is most pronounced for the quickly changing litter carbon pool and in particular for the moist and wet forest soils.

The monitoring of forest soils aim to document that forest soils are not a major source for emissions of CO_2, i.e. that there is no detectable depletion in soil carbon. In the provisions for Kyoto Protocol reporting given in the so-called Kyoto Rulebook it is said that "accurate estimation and reporting is not obligatory for a certain pool if the country can demonstrate that the pool is not a source". This may be called the "not source principle" (Somogyi & Horvath, 2007). According to IPCC (2003) the necessary documentation may come from various sources such as:

- Representative and verifiable sampling and analysis to show that the pool has not decreased
- Reasoning based on sound knowledge of likely system responses
- Surveys of peer-reviewed literature for the activity, ecosystem type, region and pool in question

- Combined methods

Based on literature and reasoning based on sound knowledge there is little evidence to support that the soil C pool in forest remaining forest would currently be changing to an extent that would be detectable by sampling. For well-drained soils there may be changes in soil carbon stocks at fine spatial resolution (ha-level) due to clearcutting and replanting, but for the entire forest area with the whole range of age classes, the assumption is that soil carbon stocks are unchanged over time. In fact, the conversion toward close-to-nature forestry with continuous crown cover and abandonment of clearcutting suggests a future increase in soil carbon stocks rather than depletion (Brunner et al., 2005; Yanai et al., 2000). Areas with wet forest soils have probably been sources for increased CO_2 emissions in a period after ditching and drainage activities took place from the late 19th century. These activities led to increased mineralization of peaty soils. However, during the last 20 years, drainage activities have diminished strongly and has completely ceased in state forests. Here, the natural hydrological conditions are actively restored by filling up ditches in some areas. It is expected that this change in management will lead to sequestration of carbon as these forest soils gradually get wetter.

Since the reporting in 2009 for 1990-2007, quantitative information has become available; a project (SINKS) initiated in 2007 has delivered data on soil C change based on repeated sampling of soil C pools in forests remaining forests, and more data on soil C pools will be available before the project ends. The preliminary data suggest that forest soil C pools are not sources for CO_2 and, thus supporting that more accurate estimates of litter and soil C pool removals/emissions do not need to be included in the reporting.

New data

The only existing systematic sampling of Danish forest soils has been conducted within the so-called Kvadratnet ("square grid", http://www.landbrugsinfo.dk/Planteavl/Goedskning/Naeringsstoffer/Kvadratnet-for-nitratundersoegelser/Sider/Startside.aspx). Given the time constraints of the commitment period and reporting deadlines, changes in soil carbon stocks can only be assessed by resampling soils within this monitoring grid.

The "Kvadratnet" is a monitoring grid is 7x7 km and by 1990 it included 108 plots with forest cover (Østergaard & Mamsen, 1990). It was established in the 80'ies in order to optimize the applied amounts of fertilizer in agriculture by monitoring nitrate leaching to groundwater resources in the most common land uses. Soil sampling and analysis was conducted in 1986-90 in all 108 forest plots of Kvadratnettet, and a subset of 25 plots was resampled in 1994 (Breuning-Madsen & Olsson, 1995) as a part of the Pan-European forest monitoring programme, which uses these 25 plots for assessment of forest condition. The 25 plots resampled in 1994 have been resampled again in 2007 as a part of the demonstration project BioSoil under the Pan-European forest monitoring programme Forest Focus (http://biosoil.jrc.it/presentation/), and in 2008/2009 the other 83 plots were resampled, except one plot for which the land owner did not grant access to re-sampling).

Mineral soil samples from 1990 are thus available from 108 forest plots. The sampling was complete for the period 2007-2010, while soil-archive samples from 1990 were missing for 6 plots. Soil samples from 1986-1987 were used for 1 of these plots while it was not possible to retrieve archived soil samples for the last 5 plots. The sampling of O-horizons was also complete for the 108 plots for the period 2007-2009, while O-horizon samples from 1990 were only available from 32 plots. Soil samples and results from 1994 were only used to check other data.

The plots were in all cases (with a few exceptions due to practical circumstances) designed as a 50 x 50 m square. In 2007-09 ten forest floor and mineral soil samples were collected along a transect determined as diagonal from south-west to north-east corner of the square. In the 1990 sampling 16 soil cores were done randomly across the square plot, while forest floor samples were only collected occasionally in an unspecified manner.

The O-horizon samples from 2007-2009 were area-based samples (Vesterdal & Raulund-Rasmussen, 1998) removed from a 25 x 25 cm area, that were brought to the laboratory in separate bags.

The mineral soil samples from 2007-2009 were taken in the ten spots where O-horizons had been removed. A 2-3 cm thick soil corer was used. Samples from 4-5 different horizons were pooled in the field. The division into horizons differed slightly between the three sampling campaigns: 1986-1990, 2007 and 2008/2009. In 1986-1990 the division was 0-25, 25-50, 50-75 and 75-100 cm; in 2007 (the 25 BioSoil plots) it was 0-10, 10-20, 20-40, 40-80 and 80-100 cm; and in 2008/2009 0-10, 10-25m 25-50, 50-75 and 75-100 cm.

In the lab, all samples were dried at 40 °C until constant weight. Before sieving through a 2 mm sieve, more clay-rich mineral soil samples were crushed in a mortar, while sandy soil samples were gently crushed or sieved directly. The stones (>2 mm) left after sieving were weighed (DW_{stone}), while the fine soil (<2 mm) was dried at 40 °C for at least 48 h, and then weighed (DW_{soil}). A sub-sample of the fine soil, about 20 g, was removed after thorough mixing for finer grinding in an agate mortar.

The ten O-horizon samples from each plot were weighed separately, and then ground in Retsch grinder through a 2 mm net. From each of the ten samples, 10% of the material was removed after thorough mixing to get a pooled sample for the plot. About 100 ml of the pooled sample was removed after thorough mixing and then ground more finely in a Tecator mill.

Mineral soil samples were analysed by dry combustion (Elementar Analyzer) for total organic carbon (TOC) and O-horizon samples for total carbon by a laboratory certified according to ISO 10694. Analyses were done by Agrolab/ Institut Koldingen, Sarstedt, Germany.

For each of the plots, the mineral soil carbon stocks in 2007-2009, C_{m-2009} (tC ha^{-1}), was calculated as

$$C_{m-2009} = \sum_{i=1}^{4(or5)} d_{m-2009} \cdot 10000 \cdot (1 - RV_{stone-2009}) \cdot \rho_{soil} \cdot c_{soil-2009}$$

where d_m is the depth of a given horizon (m), and ρ_{soil} is the bulk density of soils (g cm^{-3}) assessed by use of published pedotransfer functions (Vejre et al., 2003). $c_{soil-2009}$ is the C concentration (mg g^{-1}). RV_{stone} is the relative volume of the stone (versus that of the fine soil):

$$RV_{stone-2009} = \frac{DW_{stone-2009} / \rho_{stone}}{DW_{stone-2009} / \rho_{stone} + DW_{soil-2009} / \rho_{soil}}$$

where ρ_{stone}=2.65 g cm^{-3}, $DW_{soil-2009}$ (g)is the dry weight of the fine soil (<2 mm) in the soil samples from 2007-2009 and $DW_{stone-2009}$ (g) is correspondingly the weight of stones in the soil sample (>2 mm).

For each of the plots, the forest floor carbon stocks in 2007-2009, $C_{ff-2009}$ (tC ha^{-1}), was calculated as

$$C_{ff-2009} = \sum_{i=1}^{10} DW_{ff-2009,i} \cdot 0.0016 \cdot c_{ff-2009}$$

where $DW_{ff-2009,i}$ (g dry weight) is the dry weight of sample number i, i=1-10 and $c_{ff-2009}$ is the C concentration of the pooled sample per plot (mg g^{-1})

The mineral soil dry weight in 1990 was calculated in the same manner as for 2007-2009, assuming that the relative stone volume was identical to that of 2007-2009. The forest floor depth was, however, not measured in 1990, nor was an area-based the forest floor weight recorded. Forest floor depth (d_{ff}, m) measured for profiles on some of the plots 1986-1989 was used instead, while forest floor densities for the individual plots were obtained from the new measurements performed in 2007-2009. When data was available, forest floor C stocks in 1990, $C_{ff-1990}$ (tC ha-1) were calculated as

$$C_{ff-1990} = d_{ff} \cdot 10000 \cdot \rho_{ff-2009} \cdot c_{ff-1990}$$

where $c_{ff-1990}$ (mg g^{-1}) is the carbon concentration of the forest floor samples from 1990 (measured in 2009), and $\rho_{ff-2009}$ (g m^{-3}) is the average bulk density of the forest floor for the individual plot as measured in 2009:

$$\rho_{ff-2009} = \frac{\sum_{i=1}^{10} DW_{ff,i}}{0.25 \cdot 0.25}$$

Considering the forest structure in Denmark with many small forests (about 70% of the forest estates are of less than 5 ha) the "Kvadranet" is a very coarse grid. Even if the grid was fully sampled, it is therefore unlikely that the 108 plots represent the Danish forest area of approximately 500.000 ha. We thus evaluated based on power analyses that further sampling was necessary for future monitoring and chose to include a subset of the permanent plots of the National Forest Inventory (NFI) for this purpose.

It will not be possible, as with the "Kvadratnet", to resample soils of the NFI plots for changes in soil C within the short time frame before Kyoto Protocol reporting. From 2012 an onward the NFI plots can be resampled to better support the work to demonstrate that soil carbon stocks are not a source for CO_2 emissions. As the Danish reporting of the three forest carbon pools aboveground biomass, belowground biomass and dead wood is based on the NFI, this will also ensure the link between monitoring of all five forest carbon pools identified by IPCC (2003). In the first reporting efforts, however, information on C stocks and site properties from the NFI will enable better upscaling of results from "Kvadratnet" to the Danish forest area.

Changes in forest soil carbon stocks in forests planted before 1990

The preliminary results from the "Kvadratnet" showed that there is a large variation in soil C pools among sites for both forest floors and mineral soils. The mean C pool of forest floors was about 22 and 28 tC ha^{-1} in 1990 and 2007-09 respectively. The corresponding C pools for mineral soils were 156 in 1990 and 157 tC ha^{-1} in 2007-09 (Table 7.12). The mean changes in forest floor and mineral soils pools between 1990 and 2007-2009 (5.6 and 1.5 tC ha^{-1} yr^{-1} respectively) were not significant (Table 7.13, Figure 7.1a-b).

Table 7.12 Basic statistics on soil C pools measured in the "Kvadratnet".

	Mean pool	Standard deviation	Minimum	Maximum
	tC ha^{-1}			
Forest floor 1990	22.12	19.12	0.76	80.34
Forest floor 2007-2009	27.68	30.05	3.94	164.48
Mineral soil 1990	155.78	115.91	29.31	848.14
Mineral soil 2007-2009	157.26	100.34	18.66	853.08

Table 7.13 Basic statistics on the differences in C soil pools between 1990 and 2007-2009 and statistics from a simple t-test (H_0: change in soil C stock = 0).

	Total number of sites	Number of sites in t-test	Mean change	Std	Mininmum	Maximum	P-value
			(tC ha^{-1})				
Forest floor	108	31	5.56	24.78	-61.44	84.13	0.22
Mineral soil	108	104	1.48	47.56	-182.62	131.51	0.75

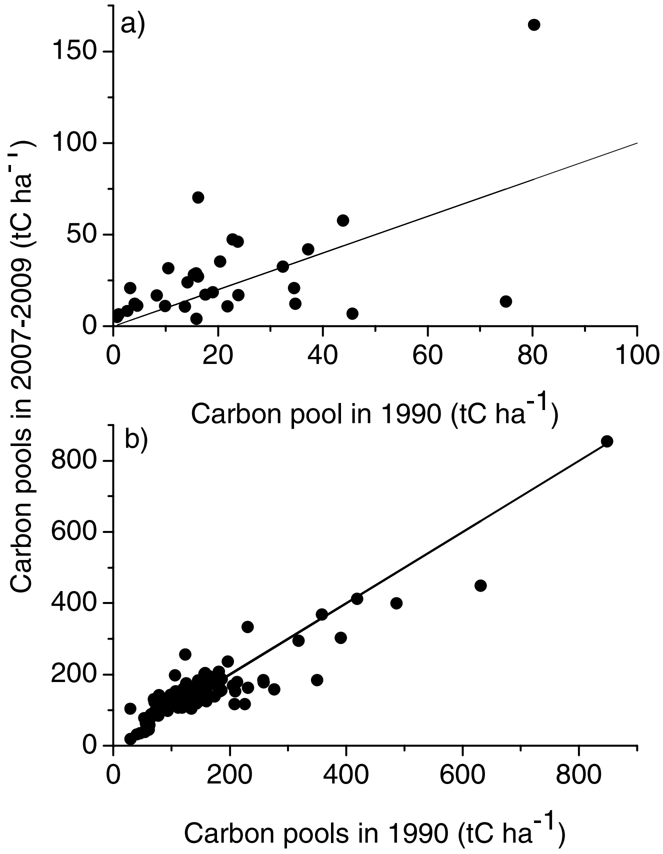

Figure 7.1 C pools in forest soils for forest before 1990. a) Forest floor C in 2007-2009 versus 1990, b) Mineral soil C in 2007-2009 versus 1990. Lines: y=x.

Some mineral soils had one or several horizons of organic origin, and these soils had very high soil C stocks to 1 m depth (>300 tC ha^{-1}), and these will probably be handled separately in further work with the data. Determination of true changes in organic soils requires that the total depth of the organic layer is known, while soils were only sampled until 1 m in SINKS.

Uncertainties and time-series consistency

Danish national forest inventories have developed over the years from the earliest inventories more than a century ago. More recently the development has been quite rapid, which may lead to inconsistencies in estimation of forest carbon pools in relation to LULUCF.

In the 1990 forest census the number of questionnaires sent to respondents was 22,300. In the subsequent inventory the number of respondents increased to 32,300. Not unexpectedly this lead to a substantial increase in estimated forest area, which is not possible to separate from the actual increase in forest area that occurred during that period of time. Also, it is not possible to single out the effect of the increased number of questionnaires on estimates of species distribution, carbon pools etc.

In 2002, the sample based forest inventory released the previous forest census for the first time enabling annual forest statistics. The NFI includes areas and forest owners that have not previously been included in the forest census. Firstly because not every forest owner was included in the previous surveys and secondly because not all forest areas according to the FAO definitions would be perceived as forest by the respondents. Consequently, the change from questionnaire based forest census to sample based forest inventory has lead to an increase in forest area estimates that is not possible to separate from the actual increase in forest area that occurred during that period of time.

Specifically, in relation to the reporting of carbon pools in forest, the change from questionnaire based forest census to sample based forest inventory has changed the calculation of forest volume, biomass and carbon. In the forest census, forest carbon is estimated from the reported forest area within different species, age and site classes and a number of forest growth models. In the forest inventory, forest volume is measured on the plots. This has lead to a substantial increase in forest volume, biomass and carbon estimates, mainly due to the methodological differences.

In the estimation of carbon emissions from existing forests, the information collected in relation to different forest census and inventories is combined with the satellite based landuse land use / land cover map for the Kyoto reference year 1990 and for the year 2005. Hereby, consistent estimates of emissions from existing forests are obtained.

Below is made and a first Tier 1 estimate of the uncertainty in the forest, Table 7.14. This will be evolved before the next submission.

Table 7.14 First Tier 1 estimate of the uncertainty in the forest.

		1990	2008					
		Emission/sink, Gg CO_2-eqv.	Emission/sink, Gg CO_2-eqv.	Activity data, %	Emission factor, %	Combined uncertainty	Total uncertainty, %	Uncertainty 95 %, Gg CO_2-eqv.
5. LULUCF		-887.5	1464.1				16.9	247.0
5.A Forests		-879.0	442.2				12.6	55.6
Broadleaves, Forest remaining forest	CO2	-648.7	199.2	15	10	18.0	18.0	35.9
Conifers, Forest remaining forest	CO2	-254.3	238.7	15	10	18.0	18.0	43.0
Broadleaves, Land converted to forest	CO2	3.3	-3.1	15	15	21.2	21.2	0.7
Conifers, Land converted to forest	CO2	5.1	-4.8	15	15	21.2	21.2	1.0
Drainage of forest soils	N2O	15.7	12.2	30	75	80.8	80.8	9.9

QA/QC and verification

A continuous focus on the measurements of carbon pools in forest will contribute to QA/QC and verification in the following submissions. As we gain more data through remeasurements of permanent sample plots in the NFI this will further support the verification of the data reported.

Ongoing development of the NFI in terms of sampling procedures and estimation methods are esential for the continued QA/QC process of the NFI.

Integration with multi phase and multi scale inventory - through e.g. other in-situ data like LiDAR scanning or remote sensing like satellite imagery will through research contribute to the continued QA/QC process of the NFI and the carbon stock estimates for forests.

Recalculations and changes made in response to the review process

As response to review comments a full recalculation of forest carbon pools have been performed for the period 1990 to 2009.

The carbon stock change for forests has been estimated based on best available data - which include the following main data sources:

- National Forest Inventory - NFI - conducted by Forest and Landscape Denmark for The Danish Forest and Nature Agency, Ministry of Environment. The NFI started in 2002 and is a continuous forest inventory with partial replacement. The rotation is 5 years. (Nord-Larsen et al 2008) - See Chapter XX 7.1.2 for further details.
- Forest Census 1990 and 2000, conducted by Statistics Denmark - in cooperation with The Danish Forest and Nature Agency and Forest and Landscape Denmark. (Danmarks Statistik 1994, Larsen & Johannsen 2002) - See below for short description.
- Mapping of the forest area based on satellite images in 1990 and 2005, with suppport from ESA - GMES - FM and the Ministry of Climate and Energy. (Prins 2009) - See Chapter XX 7.1 for further details.

Forest Census

From 1881 to 2000, a National Forest Census has been carried out roughly every 10 years based on questionnaires sent to forest owners (Larsen and Johannsen, 2002). Since the data was based on questionnaires and not field observations, the actual forest definition may have varied. The basic definition was that the tree covered area should be minimum 0.5 ha to be a forest. There were no specific guidelines as to crown cover or the height of the trees. Open woodlands and open areas within the forest were generally not included. All values for growing stock, biomass or carbon pools based on data from the National Forest Census were estimated from the reported data on forest area and its distribution to main species, age class and site productivity classes. The two last censuses were carried out in 1990 and 2000.

The 1990 National Forest Census was based on reported forest statistics from 22,300 respondents, resulting in information on area, main species, age class distribution and productive indicators. The estimated forest area was 445,000 ha or 10.3% of the land. Of the total forest area 64% was coniferous forest and 34% was deciduous forest (the remainder was temporarily unstocked). The total volume was estimated at 55.2 mio. cubic metres of which 57% was coniferous.

The number of respondents in the 2000 National Forest Census was 32,300, which is considerably higher than in the 1990 survey. The change in the number of respondents probably contributed to the observed increase in forest area and growing stock between the 1990 and 2000 census. The estimated forest area was 486,000 ha or 11.3% of the land. Of the total forest area 60% was coniferous forest and 36% was deciduous forest (the remainder was temporarily unstocked). The total volume was estimated at 77.9 mio. cub. metres of which 63% was coniferous.

Recalculation for 1990 - 2009

Based on mapped forest area in 1990 and in 2005 a recalculation of carbon stored in both forest remaining forest and in afforestation since 1990 have been performed. The forest areas in 1990 as well as in 2005 have been mapped to be larger than previously estimated for the times. The recalculation of carbon stock in 1990 and in 2000 used age distribution as reported in census 1990 and in 2000 as an expression of the total forest land allocation to species and ages. Based on the actual measurements of carbon storage in different species and age classes with the current National Forest Inventory, the total standing carbon stock was calculated. For each of the years 1990 - 2000 calculated a standing carbon stock as a moving average, corrected for the deforestation which was detected. Wind throws and the effects of these are included in the overall estimation of changes in carbon stock. As carbon stock is based on moving average the annual effect is not dramatic. For a more detailed description of the analyses see Johannsen et al 2009.

Since the NFI was initiated in 2002, it is representative from 2005. Calculation of carbon stock in the period 2000-2004 is based on NFI in 2005 and carbon stock as calculated for 2000. For 2005-2009 carbon stock is calculated solely on the basis of the NFI - with additional information about the total forest area from satellite image mapping.

In the transition from the recalculation of data 1990 - 2005 to the NFI based data there is a number of basic structural elements of the Danish forests that become visible. One issue it the significantly higher proportion of broadleaved trees, due to mixed stands that previously was reported as purely conifers. This causes the amount of carbon in broadleaved category to increase steadily until 2005, where after the overall trend of the forest carbon pools result in first a slow down of carbon accumulation and in the last year a decline. The main reasons for the change in pattern is a combination of gradual change in inventory and a gradual change in forest management and the current structure of the forests. For conifers a decline is recalculated for the period since 2000, as the proportion of conifers has declined with the NFI data and in the later years is influenced by the overall gradual change in forest management and the current structure of the forests.

The data for 2008 and a preliminary forecast until 2020 show a decreasing trend of forest carbon stock. This is due to the current high proportion of old trees, which face rejuvenation. Hereby large old trees felled and replaced by new small trees. The net result is that the total carbon stock decreases. This has gradually affected the estimates for the years since 2007 and hence a decline in carbon stock is seen for 2008. If the forests had a completely even distribution of ages, carbon stock would be virtually constant - assuming unchanged harvesting and growth. Changes in forest management, may affect the development of forests. Thus, a postponement of cutting of old trees - will postpone the decline in carbon storage. Conversely, increased logging (e.g. due to increased demand, increased price or similar) may lead to a sharper decline in carbon stock.

For the afforestated areas a steady increase in carbon stocks is expected also in the future years. The rate of increase of area will depend on both availability of land and on possible subsidies for afforestation. Deforestation occurs mainly in relation to other specific projects e.g. for nature restoration or test areas for wind mills.

Planned improvements

A QA/QC of the Land Use matrix will be performed before the next submission.

National expansion functions for main tree species are expected to be implemented for the next submission, based on sampling of trees from Danish forests.

Documentation for carbon pools in soil and litter is expected to be further improved in the next submission.

7.2.2 Land converted to forests

Forest area

See section 1.2.1.1 Information on approaches used for representing land areas and on land-use databases used for the inventory preparation

Forest definition

See section 1.2.1.2 Land-use definitions and the classification systems used and their correspondence to the LULUCF categories (e.g. land use and land-use change matrix)

Methodological issues for land converted to forest

See also section 1.2.1.3

With respect to the option for distinguishing forest with and without harvesting, it is not possible with the available data. Data from the National Forest Inventory is utilised based on the land use mapping to identify sample plots on AR areas. It is - however not possible to determine the amount of harvesting. As we furthermore apply an approach utilising total carbon stock change growth and harvesting is included in the overall estimation.

Arable land to forest: soils

Introduction

Changes in soil carbon pools following afforestation were for the first time been included in the NIR for 2008 covering the period until 2006. The included soil C pool changes concerned only C sequestration due to development of forest floors, i.e. the organic layer on top of the mineral soil. We included C sequestration in this layer since national scientific projects had indicated that this was the soil compartment mainly prone to changes following land-use change. In the previous NIRs we did not account for possible changes in C pools of the mineral soil; based on chronosequence studies of afforested stands (http://www.sl.kvl.dk/afforest/), no consistent changes had been detected in mineral soil organic matter during the first 30 years following afforestation (Vesterdal et al., 2002; Vesterdal et al., 2007). These conclusions are supported by new data.

New data

New information on carbon pools in forest soils is available from the national project, SINKS. In this project forest soils are sampled in two grids, "Kvadratnettet" and the National Forest Inventory (NFI), see section 1.2.1.3 for a description.

Apart from 108 plots in forests planted before 1990, the "Kvadratnet" included 15 plots in afforestation since 1990. The sampling took place together with the sampling in forests planted before 1990, and was thus complete for the period 2007-2009. Archived soil samples from 1990, when the plots were arable land, were missing for 1 plot.

The sampling, the sample preparation, chemical analyses and calculations were similar to that performed from forests planted before 1990, see 1.2.1.3.

Some of the 300 plots being sampled in the NFI grid are probably also located in forests planted since 1990. The sampling is currently being performed, and these data will be reported in the next NIR.

Changes in forest soil carbon stocks in forests planted on arable land since 1990

The average C sequestration rates for forest floors for broadleaves and conifers were estimated from the information from scientific projects in afforestation chronosequences; the average annual sequestration of C in forests floors was 0.09 and 0.31 tC ha^{-1} yr^{-1} under broadleaves and conifers, respectively (Table 7.15.). These rates of change have been used for calculation of forest floor C sequestration in afforested land.

Table 7.15 Forest floor C sequestration rates in afforestation areas for different species in national chronosequential studies.

Tree species category	Tree species	Study type	Age (yr)	Forest floor C sequestration (tC ha^{-1} yr^{-1})	Source*
Broadleaves	Oak	Chronosequence	29	0.08	1
	Oak	Stand	30	0.02	2
	Oak	Stand	30	0.05	2
	Oak	Stand	30	0.04	2
	Oak	Stand	30	0.02	2
	Oak	Stand	30	0.13	3
	Oak	Stand	40	0.09	3
	Beech	Stand	30	0.09	2
	Beech	Stand	30	0.10	2
	Beech	Stand	30	0.12	2
	Beech	Stand	30	0.13	2
	Beech	Stand	30	0.18	3
	Beech	Stand	40	0.14	3
	Average (SEM)			*0.09 (0.01)*	
Conifers	Norway	Chronosequence	30	0.35	1
	Spruce	Chronosequence	41	0.43	1
		Stand	30	0.21	2
		Stand	30	0.15	2
		Stand	30	0.20	2
		Stand	30	0.30	2
		Stand	30	0.30	3
		Stand	40	0.65	3
	Sitka spruce	Stand	30	0.43	2
		Stand	30	0.24	2
		Stand	30	0.22	2
		Stand	30	0.25	2
	Average (SEM)			*0.31 (0.04)*	

* 1) Vesterdal et al. (2007), 2) Vesterdal & Raulund-Rasmussen (1998), 3) Vesterdal et al. (2008).

The results from scientific projects have lately been checked by analysis of preliminary results from the "Kvadratnet". The afforested plots in the monitoring grid also revealed large variation in soil C pools among for both forest floors and mineral soils (Table 7.16). The mean C pool of the forest floor among the afforested sites was about 2.5 tC ha^{-1} in 2007-2009 (and supposedly 0 tC ha^{-1} at the time of the afforestation) while the mean C pools for mineral soils were 114 and 108 tC ha^{-1} in 1990 and 2007-2009 respectively (Table 7.17). The mean change in mineral soils pools between 1990 and 2007-2009 (-1.87 tC ha^{-1} yr^{-1}) was not significant (Table 7.16 and Figure 7.2) while there, as expected, was a significant sequestration of C in the forest floor due to litterfall inputs and subsequent build up of the organic layer (Table 7.17, Figure 7.3). The age of the afforested stands ranged from 8-19 years, so only the establishment phase was covered.

Table 7.16 Basic statistics on soil C pools measured in the "Kvadratnet".

	Mean C pool	Std	Min	Max
		(tC ha^{-1})		
Forest floor at the time of the afforestation	-	-	-	-
Forest floor 2007-2009	2.53	1.79	0.25	5.56
Mineral soil 1990	113.63	35.37	68.00	186.06
Mineral soil 2007-2009	107.83	41.25	52.82	220.06

7.17 Statistics from a simple t-test on the change in soil C between ca. 1990 and 2009 for forests after 1990.

	Total number of sites	Number of sites in t-test	Mean change	Std	Min	Max	P-value
				(tC ha^{-1})			
O-horizon	15	15	2.53	1.79	0.25	5.56	<.0001
Mineral soil	15	14	-1.87	17.59	-35.32	34.00	0.70

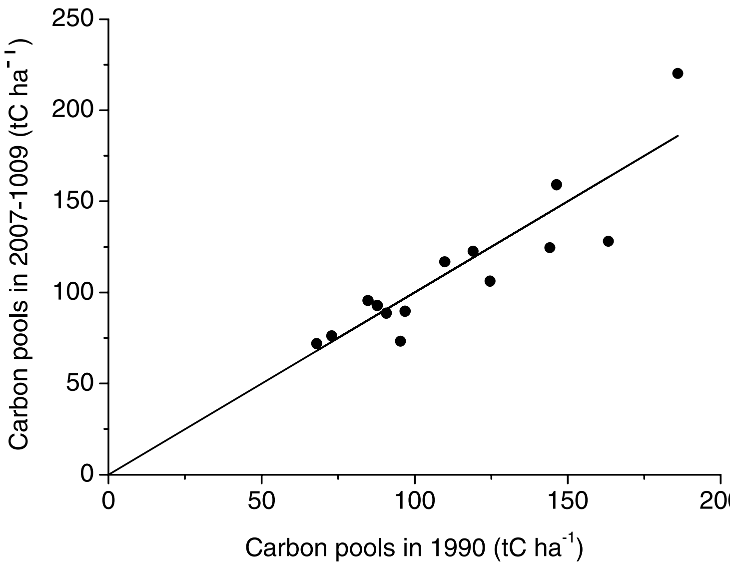

Figure 7.2 C pools in mineral soils in 2009 versus 1990. Forests established on arable land since 1990. Line: y=x.

The amount C in the forest floors increased with the age of the afforested stand (Figure 1.3), while this was not the case for the mineral soil (Figure 1.4).

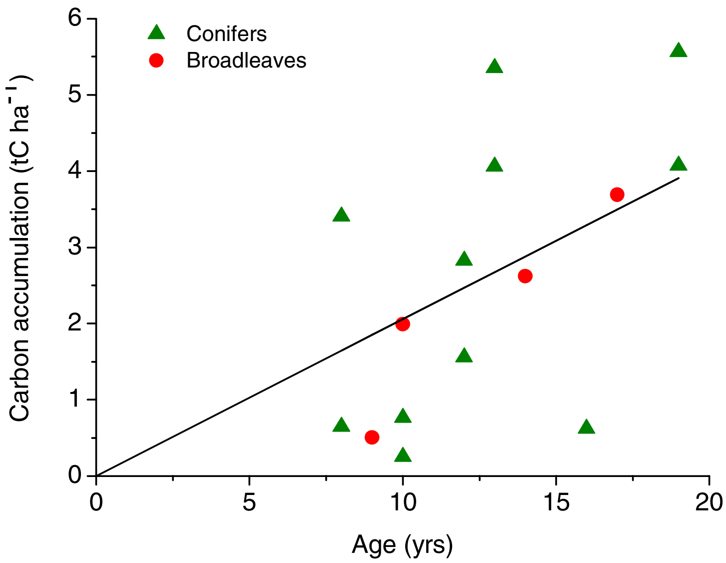

Figure 1.3 Forest floor C pools in forests afforested since 1990 in the "Kvadratnet". The regression was forced through (0,0) (C acc. = 0.2057 x age, R^2=0.3124, p<0.0001).

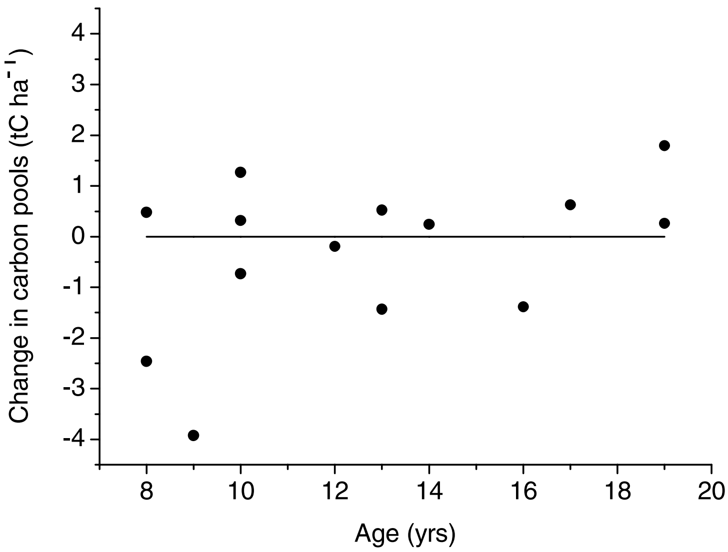

Figure 7.4 Change in mineral soil C stocks for forests since 1990. Line: y=0 (Regression line (not shown): R^r=0.0005, p=0.9356).

Average C sequestration rates for forest floors for broadleaves and conifers were also estimated from "Kvadratnettet" in order to check the forest floor C sequestration rates used in reporting; in this case the average annual sequestration of C in forests floors was 0.16 and 0.20 t C ha^{-1} yr^{-1} under broadleaves and conifers, respectively (Table 7.18). These values are intermediate compared to the values obtained from 30-40 yr-old stands.

Table 7.18 Forest floor C sequestration rates in afforestation areas for different species. Data from the "Kvadratnet".

Tree species category	Tree species	Study type	Age (yr)	Forest floor C sequestration (tC ha^{-1} yr^{-1})	Site
Broadleaves	Oak	Monitoring plots	14	0,19	837
	Oak	Monitoring plots	17	0,22	301
	Maple	Monitoring plots	9	0,06	485
	Lime	Monitoring plots	10	0,20	571
	Average (SEM)			*0.16 (0.07)*	
Conifers	Norway spruce	Monitoring plots	19	0,21	479
	Sitka spruce	Monitoring plots	13	0,41	335
	Sitka spruce	Monitoring plots	10	0,03	340
	Normann fir	Monitoring plots	13	0,31	31
	Normann fir	Monitoring plots	16	0,04	171
	Normann fir	Monitoring plots	12	0,13	235
	Normann fir	Monitoring plots	8	0,08	292
	Normann fir	Monitoring plots	12	0,24	689
	Silver fir	Monitoring plots	19	0,29	66
	Larch	Monitoring plots	8	0,43	334
	Mixed conifers	Monitoring plots	10	0,08	509
	Average (SEM)			*0.20 (0.14)*	

Lastly we combined all data to explore the trends in forest floor C stocks among broadleaves and conifers (Figure 7.6). The used rates seem reasonable, even if the inclusion of new data indicate that it might be too high for conifers in the stand establishment phase.

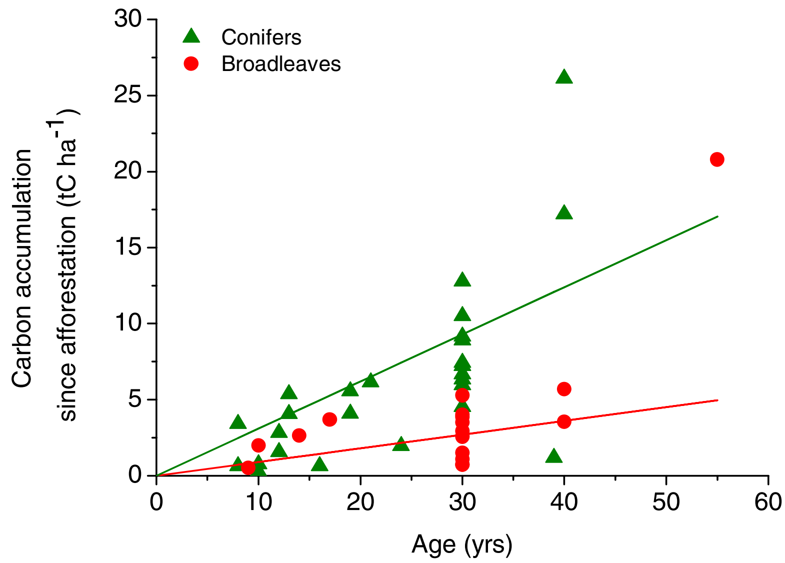

Figure 7.6 Forest floor C pools in afforested plots. All available data from chronosequential studies and the "Kvadratnet" are included. Lines show the C sequestration rates used in the reporting: 0.31 tC ha^{-1} yr^{-1} for conifers and 0.09 tC ha^{-1} yr^{-1} for broadleaves.

In conclusion, preliminary results from the SINKS project shows that mineral soil C pools for forests on former arable land need not be reported at this stage. The data from the SINKS project support the conclusions drawn from Vesterdal et al. (2002, 2007), Vesterdal and Raulund-Rasmussen (1998), and Vesterdal et al. (2008) for forest floors and suggest that minerals soils of afforested arable lands are not sources of CO_2.

Until final results from the SINKS project are available we continue to use the previously used average C sequestration rates: 0.09 tC ha^{-1} yr^{-1} for broadleaves and 0.31 for conifers. During the Kyoto commitment period 2008–2012 (5 years), it is thus estimated that the Danish afforestation activities will result in sequestration of 20-25 Gg CO_2 yr^{-1} in the forest floor.

The sequestration of CO_2 in forest floors in forests established since 1990 has gradually increased to about 20 Gg CO_2 in 2008. The annual CO_2 sequestration will increase much more over the next decades when cohorts of afforestation areas enter the stage of maximum current increment.

Uncertainties and time-series consistency

See section 1.2.1.4 and 1.2.2.6 for recalculation since 1990.

QA/QC and verification

A continous focus on the measurements of carbon pools in land converted to forest will contribute to QA/QC and verification in the following submissions. See also Chapter 1.2.1.5

Recalculations, including changes made in response to the review process

As response to review comments a full recalculation of forest carbon pools have been performed for the period 1990 to 2009.

The carbon stock change for forests has been estimated based on best available data - which include the following main data sources:

- National Forest Inventory - NFI - conducted by Forest and Landscape Denmark for The Danish Forest and Nature Agency, Ministry of Environment. The NFI started in 2002 and is a continous forest inventory with partial replacement. The rotation is 5 years. (Nord-Larsen et al 2008) - See Chapter XX 7.1.2 for further details.
- Forest Census 1990 and 2000, conducted by Statistics Denmark - in cooperation with The Danish Forest and Nature Agency and Forest and Landscape Denmark. (Danmarks Statistik 1994, Larsen & Johannsen 2002) - See Chapter 1.2.1.6 for a short description.
- Mapping of the forest area based on satellite images in 1990 and 2005, with suppport from ESA - GMES - FM and the Ministry of Climate and Energy. (Prins 2009) - See Chapter XX 7.1 for further details.

Recalculation for 1990 - 2009

Based on mapped forest area in 1990 and 2005 a recalculation of carbon stored in afforestation since 1990 have been performed. Since the NFI was initiated in 2002, it is representative from 2005. Calculation of carbon stock in the period 2000-2004 is based on NFI in 2005 and carbon stock as calculated for 2000. For 2005-2009 carbon stock is calculated solely on the basis of the NFI - with additional information about the total forest area from satellite image mapping.

For the afforestated areas a steady increase in carbon stocks is estimated. With the utilisation of the NFI since 2005 the data for the carbon pools under AR is based on direct measurements of change in total carbon stock.

References - See Chapter 1.2.1.6:

Planned improvements

A QA/QC of the Land Use matrix will be performed before the next submission.

National expansion functions for main tree species are expected to be implemented for the next submission, based on sampling of trees from Danish forests.

Documentation for carbon pools in soil and litter is expected to be further improved in the next submission.

7.3 Cropland – 5B

7.3.1 Cropland and cropland management – 5B1

The total Danish cropped agricultural area of approximately 2.7 million ha can relate to approximately 700 000 individual fields, which again is located at 220 000 land parcels. This gives an average field size of less than four ha. The actual crop grown in each land parcel (LPIS) is known from 1998 and onwards. Since 1990 has the agricultural area recorded by Statistics Denmark decreased from 2.78 million ha to 2.67 million. The total crop yield is however at the same level and increasing due to improved cropping techniques. The main reason is urbanisation and afforestation. The major part of the agricultural area is grown with annual crops: cereals, grass in rotation, oilseed, sugarbeets, potatoes and temporarily set-a-side. Grass outside rotation is reported under Grassland.

Table 7.19 shows the development in the agricultural area from 1990 to 2008 (Statistics Denmark). A general trend is a continuous decrease of 6 000 - 7 000 ha pr yr in the agricultural area.

Table 7.19 Cropland area in Denmark 1990-2008 according to Statistics Denmark and the Land Use Matrix, ha.

Greenhouse gas source and sink categories	1990	1995	2000	2005	2006	2007	2008
Annual crops (CL) 1	2 236 535	1 969 275	1 938 633	1 953 306	1 951 598	1 923 448	1 976 815
Grass in rotation (CL)	306 325	310 568	330 834	342 417	361 351	352 640	390 536
Permanent grass (CL and GL)	217 235	207 122	166 261	192 968	189 384	196 630	189 962
Horticulture – vegetables (CL)	16 428	12 915	10 803	9 557	10 071	9 978	11 341
Perennial fruit trees – perennial wooden crops (CL)	7 892	8 367	8 010	8 237	8 083	8 322	8 294
Set-a-side (CL)	3 861	217 801	192 441	200 751	190 020	171 743	90 947
Willow in the cropland for energy purposes (CL)	667	986	1 304	1 622	1 686	1 749	1 813
Hedgerows (CL)	61 326	60 910	60 465	60 096	60 033	59 929	59 840
“Other agricultural land”	66 048	94 838	138 895	45 217	34 827	74 867	63 990
Total agricultural land area reported by Statistics Denmark	2 788 276	2 726 048	2 646 982	2 707 236	2 710 507	2 662 761	2 667 895
Total land area reported under Cropland	2 923 867	2 896 899	2 865 326	2 836 057	2 829 406	2 822 845	2 817 835

[1]CL refers to that the area is treated under Cropland. GL refers to Grassland.

Cropland area

The Cropland area is defined as the agricultural area as given by Statistics Denmark, Perennial wooden crops (fruit trees, orchards and willow), hedgerows (perennial trees/bushes not meeting the forest definition) in the agricultural landscape and “Other agricultural land”. The latter is defined as the difference in the area between the total Cropland area as defined by the performed Remote Sensing (see Table 7.1) minus agricultural crops in rotation as given by statistics Denmark minus the area with fruit trees and the area with hedgerows. “Other agricultural land” is thus comparable small areas and probably without agricultural and wooden crops which cannot be allocated to other land use categories. In the inventory C in living biomass for “Other agricultural land” is given the same value as for annual crops so than inter-annual changes in the cropland area from Statistics Denmark are eliminated.

The area with Perennial wooden crops are the area given by Statistics Denmark and for some categories is it split further down with data from the EU crop subsidiary system, which gives information on which crops are grown where on species level.

The main data for land use in Cropland (5.B.1) is the agricultural area given by Statistics Denmark. Both annual agricultural and wooden perennial crops are allocated into grids (climatic, soil type and municipality) with the help of the EU Land Parcel Information System (LPIS). LPIS contains information of the exact position of the field. The survey data from Statistics Denmark differs a little from the LPIS system (<±2% for the major crops). For the calculations is used area and yield data from each region reported by Statistics Denmark.

The area with hedgerows is based on analysis of aieral photos from 1990 and 2005.

Cropland definition

The land area under "CL" consists of: Cropland with annual crops, cropland with wooden perennial crops, area with hedgerows and “Other agricultural area”. The latter consists of small undefined areas lying inside the area which is allocated as cropland in the cropland area.

For purposes of the calculations for annual crops is used a division as follows: Winter and spring wheat, rye, triticale, winter and spring barley, oat, winter and spring rape, grass for grass seed production, grassland in rotation, potatoes, sugar beets, peas, maize for silage, cereals for silage, vegetables and miscanthus.

For purposes of perennial wooden crops is used a division as follows: Apple, Pears, Cherries, Plumes, Rosehips, Elderberries, Hazel and Walnuts, Grapes, Other fruit trees, Black current, Other fruit bushes, Hedgerows and Willows.

Biomass from Christmas trees in the agricultural area is reported under forests.

Cropland - Methodological issues

The following data sources are used for determination of cropland area, for determination of any land-use changes, for allocation of natural and administrative parameters, for development of emission factors for soils and biomass and for calculation of carbon stocks in soils and biomass at various times. Agricultural area data from Statistics Denmark, 1988 to 2008

- Area and harvest surveys from Statistics Denmark, 1986 to 2008
- Area with willow from the agricultural subsidiary system

- EUs Land Parcel Information System, 2000 and onwards (grown crops on field and soil level)
- Digital soil map, 1:25.000
- Arial photos of hedgerows in 1990 and 2005
- Hedgerow planting data 1977 to 2008
- Lime consumption data 1988 to 2008

The model for C stock changes in hedges is based on a growth model from the National Forest Inventory (NFI) classified into plant and soil type and height.

Emissions from living biomass

For annual agricultural crops on cropland remaining cropland (5B1) is it assumed that no changes in above-ground, below-ground, dead biomass and litter are occurring cf. IPPC 2003 (3.3.1.1.1). The variations in the actual agricultural area collected by Statistics Denmark may vary up to 100,000 hectares per year. When estimating the C stock in living biomass such changes may create large variations between years which may be artefacts. As the amount of living biomass is defined according to the time where the peak of living biomass is occurring the variation in the area from Statistics Denmark create large fluctuations in the C stock in living biomass compared to other sources. To counteract this problem has the sub-division "Other agricultural land" been created with a default C stock of living biomass as in the designated agricultural area. The default C stock in living biomass is equivalent to an average spring barley crop with aboveground biomass of 9,577 kg DM (dry matter) pr hectare and a below ground DM of 2,298 kg pr hectare. Default dry matter values for the different crop categories used in the inventory is given in Table 7.20.

Table 7.20 Default values for the amount of DM (dry matter, kg per hectare) used for estimating C stock changes where land use conversions takes place.

		Dry matter, kg DM pr hectare	
		Above ground biomass	Below ground biomass
Cropland		9 577	2 298
Grassland	Improved Grassland	2 400	6 720
	Unmanaged Grassland	2 200	400
Wetlands	Peat extraction	0	0
	Other Wetland	3 600	10 080
Settlements		2 200	2 200
Other land		4 000	4 000

Fruit trees and other perennial wooden plants

Fruit trees, other perennial commercial wooden plants and durable horticultural plantations are reported separately under Cropland (Table 5.B). These are only of minor importance in Denmark. The total area for different main classes and the used C stock in above-ground and below-ground biomass are given in Table 7.21. Due to the limited area and small changes between years the CO_2 removal/emission is calculated without a growth model for the different tree categories. Instead the average stock figures are used in Table 7.21 multiplied with changes in the area to estimate the annual emissions/removals. Perennial horticultural crops account for approximately 0.07 % of the standing C-stock. Christmas trees are reported under forest (5.A).

The carbon fraction of dry matter (DM) is assumed to be 0.5 for all species. For parameter estimation of living biomass, see Gyldenkærne et al. 2005 for fruit trees, for willow and Micanthus:
http://www.nordicbiomass.dk/dansk/nye_afgroeder.asp

Table 7.21 Mg living biomass per hektar and area, ha, with perennial wooden trees and – bushes, 1988-2008.

	Living biomass, Mg DM per ha	1988	1990	1995	2000	2005	2008
Black currant	5.20	583	1269	1828	1492	2001	2071
Other berries	5.20	339	344	275	351	486	485
Rosehip	13.99	103	89	69	79	108	118
Cherries	25.45	1787	1787	2653	2804	2131	1951
Plumes	25.45	35	46	26	33	54	52
Hazelnut and Walnuts	25.45	27	36	25	20	21	31
Apples	33.76	3103	2726	1658	1678	1751	1797
Pears	13.99	417	351	546	441	413	442
Elderberry	25.45	6	7	5	7	10	8
Grapes	5.20	25	20	19	23	24	23
Other fruit trees	13.99	124	166	121	99	143	163
Rowan-berries	33.76	5	1	7	2	3	8
Willow	14.79	444	667	986	1304	1622	1813
Miscanthus	10.54	15	20	32	44	57	64
Total, ha		7013	7530	8250	8377	8823	9025

Hedgerows

Since the beginning of the early 1970s governmental subsidiaries have been given to increase the area with hedgerows to reduce soil erosion. Annually financial support is given to approximately 600-800 km of hedgerow pr year. There are no figures of how many hedgerows which has been removed in the same period as these to a large extend are not protected. Therefore has 144 areal photos on a 2*2 km2 square for 1990 and 2005 been analysed to monitor and detect changes in the landscape (Fuglsang et al., in prep). The squares are distributed throughout Denmark in a stratified way according to primarily soil and wind conditions (Figure 7.7). A very large dynamic in the location of the hedges between 1990 and 2005 was observed (Figure 7.8). Only areas not meeting the definition of forests and areas not classified under Perennial Wooden crops (fruit trees, willows etc.) were included in the analysis. The hedges were further allocated into eight different regions, mainly according to soil type (e.g. growth pattern).

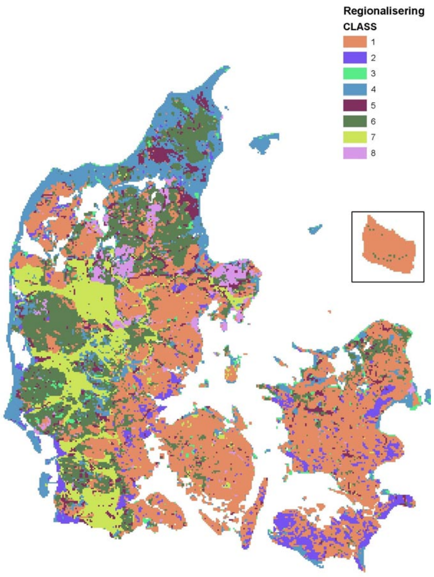

Figure 7.7 Designated areas with different types/classes of hedges.

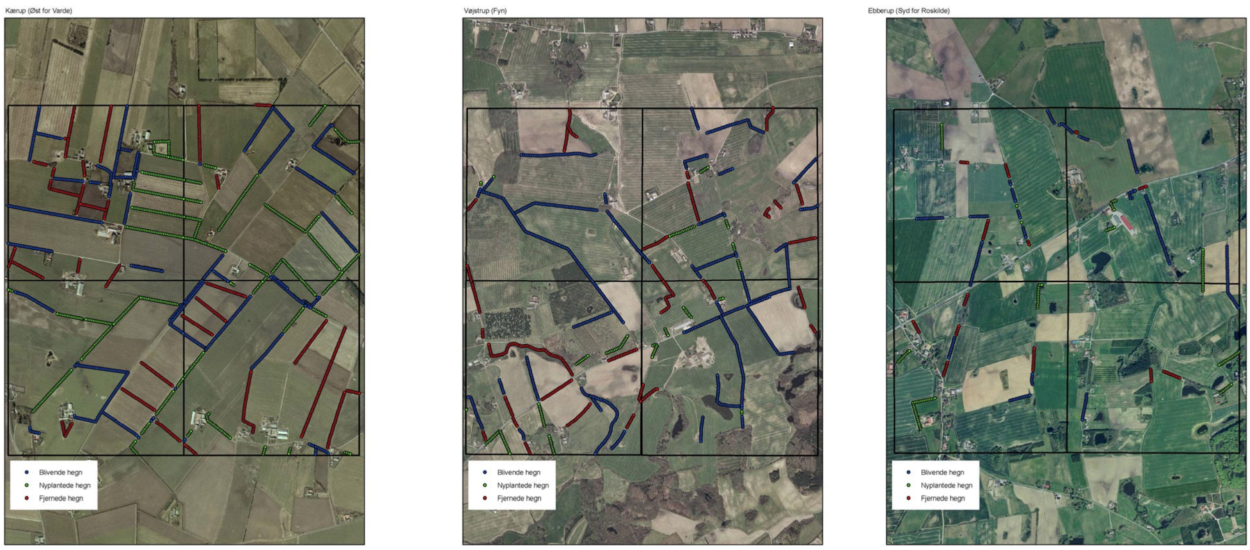

Figure 7.8 The dynamics of hedgerows in the Danish Landscape 1990 to 2005. Blue colour indicates no changes, red colours are removed hedges and green colours are new hedges (Source: M. Fuglsang, NERI).

The overall results from the analysis of hedges are show in Table 7.22. The total area with hedges has decreased with 2 % but the total volume and the C stock has increased due to changed sizes and composition.

Table 7.22 Hedges in the cropland 1990 and 2005.

	1990	2005	Change 1990-2005
Area, ha	61,326	60,093	-2.0%
Volume, mio. m3	4,139	4,402	6.4%
C stock, Gg	939	1,072	14.2%

In Table 7.23 is shown the actual planting and removal rates for hedgerows. In the 1970 and 1980 was there less concern to protect and maintain the hedgerows. Therefore there was a substantial loss in hedgerows. The governmental subsidiary is headed towards broadleaved hedgerow replacing old single-rowed conifers (mainly *Picea glauca*). In 1990 75 % of the replaced conifers hedgerows were replaced with 3- to 6-rowed broad-leaved hedges. In 2005 only 20 % is replacements and the remaining is new hedges cf. Table 7.23. "Plantning og Landskab, Landsforeningen" (www.laeplant.dk) is responsible for all administration, registration and mapping of all subsidised hedgerow planting in Denmark.

Table 7.23 Hedges planted and removed under the governmental subsidiary system 1985 to 2008.

	1985	1990	1995	2000	2005	2008
Planted 3-rowed, km	1082	928	560	852	390	400
Planted 6-rowed, km	0	0	252	250	115	150
Percentage removed, %	75%	75%	36%	27%	20%	20%
Percentage new, %	25%	25%	64%	74%	80%	80%
Hedges removed, ha	608	522	218	219	76	83

The biomass estimation of the hedges is based on measurements made in the Danish NFI where plots with similar height and plant species are used as transfer functions. Figure 7.9

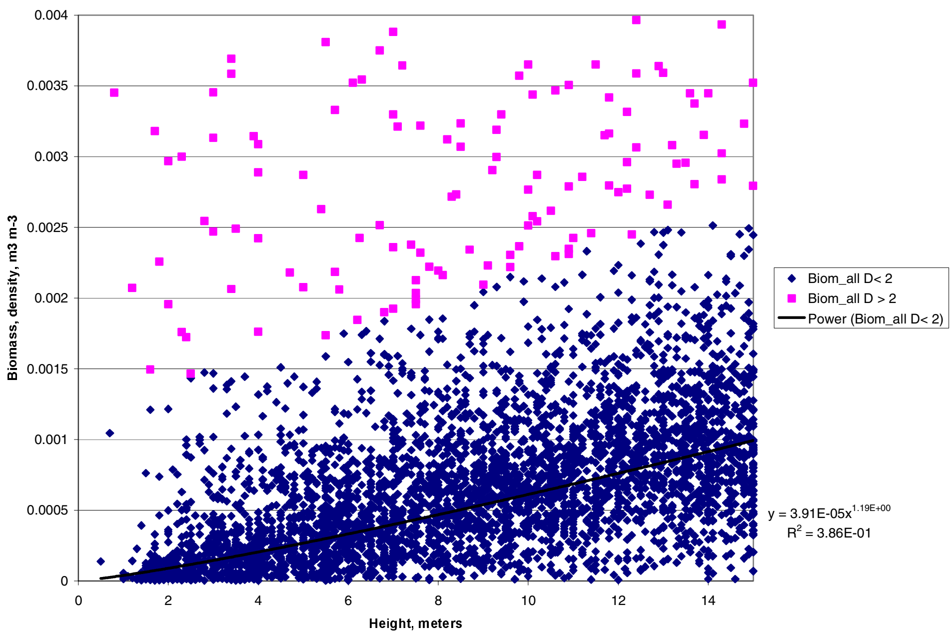

Figure 7.9 Biomass function estimated as m^3 biomass per m^3 versus tree height in NFI plots less than xx meter (Courtesy Thomas Nord-Larsen, SL, LIFE, KU).

Emission from soils

Based on a GIS analysis of the data in the LPIS and the soil map is the agricultural area distributed between mineral soils and organic soils and subdivided into cropland and permanent grassland. Table 7.24 and 7.25 shows the main result from the GIS analysis. It can be seen, as expected, that set-a-side, grass in rotation and permanent grass is more common on organic soils than on mineral soils.

A new soil map for the agricultural soils is under compilation. The new soil map will be available for the submission in 2011 and combined with updated EF for organic soils it will change the emission estimates for the cropland sector for the whole period. For the 2010 submission is used the same methodology for organic soils as in the 2009 submission, whereas for mineral soils is used an updated version of C-TOOL (Petersen et. al. 2010).

The percentage distribution in Table 7.25 is used as parameters when estimating the land use between different categories for all years between 1990 and 2008. These figures will be updated in the 2011 submission. See planned improvements.

Table 7.24 The distribution of crops between organic and mineral soils in 1998 according to the GIS-analysis.

Soil type	Annual crops in rotation	Set-a-side	Grass in rotation	Permanent grass	Total
Organic	82 191	16 056	24 885	27 864	150 997
Mineral	2 098 396	126 777	214 053	114 944	2 554 169
Total	2 180 587	142 833	238 938	142 808	2 705 166

Table 7.25 The distribution of organic soils and mineral soils in per cent in 1998.

Soil type	Annual crops in rotation	Set-a-side	Grass in rotation	Permanent grass	Total
Organic	54	11	16	18	100
Mineral	82	5	8	5	100

Table 7.26 The percentage distribution of the agricultural area used in the emission model.

Soil type	Annual crops in rotation	Set-a-side	Grass in rotation	Permanent grass
Organic	3.8	11.2	10.4	19.5
Mineral	96.2	88.8	89.6	80.5
Total	100.0	100.0	100.0	100.0

Furthermore the organic soils are divided in shallow and deep organic soils. 38 % of the organic soils are according to the Danish soil classification deep organic soils (Sven Elsnap Olesen, DIAS, pers. comm).

Mineral soils – 5B1

For C changes in for agricultural crops is used a 3-pooled dynamic soil model (Petersen 2003, Petersen et al. 2002, 2005, 2010, Gyldenkærne et al. 2005) to calculate the soil carbon dynamics in relation to the Danish commitments to UNFCCC. C-TOOL is only used in CL. No change in the C-stock in soils under perennial wooden plants, hedgerows and "Other agricultural cropland" is expected and reported as IE. These areas are also only a minor part of the cropland area. For agricultural crops is C-TOOL run on a regional level.

C-TOOL

C-TOOL is a 3-pooled dynamic model, where the approximate average half-live times for the three different pools are 0.6-0.7 years, 50 years and 600-800 years. The main part of biomass returned to soil each year is in the first and easiest degradable pool. C-TOOL is parameterised and validated against long-term field experiments (100-150 years) conducted in Denmark, UK (Rothamsted) and Sweden and is "State-of-art". A detailed description of C-TOOL can be found at www.agrsci.dk/c-tool/index.htmls. A simple diagram of C-TOOL is shown in Figure 7.10.

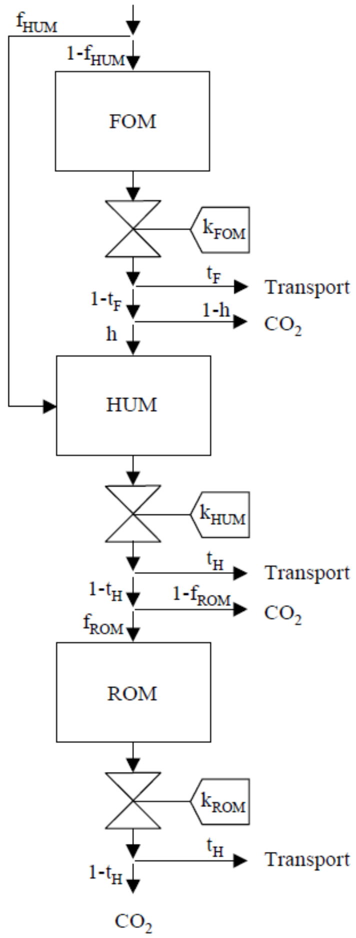

Figure 7.10 A simple diagram of C-TOOL. Please refer to www.agrsci.dk/c-tool for more information.

Input data to C-TOOL and out put
As C input to each region is for each year taken the actual crop area and crop yield from Statistics Denmark for that particular region and crop species as given by Statistics Denmark (www.dst.dk Table AFG, AFG07, HST7 and HST77). The dry matter content depends on the actual crop. For cereals it is 15 per cent.

The amount of agricultural residues returned to soil is the amount estimated by Statistics Denmark (www.dst.dk Table HALM and HALM1). The dry matter content depends on the actual crop. For cereals it is 16 per cent.

The amount of animal manure produced and applied to soil is estimated with the same methodology as in the Agricultural sector for estimating CH_4 and N_2O emission where annually updated feeding and excreting data are provided for the regulation of the animal production in Denmark. Here detailed data on the number of animal, housing and manure type are available on farm level. This also includes data whether the manure has been biogassed or not. The manure data are used as input to C-TOOL.

To reduce N leaching has there since 1997 has been a demand for growing N catch crops in Denmark. Besides reducing the N leaching these crops is increasing the carbon stock in the soil. Between 120,000 and 200,000 hectares of the agricultural area has this additional crop every year (Table 7.27). The demand for catch crops has altered the way of farming in two main ways. For farmers with cattle the farmers are sowing grass seed in their normal cereal fields. This grass sword must not be ploughed into the soil before winter/next spring. For farmers growing grass seed, which is common in Denmark, is old grass seed fields not ploughed before next spring in contradiction to the current situation where it would be ploughed early autumn. It has been estimated that the obligatory catch crops are increasing the amount of C returned to soil with 0.36 to 2.14 tonnes C per hectare per year (Olesen et al. 2004). The area with catch crops in each region is estimated from each farms obligatory N accounting, in which the area of catch crops area given on farm level (www.pdir.dk). In total there has been an annual area of app. 200,000 hectares with catch crops.

Table 7.27 Area with catch crops 1998-2008, ha. (www.pdir.dk).

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
No. of holdings	55055	54454	52976	50676	48772	48106	45000	42247	49067	49023	46065
average ha pr holding	4.1	3.4	3.5	2.5	2.5	2.5	2.67	2.91	2.51	2.33	2.67
Total area, ha	225725	185144	185416	126690	125963	124794	124793	145060	189025	122290	120000*

* preliminary figure.

C-TOOL is initiated with data from 1985 and run multipliable times until stability, before the emissions from 1985 and onwards was calculated. Actual monthly average temperatures are used as temperature driver. The main drivers in the degradation of soil biomass are temperature and humidity. The Danish climate is quite humid with winter temperatures around zero degrees Celsius and hence is the importance of soil humidity on the model outcome low in contradiction to temperature, which has a high effect on the emission. As mentioned, when biomass is returned to the soil the major part of it is quite easily degradable. Warm winters with unfrozen soils in connection with high inputs of biomass will therefore, as a result, yield high emissions from the soil compared to more cold years, which will yield low emissions. E.g. the carbon sequestration in 1990, 1998 and 2000 (Figure 7.11) are due to high harvest yields and normal temperatures, whereas the peak in 1993 is due to a normal harvest year but with very low temperatures with low degradation rates.

In the most recent years (1999-2008), there have been very warm winters in Denmark. In 18 out of the last 20 years has the annual average temperature been above the average temperature from 1961 to 1990. Year 2008 was the third warmest year ever registered in Denmark with an average temperature of 9.4 °C or 1.7 °C above the average from 1961 to 1990.

Year 2006 resulted in a high loss due to the warmest year up to then combined with a harvest yield 5% below the average for 1997 to 2008 (measured as kernel yield from cereals). In this year the organic matter input from crop residues and animal manure were not able to compensate for the loss. 2007 was not so warm which led to an increase in the C-stock. Although 2008 were the warmest year ever recorded still a slight increase compared to 2007 was estimated due to good harvest. The modelled CO_2-emission from the mineral soils shows that the C level in mineral soils in 2008 year is still far from the amount of C which was estimated at the end of 2005. (Figure 7.11 and Table 7.28).

As a whole is the modelled emissions found to be the most realistic emissions estimates for Denmark. As described in the agricultural sector the Danish farmers has faced increased demands for lower environmental impact since the mid 1980s. This includes, among others, ban on field burning and increased demands for winter green crops (winter cereals and autumn sown catch crops such as grass and rape) to reduce leaching of nitrogen and ban on autumn application of animal manure. This change in agricultural praxis has influence on the C stock in soil in the longer term. The general effect on the C stock in soil is that the 1980s showed a decrease in the C stock. In the 1990s the C stock seems to have been stabilised and in future a small increase in the C-stock is expected, although it depends on how big the global warming will be in near future.

The losses from soils are quite high in these years and higher than expected if having used average standard temperatures for 1961-90. If average temperatures were used the model calculation would show an overall increase in the soil C stock.

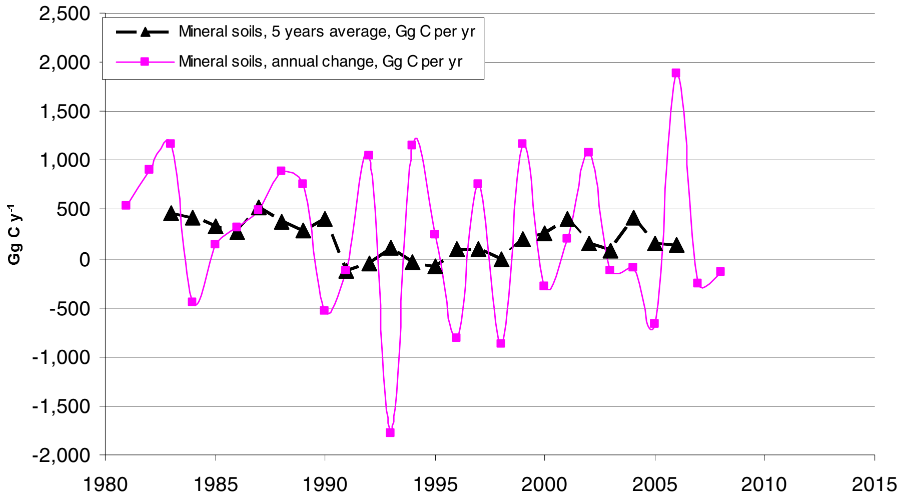

Figure 7.11 Modelled total annually emission and five-year average from all mineral soils in Denmark, Gg C pr yr from 1980 to 2008. Positive values are loss of carbon (emission) and negative values are carbon sequestration.

Table 7.28 Modelled carbon stock (0-100 cm) in mineral soils from 1980 to 2008. Positive emissions are loss of carbon and negative values are carbon sequestration.

Year	Carbon stock, Gg C	Emission, Gg C pr yr
1980	431.19	
1981	430.66	529.815
1982	429.76	895.433
1983	428.59	1172.664
1984	429.03	-441.644
1985	428.89	144.415
1986	428.57	312.376
1987	428.09	484.752
1988	427.21	884.178
1989	426.45	754.498
1990	426.99	-535.562
1991	427.12	-129.745
1992	426.07	1050.387
1993	427.85	-1782.208
1994	426.70	1147.071
1995	426.46	246.084
1996	427.26	-809.088
1997	426.50	762.832
1998	427.37	-868.772
1999	426.21	1164.558
2000	426.49	-283.691
2001	426.29	200.984
2002	425.21	1078.286
2003	425.33	-118.229
2004	425.42	-89.632
2005	426.09	-673.394
2006	424.21	1882.801
2007	424.46	-253.162
2008	424.61	-143.654

Organic soils - 5B1

In Table 7.24 is show the area with organic soils >10 % OM which are the default Danish definition. These figures are based on old soil maps. For the purpose of the reporting has an estimate of the area with organic soils >20 % OM been estimated based on our best expert knowledge. It is assumed that app. only 50% of the organic soils will meet the IPCC definition and consequently has the area been reduced accordingly. The emission from organic soils is estimated from the actual land use of the organic soils in four groups: annual crops, set-a-side, grass in rotation and permanent grassland. Emission from organic soils on permanent grassland is reported under Grassland (Table 5.C.1)

The current used emission factors for organic soils are shown in Table 7.29. Negative values indicates a built up of organic matter. Wet organic soils are defined as having a water table between 0 and 30 centimetres below the surface and thus not suitable for driving with agricultural machineries.

The carbon dioxide emission factor from the organic soils is based on emission data from Denmark, UK, Sweden, Finland and Germany, adjusted for differences in annual mean temperature to the average Danish climate (Svend E. Olesen, DIAS, 2005). E.g. data from southern Finland are adjusted with a factor of 2 and data from central Germany with a factor of 0.6.

Table 7.29 Emission factors for organic soils. Negative values indicates a built up.

	% organic soils[1]	% with deep organic soils	% wet soils	Emission factor, t C pr ha pr yr			
				Dry shallow	Dry Deep	Wet shallow	Wet Deep
Annual crops	3.8	38	0	5	8	0	0
Grass in rotation	11.2	38	0	5	8	0	0
Set-a-side	10.4	38	26	3	4	-0.5	-0.5
Permanent grass (drained)	19.5	38	26	3	4	-0.5	-0.5

[1]Percentage of the total area from the annual survey from Statistics Denmark classified as organic

Emissions of nitrous oxide from organic soils are estimated from degradation of organic matter and the C:N-ratio in the organic matter. Figure 7.12 shows the C:N-ratio for 160 different soils. Hence for organic soils are used a C:N-ratio of 20. The IPCC Tier 1 value of 1.25 % is used as emission factor.

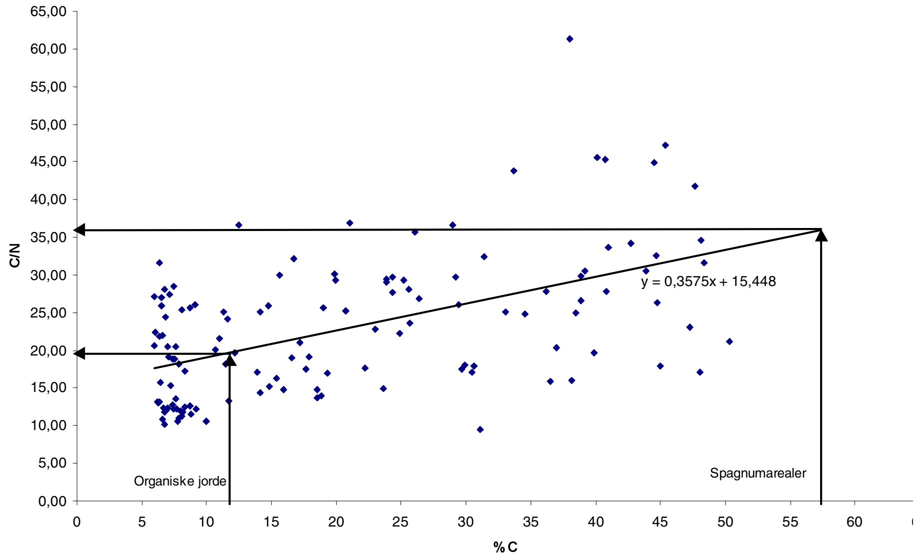

Figure 7.12 C:N-ratio in organic soils in relation to soil carbon content (Olesen 2004).

The estimated emissions from organic soils are given in Table 7.30. The approximately area distribution are shown in Table 7.25 and the emission factors are given in Table 7.29. For 1990 to 2008 the different classes are given as a fixed percentage of the total annual area from Statistics Denmark. As a consequence is all CO_2 emissions from organic soils converted from other Land Use categories reported under 5.B.1 and not under 5.B.2.1 to 5.B.2.5. The related N_2O emission is reported in the agricultural sector in Table 4.Ds1.

A completely new soil map for the organic soils covering all agricultural soils in Demark as well as new emission factors are currently under development and will be finished for the 2011 submission. A recalculation of the will therefore be performed in the next submission.

Table 7.30 Emissions from organic soils 1990 to 2008.

Greenhouse gas source and sink categories	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
					Gg C					
Cropland, Gg C pr yr	288	287	288	289	294	278	282	279	285	278
Grassland, Gg C pr yr	25	25	24	23	22	24	22	20	18	19
Total organic soils	313	312	312	312	316	302	305	299	303	297

Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008
					Gg C				
Cropland, Gg C pr yr	279	279	272	273	269	283	288	282	292
Grassland, Gg C pr yr	19	20	21	21	20	23	22	23	22
Total organic soils	298	300	293	294	290	304	310	305	314

Uncertainties and time-series consistency

A Tier 1 uncertainty analysis has been made for part of the LULUCF sector cf. Table 7.31. The uncertainty in the activity data for the agricultural sector is very low. The highest uncertainty is associated to the emission factors. Especially the emission/sink from mineral soils and organic soils has a high influence on the overall uncertainty.

The LULUCF sector contributes to a large extend to the total estimated uncertainty. In recognition of the difficulties in analyses of uncertainty, the estimated uptake of CO_2 in the forestry sector must be treated with caution.

Table 7.31 Tier 1 uncertainty analysis for Cropland for 2008.

		1990 Emission/sink, Gg CO_2-eqv.	2008 Emission/sink, Gg CO_2-eqv.	Activity data, %	Emission factor, %	Combined uncertainty	Total uncertainty, %	Uncertainty 95 %, Gg CO_2-eqv.
5.B Cropland		-1015.0	608.1				34.2	208.1
Living biomass	CO_2	-53.0	48.4	10	20	22.4	22.4	10.8
Mineral soils	CO_2	-2020.7	-510.7	10	20	22.4	22.4	114.2
Organic soils	CO_2	1055.5	1070.0	10	50	51.0	51.0	545.6
Disturbance, Land converted to cropland	N_2O	3.2	0.4	50	75	90.1	90.1	0.4

The time-series are complete.

QA/QC and verification

A general QA/QC plan is developed for cropland. The following Points of Measures (PM) are taken into account.

- Collection and error check on in-data
- Control of sums
- Comparison with other data

The area estimates for cropland and grassland are very precise due to unrestricted access to detailed data from EUs Integrated Administration and Control System (IACS) on agricultural crops on field level and the use of the vector based Land Parcel Information System (LPIS). This access includes both Statistics Denmark and NERI. The total uncertainty in the major crop data is estimated by Statistics Denmark to be <2 %. Together with detailed soil maps this gives a unique possibility to estimate the agricultural crops on different soil types and hence track changes in land use. However, IACS and LPIS are only available from 1998 and onwards, and estimates for 1990 are therefore more uncertain. The QA of crop data is made by Statistics Denmark.

Data on newly planted and removed hedgerows are based on subsidised hedgerows and QA is carried out by "Plantning og Landskab, Landsforeningen" who is responsible for the administration of the subsidiaries. The uncertainty in the number of plants used for the hedgerows is not estimated but is assumed to be very low because of the subsidised system.

There is an unknown uncertainty in the number of un-registered removal of hedgerows. A linear approach has therefore been made "missing" hedges over the years. Establishment of wetlands is based on vector maps received from every county in Denmark. The uncertainty is not estimated but assumed to be very low due to the subsidised system.

A Danish national soil sampling program was initiated in 1987 on approximately 600 agricultural fields scattered throughout Denmark on all soil types. Resampling was made in 1998 in 320 plots. A new resampling has taken place late autumn in 2008/spring 2009 but these data will first be available for verification purposes of the C-stock development in soils and the estimation made by C-TOOL in the next submission.

The results from the previous soil sampling showed that from 1987 to 1998 a decrease in soil C was found on pig farms and farms without animal husbandry. On cattle farms an increase in soil C was registered, probably due to high manure application rates and a high percentage of grass in the rotation (grass has a large amount of root residues). An up scaling to the whole Danish area yields was assumed to be very uncertain. However, the up scaling showed an insignificant increase in soil C of two tonnes C pr ha from 110 tonnes pr ha to 112 tonnes pr ha (0-50 cm depth) in this period (Heidmann et al. 2001). This can be compared with that C-TOOL in the same period has estimated a loss of 0.2% of the C-stock in cropland soils. It must therefore be assumed that C-TOOL so far is estimating the development in accordance with the real development.

The amount of consumed lime used is more uncertain. Data is collected by DAAC from all suppliers and importers and published every year in "Planteavlsorientering." The collected data is assumed to be very reliable. No uncertainty analysis has been made, but it is assumed that it is in the range of 5-10 %. The emission factor may be overestimated due to expected leaching of CO_3^{--}, however no data are available on this issue.

A range of experts from the Faculty of Agricultural Sciences, Aarhus University are repeatedly involved in discussions and report writings on topics related to the inventory.

Recalculations, including changes made in response to the review process

Recalculations have been made for all emission estimates for Cropland.

The previous review has recommended and sensitivity analysis of C-TOOL. It has not been possible to follow this recommendation in this submission due to that the response from the ERT was received too late for this submission. A sensitivity analysis will be included in the 2011 submission. All other comments from the ERT has been reflected and incorporated in this submission.

Previously was the annual estimate from soils based on a five-year average to avoid very large inter-annual fluctuations in the inventory. The ERT has recommended Denmark to use the estimated real annual emission in the inventory. This has been included. This leads to much higher variability between years due to differences in crop yield and climatic conditions.

As major changes have been made for CL has a recalculation been made for all years.

Planned improvements

To document the emissions and the carbon stock changes in LULUCF sector a 72 million DKK grant has been given for research and documentation purposes. Some of the results have been included in this submission whereas others will be included in the 2011 submission. What remains is completely new soil map for the agricultural soils, verification of the development of C-stock in soils from the soil sampling programme, establishing of national emission factors for CO_2, CH_4 and N_2O from organic soils and a QA/QC of the Land Use Change matrix.

As a consequence will the estimated emission from cropland soils be recalculated next year. This will in particularly change the emission from both mineral soils and organic soils as the split between the two areas may change substantially. The soil sampling in the agricultural grid has taken place, but the data are currently not available for the NIR.

7.3.2 Land converted to cropland – 5B2

Agriculture covers more than 63% of the total area giving a large impact on environment. As a consequence are there many initiatives for transferring agricultural land into natural habitats and forest as well as the continuous development of infra structure demands more land. Land converted to cropland is not very common. The land use matrix showed that 17,084 hectares were converted from 1990 to 2008. A major part is GL converted to CL. A small area seems to be converted from SE to CL. As this is unlikely a thoroughly quality control will be performed before the next submission.

Approaches used for representing land

The area converted from other land use to cropland is based on remote sensing of the Danish area in 1990 and 2005 combined with data in LPIS on which crops are grown in each field. If the land use in a particular pixel is an annual crop or other cropland species the conversion is recorded as a conversion to Cropland.

Methodological issues

Change in carbon stock in living biomass

For land converted to cropland is used a standard default gain value of 9,577 kg DM (dry matter) per hectare in above-ground biomass and 2,298 kg DM per hectare in below-ground biomass. This value is equivalent to the average harvest of living biomass for all cereals grown in Denmark from 2000 to 2009 inclusive straw, stubble and glumes. For conversion from DM to carbon a default fraction of 0.5 kg C per kg DM is used.

For conversion from cropland to other land use categories are used the same value but recorded as a loss of carbon in the respective category (5A2, 5C2, 5D2 and 5E2).

The loss in living biomass for conversion from another land use category into CL is estimated as the default value for DM in that particular land use category. I.e. for deforestated areas are used the average C stock per hectare for all deforestated areas according to the 0.

Change in carbon stock in dead organic matter

When forest land is converted to cropland it is assumed that all dead organic matter will be cleared. The actual amount depends on which type of forest which is converted.

Conversion from other categories is assumed as NA as no dead organic matter is reported for these categories.

Change in carbon stock in soils

When forest land is converted to cropland it is assumed that all organic matter in the O-horizon disappears. The actual amount depends on which type of forest which is converted. No changes in the soil carbon stock in the A- and B-horizons are expected. In the following year C-TOOL will assume that the soil will have a default value similar to the average of C stock in that grid.

For other conversions no changes in the soil C stock is assumed.

Uncertainties and time-series consistency

The time series are complete.

See Uncertainties and time-series consistency in section 7.3.1

QA/QC and verification

See QA/QC and verification in section 7.3.

Recalculation

See recalculation in section 7.3.

Planned improvements

See Planned improvements in section 7.3.

7.4 Grassland – 5C

7.4.1 Grassland remaining grassland – 5C1

Denmark is an intensive agricultural country with many small holders and small fields where CL and GL are mixed together making it difficult to distinguish between dedicated CL and dedicated GL. According to the Danish Land Parcel Information System (LPIS) were there approx. 63,000 fields of total 189,721 ha with permanent GL in 2008 giving an average size of three ha. Many of these areas cannot bee seen as permanent GL and therefore included in CL. There is some common grazing land which is protected from ploughing. Furthermore are there heath land and other areas, e.g. scrub land, which may be grazed by sheep or land which is kept open for recreational purposes. Some part may contain wooden plants which do not meet the thresholds for forest. This is land where the crown cover is below 10 % and where the height at maturity do not reach 5 meter.

The used definition of GL is therefore common grazing land according to the LPIS, heath land which may or may not are used for sheep grazing as well as all other areas not meeting the definitions of FL. Some small areas in the landscape may qualify as moors, fens and raised bogs. These are included in OL.

Grassland area

The total area with grassland has been estimated the Land Use matrix. In 1990 it was estimated to 120,294 ha increasing to 161,374 ha in 2008. This increase is mainly due to that FF is turned into GL.

Grassland definition

The Danish definition of grassland is common grazing land according to the LPIS, heath land which may or may not are used for sheep grazing as well as all other areas not meeting the definitions of forest land.

Methodological issues for grassland

The grazing land area is sub-divided into strict "grazing land" and "Other grassland". Grazing land is areas where cattle and sheep are fenced (often common grassland) and only a small grass sword is available. The area with "grazing land" is limited to app. individual 340 fields. In total common grazing land were 7,300 hectares in 2008.

"Other Grassland" may contain bushes and other wooden plants.

The area for grazing land is the area in the LPIS, and the rest of the Grassland is the residual part of the grassland area.

Change in carbon stock in living biomass

No changes in living biomass are assumed for GL remaining GL except for a minor conversion between "grazing land" and "Other grassland".

For conversion from grassland to other land use categories are used the same value but recorded as a loss of carbon in the respective category (5A2, 5B2, 5D2 and 5E2).

Change in carbon stock in dead organic matter

No changes in dead organic matter are estimates as this is not occurring for this category.

Change in carbon stock in soils

No changes in the carbon stock in mineral soils are assumed. For organic soils is used a default EF of 3,380 kg C per ha per year (see 0 for further information. This value will be validated further in the documentation project and updated in the next submission.

Uncertainties and time-series consistency

Table 7.32 Tier 1 uncertainty analysis for Grassland for 2008.

		1990 Emission/sink, Gg CO_2-eqv.	2008 Emission/sink, Gg CO_2-eqv.	Activity data, %	Emission factor, %	Combined uncertainty	Total uncertainty, %	Uncertainty 95 %, Gg CO_2-eqv.
5.C. Grassland		275.5	140.5				31.0	43.5
Living biomass	CO_2	182.6	59.2	10	20	22.4	22.4	13.2
Organic soils	CO_2	92.9	81.2	10	50	51.0	51.0	41.4

The time series are complete.

QA/QC and verification

See QA/QC and verification in section 7.3.1

Recalculations

No recalculation has been made.

Planned improvements

For the next submission will a new soil map for the organic soils be available as well as updated EF. Therefore will a complete recalculation for the organic soils be performed next year.

7.4.2 Land converted to grassland – 5C2

As agriculture covers more than 63 % and in order to reduce the environmental impact is there a strategy for turning CL into GL and where D takes place it is often turned into GL. The major part of the observed conversions is D where the definition of FL is no longer met.

Approaches used for representing land

The area converted from other land use to GL is based on remote sensing of the Danish area in 1990 and 2005 combined with data in LPIS on which crops are grown in each field.

Methodological issues

Change in carbon stock in living biomass

For land converted to "grazing land" is used a standard default gain value of 2,400 kg DM (dry matter) per hectare in above-ground biomass (IPCC 2006, Table 6.4) and 6,720 kg DM per hectare in below-ground biomass (IPCC 2006, Table 6.1). For "Other grassland" not purely free of wooden trees/bushes it is assumed that there is a living biomass of 2,200 kg DM per ha in above ground biomass and 400 kg DM per ha in below ground biomass (source Nord-Larsen et al. 2009). These figures are based on the NFI measurements of Other wooded land - with crown cover of 6-

10% crown cover or trees witch not can reach a height of 5 meters at maturity. For conversion from DM to C is used a default fraction of fraction of 0.5 kg C per kg DM. These factors will be examined further until the next submission.

For conversion from grassland to other land use categories are used the same value but recorded as a loss of carbon in the respective category (5A2, 5B2, 5D2 and 5E2).

Change in carbon stock in dead organic matter
When forest land is converted to GL it is assumed that all dead organic matter will be cleared. The actual amount depends on which type of forest which is converted.

Conversion from other categories is assumed as NA as no dead organic matter is reported for this category.

Change in carbon stock in soils
When FL is converted to GL it is assumed that all organic matter in the O-horizon disappears (litter layer). The actual amount depends on which type of forest which is converted. No changes in the soil carbon stock in the A- and B-horizons are assumed. For conversion of CL to GL is it assumed that the actual value in the CL is maintained in the GL.

For other conversions no changes in the soil C stock is assumed.

Uncertainties and time-series consistency
See Section 7.3.1.

7.5 Wetlands – 5D

Wetland includes wetland remaining wetland, wetlands for peat extraction and re-established anthropogenic wetlands. Wetlands are in the current submission only managed land for peat extraction and land converted to wetlands since 1990. In the next submission a further subdivision will be made into:

- unmanaged fully water covered wetlands (lakes and rivers),
- unmanaged partly water covered wetlands (fens and bogs),
- managed water reservoirs (currently not occurring in Denmark),
- managed drained land for peat extraction,
- managed partly water covered wetlands (re-established wetlands on primarily former cropland and grassland).

7.5.1 Wetlands remaining wetlands – peat extraction – 5D1

Until a more thoroughly QA/QC of the EO and other data sources has been performed WE remaining WE consists only of land for peat extraction. Due to environmental concerns has the area used for peat extraction been reduced since 1990 and no new peat excavations licences has been issued.

Wetland area

The total area with peat extraction is about 300 hectares open surface (Lykke Larsen, Pindstrup Mosebrug, personal comm.). Based on aieral photos it is etimated that 1,598 hectares in 1990 and 1,575 hectares in 2008 are land connected to the peat extraction areas.

Approaches used for representing land areas

The area for wetlands remaining wetlands is a vector map layer made by NERI based on aerial photos of the four excavation sites (Figure 7.13). The actual three locations are Fuglsø mose on Djursland and Lille Vildmose and Store Vildmose in Northern Jutland. All four sites are nutrient poor raised bogs.

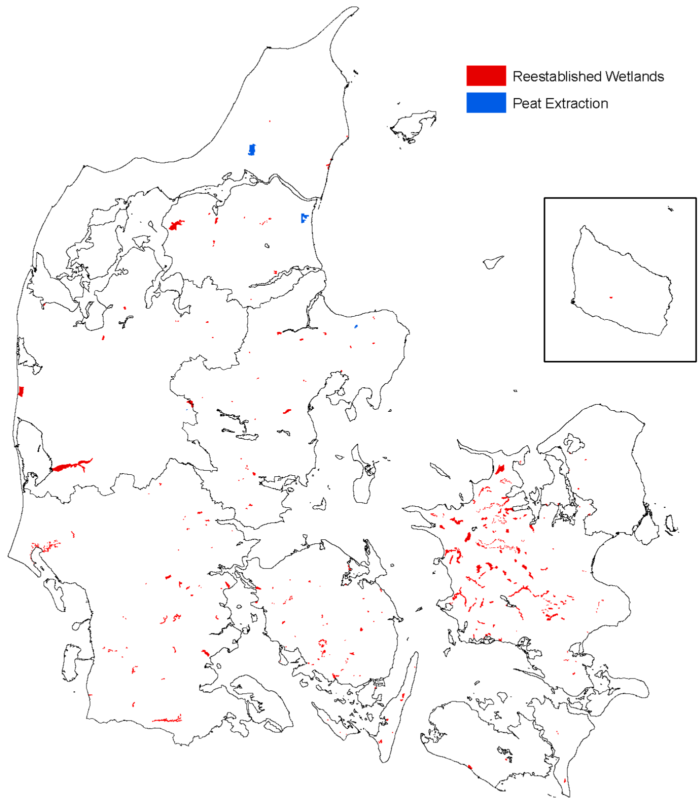

Figure 7.13 Areas with established wetlands, increased water tables and peat extraction in 2008.

Methodological issues for peat land

Change in carbon stock in living biomass

No living biomass is occurring on the peat extraction sites.

Change in carbon stock in dead organic matter

Dead organic matter is not occurring.

Change in carbon stock in soils

The surface emission from the open area is calculated according Tier 1 (IPCC, 2003) for nutrient poor areas with an emission factor of 0.5 tonnes C per hectare land with peat extraction per year. Because the underlying default factor is mainly based on Finish data (IPCC Table 3.5.2.), a higher emission factor than recommended is chosen. This is in accordance with the difference in temperatures between Denmark and Finland.

The amount of excavated peat (m^3 per year) is for each individual extraction site reported to and published by Statistics Denmark (www.dst.dk, Table RST). The total amount of peat excavated has since 1990 been reduced from 399,000 m^3 to 145,000 m^3 in 2008. For conversion to soil C is used a density factor of 200 kg per m^3 (personal comm. with Pindstrup Mosebrug, www.pindstrup.dk) who is responsible for the major part of the extraction sites, a DM content of 0.5, an ash content of 0.02 (www.pdir.dk) and a C-content of 0.58 kg C per kg OM.

Nitrous oxide emission

The nitrous oxide emission from peat land is estimated from the total N-turnover multiplied with the default IPCC emission factor of 1.25 %. The C:N-ration in the peat is estimated to 36 in an analysis from the Danish Plant Directorate (www.pdir.dk). Hence the N_2O emission is estimated to 0.546 kg N_2O per tonnes C. Only nitrogen in the degradation of the surface is accounted for in the inventory. N_2O from N in the excavated peat is not estimated.

Uncertainties and time-series consistency

Table 7.33 Tier 1 uncertainty analysis for WE remaining WEs and re-established WE for 2008.

		1990	2008					
		Emission/sink, Gg CO_2-eqv.	Emission/sink, Gg CO_2-eqv.	Activity data, %	Emission factor, %	Combined uncertainty	Total uncertainty, %	Uncertainty 95 %, Gg CO_2-eqv.
5.D Wetlands		86.2	-7.2				39.0	2.8
Reestablished wetlands	CO_2	0.0	-12.0	10	50	51.0	51.0	6.1
Land for peat extraction	CO_2	86.1	4.8	10	50	51.0	51.0	2.4
Land for peat extraction	N_2O	0.1	0.1	10	100	100.5	100.5	0.1

The time-series are complete.

QA/QC and verification

The peat excavation area has been verified with aerial photos and the amount of excavated peat is made by Statistics Denmark.

Recalculation

Previous were also imported peat included in the Danish inventory. From this submission is only CO_2 emissions from Danish peat included. Previous were avoided CH_4 emission from the drainage of land where peat extraction takes place included. This has been removed from the inventory based on a recommendation from the ERT.

Category-specific planned improvements

No improvements are planned.

Table 7.34 Annual emissions from peat extraction areas and re-established wetlands 1990 to 2008, Gg CO_2 pr yr and Mg N_2O pr yr.

Greenhouse gas source and sink categories	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Emission, Gg CO_2 pr yr	86.45	78.11	77.70	65.19	39.59	45.88	64.65	85.90	49.13	35.69
Emission, Mg N_2O pr yr	0.435	0.435	0.435	0.435	0.435	0.435	0.434	0.434	0.434	0.434
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
Emission, Gg CO_2 pr yr	32.81	39.37	47.92	41.44	46.39	40.11	38.33	15.89	-7.29	
Emission, Mg N_2O pr yr	0.434	0.430	0.430	0.430	0.430	0.430	0.430	0.430	0.430	

7.5.2 Land converted to wetland – 5D2

In order to restore nature and reduce the environmental impact has Denmark actively re-established WE. The size of each restoration project range from less than 1 ha up to 2,500 ha. The benefit of the restoration programme is more nature but also a reduction in leaching of nitrogen into lakes, rivers and coastal water. The establishment of WE takes place either as large areas turned into lakes or low laying fens.

Since 1990 15,465 ha has been established. These are partly on land classified as OL, but also conversion on CL and GL are frequent. A major part is restored as a part of the Danish Action Plan for the Aquatic Environment part two (VMP II, running from 1997 to 2006) where land was bought for this purpose. It is accounted for that the establishment often takes place in connection to existing wetlands.

Water reservoirs for human purposes have not been established for the last 100 years and therefore currently reported as NO.

Approaches used for representing land areas

Geographical vector layers are available for all established WE. At the moment is it assumed that the whole area is converted to partly water covered areas although some part of it must be assumed to be converted to fully water covered. This outstanding issue will be solved in the next submission. Partly covered WE will normally have a water table between 0 and 20 cm below the surface in the summer. Many of the established wetlands are part of an environmental programme where the water table are raised to 10 cm below the surface. These areas are not suitable for farming because it is not allowed to drain these areas. The established WE areas from 1990 to 2007 are shown in figure 7.13.

Methodological issues

Change in carbon stock in living biomass

For land converted to partly covered wetland is used a standard default gain value of 4,000 kg DM (dry matter) per hectare in above-ground biomass and 1,200 kg DM per hectare in below-ground biomass. For conversion from DM to C a default fraction of 0.5 kg C per kg DM is used.

For conversion from wetland to other land use categories are used the same value but recorded as a loss of carbon in the respective category (5A2, 5B2, 5C2 and 5E2).

Change in carbon stock in dead organic matter

When forest land is converted to wetland it is assumed that all dead organic matter will be cleared. The actual amount depends on which type of forest which is converted.

Conversion from other categories is assumed as NA as no dead organic matter is reported for this category.

Change in carbon stock in soils

A default C sequestration of 0.5 tonnes C per hectare is assumed for land converted to WE.

Nitrous oxide emission

No estimates for the N_2O emission from re-established wetlands have been made.

Methane emission

CH_4 emissions are not estimated due to lack of methodology.

Uncertainties and time-series consistency

The time series are complete.

QA/QC and verification

No verification has been made yet.

Recalculation

A recalculation has been made due to new area data on the established WE has been obtained. Furthermore has the availability of the remote sensing data made it possible to locate the exact position in relation to WE remaining WE.

Planned improvements

A full WE map for whole Denmark is planned where the area is subdivided into fully water covered and partly water covered areas for both WE remaining WE and land converted to WE. A literature study for updated values for living biomass as well as for an eventual gain in soil carbon for WE will be made and incorporated in the next submission.

7.6 Settlements – 5E

The annual changes in C-stock in settlements are assumed to be negligible, and because no estimates have been made, most changes are reported as NE in the CRF Table 5.E. For reporting purposes for land use conversions is a default biomass in low buildings, grave yards established.

7.6.1 Settlements remaining Settlement – 5E1

Settlement area

The total area with SE has been estimated to 388,687 hectares in 1990 increasing to 440,528 hectares in 2008 or app. 10% of the total Danish area.

Settlement definition

For further improvements has SE been subdivided in four categories: Urban core, Industrial areas, roads, high build-up areas and low build-up areas. Only for low build-up areas are C reported. Low build-up areas are characterised as single-family houses surrounded by gardens, graveyards, sports facilities etc.

Methodological issues

Change in carbon stock in living biomass

No changes in carbon stocks are reported for SE remaining SE.

Change in carbon stock in dead organic matter

No changes in carbon stocks are reported for SE remaining SE.

Change in carbon stock in soils
No changes in carbon stock in soils are assumed.

Uncertainties and time-series consistency

Table 7.35 Tier 1 uncertainty analysis for Settlements for 2008.

		1990 Emission/sink, Gg CO_2-eqv.	2008 Emission/sink, Gg CO_2-eqv.	Activity data, %	Emission factor, %	Combined uncertainty	Total uncertainty, %	Uncertainty 95 %, Gg CO_2-eqv.
5.E Settlements		79.6	51.8				51.0	13.9
Living biomass	CO_2	79.6	51.8	10	50	51.0	51.0	26.4

The time-series are complete.

QA/QC and verification
No QA/QC has been performed.

Recalculations
No recalculations have been made.

Planned improvements
A further subdivision in the above mentioned four categories is planned as well as an improved estimation of the amount of living biomass in this category.

7.6.2 Land converted to Settlement – 5E2

Land converted to SE is mostly taking place around the big cities and primarily on cropland.

Settlement area
The area converted from other land use to SE is based on remote sensing of the Danish area in 1990 and 2005 combined with the cadastral maps and road vector maps. From 2005 an onwards is used the development in the number of houses and other buildings in the cadastral maps.

Methodological issues

Change in carbon stock in living biomass

For land converted to single-family houses is used a standard default gain value of 2,200 kg DM (dry matter) per hectare in above-ground biomass and 2,200 kg DM per hectare in below-ground biomass. For conversion from DM to C a default fraction of 0.5 kg C per kg DM is used.

For conversion from settlements to other land use categories are used the same value but recorded as a loss of carbon in the respective category (5A2, 5B2, 5C2 and 5D2).

Change in carbon stock in dead organic matter
When forest land is converted to settlements it is assumed that all dead organic matter will be cleared. The actual amount depends on which type of forest which is converted.

Conversion from other categories is assumed as NA as no dead organic matter is reported for these categories.

Change in carbon stock in soils
No changes in carbon stock in soil are assumed.

Uncertainties and time-series consistency
See Uncertainties and time-series consistency in section 7.6.1

The time-series are complete.

QA/QC and verification
No QA/QC has been performed.

Category-specific recalculations
No recalculations have been made.

Planned improvements
A quality assessment of the land use transitions matrix will probably change the area slightly. The planned QA of the matrix will be included in the next submission. This will also include a verification of the amount of living biomass in the cities.

7.7 Other land

No permanent snow cover exists in Denmark and only a very small insignificant area with rocks and cliffs. OL is therefore unmanaged area like moors, fens, beaches, sand dunes and lakes which area is included in the total official land area of 43 098 km^2 and other areas without human interference.

No land use changes from 5A, 5B, 5C, 5D and 5E is reported. The total area with OL is reported to 342,688 hectares in 1990 decreasing to 312,421 hectares in 2008.

A more thoroughly analysis of OL will be performed and included in the next submission.

7.8 Direct N_2O emissions from N fertilization of Forest Land and Other land use – 5(I)

Only a very small amount of nitrogen fertilisers are used in the Danish forests and primarily to Christmas trees. All emissions are reported under Agriculture Table 4.Ds1 since there is only one common national statistics for N fertilization in agriculture and forestry.

7.9 Non-CO_2 emissions from drainage of forest soils and wetlands – 5(II)

A large proportion of the Danish forest area may be considered as drained in the sense that the natural hydrology has been modified by establishment of ditches. Large forest areas have been drained in order to enable establishment of Norway spruce in depressions, fens and pond areas. As an example, a major state forest Gribskov in Northern Zealand by 1850 had an estimated wetland area 400% larger than that of 1988 (http://www.skovognatur.dk/Ud/Beskrivelser/Hovedstaden/Gribskov/VandetTilbage.htm). During the recent years, there has been an effort to restore wetland habitat in the state forests and several drained areas have been restored by filling up ditches, and in many areas of the state forests ditches are no longer maintained and will be gradually more and more ineffective over time.

Very few data exist for N_2O emissions in Danish forests. A national project and EU projects have provided data for hydrological gradients in mini-catchments in an old-growth forest and an afforestation area (Christiansen et al., in prep.) and data for one intensively studied beech forest plot (Skiba et al., 2009). For general application at the national level, tier 1 methods will be applied based on default emission factors (IPCC GPG). Emission factors will be compared with the few examples of emission factors data from national projects.

7.9.1 Methodological issues

Equation 3a.2.1 of IPCC GPG was used for estimation of direct N_2O emissions from drained forest soils (tier 1).

Default emission factors (IPCC GPG, Table 3a.2.1) were used for calculation of N_2O emissions. Danish organic soils were considered to be "Nutrient Rich" based on the general presence of fens (minerotrophic peat) and the relatively high N deposition to Danish forests. Rewetted forest soils were assumed to have an N_2O emission corresponding to the natural level and emissions were therefore by default set to zero in accordance with IPCC GPG.

7.9.2 Areas of drained forest soils

Based on expert judgement, the area of drained forest soils were 65% of mineral forest soils and 75% of organic forest soils in 1990. It is further judged that the amount of drained forest soils have decreased in the period until 2008 resulting in the area of drained forest soils were 55% of mineral forest soils and 50% of organic forest soils. Organic soils constituted 5% of the forest area based on information on presence of peat from the NFI. A more detailed analysis of forest soils including a mapping is under preparation and will be utilised for the next reporting.

7.9.3 Emissions of N_2O from drained forest soils

Estimates of N2O emissions (Gg N_2O per yr) from drained forest soils in 1990 and 2008 are based on the IPCC 2003 values. This means that for mineral soils is 0,06 kg N2O-N per ha per yr and for organic soils 0,6 kg N2O-N per ha per yr.

Emission factors are generally in reasonable accordance with those obtained in national projects. In mini-catchments, Christiansen et al. (in prep.) found average annual emissions of 0.56±1.1 kg N_2O-N per ha per yr for an afforested stand (30 years) and of 0.78±4.2 kg N_2O-N per ha per yr for an old-growth forest. Both sites included hydrological gradients from wet/moist to well-drained conditions. For a well-drained Danish beech forest site, Skiba et al. (2009) reported average annual emissions of 0.45±0.48 kg N_2O-N per ha per yr.

7.10 N_2O emissions from disturbance associated with land-use conversion to cropland – 5(III)

The main land-use conversion involving deforestation is the conversion from forest to grassland. This land-use change is expected to be a source for N_2O emissions due to the decomposition of forest floors and corresponding increased mineralization of N. It is assumed that forest floors are completely decomposed during the conversion. Emissions of N_2O are based on default emission factors (IPCC, 2003).

7.10.1 Methodological issues

For all deforestated areas is it assumed that the forest floor disappear regardsless if the land use conversion is into CL, GL, WE or SE. This is in contradiction to the guidelines and Table 5(III) which is only related to disturbance associated with land-use conversion to CL.

Emissions of N_2O from deforestation were assumed to originate only from mineralization of forest floors since SOC stocks in mineral soils are assumed constant following land-use change from forestry to grassland. The average nitrogen content of forest floors based on the repeated soil inventory was used to estimate the N mineralized for confers and broadleaves, respectively. A proportion of 1.25% of the N stock mineralized is assumed to be emitted as N_2O-N.

7.10.2 Emissions of N_2O from deforestation and land-use conversion

The average N content of broadleaf and conifer forest floors for Danish forest plots are given in Table 7.36 together with the estimated N fraction emitted as N_2O. According to IPCC (2003), a default fraction of 1.25% is assumed emitted as N_2O-N during mineralization of the total N content following conversion.

Table 7.36 Total N content of forest floors in Denmark from the systematic grid "Kvadratnettet". The total N content is used for estimation of the amount of N (1.25%) emitted as N_2O during mineralization of the total forest floor N content following land-use change from forest to grassland.

Tree species	Number of plots	Mean N content (kg ha^{-1})	Standard dev. (kg ha^{-1})	Min N content (kg ha^{-1})	Max N content (kg ha^{-1})	N_2O-N, (kg ha^{-1})
Broadleaves	48	359	310	42	1472	4.5
Conifers	60	728	637	20	3447	9.1

In 1990, emissions of N_2O from deforestation were estimated at 0.014 Gg N_2O for mineral soils and 0.011 Gg N_2O for organic soils. In 2008 the figures were 0.001 and 0.001 Gg N_2O for mineral and organic soils, respectively.

7.11 CO_2 emissions from agricultural lime application – 5(IV)

Liming of agricultural soils has taken place for many years. Only a very little amount of lime is applied in forests (<0.5 %) and on permanent grassland. Therefore all liming is included in the inventory under cropland (Table 5(IV)).

The Danish Agricultural Advisory Centre (DAAC) has published the lime consumption for agricultural purposes annually since 1960 (Table 7.37). DAAC are collecting data from all producers and importers. By legislation all producers and importers are obligated to have their products analysed for acid neutralisation content. The analysis is carried out by the Danish Plant Directorate and published annually (PDIR 2004). The published data from DAAC are corrected for acid neutralisation contents for each product and thus given in pure $CaCO_3$. For that reason there is no need to differ between lime and dolomite as made in the guidelines, as this has already been included in the background data. The data from DAAC includes all different products used in agriculture, including e.g. $CaCO_3$ from the sugar refineries.

The amount of lime used in private gardens has been estimated from the main supplier to private gardens. According to the company (Kongerslev Havekalk A/S, pers. comm.) they are responsible for 80 % of the sale to private gardens. Their sales figures have been used to estimate the total consumption in private gardens. Furthermore the figures are corrected for acid neutralisation capacity according to the data from the Danish Plant Directorate. This gives an approximate amount of 2,300 tonnes $CaCO_3$ pr year in private gardens. This figure has been used for all years.

The amount of lime used for agricultural purposes has declined with 70 % since 1990. From 2000 to 2008 has the consumption been very stable around 500 Gg CaCO3. 500 Gg is expected to be the lowest consumption needed to maintain appropriate pH values in the Danish agricultural soils at the moment. The main reason for the reduced lime consumption is a decreased need for acid neutralisation due to less SO_X deposition in Denmark (which also can be seen in the Norwegian inventory) and a reduced consumption of fertilisers containing ammonium. The inter-annual variation is primarily due to weather conditions (if it is possible to drive in the fields) and the economy in agriculture.

The amount of C is calculated according to the guidelines where the carbon content is 12/100 of the $CaCO_3$. It is assumed that all C disappear as CO_2 the same year as the lime is applied.

Table 7.37 Lime application to cropland and grassland and in forests, 1988-2008.

Greenhouse gas source and sink categories	1988	1989	1990	1991	1992	1995	2000	2005	2008
Agriculture, Gg $CaCO_3$	1574	1900	1283	1049	810	1125	590	497	518
Private gardens, Gg $CaCO_3$	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3
Total, Gg $CaCO_3$	1576	1902	1285	1051	812	1127	592	499	520
Total, Gg C pr yr	693	836	565	462	357	496	260	220	229

Table 7.38 Tier 1 uncertainty analysis for Liming for 2008.

		1990 Emission/sink, Gg CO_2-eqv.	2008 Emission/sink, Gg CO_2-eqv.	Activity data, %	Emission factor, %	Combined uncertainty	Total uncertainty, %	Uncertainty 95 %, Gg CO_2-eqv.
5(IV) Liming	CO_2	565.2	228.8	5	50	50.2	50.2	115.0

The time-series is complete.

7.12 Biomass burning – 5(V)

Controlled burning of wooden biomass is only taking place to very small and insignificant amount and hence not reported.

No estimates for wild fires are reported. Due to the cold and wet conditions in Denmark are there only sporadic and small wild fires in the summer accounting for less than 2-10 hectares per year.

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8 Waste (CRF sector 6)

8.1 Overview of the sector

The waste sector consists of the CRF source category 6.A Solid Waste Disposal on Land, 6.B. Wastewater Handling, 6.C. Waste Incineration and 6.D. Other.

For 6.A. Solid Waste Disposal on Land CH_4 emissions are considered in this Chapter as a result of calculations in continuation of previously used and reported methodology. Analysis and investigations have been initiated as a result of the 2007 in-country review and the review on the 2009 submission.

For 6.B. Wastewater Handling, the CH_4 and N_2O emissions were introduced in the inventory submissions for the first time in 2005 based on survey of available input data and methodological development in 2004-2005 as described Thomsen, M. & Lyck, E., 2005 and in the NIR in 2005 (Illerup et al, 2005). Smaller methodological revisions were introduced in the submission in 2006 (Illerup et al., 2006). For the 2008 submission minor revisions were introduced related to the calculation of the Gross methane emissions. For this year's submission, and as a result of the 2007 in-country review and the review on the 2009 submission, an evaluation and improved documentation of activity data have been realised. Major changes are introduced by corrected activity data on sludge used for biogas and energy production. As a result thereof an adjustment of the methodology for calculation the methane emission is presented. Furthermore, a first attempt for a national emission factor based on a mass balance of the total N content within the boundary of the WWTPs is presented.

For the CRF source category 6.C. Waste Incineration, the main emissions are included in the energy sector since allmost all waste incinerated in Denmark is used in energy production. New for this submission are minor emissions from non-biogenic Waste Incineration: Cremation of corpses and carcasses and accidental fires.

For the source sector 6.D. "Waste Other" emissions from combustion of biogas in biogas production plants was included (mentioned as Gasification of biogas in the CRF tables) for the years 1994-2005 where these emissions existed. Emissions from this activity are not occurring in 2006 - 2008.

In Table 8.1.1, an overview of all the emissions is presented. The emissions are taken from the CRF tables and are presented as rounded figures.

Table 8.1.1 Emissions for the waste sector, Gg CO_2 equivalents.

		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
6 A. Solid Waste Disposal on Land	CH_4	1 111	1 138	1 153	1 171	1 138	1 104	1 103	1 057	1 023	1 059
6 B. Wastewater Handling	CH_4	30	30	30	31	34	37	39	42	45	44
6 B. Wastewater Handling	N_2O	106	103	92	109	120	110	93	87	89	86
6 C. Waste incineration	CO_2	21	21	23	21	22	24	25	24	22	24
6 C. Waste incineration	CH_4	2.6	2.7	2.9	2.6	2.7	3.1	3.1	2.9	2.6	2.8
6 C. Waste incineration	N_2O	0.20	0.20	0.20	0.21	0.21	0.21	0.21	0.21	0.21	0.22
6 D Other	CH_4+N_2O	NO	NO	NO	NO	0.001	0.003	0.003	0.003	0.025	0.031
6. Waste	Total	1 271	1 296	1 301	1 336	1 316	1 279	1 264	1 213	1 182	1 216
Continued		2000	2001	2002	2003	2004	2005	2006	2007	2008	
6 A. Solid Waste Disposal on Land	CH_4	1 069	1 088	1 053	1 097	1 017	1 019	1 080	1 064	1 057	
6 B. Wastewater Handling	CH_4	45	45	49	50	48	47	46	47	47	
6 B. Wastewater Handling	N_2O	93	87	100	79	78	87	75	81	105	
6 C. Waste incineration	CO_2	23	23	23	24	22	23	25	26	29	
6 C. Waste incineration	CH_4	2.8	2.7	2.7	2.9	2.6	2.7	2.9	3.2	3.3	
6 C. Waste incineration	N_2O	0.22	0.22	0.23	0.22	0.23	0.24	0.27	0.28	0.28	
6 D Other	CH_4+N_2O	0.029	0.019	0.022	0.025	0.020	0.016	NO	NO	NO	
6. Waste	Total	1 233	1 246	1 228	1 255	1 168	1 179	1 229	1 222	1 241	

6.A. Solid Waste Disposal on Land is the dominant source in the sector with contributions in the time-series varying from 85.2 % (2008) to 88.6 % (1992) of the total emission, given in CO_2 equivalents, originating from the waste sector. Throughout the time-series, the emissions are decreasing due to a reduction in the amount of waste deposited. Comparing 1990 and 2008 the decrease is 4.9 %. Several parameters were for this submission changed due to the review on the 2009 submission, cf Section 8.2 in this chapter.

6.B. Wastewater Handling. For this source, N_2O contributes the most to the sectoral total, varying between contributions of 6.1 % (2006) and 9.1 % (1994). In 2008 the contribution is 8.4 %. In absolute terms, the N_2O emission from this source displays minor variations in the time-series 1990-2008. Comparing 1990 and 2008, the N_2O emission in 2008 is lower by 1.6%. CH_4 from this source contributes with between 2.3 % (1993) and 4.1 % (2004) of the sectoral total. In 2008 the contribution is 3.8 %. The CH_4 emissions increase steadily over the time-series, the emission in 2008 is 55.5 % higher than in 1990.

6.C. Waste Incineration. For this source non-biogenic Waste Incineration was introduced for the first time in this submission. The source contributes with CO_2, CH_4 and N_2O emissions. CO_2 emissions are dominating this source and contributes from 1.6 % (1993) to 2.3 % (2008) to the sectoral total. The contribution from the sum of CH_4 and N_2O is for the time-series 1990-2008 below 0.3 %. The trend for the total emissions 1990 - 2008 from this source is increasing compared to 1990 the 2008 emission is 34.6 % higher. Accidential fire has more than doubled its contribution to CO_2-eqv. emissions from 1990 to 2008 mainly due to increase in CH_4 emissions.

As a result for whole sector, the sectoral total emission in CO_2 equivalents, Table 8.1.1, decreases slightly throughout the time-series, the emission in 2008 compared to 1990 has decreased 2.4 %.

8.2 Solid Waste Disposal on Land (CRF Source Category 6A)

8.2.1 Source category description

For many years, only managed waste disposal sites have existed in Denmark. Unmanaged and illegal disposal of waste is considered to play a negligible role in the context of this category.

The CH_4 emission from solid waste disposal on land at managed Solid Waste Disposal Sites (SWDS) constitutes in 2008 a key category according to level. In 2006 and 2007 it was a key category for both level and trend. In 2005 it was a key category to level only. Before 2005 it was a key category with regard to level and trend. The emission estimates for the CH_4 emission is decreasing with 4.9 % from 1990 to 2008. For this submission the category was revised and recalculated based on the input, recommendation and discussion with the expert review team on the 2009 submission (Nielsen, O.-K. et al 2009), cf. section 8.2.5.

A quantitative overview of this source category and its main data are shown in Table 8.2.1 with the amounts of landfilled waste, the annual CH_4 gross emissions from the waste, the CH_4 collected at landfill sites and used for energy production, the amount of CH_4 gas oxidised and the resulting emissions for the years 1990-2008. The amount of waste and the resulting CH_4 emission can be found in the CRF tables submitted as well.

In general, the amount of deposited waste has decreased markedly throughout the time-series. The increase in waste deposited from 2005-2007 levels to 2008 is due solely to an increase in Ash and Slag deposited, cf. table 8.2.8. The general development for solid waste is a result of action plans by the Danish government called the "Action plan for Waste and Recycling 1993-1997" and "Waste 21 1998-2004" (The Danish Government 1999). The latter plan had, inter alia, the goal to recycle 64 %, incinerate 24 % and deposit 12 % of all waste. The goal for deposited waste was met in 2000. Further, in 1996 a municipal obligation to assign combustible waste to incineration was introduced. In 2003, the Danish Government set up targets for the year 2008 for waste handling in a “Waste Strategy 2004-2008” report (The Danish Government 2003). According to this strategy, the target for 2008 is a maximum of 9 % of the total waste to be deposited. In the waste statistics report for the year 2004, data shows that this target was met, since 7.7 % of total waste was deposited in 2004 (Danish Environmental Protection Agency 2006a). Further in 2005 the amount decreased compared to 2004 and was only 6.9 % of the total waste amount (DEPA 2006b). In 2006 and 2007 the contribution decreased further to 6.5 and 6.4 %, respectively. In 2008 the contribution was 6.9%. The Danish Government in 2009 set up targets for 2012 according to which a maximum of 6 % the total waste produced is to be deposited (The Danish Government 2009).

The decrease in the emission throughout the time-series is much less than the general decrease in the amount of waste deposited. This is due to the time involved in the processes generating the CH_4, which is reflected in the model used for emission calculation.

Table 8.2.2 Waste amounts in landfills and their CH_4 emissions 1990-2008.

Year	Waste	Annual gross emission	Biogas Collected	Gas oxidized	Annual Net Emission	
	ktonnes	ktonnes CH_4	ktonnes CH_4	ktonnes CH_4	ktonnes CH_4	ktonnes CO_2-eqv
1990	3 175	59.3	0.5	5.9	52.9	1 111
1991	3 032	60.9	0.7	6.0	54.2	1 138
1992	2 890	62.4	1.4	6.1	54.9	1 153
1993	2 747	63.7	1.7	6.2	55.8	1 171
1994	2 604	64.9	4.6	6.0	54.2	1 138
1995	1 957	65.8	7.4	5.8	52.6	1 104
1996	2 507	66.5	8.2	5.8	52.5	1 103
1997	2 083	67.1	11.1	5.6	50.3	1 057
1998	1 859	67.3	13.2	5.4	48.7	1 023
1999	1 467	67.5	11.5	5.6	50.4	1 059
2000	1 482	67.6	11.0	5.7	50.9	1 069
2001	1 300	67.6	10.0	5.8	51.8	1 088
2002	1 174	66.9	11.2	5.6	50.2	1 053
2003	966	66.0	7.9	5.8	52.3	1 097
2004	1 000	64.8	11.0	5.4	48.4	1 017
2005	957	63.6	9.7	5.4	48.5	1 019
2006	976	62.6	5.5	5.7	51.4	1 080
2007	956	61.7	5.4	5.6	50.6	1 064
2008	1 045	60.8	4.8	5.6	50.3	1 057

Disposal of waste takes place at 134 registered sites (year 2001, DEPA 2006b). The organic part of the deposited waste at these sites generates CH_4 gas, of which some is collected and used as biogas in energy-producing installations at 26 sites (DEPA 2003). The Danish Energy Agency registers the gas amounts recovered at disposal sites in energy units (TJ) (Danish Energy Agency 2009). For the emission estimation this amount of gas in energy unit is converted to volume of gas using the calorific value of 20 MJ pr m^3. As for the FOD-model the content of CH_4 in the gas recovered is estimated to 50%. The density of CH_4 is 0.718 kg pr m^3. The full calculation is: CH_4 recovered (ktonnes) = Biogas used (TJ) x 50% x 0.718 (kg pr m^3) / 20 (MJ pr m^3).

8.2.2 Methodological issues

Activity data and emission factors

The data used for the amounts of municipal solid waste deposited at managed solid waste disposal sites are (according to the official registration) worked out by the Danish Environmental Protection Agency (DEPA) in the so-called ISAG database (DEPA 1996a, 1998a, 1999a, 2001a, 2001b, 2002a, 2004a, 2004b, 2005a, 2006a, 2006b, 2008, 2010).

The registration of the amounts of waste deposited takes place in the ISAG database in the following waste categories:

- Domestic Waste
- Bulky Waste
- Garden Waste
- Commercial & Office Waste
- Industrial Waste
- Building & Construction Waste

- Sludge
- Ash & Slag

However, for CH_4 emission estimation, a division of waste types is needed in categories with data for the Degradable Organic Carbon (DOC) content. For the following categories, investigations of DOC content etc. have been carried out for Danish conditions:

- Waste food
- Cardboard
- Paper
- Wet cardboard and paper
- Plastics
- Other combustible
- Glass
- Other, not combustible

The Danish investigation shows that the waste types contain the fraction of DOC as shown in Table 8.2.3.

Table 8.2.3 Fraction of DOC in waste types.

Waste Type	DOC-fraction of Waste
Waste food	0.20
Cardboard	0.40
Paper	0.40
Wet cardboard and paper	0.20
Plastics	0
Other combustible	0.20 - 0.57
Glass	0

Since the Danish solid waste disposal sites (SWDS) are well-managed, it is assumed that a methane correction factor of 1 can be used (IPCC 2000, page 5.9, Table 5.1). Furthermore, 0.50 is used as the fraction of DOC dissimilated, which is considered good practice (IPCC 2000, page 5.9). Finally, the fraction of CH_4 in landfill gas is taken as 0.5 (IPCC 2000, page 5.10). These parameters lead to the calculation of a "general emission factor" for DOC as shown in Table 8.2.4. In the model formulation in this table oxidisation (in sub layers) has been kept and been put to 0 - as compared to former model formulation with this parameter set to 0.10.

Table 8.2.4 Calculation of general emission factor for DOC.

Parameter	Description	Input	Calculation
A	fraction of DOC oxidised in sub layers	0	
1 – a = b	fraction of DOC not oxidised in sub layers		1
C	fraction of DOC dissimilated	0.50	
b • c	fraction of DOC emitted as gas		0.50
D	fraction of gas emitted as CH_4	0.50 (as C)	
b • c • d	fraction of DOC emitted as CH_4		0.250 (as C)
b • c • d • (12 + 4 • 1) /12	fraction of DOC emitted as CH_4 = emf for DOC		0.333 (as CH_4)

DOC: Degradable Organic Carbon.

Combining Table 8.2.3 and Table 8.2.4 gives emission factors for waste types, Table 8.2.5.

Table 8.2.5 DOC-fraction and fraction of waste emitted as CH_4 according to waste types.

Waste type	DOC-fraction of waste (1)	Fraction of waste emitted as CH_4 emf (2)
Waste food	0.2	0.066
Card-board	0.4	0.133
Paper	0.4	0.133
Wet card-board and paper	0.2	0.066
Plastics	0	0
Other combustible	0.20 - 0.57	0.066 - 0.190
Glass	0	0
Other not combustible	0	0

Column (2) is column (1) multiplied by emf for DOC (= 0.333).
“Other Combustible” varies in DOC-fraction according to ISAG waste types.
Unit of column (2) is “fraction”. Example: 1 tonne of waste food: 66 kg of CH_4 is emitted.

The emission estimates are built upon a composition of the deposited waste, as shown in Table 8.2.6, and are according to Danish investigations.

Table 8.2.6 ISAG waste types and their content of waste types, fractions.

Materiale fractions in	Waste food	Card-Board	Paper	Wet Card-board and paper	Plastics	Other combu-stible	Glass	Metal	Other not combu-stible	Sum
Domestic Waste	0.379	0.017	0.128	0.264	0.068	0.034	0.017	0.047	0.047	1.00
Bulky Waste		0.078	0.233		0.047	0.457	0.085	0.085	0.016	1.00
Garden Waste						0.760			0.240	1.00
Commercial & office Waste	0.252	0.311	0.039	0.107	0.049	0.097	0.049	0.049	0.049	1.00
Industrial Waste	0.062	0.019	0.070	0.015	0.012	0.058	0.037	0.183	0.543	1.00
Building & constr. Waste						0.070			0.930	1.00
Sludge						0.290			0.71	1.00
Ash & slag									1.00	1.00

Table 8.2.6 forms the connection between the ISAG data material fractions (left column) and waste types (upper row) where emission factors have been calculated (Table 8.2.5). The composition as shown in Table 8.2.6 is kept for the whole time-series, but analysis on the sensitivity of the output (CH_4 emissions) of the model as regards waste composition has been carried out as described below.

The emission factors for the ISAG waste types are then calculated as the weighted average according to Table 8.2.5 and Table 8.2.6. The result is shown in Table 8.2.7.

Table 8.2.7 Emission factor for ISAG waste types, kg CH_4 pr kg waste.

	ISAG Waste Type							
	Domestic Waste	Bulky Waste	Garden Waste	Commercial & office Waste	Industrial Waste	Building & Con-struct. Waste	Sludge	Ash & Slag
Weighted emission factor	0.0644	0.1023	0.0633	0.0835	0.0237	0.00934	0.0551	0.0

The detailed explanation on the composition of waste and the methodlogy to obtain emission factors in this section of the NIR report has been given above, since the parameters for SWDS in the CRF format are found not to be fully descriptive for the Danish data and for the methodology used.

The model and its results

The CH_4 emission estimates from SWDSs are based on a First Order Decay (FOD) model suited to Danish data availability and conditions and according to an IPCC tier 2 approach. The input parameters for the model are yearly amounts of waste, as reported to the ISAG database, and the emission factors according to Table 8.2.7. In the model, the half-life time of the carbon of 14 years is used, corresponding to:

$k = \ln 2/14 = 0.050\ year^{-1}$ (refer IPCC 2000, page 5.7)

The time lag factor is corresponding to half a year since the model used accounts for emissions from waste deposited year x starting from January 1, in year x+1.

The model calculations are not performed pr landfill site, but for all waste deposited at all sites.

The yearly amounts of the different waste types and their emission factors are used to calculate the yearly potential emission. From the potential emission, the annual gross emission is calculated using the model. The CH_4 captured by biogas installations at some of the sites is subtracted from this emission. The amounts of CH_4 captured are according to the Danish energy statistics. Further, CH_4 gas oxidised is subtracted. The result is annual net emissions. The waste amounts and the calculated CH_4 emissions are shown in Table 8.2.8.

Table 8.2.8 Amounts of waste and CH_4 emissions for 1990-2008.

Year	Domestic Waste	Bulky Waste	Garden Waste	Com-mercial & office Waste	Industrial Waste	Building & construction Waste	Sludge	Ash & Slag	Waste Total	Potential emission	Annual Gross Emission	Biogas collected	Annual net emission before oxidation	Annual net emission after ox. 0.1
						Ktonnes CH_4								
1990	198.9	250.7	85.2	109.3	822.4	951.4	222.1	535.0	3 175.1	95.7	59.3	0.5	58.8	52.9
1991	198.7	259.0	70.7	120.0	824.3	804.3	193.3	562.0	3 032.3	93.6	60.9	0.7	60.2	54.2
1992	198.4	267.3	56.1	130.7	826.2	657.2	164.6	589.0	2 889.6	91.5	62.4	1.4	61.0	54.9
1993	198.2	275.7	41.6	141.3	828.1	510.1	135.8	616.0	2 746.8	89.4	63.7	1.7	62.0	55.8
1994	198.0	284.0	27.0	152.0	830.0	363.0	107.0	643.0	2 604.0	87.3	64.9	4.6	60.2	54.2
1995	190.0	286.0	17.0	128.0	779.0	321.0	101.0	135.0	1 957.0	85.2	65.8	7.4	58.4	52.6
1996	132.0	275.0	6.0	135.0	822.0	317.0	117.0	703.0	2 507.0	80.3	66.5	8.2	58.4	52.5
1997	83.0	248.0	6.0	170.0	707.0	264.0	130.0	475.0	2 083.0	77.2	67.1	11.1	55.9	50.3
1998	98.0	234.0	20.0	161.0	746.0	266.0	124.0	210.0	1 859.0	71.7	67.3	13.2	54.1	48.7
1999	117.0	239.0	3.0	164.0	582.0	224.0	126.0	12.0	1 467.0	72.0	67.5	11.5	56.1	50.4
2000	85.0	264.0	7.0	152.0	611.0	269.0	94.0	0.0	1 482.0	68.7	67.6	11.0	56.6	50.9
2001	50.0	180.0	3.0	150.0	583.0	260.0	64.0	10.0	1 300.0	67.8	67.6	10.0	57.6	51.8
2002	37.0	161.0	4.0	137.0	520.0	229.0	48.0	38.0	1 174.0	54.1	66.9	11.2	55.7	50.2
2003	24.0	143.0	4.0	131.0	379.0	170.0	55.0	60.0	966.0	47.7	66.0	7.9	58.1	52.3
2004	11.0	132.0	5.0	140.0	452.0	172.0	42.0	46.0	1 000.0	41.0	64.8	11.0	53.8	48.4
2005	11.9	164.5	5.4	152.4	352.2	207.7	34.6	28.0	956.7	40.9	63.6	9.7	53.9	48.5
2006	13.5	156.4	5.7	150.8	375.3	203.9	39.4	30.6	975.5	42.9	62.6	5.5	57.2	51.4
2007	19.0	146.2	6.4	160.4	364.1	171.9	43.4	44.4	955.6	42.8	61.7	5.4	56.3	50.6
2008	20.0	109.0	7.0	152.0	389.0	177.0	33.0	158.0	1 045.0	42.6	60.8	4.8	55.9	50.3

The total waste amount in Table 8.2.8 is the sum of the different waste types and thereby includes Industrial Waste, Building and Construction Waste. The total waste amount is reported as the activity data for the Annual Municipal Solid Waste (MSW) at SWDSs in the CRF Table 6.A. In so doing and in referring to the discussion of waste amounts in IPCC (2000), page 5.8, it is clear that these amounts are not really characteristics of the term "Municipal Solid Waste". Furthermore, it should be noted that these amounts are used to calculate the amounts of waste produced pr capita in the Table 6A,C of the CRF and that these pr capita amounts may not, therefore, be comparable with those used by other parties using different approaches.

The implied emission factor (IEF) in the CRF tables reflects an aggregated emission factor for the model. This IEF has increased through the time-series from 1990 to 2003, despite the general decreasing trend in the amount of waste. This is due to the model, where emissions from the waste deposited are being calculated to take place in years after the actual year of deposition

This method used for oxidation corresponds to the assumption that the oxidation takes place in the top layers of the landfills. Since the Danish solid waste disposal sites (SWDSs) are well-managed, it is assumed that 10 % of the CH_4 produced by the waste is oxidised (OX = 0.1; refer IPCC 2000, page 5.10). Furthermore, an analysis has been carried out on the introduction of individual half-life times for the emissions of CH_4 from the waste sectors used, Table 8.2.9.

Table 8.2.9 Analyses of CH_4 emissions for 1990-2006 using individual half-life time for waste sectors.

	Domestic Waste	Bulky Waste	Garden Waste	Commercial & Office Waste	Industrial Waste	Building & construction Waste	Sludge	Ash & Slag	Total Annual Gross CH_4 emission KT
Half-life time (year)	4	23	7	12	17	17	4		
Year				CH_4 emission ktonnes					
1990	11.6	9.3	7.1	3.4	10.0	7.6	16.1	0.0	65.1
1991	11.8	9.8	6.9	3.7	10.4	7.7	15.5	0.0	65.7
1992	12.0	10.3	6.7	4.1	10.7	7.7	14.7	0.0	66.1
1993	12.1	10.8	6.4	4.5	11.1	7.6	13.8	0.0	66.2
1994	12.2	11.3	6.0	4.9	11.4	7.5	12.8	0.0	66.1
1995	12.3	11.8	5.6	5.3	11.8	7.3	11.7	0.0	65.8
1996	12.3	12.4	5.2	5.6	12.0	7.1	10.7	0.0	65.3
1997	11.7	12.8	4.7	5.9	12.3	7.0	10.0	0.0	64.5
1998	10.7	13.2	4.3	6.4	12.5	6.8	9.6	0.0	63.5
1999	10.0	13.5	4.0	6.8	12.7	6.6	9.1	0.0	62.8
2000	9.6	13.8	3.7	7.2	12.7	6.4	8.8	0.0	62.3
2001	8.9	14.2	3.4	7.5	12.8	6.3	8.2	0.0	61.4
2002	8.0	14.4	3.1	7.8	12.9	6.1	7.5	0.0	59.7
2003	7.1	14.4	2.8	8.0	12.8	6.0	6.7	0.0	57.8
2004	6.2	14.4	2.6	8.1	12.7	5.8	6.1	0.0	56.0
2005	5.4	14.4	2.4	8.3	12.6	5.6	5.5	0.0	54.2
2006	4.6	14.5	2.2	8.6	12.4	5.5	4.9	0.0	52.7
2007	4.0	14.5	2.0	8.8	12.3	5.3	4.5	0.0	51.5
2008	3.6	14.5	1.8	9.1	12.1	5.2	4.2	0.0	50.5

Comparing Table 8.2.9 with Table 8.2.8, it can be seen that the emissions using individual half-life times are higher for the time-series 1990-1994 and smaller for the time-series 1996-2008. The difference goes from +9.8 % in 1990 to -16.8 % in 2008. The trend for this percentage is steady decreasing. Please note that this comparison is for annual gross emission (not net emission).

During the past reviews the composition of the waste during the time-series was discussed. Few large scale investigations of waste composition exist. The study on which the composition used here is based on waste composition in 1985, Table 8.2.6. A suggestion by the reviewers were that the composition should be further studied and analysed. In the NIR 2008 and 2009 was shown the sensitivity of the FOD-model to the waste composition was presented. In this NIR this analysis has been carried out for the time-series 1990-2008, with the revised model, cf. section 8.2.6. Based on a estimate on how composition may have changed from 1985 to 2008 a model version where the change in emission factor for the individual waste types was interpolated linearly between the composition in 1985 and the estimate of the composition in 2008.

In Table 8.2.10 is shown estimates of the percentage changes of the composition from 1985 to 2008 and in Table 8.2.11 is shown the composition in 2008 resulting from the estimated changes. In Table 8.2.10 the waste type "Other not combustible" is not shown, since the way this version of the model has been made the change for this type is not an input parameter, but is a result of the other estimates to make the fraction sum become one, refer Table 8.2.11.

Table 8.2.10 An estimate of changes in fraction for ISAG waste types from 1985 (Table 8.2.6) to 2008.

Material fractions in	Waste-Food	Card-Board	Paper	Wet Cardboard and paper	Plastics	Other combustible	Glass	Metal
Domestic Waste	-90	+30	+30	+30	+50	+10	+30	+20
Bulky Waste		+10	-30		+50	+10	-30	+10
Garden Waste						+30		
Commercial & office Waste	-90	+20	+30	+20	+50	+10	0	0
Industrial Waste	-90	+20	+30	+20	+50	+10	0	0
Building & constr. Waste						+20		
Sludge						+20		
Ash & slag								

Table 8.2.11 ISAG waste types and their content (fraction) of waste types for 2008.

Material fractions in	Waste-food	Card-Board	Paper	Wet Card-board and paper	Plastics	Other combusti-ble	Glass	Metal	Other not combus-tible	Sum
Domestic Waste	0.038	0.022	0.166	0.343	0.102	0.037	0.022	0.056	0.056	1.00
Bulky Waste		0.085	0.163		0.070	0.503	0.060	0.094	0.026	1.00
Garden Waste						0.988			0.012	1.00
Commercial & office Waste	0.025	0.373	0.050	0.128	0.073	0.107	0.049	0.049	0.147	1.00
Industrial Waste	0.006	0.022	0.091	0.017	0.019	0.064	0.037	0.183	0.559	1.00
Building & constr. Waste						0.084			0.916	1.00
Sludge						0.348			0.652	1.00
Ash & slag									1.000	1.00

In the choice of percentage changes for the composition of waste between 1985 and 2008 is reflected a large reduction of Waste food and a pronounced increase in Plastics, refer Table 8.2.10.

In Table 8.2.12 is shown the Gross emission of CH_4 calculated with the model formulated as just explained and half lifetime 14 years. In the table this result is compared with the model with fixed composition and used for the CRF-reporting.

Table 8.2.12 Result of calculation of Gross emissions CH_4 with model based on changing waste composition and the model with fixed composition.

Year	Annual Gross emissions ktonnes CH_4			Per cent
	Fixed 1985 composition	Changing composition 1985-2008	Diff	Diff
1984	45.3	45.3	0.0	0.0
1985	47.9	47.9	0.0	0.0
1986	50.6	50.6	0.0	0.0
1987	53.1	53.1	0.0	0.0
1988	55.4	55.4	0.0	-0.1
1989	57.4	57.5	-0.1	-0.1
1990	59.3	59.4	-0.1	-0.2
1991	60.9	61.1	-0.1	-0.2
1992	62.4	62.6	-0.1	-0.2
1993	63.7	63.9	-0.2	-0.2
1994	64.9	65.0	-0.2	-0.2
1995	65.8	66.0	-0.1	-0.2
1996	66.5	66.7	-0.1	-0.2
1997	67.1	67.2	-0.1	-0.2
1998	67.3	67.4	-0.1	-0.2
1999	67.5	67.6	-0.1	-0.2
2000	67.6	67.7	-0.1	-0.2
2001	67.6	67.7	-0.1	-0.2
2002	66.9	67.0	-0.1	-0.2
2003	66.0	66.1	-0.1	-0.2
2004	64.8	64.9	-0.1	-0.2
2005	63.6	63.7	-0.1	-0.2
2006	62.6	62.7	-0.1	-0.2
2007	61.7	61.8	-0.1	-0.2
2008	60.8	60.9	-0.1	-0.2

It is seen from Table 8.2.12 that the difference is small, which shows that the calculation of the model is rather robust against changing composition of the waste seen in combination with the half life time of 14 years.

In Annex 3.E, further details on the model for the CH_4 emission from solid deposited waste are given.

8.2.3 Uncertainties and time-series consistency

Uncertainty

Tier 1. The parameters considered in the uncertainty analyses and the estimated uncertainties of the parameters are shown in Table 8.2.13. The reference is IPCC (2000), page 5.12, Table 5.2. For all uncertainties, symmetric values based on maximum numeric values are estimated as the uncertainties for the whole inventory is a tier 1 approach to be summed up in the IPCC (2000), Table 6.1. Uncertainties are estimated on parameters, which in principle used in factors for multiplication, so that the final uncertainty is estimated with Equation 6.4 in the IPCC (2000).

As regards the uncertainty given in the IPCC (2000), for the methane generation constant, k, (-40 %, +300 %), this uncertainty cannot be included in simple equations for total uncertainties, such as IPCC (2000), Equations 6.3 and 6.4. The reason is that k is a parameter in the exponential function for the formula for emission estimates. Based on equations in Limpert et. al., 2001, and based on the assumption that the k-values can be descriebed by a log-normal distribution and that the uncertainties given in IPCC (2000) are 95 % confidens values. Using these equations with the k uncertainty value 300 % from IPCC (2000) the uncertainty connected to the methan rate constant is as shown in Table 8.2.13.

The final uncertainty on the emission factor is based on uncertainty estimates in Table 8.2.13 and, and is approximated with IPCC (2000) Equation 6.4:

Uncertainty of emission factor total % = SQRT($50^2+30^2+10^2+10^2+100^2$) = 117.9 %.

Table 8.2.13 Uncertainties for main parameters of emissions of CH_4 for SWDS.

Parameter	Uncertainty %	Note
The Waste amount sent to SWDS	10	Since the amounts are based on weighing at the SWDS the lower value in IPCC (2000), is used
Degradable Organic Carbon DOC	50	
Fraction of DOC dissimilated	30	
Methane Correction Factor	10	
Fraction of CH4 in landfill gas	10	
Methane Generation Rate Constant	100	see the text

These uncertainties give the combined tier 1 uncertainty (%) for the emission as

SQRT($10^2+117.9^2$) = 118.3

<u>Tier 2.</u> For the general approach to the tier 2 analysis in this submission reference is given to Section 1.7. To use this approach the decay model has to be thought of as a multiplication of activity data and emissionfactors. As activity data is taken the total amount of waste being deposited (Table 8.2.2) and as emissionsfactor the implied emissionfactor (ief) as a result of division of the emission (Table 8.2.2) and the waste amount deposited. For uncertainties are used the tier 1 uncertainties, i.e. uncertainty for waste amounts 10 % and uncertainty of ief as 117.9. The confidence limits for uncertainties that are inserted in tier 1 and tier 2 Monte Carlo are different in the present version of tier 2, in a way that uncertainties to be entered in tier 2 equals the standard deviation and in tier 1 equals the 95 % confidence interval, cf. section 1.7. Using the Monte Carlo simulation the result for 2008 as shown in Table 8.2.14.

Table 8.2.14 Monte Carlo simulation of 2008 emissions of CH_4 for SWDS.

Emissions (tonnes CH4)		
Median	Below 2.5%	Above 97.5%
I	J	K
52700	11406	236469

This simulation results in the tier 2 uncertainties in Table 8.2.15

Table 8.2.15 TIER 2 uncertainties of 2008 emissions of CH_4 for SWDS.

	(I-J)/I*100 - X	(K-I)/I*100 + Y	Average (Tier 2)
Uncertainty %	78	349	214

Time-series consistency and completeness

Registration of the amount of waste has been carried out since the beginning of the 1990s in order to measure the effects of action plans. The activity data is, therefore, considered to be consistently long enough to make the activity data input to the FOD model reliable. For further information on activity data and on the general behaviour of the FOD model, refer to Annex 3.F.

The consistency of the emissions and the emission factor is a result of the same methodology and the same model used for the whole time-series. The parameters in the FOD model are the same for the whole time-series. The use of a model of this type is recommended in IPCC (1997) and IPCC (2000). The half-life time parameter used is the default value recommended by IPCC (2000).

As regards completeness, the waste amounts used, as registered in the ISAG system, do not only include traditional Municipal Solid Waste (MSW), but also non-MSW as Industrial Waste, Building and Construction Waste and Sludge. The composition of these waste types is, according to Danish data, used to estimate DOC values for the waste types (refer IPCC 2000, page 5.10).

8.2.4 QA/QC and verification

QA/QC-procedure

In previous reviews it was recommended to improve the description. In the review of the 2005 NIR it was acknowledged that this effort has taken place and has improved the NIR. It is the intention to publish a sector report for the Waste Sector. The main effort has, however, centred on improving the description in the NIR.

A proposal for formal agreements with regard to data deliverance has been put forward to DEPA concerning provision of annual waste amounts. However, such an agreement has not yet been signed. Since it is a statutory requirement that waste amounts are reported to DEPA, the agreement may potentially not be required (refer to the remarks under DS.1.3.1). DEPA is supposed to make a yearly report on the reception of the registrations, etc.

In general terms, for this part of the inventory, the Data Storage (DS) Level 1 and 2 and the Data Processing (DP) Level 1 can be described as follows:

Data Storage Level 1

The external data level refers to the placement of original data for amounts of waste categories or fractions. These categories/fractions are linked to data on waste types with known content of degradable organic carbon, see Section 8.2.2. Data for CH_4 recovery are used. Further (external) data are parameters to the FOD model. For further details on the external data, refer to the table below.

Table 8.2.16 Details on external data.

File or folder name	Description	AD or Emf.	Reference	Contacts	Data agreement/ Comment
	Report on 2007 and 2008 amounts according to the waste fractions.	Activity data	Danish Environmental Protection Agency (DEPA), Waste Statistics (Affaldsstatistik)	Unit for Soil and Waste Martin Sune Møller	The amounts are registered due to statutory requirements
Basic Data	Dataset for energy-producing SWDS	CH_4 recovery data	The Danish Energy Authority (DEA)	Peter Dal	Prepared due to the obligation of DEA
swds_fod_model.xls	Excel file with the FOD model	Parameters of the FOD model	IPCC 1997 and 2000	Erik Lyck	

Data Processing Level 1

This level, for SWDS, comprises a stage where the external data are treated internally, preparing for the input to the NERI First Order of Decay model, see Section 8.2.2. The model runs are carried out and the output stored.

Data Storage Level 2

Data Storage Level 2 is the placement of selected output data from the FOD model as inventory data on SNAP levels in the Access (CollectER) database.

Points of measurement

The present stage of QA/QC for the Danish emission inventories for SWDS is described below for DS and DP level 1 Points of Measurement (PMs). This is to be seen in connection with the general QA/QC description in Section 1.6 and, especially, 1.6.10 on specific description of PMs common to all sectors, general to QA/QC.

Data Storage level 1	1. Accuracy	DS.1.1.1	General level of uncertainty for every dataset including the reasoning for the specific values

With regard to the general level of uncertainty, the amounts in waste fractions/categories are rather certain due to the statutory environment for these data, while the distribution of waste fractions according to waste type and their content of DOC is more uncertain. It is generally accepted that FOD models for CH_4 emission estimates offer the best and the most certain way of estimation. The half-life in the FOD models is an important parameter with some uncertainty.

Data Storage level 1	1. Accuracy	DS.1.1.2	Quantification of the uncertainty level of every single data value including the reasoning for the specific values.

The uncertainties of the DEPA data are not available in the DEPA reporting. The uncertainties are taken from IPCC (1997) and (2000). A special uncertainty/sensitivity analyses connected to the uncertainty/variation of the half-life parameter is carried out. DEA data on CH_4 recovery are considered to be precise. Refer to Section 8.2.3 on uncertainty.

Data Storage level 1	2.Comparability	DS.1.2.1	Comparability of the data values with similar data from other countries, which are comparable with Denmark, and evaluation of discrepancy.

Only some comparison of Danish data values from external data sources with corresponding data from other countries has been carried out in order to evaluate discrepancies. For many countries SWDS waste amounts do not – as for the Danish data – include waste from industrial sources, which presents a difficulty with regard to comparison.

Data Storage level 1	3.Completeness	DS.1.3.1	Documentation showing that all possible national data sources are included by setting down the reasoning behind the selection of datasets.

The following external data sources are used for the inventory on SWDS (refer also to the table above):

- Danish Environmental Protection Agency, ISAG database: amounts of the various waste fractions deposited (refer to Section 8.2.2).
- A Danish investigation on the waste types in waste fractions and the content of degradable organic carbon in waste types.
- Danish Energy Authority: Official Danish energy statistics: CH_4 recovery data.

The selection of sources is obvious. The ISAG database is based on statutory registrations and reporting from all Danish waste treatment plants for all waste entering or leaving the plants. Information concerning waste in the previous year must be reported to the DEPA each year, no later than 31 January. Registration is made by weight. For recovery data, the DEA registers the energy produced from plants where installations recover CH_4. for the energy statistics.

For the parameters of the FOD model, references are made to IPCC (1997) and IPCC (2000).

Data Storage level 1	4.Consistency	DS.1.4.1	The origin of external data has to be preserved whenever possible without explicit arguments (referring to other PMs).

The origin of external activity data has been preserved as much as possible. The starting year for the FOD model used is 1960, using historic data for waste quantities. Since 1994, data is according to the Danish ISAG reporting system. For further information on the origin of activity data, refer to Annex 3F. Files are saved for each year of reporting. In this way changes to previously received data is reflected and explanations are given.

The FOD model and its parameters have been used consistently, throughout the time-series, refer to Section 8.2.3.

Data Storage level 1	6.Robustness	DS.1.6.1	Explicit agreements between the external institution holding the data and NERI about the conditions of delivery.

It is a statutory requirement that amounts of waste are reported annually to DEPA, no later than January 31 for the previous year which corresponds well with the inventory development. No explicit agreement has yet been made.

Data Storage level 1	7.Transparency	DS.1.7.1	Summary of each dataset including the reasoning for selecting the specific dataset

The summary of the dataset can be seen in Table 8.8 in Section 8.2.2. For the reasoning behind the selection of the specific dataset, refer to DS 1.3.1.

Data Storage level 1	7.Transparency	DS.1.7.3	References for citation for any external dataset have to be available for any single value in any dataset.

These references exist in the description given in the Section 8.2.2.1, under methodological issues.

Data Storage level 1	7.Transparency	DS.1.7.4	Listing of external contacts for every dataset

The following list shows the person responsible and contact information for delivery of data:

Danish Environmental Protection Agency: Martin Sune Møller, (masmo@mst.dk) and Lone Lykke Nielsen (lln@mst.dk)

Danish Energy Authority: Peter Dal (pd@ens.dk)

Data Processing level 1	1. Accuracy	DP.1.1.1	Uncertainty assessment for every data source as input to Data Storage level 2 in relation to type of variability. (Distribution as: normal, log normal or other type of variability)

Tier 1 and Tier 2 uncertainty calculations are made. The use of the Tier 1 methodology presumes a normal distribution of activity data and emission factor variability. The extent to which this requirement is fulfilled still needs to be elaborated. The uncertainty on the half-life time cannot be implemented on a Tier 1 level and a special assessment has been given.

Data Processing level 1	1. Accuracy	DP.1.1.2	Uncertainty assessment for every data source as input to Data Storage level 2 in relation to scale of variability (size of variation intervals)

The uncertainty assessment has been given in Section 8.2.3.

Data Processing level 1	1. Accuracy	DP.1.1.3	Evaluation of the methodological approach using international guidelines

An evaluation of the methodological approach, in comparison with the Tier 1 level, has been made, see Section 8.2.4. This shows that the emissions from waste estimated according to the default methodology from IPCC (1997) and IPCC (2000) will deviate considerably from those in this submission, also since the waste amounts estimated in the latter methodologies deviate from those used for Denmark.

Data Processing level 1	1. Accuracy	DP.1.1.4	Verification of calculation results using guideline values

From the evaluation carried out, see DP.1.1.3, it is clear that no direct verification can be carried out, since the method is a Tier 2 method, in accordance with IPCC (1997) and IPCC (2000).

Data Processing level 1	2.Comparability	DP.1.2.1	The inventory calculation has to follow the international guidelines suggested by the UNFCCC and IPCC.

The calculation used is a Tier 2 methodology from IPCC (1997) and (2000).

Data Processing level 1	3.Completeness	DP.1.3.1	Assessment of the most important quantitative knowledge which is lacking.

There is no quantitative knowledge in the methodology on either (1) the shift over time in waste types within waste fractions and in DOC content in waste types or (2) possible individual conditions relating to the SWD sites. On going research might change this lack. In this NIR the sensitivity of the model with regards to waste composition has been preliminary investigated.

Data Processing level 1	3.Completeness	DP.1.3.2	Assessment of the most important cases where access is lacking with regard to critical data sources that could improve quantitative knowledge.

There is no direct data to elucidate the points mentioned under DP.1.3.1.

Data Processing level 1	4.Consistency	DP.1.4.1	In order to keep consistency at a high level, an explicit description of the activities needs to accompany any change in the calculation procedure.

There is no change in calculation procedure during the time-series and the activity data is, as far as possible, kept consistent for the calculation of the time-series.

Data Processing level 1	5.Correctness	DP.1.5.1	Show at least once, by independent calculation, the correctness of every data manipulation.

The model has been checked to give the results to be expected on fictive input data with known result, se Annex 3F.

Data Processing level 1	5.Correctness	DP.1.5.2	Verification of calculation results using time-series

The time-series of activities and emissions in the FOD-model output, in the SNAP source categories and in the CRF format have been prepared.

The time-series are examined and significant changes are checked and explained. Comparison is made with the previous year's estimate and any major changes are verified.

Data Processing level 1	5.Correctness	DP.1.5.3	Verification of calculation results using other measures

The correct interpretation in the model of the methodology and the parameterisation has been checked, refer DP.1.5.1.

Data Processing level 1	5.Correctness	DP.1.5.4	Shows one-to-one correctness between external data sources and the databases at Data Storage level 2

Data transfer control is made from the external data sources and to the SNAP source categories at level 2. This control is carried on further to the aggregated CRF source categories.

Data Processing level 1	7.Transparency	DP.1.7.1	The calculation principle and equations used must be described

The calculation principle and equations are described in Section 8.2.2. Further transparency comes as a consequence of using Tier 2 method of IPCC (1997) and (2000).

Data Processing level 1	7.Transparency	DP.1.7.2	The theoretical reasoning for all methods must be described

The theoretical reasoning is described in Section 8.2.2 and, due to the used of the Tier 2 method in IPCC (1997) and (2000), is also described in these IPCC reports.

Data Processing level 1	7.Transparency	DP.1.7.3	Explicit listing of assumptions behind all methods

The assumption is that the emissions can be described according to a FOD model as described in IPCC (1997) and (2000) for SWDS. Furthermore, it is assumed that this FOD model can be run with the parameters as they are listed in Section 8.2.2.

Data Processing level 1	7.Transparency	DP.1.7.4	Clear reference to dataset at Data Storage level 1

Refer to the table at the start of this Section (8.2.4).

Data Processing level 1	7.Transparency	DP.1.7.5	A manual log to collect information about recalculations

Recalculation changes in the emission inventories are described in the NIR. The logging of the changes takes place in the yearly model file.

Data Storage level 2	5.Correctness	DS.2.5.1	Documentation of a correct connection between all data types at level 2 to data at level 1

The full documentation for the correct connection exists through the yearly model file, its output and report files made by the CollectER database system.

Data Storage level 2	5.Correctness	DS.2.5.2	Check if a correct data import to level 2 has been made

This check is performed, comparing model output and report files made by the CollectER database system, refer to DS.2.5.1.

Suggested QA/QC plan for SWDS

The following points are a list of QA/QC tasks to be considered directly in relation to the SWDS part of the Danish emission inventories:

Data at storage level 1

- A further comparison with external data from other countries in order to evaluate discrepancies.
- Agreement on the data deliverance consistency and stability.
- Investigations into the possibility of obtaining data on variations in waste fraction composition and DOC content in the time-series.

Data processing level 1

More work on uncertainty calculations.

Further evaluation of FOD modelling with half-life time depending on individual waste types.

QA on evaluation and verification

It is good practice, and a QA procedure, to compare the emission estimates included in the inventories with the IPCC default methodology.

In Table 8.2.17, default methodology is presented using the IPCC (1997) or IPCC (2000), as appropriate. The parameters (on the pages in IPCC 1997 and 2000) used are referred to in the table. As seen against the calculation of DOC in the default methodology, the Danish data is not suited for direct use. Referring to the formula in the IPCC (2000), p5.9, it is assumed (referring to Table 8.2.6, above) that A comprises “Cardboard”, “Paper” and “Wet Cardboard and Paper”; that B comprises “Plastic”, “Other Combustible” and “Other not Combustible”; and that C comprises “Waste Food”. A mean fraction of these categories was calculated for use in the default methodology.

Table 8.2.17 IPCC default methodology for CH_4 emissions from SWDS for 1990-2008. Notation: IPCC (1997) and IPCC (2000)

Parameter	Reference		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
	Population	1000 cap	5 135	5 146	5 162	5 181	5 197	5 216	5 251	5 275	5 295	5 314
MSW	Waste generation rate GL Table 6-1	Kg pr cap pr day	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26
MSWT	Waste generation GL Table 6-1	Gg pr yr	2 362	2 367	2 374	2 383	2 390	2 399	2 415	2 426	2 435	2 444
MSWF	Fract. of waste to SWDS GL Table 6-1		0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
MCF	Methan Corr Factor GPG p 5.8		1	1	1	1	1	1	1	1	1	1
DOC	Degr Organic C GPG p 5.9		0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19
DOCF	Fract DOC diss GPG p 5.9		0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55
F	Fraction CH_4 in gas GPG p5.10		0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Lo	Methan gener. pot GPG p5.8		0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
R	Danish Energy statistics	Gg CH_4 pr yr	0.5	0.7	1.4	1.7	4.6	7.4	8.2	11.1	13.2	11.5
OX	Oxid. Factor GPG p5.10		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
CH_4 emission		Gg CH_4 pr yr	29.7	29.6	29.0	28.8	26.3	23.9	23.5	20.9	19.2	20.9
Continued			2000	2001	2002	2003	2004	2005	2006	2007	2008	
	Population	1000 cap	5 330	5 349	5 368	5 384	5 398	5 411	5 427	5 447	5 476	
MSW	Waste generation rate GL Table 6-1	Kg pr cap pr day	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26	
MSWT	Waste generation GL Table 6-1	Gg pr yr	2 451	2 460	2 469	2 476	2 482	2 488	2 496	2 505	2518	
MSWF	Fract. of waste to SWDS GL Table 6-1		0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	
MCF	Methan Corr Factor GPG p 5.8		1	1	1	1	1	1	1	1	1	
DOC	Degr Organic C GPG p 5.9		0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	
DOCF	Fract DOC dissimilated GPG p 5.9		0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	
F	Fraction CH_4 in gas GPG p5.10		0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	
Lo	Methan gener. pot GPG p5.8		0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	
R	Danish Energy statistics	Gg CH_4 pr yr	11.0	10.0	11.2	7.9	11.0	9.7	5.5	5.4	4.8	
OX	Oxid. Factor GPG p5.10		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	
CH_4 emission		Gg CH_4 pr yr	21.4	22.4	21.4	24.4	21.8	23.0	26.9	27.1	27.8	

The table shows that the default methodology underestimates the amounts of waste deposited and the CH_4 emissions by a factor of 2-3. The reason for this is that the default methodology does not seem to include Industrial Waste, which is deposited in considerable quantities in Denmark, Table 8.2.8.

A further option in the default methodology is to include the total waste amount registered with the waste generation rate for total waste, and include the fraction of waste deposited to SWDS, Table 8.2.18. The fraction as well as the generation rate for total waste is included in the CRF Table 6 A “Additional Information”.

Table 8.2.18 As Table 8.2.18 but with ISAG registered waste amounts and fraction of waste deposited to SWDS. Notation: IPCC (1997) and IPCC (2000).

Parameter	Reference		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
	Population	1000 cap	5 135	5 146	5 162	5 181	5 197	5 216	5 251	5 275	5 295	5 314
MSW	Waste generation rate ISAG	kg pr cap pr day	5.4	5.5	5.6	5.7	5.9	6.0	6.7	6.7	6.3	6.3
MSWT	Waste generation	Gg pr yr	10 169	10 403	10 637	10 871	11 105	11 466	12 912	12 857	12 233	12 233
MSWF	Fract. of waste to SWDS ISAG		0.30	0.28	0.27	0.25	0.23	0.24	0.20	0.16	0.15	0.12
MCF	Methan Corr Factor GPG p 5.8		1	1	1	1	1	1	1	1	1	1
DOC	Degr Organic C GPG p 5.9		0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19
DOCF	Fract DOC dissimilated GPG p 5.9		0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55
F	Fract CH_4 in gas GPG p5.10		0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Lo	Methan generation potential GPG p5.8		0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
R	Danish Energy statistics	Gg CH_4 pr yr	0.5	0.7	1.4	1.7	4.6	7.4	8.2	11.1	13.2	11.5
OX	Oxid. Factor GPG p5.10		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
CH_4 emissions		Gg CH_4 pr yr	194.9	187.4	178.9	170.2	158.7	168.8	157.4	121.2	105.2	83.3
Continued			2000	2001	2002	2003	2004	2005	2006	2007	2008	
	Population	1000 cap	5 330	5 349	5 368	5 384	5 398	5 411	5 427	5 447	5 476	
MSW	Waste generation rate ISAG	kg pr cap pr day	6.7	6.5	6.7	6.4	6.8	7.2	7.8	7.8	7.8	
MSWT	Waste generation	Gg pr yr	13 031	12 768	13 105	12 614	13 359	14 210	15 459	15 476	15 575	
MSWF	Fract. of waste to SWDS ISAG		0.11	0.10	0.09	0.08	0.08	0.08	0.07	0.06	0.07	
MCF	Methan Corr Factor GPG p 5.8		1	1	1	1	1	1	1	1	1	
DOC	Degr Organic C GPG p 5.9		0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	
DOCF	Fract DOC dissimilated GPG p 5.9		0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	
F	Fract CH_4 in gas GPG p5.10		0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	
Lo	Methan generation potential GPG p5.8		0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	
R	Danish Energy statistics	Gg CH_4 pr yr	11.0	10.0	11.2	7.9	11.0	9.7	5.5	5.4	4.8	
OX	Oxid. Factor GPG p5.10		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	
CH_4 emissions		Gg CH_4 pr yr	81.5	72.4	65.2	57.2	55.4	53.9	58.9	57.9	64.0	

The result of this adjusted default methodology is CH_4 emissions, which in the beginning of the time-series represent highly overestimated emissions and in the later part of the time-series 2002-2007 represent somewhat underestimated emissions compared with the results of the FOD model. One explanation is that the FOD model reflects the ongoing process over the years with regard to the generation of CH_4 from waste deposited in previous years, while the default method only estimates emissions reflecting the waste deposited the same year.

8.2.5 Source specific Recalculations

For the submissions in 2010, recalculations have been carried out in relation to the final submission in 2009 of inventories for the years 1990-2007 (Nielsen, O.-K. et al 2009).

The recalculation represents for 2006-2007 updates in the energy statistics on the uptake of CH_4 by installations at SWDSs for energy production. This change in itself increase the emissions for 2006 and 2007 around 4% as compared to the 2009 submission.

The main recalculations are results from comments, recommendations and discussions with the expert review team on the 2009 submission This review has resulted in the following changes:

The DOC content of Plastics has been changes from 85 to 0 %. This was an error in the previous model formulation. This change in itself lowered the time-series of emissions from 9.5 (1990) to 13.1 % (2002) as compared to the 2009 submission.

The content of CH_4 in the gas emitted has been changed from 45 to 50 % to better reflect the GPG values. This change in itself increased the time-series of emissions from 11.2 (1990) to 13.4 % (1998) as compared to the 2009 submission.

The half year time has been changes from 10 to 14 years according to the default value in the GPG. This change in itself lowered the time-series of emissions from 15.0 (1990) to 4.2 % (2007) as compared to the 2009 submission.

The model formulation has been changed to reflect the accepted fact that emission from waste deposited starts after some time delay. The model now starts to estimate emissions from waste deposited January 1, the year after the waste was deposited. This change in itself lowered the time-series of emissions from 11.9 (1990) to 6.4 % (2007) as compared to the 2009 submission.

Further, and not a result of the review, a minor error in model formulation for the year 2007 has been corrected. This change in itself lowered the value of emissions in 2007 with 0.3 % as compared to the 2009 submission.

The total recalculation implies changes in the time series of emissions from -16.8 (1990) to +0.1 % 2007.

8.2.6 Source specific planned improvements

In response to the expert review team on the in-country review for the 2006 submissions and the review on the 2008 submission, the methodology has been investigated with regards to the sensitivity for the composition of waste. Having more information on the actual recent composition of waste, investigations are planned to combine the revised model with waste type individual half-life time. References in IPCC 2006 Guidelines will be analysed in this context (IPCC 2006).

Finally further QA/QC analyses and elaborations on the TIER 2 uncertainty will be taken into consideration.

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8.3 Wastewater Handling (CRF Source Category 6B)

8.3.1 Source category description

This source category includes an estimation of the emission of CH_4 and N_2O from wastewater handling. CH_4 is produced during anaerobic conditions and treatment processes, while N_2O may be emitted from anaerobic as well as aerobic processes (e.g. Adouani et al., 2009; Kampschreur et al, 2009).

Regarding the CH_4 emission, the gross emission calculated from the wastewater influent amount of degradable organic matter is unchanged in this year's submission, while the approach for estimating the fraction of recovered CH_4 has been corrected.

Until the present submission, the calculated CH_4 potentials not emitted, i.e. recovered or reused for energy production (DEPA, 1989, 1999b, 2001b, 2003b, 2004b, 2009) subtracted the gross emission and a net CH_4

emission was derived (Thomsen and Lyck, 2005). This approach has been modified in this year's submission.

A comparative analysis of the Danish sludge database, held by the Danish EPA, and data from the Danish Energy statistics, revealed that sludge amount reported under the category 'anaerobic stabilisation' in corresponds to sludge used for biogas and energy production on-site the individual WWTPs, while the reported final disposal category ' biogas' as presented in the DEPA reports (DEPA, 1989, 1999b, 2001b, 2003b, 2004b, 2009) accounts only for the sludge amounts produced at mainly aerobic operated WTTPs and therefore sent to biogas plants outside these WWTPs (Nielsen et al, 2010). The approach for deriving at the amount of recovered and reused methane potential has been corrected according to:

- a mass balance performed by access to the Danish Sludge database using the percent amounts of sludge reported as 'treated by anaerobic and aerobic stabilisation' summing up to, approximately, the total amounts of sludge produced,
- verification by a comparison with reported energy data originating from municipal WWTPs in the Danish Energy Statistics.

As the Danish sludge database does not cover the whole reporting time series and furthermore, the reporting frequency by the WWTPs is varying as reporting is occurring on a voluntary basis and good agreement in the existing methodology adjusting for earlier years underestimations of the amount of recovered methane has been adopted as presented below.

Regarding the N_2O emissions, a mass balance of the total N flow in the influent and effluent wastewater, as well the N content of the final sludge is presented. For all years, the influent load of organic carbon, total N content in the influent and effluent waste water extracted from the database on wastewater quality parameters held by the Agency for Spatial and Environmental Planning that is part of the Ministry of the Environment available at www.miljoeportalen.dk (cf. Table 8.3.3.). With additional data on the total N content of the final sludge it is possible to derive the total amount of N emitted from the waste water treatment processes. From this mass balance a first attempt to derive an improved estimate of a national emission factor for N_2O for the direct emissions from wastewater treatment is presented.

The CH_4 emission from wastewater handling constituted a key category to trend in 2006 and 2007. However, recalculations, using the changed methodology, leave the wastewater handling of minor importance, i.e. not being a key category. (cf. Annex 1). The emission estimates for the CH_4 emission from wastewater handling has increased with 56 % from 1990 to 2008 mainly caused by an increasing amount of sludge treated at anaerobic conditions with methane recovery.

Methane emission

The emission of CH_4 is calculated as the gross emission minus the amount of CH_4 potential not emitted; i.e. recovered for energy production (Nielsen et al., 2010). The not emitted methane potential corresponds to the amount of sludge used for biogas to energy production. The gross emission, i.e. methane produced in relation to anaerobic treatment processes has not been changed, but a comparative analysis of data have verified that anaerobic processed at the Danish WTTPs occur in all cases with high efficiency energy production. As such the net emission is calculated as 10 percent of the anaerobic treatment processes, according to DEPA experts, and verified in Nielsen et al., 2010, all occurring with high efficiency recovery of methane for energy production:

$$CH_{4,net} = TOW_{inlet} \cdot EF_{CH_4} \cdot 0.1 \qquad \text{Eq. 8.31}$$

where the EF at national level equals 0.15 kg CH_4 pr kg BOD (Thomsen and Lyck, 2005) and the major factor determining the net emission is the amount of sludge treated at anaerobic conditions; 90% of the methane production being recovered with energy production (Nielsen et al., 2010) and 10% fugitive emissions occurring from the aerobic treatment processes, assumed to include partly anaerobic conditions in the sewerage system and septic tanks.

A summary of the calculated methane potentials constituting the summed up the gross CH_4 emission potential during anaerobic treatment processes, the recovered methane, i.e. biogas production, and resulting net emission of CH_4 from 1990 to 2008 is given in Table 8.3.1.

Table 8.3.1 Gross, recovered and net CH_4 emission from the 6.B Wastewater handling in Denmark, 1990-2008, Gg.

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Gross CH_4 emission [Gg]*	14.49	14.46	14.51	14.91	16.20	17.49	18.79	20.10	21.42	21.04
Recovered CH_4 [Gg]**	13.04	13.01	13.06	13.42	14.58	15.74	16.91	18.09	19.28	18.93
Net CH_4 emission [Gg]***	1.45	1.45	1.45	1.49	1.62	1.75	1.88	2.01	2.14	2.10
Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	
Gross CH_4 emission [Gg]	21.22	21.65	23.43	24.03	22.96	22.47	21.99	22.51	22.54	
Recovered CH_4 [Gg]	19.10	19.49	21.08	21.63	20.66	20.23	19.79	20.25	20.28	
Net CH_4 emission [Gg]	2.12	2.17	2.34	2.40	2.30	2.25	2.20	2.25	2.25	

*Gross emission corresponding to the total theoretical methane potential in anaerobic treatment processes derived from the influent amount of organic degradable matter.

**not emitted, covers the amount of methane recovered for energy production.

***net emission corresponds to the 10% fugitive and unintentional releases from pipes and/or flaring during intended closed and/or controlled active sludge reactors and anaerobic digested tanks. The high percent value for fugitive emission chosen by purpose of indirectly accounting for the not estimated fugitive emissions during partly anaerobic conditions in deep lagoons, the sewerage system and septic tanks.

Based on this simplified approach, the percent methane recovered for energy production increased has increase 56 % throughout the period, 1990-2008.

Still, only 43 % of the total amount of sludge is treated by anaerobic stabilisation with 90% methane recovery for energy production. For 57 % of the wastewater sludge treated by aerobic treatment processes and an unexplored energy potential in municipal sewage sludge of more than 50 % exists.

For details regarding activity data the reader is referred to Nielsen et al, 2010.

Nitrous oxide emission

The emission of N_2O from wastewater handling is calculated as the sum of contributions from wastewater treatment processes at the WWTPs and from sewage effluents. The emission from effluent wastewater, i.e. indirect emissions, includes separate industrial discharges, rainwater-conditioned effluents, effluents from scattered houses, from mariculture and fish farming. In Table 8.3.2, the summed up emission of N_2O from effluent and the contribution from direct N_2O emissions to the total N_2O emission, i.e. the sum of indirect and direct N_2O emissions, is presented.

Table 8.3.2 N_2O emission from effluents from point sources, from wastewater treatment processes and in total, tonnes.

year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
N_2O, indirect	265	252	219	273	268	238	180	158	154	147
N_2O, direct	77	81	76	79	118	118	119	122	133	130
N_2O, Total	343	333	296	352	386	356	298	281	287	277
Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	
N_2O, indirect	157	134	137	109	119	111	109	100	95	
N_2O, direct	142	145	185	148	132	170	134	163	225	
N_2O, Total	299	279	323	256	251	280	242	263	321	

* - activity data are not reported in the national statistics

The direct emission trend increases slightly, reaching a stable level from 1997 onwards. The decrease in the indirect emission from wastewater effluent is due to the technical upgrading of the WWTPs and the resulting decrease in wastewater effluent nitrogen loads. The indirect emission, which is the major contributor to the emission of nitrous oxide, is not expected to decrease much more in future, as effluent reduction of N compared to the influent load has increased from 65 % in 1993 to 80 % in 2004 (Thomsen & Lyck, 2005). In the latest report from ASEP it is stated that the nitrogen emissions with effluents have decrease with 82% in 2008 compared to 1989the reduction compared to 1989 (ASEP, 2010)

Regarding the calculated time trend in indirect N_2O emission from 1990 to 2007 has decreased 62 % N_2O, and the direct N_2O emission has increased 67 %. In absolute figures the indirect emission is a major contributor and the resulting total N_2O emission has decreased 46 % from 1990 to 2007.

8.3.2 Methodological issues

A country-specific methodology has been developed for estimating CH_4 and N_2O emissions for wastewater handling in Denmark as described in Thomsen and Lyck, 2005. This section is divided into methodological issues related to the CH_4 and N_2O emission calculations, respectively.

Activity data and emission factors used in the estimation of CH_4 emissions

The methodology developed for this submission for estimating emission of methane from wastewater handling follows the IPCC Guidelines (IPCC, 1997) and IPCC Good Practice Guidance (IPCC, 2000).

According to the IPCC GL, the emission should be calculated for domestic and industrial wastewater and the resulting two types of sludge, i.e. domestic and industrial sludge. However, the information available for the Danish wastewater treatment systems does not fit into the above categorisation as a significant fraction of the industrial wastewater is treated at centralised municipal wastewater treatment plants (WWTPs). Furthermore, monitoring data on the influent biological oxygen demand (BOD) are available for mixed industrial and household wastewater, which are used for calculating the total organic waste (TOW) in the influent wastewater. The methodology has been validated in Thomsen and Lyck, 2005 and in Nielsen et al, 2010.

Assuming that the characteristics of the TOW in domestic and industrial wastewater are similar, the division into emissions from domestic and industrial sewage sludge may be derived by subtracting the industrial contribution to the total emissions corresponding to the percent contribution given in Table 8.3.3.

Activity data used for calculating the Gross emission of Methane

From 1990 to 1998, the IPPC default methodology for household wastewater has been applied by accounting and correcting for the industrial influent load (Thomsen & Lyck, 2005). TOW activity data used for calculating the gross emission are given in Table 8.3.3.

Table 8.3.3 Total degradable organic waste (TOW) calculated by use of the default IPCC method corrected for contribution from industry to the influent TOW and country-specific data.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Contribution from industrial inlet BOD	2.5	2.5	2.5	5.0	13.6	22.2	30.8	39.4	48	41
Population (1000)	5 140	5 153	5 170	5 188	5 208	5 228	5 248	5 268	5 287	5 305
TOW [Gg] -; corrected IPPC method*	96.62	96.39	96.71	99.42	107.97	116.59	125.28	134.02	142.80	-
TOW [Gg] - country-specific data**	-	-	-	-	-	-	-	-	-	140.25
	2000	2001	2002	2003	2004	2005	2006	2007	2008	
Contribution from industrial inlet BOD	42	38	38	37	40.5	40.5	40.5	40.5	40.5	
Population (1000)	5 322	5 338	5 351	5 384	5 398	5 411	5 427	5 447	5 476	
TOW [Gg] - corrected IPPC method*	-	-	-	-	-	-	-	149.93	150.04	
TOW [Gg] - country-specific data	141.49	144.36	156.18	160.21	153.06	149.83	146.59			

*TOW = (1+I/100) x (P x D_{dom}), where P is the Population number, D_{dom}= 18250 kg BOD pr 1000 persons pr yr and I is the percent contribution from industry to the influent wastewater TOW content.

The gross emission of CH_4 is calculated by using the TOW data given in Table 8.3.3 multiplied by a country-specific EF of 0.15 kg CH_4 pr kg BOD, derived as described in the last years NIR (Thomsen and Lyck, 2005; Nielsen et al., 2009) and according to:

$$EF = B_o \cdot MCF \qquad \text{Eq.8.3.2}$$

where the maximum methane producing capacity, B_o equals 0.6 kg CH_4 pr kg BOD (IPCC, 2000). MCF equals the fraction of BOD that will ultimately degrade anaerobic set equal to the average per cent amount of sludge treated anaerobic divided by 100; assuming that all of the sludge treated anaerobic is treated 100 % anaerobic and as such no weighted MCF is calculated (IPCC, 2000).

Access to the Danish Water Quality Parameter Database was obtained in the summer 2009, which allowed for a comparison between plant-specific measurements and BOD data in Table 8.3.3. These data are presented in Nielsen et al, 2010 and have been used together with data from DEPA reports (Thomsen and Lyck, 2005) to derive yearly uncertainty estimates of the activity data (cf. Section 8. 3.3 and Nielsen et al., 2010).

Approach used for calculating the recovered methane potential

According to expert knowledge within the DEPA, close to 100% methane recovery is characteristic for all Danish WWTPs.

Of the total influent load of organic wastewater, the amount treated by anaerobic stabilisation has been verified as acceptable measure for the amount of sludge used for biogas and energy production when correcting for fugitive emissions. The verification is presented in depth in Nielsen et al., 2010 and is based on a comparative analysis of activity data on 1) energy production from municipal sewage sludge, extracted from the

Danish Energy Statistics and 2) sludge statistics derived from the Danish Sludge Database (Nielsen et al, 2010) with the existing methodology.

This first stage comparative analysis revealed that the methane production from the amount of sludge reported under the reporting category 'anaerobic stabilisation' within the Danish Sludge Database, equals the methane potential, with origin from Danish municipal WWTPs, needed for producing the amount of energy reported within the Energy Statistics (Nielsen et al, 2010).

The above described comparative analysis of different databases justifies the assumption that all sludge reported under the category 'anaerobic stabilisation' (DEPA, 1989, 1999b, 2001b, 2003b, 2004b, 2009) represents the on-site methane (biogas) to energy production characterised by high efficiency methane recovery (Nielsen et al., 2010).

The existing methodology based on TOW data was in agreement with the above two approaches of estimating the amount of recovered methane, why the simplified approach was adopted for this years submission as presented in Eq. 8.3.1. Having verified that the gross emission refers only WWTPS operating at anaerobic conditions and closed system with close to 100% recovery of methane. Furthermore, that only the fraction of sludge (approximately 60% dw) treated by close to a 100% aerobic conditions are reported under the final categories 'combustion' and 'other', the final disposal categories used in earlier submission is left out, as only an estimate of the unintentional and/or fugitive emissions is needed for deriving at the net emission.

For this year's submission, the recovery is in conclusion set to 90% of the gross emission; i.e. the amount of sludge used for biogas production.

Net CH_4 emission

The high end per cent fugitive emission of 10% (IPCC, 1996, 1997 and 200) were chosen by purpose of implicitly accounting for the fugitive emissions that may occur at unintentional partly anaerobic conditions in deep lagoons, septic tanks and the sewerage system. Fugitive emissions from biogas to energy production may result from fugitive emissions from pipes and/or flaring during intended closed and/or controlled active sludge reactors and anaerobic digester tanks.

In conclusion: At this stage a first phase explorative analysis of activity data on reported sludge amounts at plants level has been performed. Data still needs further quality assurance and control before a full mass balance and emission inventory based on activity data from the Danish Sludge database may be obtained (cf. Nielsen et al, 2010 and section 8.3.10). However, the first stage comparative analysis of Danish Sludge Database and data from the Energy Statistics are presented in Nielsen et al., 2010 a net emission of methane calculated by the simplified IPCC methodological approach, based on national monitored BOD data, as presented in Eq. 8.3.1 above and in Table 8.3.3.

According to Møller et al, 2009, around 3-5% fugitive methane emission originates from the biogas to energy production. Thus 5-7% is implicitly accounting for the fugitive emissions from unintentional methane production and emission during reported the around 60% dw sludge treated by aerobic stabilisation and 'other' treatment processes (DEPA, 1989, 1999b, 2001b, 2003b, 2004b, 2009); including collection, storage, and sewerage systems.

Overall time trends

The trends in the CH_4 emission from the Danish WWTPs, as summarised in Table 8.3.1, are presented graphically in Figure 8.3.1.

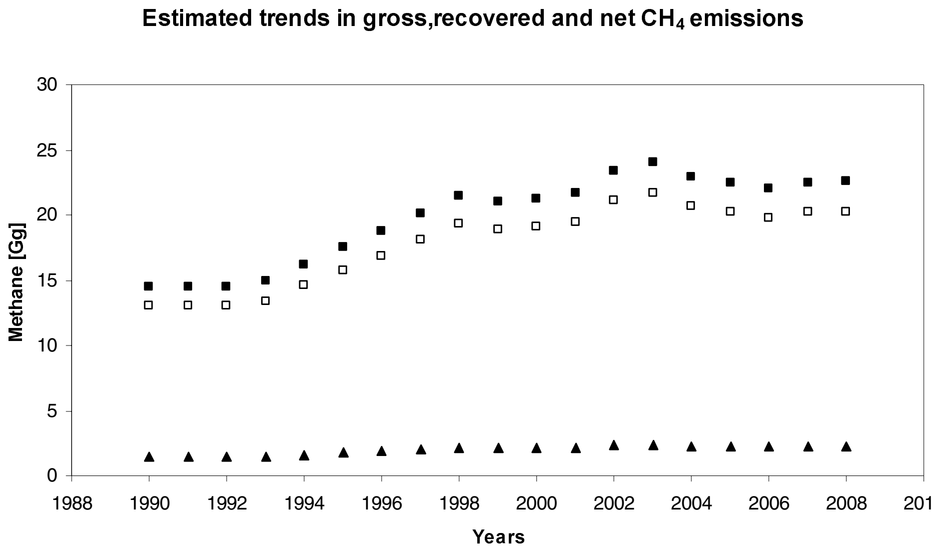

Figure 8.3.1 Time trends for gross emission (closed squares), recovered methane for biogas and energy production (open squares) and fugitive emissions (closed triangles).

The amount of recovered methane has been set to a constant level of 90 % of the gross emission; the level validated based on a mass balance of registered sludge in the Danish sludge data and the national energy statistics (cf. Nielsen et al., 2010). As such the fugitive emissions has increased from 1.45 Gg in 1990 to 2.25 Gg methane in 2008; i.e. an increase in the fugitive emissions from wastewater treatment of 55 %.

Methodological issues related to the estimation of N_2O emissions

N_2O may be generated by nitrification (aerobic processes) and denitrification (anaerobic processes) during biological treatment. Starting material in the influent may be urea, ammonia and proteins, which are converted to nitrate by nitrification. Denitrification is an anaerobic biological conversion of nitrate into dinitrogen. N_2O is an intermediate of both processes. Danish investigation indicates that N_2O is formed during aeration steps in the sludge treatments process as well as during anaerobic treatments; the former contributing most to the N_2O emissions during sludge treatment (Gejlsberg et al., 1999). However, a recent review by Kampschreur et al. documents great variations and complexity in the N_2O formation processes according to e.g. BOD, temperature, oxygen level e.g. pH (Nielsen et al, 2010; Kampschreur et al., 2009).

Method used for calculating the direct N_2O emission

Improved access to activity data has allowed for a full mass balance of the N flow within the Danish WWTPs. However, due to incompleteness and low accuracy of the reported N content in sludge, the methodology adopted for deriving the direct emission of laughter gas, is based on a complete time series of the total influent N load. The approach for derived the new EF value is documented in Nielsen et al. 2010.

The direct emission from wastewater treatment processes is calculated according to equation 8.3.3:

$$E_{N_2O} = 0.0032 \cdot m_{N,\inf luent} \cdot \frac{M_{N_2O}}{2 \cdot M_N}$$
Eq. 8.3.3

According to Kampschreur et al, 2009, around 90% of the emitted N2O originated from the activated sludge processes. Based on this review the average of two highest EF values from activate sludge process was adopted; i.e. 0.6 % N_2O (Wicht et al., 1995) and 0.035 % (Czepiel et al., 1995), both reported in units of per cent N load in the influent wastewater.

In comparison, using the mass balance for the years where data on the N content in the final sludge are available, a per cent content of N_2O ranging from 0.4-0.7 % may be derived (Nielsen et al, 2010) which is high compared to a study by Chiu and Chung (2003) measured the distribution of N_2, N_2O and CO_2 under different NO_3^- and C/N ratios and found percent distribution of respectively 96-99 %, 0.001-0.006% and 1.1-3.8 %. One reason may be that Danish reported sludge amounts are based on a voluntary reporting scheme with varying reporting frequencies (cf. the chapter 8.3.4 and 8.3.6).

Activity data and EF for calculating the direct N_2O emission

At the in-country review in 2007, the ERT has recommended Denmark to derive a national N_2O emission factor in place of the methodological approach used in earlier NIRs. The former EF was derived from a factor of 3.2 g N_2O pr capita (Czepiel, 1995) multiplied by an average correction factor to account for the industrial influent load as described in Thomsen and Lyck, 2005.

The former EF value varied from 3.8 N_2O pr capita in 1990 increasing to around 11 g N_2O pr capita from 1997 and forward from which the contribution to the influent organic degradable matter from industries has been at a constant level.

This year's submission includes an attempt to derive a more accurate estimate of the emission factor based on Danish monitoring data on the total N content in the influent, effluent and final sludge. An in dept presentation of available activity data may be found in Nielsen et al., 2010.

For reasons of comparison the below presented best approach for deriving at a national EF are given in units of g N_2O pr capita in the last column.

Table 8.3.4 Total nitrogen content in the influent wastewater, estimated emissions and emission factors for the Danish municipal WWTPs, national level.

year	Total N, influent [tonnes]	Total N, effluent [tonnes]	Total N, finael sludge [tonnes]	Emission [Gg N_2O]	EF [g N_2O pr capita]
1990	14679	6249		0.07727	15
1991	15398	5735		0.08106	16
1992	14492	4471		0.07629	15
1993	15010	3480		0.07902	15
1994	18675	3887		0.07902	19
1995	22340	4293	7552	0.11760	23
1996	22580	3395	6901	0.11887	23
1997	23243	3289	6692	0.12236	23
1998	25329	3763	6572	0.13334	25
1999	24738	3517	6546	0.13023	25
2000	26952	3330	6817	0.14188	27
2001	27499	3633	6902	0.14476	27
2002	35187	4161	6327	0.18523	35
2003	28038	3037		0.14760	27
2004	24991	3073	2474	0.13156	24
2005	32288	2931	1945	0.16997	31
2006	25401	3040	1715	0.13372	25
2007	30899	3673	3015	0.16266	30
2008	42808	3142		0.22535	41

As may be observed from the implied EF values provided in the last column in Table 8.3.4, the methodology applied for deriving the Danish direct emissions of laughter gas from wastewater treatment processes have resulted in an increase in the former EF value of 11 g N_2O pr capita from 1997 and forward of, on average, a factor 2.5.

The national EF value may be expressed as 4.99 g N_2O pr kg N load in the influent wastewater reducing eq. 8.3.3 to:

$$E_{N_2O} = EF_{direct} \cdot m_{N,\inf luent} \qquad \text{Eq. 8.3.4}$$

The estimated emissions presented in Table 8.3.4 has been compared to a mass balance indicating the percent composition of N_2O of the total N emitted to be below 0.5%. The methodology adopted for estimating the direct N_2O emission only relies on the influent N load as activity data.

A presentation of a mass balance of the total nitrogen in the influent, effluent wastewater and the final sludge way be addressed in the report by Nielsen et al., 2010.

Methodology – Indirect emissions - from sewage effluents

For the indirect emissions, monitoring data on the effluent wastewater N load are available from the Danish Water Quality Parameter Database held by the Agency for Spatial and Environmental Planning (DEPA, 1994, 1995, 1996, 1998, 1999a, 2000, 2001a, 2002, 2003a, 2004a, 2005a, 2005b and ASEP, 2007, 2009, 2010). The formula used for calculating the emission from effluent WWTP discharges is:

$$E_{N_2O,WWTP,effluent} = D_{N,WWTP} \cdot EF_{N_2O,WWTP,effluent} \cdot \frac{M_{N_2O}}{2 \cdot M_N} \qquad \text{Eq. 8.3.5}$$

$D_{N.WWTP}$ is the effluent discharged sewage nitrogen load consisting of contributions from municipal wastewater treatment plants, the separate industry, effluent from mariculture and fish farming, rainwater conditioned effluents and scattered houses not connected to the sewerage system.

$EF_{N2O.WWTP.effluent}$ is the IPCC default emission factor of 0.01 kg N_2O-N pr kg sewage-N produced (IPCC (1997) GL, p 6.28)

M_{N2O} / M_{N2} is the mass ratio i.e. 44/28 to convert the fraction of discharged N emitted as laughter gas from units in mass of total N to emissions in mass N_2O.

Activity data used for calculation of the indirect N_2O emission

In Table 8.3.5 activity data refers to the effluent discharged sewage nitrogen load ($D_{N,\ WWTP}$,).

Table 8.3.5 Discharges* of nitrogen from point sources, tonnes.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Separate industrial discharges	n.r	n.r	n.r	2 574	2 737	2 471	1 729	1 800	1 428	863
Rainwater conditioned effluent	n.r	921	882	1 025	1 207	867	629	800	968	975
Scattered houses	n.r	n.r	n.r	1 280	1 210	1 141	1 143	1 123	997	972
Mariculture and fish farming	n.r	n.r	n.r	1 737	1 684	1 735	1 543	1 494	1 241	1 418
Municipal and private WWTPs	16 884	15 111	13 071	10 787	10 241	8 938	6 387	4 851	5 162	5 135
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
Separate industrial discharges	897	812	752	509	469	441	441	315	315	
Rainwater conditioned effluent	762	758	1 005	685	827	622	856	690	690	
Scattered houses	979	1 005	968	957	931	919	907	890	890	
Mariculture and fish farming	2 714	1 757	1 487	1 162	1 335	1 225	1 078	1031	1031	
Municipal and private WWTPs	4 653	4 221	4 528	3 614	4 027	3 825	3 623	3444	3142	

Data for 2007 are based on regression form the existing data set (personal communication: Karin Dahlgren Laursen, Agency for Spatial and Environmental Planning). Data form 2008 are taken from DEPA, 2009.

Overall time trends

The trends in the direct N_2O emission from WWTPs, the indirect emission from wastewater effluent and the total, as summarised in Table 8.3.2, are presented graphically in Figure 8.3.2.

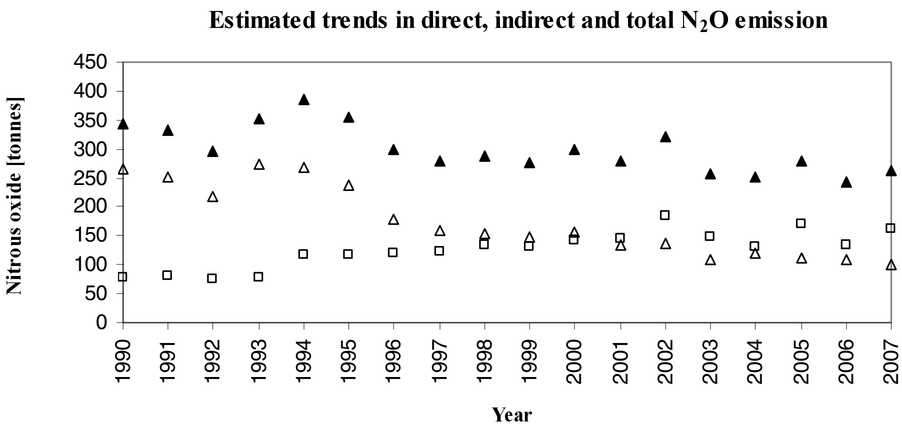

Figure 8.3.2 Time trends for direct emission of N_2O (open squares), indirect emission, i.e. from wastewater effluents (open triangles), and total N_2O emission (black triangles).

The decrease in the emission from effluent wastewater is due to the technical upgrade and centralisation of the Danish WWTPs following the adoption of the Action Plan on the Aquatic Environment in 1987. The increase in the direct N_2O emission are a result of an increase in influent TOW due to a gradually increase in the number of industries connected to the municipal sewage system; reaching a constant level from 1997-1999 and onwards according to the ASAP. The contribution from the direct emission is exceeding the contribution from N_2O emission from the effluent wastewater from 2001 and forward; the reason is the derivation of a national EF value for the direct emission which is on average a factor 2.5 higher compared to the EF used in formed submissions as described above and in Nielsen et al., 2010.

Varying amounts of inflowing rainwater, infiltration of groundwater, as well as exfiltration of wastewater (DEPA, 1994, 1995, 1996, 1998, 1999a, 2000, 2001a, 2002, 2003a, 2004a, 2005a, 2005b; ASEP, 2007, 2009, 2010; Vollertsen et al, 2002), may contribute to the "noise" or fluctuation in the time trend of the calculated indirect N_2O emission.

8.3.3 Uncertainties and time-series consistency

Uncertainty

Two set of uncertainty estimates are made for the Danish emission inventory for greenhouse gases based on Tier 1 and Tier 2 methodology, respectively. The uncertainty models follow the methodology in IPCC Good Practise Guidance (IPCC, 2000). Tier 1 is based on the simplified uncertainty analysis and Tier 2 is based on Monte Carlo simulations.

The parameters considered in the uncertainty analyses and the estimated uncertainties of the parameters are shown in Table 8.3.6. For all uncertainties, symmetric values based on maximum numeric value are estimated.

Table 8.3.6 Uncertainties for main parameters of emissions for wastewater handling, average uncertainty 1990-2008.

Parameter	Uncertainty, Tier 1	Uncertainty, Tier 2	Reference/Note	Emission type
TOW	33	17	Tier 2, average uncertainty, 1990-2008	CH_4 emission
Maximum methane producing Capacity (Bo)	30	15	Tier 1, Default IPCC value (GPG, Table 5.3, p 5.19)	
Fraction treated anaerobically, i.e. the methane conversion factor (MCF)	73	37	Tier 2, average uncertainty, 1990-2008	
EF(CH_4)	78	40	Tier 1, SQRT (30^2+73^2)	
Influent wastewater N	37	19	Tier 2, average uncertainty, 1990-2008	Direct N_2O emission
EFN_2O,direct	98	50	Tier 2 estimate	
$D_{N.WWTP}$ is the effluent discharged sewage nitrogen load	59	30	Tier 2, average uncertainty, 1990-2008	Indirect N_2O emission
$EF_{N2O.WWTP.effluent}$ is the IPCC default emission factor of 0.01 kg N_2O-N pr kg sewage-N produced	39	20	Tier 2 estimate	

Default IPCC values are assumed to be given at 95 % confidence level. Where available data allows for the estimation of standard deviation on existing data sources, these have been used to derive a Tier 1 estimate according to equation 8.3.6.

The input parameter uncertainties given in Table 8.3.7 are based on simple derived standard deviation on existing data sources where possible. Tier 2 uncertainty model is based on Monte Carlo simulations and input uncertainty of one standard deviation, corresponding to the 68 % confidence interval assuming a log-normal distribution

Table 8.3.7 Uncertainties for main parameters of emissions for wastewater handling for, respectively, 1990 and 2008.

Parameter	Uncertainty, 1990	Uncertainty, 2008
TOW	17	17
Maximum methane producing Capacity (Bo)	15	15
Fraction treated anaerobically, i.e. the methane conversion factor (MCF)	37	37
EF(CH_4)	40	40
Influent wastewater N	51	7
EFN_2O,direct	50	50
$D_{N.WWTP}$ is the effluent discharged sewage nitrogen load	51	7
$EF_{N2O.WWTP.effluent}$ is the IPCC default emission factor of 0.01 kg N_2O-N pr kg sewage-N produced	20	20

Recalculations between Tier 1 and 2 have been performed according to equation 8.3.6:

$$U_{68/Tier1} = U_{95/Tier2} / 1.96 \qquad \text{Eq. 8.3.6}$$

Results

The results of Tier 1 uncertainty model for 2008 are presented in Table 8.3.8. The contribution to the total emission uncertainty is observed for the direct N_2O emission followed by the methane and indirect N_2O emission. Regarding the time trend, the largest uncertainty is observed for the direct N_2O which also shows the largest increasing trend. When looking at the total trend, the large increasing trend for the direct N_2O emissions is levelled out by a similar decreasing trend for indirect N_2O emission. The total emission form wastewater handling in 2008 is 147 Gg CO_2.eqv, the uncertainty 42 %. The trend for the total emission is 7 % and the trend uncertainty $\pm$38 %.

Table 8.3.8 Uncertainty estimates for total emissions in 2008 and emission trends from the Tier 1 uncertainty model.

	Emission [Gg CO_2-eqv]	Uncertainty, %	Trend, %	Uncertainty, %
		Lower and upper (±)		Lower and upper (±)
CH_4	47	90	56	68
$N_20_{, indirect}$	29	71	-64	21
$N_2O_{, direct}$	70	105	192	108
GHG	147	42	7	38

Table 8.3.9 Uncertainty estimates for total emissions in 1990 and 2008 and for the emission trends from the Tier 2 uncertainty model.

	1990			2008			1990-2008		
	Median emission, [Gg CO_2-eqv]	Uncertainty %		Median emission, [Gg CO_2-eqv]	Uncertainty %		Median trend %	Uncertainty %	
		Lower (-)	Upper (+)		Lower (-)	Upper (+)		Lower (-)	Upper (+)
$N_2O_{,\ total}$	110	51	111	106	40	84	-4	2420	3630
CH_4	30	51	108	47	51	108	56	50	51
GHG	145	43	86	157	35	62	9	95	100

The Tier 1 and Tier 2 emission uncertainty estimates are in the same range for the median emission values, whereas the trend uncertainty at Tier 2 level for the sum GHG is higher. This is due to the input uncertainty values for laughter gas at Tier 2 level, influencing the trend uncertainty the most. The N_2O uncertainties on the trend in the tier 2 uncertainty analysis may only be seen as an indicator for a large number of uncertainties while the values are less accurate.

Time-series consistency and completeness

Registration of the activity data needed for the calculation of nitrous oxide emission from the effluent water has been registered as a measure of the effectiveness (distance to target) of the Action Plan on the Aquatic Environment since 1987, whereas the sludge data base are based on voluntary reporting.

Consistency and completeness have been improved by access to the Danish Water Quality Parameter Database (www.miljoeportalen.dkk) and the Danish Sludge Database held by DEPA. A first evaluation and quality assessment of the existing sludge data are presently in Nielsen et al, 2010. A second stage data gap filling and harmonisation of plant-specific data between different data sources will be performed and expected to improve the accuracy of the activity data used for calculating both methane and laughter gas emissions.

At this point, data regarding industrial on-site wastewater treatment processes is not available at a level that allows for calculation of the on-site industrial contribution to CH_4 or N_2O emissions. The degree to which industry is covered by the estimated emission is, therefore, dependent on the amount of industrial wastewater connected to the municipal sewer system. Any direct emissions from pre-treatment on-site are not covered in this inventory.

8.3.4 QA/QC and verification

QA/QC-procedure

The methodology for estimating emissions from wastewater handling was introduced for the first time in the inventory submission in March-April 2005. Data in this methodology has been updated and revised were possible for the current submission involving activity data for 2004-2007 as presented in the preceding sections. As the activity data has been improved, there has been introduced smaller changed in the methodology in the 2006 submission and 2008 submission. These smaller changes will be documented together with the improved data quality as mentioned in the above section in the future.

In general terms, for this part of the inventory, the Data Storage (DS) Level 1 and 2 and the Data Processing (DP) Level 1 can be described as follows:

Data Storage Level 1

The external data level refers to the placement of input data used for deriving yearly activity and emission factors; references in terms of report and databases used for deriving input for the emission calculations. Reports and a list of links to external data sources are stored in a common data storage system including all sectors of the yearly NIRs.

Table 8.3.10 Overview of yearly stored external data sources at DS level1.

http, file or folder name	Description	AD or EF	Reference	Contact(s)	Data agreement/ comment
NERI data-exchange folder I:\ROSPROJ\LUFT-_EMI\Inventory\waste sector\ 6 B. Wastewater Handling\NIR2008\DS1*	Inventory data storage system	AD and EF	NERI	Marianne Thomsen (mth@dmu.dk	
Report series may be found at: www.mst.dk	Reported sludge and water quality parameters	AD	Report series from DEPA: "*Wastewater from municipal and private wastewater treatment plants*" and "*Point sources*".	Karin Dahlgren (kdl@blst.dk) And Marianne Thomsen (mth@dmu.dk)	Public available reports
Danish Water Quality parameter Database	Yearly reported wastewater characteristics at plant level	AD	www.miljoeportalen.dk	Marianne Thomsen (mth@dmu.dk)	Authorised access
Danish Sludge Database	Yearly reported sludge characteristics at plant level	AD	DEPA	Linda Bagge (Baggemst.dk) Marianne Thomsen (mth@dmu.dk)	none
http://www.statistikbanken.dk/FU5	Population statistics	AD	Statistics Denmark	Marianne Thomsen (mth@dmu.dk)	Public access
http://danva.dk	Medium and small WWTP influent data used for calculating a correction factor accounting for the industrial contribution to wastewater characteristics	EF	The Danish water and wastewater institution	Marianne Thomsen (mth@dmu.dk)	Access by membership

*The data storage level 1 consists of DEPA reports and other sources listed in the Table.

Data Processing Level 1

This level, for wastewater handling, comprises a stage where the external data are treated internally, preparing for the input to the country-specific models. Programming as to automatically calculations based on activity data and emission factors are not yet fully operational. Calculations are carried out and the output stored in a not editable format each year. The DP at level 1 has been improved to fit into a more uniform and easily accessible data reporting format. Regarding the derivation of activity data and emission factors used in the model calculations, this years improvements are documented in Nielsen et al, 2010.

Data Storage Level 2

Data Storage Level 2 is the placement of selected output data from the country-specific models as inventory data on SNAP levels in the Access (CollectER) database.

Points of measurement

The present stage of QA/QC for the Danish emission inventories for wastewater handling is described below for DS and DP level 1 Points of Measurement (PMs). This is to be seen in connection with the general QA/QC description in Section 1.6 and, especially, 1.6.10 on specific description of PMs common to all sectors, general to QA/QC.

Data Storage level 1	1. Accuracy	DS.1.1.1	General level of uncertainty for every dataset including the reasoning for the specific values

This year a tier 2 uncertainty calculation has been performed. Improved access to databases has improved the estimations of uncertainty in input data as presented in Nielsen et al., 2010. With regard to emission factor for the direct emission of laughter gas, the uncertainty is still high due to missing monitoring data on this aspect.

Data Storage Level 1	1. Accuracy	DS.1.1.2	Quantification of the uncertainty level of every gle data value including the reasoning for the cific values.

Uncertainties on defaults numbers are taken from the IPCC GL and GPG. Uncertainty of activity data are based on simple standard deviations accompanying the yearly reported monitoring data. Documentation of specific uncertainty values are provided in Nielsen et al., 2010.

Data Storage level 1	2.Comparability	DS.1.2.1	Comparability of the data values with similar data from other countries, which are comparable with Denmark, and evaluation of discrepancy.

Comparison of Danish data values with data sources from other countries has been carried out in order to evaluate discrepancies as presented in the national verification report by Fauser et al., 2006 and the methodology report by Thomsen & Lyck, 2005 and Nielsen et al, 2010.

Data Storage level 1	3.Completeness	DS.1.3.1	Documentation showing that all possible national data sources are included by setting down the reasoning behind the selection of datasets.

Methodology, reasoning and relevance of data sources used as input at DS level 1 have been improved by access to the Danish Water Quality Parameter Database and held by the Agency for Spatial and Environmental Planning (ASEP) and the Danish Sludge Database held by the DEPA. Activity covers the whole time series.

Direct nitrous emissions from separate industries, methane emission from industrial WWT and separate biogas production including industrial sludge are not included in the inventory.

Data Storage level 1	4.Consistency	DS.1.4.1	The origin of external data has to be preserved whenever possible without explicit arguments (referring to other PMs).

The origin of external activity data has increase due to increase in the completeness by access to databases DS 1.3.1. Files are saved for each year of reporting in a non editable format. In this way changes to previously received data and calculations is reflected and explanations are given.

Data Storage level 1	6.Robustness	DS.1.6.1	Explicit agreements between the external institution holding the data and NERI about the conditions of delivery.

This point may still be critical due to the missing timing full reporting and completeness of the databases held by the ASEP and DEPA respectively with respect to the submission date of the yearly NIR.

Data Storage level 1	7.Transparency	DS.1.7.1	Summary of each dataset including the reasoning for selecting the specific dataset

A summary of the data set can be seen in section 8.3.1 and 8.3.2. For the reasoning behind the selection of the specific dataset, refer to methodology report by Nielsen et al, 2010.

Data Storage level 1	7.Transparency	DS.1.7.3	References for citation for any external dataset have to be available for any single value in any dataset.

These references exist in the description given in the Section 8.3, under methodological issues. In addition, they are directly accessible from the reports given in the list of references including link to internet accessible formats and stored every year in the given data exchange folder at NERI (cf. Table 8.3.10).

Data Storage level 1	7.Transparency	DS.1.7.4	Listing of external contacts for every dataset

Contact persons related to the delivery of data related to wastewater and sewage sludge is, respectively, Karin Dahlgren from the ASEP and Environmental Planning and Linda Bagge from DEPA.

Data Processing level 1	1. Accuracy	DP.1.1.1	Uncertainty assessment for every data source as input to Data Storage level 2 in relation to type of variability. (Distribution as: normal, log normal or other type of variability)

Tier 1 uncertainty calculations are made. The use of the Tier 1 methodology presumes a normal distribution of activity data and emission factor variability. Uncertainties are reported in section 8.3.3.

Data Processing level 1	1. Accuracy	DP.1.1.2	Uncertainty assessment for every data source as input to Data Storage level 2 in relation to scale of variability (size of variation intervals)

The uncertainty assessment has been given in Section 8.3.3.

Data Processing level 1	1. Accuracy	DP.1.1.3	Evaluation of the methodological approach using international guidelines

An evaluation of the methodological approach, in comparison with the check and default IPCC methodology and is presented in Thomsen & Lyck, 2005. Improvements introduced this year are documented in Nielsen et al., 2010.

Data Processing level 1	1. Accuracy	DP.1.1.4	Verification of calculation results using guideline values

This has been performed in Thomsen & Lyck, 2005 and in the NIR 2006 submission. For this year improvements further verification are documented in Nielsen et al., 2010.

Data Processing level 1	2.Comparability	DP.1.2.1	The inventory calculation has to follow the international guidelines suggested by the UNFCCC and IPCC.

The calculations follow the IPCC GL and GPG. Exemptions have been documented when ever occurring.

Data Processing level 1	3.Completeness	DP.1.3.1	Assessment of the most important quantitative knowledge which is lacking.

- Sludge from industries treated within the separate industries and private biogas plants are missing in the inventory
- Full mass balance of sludge amounts and between stabilisation and final disposal categories.
- Quality assurance and harmonisation of plant identification and plant-specific data included in the Energy statistics, Sludge Database and wastewater quality parameter Database.
- Data gap-filling if needed by contacting missing plants and including missing plant data.
- Knowledge of treatment processes at the individual plants
- Knowledge on the fractional composition of N_2, NO, N_2O in gas emitted from active sludge treatment processes.
- Quantitative knowledge on the characteristics of industrial versus domestic influent organic carbon.
- Data on fugitive emissions from the sewerage system and septic tanks may be found by a survey in national reports published by e.g. DANVA.

Data Processing level 1	3.Completeness	DP.1.3.2	Assessment of the most important cases where access is lacking with regard to critical data sources that could improve quantitative knowledge.

Information on methane emissions for separate industries may be of importance. In addition changes in final disposal categories and related methane potentials recovered or not emitted.

Data Processing level 1	4.Consistency	DP.1.4.1	In order to keep consistency at a high level, an explicit description of the activities needs to accompany any change in the calculation procedure.

Full times series has been obtained lately this year by better access to data reported at plant level. As far as possible, the calculation procedures are kept consistent for the calculation of the time-series. However, major changes have occurred in the amounts of methane recovered and recalculations fro the whole time series has been performed as documented in this NIR and in Nielsen et al., 2010.

Data Processing level 1	5.Correctness	DP.1.5.1	Show at least once, by independent calculation, the correctness of every data manipulation.

The model has been checked by comparison with the IPCC default methodologies as presented in Thomsen & Lyck, 2005. Changes in methodology due to improved data availability in this years submission documented in Nielsen et al.,2010.

Data Processing level 1	5.Correctness	DP.1.5.2	Verification of calculation results using time-series

The time-series of activities and emissions in the model output, in the SNAP source categories and in the CRF format have been prepared. The time-series are examined and significant changes are checked and explained.

Data Processing level 1	5.Correctness	DP.1.5.3	Verification of calculation results using other measures

The correct interpretation in the model of the methodology and the parameterisation has been checked as far as possible, refer DP.1.5.1.

Data Processing level 1	5.Correctness	DP.1.5.4	Shows one-to-one correctness between external data sources and the databases at Data Storage level 2

Data transfer control is made from the external data sources and to the SNAP source categories at level 2. This control is carried on further to the aggregated CRF source categories.

Data Processing level 1	7.Transparency	DP.1.7.1	The calculation principle and equations used must be described

The calculation principle and equations are described in Section 8.3.2 and 8.3.3 and in Nielsen et al., 2010.

Data Processing level 1	7.Transparency	DP.1.7.2	The theoretical reasoning for all methods must be described

The theoretical reasoning is described in Section 8.4.3 and in Thomsen & Lyck, 2005 and lastly Nielsen et al.,2010.

Data Processing level 1	7.Transparency	DP.1.7.3	Explicit listing of assumptions behind all methods

The assumption is that the emissions can be described according to the applied methodology and models as these are developed in accordance to the IPCC GL and GPG for wastewater handling.

Data Processing level 1	7.Transparency	DP.1.7.4	Clear reference to dataset at Data Storage level 1

Refer to the Table 8.3.10 and DS.1.1.1 above.

Data Processing level 1	7.Transparency	DP.1.7.5	A manual log to collect information about recalculations

Recalculation changes in the emission inventories are described in the NIR. The logging of the changes takes place in the yearly model file.

Data Storage level 2	5.Correctness	DS.2.5.1	Documentation of a correct connection between all data types at level 2 to data at level 1

The full documentation for the correct connection exists through the yearly model file, its output and report files made by the CollectER database system.

Data Storage level 2	5.Correctness	DS.2.5.2	Check if a correct data import to level 2 has been made

This check is performed, comparing model output and report files made by the CollectER database system, refer to DS.2.5.1.

8.3.5 Recalculations

The emissions from wastewater handling were until the 2005 submission reported as zero. Major changes have occurred in the available activity data. The amount of recovered methane has been documented and verified and an adjusted approach for deriving the net emission, corresponding to the fugitive emissions, from WWTPs has been implemented. Recalculation for the whole time-series is presented in Table 8.3.11.

Table 8.3.11 Percent changes in the net methane emission from waste water handling as result of recalculation for the whole time series performed in this year's submission.

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
CH_4,net (Gg), 2010 submission	1.45	1.45	1.45	1.49	1.62	1.75	1.88	2.01	2.14	2.10
CH_4,net (Gg), 2009 submission	5.98	5.84	5.78	6.07	7.24	8.43	9.62	11.81	12.03	11.28
Percent change	-76	-75	-75	-75	-78	-79	-80	-83	-82	-81
Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	
CH_4,net (Gg), 2010 submission	2.12	2.17	2.34	2.40	2.30	2.25	2.20	2.25	2.25	
CH_4,net (Gg), 2009 submission	10.34	11.02	14.78	14.30	13.08	12.45	11.82	12.20		
Percent change	-79	-80	-84	-83	-82	-82	-81	-82		

The significant reduction in the methane emission from wastewater treatment is a result improved documentation of the biogas production, and i.e. methane recovery, in Denmark obtained by access to the Danish Sludge Database.

As recommended by the ERT, a first attempt for the derivation of a national N_2O emission factor has been performed. A mass balance for the total N flow within the Danish WWTPs are presented in Nielsen et al., 2010 and the methodological aspects are presented in chapter 8.3.3. The derived emission factor influences the whole time series as presented in Table 8.3.12.

Table 8.3.12 Percent changes in the direct N_2O emission from waste water handling as result of recalculation for the whole time series performed in this year's submission

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
N_2O, direct, submission 2010	77	81	76	79	118	118	119	122	133	130
N_2O, direct, submission 2009	17	17	17	19	28	35	43	51	55	56
Percent change	361	383	354	315	319	231	176	140	143	133
Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2008
N_2O, direct, submission 2010	142	145	185	148	132	170	134	163	225	
N_2O, direct, submission 2009	54	47	49	52	51	51	53	53		
Percent change	165	207	276	186	157	231	154	208		

8.3.6 Planned improvements

Suggested QA/QC plan for wastewater handling

As described in chapter 8.3.4 and in Nielsen et al., 2010.

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8.4 Waste Incineration (CRF Source Category 6C)

The CRF source category *6.C. Waste Incineration,* includes cremation of human bodies, cremation of animal carcasses and accidental fires of buildings and vehicles.

Incineration of municipal, industrial and clinical waste takes place with energy recovery, therefore the emissions are included in the relevant subsectors under CRF sector 1A. For documentation please refer to chapter 3.2. Flaring off-shore and in refineries are included under CRF sector 1B2c, for documentation please refer to chapter 3.5. No flaring in chemical industry occurs in Denmark.

Table 8.4.1 gives an overview of the Danish greenhouse gas emission from the CRF source category 6.C waste incineration.

CO_2 emissions from cremations of human bodies and animal carcasses are considered to be biogenic. Because of the high contents of wood in building structures, 81 % of all CO_2-eqv. GHG emissions from accidental building fires are biogenic CO_2 emissions.

While emissions from human cremations have been steady over the last two decades, emissions from animal cremation have increased. In 1990, incineration of animal carcasses stood for 5 % of the total emission of CO_2-eqv. from cremations. In 2008 this number has increased to 33 %. Non-biogenic GHG emissions from cremations are miniscule.

Even when biogenic GHG emissions are not considered, accidental building fires contribute to 63-73 % of all emissions from source category 6C. Non-biogenic emissions from cremation are only 3-4 % and the remaining stems from accidental vehicle fires.

Table 8.4.1 Overall emission of greenhouse gases from cremations and accidental fires.

		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
CO_2 emission from											
Human cremation	Gg	2.05	2.04	2.07	2.16	2.14	2.19	2.17	2.15	2.09	2.12
Animal cremation	Gg	0.12	0.12	0.13	0.14	0.15	0.15	0.16	0.17	0.18	0.28
Accidental building fires	Gg	87.31	90.20	98.07	86.17	86.76	100.22	101.31	93.52	83.69	89.94
- of which non-biogenic	Gg	14.69	15.17	16.50	14.49	14.59	16.86	17.04	15.73	14.08	15.13
Accidental vehicle fires	Gg	6.32	6.32	6.43	6.70	6.91	7.49	7.78	7.96	8.21	8.42
Total biogenic	Gg	74.79	77.19	83.78	73.98	74.45	85.71	86.60	80.11	71.88	77.21
Total non-biogenic	Gg	21.01	21.50	22.92	21.19	21.51	24.35	24.82	23.69	22.28	23.54
CH_4 emission from											
Human cremation	Mg	0.48	0.48	0.49	0.51	0.50	0.52	0.51	0.50	0.49	0.50
Animal cremation	Mg	0.03	0.03	0.03	0.03	0.03	0.04	0.04	0.04	0.04	0.07
Accidental building fires	Mg	112.51	116.24	126.39	111.05	111.81	129.16	130.56	120.52	107.86	115.91
Accidental vehicle fires	Mg	13.17	13.18	13.39	13.95	14.41	15.61	16.20	16.58	17.10	17.54
Total	Mg	126.19	129.93	140.29	125.54	126.75	145.32	147.31	137.64	125.49	134.00
N_2O emission from											
Human cremation	Mg	0.60	0.60	0.61	0.63	0.63	0.64	0.64	0.63	0.61	0.62
Animal cremation	Mg	0.03	0.04	0.04	0.04	0.04	0.05	0.05	0.05	0.05	0.08
Accidental building fires	Mg	NAV	NAV	NAV	NAV	NAV	NAV	NAV	NAV	NAV	NAV
Accidental vehicle fires	Mg	NAV	NAV	NAV	NAV	NAV	NAV	NAV	NAV	NAV	NAV
Total	Mg	0.64	0.63	0.65	0.68	0.67	0.69	0.68	0.68	0.67	0.71
6C. Waste incineration											
Non-biogenic CO_2-eqvivalents	Gg	23.85	24.42	26.07	24.04	24.38	27.62	28.12	26.79	25.13	26.58
Continued		2000	2001	2002	2003	2004	2005	2006	2007	2008	
CO_2 emission from											
Human cremation	Gg	2.08	2.09	2.13	2.10	2.08	2.04	2.06	2.09	2.09	
Animal cremation	Gg	0.34	0.35	0.35	0.36	0.44	0.59	0.86	0.99	1.03	
Accidental building fires	Gg	88.07	86.64	83.91	94.58	81.68	84.88	92.79	105.32	103.99	
- of which non-biogenic	Gg	14.81	14.57	14.11	15.91	13.74	14.28	15.62	17.64	17.55	
Accidental vehicle fires	Gg	8.53	8.53	8.48	8.45	8.48	8.74	9.17	8.44	10.95	
Total biogenic	Gg	75.69	74.50	72.27	81.13	70.46	73.23	80.10	90.76	89.56	
Total non-biogenic	Gg	23.34	23.10	22.59	24.36	22.22	23.01	24.79	26.08	28.50	
CH_4 emission from											
Human cremation	Mg	0.49	0.49	0.50	0.49	0.49	0.48	0.48	0.49	0.49	
Animal cremation	Mg	0.08	0.08	0.08	0.08	0.10	0.14	0.20	0.23	0.24	
Accidental building fires	Mg	113.50	111.65	108.13	121.89	105.26	109.38	119.70	135.29	134.32	
Accidental vehicle fires	Mg	17.77	17.77	17.67	17.60	17.67	18.20	19.11	17.58	22.81	
Total	Mg	131.84	129.99	126.38	140.06	123.52	128.20	139.50	153.60	157.86	
N_2O emission from											
Human cremation	Mg	0.61	0.61	0.63	0.62	0.61	0.60	0.61	0.61	0.61	
Animal cremation	Mg	0.10	0.10	0.10	0.10	0.13	0.17	0.25	0.29	0.30	
Accidental building fires	Mg	NAV	NAV	NAV	NAV	NAV	NAV	NAV	NAV	NAV	
Accidental vehicle fires	Mg	NAV	NAV	NAV	NAV	NAV	NAV	NAV	NAV	NAV	
Total	Mg	0.71	0.72	0.73	0.72	0.74	0.77	0.86	0.90	0.92	
6C. Waste incineration											
Non-biogenic CO_2-eqvivalents	Gg	26.33	26.05	25.47	27.52	25.04	25.94	27.99	29.59	32.10	

8.4.1 Human cremation

The incineration of human bodies is a common practice that is performed on an increasing part of the yearly deceased. All Danish incineration facilities use optimised and controlled combustions, with temperatures reaching 800-850 °C, secondary combustion chambers, controlled combustion air flow and regulations for coffin materials.

However, the emissions caused by cremations can still contribute to a considerable part of the total national emissions. Emissions are calculated for greenhouse gases CO_2 (biogenic), CH_4 and N_2O.

Methodological issues

There are 31 crematoria in Denmark, some with multiple furnaces, 21 facilities are run by the church and 10 by the local authorities (DKL 2009, KM 2006).

During the 1990es all Danish crematoria were rebuilt to meet new standards. This included installation of secondary combustion chambers and in most cases, replacement of old primary incineration chambers (Schleicher et al. 2001). All Danish cremation facilities are therefore performing controlled incinerations with a good burn-out of the gases, and a low production of pollutants. But only a very few crematoria are equipped with flue gas cleaning (bag filters with activated carbon).

Following the development of new technology, the emission limits for crematoria are lowered again in 1/2011. These new standard terms were originally expected from 1/2009 but have been postponed two years for existing crematoria. Table 8.4.2 shows a comparison of the emission limits from 2/1993 and the new standard limits.

Table 8.4.2 Emission limit values mg pr normal m^3 at 11 % O_2 (Schleicher & Gram 2008).

Component	Report 2/1993	Standard terms (1/2011)
	Emission limit value mg pr normal m^3 at 11 % O_2	
CO_2	500	500
Other demands:		
Stack height	3 m above rooftop	3 m above rooftop
Temperature in stack	Minimum 150 °C	Minimum 110 °C
Flue gas flow in stack	8 – 20 m/s	No demands
Temperature in after burner	850 °C	800 °C
Residence time in after burner	2 seconds	2 seconds

Activity data

Table 8.4.3 shows the time-series of total number of nationally deceased persons, number of cremations and of the fraction of cremated corpses from the total number of deceased. Data for the total number of nationally deceased persons is collected from Statistics Denmark (2009). Data describing the number of cremations and the cremation fraction is gathered from the Association of Danish Crematoria (DKL 2009).

Table 8.4.3 Data human cremations (DKL 2009).

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Nationally deceased	60 926	59 581	60 821	62 809	61 099	63 127	61 043	59 898	58 453	59 179
Cremations	40 991	40 666	41 455	43 194	42 762	43 847	43 262	42 891	41 660	42 299
Cremation fraction, %	67.3	68.3	68.2	68.8	70.0	69.5	70.8	71.6	69.1	74.4

Continued

	2000	2001	2002	2003	2004	2005	2006	2007	2008
Nationally deceased	57 998	58 355	58 610	57 574	55 806	54 962	55 477	55 604	54 591
Cremations	41 651	41 707	42 539	41 997	41 555	40 758	41 233	41 766	41 788
Cremation fraction, %	71.8	71.5	72.6	72.9	74.5	74.2	74.3	75.1	76.6

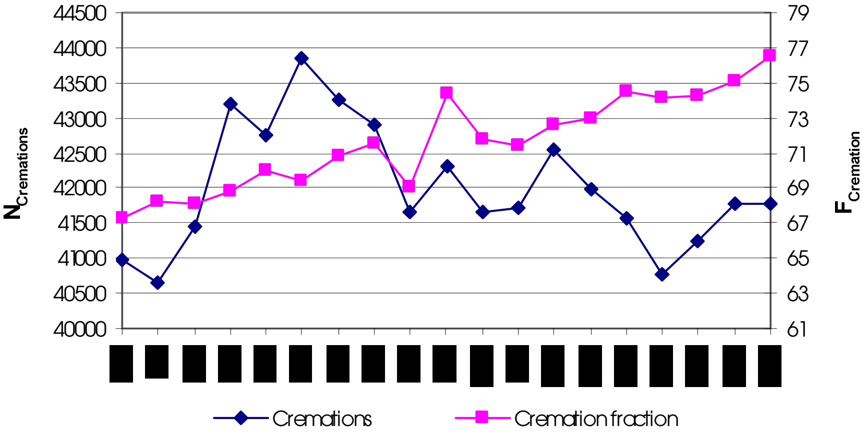

Figure 8.4.1 Time series of cremations (DKL 2009), where the number of cremations, $N_{cremations}$, is shown at the left Y-axis. The cremation percentage, $F_{cremations}$, shows the percent of cremation deceased of the total deceased from the year 1990 to 2008.

Even though the total number of yearly cremations is fluctuating, the cremation percentage has been increasing since 1990, and is likely to continue to increase.

Emission factors

For crematoria, emissions are calculated by multiplying the total number of cremations by the emission factors. Since there are no measurements available of the yearly emission from Danish crematoria, the estimation of emissions is based on emission factors from literature. The estimation is based on the measurements performed in countries that are comparable with Denmark. By comparable is meant countries that use similar incineration processes, similar cremation techniques including support fuel and have a similar composition of sources to lifetime exposure, lifetimes and coffins.

A literature search has provided emission factors for CO_2, CH_4 and N_2O from the two sources Fontelle et al. and Aasestad. It has not been possible to find any additional data to validate the emission factors.

Concerning the burning of animal carcasses in animal crematoria there is not much literature to be found. NAEI (2007) provides emission factors with the unit kt, but since no explanation is provided as to that amount this emission factor is valid for, the database is not of any use as a source.

Emission factors for CO_2, CH_4 and N_2O are collected from the literature search on human cremation, and it is assumed that humans and animals are similar in composition for this purpose. Emission factors from human cremation are recalculated to match the activity data for animal cremation, emission pr Mg.

Table 8.4.4 lists the emission factors and their respective references.

Table 8.4.4 Emission factors for human and animal cremation with references.

	Human cremation		Animal cremation		
Pollutant name	Unit	Emission factor	Unit	Emission factor	Reference
CO_2, biogenic	kg pr body	50.1	kg pr Mg	770	Fontelle et al.
CH_4	g pr body	11.8	g pr Mg	182	Aasestad
N_2O	g pr body	14.7	g pr Mg	226	Aasestad

8.4.2 Animal cremation

The burning of animal carcasses in animal crematoria follows much the same procedure as human cremation. Animal cremation facilities use similar two chambered furnaces and controlled combustion. However animals are burned in special designed plastic (PE) bags rather than coffins.

Emission from animal cremation is also similar to that of human cremation.

Animal cremations are performed in two ways, individually where the owner often pays for receiving the ashes in an urn or collectively which is most often the case with animal carcasses that are left at the veterinarian.

Methodological issues

Open burning of animal carcasses is illegal in Denmark and is not occurring, and small-scale incinerators are not known to be used at Danish farms. Livestock that is diseased or in other ways unfit for consumption is disposed of through rendering plants, incineration of livestock carcasses is illegal and these carcasses are therefore commonly used in the production of fat and soap at Daka Bio-industries.

The only animal carcasses that are approved for cremation in Denmark are deceased pets and animals used for experimental purposes, where the burning must take place at a specialised animal crematorium. There are four animal crematoria in Denmark but one of these is situated at a waste incineration company in northern Vendsyssel called AVV. The special designed cremation furnaces are at this location connected to the flue gas cleaning equipment of the waste incineration plant and the emission from the cremations are included in the yearly inventory from AVV and consequently included under waste incineration in this report. Therefore only three animal crematoria are discussed in this section.

Animal by-products are considered waste, and emission from animal crematoria must therefore comply with the EU requirements for waste incineration. The EU directive (2000/76/EF) on waste incineration has been transferred into Danish law (Statutory order nr.162[16]).

The incineration of animal carcasses is, as the incineration of human corpses, performed in special furnaces. All furnaces at Danish pet crema-

[16] Bekendtgørelse nr. 162 af 11. marts 2003 om anlæg der forbrænder affald.

toria have primary incineration chambers with temperatures around 850 ºC and secondary combustion chambers with temperatures around 1100 ºC. The fuel used at the Danish facilities is natural gas.

Emissions from pet cremations are calculated for CO_2 (biogenic), CH_4 and N_2O. Emissions are estimated by using the same emission factors as for human cremation.

Activity data for the amount of animal carcasses incinerated are gathered directly from the pet crematoria. There is no national statistics available on the activity of animal crematoria. The precision of activity data therefore depends on the information provided by the crematoria.

Table 8.4.5 lists the four Danish crematoria, their foundation year and provides each crematorium with an id letter.

Table 8.4.5 Animal crematoria I Denmark.

Id	Name of crematorium	Founded in
A	Dansk Dyrekremering ApS	May 2006
B	Ada's Kæledyrskrematorium ApS	Unknown, existed in more than 25 years
C	Kæledyrskrematoriet	2006
D	Kæledyrskrematoriet v. Modtage-station Vendsyssel I/S	-

Crematoria D is situated at the AVV waste incineration site and the emission from this site is, as previously mentioned, included in the yearly inventory from AVV and consequently included under waste incineration in this report. From here on only crematoria A-C are considered.

Table 8.4.6 lists the activity data for crematoria A, B, C and the total national cremated amount for the years 1990-2008.

Table 8.4.6 Activity data. Source: direct contact with all Danish crematoria.

Year	Amount cremated at crematorium A, Mg	Amount cremated at crematorium B, Mg	Amount cremated at crematorium C, Mg	Amount cremated nationally, Mg
1990	-	150	-	150
1991	-	160	-	160
1992	-	170	-	170
1993	-	180	-	180
1994	-	190	-	190
1995	-	200	-	200
1996	-	210	-	210
1997	-	220	-	220
1998	-	235	-	235
1999	-	368	-	368
2000	-	443	-	443
2001	-	452	-	452
2002	-	451	-	451
2003	-	462	-	462
2004	-	571	-	571
2005	-	762	-	762
2006	300	798	18	1 116
2007	450	802	32	1 284
2008	450	848	40	1 338

Crematorium A delivered activity data for 2008 as the interval 400-500 Mg, the exact value is assumed to be the average of this interval and the rate is assumed to be constant back to the year 2006. The activity data for Crematoria A in 2006 is rated according to the founding of the site in May of 2006.

Crematorium B delivered exact yearly activity data for the years 1998-2008. They were not certain about the founding year but have existed for more than 25 years. The estimated activity data for 1990-1997 are shown as the thick line in Figure 8.4.2 and added a trendline and the equation of the trendline.

It is not possible to extrapolate data back to 1990 because the activity, due to the steep trendline, in this case would become negative from 1993 and back in time.

Statistic data describing the national consumption for pets including food and equipment for pets was evaluated as surrogate data. These statistic data show an increase of consumption of 6 % from 1998 to 2000, in the same period the national amount of cremated animal carcasses increased with 89 % and no correlation seems to be present. Since there are no other available data on the subject of pets, it is concluded that there are no surrogate data available. The activity data for the period of 1990-1997 are estimated by en expert judgement. The estimated data are shown in Table 8.4.6 and the following Figure 8.4.2.

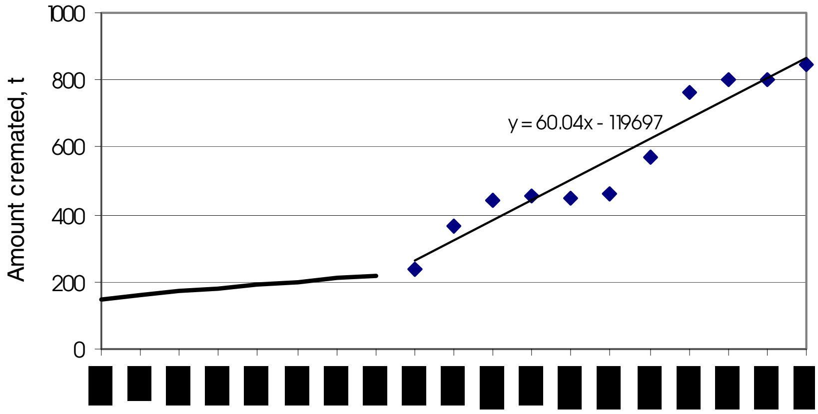

Figure 8.4.2 The amount of cremated carcasses in Mg at crematorium B, the oldest and largest crematorium in Denmark. Data from 1998-2008 are delivered by the crematorium and is considered to be exact, these data are marked as points. Data from 1990-1997 are estimated and are shown as the thick line in the figure.

8.4.3 Accidental fires

Accidental fires cover fires in vehicles, buildings and landfill fires. Emissions from accidental fires are calculated for CO_2, CH_4 and N_2O.

Methodological issues
Building fires
Emissions from building fires are calculated by multiplying the number of building fires with selected emission factors. Four types of buildings are separated with different emission factors: detached houses, undetached houses, apartment buildings and industrial buildings.

Activity data for building fires are classified in three categories: large, medium and small. The emission factors comply for full scale building fires and the activity data is therefore recalculated as a full scale equivalent where it is assumed that a medium and a small fire leads to 50 % and 5 % of a large fire respectively, and that a large fire is a full scale fire.

Vehicle fires

Emissions from vehicle fires are calculated by multiplying the number of vehicle fires with selected emission factors. Emission factors are only available for different vehicle types, whereas it is assumed that all the different vehicle types leads to similar emissions. The activity data is recalculated as an yearly combusted mass by multiplying the number of different vehicles fires with the Danish registered average weight of the given vehicle type.

Landfill fires

Accidental landfill fires have not been calculated for this year's inventory, this category is under development.

Activity data

In January 2005 it became mandatory for the local authorities to register every rescue assignment in the *online data registration- and reporting system* called ODIN, ODIN in developed and run by the Danish Emergency Management Agency (DEMA). As a result of this, some activity data from 2005 and forth can not be directly compared with older data. For example, some specific rescue assignments were not registered prior to the year 2005, and a compilation of data might therefore give the impression of a certain development, even though it is not actually the case. (DEMA 2007)

Table 8.4.7 shows the occurrence of fires in general, building fires and vehicle fires registered at DEMA.

Table 8.4.7 Occurrence of building and vehicle fires.

Year	All fires	Building fires	Vehicle fires
1990	17 025	6 841	1 881
1991	17 589	7 068	1 883
1992	19 124	7 685	1 892
1993	16 803	6 752	1 898
1994	16 918	6 798	1 908
1995	19 543	7 853	1 999
1996	19 756	7 939	2 074
1997	18 236	7 328	2 139
1998	16 320	6 558	2 196
1999	17 538	7 048	2 248
2000	17 174	6 901	2 281
2001	16 894	6 789	2 311
2002	16 362	6 575	2 341
2003	18 443	7 411	2 353
2004	15 927	6 400	2 389
2005	16 551	6 651	2 461
2006	16 965	7 221	2 546
2007	18 519	7 855	2 392
2008	20 915	7 938	2 954

Building fires

Activity data for accidental building fires is given by DEMA. Fires are categorised to three extents, large, medium and small. A large fire is in this context defined as a fire that involves the use of two or more fire hoses for fire extinguishing and is assumed to typically involve a complete house, one or more apartments, or at least part of an industrial complex. A medium size fire is in this context defined as a fire involving the use of only 1 fire hose for fire-fighting and will typically involve a part of a single room in an apartment or house. And a small size fire is in this context defined as a fire that was extinguished before the arrival of the fire service, extinguished by small tools or a chimney fire.

The total number of registered fires is known for the years 1990-2008. For the years 2006-2008 the total number of registered building fires are known, and by assuming that the share of building fires in respect to the total number of registered fires, can be considered as constant for every year back to 1990, the total number of building fires can be calculated for the years 1990-2005.

Furthermore the building fires that occurred in the years 2006-2008 are subcategorising into industrial building, detached house, undetached house and apartment building fires. And by once again assuming that the average of these shares are representative for the years 1990-2005, the building fires from the earlier years are also subdivided into these four building types.

Table 8.4.8 states the registered activity data for building fires for the years 2006-2008, divided in both size and building type. The calculated averages describes the average share of building fires from 2006-2008 of a certain type and size, in relation to all fires (building and non-building) of the same size and during the same three years period.

Table 8.4.8 Registered occurrence of building fires.

		Industry	Detached	Undetached	Apartment	All building fires
2006	large	214	945	236	117	1 512
	medium	243	950	346	624	2 163
	small	242	1 449	585	977	3 253
	all	699	3 344	1 167	1 718	6 928
2007	large	268	988	239	152	1 647
	medium	324	1 021	391	720	2 456
	small	369	1 432	717	932	3 450
	all	961	3 441	1 347	1 804	7 553
2008	large	244	1 153	206	145	1 748
	medium	216	1 153	306	796	2 471
	small	107	1 567	694	1 013	3 381
	all	567	3 873	1 206	1 954	7 600
Average, %	large	32.61	28.95	18.31	7.56	21.57
	medium	35.17	29.31	28.04	39.08	31.93
	small	32.23	41.73	53.66	53.36	46.50

As mentioned above, it is assumed that the average percentages provided by the years 2006-2008 are compliable for the years 1990-2005. Hereby, similar activity data can be estimated back to 1990.

It is furthermore assumed that a medium size fire has a damage rate of 50 % compared to a large (full scale) fire and that a small size fire leads to the emission of 5 % of a large fire. From these damage rates, a full scale equivalent can be calculated from the earlier calculated activity data, results are shown in the following Table 8.4.9.

Table 8.4.9 Full scale equivalent activity data for accidental building fires from the years 1990-2008 (DEMA).

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Industry	333	344	374	329	331	382	386	357	319	343
Detached	1 407	1 454	1 581	1 389	1 398	1 615	1 633	1 507	1 349	1 450
Undetached	378	390	424	373	375	434	438	405	362	389
Apartment	471	486	529	465	468	540	546	504	451	485

Continued

	2000	2001	2002	2003	2004	2005	2006	2007	2008
Industry	336	330	320	361	312	324	348	448	357
Detached	1 420	1 396	1 352	1 524	1 317	1 368	1 492	1 570	1 808
Undetached	381	375	363	409	353	367	438	470	394
Apartment	475	467	452	510	440	458	478	559	594

The amount of detailed activity data is still limited due to the few years of reported data in the ODIN system, during the next years more data will become available providing a better basis for extrapolating back in time.

Vehicle fires

Activity data for accidental vehicle fires is, like accidental building fires, given by The Danish Emergency Management Agency (DEMA). The activity data is categorised in cars (lighter than 3500 kg), buses, trucks, vans, motor homes, mobile homes, motorcycles/mopeds and tankers. These are gathered in five categories; passenger cars, buses, light duty vehicles (vans, motor homes, mobile homes), heavy duty vehicles (trucks and tankers) and motorcycles/mopeds.

The total number of registered vehicles is known for all years 1990-2008 (Statistics Denmark), but the number of vehicle fires is only known for the years 2007 and 2008. By assuming that the share of vehicle fires in relation to the total number of registered vehicles of the respective categories can be counted as constant, the number of vehicle fires is estimated for the years 1990-2006. Table 8.4.10 states the total number of national registered vehicles, the number of vehicle fires and the average share of burned vehicles from 1990-2008.

Table 8.4.10 Different types of nationally registered vehicles and yearly numbers of vehicle fires.

	Passenger cars			Buses			Light duty vehicles		
	Registered nationally	Share, %	Fires	Registered nationally	Share, %	Fires	Registered nationally	Share, %	Fires
1990	1 645 414	0.084	1 379	8 080	0.650	53	197 876	0.044	88
1991	1 649 127	0.084	1 382	7 429	0.650	48	201 996	0.044	90
1992	1 660 339	0.084	1 391	7 529	0.650	49	206 502	0.044	92
1993	1 663 933	0.084	1 394	7 576	0.650	49	212 616	0.044	95
1994	1 668 102	0.084	1 398	7 680	0.650	50	220 911	0.044	98
1995	1 732 058	0.084	1 451	9 813	0.650	64	228 385	0.044	102
1996	1 792 012	0.084	1 501	9 882	0.650	64	233 914	0.044	104
1997	1 840 218	0.084	1 542	9 861	0.650	64	240 255	0.044	107
1998	1 876 585	0.084	1 572	9 915	0.650	64	248 965	0.044	111
1999	1 907 657	0.084	1 598	9 840	0.650	64	259 157	0.044	115
2000	1 917 274	0.084	1 606	9 820	0.650	64	272 122	0.044	121
2001	1 932 931	0.084	1 619	9 695	0.650	63	282 847	0.044	126
2002	1 946 172	0.084	1 630	9 637	0.650	63	295 436	0.044	131
2003	1 949 909	0.084	1 634	9 636	0.650	63	309 601	0.044	138
2004	1 968 412	0.084	1 649	9 511	0.650	62	336 025	0.044	150
2005	2 013 240	0.084	1 687	9 543	0.650	62	372 630	0.044	166
2006	2 064 681	0.084	1 730	9 519	0.650	62	414 389	0.044	184
2007	2 151 636	0.077	1 658	9 410	0.584	55	402 410	0.038	151
2008	2 200 000	0.091	1 991	9 500	0.716	68	410 000	0.051	211

Continued

	Heavy duty vehicles			Motorcycles/mopeds		
	Registered nationally	Share, %	Fires	Registered nationally	Share, %	Fires
1990	40 123	0.311	125	164 111	0.144	237
1991	40 958	0.311	127	163 362	0.144	236
1992	41 872	0.311	130	159 024	0.144	230
1993	43 111	0.311	134	156 405	0.144	226
1994	44 794	0.311	139	154 376	0.144	223
1995	46 309	0.311	144	165 313	0.144	239
1996	47 430	0.311	147	178 096	0.144	257
1997	47 802	0.311	149	192 364	0.144	278
1998	48 827	0.311	152	205 654	0.144	297
1999	49 245	0.311	153	220 064	0.144	318
2000	49 185	0.311	153	233 695	0.144	337
2001	48 811	0.311	152	243 390	0.144	351
2002	48 148	0.311	150	253 731	0.144	366
2003	47 703	0.311	148	256 779	0.144	371
2004	47 480	0.311	148	263 815	0.144	381
2005	48 312	0.311	150	274 264	0.144	396
2006	49 683	0.311	154	287 672	0.144	415
2007	50 760	0.268	136	302 914	0.129	392
2008	51 500	0.353	182	315 000	0.159	502

The average weight of a passenger car, bus, light commercial vehicle and truck are known for every year back to 1993 (Statistics Denmark). The corresponding weights from 1990 to 1992 and the average weight of a unit from the category "motorcycles/mopeds" are estimated by an expert judgment. The total amount of vehicle involved in fires can then be calculated from the number of vehicle fires and the average weights of the different vehicle types. It is assumed that only 70 % of the total vehicle mass involved in a fire actually burns, see Table 8.4.11.

Table 8.4.11 Average vehicle mass involved in fires.

	Passenger cars		Busses		Light duty vehicles	
	Vehicle fires	Average weight, kg	Vehicle fires	Average weight, kg	Vehicle fires	Average weight, kg
1990	1 379	850	53	10 000	88	2 000
1991	1 382	850	48	10 000	90	2 000
1992	1 391	850	49	10 000	92	2 000
1993	1 394	901	49	10 068	95	2 297
1994	1 398	908	50	10 512	98	2 382
1995	1 451	923	64	10 807	102	2 492
1996	1 501	935	64	10 899	104	2 638
1997	1 542	948	64	10 950	107	2 746
1998	1 572	964	64	10 960	111	2 848
1999	1 598	982	64	11 140	115	2 964
2000	1 606	999	64	11 195	121	3 103
2001	1 619	1 012	63	11 312	126	3 238
2002	1 630	1 024	63	11 387	131	3 333
2003	1 634	1 039	63	11 479	138	3 442
2004	1 649	1 052	62	11 572	150	3 561
2005	1 687	1 068	62	11 560	166	3 793
2006	1 730	1 086	62	11 684	184	4 120
2007	1 658	1 105	55	11 753	151	4 505
2008	1 991	1 122	68	11 700	211	4 710

Continued

	Heavy duty vehicles		Motorcycles/mopeds			
	Vehicle fires	Average weight, kg	Vehicle fires	Average weight, kg	Total vehicle mass involved in fires, Mg	Total vehicle mass burnt, Mg
1990	125	15 000	237	80	3 762	2 633
1991	127	15 000	236	80	3 765	2 635
1992	130	15 000	230	80	3 825	2 678
1993	134	14 921	226	85	3 987	2 791
1994	139	14 863	223	86	4 116	2 881
1995	144	14 991	239	85	4 460	3 122
1996	147	15 119	257	86	4 628	3 240
1997	149	15 178	278	87	4 736	3 315
1998	152	15 302	297	90	4 885	3 420
1999	153	15 408	318	91	5 010	3 507
2000	153	15 394	337	93	5 078	3 555
2001	152	15 061	351	94	5 076	3 553
2002	150	14 654	366	94	5 048	3 534
2003	148	14 188	371	95	5 028	3 520
2004	148	13 756	381	96	5 049	3 534
2005	150	13 412	396	98	5 200	3 640
2006	154	13 334	415	100	5 461	3 823
2007	136	13 427	392	102	5 024	3 517
2008	182	13 407	502	104	6 516	4 561

Emission factors

Building fires

For building fires, emissions are calculated by multiplying the number of full scale equivalent fires by the emission factors. The estimation of emissions is based on emission factors from literature. The estimation is based on the measurements and estimations performed in countries that are comparable with Denmark. By comparable is meant countries that have similar building traditions, in relation to the material used in building structure and interior.

In the process of selecting the best reliable emission factors for the calculation of the emissions from Danish accidental building fires, a range of different sources have been studied. Unfortunately it is difficult to do an interrelated comparison of the different sources because they all establish emission factors on different assumptions and many of these assumptions are not fully accounted for. Table 8.4.12 lists the emission factors that were chosen as the best reliable and their respective references.

Table 8.4.12 Emission factors building fires.

	Unit	Detached houses	Undetached houses	Apartment buildings	Industrial buildings	Source
CO_2 - total	Tonnes pr fire	31.2	25.8	14.9	80.0	Blomqvist et al. 2002
CO_2 - biogenic	Tonnes pr fire	25.8	21.3	12.3	67.6	Blomqvist et al. 2002
CO_2 - non-biogenic	Tonnes pr fire	5.44	4.49	2.60	12.34	Blomqvist et al. 2002
CH_4	Kg pr fire	41.8	34.5	17.4	97.5	NAEI 2007
N_2O	-	NAV	NAV	NAV	NAV	-

NAV = not available

The average floor space in Danish buildings is stated in Table 8.4.13. The data is collected from (Statistics Denmark) and takes into account possible multiple building floors but not attics and basements. The average floor space in industrial buildings, schools etc. is estimated to 500 square meters for all years.

Table 8.4.13 Average floor space in building types.

	Detached	Undetached	Apartment
1990	156	129	75
1991	156	128	75
1992	155	128	75
1993	155	128	75
1994	155	128	75
1995	155	129	75
1996	155	129	75
1997	155	129	75
1998	155	130	75
1999	155	130	75
2000	156	131	75
2001	160	131	75
2002	161	131	75
2003	162	131	75
2004	163	132	75
2005	162	131	76
2006	163	132	76
2007	160	132	76
2008	161	133	77

Statistics Denmark, BOL51 and BOL 511.

Persson et al. (1998) gives for Swedish conditions an emission factor for CO_2 expressed as kg pr Mg of object burned and divided in three different objects; house, apartment and schools of average Swedish sizes. The data is based on the distribution of combustible material in the interior of the different building types, and does not take into account the combustible material in the structure itself. These emission factors are recalculated using Danish data for average building sizes, resulting in the subdivision of building types in detached, undetached, apartment and industrial buildings.

Persson et al. (1998) sets a rate of weight loss at 12.4 %, but does not specify any further on different building types. It seems quite unrealistic that the same rate of weight loss applies for houses and industrial buildings, resulting in the conclusion that there is most likely an overestimation on the emission factors for industrial buildings.

In 2002 a report on the further development of this data was published in Blomqvist et al. (2002), this report added data for the amount of combustible material in the building structure. The emission factors from this source is calculated by combining the estimated amount of combustible material in the building structure itself, with the amount of combustible material estimated in Persson et al. (1998) to be in the interior of the different building types. Again, Danish data for the average floor space in different building types is used to divided the emission factors into the four categories; detached houses, undetached houses, apartment buildings and industrial buildings.

The emission factors from both Persson et al. (1998) and Blomqvist et al. (2002) are probably overestimated due to building traditions, because wood is use to a further extent in Sweden and Norway contra Denmark.

Being that Persson et al. (1998) and Blomqvist et al. (2002) are the only sources to CO_2 emission factors, Blomqvist et al. (2002) is the best available source as this provides a more recent and more detailed method. The share of CO_2 emission that stems from the burning of wood is calculated from the estimated wood contents in an average house. Blomqvist et al. (2002) specifies that an average house of 120 square meters has a structure that consists of 9000 kg wood and an interior that consists of 2780 kg wood. With a CO_2 yield factor of 1.63 kg pr kg wood and a Danish average floor area of 161 square meters, the CO_2 emission from the burning of wood in a full scale detached house fire is 25.76 Mg pr fire.

NAEI (2007) represents the UK National Atmospheric Emissions Inventory; this is the only source that provides emission factors CH_4. NAEI presents emission factors in mass emission pr mass burned. For the calculation of this emission factor to a unit that is comparable with those of the emission factors from the other sources, the building masses are estimated using the same methodology as Hansen (2000) and stated in Table 8.4.14 for 2008.

Table 8.4.14 Building mass pr building type.

	Unit	Detached house	Undetached house	Apartment building	Industry building
Average floor area*	m^2	161	133	77	500
Building mass pr floor area	kg pr m^2	40	40	35	30
Total building mass	Mg pr fire	6.4	5.3	2.7	15.0

* 2008 numbers.

No data was available for N_2O.

Vehicle fires

In the process of selecting the best reliable emission factors for the calculation of the emissions from Danish vehicle fires, a different source has been studied. Unfortunately it is difficult to do an interrelated comparison of the different sources because they all establish emission factors on different assumptions and many of these assumptions are not fully accounted for. Table 8.4.15 lists the accessible emission factors and their respective references.

Table 8.4.15 Emission factors vehicle fires.

	unit	Emission factor	Source
CO_2, fossil	kg pr Mg	2 400	Lönnermark et al. 2004
CH_4	kg pr Mg	5	NAEI 2007
N_2O	-	NAV	-

NAV = not available

Even though NAEI (2007) does not have any references as to where they have collected data, this is the chosen source for emission from vehicle fires because it is the only available source.

Persson et al. (1998) and Lönnermark et al. (2004) are the only available sources to CO_2 emission factors for vehicle fires. Since Lönnermark et al. (2004) is the more resent source and establishes its emission factors on experimental data, this is chosen as the best reliable source.

No data was available for N_2O.

8.4.4 Uncertainties and time-series consistency

Cremations

The uncertainty of the number of human cremations is miniscule, however for the purpose of uncertainty calculation it has been set to 1 %.

The uncertainty of the activity data from animal cremations is also minimal for the most recent years (1998-2008) but is increasing back in time (to 80 % in 1990). The uncertainty is set to 50 % for all years.

95 % confidence interval uncertainties for the emission factors used in this inventory, and at the present level of available information, are shown in Table 8.4.16

Table 8.4.16 Estimated uncertainty rates for activity data and emission factors, %.

	Human cremation		Animal cremation	
Pollutant	Activity data	Emission factor	Activity data	Emission factor
CO_2	NO		NO	
CH_4	1	150	50	150
N_2O	1	150	50	150

NO = not occurring

Accidental fires

Table 8.4.17 lists the 95 % confidence interval uncertainties for accidental building fires and vehicle fires. The uncertainties are assumed valid for all years 1990-2008.

The uncertainty of the total number of accidental fires is miniscule, but the division into building and transportation types might lead to a small uncertainty, primarily caused by the category "other". The uncertainty for both building and vehicle activity data is therefore set to 10 %. The uncertainty is lowest for recent years.

The tier 1 uncertainties for the activity data and emission factors used in this inventory, and at the present level of available information, are shown in Table 8.4.17

Table 8.4.17 Estimated uncertainty rates for composting and accidental fires, %

	Building fires		Vehicle fires	
Pollutant	Activity data	Emission factor	Activity data	Emission factor
CO_2	10	500	10	500
CH_4	10	700	10	700
N_2O	10	NAV	10	NAV

NAV = not available

Tier 1 uncertainty results

The tier 1 uncertainty estimates for waste incineration emission inventories are calculated from 95 % confidence inverval uncertainties, results are shown in Table 8.4.18

The uncertainty interval for GHG is estimated to be ±328.3 % and the trend in GHG emission is 34.6 % ±70.7 %-age points. The main sources of uncertainty for GHG emission are accidental fires. The main source of uncertainty in the trend in GHG emission is accidental vehicle fires.

Table 8.4.18 National tier 1 uncertainty estimates for waste incineration

Pollutant	Total emission uncertainty, %	Trend 1990-2008, %	Trend Uncertainty %-age points
GHG	±328.3	34.6	±70.7
CO_2	±363.0	35.7	±80.6
CH_4	±604.2	25.1	±52.1
N_2O	±113.2	44.1	±90.6

Tier 2 uncertainty results

The tier 2 uncertainty estimates for waste incineration emission inventories are calculated from 50 % confidence interval uncertainties, results are shown in Table 8.4.19. The estimates were based on a Monte Carlo approach as described in this NIR section 1.7.

Table 8.4.19 National tier 2 uncertainty estimates for waste incineration

Category 6C	1990 Total emission Uncertainty interval	2008 Total emission Uncertainty interval	2008 Trend Uncertainty
GHG	41.6 Gg (-66 %, +295 %)	54.8 Gg (-67 %. +322 %)	12.6 Gg (-72 %, +459 %)
CO_2	33.4 Gg (-74 %, +368 %)	44.4 Gg (-74 %, +385 %)	10.3 Gg (-78 %, +534 %)
CH_4	232.3 Mg (-79 %, +599 %)	290.1 Mg (-79 %, +593 %)	53.2 Mg (-80 %, +704 %)
N_2O	0.7 Mg (-63 %, +180 %)	1.0 Mg (-57 %, +133 %)	0.3 Mg (-66 %, +218%)

GHG emissions are calculated in CO_2-equivalents.

The medians for the national emissions from source category 6.C calculated with the tier 2 method, are about twice as high as those calculated with the tier 1 method. This is an example of how high uncertainties on small total emissions can cause considerable variations.

The following Figures 8.4.3, 8.4.4 and 8.4.5 show the graphical comparison of tier 1 and tier 2. Figure 8.4.3 and 8.4.4 show the uncertainties of the total emissions from 1990 and 2008 respectively and Figure 8.4.5 shows the uncertainties of the trend.

Tier 1 uncertainties are the same for 1990 and 2008 because the uncertainty input data are the same for all years. The only input data that vary over time are the activity data and for tier 2, results will vary a bit because of the calculation method. The biggest uncertainties lies with the accidental fires, since there are no N_2O emissions form this source the N_2O uncertainty intervals are shorter than those for the other compounds, see Figure 8.4.3 vs. 8.4.4 or Table 8.4.19.

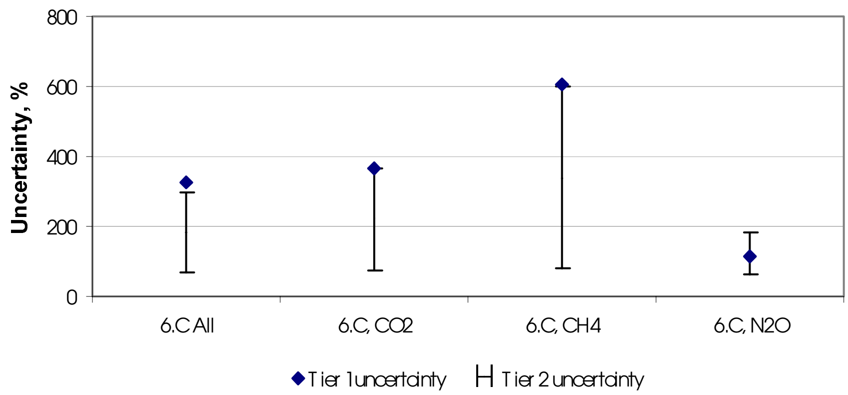

Figure 8.4.3 A graphical comparison of tier 1 and tier 2 uncertainties for 1990.

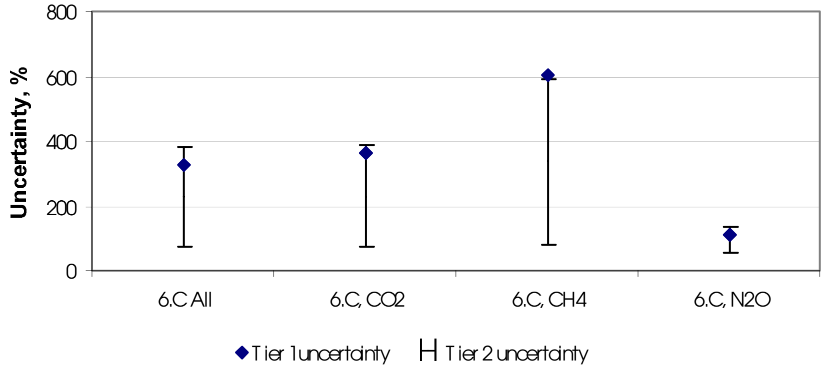

Figure 8.4.4 A graphical comparison of tier 1 and tier 2 uncertainties for 2008.

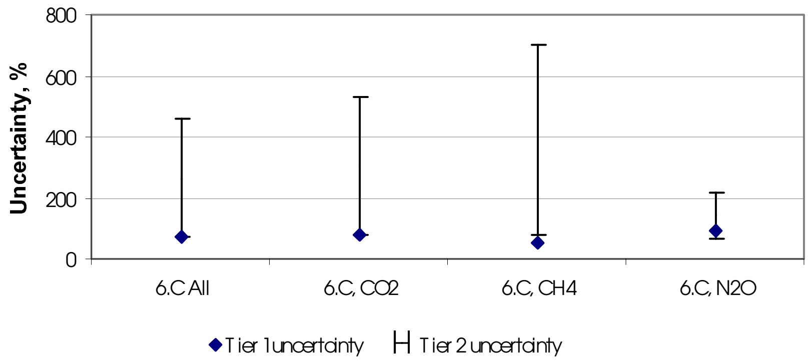

Figure 8.4.5 A graphical comparison of tier 1 and tier 2 trend uncertainties for 2008. The uncertainty interval for N_2O exceeds the shown y-axis as the upper limit is calculated to 10129%, see Table 8.4.19.

8.4.5 Source-specific QA/QC and verification

The specific QA/QC activities for this sector are under development.

8.4.6 Source-specific recalculations

The emissions from sources described in this section are estimated for the first time in this submission.

8.4.7 Source-specific planned improvements

GHG emissions from accidental building and vehicle fires will be moved to section 6.D.

Uncertainty input used in tier 1 and tier 2 calculations will be analysed more thoroughly.

Source-specific QA/QC and verification is under development

8.4.8 Source-specific performed improvements

In the 2010 Danish NIR have been added GHG emissions from cremation of human bodies and animal carcasses and emissions from accidental building and vehicle fires.

Tier 1 and tier 2 calculations have been carried out for both cremation and accidental fires.

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8.5 Waste Other (CRF Source Category 6D)

This category is a catch all for the waste sector. Emissions in this category could stem from sludge spreading, compost production, biogas production and other combustion.

8.5.1 Sludge spreading

Sludge from waste water treatment plants is only spread out in the open with the purpose of fertilising crop fields. Any greenhouse emissions that might derive from this activity are estimated in Chapter 6 (CRF Sector 4).

8.5.2 Biogas production

Emissions from biogas production are divided and reported in different sections of this inventory according to use.

For the biogas production from organic waste with the purpose of energy production, the fuel consumption rate of the biogas production plants refers to the Danish energy statistics. The applied emission factors are the same as for biogas boilers. See this NIR Chapter 3, Energy.

Biogas production from manure is included in this NIR Chapter 6, Agriculture.

The fugitive emissions of CH_4 from the production of biogas from sludge from waste water treatment have been set to 10% of the biogas production. The methodology used for estimation the CH_4 and N_2O emissions from wastewater handling are described in this NIR Chapter 8.3, Wastewater Handling.

Biogas production in this section only covers fugitive emissions from the handling of biological waste, sludge and manure. This includes activities like storage, pre- and after-treatment and fugitive emissions from the anaerobic digestion that is the actual production. However, emissions on these activities are considered negligible.

8.5.3 Other combustion

Other combustion sources include open burning of yard waste, wild fires, tobacco smoking, barbeques and fire works.

In Denmark, the open burning of private yard waste is under different restrictions according to the respective municipality. These restrictions involve what can be burned but also the quantity, how, when and where or in some cases a complete banning. There is no registration of private waste burning and the activity data on this subject are very difficult to estimate. People are generally appealed to compost their yard waste or to dispose of it through one of the many waste disposal/recycling sites.

The occurrence of bonfires at midsummer night and in general are likewise not registered, therefore it has not been possible to obtain activity data.

Due to the cold and wet climate conditions in Denmark wild fires very seldom occurs. Controlled burnings are completely prohibited and the occasional wild fires are of such a small scale that this activity is assumed negligible.

The use of tobacco, barbeques and fire works is under investigation.

Source-specific planned improvements

Greenhouse gas emissions from composting will be added to next year's inventory.

National emissions from tobacco smoking, barbeques and fire work are under development.

The part on emissions from accidental building and vehicle fires will be moved to this section from 6.C

Estimations of emissions from accidental landfill fires are underdevelopment.

Uncertainty calculations will be added in next year's inventory.

Source-specific performed improvements

The source category "Other combustion" has been presented briefly. The investigation behind this presentation provides an overview of possible future improvements.

9 Other (CRF sector 7)

In CRF Sector 7, there are no activities and emissions for the inventories of Denmark. Previously in the inventories of the Kingdom of Denmark (Denmark, Faroe Islands and Greenland) emissions from Faroe Islands and Greenland were reported in Sector 7. This has now been changed so that Greenland and Faroe Islands are included in full CRF's.

For further detail on the emissions from Greenland and the Faroe Islands please see Annex 9 and 11.

10 Recalculations and improvements

The CRF recalculation tables for Denmark produced with the CRF Reporter software tool do not include correctly the recalculations for Denmark made since the NIR submission in April 2009. The reason for this is that selection of the CRF submission against which the recalculations are to be seen has been carried out by the UNFCCC Secretariat and cannot be changed by the parties. At present, the CRF includes as the submission to which the recalculations relate the 2009 submission for the Kingdom of Denmark (i.e. Denmark as well as Greenland and the Faroe Islands), which has been submitted in 2009 under the Climate Change Convention and submitted in parallel to the inventories for Denmark. However, only one recalculation database can be included pr database. Since for this submission for the first time separate CRF tables are produced for Greenland and for the Faroe Islands this improves the recalculation tabel posibilities in the CRF for the next submission. But still for this submission for this chapter recalculation tables are based on an excel file made with links to actually in 2009 submitted data and to data in this 2010 submission. The analysis made is for Denmark only (excluding Greenland and Faroe Island). An extraction of the file only showing source categories for which there have been recalculations is Tables 10.2-5. The aggregation level of the analysis and these tables is the level also used in the CRF recalculation tables.

10.1 Explanations and justifications for recalculations

Explanations and justifications for the recalculations performed for this submission and since submission of data in the CRF-format for submission to UNFCCC due April 15, 2009 for Denmark are given in the following sector chapters:

Energy:

- Stationary Combustion — Chapter 3.2.8
- Transport — Chapter 3.3.7
- Fugitive emissions — Chapter 3.5.8

Industry:

- Mineral products — Chapter 4.2.5
- Food and drink — Chapter 4.5.4
- Consumption of f-gases — Chapter 4.7.5

Solvents and Other Product Use — Chapter 5.8

Agriculture — Chapter 6.9

LULUCF

- Forest Land — Chapter 7.2.1, 7.2.2

- Crop Land Chapter 7.3
- Grassland Chapter 7.4
- Wetlands Chapter7.5
- Settlements Chapter 7.6

Waste

- Solid Waste Disposal on Land Chapter 8.2.5
- Wastewater Chapter 8.3.5

The main recalculations since the 2009 submission are:

Energy

Stationary Combustion

Update of fuel rates according to the latest energy statistics. The update included the years 1980-2007. The most changes were for the years 2006 and 2007.

The split of the CO_2 emission factor for municipal waste between biomass and fossil fuel have been recalculated. This has led to an increased fossil CO_2 emission from waste incineration for the whole time-series.

Improved emission factors for decentralised CHP plants referring to a Danish emission measurement program (Nielsen et al. 2010) have been implemented. This has affected emissions of CH_4 and N_2O from several plant types.

Mobile sources

Road transport

The total mileage per vehicle category from 2005-2008 have been updated based on the traffic index development (derived from traffic counts on selected roads) from the Danish Road Directorate. In addition new data prepared by DTU Transport for the Danish Infrastructure Commission has given information of the total mileage driven by foreign trucks on Danish roads. This mileage contribution has been added to the total mileage for Danish trucks on Danish roads, for trucks > 16 tonnes of gross vehicle weight. The data from DTU Transport was estimated for 2005, and by using appropriate assumptions the mileage have been backcasted to 1985 and forecasted to 2008.

For passenger cars the new division of total mileage into gasoline and diesel made by the Danish Road Directorate is regarded as very broad. Hence in the subsequent model calculations, the fuel and emission results for diesel passenger cars are adjusted with the overall sales/calculated fuel ratio, being applied to the estimates for the other diesel vehicle categories as well. This is a change compared to previous year's inventory submissions for which the diesel passenger car results remain unadjusted.

Military

Emission factors derived from the new road transport simulations have caused some emission changes from 1985-2007. The minimum and maximum emission differences (min %, max %) for the different emission components are: CH_4 (0 %, 4 %) and N_2O (0 %, 2 %).

Aviation

En error for 2007 has been corrected. Erroneously, the flights between Denmark and Greenland/Faroe Islands were treated as international flights. As a result of this correction the fuel consumption and emissions change substantially. The fuel consumption and CO_2 emission increases are 51%, whereas CH_4 and N_2O emissions increase by 22 % and 26 %, respectively.

Very small emission changes between 0 % and 2 % occur for the years 2001-2006, due to inclusion of new representative aircraft types.

Fugitive emissions

Emissions from distribution of town gas have been included in the emission inventory for the years 1985-2008. The input data are sparse as more of the distribution companies have been closed down. Only in the cities of Copenhagen and Aalborg town gas is still being distributed. Another two distribution companies are included in the inventory. Those were closed in 2004 and 2006, respectively. To complete the time-series interpolation and extrapolation has been used on basis of the available data. The uncertainties are expected to be large both regarding the distribution for years without data, the distribution loss and the gas composition.

The emission factors for flaring in refineries have been updated. The emission factors for NMVOC and CH_4 are based on new information on the fuel gas composition from one of the two Danish refineries. The same emission factors are adopted for the second Danish refinery. Emission factors from the EMEP/EEA guidebook (2009) are used to calculate emissions of NO_x, CO and N_2O. CO_2 emission factors are based on data from the ETS reports for 2006-2008 and the calorific values for fuel gas for one refinery. For SO_2 the TIER 1 emission factors for stationary combustion from the EMEP/EEA guidebook (2009) are used.

Industry

The emission of CO_2 from production of cement has been revised for the years 1998-2005 based on new information from the company.

For yellow bricks and expanded clay products the CO_2 emission has been adapted from the company reports to EU-ETS as the emission factors calculated previously and used until 2005 were found not to be in line with the actual emission.

In the category 2F4 Aerosols/Metered Dose Inhalers metered dose inhalers have been included for 2008 and the emissions has also been recalculated from 1998 - 2007.

Solvents

An improved and more detailed source allocation method has been implemented, which enables emission calculation on SNAP sub-category level.

Agriculture

A new method – a Tier 2/CS methodology - for the calculation of CH_4 from manure management has been implemented by using national values of manure conditions. The consequences of the recalculations shows increases in the years 1990 - 2007 from 16 % to 1 % given in CO_2-equivalents with a falling tendency.

Calculations of nitrogen loss from manure have been adjusted to TAN therefore recalculations have been made. Furthermore an error in the database calculations of N_2O has been corrected. These changes decrease the emission of N_2O from manure management in the years 1990-2005 up to 4 % in CO_2-equivalents, and increase emission in 2006 by 1 % and in 2007 decrease emission by 14 %.

New data for the number of animals and the distribution on stable types have been implemented. As recommended of ERT the amount of feed and N ab animal for heifers have been interpolated in the years 2005-2006 to even out high differences. Also for dairy cattle, piglets and slaughter pigs the amount of feed has been interpolated for the amounts of cattle in 2006 and piglets and slaughter pigs in 1991-1993. Three new categories of animals are included, deer, pheasants and ostriches. New data for the use of sewage sludge as fertilizers for the years 2002, 2005 and 2007 have been implemented.

Field burning of agricultural wastes have been included and it effects the total emission by less than 1 % for all compounds.

Waste

The DOC content of Plastics has been changes from 85 to 0 %. This was an error in the previous model formulation. This change in itself lowered the time-series of emissions from 9.5 (1990) to 13.1 % (2002) as compared to the 2009 submission.

The content of CH_4 in the gas emitted has been changed from 45 to 50 % to better reflect the GPG values. This change in itself increased the time-series of emissions from 11.2 (1990) to 13.4 % (1998) as compared to the 2009 submission.

The half year time has been changes from 10 to 14 years according to the default value in the GPG. This change in itself lowered the time-series of emissions from 15.0 (1990) to 4.2 % (2007) as compared to the 2009 submission.

The model formulation has been changed to reflect the accepted fact that emission from waste deposited starts after some time delay. The model now starts to estimate emissions from waste deposited January 1, the year after the waste was deposited. This change in itself lowered the time-series of emissions from 11.9 (1990) to 6.4 % (2007) as compared to the 2009 submission.

The methane emission from wastewater treatment has been significantly reduced as a result of improved documentation of the biogas production, and i.e. methane recovery, in Denmark obtained by access to the Danish Sludge Database.

As recommended by the ERT, a first attempt for the derivation of a national N_2O emission factor for waste water treatment has been performed.

Emissions from incineration of corpses and carcasses and emissions from accidental fires are included in the inventory for the first time.

LULUCF

Based on mapped forest area in 1990 and in 2005 a recalculation of carbon stored in both forest remaining forest and in afforestation since 1990 have been performed. The forest areas in 1990 as well as in 2005 have been mapped to be larger than previously estimated for the times. The recalculation of carbon stock in 1990 and in 2000 used age distribution as reported in census 1990 and in 2000 as an expression of the total forest land allocation to species and ages. Based on the actual measurements of carbon storage in different species and age classes with the current National Forest Inventory, the total standing carbon stock was calculated. For each of the years 1990 - 2000 calculated a standing carbon stock as a moving average, corrected for the deforestation which was detected. Wind throws and the effects of these are included in the overall estimation of changes in carbon stock.

Previously was the annual estimate from soils based on a five-year average to avoid very large inter-annual fluctuations in the inventory. The ERT has recommended Denmark to use the estimated real annual emission in the inventory. This has been included. This leads to much higher variability between years due to differences in crop yield and climatic conditions.

As major changes have been made for CL recalculations have been made for all years.

Previous were also imported peat included in the Danish inventory. From this submission is only CO_2 emissions from Danish peat included. Previous were avoided CH_4 emission from the drainage of land where peat extraction takes place included. This has been removed from the inventory based on a recommendation from the ERT.

A recalculation has been made due to new area data on the established WE has been obtained. Furthermore has the availability of the remote sensing data made it possible to locate the exact position in relation to WE remaining WE.

10.2 Implications for emission levels

For the national total CO_2 equivalent emissions without Land-Use, Land-Use Change and Forestry, the general impact of the improvements and recalculations performed is small and the changes for the whole time-series are between -0.20 % (1990) and +0.86 % (2006). Therefore, the implications of the recalculations on the level and on the trend, 1990-2007, of this national total are small, refer Table 10.1.

For the national total CO_2 equivalent emissions with Land-Use, Land-Use Change and Forestry, the general impact of the recalculations is larger due to recalculations in the LULUCF sector. The changes vary between –6.27 % (1993) and +12.23 % (2006), refer Table 10.1.

Table 10.1 Recalculation performed on national total year 2010 for 1990-2007. Differences in pct of CO_2-eqv between this submission and the April 2009 submission for DK, excluding Greenland and Faroe Islands.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Total CO_2 Equiv. Emissions with Land-Use Change and Forestry	-2.78	2.29	8.37	-6.27	7.94	4.04	-0.92	5.33	-1.01	9.02
Total CO_2 Equiv. Emissions without Land-Use Change and Forestry	-0.20	-0.13	-0.06	-0.02	0.02	0.12	0.31	0.21	0.29	0.49
Continued	2000	2001	2002	2003	2004	2005	2006	2007		
Total CO_2 Equiv. Emissions with Land-Use Change and Forestry	-2.15	3.11	9.27	3.50	1.15	-3.28	12.23	3.05		
Total CO_2 Equiv. Emissions without Land-Use Change and Forestry	0.76	0.40	0.39	0.44	0.36	0.55	0.86	0.30		

10.3 Implications for emission trends, including time-series consistency

It is a high general priority in the considerations leading to recalculations back to 1990 to have and preserve the consistency of the activity data and emissions time-series. As a consequence activity data, emission factors and methodologies are carefully chosen to represent the emissions for the time-series correctly. Often considerations regarding the consistency of the time-series have led to recalculations for single years when activity data and/or emission factors have been changed or corrected. Furthermore, when new sources are considered, activity data and emissions are as far as possible introduced to the inventories for the whole time-series based on preferably the same methodology.

The implication of the recalculations is further shown in Tables 10.2-10.4. There are new sources introduced with this submission, e.g. "waste other". The implications for recalculation for these sources are not shown in Tables 10.2-10.4. The new sources are included in the recalculation data in Tabel 10.1.

Table 10.2 Recalculation for CO_2 performed year 2010 for 1990-2007. Differences in Gg CO_2-eqv. between this and the April 2009 submission for DK. Excluding Greenland and Faroe Islands.

		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Total National Emissions and Removals		**-1 757.75**	**1 975.02**	**6 240.33**	**-4 446.79**	**6 366.09**	**3 232.03**	**-681.82**	**4 473.86**	**-431.94**	**6 608.49**	**-1 339.21**	**2396.94**	**6476.26**	**2770.11**	**1141.33**	**-1835.54**	**8 572.54**	**2 449.68**
1. Energy		**81.22**	**122.95**	**208.66**	**250.96**	**256.84**	**338.46**	**428.78**	**476.49**	**554.40**	**547.71**	**694.02**	**559.88**	**586.36**	**612.79**	**633.76**	**617.53**	**614.06**	**666.76**
1.A.	Fuel Combustion Activities	45.06	48.67	131.90	185.42	193.06	286.48	371.87	398.97	500.32	434.21	624.26	483.01	523.74	545.26	556.18	558.87	560.56	615.25
1.A.1.	Energy Industries	42.22	45.54	123.50	173.58	181.19	269.65	353.02	380.82	488.99	411.58	614.70	465.62	495.53	502.30	523.18	522.61	554.06	563.23
1.A.2.	Manufacturing Industries and Construction	0.08	0.08	0.28	0.37	0.25	0.36	0.42	0.36	0.43	0.53	7.53	15.83	26.64	21.02	28.76	28.85	-5.43	1.52
1.A.3.	Transport	0.12	0.11	0.20	1.02	0.09	0.15	0.07	0.10	0.18	0.05	0.01	1.37	1.39	1.50	1.47	1.36	-0.81	42.65
1.A.4.	Other Sectors	2.65	2.93	7.93	10.44	11.52	16.32	18.36	17.70	10.72	22.05	2.03	0.19	0.19	20.43	2.77	6.06	12.73	7.84
1.B.2.	Oil and Natural Gas	36.16	74.28	76.75	65.55	63.78	51.98	56.92	77.52	54.08	113.50	69.75	76.87	62.63	67.53	77.58	58.66	53.51	51.51
2. Industrial Processes		**0.00**	**4.49**	**4.15**	**4.26**	**4.36**	**2.35**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.31**
2.A.	Mineral Products	-4.45	0.00	0.00	0.00	0.00	-1.56	-3.80	-4.29	-4.90	-4.71	-3.90	-4.95	-4.47	-4.49	-3.97	-4.46	-2.17	-1.41
3. Solvent and Other Product Use		**-44.28**	**-43.24**	**-42.21**	**-41.17**	**-40.13**	**-33.89**	**-35.04**	**-32.83**	**-28.56**	**-28.12**	**-27.77**	**-25.62**	**-27.89**	**-24.76**	**-22.19**	**-24.92**	**-21.49**	**-23.85**
5. Land-Use Change and Forestry (net)		**-1 815.70**	**1 869.33**	**6 046.81**	**-4 682.04**	**6 123.52**	**2 900.77**	**-1 100.37**	**4 006.51**	**-980.06**	**6 065.35**	**-2 028.81**	**1839.59**	**5895.20**	**2157.72**	**507.54**	**-2451.17**	**7 955.17**	**1 780.39**

Table 10.3 Recalculation for CH_4 performed year 2010 for 1990-2007. Differences in Gg CO_2-eqv. between this and the April 2009 submission for DK. Excluding Greenland and Faroe Islands.

		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Total National Emissions and Removals		**-190.42**	**-207.80**	**-232.37**	**-258.80**	**-246.10**	**-258.63**	**-276.03**	**-314.54**	**-322.12**	**-303.65**	**-265.46**	**-277.10**	**-326.52**	**-304.12**	**-263.45**	**-222.61**	**-90.62**	**-165.02**
1. Energy		**3.93**	**6.09**	**6.09**	**6.15**	**5.47**	**5.75**	**5.75**	**4.36**	**4.28**	**4.89**	**3.60**	**-3.07**	**-14.15**	**-21.49**	**-14.15**	**-2.26**	**17.36**	**15.09**
1.A.	Fuel Combustion Activities	0.08	0.10	0.11	0.11	0.13	0.13	0.10	0.10	0.13	0.12	0.12	-10.06	-19.16	-27.05	-19.85	-8.37	12.27	14.09
1.A.1.	Energy Industries	0.01	0.01	0.02	0.03	0.08	0.08	0.05	0.06	0.09	0.09	0.04	-8.15	-15.53	-22.25	-16.45	-8.43	7.38	9.62
1.A.2.	Manufacturing Industries and Construction	0.00	0.00	0.00	0.00	-0.03	-0.04	-0.03	-0.03	-0.03	-0.03	-0.03	-0.54	-0.94	-1.42	-1.13	-0.68	0.34	0.29
1.A.3.	Transport	0.08	0.09	0.09	0.08	0.08	0.07	0.08	0.07	0.07	0.06	0.10	0.10	0.11	0.28	0.11	0.42	0.50	0.29
1.A.4.	Other Sectors	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	-1.46	-2.80	-3.65	-2.39	0.31	4.05	3.88
1.B.2.	Oil and Natural Gas	3.84	5.98	5.98	6.04	5.34	5.63	5.65	4.26	4.15	4.76	3.48	6.99	5.01	5.56	5.70	6.11	5.09	1.00
4. Agriculture		**121.90**	**95.63**	**65.21**	**39.75**	**70.06**	**69.59**	**65.10**	**57.71**	**44.61**	**36.19**	**46.64**	**29.68**	**46.95**	**44.21**	**41.28**	**48.64**	**91.71**	**24.15**
4.A.	Enteric Fermentation	2.12	-0.64	-2.80	-4.59	1.79	1.76	1.74	10.30	8.18	10.30	12.48	13.41	20.74	20.30	24.92	49.63	114.34	12.68
4.B.	Manure Management	117.95	94.37	66.20	42.36	66.36	65.67	61.22	45.14	33.56	23.17	31.47	13.45	23.87	21.09	13.40	-3.99	-25.67	8.84
6. Waste		**-316.85**	**-310.11**	**-304.26**	**-305.29**	**-322.23**	**-334.57**	**-347.48**	**-377.20**	**-371.59**	**-345.23**	**-316.18**	**-304.21**	**-359.82**	**-327.34**	**-291.07**	**-269.48**	**-200.18**	**-204.76**
6.A.	Solid Waste Disposal on Land	-224.31	-220.61	-216.39	-211.75	-206.78	-197.37	-188.01	-174.20	-166.61	-155.36	-146.33	-120.96	-101.37	-80.39	-67.11	-57.82	-0.98	0.53
6.B.	Wastewater Handling	-95.19	-92.23	-90.82	-96.18	-118.12	-140.24	-162.56	-205.89	-207.61	-192.68	-172.62	-185.98	-261.10	-249.89	-226.56	-214.35	-202.14	-208.52

Table 10.4 Recalculation for N_2O performed year 2010 for 1990-2007. Differences in Gg CO_2-eqv. between this and the April 2009 submission for DK. Excluding Greenland and Faroe Islands.

		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Total National Emissions and Removals		**14.99**	**18.38**	**11.34**	**24.37**	**40.04**	**36.58**	**147.67**	**29.17**	**8.66**	**130.46**	**110.58**	**11.17**	**25.30**	**25.76**	**-115.95**	**-37.23**	**89.85**	**-299.03**
1. Energy		**-0.34**	**-1.21**	**-1.42**	**-1.54**	**-1.40**	**-3.06**	**-4.93**	**-5.86**	**-6.18**	**-7.40**	**-6.33**	**-8.92**	**-10.25**	**-10.93**	**-14.34**	**-10.30**	**-12.63**	**-8.43**
1.A.	Fuel Combustion Activities	0.33	0.18	0.01	-0.29	-0.12	-2.07	-3.84	-4.27	-4.99	-4.85	-4.64	-7.13	-8.75	-9.39	-12.63	-9.07	-11.45	-8.40
1.A.1.	Energy Industries	-0.12	-0.30	-0.52	-0.92	-1.50	-3.37	-4.47	-4.80	-5.26	-5.11	-5.00	-7.39	-8.69	-10.50	-12.50	-10.66	-13.49	-12.08
1.A.2.	Manufacturing Industries and Construction	0.00	0.00	0.00	0.00	0.87	1.00	0.69	0.63	0.47	0.51	0.45	0.08	-0.21	0.18	-0.21	0.01	-0.46	-0.38
1.A.3.	Transport	0.39	0.41	0.58	0.76	0.78	0.72	0.67	0.85	0.93	0.89	0.95	1.17	1.14	1.79	0.96	2.28	3.08	4.37
1.A.4.	Other Sectors	0.06	0.06	-0.07	-0.15	-0.28	-0.45	-0.74	-0.97	-1.16	-1.16	-1.05	-1.01	-1.00	-0.87	-0.90	-0.72	-0.59	-0.33
1.A.5.	Other	0.00	0.01	0.01	0.01	0.01	0.02	0.01	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.02	0.03	0.02	0.03
1.B.2.	Oil and Natural Gas	-0.67	-1.39	-1.43	-1.25	-1.28	-0.99	-1.09	-1.59	-1.19	-2.55	-1.69	-1.78	-1.50	-1.55	-1.71	-1.24	-1.18	-0.03
4. Agriculture		**-22.34**	**-17.27**	**-23.61**	**-7.79**	**-3.12**	**-0.62**	**114.00**	**-1.35**	**-22.65**	**95.10**	**69.63**	**-25.48**	**-20.02**	**-8.12**	**-140.59**	**-76.70**	**64.03**	**-337.79**
4.B.	Manure Management	-18.04	-17.89	-19.15	-19.91	-19.72	-19.36	-19.26	-18.01	-18.38	-17.98	-19.90	-19.44	-20.57	-20.91	-23.56	-6.50	5.76	-80.93
4.D.	Agricultural Soils (2)	-4.99	-0.10	-5.15	11.36	15.87	17.91	132.44	15.79	-5.37	112.04	88.50	-7.12	-0.35	11.71	-118.17	-71.35	57.10	-257.87
5. Land-Use Change and Forestry (net)		**18.89**	**16.92**	**17.93**	**15.11**	**16.89**	**14.73**	**15.27**	**14.36**	**14.18**	**18.51**	**19.73**	**16.06**	**13.58**	**14.86**	**14.20**	**13.12**	**13.06**	**12.87**
6. Waste		**18.77**	**19.93**	**18.44**	**18.60**	**27.67**	**25.53**	**23.33**	**22.01**	**23.32**	**24.26**	**27.54**	**29.50**	**42.00**	**29.95**	**24.78**	**36.66**	**25.40**	**34.32**
6.B.	Wastewater Handling	18.58	19.74	18.24	18.39	27.46	25.32	23.11	21.80	23.11	24.04	27.32	29.28	41.77	29.73	24.55	36.42	25.13	34.04

Table 10.5 Recalculation for HFCs (HFC 134a) performed year 2010 for 1990-2007. Differences in Gg CO_2-eqv. between this and the April 2009 submission for DK. Excluding Greenland and Faroe Islands.

		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
2.F.	Consumption of Halocarbons and SF_6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	1.06	2.10	3.14	4.18	5.23	6.27	7.31	8.36	9.90

10.4 Recalculations, including those in response to the review process, and planned improvements to the inventory (e.g. institutional arrangements. inventory preparations)

The review on the submissions in 2007 and 2008 was finalised and the report was published April 15, 2009. The main recommendations are listed in table 10.5.

Unfortunately the draft review report for the review of the 2009 submission was available as late as February 22, 2010 (the final version are dated April 15, 2010), which was too late to take the recommendations into account for this submission. However, some of the issues pointed out during the review have been incorporated into this submission, for example in the energy sector, agriculture and waste. However, full implementation of recommendations and suggestions of the reviewers in the main findings etc. was not possible in the time left to this submission and the start of the implementation awaits the final review report.

CRF	ERT Comment	Denmark's response	Reference
General	Report emissions from Greenland under the relevant sectors instead of under the category other.	Denmark will for the 2010 submission provide a full CRF for Greenland, and a full CRF for Denmark and Greenland aggregated. Separate CRF's submitted for Greenland and for Denmark under the EU, Kyoto Protocol and the Climate Convention.	
General	The incorporation of emissions from Greenland into the respective category discussions in the NIR and under the respective cross-cutting issues and procedures (e.g. key category analysis, uncertainty, QA/QC and recalculations);	We have some problems implementing this recommendation. Denmark has 3 different reporting obligations under the Convention, Kyoto Protocol and the European Union. This recommendation suggests that Denmark should provide 3 different National Inventory Reports for the different submissions complete with 3 editions of each table and figure in the entire report. This would be very time consuming and would not be an efficient way to use resources. Additionally the emission inventory for Greenland and Denmark are independent, there are no common data suppliers, and the methods and emission factors used are different from Denmark, therefore we believe that reporting on the methods and emission factors for Greenland separately increases transparency of the inventory. We will provide a chapter in the NIR describing the trend, recalculations, QA/QC, KCA and uncertainties of the Denmark + Greenland submission. This will first be fully implemented in the 2011 submission	
General	Strengthen its national system to ensure adherence to decision 15/CMP.1 with respect to having a single national entity responsible for the national inventory of Denmark (Including Greenland)	Denmark has strengthened the National System by establishing an agreement with the Government of Greenland.	Chapter 13.
General	Provide tier 2 uncertainty estimates in order to identify where improvements to the inventory should be focused.	Tier 2 uncertainties have been estimated at the sectoral level. For the 2011 submission it will be combined to an overall tier 2 uncertainty estimate.	See sectoral chapters on uncertainties.
General	Undertake a tier 2 key category analysis.	A tier 2 key category analysis has been performed.	Annex 1.
1A Feedstocks and non-energy use of fuels	To improve accuracy and completeness, the ERT recommends that Denmark estimate and report emissions from the non-energy use of bitumen, lubricants and white spirit in future annual submissions.	Denmark has estimated and reported emissions from these sources. White spirit is included in CRF sector 3, while bitumen and lubricants are included in CRF sector 2.	Chapter 4 and 5.
1A1a Public electricity and heat production: solid fuels – CO_2	Denmark has included EU ETS data causing a decrease in IEF. To improve accuracy and transparency and to ensure conformity with the Re-	Denmark has expanded and improved the documentation for the use of EU ETS data in the energy sector.	Chapter 3.2.5

	vised 1996 IPCC Guidelines and the IPCC good practice guidance, the ERT recommends that Denmark: (a) Provide sufficient background information on plant-specific data such as the methods used by the plants to estimate the carbon content, oxidation factor and calorific value of the fuel, the origin of the coal used and the corresponding physical properties, and if possible cross-checks of the information reported by the plant with that obtained from the fuel supplier; (b) Assess time-series consistency and explain the reason for the recent variability of CO2 EFs; (c) Verify the information provided by the plants as more data become available.		
1A Stationary combustion: gaseous fuels – CO_2	Emissions from the use of town gas are estimated using the EF for natural gas. The ERT reiterates previous recommendations that Denmark improve the background documentation, particularly by providing the average composition profile of town gas.	Denmark improved the documentation in the 2009 NIR.	Chapter 3.2.5
1A3 Road transport: liquid fuels – CH_4 and N_2O	The change of non-CO_2 EFs associated with the use of bioethanol in gasoline blends has not been taken into account when estimating the corresponding emissions. The ERT suggests that Denmark assess probable changes to these EFs in its next annual submission.	No data has previously been available indicating different CH_4 and N_2O emission factors for blends of fossil and biogenic fuels. This issue is being followed in case new research indicates otherwise.	Chapter 3.3.2.
2A Cement production – CO_2	The ERT noted that the methods used by Denmark to estimate CO_2 emissions from cement production for 1990–1998, 1999–2005 and 2006 are not identical. The ERT therefore strongly recommends that Denmark report correct emissions estimates, make efforts to analyse the causes of the decrease in	The EF depends on the ratio: white/grey cement and the ratio: GKL-clinker/FHK-clinker/SKL-RKL-clinker. The ratio white/grey cement is known from 1990-1997 with maximum in 1990 and thereafter decreasing. The ratio: GKL-clinker/FHK-clinker/SKL-RKL-clinker is known from 1990-1997. The individual EF for the different clinker types are respectively: 0,477, 0,459, and 0,610 ton CO_2/ton. Production of SKL-RKL-clinker peaks in 1991 and decrease hereafter. FKH-clinker is introduced in 1992 and increase to 35% in 1997.	Chapter 4.2.

	the IEF in recent years and provide an explanation in the NIR in its next annual submission.	When estimating the activity for 1990-1997 the amount of white cement is summed with the amount of clinker. Information on the total production of clinker from 1998-2008 has been provided by the company recently. The company has at the same time stated that data until 1997 can not be improved as they are not available anymore.	
2C Iron and steel production – CO_2	CO_2 emissions from iron and steel production in 2002, 2003, 2004 and 2006 are reported as "NA, NO" in the CRF. Denmark explained in the NIR that this is due to the ceasing of electro-steelwork operations. However, the ERT found that "NE" should be also used for this category, because Denmark stated in the NIR that the CO_2 emissions from iron foundries have not yet been included and that it hopes to investigate and include them in the future.	Denmark has revised the notation keys for 2C. The emission estimates for CO_2 from iron foundries is still under development.	
2F Consumption of halocarbons and SF6 – HFCs	Denmark explained in the NIR that the slowing of the rate of emissions in recent years seems to be due to regulations restricting the use of F-gases that have been in place since 1 March 2001 in the form of taxation and a ban on the use of these gases in new installations. The ERT encourages Denmark to further analyse the cause of the overall trend and inter-annual changes in emissions from each subcategory in this category, and to provide further explanation of this in the NIR in its next annual submission.	The trend discussion has been considerably enlarged and improved as compared to the previous NIR with explanations on the trends occurring in relation to the existing regulations.	Chapter 4.6.
2F Consumption of halocarbons and SF6 – HFCs	According to the NIR, a comparison of potential and actual emissions was only carried out in 1995–1997 and, for all three years, the potential emissions are approximately higher than actual emissions by a factor of 3. However, there is no further explanation in the NIR of the	Since potential emission calculation is in fact a tier 1 methodology, comparison to the tier 2 model methodology is not paid much attention since it is two very different methodologies.	

	difference between potential and actual emissions. The ERT encourages Denmark to compare potential and actual emissions for the whole time series and to analyse the reason for any differences, with a view to improving its determination of EFs over time.		
3D Solvent and other product use (other) – N_2O	For N_2O from fire extinguishers, aerosol cans and other uses, emissions are reported as "NA" in the CRF. However, AD for these subcategories are reported as "NE", which implies that emissions should also have been reported as "NE". The ERT encourages Denmark to collect data on AD (e.g. sales data) for these subcategories and to estimate and report N2O emissions. Otherwise, "NA" should be corrected to "NE" and a clear explanation should be provided in the NIR in the next annual submission as to why these emissions have not been estimated.	Denmark has corrected the notation keys, and provided an explanation for the sources that are reported as not estimated.	CRF and NIR Chapter 5.
4A Enteric fermentation – CH_4	To provide an ongoing QC check of the results obtained using the country-specific model, the ERT recommends that Denmark also prepare estimates using the tier 2 method described in the IPCC good practice guidance and that the Party report on the results in future NIRs.	As recommended by ERT a Tier 2 estimate has been provided and reported in NIR 2010 I order to QC check the country specific model. The result shows a good correlation by using the country specific methodology.	Chapter 6.2.4
4A Enteric fermentation – CH_4	The ERT recommends that Denmark include a summary of the data used to estimate Ym and that it consider providing a comparison with similar data published by Statistics Denmark in the NIR in its next annual submission.	As recommended by the ERT a more detailed description of the key model parameters used to calculate the national Ym value are given in NIR 2009. Furthermore data from Statistics Denmark covering the area of cultivated maize and sugar beet for feeding is given in table in Annex.	Chapter 6.2.2 and Annex 3D table 3b (area of sugar beet for feeding and maize)
4B Manure management – CH_4	CH_4 emissions from manure management were estimated using tier 2 methodologies where appropriate, country-specific volatile solid excretion rate (VS), IPCC default values for CH_4-producing capacity (Bo) and a CH_4	DK has decided to maintain the use a methane correction factor MCF for liquid manure by 10% as given in the Reference Manual 1996. In GPG the MCF was changed to 39% without any scientific arguments. Most of the slurry in DK is stored under cold conditions (>5-10 degrees) and the CH4 formation merely stops at 4 degrees. That is the main reason why we se no plausible arguments to use 39% under Danish	

	correction factor. For liquid slurries, however, Denmark does not use the default CH_4 correction factor provided by the IPCC good practice guidance, which it argues is not appropriate for Danish conditions. Instead, Denmark uses a factor taken from the Revised 1996 IPCC Guidelines on the basis of two laboratory studies, the application of which, Denmark acknowledges, is not representative. To ensure consistency with the IPCC good practice guidance, the ERT recommends that the Party review the latest international literature and country studies, and consider whether the CH_4 correction factor currently selected could be justified more strongly in the NIR or, alternatively, whether the factor should be revised in its next annual submission.	conditions. Review of other countries with comparable climate conditions indicates that the 10% better reflects the Danish conditions than the 39% given in the GPG. Sweden, Finland, Norway, Belgium, Netherlands and Germany all use a MCF factor between 10% and 15%.	
4B Manure management – N_2O	Denmark uses the IPCC methods and default factors for this category. However, the IEF declines slightly over time as a result of a small reduction in emissions due to the treatment of slurries for biogas. Given that this process is not described in the IPCC good practice guidance, the ERT recommends that Denmark include information from supporting studies on key model parameters in the NIR to enhance transparency and understanding of the methods used in its next annual submission.	As recommended by the ERT further information is supplied in NIR 2009. In annex 3D is given a overview of all key model parameters	Chapter 6.3.2 and Annex 3D table 8
4D3 Indirect emissions from agricultural soils – N_2O	Indirect emissions from agricultural soils have declined by 41.4 per cent since 1990, owing to the decline in the use of synthetic fertilizer and a decline of 13.9 per cent since 1990 in the FracLEACH value. The decline in FracLEACH was calculated from the application of two models reported in a paper only available in Danish. Conse-	As recommended by the ERT further information about the model used to calculate the nitrogen leaching on national scale is provided in NIR 2009	Chapter 6.4.2 – Nitrogen leaching and Runn-off and Annex 3D 1.4

	quently, the ERT recommends that Denmark include details of key model parameters from supporting studies in its next annual submission to enhance transparency and understanding of the models used.		
5A1 Forest land remaining forest land – CO_2	The source for AD for forest land and for forest land remaining forest land is the forestry census. This is problematic because, as is explained in the NIR, figures from this source for 1990 and 2000 cannot be compared directly owing to the differing number of respondents in the two censuses. Furthermore, the forestry census provides no guidelines on the crown cover or the heights of trees. Denmark is aware of this problem and, has initiated work on the land-use matrix. The ERT urges the Party to prioritize this work and to use the new information produced in its next annual submission. The ERT advises the Party to document the creation of the land-use matrix and the new forest information in a report written in English and/or an annex to the NIR.	The whole LULUCF sector has been revised as a consequence of the KP LULUCF reporting. The land-use matrix is established.	Chapter 7 & 11.
5C Grassland – CO_2	Denmark reports in the NIR that the change in the reported area of grassland from 2005 onwards is a result of changes in data collection rather than changes in actual area. The Party informed the ERT that it is planning to change the definition of grassland and reclassify most of the permanent grassland data from Statistics Denmark to the cropland category. This means that a recalculation for the whole time series should be performed in 2009 or 2010. The ERT recommends that Denmark carry out this work in combination with the creation of the land-use matrix.	The whole LULUCF sector has been revised as a consequence of the KP LULUCF reporting. The land-use matrix is established.	Chapter 7 & 11.

5D Wetlands – N_2O	The Party informed the ERT that the re-established wetlands category consists of agricultural land (68 per cent), which was reported, and the remaining wetlands (32 per cent), which were not reported. The Party provided the ERT with a definition of wetlands. Established wetlands are defined as areas designed to remove leaching N or increase the natural value of an area, whereas raised water tables are areas of land where drainage has been stopped so that the water table is 10–30 cm below the soil surface in summer and around or just below the soil surface in winter (i.e. not totally water-logged). The ERT recommends that Denmark include this definition in the NIR in its next annual submission.	The whole LULUCF sector has been revised as a consequence of the KP LULUCF reporting. This issue is no longer relevant.	Chapter 7 & 11.
6A Solid waste disposal on land – CH_4	To estimate emissions from solid waste disposal on land, Denmark applied the IPCC tier 2 method with country-specific EFs by waste type and CH_4 generation constant (k). The ERT encourages Denmark to obtain more suitable waste composition data reflecting the current situation and to explain how the specific k value of 0.693 per year was arrived at.	The CH_4 generation constant was varied according to waste type only for a sensitivity analyses, showing a rather limited influence on the output (the CH_4 emission). Also the influence on the output of the waste composition was shown in a sensitivity test and as a study prior to investigation of waste composition. For the 2010 submission the half-life time was changed from 10 to IPCC default value of 14 years.	Chapter 8.2.

More information on the specific responses to the review has been given in the sectoral chapters of this report.

10.5 Explanations, justifications and implications of recalculations for KP-LULUCF inventory

This is the first year Denmark is reporting KP LULUCF, therefore no recalculations have been performed.

11 KP-LULUCF

11.1 General information

In the following text is the abbreviations used in accordance with definitions in the IPCC guidelines:

A:	Afforestation
R:	Reforestation
D:	Deforestation
FF:	Forest remaining Forest, areas remaining forest after 1990
FL:	Forest Land meeting the Danish definition of forests
CL:	Cropland
GL:	Grassland
SE:	Settlements
OL:	Other land, unclassified land
FM:	Forest Management, areas managed under article 3.4
CM:	Cropland Management, areas managed under article 3.4
GM:	Grazing land Management, areas managed under article 3.4

11.1.1 Definition of forest and any other criteria

For the estimation of anthropogenic emissions by sources and removals by sinks associated with afforestation (A), reforestation (R) and deforestation (D) since 1990 under Article 3.3 and forest management (FM) under Article 3.4 of the Kyoto Protocol, the following forest definition will be applied:

- Minimum values for tree crown cover: 10 per cent tree crown cover for forests.
- Minimum values for land area: 0.5 ha.
- Minimum value for tree height: trees must be able to reach a minimum height of 5 m in the site.

In addition, the forest area includes temporarily unstocked areas, smaller open areas in the forest needed for management purposes and fire breaks. Forests in national parks, reserves, or areas under special protection are included. Windbreaks and groves covering more than 0.5 ha and with a minimum width of 20 m are also considered as forests. Farmlands, fruit plantations for commercial purposes, orchards, gardens (houses and summer houses) are NOT included in the forest area. Willow plantations on agricultural soils for bioenergy purposes are included in Cropland (CL).

11.1.2 Elected activities under Article 3, paragraph 4, of the Kyoto Protocol

As regards the possibility of including in the first commitment period emissions and removals associated with land use, land-use change and forestry activities under Article 3.4 of the Kyoto Protocol, it has been decided to include emissions and removals from forest management (FM), cropland management (CM) and grazing land management (GM).

The national system has identified land areas associated with the activities under Article 3.4 of the Kyoto Protocol in accordance with definitions, modalities, rules and guidelines relating to land use, land-use change and forestry activities under the protocol by satellite monitoring, use of EU Land Parcel Information System (LPIS), detailed crop information data on field level, soil mapping and sample plots from the national forest inventory (NFI).

Inventories of emissions and removals under Article 3.3 and Article 3.4 are prepared for 2009, and reported annually in 2010 together with the other greenhouse gas inventory information.

11.1.3 Description of how the definitions of each activity under Article 3.3 and each elected activity under Article 3.4 have been implemented and applied consistently over time

The definition of aforestation, reforestation and deforestration is in accordance with the GPG (IPCC 2003).

Aforestation or reforestation is identified when areas have wooded tree-cover and fulfils the forest definition given above. The time of the A is given by the time of action - e.i. planting of trees. For R the time is given by the first spontaneous regeneration of tress, typically either by absence of management or by management inducing natural regeneration. All types of establishment of forest (A or R) is considered human induced, as all land area of Denmark is under management or as minimum specifically left for spontaneous revegetation. Regulations and support for A and R include natural revegetation as a specific method, often supplementing already existing forest areas. (Danish Forest and Nature Agency, Support for Sustainable Forestry - active until 2010.
http://www.skovognatur.dk/Skov/Privat/Tilskud/Baeredygtig/)

Deforestation is identified where areas in 1990 were covered by forest and where subsequent information (through remote sensing or NFI) is recorded to have another land use. Deforestation occurs for a number of reasons, e.g. nature restoration which in the period 1990 - 2008 have been the predominant reason. Other reasons can be urban or infrastructure development.

Temporarily unstocked areas - as integral part of forest management or as result of windthrow - which is expected to continue in forest management is not considered deforestation.

As for the forest management (Article 3.4) - the forest areas fulfilling the definition given above are included under this activity. All forest areas are considered managed due to the intense utilisation of the land area of Denmark. All inventories apply this approach. The Forest Act in Denmark gives the frame for most of the forest area ('Fredskov') - thereby ensuring continued forest cover - or by deforestation at least aforestation of a similar area or in most cases the double area. As described in Chap. 7 the changes in forest floor and mineral soils pools are not significant in the period observed (1990-2008) and are hence not considered being a source of emmissions.

For Cropland and Grassland has the area accounted for under Art. 3.4 been estimated with the EO mapping combined with agricultural data from Statistics Denmark and the EU agricultural subsidiary system. Only areas which are reported as CL and GL are included in the accounted area.

11.1.4 Description of precedence conditions and/or hierarchy among article 3.4 activities and how they have been consistently applied in determining how land was classified

All Forest activities have precedence, after this Cropland activities and then Grassland activities.

Afforestation has precedence. All land converted to forest are included as afforested area. Deforestated areas are reported under D. The following categories in the Convention reporting are included under afforestation:

- 5A21 CL to A
- 5A22 GL to A
- 5A23 WE to A
- 5A24 SE to A
- 5A25 OL to A

Deforestation is estimated as:

- 5B21 to CL
- 5C21 to GL
- 5D21 to WE
- 5E21 to SE
- 5F21 to OL

FM activities are only related to:

- 5A1 Forest remaining Forest

CM activities are related to:

- 5B1 CL remaining CL
- 5B22 GL to CL
- 5B23 WE to CL
- 5B24 SE to CL
- 5B25 OL to CL

GM activities area related to:

- 5C1 GL remaining GL
- 5C22 CL to GL

- 5C23 WE to GL
- 5C24 SE to GL
- 5C25 OL to GL

No elected land has left land which is accounted for. Land conversion between elected activities (FM, CM and GM) has been allowed. FL, CL and GM which has been converted to WE and SE is still included in the accounted area. No land elected under 3.4 activities has been converted to Other Land. Other land converted to elected activities is included in the respective category. As a consequence has there been a steady increase in land which is accounted for under Art. 3.3 and Art. 3.4 (Table 11.1) with 35 182 hectares from 1990 to 2008.

Table 11.1 The development in the different land areas which is included in the accounting.

	1990	1995	2000	2005	2006	2007	2008
AF	711	9 795	21 590	31 393	34 394	34 778	38 199
D	884	2 557	4 745	6 353	6 467	6 581	6 694
FM	539 788	537 232	535 777	533 517	533 403	533 289	533 175
CM	2 923 179	2 914 705	2 897 970	2 883 540	2 879 856	2 876 263	2 874 220
GM	117 102	132 772	145 443	157 716	159 959	162 258	164 557
Total area, kHa	3 581 664	3 597 061	3 605 525	3 612 518	3 614 078	3 613 168	3 616 845

The Land Use matrix developed for the purpose of reporting Art. 3.3 and 3.4 activities for 2008 are shown in Table 11.2.

Table 11.2 Land Use matrix for art. 3.3 and 3.4 activities in 2008.

From previous inventory year / To current inventory year		Article 3.3 activities: Afforestation and Reforestation	Article 3.3 activities: Deforestation	Article 3.4 activities: Forest Management (if elected)	Article 3.4 activities: Cropland Management (if elected)	Article 3.4 activities: Grazing Land Management (if elected)	Article 3.4 activities: Revegetation (if elected)	Other [5]	Total area at the beginning of the current inventory year[6]
		(kha)							
Article 3.3 activities	Afforestation and Reforestation	35.78	NO						35.78
	Deforestation		8.91						8.91
Article 3.4 activities	Forest Management (if elected)		0.11	533.05					533.17
	Cropland Management[4] (if elected)	2.00	NO		2,870.48	2.33	NA		2,874.81
	Grazing Land Management[4] (if elected)	0.05	NO		0.30	161.79	NA		162.13
	Revegetation[4] (if elected)	NA			NA	NA	NA		NA
Other [5]		1.38	NO	NO	3.44	0.43	NA	689.75	695.00
Total area at the end of the current inventory year		39.20	9.03	533.05	2,874.22	164.56	NA	689.75	4,309.80

11.2 Land-related information

11.2.1 Spatial assessment unit used for determining the areas of the units of land under Article 3.3

Aforestation and reforestation is identified where areas in 1990 not were covered by forest and where subsequent information (through remote sensing or NFI) is recorded to have forest cover fulfilling the forest definition. Even though the definition for A and R refers to the time of establishemt, there may be a slight time delay in the actual recording of the A/AR. This will be improved through more frequent land use mapping and improved methods for mapping in the coming years.

Deforestation is identified where areas at the beginning of the commitment period were covered by forest and where subsequent information (through remote sensing or NFI) is recorded to have another land use. The identification of the areas is in most cases supported by reports on e.g. nature restoration or establishment of settlements.

11.2.2 Methodology used to develop the land transition matrix

A land use/land cover map was produced for the Kyoto reference year 1990 and for the year 2005 based on EO data (23 August 1990) and other data produced from 1992-2005. The primary data used is Landsat imagery mainly Landsat 5 (TM) and 7 (ETM+) data to classify and estimate the area. These data has been combined with different vector layers such as cadastral maps, road maps, wetland areas, agricultural land use data, vector layers of established wetlands, gravel maps etc. as well as aerial photos. Portions of seven scenes covering the whole country were classified into forest and non-forest classes. The approach involved the integration of sampling, image processing, and estimation. Initial maps were produced by Erik Prins, Prins Enginering as part of the GMES project GSE-FM (Prins 2009). Successively a supplementary analysis is being processed. The product is specified by a Minimum Mapping Unit (MMU) of 0.5 ha, a geometric accuracy of < 15 m RMS and a thematic accuracy of 90% +/- 5% for the six major Kyoto classes: Forest, Cropland, Grassland, Wetland, Settlements, and Other. Forest has a 0.5 ha MMU, however, is subdivided without MMU into conifer, deciduous, mixed, and temporary un-stocked forest.

In Chapter 7, Table 7.1 is showed the overall development from 1990 to 2005. The preliminary result is an increase in the afforsted area of 35,755 hectares, but also that deforestation has taken place of approximately 9,000 ha. Afforestation is mainly taking place on CL and OL not previous classified as forest. Areas, which is deforestated is mainly converted to GL and to a less extend into CL. Since 1990 has more than 63,000 hectares been changed into SE and other infra structures. No FF, CL and GL are converted into OL by definition.

11.2.3 Maps and/or database to identify the geographical locations, and the system of identification codes for the geographical locations

Whole the Danish territory except the Faroe Islands is included. Greenland is submitting a full separate NIR and CRF to be included in the submission to UNFCCC (Annex 9). This chapter includes only the territory of Denmark without Greenland. Denmark is reported as one unit and no sub-geographical locations are used.

11.3 Afforestation, Reforestation & Deforestation (ARD)

11.3.1 Methods for carbon stock change and GHG emission and removal estimates

For afforestation the carbon stock change in the period 1990 - 2008 is based both on the area of afforestation, the information on species composition from the Forest Census 2000 and from the NFI.

In the afforestation a steady increase in carbon stock is found. The species composition is based on the information from the 2000 Forest Census for the period 1990-2000. Subsequently the NFI provides information on the afforestation area and the carbon pools in these areas - up till 2007. The estimates for the carbon pools in the afforestation are similar to previous estimates, with a slight increase due to the new knowledge on species composition and average carbon stock in those areas based on the NFI data.

Carbon stock change caused by deforestation is estimated based on the deforestated area and the mean values of carbon stock in the total forest area. This is due to the fact that no specific knowledge is available on the carbon pools of the deforested areas.

Further details are available in Johannsen et al. 2009.

11.3.2 Description of the methodologies and the underlying assumptions used

See above.

11.3.3 Justification when omitting any carbon pool or GHG emissions/removals from ARD

When deforestation occurs it is assumed that all dead organic matter will be cleared. The actual amount depends on which type of forest which is converted.

11.3.4 Information on whether or not indirect and natural GHG emissions and removals have been factored out

No factoring out has been performed in the emission and removal estimates.

11.3.5 Changes in data and methods since the previous submission (recalculations)

No recalculation has been performed.

11.3.6 Uncertainty estimates

Not available - included in later version.

11.3.7 Information on other methodological issues

See Chapter 7.

11.3.8 The year of the onset of an activity, if after 2008

Not applicable.

11.4 Forest Management (FM)

11.4.1 Methods for carbon stock change and GHG emission and removal estimates

See Chapter 7 in LULUCF on "Forest remaining forest (5.A.1)".

11.4.2 Methodologies and the underlying assumptions

See Chapter 7 in LULUCF on "Forest remaining forest (5.A.1)".

11.4.3 Omission of pools from FM

No pools omitted.

11.4.4 Factoring out

No factoring out have been performed.

11.4.5 Recalculations

No recalculation has been performed.

11.4.6 Uncertainty estimates

Not available.

11.4.7 Information on other methodological issues

See Chapter 7 in LULUCF on "Forest remaining forest (5.A.1)".

11.4.8 The year of the onset of an activity, if after 2008

Not applicable.

11.5 Cropland Management (CM)

11.5.1 Methods for carbon stock change and GHG emission and removal estimates

CL is subdivided in four classes: agricultural CL, wooded perennial fruit plantations, hedgerows and "other agricultural CL".

11.5.2 Methodologies and the underlying assumptions used

The area with agricultural CL are given as the agricultural area in Statistics Denmark for cereals, fodder crops, grass for seed, sugar beets, potatoes and other root crops.

The same methodology as used in the Convention reporting is used in the KP reporting.

Land converted from other Land use categories to CL is included under CL. Land converted to forest is reported under forest (AR). Land which according to the land use matrix is converted to WE and SE are still included in CM. Land conversion to OL is not allowed.

As shown in the CL sector is there a very high variability in the emissions from agricultural soils due to the actual harvest yield and the actual climatic conditions. To reduce the interannual variability in the accounting under the Kyoto-protocol is for the base year used the recommended five-year average, IPCC, 2004, Section 4.2.3.7 p 4.23. The averaging is only used for the sub-division "Agricultural cropland" and "Liming" and not for the minor sources such as perennial wooden plants and hedges which shows very little variability. The emission in the base year for the subdivision "Agricultural cropland" is a five-years average for above- and below-ground biomass, soil carbon and lime consumption symmetric around 1990, i.e. 1988 to 1992. For the first year in the commitment period is used the actual emission as reported under the Climate Convention. This approach will be followed in the coming years. As a result will the total accounting in the first commitment period include five years, equal to the number of years in the base year.

11.5.3 Omission of pool from CM

Aboveground and belowground living biomass, litter and dead organic are only reported for perennial woody crops in accordance with IPCC GPG 2003. No litter and dead organic matter are reported under CL as this is seen as not occurring or as very insignificant as it is only related to the small area with fruit plantations and hedges.

Under cropland are therefore only reported above- and belowground living biomasses for perennial fruit plantations, hedgerows and willow plantations for bioenergy purposes on agricultural land. Christmas trees are reported under FL.

11.5.4 Factoring out

The dramatic increase temperature in the latter years results in a higher turn-over rate of organic matter in soils leading to an increased emission from soils compared to pre 1990. For agricultural soils is Denmark using a dynamical temperature dependent model (Tier 3) which is expected to give the best estimate of the actual emission from soils compared to most other methods. If Denmark has used the default IPCC Tier 1 or 2 there would likely have been a *negative* factoring out, because the EF in these methods are based on long-term scientific data and thus not having the recent increase in temperatures included. Therefor by using the actual temperature in the Tier 3 no factoring out has been made, contrary the opposite.

11.5.5 Recalculations

No recalculation has been performed.

11.5.6 Uncertainty estimates

No uncertainty analysis has been performed.

11.5.7 Information on other methodological issues

None

11.5.8 The year of the onset of an activity, if after 2008

Not applicable.

11.6 Grazing land management (GM)

11.6.1 Methods for carbon stock change and GHG emission and removal estimates

Grazing land is defined as land used for permanent grazing as well as dry land not meeting the definitions for FF, CL, WE or SE. GL is subdivided into two types: Land strictly used for grazing and other grassland. Land used for grazing has no wooden vegetation whereas other grassland may have some wooden vegetation that does not meet the forest definition. The area with strict grazing land is given as the area recorded as "common grassland" in the EU agricultural subsidiary system. Other grassland is estimated as the difference between the grazing land and the area classified as Grassland with remote sensing.

11.6.2 Description of the methodologies and the underlying assumptions used

As all the grazed grassland is more or less unimproved without fertiliser and no changes in management practice has been applied. This is in accordance with IPCC GPG 2003 (3.4.1.2.1.2).

For land converted to GL and not purely free of wooden trees/bushes it is assumed that there is a living biomass of 2,200 kg DM per ha in above ground biomass and 400 kg DM per ha in below ground biomass (source Nord-Larsen et al. 2009). These figures are based on the NFI measurements of Other wooded land - with crown cover of 6-10% crown cover or trees which not can reach a height of 5 meters at maturity.

In Grassland it is assumed that no changes in soil carbon stock in mineral soils are occurring. For organic soils is assumed an emission as reported in Section 7.

11.6.3 Factoring out

No factoring out has been made.

11.6.4 Recalculations

No recalculation has been performed.

11.6.5 Uncertainty estimates

No uncertainty analysis has been performed.

11.6.6 Information on other methodological issues

None.

11.6.7 The year of the onset of an activity, if after 2008

Not applicable.

11.7 Article 3.3

11.7.1 Information that demonstrates that activities under Article 3.3 began on or after 1 January 1990 and before 31 December 2012 and are direct human-induced

The land use mapping in 1990, 2005 and again at the end of the period 2012 is the documentation that activities under Article 3.3 began after 1.1.1990. As all land area is under management, all changes are evaluated as direct human induced. This also includes A and R which are based on approved methods of establishing new forest - both planting and natural revegetation. In some cases the absence of removal of tree growth is an easy and cheap method for establishing new forest. Hence this method also has been supported through public support for establishment of new forest areas.

11.7.2 Information on how harvesting or forest disturbance that is followed by the re-establishment of forest is distinguished from deforestation

Deforestation is detected by analysis of satellite images. Furthermore deforestation of larger areas is confirmed by e.g. projects on nature restoration. Temporarily unstocked areas are typically located within larger forest areas and will in most cases be reforestated within a period of 10 years as according to the Forest Act of Denmark, which applies to all Legal Forest Reserves (Fredsskov) and equals approximately 75 % of the total forest area. Clearcuts outside forests - e.g. small plantations of conifers on former cropland - is considered deforestation.

Most forest areas - including new forest areas - are subject to intermediate thinnings - harvesting of small trees. This is done with the purpose of reducing stem number and often to produce firewood or wood chips. Clearcuts of new forest areas occours in most cases first at maturity of the stand – after 50-100 years. A subset of the new forest area are managed as coppice like management, e.g. for production of christimas trees.

11.7.3 Information on the size and geographical location of forest areas that have lost forest cover but which are not yet classified as deforested

This information will be available after the QA/QC analysis of the land use maps of 1990 and 2005, which will be performed during 2010.

11.8 Article 3.4

11.8.1 Information that demonstrates that activities under Article 3.4 have occurred since 1 January 1990 and are human-induced

Forest Management

In FM all forest area is under management and changes in carbon stock are hence seen as human induced. The baseline for 1990 is estimated as documented in Johannsen et al. 2009.

Cropland Management

Since 1990 major changes in Danish Agriculture has taken place. Due to environmental demands for "green crops during winter" the previous major crop, spring barley been replaced by primarily winter wheat. Furthermore has a ban on field burning been implemented on January 1990 (Executive order NO. 142 of 08/03/1989). This has reduced the burning of field residues which were widely occurring until then. Furthermore as part of reducing the leaching of nitrogen is there an executive order NO. 624 of 15/07/1997, which demands the farmers that a certain percent of the area shall be grown with an extra crop after harvest of annual crops. Currently about 8 percent of the agricultural area is having an extra crop. From 2003 agricultural areas has been taken out of rotation due to demanded borders along watersheds to protect the watersheds.

Grassland Management

No specific activities have taken place in Grassland to increase or decrease the C stock. GM was elected so that all human induced activities affecting the C stock in the landscape are included in the Danish commitments under the Kyoto Protocol. Furthermore is it very difficult to distinguish between activities in CM and GM in the heterogenic patchy Danish landscape.

11.8.2 Information relating to Cropland Management, Grazing Land Management and Revegetation, if elected, for the base year

No further information is available.

11.8.3 Information relating to Forest Management

No further information is available.

11.9 Other information

11.9.1 Key category analysis for Article 3.3 activities and any elected activities under Article 3.4

According to the IPCC Good Practice Guidance for LULUCF a category that is identified as key in the UNFCCC inventory should also be considered key under the Kyoto Protocol (IPCC GPG, 2003).

The following LULUCF categories were identified as key categories in the UNFCCC reporting:

- Cropland remaining cropland – organic soils
- Cropland remaining cropland – mineral soils
- Cropland converted to forest land – conifers
- Cropland converted to forest land – broadleaves
- Forest land remaining forest land

According to Table 5.4.4 in the IPCC GPG for LULUCF this means that the following Kyoto Protocol activities are initially considered key:

Table 11.3 Relationship between activities in the UNFCCC LULUCF and the KP-LULUCF

LULUCF activity	KP-LULUCF activities
Land remaining Land	FM, GM, CM
Land converted to forest land	AR
Cropland remaining cropland	CM, RV

For Denmark the relevant KP-LULUCF activity corresponding to forest land remaining forest land identified as being a key category in the UNFCCC reporting is FM. For land converted to forest afforestation/reforestation is a key category. For cropland remaining cropland the relevant KP-LULUCF activity is CM.

Therefore AR, FM and CM are considered key categories in the Danish KP-LULUCF inventory.

11.10 Information relating to Article 6

There are no Article 6 projects (Joint Implementation) on the Danish territory.

12 Information on accounting of Kyoto units

Referring to Decision 15/CMP.1 on Guidelines for the preparation of the information required under Articles 7 of the Kyoto Protocol (UNFCCC, 2006), this chapter and chapters 14 and 15 include information and references to Denmark's and Greenland's annual non-inventory information under the Kyoto Protocol.

12.1 Background information

In accordance with paragraph 10 of the annex to Decision 15/CMP.1 information on emission reduction units, certified emission reductions, temporary certified emission reductions, long-term certified emission reductions, assigned amount units and removal units will be reported for the first calendar year in which these units will be transferred or acquired.

12.2 Summary of information reported in the SEF tables

The information required is contained in the UNFCCC Standard Electronic Format (SEF) application version 1.2. The full set of SEF tables contains confidential information according to EU Law. In order to allow for the NIR to be published, the SEF file is submitted separately. The data attached in Annex 6 consists of data allowed to be published according to EU Law. This is described in the section "Publicly accessible information."

12.3 Discrepancies and notifications

Annex 1 parties are also required to submit four reports according to paragraphs 12 to 16 of the annex to decision 15/CMP.1. These reports are:

- Paragraph 12 – List of discrepancies identified by the ITL.
- Paragraph 13/14 – List of notifications from the CDM Executive Board regarding lCERs.
- Paragraph 15 – List of non-replacement identified by the ITL.
- Paragraph 16 – List of invalid Kyoto units.

The list described in paragraph 12 is contained in Annex 6 as "Report – List of discrepancies identified by the ITL according to paragraph 12 of the annex to decision 15/CMP.1".

The lists described in paragraph 13-15 are not included in this NIR, as there are no tCERs or lCERs in the Danish Registry. For paragraph 16, the Danish Registry has yet to receive invalid Kyoto units. This also renders this list unnecessary to submit. The discrepancies have been found in the daily reconciliation and have all been solved by manual intervention by either the Danish Registry or the CITL/ITL depending on which stage the transaction was in.

12.4 Publicly accessible information

Information to be publically available from the SEF is included in Annex 6 (SEF data allowed to be published according to Commission Regulation (EC, 2004)). The parts of the SEF report that is attached in Annex 6 will also be publically available on the Danish Energy Agency website (http://www.ens.dk/en-US/ClimateAndCO2/emissiontradingscheme/DKemissiontradingagency/Sider/Forside.aspx)

Other information that is required to be publically available can be found on the Danish Energy Agency's registry website: https://www.kvoteregister.dk/reportTransactionInformation.do

This information includes information on each account as required in paragraph 45 of the annex to Decision 13/CMP.1. Please note that the contact information (paragraph 45 (e)) requires the consent of the account holder according to EU law. Thus, all of this information is not publically available.

Information on article 6 projects is not available as the Denmark to this date has not approved any Joint Implementation projects in Denmark.

12.5 Calculation of the commitment period reserve

The calculation of the Commitment Period Reserve (CPR) is based on the assigned amount of 276,838,955 tonnes of CO_2 equivalents. Subsequently, the CPR calculated as 90 % of the assigned amount is 249,155,060 tonnes CO_2 equivalent, during the commitment period and has not changed since the Report of the review of the initial report of Denmark published on 2 November 2007. The commitment period reserve has not changed since the previous submission, as 100 per cent times the most recent inventory times five would amount to a higher value.

The software still checks if the CPR is respected before a transaction from the Danish Registry can be carried out.

The CR Software that the Danish Emission Trading Registry is using as registry software was approved by the UNFCCC in the Independent Assessment Report the 16th of October 2007. Changes in the software have not been of a significance that has required a new Independent Assessment Report and software testing since then.

12.6 KP-LULUCF accounting

The accounting of domestic KP-LULUCF activities will not begin until Removal Units (RMUs) are issued after publication of the review report from the review of the NIR 2010 and no question of implementation regarding the KP-LULUCF inventories has been raised.

Referring to the KP-LULUCF inventory (Denmark and Greenland) Denmark expect to be able to issue 2,362,751 tonnes CO_2 equivalent as RMUs on the basis of activities in 2008 under Articles 3.3 and 3.4 of the Kyoto Protocol.

Table 12.1. Information on accounting for activities under articles 3.3 and 3.4 of the Kyoto Protocol

Greenhouse gas source and sink activities		Net emissions/-removals		Accounting Parameters	Accounting Quantity
	BY(5)	2008	Total		
		(Gg CO_2 equivalent)			
A. Article 3.3 activities					
A.1. Afforestation and Reforestation					-69.81
A.1.1. Units of land not harvested since the beginning of the commitment period		-69.81	-69.81		-69.81
A.1.2. Units of land harvested since the beginning of the commitment period					IE.NA
Denmark		IE.NA	IE.NA		IE.NA
A.2. Deforestation		35.89	35.89		35.89
B. Article 3.4 activities					
B.1. Forest Management		293.19	293.19		293.19
3.3 offset				0.00	0.00
FM cap				916.67	293.19
B.2. Cropland Management	3471.77	863.55	863.55	3471.77	-2608.22
B.3. Grazing Land Management	95.45	81.65	81.65	95.45	-13.80

References

EC, 2004: COMMISSION REGULATION (EC) No 2216/2004 of 21 December 2004 for a standardised and secured system of registries pursuant to Directive 2003/87/EC of the European Parliament and of the Council and Decision No 280/2004/EC of the European Parliament and of the Council. Available at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2004:386:0001:0077:EN:PDF

DEA, 2010: Publically available information on the Danish Energy Agency's Registry website. Available at: https://www.kvoteregister.dk/reportTransactionInformation.do

DEA, 2010: Publically available information on the on the Danish Energy Agency's general website. Available at: http://www.ens.dk/en-US/ClimateAndCO2/emissiontradingscheme/DKemissiontradingagency/Sider/Forside.aspx

UNFCCC, 2006: Report of the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol on its first session, held at Montreal from 28 November to 10 December 2005. Available at: http://unfccc.int/resource/docs/2005/cmp1/eng/08a02.pdf

UNFCCC, 2007: Report of the review of the initial report of Denmark. Available at: http://unfccc.int/resource/docs/2007/irr/dnk.pdf

13 Information on changes in the national system

The National system in Denmark has been strengthened by the signing of a formal data delivery agreement with the Government of Greenland.

The data agreement ensures that Greenland will make a complete CRF reporting of emissions and removals, and send the data to NERI. NERI is responsible for aggregating the CRF's from Denmark and Greenland and to submit a common CRF under the Kyoto Protocol.

14 Information on changes in the national registry

Referring to paragraph 22 of the annex to Decision 15/CMP.1, information on any changes that have occurred in the national registry, compared with information reported in the last submission should be included in this report.

However, no changes have been made since last submission (NIR 2009).

15 Information on the minimization of adverse impacts in accordance with Articles 3, paragraph 14

Referring to paragraph 23 of the annex to Decision 15/CMP.1, information on how Denmark is striving to implement commitments under the Kyoto Protocol in such a way to minimize adverse social, environmental and economic impacts on developing country Parties, particularly those identified in Article 4, paragraphs 8 and 9, of the Convention is included in this chapter.

In connection with Denmark's contribution to international climate efforts, in accordance with the Kyoto Protocol Denmark will endeavour to implement policies and measures under article 3 of the Protocol in such a way that adverse effects in other countries are minimised. However, Denmark does not consider that its contributions to international climate efforts have adverse effects in other countries as, on the contrary, the reduction of emissions of greenhouse gases in Danish commitments under the Protocol will in fact contribute to limiting dangerous climate change in all countries.

If nothing is done to limit emissions of greenhouse gases, climate scenarios from the IPCC indicate that developing countries in particular will experience the greatest changes in climate.

In its international efforts, Denmark will therefore continue to take the greatest possible account of special needs and concerns of developing countries and especially least developed countries. This also applies to adverse effects which can already be ascertained from changes in the climate. The existing strong Danish focus on the special vulnerability of developing countries to climate change underlines this as further described below.

15.1 Assistance to developing country parties particularly vulnerable to climate change

The least developed countries are among the countries that are most vulnerable to climate change. Denmark therefore attaches particular importance to helping these countries adapt to climate change. A natural consequence of this is that Danish programme cooperation countries are among the least developed countries and/or the most vulnerable countries.

The climate screenings performed under the Climate Change and Development Action Programme are important instruments in ensuring that the most vulnerable countries and communities are assisted in an appropriate and integrated manner. The studies were carried out in 17 countries (programme countries and Niger and Cambodia) from December 2005 to June 2008. The 17 studies include critical information about the impact of climate change and constitute a first step to "operationalising climate proofing" of Danish bilateral development assistance. Although this form of "climate proofing" was only one of several elements in the action programme, it is the area that has been most intensively in focus since 2005.

Probably the most important issue emerging from the studies concerns the uncertainty about trends in temperature, rainfall patterns and "extreme events" and the impact of climate change on economic growth and poverty reduction. In this context, the CCS studies emphasised the need to improve knowledge, awareness and information at regional, national and community levels, through enhanced climate data collection and analysis, refined scenarios and "downscaling" climate models to specific countries and regions. There is still a lot to learn and understand about the impact of climate change.

The projects launched based on the screenings were related to capacity building, mainstreaming of climate change, forest management, strengthening the link between climate change adaptation and disaster risk reduction as well as coastal and water resource management. The largest support to till date to a vulnerable country is the climate change adaptation and mitigation programme in Vietnam of 200 Mill. DKK. One third of the grant is allocated to climate change mitigation through energy efficiency and the remaining part is allocated to support the climate change adaptation.

15.2 EU-wide climate policies and measures

This section provides information on how Denmark through its role as a member state in the EU is also supporting the implementation of the commitments under Article 3, paragraph 14 of the Kyoto Protocol. The EU is well aware of the need to assess impacts, and has built up thorough procedures for EU-wide policies and measures in line with our obligations. This includes bilateral dialogues and different platforms in which the EU interact with third countries, explain new policy initiatives and receive comments from third countries.

Impacts on third countries are mostly indirect and can frequently neither be directly attributed to a specific EU policy, nor directly measured by the EU in developing countries. Therefore, the reported information covers potential adverse social, environmental and economic impacts that result from complex assessments of indirect influences and that are based on accessible data sources in developing countries.

15.2.1 Impact assessment of EU policies

In the EU a wide-ranging impact assessment system accompanying all new policy initiatives has been established. This regulatory impact assessment is a key element in the development of the Commission's legislative proposals. The Commission is required to take the impact assessment reports into account when taking its decisions, while the impact assessments are also presented and discussed during the scrutiny of legislative proposals from the Council and the Parliament. This approach ensures that potential adverse social, environmental and economic impacts on various stakeholders (in the case on developing country Parties) are identified and minimized within the legislative process. In general, impact assessments are required for all legislative proposals, but also other important Commission initiatives which are likely to have far-reaching impacts. Below the impact assessment process implemented in the EU policy making is explained in more detail in order to better demonstrate how the EU is striving for all strategies and policies to minimize their adverse impacts. Specific guidelines for the impact assessment have been adopted (European Commission, 2009).

The Impact Assessment Guidelines specifically address impacts on third countries and also issues related to international relations. In this area the following questions have to be assessed:

- Trade relations with third countries: some policies may affect trade or investment flows between the EU and third countries; the impact assessment should analyse how different groups (foreign and domestic businesses and consumers) are affected, and help to identify options which do not create unnecessary trade barriers.
- Impact on WTO obligations: it should be analysed which impact each proposed policy option has on the international obligations of the EU under the WTO Agreement; the impact assessment should examine whether the policy options concern an area in which international standards exist.
- Impacts on developing countries: initiatives that may affect developing countries should be analysed for their coherence with the objectives of the EU development policy. This includes an analysis of consequences (or spill-overs) in the longer run in areas such as economic, environmental, social or security policies.

Key economic questions to be assessed in relation to third countries are:

- How does the policy initiative affect trade or investment flows between the EU and third countries? How does it affect EU trade policy and its international obligations, including in the WTO?
- Does the option affect specific groups (foreign and domestic businesses and consumers) and if so in what way?
- Does the policy initiative concern an area in which international standards, common regulatory approaches or international regulatory dialogues exist?
- Does it affect EU foreign policy and EU development policy?
- What are the impacts on third countries with which the EU has preferential trade arrangements?
- Does it affect developing countries at different stages of development (least developed and other low-income and middle income countries) in a different manner?
- Does the option impose adjustment costs on developing countries?
- Does the option affect goods or services that are produced or consumed by developing countries?

Key questions on social impacts in third countries are:

- Does the option have a social impact on third countries that would be relevant for overarching EU policies, such as development policy?

- Does it affect international obligations and commitments of the EU arising from e.g. the ACP-EU Partnership Agreement or the Millennium Development Goals?
- Does it increase poverty in developing countries or have an impact on income of the poorest populations?

Key questions on environmental impacts in relation to third countries are:

- Does the option affect the emission of greenhouse gases (e.g. carbon dioxide, methane etc) into the atmosphere?
- Does the option affect the emission of ozone-depleting substances (CFCs, HCFCs etc)?
- Does the option affect our ability to adapt to climate change?
- Does the option have an impact on the environment in third countries that would be relevant for overarching EU policies, such as development policy?

If third countries are likely to be affected, the impact assessment should analyse in greater detail what the specific impacts may be, how undesired effects can be avoided or minimised, or mitigated, how the policy options compare in this respect and what trade-offs have to be addressed in the final policy choice.

Consulting interested parties is an obligation for every impact assessment and all affected stakeholders should be engaged, using the most appropriate timing, forma and tools to reach them. Appropriate consultation tools can be consultative committees, expert groups, open hearings, ad hoc meetings, consultation via internet, questionnaires, focus groups or seminars/workshops. Existing international policy dialogues are also be used to keep third countries fully informed of forthcoming initiatives, and as a means of exchanging information, data and results of preparatory studies with partner countries and other external stakeholders.

The EU's recent 5th national communication provides a detailed overview of the European policies and measures to mitigate GHG emissions in all sectors. All key strategies and climate policies have been subject to impact assessments as described above. All impact assessments and all opinions of the Impact Assessment Board are published online (see http://ec.europa.eu/governance/impact/ia_carried_out/cia_2010_en.htm). In addition to the general approach described above to address adverse social, environmental and economic impacts, more specific ways to minimize impacts depend on the respective policies and measures implemented. As the reporting obligation related to Article 3, paragraph 14 does not include an obligation to report on each specific mitigation policy, the EU choses the approach to provide some specific examples for a more complete overview on the ways how the EU is striving to minimize adverse impacts.

Two major EU policies, the Directive on the promotion of the use of renewable energy (Directive 2009/28/EC as well as the extension of the EU emission trading scheme (ETS) to the aviation sector (Directive 2008/101/EC) are presented in more detail as examples in this chaper, because the related impact assessments identified potential impacts on third countries.

Example 1: Directive on the promotion of the use of renewable energy - Promotion of biomass and biofuels

The Directive on renewable energy (Directive 2009/28/EC), a part of the EU's climate and energy package, sets ambitious targets for all Member States, such that the EU will reach a 20% share of energy from renewable sources in the overall energy consumption by 2020 (with indivudal targets for each Member State) and a 10% share of renewable energy specifically in the transport sector, which includes biofuels, biogas, hydrogen and electricity from renewables. Biomass is one of the renewable energy sources promoted by this directive and biofuels will be important for the achievement of the renewable target in the transport sector.

The impact assessments related to enhanced biofuel and biomass use in the EU showed that the cultivation of energy crops have both potential positive and negative impacts. Positively, as the growing of EU demand for bioenergy generates new export revenues and employment opportunities for developing countries and boosts rural economies. Thus there could be clear economic and social benefits. At the same time, the new EU energy crop demand could increase the impact on biodiversity, soil and water resources and can have positive as well as negative effects on air pollutants. The extent of carbon reduction and other environmental effects from the promotion of biofuels can vary according to the feedstock employed, the way the feedstock and the biofuels are produced, how they are transported and how far. Growing future demand for biomass feedstock combined with growing global food consumption could add to the agricultural sector's pressure on land use and result in adverse land use change.

To address the risk of such adverse impacts, Article 17 of the EU's Directive on renewable energy sources creates pioneering "sustainability criteria", applicable to all biofuels (biomass used in the transport sector) and bioliquids. The sustainability criteria adopted are:

- establish a threshold for GHG emission reductions that have to be achieved from the use of biofuels;
- exclude the use of biofuels from land with high biodiversity value (primary forest and wooded land, protected areas or highly biodiverse grasslands),
- exclude the use of biofuels from land with high C stocks, such as wetlands, peatlands or continuously forested areas.

Developing country representatives as well as other stakeholder were extensively consulted during the development of the sustainability criteria and preparation of the directive and the extensive consultation process has been documented.

The Directive also ensures that the Commission will report every two years, in respect to both third countries and Member States which constitute a significant source of biofuels or of raw material for biofuels consumed within the Union, on national measures taken to respect the sustainability criteria for soil, water and air protection.

The criteria pursuant to Article 17 apply to biofuels and bioliquids, not to solid biomass which is also promoted by the Directive. With regard to the energy use of all biomass forms, Article 17, paragraph 9 of the Directive requires the Commission to report on "requirements for a sustainability scheme for energy uses of biomass, other than biofuels and bioliquids, by 31 December 2009." A Commission communication on biomass sustainability including an impact assessment is forthcoming.

The Directive also required the Commission to examine and report on the potential adverse impact of biomass consumption and the need for sustainability criteria. This report and associated impact assessment addresses these issues (http://ec.europa.eu/energy/renewables/transparency_platform/transparency_platform_en.htm) and finds that as the overwhelming bulk of biompass energy is derived from European sources there is no need for sustainability criteria.

The Commission will also report on biofuels' potential indirect land use change effect and the positive and negative impact on social sustainability in the Union and in third countries, including the availability of foodstuffs at affordable prices, in particular for people living in developing countries, and wider development issues. Reports shall address the respect of land-use rights. The first reports will be submitted in 2012.

The EU's biofuel sustainability criteria form the first global initiative to address the climate change and sustainability issues surrounding crop production.

The biofuels scheme, by imposing environmental standards and requiring high greenhouse gas savings (35% rising to 60%), put also pressure on the production of the raw materials used for other purposes. Some examples of voluntary sustainability scheme out of the biofuels field are in the pipeline.

Any negative economic aspects will also be monitored by the Commission. In addition, Article 18(4) of the Directive provides that the Community shall endeavour to conclude bilateral or multilateral agreements with third countries containing provisions on sustainability criteria that correspond to those of this Directive. Where the Community has concluded agreements containing provisions relating to matters covered by the sustainability criteria set out in Article 17(2) to (5), the Commission may decide that those agreements demonstrate that biofuels and bioliquids produced from raw materials cultivated in those countries comply with the sustainability criteria in question.

In addition to the sustainability criteria, several initiatives have been taken to better channel and control biofuel and biomass expansion and thereby mitigate the most serious effects. With respect to palm oil production, the Roundtable on Sustainable Palm Oil (RPSO), an initiative by WWF, producers, traders and other NGOs, has recently announced the adoption of a set of criteria for the responsible production of palm oil, which would allow palm oil production without affecting the sustainability of tropical forests and endangered species. Other similar private and public initiatives will follow for other sectors and regions.

Another way the EU will strive to minimize potential adverse impacts of biomass use is to promote second generation biomass technologies. Within the renewable energy Directive, second generation biofuels are promoted through Article 21, paragraph 2 which establishes that the contribution made by biofuels produced from wastes, residues, non-food cellulosic material, and ligno-cellulosic material shall be considered to be twice that made by other biofuels for the purposes of demonstrating compliance with national renewable energy targets; and EU research also has a major focus on bioenergy technologies. The goal of second generation biofuel processes is to extend the amount of biofuel that can be produced sustainably by using biomass consisting of the residual non-food parts of current crops, such as stems, leaves and husks that are left behind once the food crop has been extracted, as well as other crops that are not used for food purposes (non food crops) and also industry waste such as woodchips, skins and pulp from fruit pressing. Second generation biofuels are expected to expand the biomass feedstock available for biofuel production. Further research and impact assessments in this area are necessary to assess e.g. the long-term effects of the energy use of non-food parts of crops compared to their existing use.

Example 2: Inclusion of aviation in the EU emission trading scheme

In 2005 the Commission adopted a Communication entitled "Reducing the Climate Change Impact of Aviation", which evaluated the policy options available to this end and was accompanied by an impact assessment. The impact assessment concluded that, in view of the likely strong future growth in air traffic emissions, further measures are urgently needed. Therefore, the Commission decided to pursue a new market-based approach at EU level and included aviation activities in the EU's scheme for greenhouse gas emission allowance trading. The finally adopted legislation was the result of an extensive stakeholder consultation including an internet consultation and an Aviation Working Group of experts set up as part of the European Climate Change Programme that identified the integration of aviation in the EU ETS as the lowest cost option to address the challenge of reducing emissions from this sector. The impact assessment also specifically addressed the effects on developing countries (European Commission, 2006).

Aircraft operators from developing countries will be affected to the extent they operate on routes covered by the scheme. Data from Eurocontrol on the nationality of operators has been used to make an estimate of the aggregated costs for third country airlines from regions that include developing countries. As operators from third countries generally represent a limited share of emissions covered, the impact is also modest. For example, the total additional operating costs for all operators based in Africa would, at current activity levels, vary from €2 to €35 million per year depending on allowance prices and the share of allowances auctioned. In terms of the economic impacts, a larger proportion of the compliance costs would naturally be borne by carriers from Annex I countries as they generally have a higher market share on the routes covered. However, carriers from developing countries that are able to operate in competition with Annex I carriers on such routes would need to be covered in order to avoid a) distortions of competition and b) discrimination as to nationality in line with the Chicago Convention.

For carriers with relatively old and inefficient fleets the impact may be higher as the effective proportion of allowances acquired for free through benchmarking is lower. However, as third country airlines would generally only have a fraction of their fleet operating in Europe, they may in some cases be able to reduce any negative effects by shifting their most efficient aircraft to operate on routes covered by the scheme.

To the extent that aviation's inclusion in the EU ETS creates additional demand for credits from JI and CDM projects, there will also be indirect positive effects as such projects imply additional investments in clean technologies in developing countries.

Similarly, additional finance for climate change mitigation and adaptation in developing countries should be raised through the auction of emissions allowances by EU Member States. The legislation provides a list of such areas by which the Member State should use the monies raised, and specifically mentions use for adaptation in developing countries.

There are further opportunities for developing countries to increase the demand for both CDM credits and future forms of sectoral mechanisms. The EU ETS legislation anticipates that third countries will take equivalent measures covering all flights departing their territory for the EU. In such circumstances, when equivalent measures are taken, the scope of the EU scheme can be reduced with the exclusion of these flights. Developing countries can thus benefit from additional demand for credits over and above the quantity that is allowed already for compliance by participants in the EU ETS.

<u>Information on how the EU gives priority, in implementing the commitments under Article 3, paragraph 14, to specific actions</u>

The EU reports activities that are related to the actions specified in the subparagraphs (a) to (f) of paragraph 24 of the reporting requirements in the Annex to decision 15/CMP.1. However, no decision was agreed yet that these actions form part of the commitment under Article 3, paragraph 14. For some of the actions specified in the reporting requirements, it seems rather unclear how they relate to the minimization of adverse social, environmental and economic impacts resulting from policies and measures to mitigate GHG emissions, e.g. information related to the cooperation activities requested are activities that help both Annex I and Non-Annex I Parties in reducing emissions from fossil fuel technologies, but they do not directly address the minimization of potential adverse impacts in Annex I Parties.

For the purposes of completeness in reporting, the all subparagraphs specified in the subparagraphs (a) to (f) of paragraph 24 of the reporting requirements in the Annex to decision 15/CMP.1 are addressed below. However the main ways how the EU is striving to minimize adverse impacts are described in the previous section.

a) The progressive reduction or phasing out of market imperfections, fiscal incentives, tax and duty exemptions and subsidies in all greenhouse-gas-emitting sectors, taking into account the need for energy price reforms to reflect market prices and externalities.

The actions addressed in subparagraph a) also form part of the commitment to implement policies and measures requested under Article 2, paragraph 1(a) (v), however Article 2 specifies that Annex I Parties shall "implement and/or further elaborate policies and measures in accordance with national circumstances, such as progressive reduction or phasing out of market imperfections, fiscal incentives, tax and duty exemptions and subsidies in all greenhouse gas emitting sectors that run counter to the objective of the Convention and application of market instruments." Subparagraph a) in the reporting requirements lacks such objective and therefore seems somewhat inconsistent with the commitment under Article 2. The promotion of research, demonstration projects, fiscal incentives or carbon taxes is important instrument to advance the objectives of the Convention, e.g. the use of renewable energies. A progressive reduction of all fical incentives or subsidies in all GHG emitting sectors would run counter the objective of the Convention and counter the ability of the EU to meet its commitment under Article 3, paragraph 1 of the Kyoto Protocol. Therfore the EU interprets this reporting requirement in a way consistent with Article 2 paragraph 1(a)(v) that the EU should focus on the progressive reduction or phasing out of market imperfections, fiscal incentives, tax and duty exemptions and subsidies that run counter the objectives of the Convention and application of market instruments.

The 2009 Review of the EU Sustainable Development Strategy assesses that "the Commission has been mainstreaming the progressive reform of environmentally harmful subsidies into its sectoral policies". For instance, environmental concerns have been gradually incorporated into the EU Common Agricultural Policy, including "decoupled" direct payments which have replaced price support; environmental cross compliance; a substantial increase in budget for rural development. As part of 2008 Common Agriculture Policy Health Check, additional part of direct aid has been shifted to climate change, renewable energy, water management, biodiversity, innovation; - transparency of agricultural subsidies has improved. It is important to note that in the other areas most subsidies are within the competence of the Member States and not of the EU, within the limits established by EU state aid rules.

EU policies aim to address market imperfections and to reflect externalities. For example the EU has made significant efforts to liberalise the internal energy market and to create a genuine internal market for energy as one of its priority objectives. The existence of a competitive internal energy market is a strategic instrument both in terms of giving European consumers a choice between different companies supplying gas and electricity at reasonable prices, but also in terms of making the market accessible for all suppliers, especially the smallest and those investing in renewable forms of energy.

With the implementation of the EU Emissions Trading Scheme, the EU uses a market instrument to implement the objective of the Convention and its commitment under Article 3, paragraph 1 of the Kyoto Protocol which aims at creating the right incentives for forward looking low carbon investment decisions by reinforcing a clear, undistorted and long-term carbon price signal.

With respect to financial support provided by the Member States to undertakings, the EU Treaty pronounces a general prohibition of "State aid". This concept encompasses a broad range of financial support measures adopted at national or sub-national level (i.e. not at EU level), and which can take various forms (subsidies, tax relieves, soft loans…). The Treaty provides for exceptions to this general prohibition. When State aid measures can contribute in an appropriate manner to the furtherance of objectives of common interest for the EU, and provided that they comply with certain strict conditions, they may be authorised by the Commission. By complementing the fundamental rules through a series of legislative acts and guidelines, the EU has established a worldwide unique system of rules under which State aid is monitored and assessed in the European Union. This legal framework is regularly reviewed to improve its efficiency. EU State aid control is an essential component of competition policy and a necessary safeguard for effective competition and free trade.

State aid reform in the EU aims to redirect aid to objectives of common interest which are related to the EU Lisbon Treaty, such as R&D&I, risk capital measures, training, and environmental protection. Environmental protection, and in particular, the promotion of renewable energy and the fight against climate change, is considered one of the objectives of common interest for the EU which may, under certain circumstances, justify the granting of State aid.

Specific "Community Guidelines on State aid for Environmental Protection"[17] have been established. The Guidelines foresee in particular the possibility to authorise the following types of State aid under certain conditions:

- Aid for undertakings which go beyond EU environmental standards or which increase the level of environmental protection in the absence of EU standards
- Aid for early adaptation to future EU standards
- Aid for energy saving
- Aid for renewable energy sources
- Aid for high-efficient cogeneration
- Aid for energy-efficient district heating (DH).

Directive 2003/96/EC on the taxation of energy products and electricity establishes EU-wide rules for the taxation of energy products used as motor or heating fuel, taxes on energy consumption, and common minimum levels of taxation. Under certain conditions the Directive allows for exemptions or reductions to promote renewable sources of energy. Thus, the tax exemptions allowed under this directive further promote the objectives of the Kyoto Protocol.

b) Removing subsidies associated with the use of environmentally unsound and unsafe technologies

There is no clear definition of environmentally unsound and unsafe technologies. However, in the context of the KyotoProtocol, unsound and unsafe technologies could be interpreted as those increasing GHG emissions.

[17] Official Journal No C 82, 1.4.2008, p.1.

Council Regulation (EC) No 1407/2002 on State Aid to the Coal Industry lays down rules for granting state aid with the aim of contributing to restructuring of the coal industry. The regulation expires at 31st December 2010. The provision of state aid is limited to the following activities:

- Aid for reduction of activity where the production units receiving aid from part of a closure plan with a final deadline of 31 December 2007;
- Aid for maintaining access to coal reserves;
- Aid to cover exceptional costs arising from rationalisation and restructuring that are not related to current production such as environmental rehabilitation and social costs.

The authorised aid has to follow a downward trend and for the EU 15 it shall not exceed for any year after 2003 the amount authorised for 2001. A separate baseline of aid authorised in 2004 is set as the ceiling for the ten new Member States. Thus, state aid provided to the coal industry has to be and is being continuously reduced. Where aid is provided under this regulation it must not result in delivered prices for the EU coal being lower than the prices of coal of similar quality from third countries. In this respect the state aid provided will not have adverse economic impacts on developing countries being coal exporters.

The phase-out of subsidies to fossil fuel production and consumption by 2010 was also one of the objectives in the Communication from the Commission "A Sustainable Europe for a Better World: A European Union Strategy for Sustainable Development (Commission's proposal to the Gothenburg European Council, 2001)"[18].

c) Cooperating in the technological development of non-energy uses of fossil fuels and supporting developing country Parties to this end;

The technological development of non-energy uses of fossil fuels is not a current research priority in the EU, nor a priority of cooperation with developing countries because the EU is not a major producer of oil and gas. Given the long-term depletion of fossil fuel resources and the decline in coal production, the EU's priority in general is the replacement of the use of fossil fuels by renewable resources.

d) Cooperating in the development, diffusion, and transfer of less-greenhouse-gas-emitting advanced fossil-fuel technologies, and/or technologies, relating to fossil fuels, that capture and store greenhouse gases, and encouraging their wider use; and facilitating the participation of the least developed countries and other non-Annex I Parties in this effort;

In March 2005, the EU and China signed an Action Plan on Clean Coal, which included cooperation on carbon capture and storage. The subsequent 2005 EU-China Summit established the EU-China Climate Change Partnership, which includes a political commitment to develop and demonstrate in China and the EU advanced, near-zero emissions coal (NZEC) technology through carbon capture and storage (CCS) by 2020. Phase I of this cooperation will be completed in 2009. Phase II of NZEC will run from 2010-2012. It will examine the site-specific requirements for and define in detail a demonstration plant and accompanying measures.

[18] See http://eur-lex.europa.eu/LexUriServ/site/en/com/2001/com2001_0264en01.pdf

It will include the technical and cost analysis of different options. Based on this analysis, the site of the power plant as well as the combustion technology (pulverised coal or IGCC), the capture technology and the transport and storage concepts will be determined. Phase II shall also include a detailed roadmap for the construction and operation of the demonstration plant as well as an Environmental Impact Assessment of the demonstration power plant and the carbon storage site. Phase III should commence thereafter and will see the construction and operation of a commercial-scale demonstration plant in China.

The Communication from the Commission entitled "Demonstrating Carbon Capture and Geological Storage (CCS) in emerging developing countries: financing the EU-China Near Zero Emissions Coal Plant project" from June 2009 sets out the plan of the European Commission to establish an investment scheme to co-finance the construction and operation of a power plant to demonstrate carbon capture and storage (CCS) technology in China. This investment scheme could serve as a model for other technology cooperation activities between developed countries and emerging/developing countries in the context of a post-2012 climate change agreement.

The EU is also cooperating with other Annex I and Non-Annex I Parties (Brazil, Saudi Arabia, China, Colombia, India, Korea, Mexico and South Africa) in the "Carbon Sequestration Leadership Forum (CSLF)". The CSLF is a Ministerial-level international climate change initiative that is focused on the development of improved cost-effective technologies for the separation and capture of carbon dioxide (CO2) for its transport and long-term safe storage. The mission of the CSLF is to facilitate the development and deployment of such technologies via collaborative efforts that address key technical, economic, and environmental obstacles. The CSLF will also promote awareness and champion legal, regulatory, financial, and institutional environments conducive to such technologies[19].3

e) Strengthening the capacity of developing country Parties identified in Article 4, paragraphs 8 and 9, of the Convention for improving efficiency in upstream and downstream activities relating to fossil fuels, taking into consideration the need to improve the environmental efficiency of these activities

In the oil and gas industry the upstream sector is a term commonly used to refer to the exploration, drilling, recovery and production of crude oil and natural gas. The downstream sector includes the activities of refining, distillation, cracking, reforming, blending storage, mixing and shipping and distribution.

The EU contributes to strengthening of the capacities of fossil fuel exporting countries in the areas of energy efficiency via the work of the Energy Expert Group of the Gulf Cooperation Council (GCC)[20], in particular in the working sub-group on energy efficiency. As part of the EU's research programme, a project called "EUROGULF" was launched with the objective of to analyse EU-GCC relations with respect to oil and gas

[19] See http://www.cslforum.org/ for more specific information
[20] The Gulf Cooperation Council covers Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates.

issues and propose new policy initiatives and approaches to enhance co-operation between the two regional groupings.

The European e-network on clean energy technologies, currently under development as part of the EU's research and development, is also aiming at the objective: promote research and technical development of clean energy technologies in the GCC countries. The Commission has recently started a project with the specific objective to create and facilitate the operation of an EU-GCC Clean Energy Network during the next three years. The network is to be set up to act as a catalyst and element of coordination for development of cooperation on clean energy.

Energy efficiency activities in the upstream or downstream sector are also candidates for CDM projects. Thus, the development of the CDM under the Kyoto Protocol and the demand of CERs by Annex I Parties under the Kyoto Protocol as well as by operators under the EU ETS have fostered such activities performed by the private sector. Related CDM projects are for example:

- Rang Dong Oil Field Associated Gas Recovery and Utilization Project in Vietnam: The purpose of this project activity is the recovery and utilization of gases produced as a by-product of oil production activities at the Rang Dong oil field in Vietnam with the involvement of ConocoPhillips (UK).
- Recovery of associated gas that would otherwise be flared at Kwale oil-gas processing plant in Nigeria involves the capture and utilisation of the majority of associated gas previously sent to flaring at Kwale OGPP plant. The Kwale OGPP plant receives oil with associated gas from oil fields operated by Eni Nigeria Agip Oil Company.
- Recovery and utilization of associated gas produced as by-product of oil recovery activities at the Al-Shaheen oil field in Qatar
- Flare gas recovery and utilisation project at Uran oil and gas processing plant in India which is handleing the oil and gas produced in the Mumbai High offshore oil field.
- Flare gas recovery and utilisation project at Hazira gas and condensate processing plant in India.
- Flare gas recovery and utilisation project from Kumchai oil field in India
- Flare gas recovery and utilisation project at the Ovade-Ogharefe oil field operated by Pan Ocean Oil Corporation in Nigeria
- Flare gas recovery and utilisation project at Soroosh and Nowrooz offshore oil fields in Iran.
- Leak reduction in aboveground gas distribution equipment in the KazTransgaz-Tbilisi gas distribution system in Georgia where leakages at gate stations, pressure regulator stations, valves, fittings as well at conection points with consumers are reduced.
- There are currently 21 Coal Mine Methane Utilization Project in China which use coalmine methane previously released to the atmosphere.

Improved energy efficiency in the energy and the transport sector in a more general way is one of the priorities in the EU's development assistance as well as for the EIB (European Investment Bank) and the EBRD (European Bank for Reconstruction and Development). Related projects and specific activities can be found for example at http://www.eib.org/projects/topics/environment/renewable-energy/index.htm or http://www.ebrd.com/country/sector/energyef/

f) Assisting developing country Parties which are highly dependent on the export and consumption of fossil fuels in diversifying their economies.

The EU actively undertakes a large number of activities aiming at reducing dependence on the consumption of fossil fuels, in particular the EU support activities for the promotion of renewable energies and energy efficiency in developing countries contribute to reduction of dependence on fossil fuels, meeting rural electricity needs, and the improvement of air quality. As explained in more detail in Chapter 8 of the EU's 5th national communication, several support programmes exist in this respect. These include:

• *Renewable energy cooperation with the Mediterranean and Gulf countries*

The major objective of the cooperation between the EU and the Mediterranean and Gulf countries in the field of renewable energy is to contribute to sustainable energy and climate mitigation and to develop an integrated and interconnected 'Green Energy Market'.

Several initiatives are already being developed by the European Union in cooperation with the partners in the Gulf region to boost energy as well as renewable energy development. This includes the EU-GCC (Gulf Cooperation Council) Energy Expert Group, which started working at the beginning of 1990s and the EU-GCC Climate Change Expert Group that has met on a regular basis since 2007. In 2009 EU and GCC partners agreed on extending energy cooperation and more specifically on establishing an EU-GCC clean energy network thus bringing together the relevant EU and GCC stakeholders. The European Commission will support the establishment of a network of key actors from public and private sectors in the EU and the GCC with a view to deepening cooperate on clean energy. This network will act as a facilitator and identify projects in fields of common interest, such as solar and other renewable energies.

Given the importance of research to further development of renewable energy in the GCC region, the Commission is also contributing to the establishment of a specific large-scale platform to foster international R&D cooperation with partners of the Gulf region.

The expansion and deployment of renewable energy is currently a key element in cooperation between the EU and the Mediterranean countries. The most important initiative is the Mediterranean Solar Plan, endorsed in 2008. The objective is the creation of 20 GW of new generation capacity in solar and other renewable energy sources around the Mediterranean Sea by 2020. The Regional Centre of Excellence for Renewable Energy and Energy Efficiency (RCREEE) facilitates development of renewable energy sources and promotion of energy efficiency measures in the Southern Mediterranean partner countries. Since 2008, when the centre was established in Cairo, the European Union has provided a financial contribution to enable the launch and initial operation of the Centre.

Bearing in mind the importance of the infrastructures necessary for deployment and exports of green energy, the EU is contributing to the Maghreb Electricity Market Integration Project (IMME). The objective is to create a sub-regional electricity market between Morocco, Tunisia and Algeria and its progressive integration with the EU's electricity market. The Commission has so far provided a support of €5.6 million. These are only some examples from the cooperation with the Mediterranean countries.

• *Africa, Caribbean and the Pacific (ACP-E) Energy Facility*

The ACP-EU Energy Facility is a contribution under the EU Energy Initiative to increase access to energy services for the poor. The Facility was approved by the joint ACPEU Council of Ministers in June 2005, with an amount of € 220 million. The main activity of the Facility is to co-finance projects that deliver energy services to poor rural areas.

The Energy Facility was mainly implemented through a €198 million Call for Proposals which was launched in June 2006. Out of 307 proposals received, 74 projects have been contracted by the end of 2008 for a total amount of €196 million from the Energy Facility, with a total project cost of €430 million.

The main activities performed through Energy Facility projects can be classified into three different groups: (1) energy production, transformation and distribution, (2) extension of existing electricity grids and (3) "soft" activities such as governance, capacity building or feasibility studies. The sources of energy used for electricity generation were mainly renewable energies (77 % of the projects). Only one project using exclusively fossil fuels was funded. In total, € 81 million of commitments have been marked as climate change related under the Energy Facility, covering support to enhance use of renewable energies or increase energy efficiency. A replenishment of the ACP-EU Energy Facility has been decided under the 10th European Development Fund for the period of 2009-2013. Endowed with € 200 million, it will focus on improving access to safe and sustainable energy services in rural and peri-urban areas. The new Energy Facility will also contribute to the fight against climate change by emphasizing the use of renewable energy sources and energy efficiency measures and by taking into account impacts of climate change on energy systems. The new Facility would start being implemented by the end of 2009.

• *Euro-Solar Programme in Latin America*

The Euro-Solar Programme is aiming to reduce poverty, allowing remote rural communities currently without access to electricity, to benefit from renewable electric energy. Approved in May 2006 and extended in December 2008, the Programme's total budget amounts to € 35.8 million, of which € 6.9 million will be provided by the Programme's eight beneficiary countries.

• *Latin America Investment Facility (LAIF)*

The European Commission plans to establish the Latin America Investment Facility (LAIF). The LAIF will focus on energy, environment and transport investment, contributing to cleaner transport infrastructure, improved energy efficiency and energy savings, the use of renewable energy, low-carbon production and of climate change adaptation technologies. The LAIF will operate by providing financial non-refundable contributions to support loans to partner countries from the European Investment Bank (EIB) and other European, multilateral and national, development finance institutions and will encourage the beneficiary governments and public institutions to carry out essential investments in the relevant sectors. The contribution of the Commission to the LAIF will be decided annually. For the year 2009, the Commission will allocate a budget of €10.85 million.

• *Global Energy Efficiency and Renewable Energy Fund (GEEREF)*

The European Commission has launched an innovative pilot instrument to involve the private sector. The Global Energy Efficiency and Renewable Energy Fund (GEEREF), launched in 2007, is focused on energy efficiency and renewable energy projects in developing countries and economies in transition. GEEREF invests in regionally-orientated investment schemes and prioritizes small investments below €10 million. In December 2008, the GEEREF Investment Committee approved two funds, and the first investments of a total value of € 22.5 million were carried out in 2009 focusing on projects in Sub-Saharan and Southern Africa and in Asia:

- €12.5 million investment in Berkeley Energy's Renewable Energy Asia Fund (REAF) for operationally and economically mature wind, hydro, solar, biomass, geothermal and methane recovery projects in India, Philippines, Bangladesh and Nepal.

- €10 million investment in the Evolution One Fund, dedicated to clean energy investment in Southern Africa (SADC countries).

In the regions where the two funds operate, there is a lack of equity investment available through the market for these types of projects. It is envisaged that GEEREF will invest in regional sub-funds for the African, Caribbean and Pacific (ACP) region, Neighbourhood, Latin America and Asia. Together the European Commission, Germany and Norway have committed about €108 million to the GEEREF over the period 2007-2011, the majority of which is provided by from the EU budget. It is envisaged that further financing from other public and private sources will be forthcoming. In 2007, the EU budget contributed €5 million towards a support facility for the GEEREF and a further €25 million in form of grants.

The EU also supports developing countries in diversifying their economies. However these activities are not limited to fossil fuel exporting countries, but open to all developing countries based on partnership agreements such as the ACP-EU Partnership Agreement. Within this partnership agreement there are five areas of EU intervention for private sector development which are:

- 1. The creation of enabling environment
- 2. The promotion of investment and inter-enterprise co-operation
- 3. Investment financing and development of financial markets

- 4. Business Development Services
- 5. Support for micro-enterprises (especially through the development of an effective microfinance market)

More specific information related to these activities can be obtained at: http://ec.europa.eu/europeaid/where/acp/sector-cooperation/economic-growth/index_en.htm

15.3 References

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Annexes to Denmark's NIR 2010, Inventories 1990 – 2008

Annex 1 Key Source Analyses

Description of the methodology used for identifying key Categories

Key Category Analysis (KCA) tier 1 and 2 for year 1990 and 2008 for Denmark (excluding Greenland and Faroe Islands) has been carried out in accordance with the IPCC Good Practice Guidance. The KCA has been carried out excl and incl the LULUCF sector. For Greenland and for a for Denmark and Greenland tier 1 KCA have been worked out, refer to Annex 9 and Annex 10, respectively.

The base year in the analysis is the year 1990 for the greenhouse gases CO_2, CH_4, N_2O and 1995 for the greenhouse F-gases HFC, PFC and SF_6. The KCA approach is a tier 1 quantitative analysis and a tier 2 approach using tier 1 uncertainties.

The level assessment of the tier 1 KCA is a ranking of the source categories in accordance to their relative contribution to the national total of greenhouse gases calculated in CO_2 equivalent units. The level key categories are found from the list of source categories ranked according to their contribution in descending order. Level key categories are those from the top of the list and of which the sum constitutes 95 % of the national total.

The trend assessment of the tier 1 KCA is a ranking of the source categories according to their contribution to the trend of the national total of greenhouse gases, calculated in CO_2 equivalents, from the base year to the year under consideration. The trend of the source category is calculated relative to that of the national totals and the trend is then weighted with the contribution, according to the level assessment. The ranking is in descending order. As for the level assessment, the cut-off point for the sum of contribution to the trend is 95 % and the source categories from the top of the list to the cut-off line are trend key categories.

In this submission for the first time a tier 2 KCA has been carried out to provide additional insight into categories being key sources. The catagorisation used is as for the tier 1 analysis and the uncertainties used are tier 1 uncertainties as listed in Annex 7.

The level tier 2 KCA is a ranking of the categories according to their relative contribution to the national total multiplied by the uncertainty of the emission of the category as the combined uncertainty on AD and on EMF. Chosen for cut of for key categories in the analysis is 90 %.

The trend tier 2 KCA is a ranking of the categories according to their relative contribution to the trend 1990-2008 of the national total multiplied by the uncertainty of the emission of the category. Chosen for cut of for key categories in the analysis is 90 %.

Since the level KCA is carried out for 1990 and 2008 (and exclusive and inclusive LULUCF) and for tier 1 and 2 in total 12 KCA tables for Denmark (excluding Greenland and Faroe Islands) has been worked out along the suggestions in the GPG Tables 7.A1-2. Further, presented are two overview tables modified from the GPG Table 7.A3 (exclusive and inclusive LULUCF) on the summary results of the KCA for 1990 for 2008 and for the trend 1990-2008.

The level of disaggregation

The starting point for the choice of source categories is presented in the GPG as Table 7.1. This table constitutes a suggested list of source categories for the KCA. It is mentioned in the GPG that categories for the KCA should be chosen in a way so that emissions from a single category are estimated with the same method and the same emission factor. Therefore, for categories in Table 7.1, which in our Corinair database are composed of activities with different emission factors or estimated with different methods, splits were made accordingly. The categorisation in accordance with this has been somewhat revised compared to the 2009 submission. The categories follows the categorisation used for the uncertainty analyses, cf Annex 7.

The source categories in the KCA for energy and stationary combustion are defined according to the fuels and their emission factors, which are as follows and not changed since previous KCA:

Table A Source categories for energy and stationary combustion defined according to the fuels and emission factors.

CO_2 emission factors, fossil	Kg pr GJ
COAL [1)]	95
COKE OVEN COKE	108
PETROLEUM COKE	92
PLASTIC WASTE	17.6
RESIDUAL OIL [1)]	78
GAS OIL	74
KEROSENE	72
NATURAL GAS	56.78
LPG	65
REFINERY GAS	56.9

[1)] These emission factors are the standard emission factors used for the year 2008. Since 2006 plant specific emission factors are also used for these fuels acquired under the EU ETS.

For energy and mobile combustion, the KCA source categories are the following activities:

Table B Source categories for energy and mobile combustion.

	Category for Key Source Analysis		CRF Cat	Part of CRF Cat	CRF cat descr.
1	Mobile combustion	Civil aviation	1.A.3.a		Transport
2	Mobile combustion	Road transportation	1.A.3.b		Transport
3	Mobile combustion	Railways	1.A.3.c		Transport
4	Mobile combustion	Navigation small boats	1.A.3.d		Transport
5	Mobile combustion	Navigation large vessels	1.A.3.d		Transport
6	Mobile combustion	Military	1.A.5.b		Other Mobil
7	Mobile combustion	National fishing		1.A.4.c	Other Sectors Agr/Fores/Fisheries
8	Mobile combustion	Agriculture		1.A.4.c	Other Sectors Agr/Fores/Fisheries
9	Mobile combustion	Forestry		1.A.4.c	Other Sectors Agr/Fores/Fisheries
10	Mobile combustion	Other mobile and machinery/industry		1.A.2.f	Manif Industries and C Other
11	Mobile combustion	Household and gardening		1.A.4.b	Other Sectors. b. Residential

The categories in Table B, numbered 1 – 3 and 6, are directly found in the CRF-tables, while numbers 7 – 9 are found under CRF category 1.A.4.c, number 10 under 1.A.2.f and number 11 under 1.A.4.b. New in this KCA is the split of Navigation in small boats and large vessels, numbers 4 and 5; the sum of the emission for the split corresponds to CRF 1.A.3.d. The categories have been chosen as source categories for the analysis due to differences in the use of fuels and fuel types and resulting differences in emission factors and uncertainties. This categorisation is used for CO_2-, CH_4- and N_2O-emissions.

For energy and Non-CO_2 emission from stationary combustion a split is made according to the following two tables:

Table C Energy: Non-CO_2 emission from stationary combustion CH_4.

CRF-category/source	Fuel
1A1+1A2+1A4	BIOMASS
Biogas fuelled engines	BIOMASS
1A1+1A2+1A4	GAS
Natural gas fuelled engines	GAS
1A1+1A2+1A4	LIQUID
1A1+1A2+1A4	WASTE
1A1+1A2+1A4	SOLID

Table D Energy: Non-CO_2 emission from stationary combustion: N_2O.

CRF-category	Fuel
1A1+1A2+1A4	BIOMASS
1A1+1A2+1A4	GAS
1A1+1A2+1A4	LIQUID
1A1+1A2+1A4	WASTE
1A1+1A2+1A4	SOLID

For Energy and Fugitive emissions the categorisation used in the KCA is according to the following table, where data can be directly found in the CRF:

Table E Fugitive emissions.

1B2c2i, Flaring oil	CO_2
1B2c2ii, Flaring gas	CO_2
1B2aiv, Oil refining and storage	CH_4
1B2aii, Oil production landbased	CH_4
1B2aii, Oil production offshore	CH_4
1B2biii, Gas transmission	CH_4
1B2biv, Gas distribution	CH_4
1B2c2i, Flaring oil	CH_4
1B2c2ii, Flaring gas	CH_4
1B2c2i, Flaring oil	N_2O
1B2c2ii, Flaring gas	N_2O

For the sectors Industry, Solvent, Agriculture, LULUCF and Waste, the source categories in the KCA are as before, activities found in the CRF source categorisation. For Industry new to this KCA is emission estimates in the "food and drink" category.

For solvent the categorisation has been made according to the following table:

Table F Solvent and Other Product Use.

3A Paint application	CO_2
3B Degreasing and dry cleaning	CO_2
3C Chemical products, manufacturing and processing	CO_2
3D5 Other	CO_2
3D5 Other	N_2O

For agriculture the categorisation used for the KCA is according to the following tables

Table G Agriculture. Agriculture soils, direct emissions.

Synthetic Fertilizers	N_2O
Animal Manure Applied to Soils	N_2O
N-fixing Crops	N_2O
Crop Residue	N_2O
Cultivation of Histosols (2)	N_2O
Other direct emissions (please specify)	N_2O

Table H Agriculture. Agriculture soils, indirect emissions.

Agriculture soils, pasture, range and paddock	N_2O
Atmospheric Deposition	N_2O
Nitrogen Leaching and Run-off	N_2O

Further, for agriculture emission estimates for "Field burning of Agriculture Residues" is a new category for this submission and entered the KCA.

For LULUCF the categorisation used for this KCA is according to the following table:

Table I LULUCF.

Forest Land remaining Forest Land	5A1 Broadleaves	CO_2
Forest Land remaining Forest Land	5A1 Conifers	CO_2
Forest Land. Land converted to Forest Land	5A2 Broadleaves	CO_2
Forest Land. Land converted to Forest Land	5A2 Conifers	CO_2
Non-CO_2 drainage of soils and wetlands	5IID Forest Land.	N_2O
Cropland	5B Cropland remaining Cr. Living biomass	CO_2
Cropland	5B Cropland remaining Cr. Mineral soils	CO_2
Cropland	5B Cropland remaining Cr. Organic soils	CO_2
N_2O Disturbance, Land converted to cropland	5III Cropland	N_2O
Grassland	5C Total Grasland. Living biomass	CO_2
Grassland	5C Grassland rem. Grasland. Organic soils	CO_2
Wetlands	5D Land converted to wetlands	CO_2
Wetlands	5D Wetlands remaining Wetlands (peat)	CO_2
Non-CO_2 drainage of soils and wetlands	5IID Wetlands. Peatland	N_2O
Settlements	5E Total settlements. Living biomass	CO_2
Agricultural lime application	5IV Cropland Limestone	CO_2

For the Waste Sector, Solid Waste Diposal on Land and Waste Water, the following categorisation directly found in the CRF is used

Table J Waste Sector, SWDS and WW.

Solid Waste Disposal Sites	CH_4
Waste Water Handling	CH_4
N_2O direct, Domestic and Commercial Wastewater	N_2O
N_2O indirect from human sewage	N_2O

New to this KCA is the split of the categories with N_2O-emission from WW.

For the Waste sector new to this submission is estimates of emissions from the following activities under Waste Incineration, the following table representing how they entered the KCA:

Table K Waste, Waste Incineration.

Accidental fires – buildings	CO_2
Accidental fires – vehicles	CO_2
Incineration of corpses	CH_4
Incineration of carcasses	CH_4
Accidental fires – buildings	CH_4
Accidental fires – vehicles	CH_4
Incineration of corpses	N_2O
Incineration of carcasses	N_2O

The selection of key source categorisation made for the KCA is well argued in relation to the intentions of the analysis in the GPG. The choice of categories identifies 113 categories for the analysis excluding LULUCF and 133 categories for the analysis including LULUCF. The categorisation in full is listed in Tables 1.13 and 1.14, excluding LULUCF including LULUCF respectively.

The result of the Key Category Analysis for Denmark for the year 1990 and 2008

The entries in the results of KCA in Tables 1.1-.12 for the years 1990 and 2008 are composed from the databases producing the CRF inventory and from CRFs for those years in this report. Note that base-year estimates are not used in the level assessment analysis for year 2008, but are only included in Table 1.1-.4 to make it more uniform with Tables 1.4-.6.

The result of the tier 1 KCA level assessment for Denmark for 1990 is shown in Table 1.1 and 1.2. For the assessment excl. LULUCF, 24 categories were identified as key categories and marked as shaded, refer Table 1.1. For the assessment incl LULUCF, 30 categories were identified as key categories, refer Table 1.2.

The result of the tier 1 KCA level assessment for Denmark for 2008 is shown in Table 1.3-.4. For the assessment excl. LULUCF, 24 categories were identified as key categories, refer Table 1.3. For the assessment incl LULUCF, 30 categories were identified as key categories, refer Table 1.4. The increase in number of key categories compared to previous KCA (24 for 2007, 23 for 2006 and 21 for 2005, 2004, 2003 and 2002, and 20 in 2001 and 2000) is due to the increased number of categories used for the KCA.

The inclusion of the LULUCF sector in the level analysis implies that the emissions in this sector are all calculated positive, i.e. the absolute value of removals are included.

The result of the tier 1 KCA trend assessment for Denmark for 1990-2008 is shown in Table 1.5-.6. For the assessment excl. LULUCF, 25 categories were identified as key categories, refer Table 1.5. For the assessment incl LULUCF, 31 categories were identified as key categories, refer Table 1.6. The increase in number of key categories compared to previous KCA (29 in 2007 and 2006, 20 in 2005, 21 in 2004 and 2003, 17 in 2002 and 2001, and 16 in 2000) is due to the increased number of categories used for the KCA. Note that according to the GPG, the analysis implies that contributions to the trend are all calculated as mathematically positive to be able to perform the ranking. The LULUCF activities are in the table included with there sign, i.e. emissions: +, removals: -.

The result of the tier 2 KCA level assessment for Denmark for 1990 is shown in Table 1.7-.8. For the assessment excl. LULUCF, 27 categories were identified as key categories, refer Table 1.7. For the assessment incl LULUCF, 33 categories were identified as key categories, refer Table 1.8.

The result of the tier 2 KCA level assessment for Denmark for 2008 is shown in Table 1.9-.10. For the assessment excl. LULUCF, 29 categories were identified as key categories, refer Table 1.9. For the assessment incl LULUCF, 34 categories were identified as key categories, refer Table 1.10.

The result of the tier 2 KCA trend assessment for Denmark for 1990-2008 is shown in Table 1.11-.12. For the assessment excl. LULUCF, 36 categories were identified as key categories, refer Table 1.11. For the assessment incl LULUCF, 36 categories were identified as key categories, refer Table 1.12.

In Tables 1.13-.14 a summary of the KCA for year 2008, is given, excl. and incl. LULUCF respectively.

Table 1.1 Key Category Analysis for Denmark, base year 1990/1995 excl LULUCF, level assessment, tier 1.

Table 7.A1 (of Good Practice Guidance)

Tier 1 Analysis -Level Assessment DK – inventory

A			B	C	E	F
IPCC Source Categories (LULUCF excluded)			Direct GHG	Base Yr Est. Ex,o Mt CO_2-eq	Base Yr Level Assessm Lx,o	Base Yr Cumul total of Col. E
Energy	Stationary combustion	Coal	CO_2	24.0771	0.3479	0.3479
Energy	Mobile combustion	Road Transportation	CO_2	9.2753	0.1340	0.4819
Energy	Stationary combustion	Gas Oil	CO_2	4.5472	0.0657	0.5477
Energy	Stationary combustion	Natural Gas	CO_2	4.3195	0.0624	0.6101
Agriculture	Agriculture soils, indirect	Nitrogen Leaching and Run-off	N_2O	3.3339	0.0482	0.6582
Agriculture	Enteric fermentation		CH_4	3.2612	0.0471	0.7054
Energy	Stationary combustion	Residual Oil	CO_2	2.5052	0.0362	0.7416
Agriculture	Agriculture soils, direct emissions	Synthetic Fertilizers	N_2O	2.3946	0.0346	0.7762
Energy	Mobile combustion	Agriculture	CO_2	1.2725	0.0184	0.7946
Waste	Solid waste disposal sites		CH_4	1.1108	0.0161	0.8106
Agriculture	Agriculture soils, direct emissions	Animal Manure Applied to Soils	N_2O	1.0502	0.0152	0.8258
Industrial Proc.	Nitric acid production		N_2O	1.0429	0.0151	0.8409
Industrial Proc.	Cement production		CO_2	0.8824	0.0128	0.8536
Agriculture	Manure management		CH_4	0.8692	0.0126	0.8662
Energy	Mobile combustion	Other Mobil and Machin-ery/Industry	CO_2	0.8415	0.0122	0.8783
Energy	Stationary combustion	Refinery Gas	CO_2	0.8062	0.0116	0.8900
Agriculture	Manure management		N_2O	0.6669	0.0096	0.8996
Energy	Mobile combustion	Navigation large vessels	CO_2	0.6656	0.0096	0.9092
Energy	Mobile combustion	National Fishing	CO_2	0.5907	0.0085	0.9178
Agriculture	Agriculture soils, indirect	Atmospheric Deposition	N_2O	0.4414	0.0064	0.9241
Energy	Stationary combustion	Petroleum Coke	CO_2	0.4103	0.0059	0.9301
Energy	Stationary combustion	Plastic Waste	CO_2	0.3937	0.0057	0.9358
Energy	Stationary combustion	Kerosene	CO_2	0.3662	0.0053	0.9411
Agriculture	Agriculture soils, direct emissions	Crop Residue	N_2O	0.3612	0.0052	0.9463
Agriculture	Agriculture soils, pasture, range and paddock		N_2O	0.3141	0.0045	0.9508
Energy	Mobile combustion	Railways	CO_2	0.2967	0.0043	0.9551
Energy	Fugitive emissions	1B2c2ii, Flaring gas	CO_2	0.2762	0.0040	0.9591
Agriculture	Agriculture soils, direct emissions	N-fixing Crops	N_2O	0.2695	0.0039	0.9630
Energy	Mobile combustion	Civil Aviation	CO_2	0.2427	0.0035	0.9665
Industrial Proc.	Foam blowing		HFC	0.1826	0.0026	0.9691
Energy	Stationary combustion	LPG	CO_2	0.1687	0.0024	0.9716
Energy	Stationary combustion	Coke	CO_2	0.1378	0.0020	0.9736
Energy	Mobile combustion	Military	CO_2	0.1190	0.0017	0.9753
Agriculture	Agriculture soils, direct emissions	Cultivation of Histosols (2)	N_2O	0.1165	0.0017	0.9770
Industrial Proc.	Lime production		CO_2	0.1155	0.0017	0.9786
Energy	Mobile combustion	Household and Gardening	CO_2	0.1128	0.0016	0.9803
Energy	Mobile combustion	Road Transportation	N_2O	0.0970	0.0014	0.9817
Solvent and Other Prod. Use	3D5 Other		CO_2	0.0857	0.0012	0.9829
Energy	Stationary combustion	1A1+1A2+1A4, BIOMASS	CH_4	0.0829	0.0012	0.9841
Waste	N_2O indirect from human sewage		N_2O	0.0822	0.0012	0.9853
Energy	Stationary combustion	1A1 + 1A2 + 1A4, SOLID	N_2O	0.0798	0.0012	0.9864
Energy	Stationary combustion	1A1 + 1A2 + 1A4, LIQUID	N_2O	0.0757	0.0011	0.9875
Industrial Proc.	Other emissions of SF_6 i.e. from double glaze windows and labora-tories		SF_6	0.0676	0.0010	0.9885
Energy	Mobile combustion	Road Transportation	CH_4	0.0551	0.0008	0.9893

Continued						
Industrial Proc.	Other, lubricants		CO_2	0.0497	0.0007	0.9900
Energy	Mobile combustion	Navigation small boats	CO_2	0.0479	0.0007	0.9907
Energy	Stationary combustion	1A1 + 1A2 + 1A4, BIO-MASS	N_2O	0.0386	0.0006	0.9913
Industrial Proc.	Magnesium production		SF_6	0.0359	0.0005	0.9918
Energy	Mobile combustion	Forestry	CO_2	0.0357	0.0005	0.9923
Industrial Proc.	Refrigeration and AC equipment		HFC and PFC	0.0357	0.0005	0.9928
Waste	Waste water handling		CH_4	0.0304	0.0004	0.9933
Industrial Proc.	Iron and steel production		CO_2	0.0284	0.0004	0.9937
Agriculture	Agriculture soils, direct emissions	Other direct emissions (please specify)	N_2O	0.0279	0.0004	0.9941
Energy	Stationary combustion	1A1 + 1A2 + 1A4, GAS	N_2O	0.0278	0.0004	0.9945
Solvent and Other Prod. Use	3A Paint application		CO_2	0.0263	0.0004	0.9949
Waste	N_2O direct, domestic and commercial wastewater		N_2O	0.0240	0.0003	0.9952
Energy	Fugitive emissions	1B2c2i, Flaring oil	CO_2	0.0234	0.0003	0.9955
Solvent and Other Prod. Use	3C Chemical products, manufacturing and processing		CO_2	0.0231	0.0003	0.9959
Industrial Proc.	Yellow bricks production		CO_2	0.0230	0.0003	0.9962
Energy	Stationary combustion	1A1 + 1A2 + 1A4, WASTE	N_2O	0.0184	0.0003	0.9965
Industrial Proc.	Glass/GlassWoll production		CO_2	0.0174	0.0003	0.9967
Energy	Fugitive emissions	1B2aii, Oil production land-based	CH_4	0.0172	0.0002	0.9970
Energy	Mobile combustion	Agriculture	N_2O	0.0153	0.0002	0.9972
Energy	Stationary combustion	1A1+1A2+1A4, SOLID	CH_4	0.0149	0.0002	0.9974
Industrial Proc.	Expanded clay		CO_2	0.0149	0.0002	0.9976
Energy	Fugitive emissions	1B2aii, Oil production off-shore	CH_4	0.0149	0.0002	0.9978
Waste	Accidental fires - buildings		CO_2	0.0147	0.0002	0.9981
Industrial Proc.	Limestone and dolomite use		CO_2	0.0137	0.0002	0.9983
Energy	Mobile combustion	Navigation large vessels	N_2O	0.0130	0.0002	0.9984
Energy	Mobile combustion	National Fishing	N_2O	0.0115	0.0002	0.9986
Energy	Stationary combustion	Brown Coal Bri.	CO_2	0.0110	0.0002	0.9988
Energy	Mobile combustion	Other Mobil and Machinery/Industry	N_2O	0.0106	0.0002	0.9989
Energy	Stationary combustion	1A1+1A2+1A4, GAS	CH_4	0.0084	0.0001	0.9990
Energy	Stationary combustion	1A1+1A2+1A4, LIQUID	CH_4	0.0068	0.0001	0.9991
Waste	Accidental fires - vehicles		CO_2	0.0063	0.0001	0.9992
Energy	Fugitive emissions	1B2biv, Gas distribution	CH_4	0.0053	0.0001	0.9993
Energy	Stationary combustion	Natural gas fuelled engines, GAS	CH_4	0.0046	0.0001	0.9994
Industrial Proc.	Food and drink		CO_2	0.0045	0.0001	0.9994
Industrial Proc.	Electrical equipment		SF_6	0.0039	0.0001	0.9995
Energy	Fugitive emissions	1B2biii, Gas transmission	CH_4	0.0036	0.0001	0.9995
Energy	Mobile combustion	Civil Aviation	N_2O	0.0032	< 0.0001	0.9996
Energy	Mobile combustion	Household and Gardening	CH_4	0.0031	< 0.0001	0.9996
Energy	Mobile combustion	Railways	N_2O	0.0025	< 0.0001	0.9997
Agriculture	Field burning of agricultural residues		CH_4+N_2O	0.0025	< 0.0001	0.9997
Waste	Accidental fires - buildings		CH_4	0.0024	< 0.0001	0.9997
Energy	Mobile combustion	Agriculture	CH_4	0.0022	< 0.0001	0.9998
Energy	Stationary combustion	Biogas fuelled engines, BIOMASS	CH_4	0.0019	< 0.0001	0.9998
Energy	Stationary combustion	1A1+1A2+1A4, WASTE	CH_4	0.0018	< 0.0001	0.9998
Industrial Proc.	Road paving with asphalt		CO_2	0.0018	< 0.0001	0.9999
Energy	Fugitive emissions	1B2c2i, Flaring oil	CH_4	0.0013	< 0.0001	0.9999
Energy	Mobile combustion	Other Mobil and Machinery/Industry	CH_4	0.0013	< 0.0001	0.9999
Energy	Mobile combustion	Military	N_2O	0.0012	< 0.0001	0.9999
Industrial Proc.	Catalysts/Fertilizers and pesticides		CO_2	0.0008	< 0.0001	0.9999
Energy	Fugitive emissions	1B2aiv, Oil refining and storage	CH_4	0.0008	< 0.0001	0.9999

Continued						
Energy	Fugitive emissions	1B2c2ii, Flaring gas	N_2O	0.0006	< 0.0001	0.9999
Energy	Mobile combustion	Household and Gardening	N_2O	0.0005	< 0.0001	0.9999
Energy	Mobile combustion	Forestry	CH_4	0.0004	< 0.0001	1.0000
Energy	Fugitive emissions	1B2c2ii, Flaring gas	CH_4	0.0004	< 0.0001	1.0000
Energy	Mobile combustion	Navigation small boats	N_2O	0.0004	< 0.0001	1.0000
Energy	Mobile combustion	Navigation small boats	CH_4	0.0003	< 0.0001	1.0000
Energy	Mobile combustion	Navigation large vessels	CH_4	0.0003	< 0.0001	1.0000
Waste	Accidental fires - vehicles		CH_4	0.0003	< 0.0001	1.0000
Energy	Mobile combustion	National Fishing	CH_4	0.0003	< 0.0001	1.0000
Energy	Mobile combustion	Railways	CH_4	0.0003	< 0.0001	1.0000
Waste	Incineration of corpses		N_2O	0.0002	< 0.0001	1.0000
Energy	Mobile combustion	Forestry	N_2O	0.0002	< 0.0001	1.0000
Energy	Mobile combustion	Civil Aviation	CH_4	0.0002	< 0.0001	1.0000
Energy	Fugitive emissions	1B2c2i, Flaring oil	N_2O	0.0001	< 0.0001	1.0000
Energy	Mobile combustion	Military	CH_4	0.0001	< 0.0001	1.0000
Industrial Proc.	Asphalt roofing		CO_2	0.0000	< 0.0001	1.0000
Waste	Incineration of corpses		CH_4	0.0000	< 0.0001	1.0000
Waste	Incineration of carcasses		CH_4	0.0000	< 0.0001	1.0000
Solvent and Other Prod. Use	3B Degreasing and dry cleaning		CO_2	0.0000	< 0.0001	1.0000
Industrial Proc.	Aerosols		HFC	0.0000	< 0.0001	1.0000
Industrial Proc.	Other i.e fibre optics		HFC and PFC	0.0000	< 0.0001	1.0000
Solvent and Other Prod. Use	3D5 Other		N_2O	0.0000	< 0.0001	1.0000
Waste	Incineration of carcasses		N_2O	0.0000	< 0.0001	1.0000
Total				**69.2041**	**1.0000**	

Table 1.2 Key Category Analysis for Denmark, base year 1990/1995 incl LULUCF, level assessment, tier 1.

Table 7.A1 (of Good Practice Guidance)

Tier 1 Analysis - Level Assessment DK – inventory

A			B	C	E	F
IPCC Source Categories (LULUCF included)			Direct GHG	Base Yr Est. Ex,o (1) Mt CO_2-eq	Base Yr Level Assessm Lx,o	Base Yr Cumul total of Col. E
Energy	Stationary Combustion	Coal	CO2	24.0771	0.3242	0.3242
Energy	Mobile combustion	Road Transportation	CO2	9.2753	0.1249	0.4491
Energy	Stationary Combustion	Gas Oil	CO2	4.5472	0.0612	0.5103
Energy	Stationary Combustion	Natural Gas	CO2	4.3195	0.0582	0.5685
Agriculture	Agriculture soils, indirect	Nitrogen Leaching and Run-off	N2O	3.3339	0.0449	0.6133
Agriculture	Enteric Fermentation		CH4	3.2612	0.0439	0.6572
Energy	Stationary Combustion	Residual Oil	CO2	2.5052	0.0337	0.6910
Agriculture	Agriculture soils, direct emissions	Synthetic Fertilizers	N2O	2.3946	0.0322	0.7232
LULUCF	Cropland	5B Cropland remaining Cr. Mineral soils	CO2	-2.0207	0.0272	0.7504
Energy	Mobile combustion	Agriculture	CO2	1.2725	0.0171	0.7676
Waste	Solid Waste Disposal Sites		CH4	1.1108	0.0150	0.7825
LULUCF	Cropland	5B Cropland remaining Cr. Organic soils	CO2	1.0555	0.0142	0.7967
Agriculture	Agriculture soils, direct emissions	Animal Manure Applied to Soils	N2O	1.0502	0.0141	0.8109
Industrial Proc.	Nitric Acid Production		N2O	1.0429	0.0140	0.8249
Industrial Proc.	Cement Production		CO2	0.8824	0.0119	0.8368
Agriculture	Manure Management		CH4	0.8692	0.0117	0.8485
Energy	Mobile combustion	Other Mobil and Machin-ery/Industry	CO2	0.8415	0.0113	0.8598
Energy	Stationary Combustion	Refinery Gas	CO2	0.8062	0.0109	0.8707
Agriculture	Manure management		N2O	0.6669	0.0090	0.8797
Energy	Mobile combustion	Navigation large vessels	CO2	0.6656	0.0090	0.8886
LULUCF	Forest Land remaining Forest L.	5A1 Broadleaves	CO2	-0.6487	0.0087	0.8974
Energy	Mobile combustion	National Fishing	CO2	0.5907	0.0080	0.9053
LULUCF	Agricultural lime application	5IV Cropland Limestone	CO2	0.5652	0.0076	0.9129
Agriculture	Agriculture soils, indirect	Atmospheric Deposition	N2O	0.4414	0.0059	0.9189
Energy	Stationary Combustion	Petroleum Coke	CO2	0.4103	0.0055	0.9244
Energy	Stationary Combustion	Plastic Waste	CO2	0.3937	0.0053	0.9297
Energy	Stationary Combustion	Kerosene	CO2	0.3662	0.0049	0.9346
Agriculture	Agriculture soils, direct emissions	Crop Residue	N2O	0.3612	0.0049	0.9395
Agriculture	Agriculture soils, pasture, range and paddock		N2O	0.3141	0.0042	0.9437
Energy	Mobile combustion	Railways	CO2	0.2967	0.0040	0.9477
Energy	Fugitive emissions	1B2c2ii, Flaring gas	CO2	0.2762	0.0037	0.9514
Agriculture	Agriculture soils, direct emissions	N-fixing Crops	N2O	0.2695	0.0036	0.9551
LULUCF	Forest Land remaining Forest L.	5A1 Conifers	CO2	-0.2543	0.0034	0.9585
Energy	Mobile combustion	Civil Aviation	CO2	0.2427	0.0033	0.9617
LULUCF	Grassland	5C Total Grassland. Living biomass	CO2	0.1826	0.0025	0.9642
Industrial Proc.	Foam Blowing		HFC	0.1826	0.0025	0.9667
Energy	Stationary Combustion	LPG	CO2	0.1687	0.0023	0.9689
Energy	Stationary Combustion	Coke	CO2	0.1378	0.0019	0.9708
Energy	Mobile combustion	Military	CO2	0.1190	0.0016	0.9724
Agriculture	Agriculture soils, direct emissions	Cultivation of Histosols (2)	N2O	0.1165	0.0016	0.9740
Industrial Proc.	Lime Production		CO2	0.1155	0.0016	0.9755
Energy	Mobile combustion	Household and Gardening	CO2	0.1128	0.0015	0.9770
Energy	Mobile combustion	Road Transportation	N2O	0.0970	0.0013	0.9783
LULUCF	Grassland	5C Grassland rem. Gra-sland. Organic soils	CO2	0.0929	0.0013	0.9796
LULUCF	Wetlands	5D Wetlands remaining Wetlands (peat)	CO2	0.0861	0.0012	0.9808

Continued						
Solvent and Other Prod. Use	3D5 Other		CO2	0.0857	0.0012	0.9819
Energy	Stationary Combustion	1A1+1A2+1A4, BIOMASS	CH4	0.0829	0.0011	0.9830
Waste	N2O indirect from human sewage		N2O	0.0822	0.0011	0.9841
Energy	Stationary Combustion	1A1 + 1A2 + 1A4, SOLID	N2O	0.0798	0.0011	0.9852
LULUCF	Settlements	5E Total settlements. Living biomass	CO2	0.0796	0.0011	0.9863
Energy	Stationary Combustion	1A1 + 1A2 + 1A4, LIQUID	N2O	0.0757	0.0010	0.9873
Industrial Proc.	Other emissions of SF6 i.e. from double glaze windows and labora-tories		SF6	0.0676	0.0009	0.9882
Energy	Mobile combustion	Road Transportation	CH4	0.0551	0.0007	0.9889
LULUCF	Cropland	5B Cropland remaining Cr. Living biomass	CO2	-0.0530	0.0007	0.9897
Industrial Proc.	Other, lubricants		CO2	0.0497	0.0007	0.9903
Energy	Mobile combustion	Navigation small boats	CO2	0.0479	0.0006	0.9910
Energy	Stationary Combustion	1A1 + 1A2 + 1A4, BIO-MASS	N2O	0.0386	0.0005	0.9915
Industrial Proc.	Magnesium Production		SF6	0.0359	0.0005	0.9920
Energy	Mobile combustion	Forestry	CO2	0.0357	0.0005	0.9925
Industrial Proc.	Refrigeration and AC Equipment		HFC and PFC	0.0357	0.0005	0.9929
Waste	Waste Water Handling		CH4	0.0304	0.0004	0.9933
Industrial Proc.	Iron and Steel Production		CO2	0.0284	0.0004	0.9937
Agriculture	Agriculture soils, direct emissions	Other direct emissions (please specify)	N2O	0.0279	0.0004	0.9941
Energy	Stationary Combustion	1A1 + 1A2 + 1A4, GAS	N2O	0.0278	0.0004	0.9945
Solvent and Other Prod. Use	3A Paint application		CO2	0.0263	0.0004	0.9948
Waste	N2O direct, Domestic and Com-mercial Wastewater		N2O	0.0240	0.0003	0.9952
Energy	Fugitive emissions	1B2c2i, Flaring oil	CO2	0.0234	0.0003	0.9955
Solvent and Other Prod. Use	3C Chemical products, manufactur-ing and processing		CO2	0.0231	0.0003	0.9958
Industrial Proc.	Yellow Bricks Production		CO2	0.0230	0.0003	0.9961
Energy	Stationary Combustion	1A1 + 1A2 + 1A4, WASTE	N2O	0.0184	0.0002	0.9963
Industrial Proc.	Glass/GlassWoll Production		CO2	0.0174	0.0002	0.9966
Energy	Fugitive emissions	1B2aii, Oil production land-based	CH4	0.0172	0.0002	0.9968
LULUCF	Non-CO2 drainage of soils and wetlands	5IID Forest Land.	N2O	0.0157	0.0002	0.9970
Energy	Mobile combustion	Agriculture	N2O	0.0153	0.0002	0.9972
Energy	Stationary Combustion	1A1+1A2+1A4, SOLID	CH4	0.0149	0.0002	0.9974
Industrial Proc.	Expanded Clay		CO2	0.0149	0.0002	0.9976
Energy	Fugitive emissions	1B2aii, Oil production off-shore	CH4	0.0149	0.0002	0.9978
Waste	Accidental fires - buildings		CO2	0.0147	0.0002	0.9980
Industrial Proc.	Limestone and Dolomite use		CO2	0.0137	0.0002	0.9982
Energy	Mobile combustion	Navigation large vessels	N2O	0.0130	0.0002	0.9984
Energy	Mobile combustion	National Fishing	N2O	0.0115	0.0002	0.9985
Energy	Stationary Combustion	Brown Coal Bri.	CO2	0.0110	0.0001	0.9987
Energy	Mobile combustion	Other Mobil and Machin-ery/Industry	N2O	0.0106	0.0001	0.9988
Energy	Stationary Combustion	1A1+1A2+1A4, GAS	CH4	0.0084	0.0001	0.9989
Energy	Stationary Combustion	1A1+1A2+1A4, LIQUID	CH4	0.0068	0.0001	0.9990
Waste	Accidental fires - vehicles		CO2	0.0063	0.0001	0.9991
Energy	Fugitive emissions	1B2biv, Gas distribution	CH4	0.0053	0.0001	0.9992
LULUCF	Forest Land. Land converted to Forest L.	5A2 Conifers	CO2	0.0051	0.0001	0.9993
Energy	Stationary Combustion	Natural gas fuelled engines, GAS	CH4	0.0046	0.0001	0.9993
Industrial Proc.	Food and Drink		CO2	0.0045	0.0001	0.9994
Industrial Proc.	Electrical equipment		SF6	0.0039	0.0001	0.9994
Energy	Fugitive emissions	1B2biii, Gas transmission	CH4	0.0036	< 0.0001	0.9995
LULUCF	Forest Land. Land converted to	5A2 Broadleaves	CO2	0.0033	< 0.0001	0.9995

Forest L.

Continued						
LULUCF	N2O Disturbance, Land converted to cropland	5III Cropland	N2O	0.0032	< 0.0001	0.9996
Energy	Mobile combustion	Civil Aviation	N2O	0.0032	< 0.0001	0.9996
Energy	Mobile combustion	Household and Gardening	CH4	0.0031	< 0.0001	0.9997
Energy	Mobile combustion	Railways	N2O	0.0025	< 0.0001	0.9997
Agriculture	Field Burning of Agricultural Residues		CH4+N2O	0.0025	< 0.0001	0.9997
Waste	Accidental fires - buildings		CH4	0.0024	< 0.0001	0.9998
Energy	Mobile combustion	Agriculture	CH4	0.0022	< 0.0001	0.9998
Energy	Stationary Combustion	Biogas fuelled engines, BIOMASS	CH4	0.0019	< 0.0001	0.9998
Energy	Stationary Combustion	1A1+1A2+1A4, WASTE	CH4	0.0018	< 0.0001	0.9998
Industrial Proc.	Road paving with Asphalt		CO2	0.0018	< 0.0001	0.9999
Energy	Fugitive emissions	1B2c2i, Flaring oil	CH4	0.0013	< 0.0001	0.9999
Energy	Mobile combustion	Other Mobil and Machinery/Industry	CH4	0.0013	< 0.0001	0.9999
Energy	Mobile combustion	Military	N2O	0.0012	< 0.0001	0.9999
Industrial Proc.	Catalysts/Fertilizers and Pesticides		CO2	0.0008	< 0.0001	0.9999
Energy	Fugitive emissions	1B2aiv, Oil refining and storage	CH4	0.0008	< 0.0001	0.9999
Energy	Fugitive emissions	1B2c2ii, Flaring gas	N2O	0.0006	< 0.0001	0.9999
Energy	Mobile combustion	Household and Gardening	N2O	0.0005	< 0.0001	0.9999
Energy	Mobile combustion	Forestry	CH4	0.0004	< 0.0001	1.0000
Energy	Fugitive emissions	1B2c2ii, Flaring gas	CH4	0.0004	< 0.0001	1.0000
Energy	Mobile combustion	Navigation small boats	N2O	0.0004	< 0.0001	1.0000
LULUCF	Wetlands	5D Land converted to wetlands	CO2	0.0004	< 0.0001	1.0000
Energy	Mobile combustion	Navigation small boats	CH4	0.0003	< 0.0001	1.0000
Energy	Mobile combustion	Navigation large vessels	CH4	0.0003	< 0.0001	1.0000
Waste	Accidental fires - vehicles		CH4	0.0003	< 0.0001	1.0000
Energy	Mobile combustion	National Fishing	CH4	0.0003	< 0.0001	1.0000
Energy	Mobile combustion	Railways	CH4	0.0003	< 0.0001	1.0000
Waste	Incineration of corpses		N2O	0.0002	< 0.0001	1.0000
Energy	Mobile combustion	Forestry	N2O	0.0002	< 0.0001	1.0000
Energy	Mobile combustion	Civil Aviation	CH4	0.0002	< 0.0001	1.0000
LULUCF	Non-CO2 drainage of soils and wetlands	5IID Wetlands. Peatland	N2O	0.0001	< 0.0001	1.0000
Energy	Fugitive emissions	1B2c2i, Flaring oil	N2O	0.0001	< 0.0001	1.0000
Energy	Mobile combustion	Military	CH4	0.0001	< 0.0001	1.0000
Industrial Proc.	Asphalt Roofing		CO2	0.0000	< 0.0001	1.0000
Waste	Incineration of carcasses		N2O	0.0000	< 0.0001	1.0000
Waste	Incineration of corpses		CH4	0.0000	< 0.0001	1.0000
Waste	Incineration of carcasses		CH4	0.0000	< 0.0001	1.0000
Solvent and Other Prod. Use	3B Degreasing and dry cleaning		CO2	0.0000	< 0.0001	1.0000
Industrial Proc.	Aerosols		HFC	0.0000	< 0.0001	1.0000
Industrial Proc.	Other i.e Fibre Optics		HFC and PFC	0.0000	< 0.0001	1.0000
Solvent and Other Prod. Use	3D5 Other		N2O	0.0000	< 0.0001	1.0000
Total				**68.3169**	**1.00**	

[1)] The Estimates include signs, where + : emission - : removal, allthough in the level analyses only the absolute values are used

Table 1.3 Key Category Analysis for Denmark, year 2008 excl LULUCF, level assessment, tier 1.

Table 7.A1 (of Good Practice Guidance)

Tier 1 Analysis - Level Assessment DK - inventory

A			B	C	D	E	F
IPCC Source Categories (LULUCF excluded)			Direct GHG Gas	Base Yr Est. Ex,o Mt CO_2-eq	Yr 2008 Est. Ex,t Mt CO_2-eq	Yr 2008 Level Assessm Lx,t	Yr 2008 Cumul total of Col. E
Energy	Stationary Combustion	Coal	CO_2	24.0771	16.0495	0.2514	0.2514
Energy	Mobile combustion	Road Transportation	CO_2	9.2753	12.9485	0.2028	0.4542
Energy	Stationary Combustion	Natural Gas	CO_2	4.3195	9.7644	0.1529	0.6071
Agriculture	Enteric Fermentation		CH_4	3.2612	2.8194	0.0442	0.6513
Agriculture	Agriculture soils, indirect	Nitrogen Leaching and Run-off	N_2O	3.3339	1.9927	0.0312	0.6825
Energy	Stationary Combustion	Gas Oil	CO_2	4.5472	1.5441	0.0242	0.7067
Energy	Stationary Combustion	Residual Oil	CO_2	2.5052	1.3593	0.0213	0.7280
Energy	Stationary Combustion	Plastic Waste	CO_2	0.3937	1.3426	0.0210	0.7490
Agriculture	Agriculture soils, direct emissions	Synthetic Fertilizers	N_2O	2.3946	1.3177	0.0206	0.7696
Energy	Mobile combustion	Agriculture	CO_2	1.2725	1.2301	0.0193	0.7889
Industrial Proc.	Cement Production		CO_2	0.8824	1.1547	0.0181	0.8070
Agriculture	Agriculture soils, direct emissions	Animal Manure Applied to Soils	N_2O	1.0502	1.1235	0.0176	0.8246
Energy	Mobile combustion	Other Mobil and Machinery/Industry	CO_2	0.8415	1.1186	0.0175	0.8421
Waste	Solid Waste Disposal Sites		CH_4	1.1108	1.0567	0.0166	0.8587
Agriculture	Manure Management		CH_4	0.8692	1.0498	0.0164	0.8751
Energy	Stationary Combustion	Refinery Gas	CO_2	0.8062	0.8411	0.0132	0.8883
Energy	Stationary Combustion	Petroleum Coke	CO_2	0.4103	0.7545	0.0118	0.9001
Industrial Proc.	Refrigeration and AC Equipment		HFC and PFC	0.0357	0.7392	0.0116	0.9117
Agriculture	Manure management		N_2O	0.6669	0.5053	0.0079	0.9196
Energy	Mobile combustion	National Fishing	CO_2	0.5907	0.4495	0.0070	0.9266
Energy	Mobile combustion	Navigation large vessels	CO_2	0.6656	0.3526	0.0055	0.9322
Energy	Fugitive emissions	1B2c2ii, Flaring gas	CO_2	0.2762	0.3478	0.0054	0.9376
Agriculture	Agriculture soils, direct emissions	Crop Residue	N_2O	0.3612	0.3051	0.0048	0.9424
Agriculture	Agriculture soils, indirect	Atmospheric Deposition	N_2O	0.4414	0.2862	0.0045	0.9469
Energy	Mobile combustion	Household and Gardening	CO_2	0.1128	0.2390	0.0037	0.9506
Energy	Mobile combustion	Railways	CO_2	0.2967	0.2367	0.0037	0.9543
Agriculture	Agriculture soils, pasture, range and paddock		N_2O	0.3141	0.2143	0.0034	0.9577
Agriculture	Agriculture soils, direct emissions	N-fixing Crops	N_2O	0.2695	0.2127	0.0033	0.9610
Energy	Stationary Combustion	1A1+1A2+1A4, BIOMASS	CH_4	0.0829	0.1866	0.0029	0.9639
Energy	Stationary Combustion	Natural gas fuelled engines, GAS	CH_4	0.0046	0.1849	0.0029	0.9668
Energy	Mobile combustion	Civil Aviation	CO_2	0.2427	0.1638	0.0026	0.9694
Energy	Mobile combustion	Road Transportation	N_2O	0.0970	0.1256	0.0020	0.9714
Agriculture	Agriculture soils, direct emissions	Cultivation of Histosols (2)	N_2O	0.1165	0.1167	0.0018	0.9732
Energy	Stationary Combustion	Coke	CO_2	0.1378	0.1120	0.0018	0.9749
Energy	Mobile combustion	Military	CO_2	0.1190	0.1076	0.0017	0.9766
Industrial Proc.	Foam Blowing		HFC	0.1826	0.1026	0.0016	0.9782
Energy	Mobile combustion	Navigation small boats	CO_2	0.0479	0.1005	0.0016	0.9798
Energy	Stationary Combustion	LPG	CO_2	0.1687	0.0960	0.0015	0.9813
Energy	Stationary Combustion	1A1 + 1A2 + 1A4, BIOMASS	N_2O	0.0386	0.0810	0.0013	0.9826
Agriculture	Agriculture soils, direct emissions	Other direct emissions (please specify)	N_2O	0.0279	0.0783	0.0012	0.9838
Waste	N_2O direct, Domestic and Commercial Wastewater		N_2O	0.0240	0.0699	0.0011	0.9849
Industrial Proc.	Lime Production		CO_2	0.1155	0.0656	0.0010	0.9859
Energy	Stationary Combustion	1A1 + 1A2 + 1A4, GAS	N_2O	0.0278	0.0613	0.0010	0.9869

Continued							
Energy	Stationary Combustion	1A1 + 1A2 + 1A4, SOLID	N_2O	0.0798	0.0490	0.0008	0.9877
Waste	Waste Water Handling		CH_4	0.0304	0.0473	0.0007	0.9884
Energy	Stationary Combustion	1A1 + 1A2 + 1A4, LIQUID	N_2O	0.0757	0.0461	0.0007	0.9891
Energy	Fugitive emissions	1B2aiv, Oil refining and storage	CH_4	0.0008	0.0459	0.0007	0.9898
Solvent and Other Prod. Use	3D5 Other		CO_2	0.0857	0.0409	0.0006	0.9905
Industrial Proc.	Limestone and Dolomite use		CO_2	0.0137	0.0387	0.0006	0.9911
Energy	Fugitive emissions	1B2aii, Oil production offshore	CH_4	0.0149	0.0386	0.0006	0.9917
Energy	Fugitive emissions	1B2aii, Oil production landbased	CH_4	0.0172	0.0366	0.0006	0.9923
Waste	N_2O indirect from human sewage		N_2O	0.0822	0.0347	0.0005	0.9928
Industrial Proc.	Other, lubricants		CO_2	0.0497	0.0340	0.0005	0.9933
Industrial Proc.	Yellow Bricks Production		CO_2	0.0230	0.0284	0.0004	0.9938
Energy	Fugitive emissions	1B2c2i, Flaring oil	CO_2	0.0234	0.0282	0.0004	0.9942
Solvent and Other Prod. Use	3D5 Other		N_2O	0.0000	0.0273	0.0004	0.9947
Energy	Mobile combustion	Road Transportation	CH_4	0.0551	0.0220	0.0003	0.9950
Energy	Stationary Combustion	Biogas fuelled engines, BIOMASS	CH_4	0.0019	0.0209	0.0003	0.9953
Energy	Stationary Combustion	1A1 + 1A2 + 1A4, WASTE	N_2O	0.0184	0.0194	0.0003	0.9956
Industrial Proc.	Aerosols		HFC	NA,NO	0.0186	0.0003	0.9959
Waste	Accidental fires - buildings		CO_2	0.0147	0.0176	0.0003	0.9962
Energy	Mobile combustion	Forestry	CO_2	0.0357	0.0172	0.0003	0.9965
Industrial Proc.	Electrical equipment		SF_6	0.0039	0.0162	0.0003	0.9967
Energy	Mobile combustion	Agriculture	N_2O	0.0153	0.0161	0.0003	0.9970
Industrial Proc.	Expanded Clay		CO_2	0.0149	0.0161	0.0003	0.9972
Industrial Proc.	Other emissions of SF_6 i.e. from double glaze windows and laboratories		SF_6	0.0676	0.0154	0.0002	0.9975
Industrial Proc.	Glass/GlassWoll Production		CO_2	0.0174	0.0151	0.0002	0.9977
Energy	Stationary Combustion	1A1+1A2+1A4, GAS	CH_4	0.0084	0.0150	0.0002	0.9979
Energy	Mobile combustion	Other Mobil and Machin-ery/Industry	N_2O	0.0106	0.0147	0.0002	0.9982
Solvent and Other Prod. Use	3C Chemical products, manufacturing and process-ing		CO_2	0.0231	0.0146	0.0002	0.9984
Waste	Accidental fires - vehicles		CH_4	0.0063	0.0109	0.0002	0.9986
Solvent and Other Prod. Use	3A Paint application		CO_2	0.0263	0.0092	0.0001	0.9987
Energy	Mobile combustion	National Fishing	N_2O	0.0115	0.0088	0.0001	0.9989
Energy	Stationary Combustion	Kerosene	CO_2	0.3662	0.0086	0.0001	0.9990
Energy	Stationary Combustion	1A1+1A2+1A4, SOLID	CH_4	0.0149	0.0081	0.0001	0.9991
Energy	Mobile combustion	Navigation large vessels	N_2O	0.0130	0.0069	0.0001	0.9992
Industrial Proc.	Other i.e Fibre Optics		HFC and PFC	NO	0.0052	0.0001	0.9993
Energy	Mobile combustion	Household and Gardening	CH_4	0.0031	0.0050	0.0001	0.9994
Energy	Stationary Combustion	1A1+1A2+1A4, LIQUID	CH_4	0.0068	0.0043	0.0001	0.9994
Energy	Fugitive emissions	1B2biv, Gas distribution	CH_4	0.0053	0.0037	0.0001	0.9995
Agriculture	Field Burning of Agricultural Residues		CH_4+N_2O	0.0025	0.0034	0.0001	0.9996
Waste	Accidental fires - buildings		N_2O	0.0024	0.0028	<0,0001	0.9996
Energy	Fugitive emissions	1B2biii, Gas transmission	CH_4	0.0036	0.0027	<0,0001	0.9996
Energy	Mobile combustion	Civil Aviation	N_2O	0.0032	0.0027	<0,0001	0.9997
Industrial Proc.	Food and Drink		CH_4	0.0045	0.0027	<0,0001	0.9997
Industrial Proc.	Catalysts/Fertilizers and Pesticides		CH_4	0.0008	0.0024	<0,0001	0.9998
Energy	Mobile combustion	Railways	N_2O	0.0025	0.0020	<0,0001	0.9998
Industrial Proc.	Road paving with Asphalt		CO_2	0.0018	0.0019	<0,0001	0.9998
Energy	Mobile combustion	Agriculture	CH_4	0.0022	0.0016	<0,0001	0.9999
Energy	Mobile combustion	Household and Gardening	N_2O	0.0005	0.0012	<0,0001	0.9999

Continued							
Energy	Mobile combustion	Military	N_2O	0.0012	0.0011	<0,0001	0.9999
Energy	Mobile combustion	Navigation small boats	N_2O	0.0004	0.0011	<0,0001	0.9999
Energy	Stationary Combustion	1A1+1A2+1A4, WASTE	CH_4	0.0018	0.0009	<0,0001	0.9999
Energy	Mobile combustion	Other Mobil and Machin-ery/Industry	CH_4	0.0013	0.0009	<0,0001	0.9999
Energy	Fugitive emissions	1B2c2ii, Flaring gas	CH_4	0.0004	0.0008	<0,0001	0.9999
Energy	Fugitive emissions	1B2c2ii, Flaring gas	N_2O	0.0006	0.0008	<0,0001	1.0000
Energy	Mobile combustion	Navigation small boats	CH_4	0.0003	0.0005	<0,0001	1.0000
Waste	Accidental fires - vehicles		N_2O	0.0003	0.0005	<0,0001	1.0000
Energy	Mobile combustion	National Fishing	CH_4	0.0003	0.0002	<0,0001	1.0000
Waste	Incineration of corpses		N_2O	0.0002	0.0002	<0,0001	1.0000
Energy	Fugitive emissions	1B2c2i, Flaring oil	CH_4	0.0013	0.0002	<0,0001	1.0000
Energy	Mobile combustion	Forestry	N_2O	0.0002	0.0002	<0,0001	1.0000
Energy	Mobile combustion	Railways	CH_4	0.0003	0.0002	<0,0001	1.0000
Energy	Mobile combustion	Navigation large vessels	CH_4	0.0003	0.0002	<0,0001	1.0000
Energy	Mobile combustion	Civil Aviation	CH_4	0.0002	0.0001	<0,0001	1.0000
Energy	Mobile combustion	Military	CH_4	0.0001	0.0001	<0,0001	1.0000
Waste	Incineration of carcasses		N_2O	0.0000	0.0001	<0,0001	1.0000
Energy	Mobile combustion	Forestry	CH_4	0.0004	0.0001	<0,0001	1.0000
Energy	Fugitive emissions	1B2c2i, Flaring oil	N_2O	0.0001	0.0001	<0,0001	1.0000
Industrial Proc.	Asphalt Roofing		CO_2	0.0000	0.0000	<0,0001	1.0000
Waste	Incineration of corpses		CH_4	0.0000	0.0000	<0,0001	1.0000
Waste	Incineration of carcasses		CH_4	0.0000	0.0000	<0,0001	1.0000
Solvent and Other Prod. Use	3B Degreasing and dry cleaning		CO_2	0.0000	0.0000	<0,0001	1.0000
Total (excl LULUCF)				**69.2041**	**63.8450**	**1.0000**	

Table 1.4 Key Category Analysis for Denmark, year 2008 incl LULUCF, level assessment, tier 1.

Table 7.A1 (of Good Practice Guidance)

Tier 1 Analysis - Level Assessment DK – inventory

A			B	C	D	E	F
IPCC Source Categories (LULUCF included)			Direct GHG	Base Yr Est. Ex,o (1) Mt CO_2-eq	Yr 2008 Est. Ex,t (1) Mt CO_2-eq	Yr 2008 Level Assessm Lx.t	Yr 2008 Cumul total of Col. E
Energy	Stationary Combustion	Coal	CO2	24.0771	16.0495	0.2416	0.2416
Energy	Mobile combustion	Road Transportation	CO2	9.2753	12.9485	0.1949	0.4365
Energy	Stationary Combustion	Natural Gas	CO2	4.3195	9.7644	0.1470	0.5835
Agriculture	Enteric Fermentation		CH4	3.2612	2.8194	0.0424	0.6260
Agriculture	Agriculture soils, indirect	Nitrogen Leaching and Run-off	N2O	3.3339	1.9927	0.0300	0.6560
Energy	Stationary Combustion	Gas Oil	CO2	4.5472	1.5441	0.0232	0.6792
Energy	Stationary Combustion	Residual Oil	CO2	2.5052	1.3593	0.0205	0.6997
Energy	Stationary Combustion	Plastic Waste	CO2	0.3937	1.3426	0.0202	0.7199
Agriculture	Agriculture soils, direct emissions	Synthetic Fertilizers	N2O	2.3946	1.3177	0.0198	0.7397
Energy	Mobile combustion	Agriculture	CO2	1.2725	1.2301	0.0185	0.7582
Industrial Proc.	Cement Production		CO2	0.8824	1.1547	0.0174	0.7756
Agriculture	Agriculture soils, direct emissions	Animal Manure Applied to Soils	N2O	1.0502	1.1235	0.0169	0.7925
Energy	Mobile combustion	Other Mobil and Machin-ery/Industry	CO2	0.8415	1.1186	0.0168	0.8094
LULUCF	Cropland	5B Cropland remaining Cr. Organic soils	CO2	1.0555	1.0700	0.0161	0.8255
Waste	Solid Waste Disposal Sites		CH4	1.1108	1.0567	0.0159	0.8414
Agriculture	Manure Management		CH4	0.8692	1.0498	0.0158	0.8572
Energy	Stationary Combustion	Refinery Gas	CO2	0.8062	0.8411	0.0127	0.8699
Energy	Stationary Combustion	Petroleum Coke	CO2	0.4103	0.7545	0.0114	0.8812
Industrial Proc.	Refrigeration and AC Equipment		HFC and PFC	0.0357	0.7392	0.0111	0.8924
LULUCF	Cropland	5B Cropland remaining Cr. Mineral soils	CO2	-2.0207	-0.5107	0.0077	0.9000
Agriculture	Manure management		N2O	0.6669	0.5053	0.0076	0.9076
Energy	Mobile combustion	National Fishing	CO2	0.5907	0.4495	0.0068	0.9144
Energy	Mobile combustion	Navigation large vessels	CO2	0.6656	0.3526	0.0053	0.9197
Energy	Fugitive emissions	1B2c2ii, Flaring gas	CO2	0.2762	0.3478	0.0052	0.9250
Agriculture	Agriculture soils, direct emissions	Crop Residue	N2O	0.3612	0.3051	0.0046	0.9296
Agriculture	Agriculture soils, indirect	Atmospheric Deposition	N2O	0.4414	0.2862	0.0043	0.9339
Energy	Mobile combustion	Household and Gardening	CO2	0.1128	0.2390	0.0036	0.9375
LULUCF	Forest Land remaining Forest L.	5A1 Conifers	CO2	-0.2543	0.2387	0.0036	0.9411
Energy	Mobile combustion	Railways	CO2	0.2967	0.2367	0.0036	0.9446
LULUCF	Agricultural lime application	5IV Cropland Limestone	CO2	0.5652	0.2288	0.0034	0.9481
Agriculture	Agriculture soils, pasture, range and paddock		N2O	0.3141	0.2143	0.0032	0.9513
Agriculture	Agriculture soils, direct emissions	N-fixing Crops	N2O	0.2695	0.2127	0.0032	0.9545
LULUCF	Forest Land remaining Forest L.	5A1 Broadleaves	CO2	-0.6487	0.1992	0.0030	0.9575
Energy	Stationary Combustion	1A1+1A2+1A4, BIOMASS	CH4	0.0829	0.1866	0.0028	0.9603
Energy	Stationary Combustion	Natural gas fuelled en-gines, GAS	CH4	0.0046	0.1849	0.0028	0.9631
Energy	Mobile combustion	Civil Aviation	CO2	0.2427	0.1638	0.0025	0.9655
Energy	Mobile combustion	Road Transportation	N2O	0.0970	0.1256	0.0019	0.9674
Agriculture	Agriculture soils, direct emissions	Cultivation of Histosols (2)	N2O	0.1165	0.1167	0.0018	0.9692
Energy	Stationary Combustion	Coke	CO2	0.1378	0.1120	0.0017	0.9709
Energy	Mobile combustion	Military	CO2	0.1190	0.1076	0.0016	0.9725
Industrial Proc.	Foam Blowing		HFC	0.1826	0.1026	0.0015	0.9740
Energy	Mobile combustion	Navigation small boats	CO2	0.0479	0.1005	0.0015	0.9756

Continued							
Energy	Stationary Combustion	LPG	CO2	0.1687	0.0960	0.0014	0.9770
LULUCF	Grassland	5C Grassland rem. Grassland. Organic soils	CO2	0.0929	0.0812	0.0012	0.9782
Energy	Stationary Combustion	1A1 + 1A2 + 1A4, BIOMASS	N2O	0.0386	0.0810	0.0012	0.9794
Agriculture	Agriculture soils, direct emissions	Other direct emissions (please specify)	N2O	0.0279	0.0783	0.0012	0.9806
Waste	N2O direct, Domestic and Commercial Wastewater		N2O	0.0240	0.0699	0.0011	0.9817
Industrial Proc.	Lime Production		CO2	0.1155	0.0656	0.0010	0.9827
Energy	Stationary Combustion	1A1 + 1A2 + 1A4, GAS	N2O	0.0278	0.0613	0.0009	0.9836
LULUCF	Grassland	5C Total Grassland. Living biomass	CO2	0.1826	0.0592	0.0009	0.9845
LULUCF	Settlements	5E Total settlements. Living biomass	CO2	0.0796	0.0518	0.0008	0.9853
Energy	Stationary Combustion	1A1 + 1A2 + 1A4, SOLID	N2O	0.0798	0.0490	0.0007	0.9860
LULUCF	Cropland	5B Cropland remaining Cr. Living biomass	CO2	-0.0530	0.0484	0.0007	0.9867
Waste	Waste Water Handling		CH4	0.0304	0.0473	0.0007	0.9874
Energy	Stationary Combustion	1A1 + 1A2 + 1A4, LIQUID	N2O	0.0757	0.0461	0.0007	0.9881
Energy	Fugitive emissions	1B2aiv, Oil refining and storage	CH4	0.0008	0.0459	0.0007	0.9888
Solvent and Other Prod. Use	3D5 Other		CO2	0.0857	0.0409	0.0006	0.9894
LULUCF	Wetlands	5D Land converted to wetlands	CO2	0.0004	-0.0404	0.0006	0.9900
Industrial Proc.	Limestone and Dolomite use		CO2	0.0137	0.0387	0.0006	0.9906
Energy	Fugitive emissions	1B2aii, Oil production offshore	CH4	0.0149	0.0386	0.0006	0.9912
Energy	Fugitive emissions	1B2aii, Oil production landbased	CH4	0.0172	0.0366	0.0006	0.9918
Waste	N2O indirect from human sewage		N2O	0.0822	0.0347	0.0005	0.9923
Industrial Proc.	Other, lubricants		CO2	0.0497	0.0340	0.0005	0.9928
LULUCF	Wetlands	5D Wetlands remaining Wetlands (peat)	CO2	0.0861	0.0331	0.0005	0.9933
Industrial Proc.	Yellow Bricks Production		CO2	0.0230	0.0284	0.0004	0.9937
Energy	Fugitive emissions	1B2c2i, Flaring oil	CO2	0.0234	0.0282	0.0004	0.9941
Solvent and Other Prod. Use	3D5 Other		N2O	0.0000	0.0273	0.0004	0.9946
Energy	Mobile combustion	Road Transportation	CH4	0.0551	0.0220	0.0003	0.9949
Energy	Stationary Combustion	Biogas fuelled engines, BIOMASS	CH4	0.0019	0.0209	0.0003	0.9952
Energy	Stationary Combustion	1A1 + 1A2 + 1A4, WASTE	N2O	0.0184	0.0194	0.0003	0.9955
Industrial Proc.	Aerosols		HFC	0.0000	0.0186	0.0003	0.9958
Waste	Accidental fires - buildings		CO2	0.0147	0.0176	0.0003	0.9960
Energy	Mobile combustion	Forestry	CO2	0.0357	0.0172	0.0003	0.9963
Industrial Proc.	Electrical equipment		SF6	0.0039	0.0162	0.0002	0.9965
Energy	Mobile combustion	Agriculture	N2O	0.0153	0.0161	0.0002	0.9968
Industrial Proc.	Expanded Clay		CO2	0.0149	0.0161	0.0002	0.9970
Industrial Proc.	Other emissions of SF6 i.e. from double glaze windows and laboratories		SF6	0.0676	0.0154	0.0002	0.9973
Industrial Proc.	Glass/GlassWoll Production		CO2	0.0174	0.0151	0.0002	0.9975
Energy	Stationary Combustion	1A1+1A2+1A4, GAS	CH4	0.0084	0.0150	0.0002	0.9977
Energy	Mobile combustion	Other Mobil and Machinery/Industry	N2O	0.0106	0.0147	0.0002	0.9979
Solvent and Other Prod. Use	3C Chemical products, manufacturing and processing		CO2	0.0231	0.0146	0.0002	0.9981
LULUCF	Non-CO2 drainage of soils and wetlands	5IID Forest Land.	N2O	0.0157	0.0122	0.0002	0.9983
Waste	Accidental fires - vehicles		CO2	0.0063	0.0109	0.0002	0.9985
Solvent and Other Prod. Use	3A Paint application		CO2	0.0263	0.0092	0.0001	0.9986
Energy	Mobile combustion	National Fishing	N2O	0.0115	0.0088	0.0001	0.9988
Energy	Stationary Combustion	Kerosene	CO2	0.3662	0.0086	0.0001	0.9989
Energy	Stationary Combustion	1A1+1A2+1A4, SOLID	CH4	0.0149	0.0081	0.0001	0.9990

Continued							
Energy	Mobile combustion	Navigation large vessels	N2O	0.0130	0.0069	0.0001	0.9991
Industrial Proc.	Other i.e Fibre Optics		HFC and PFC	0.0000	0.0052	0.0001	0.9992
Energy	Mobile combustion	Household and Gardening	CH4	0.0031	0.0050	0.0001	0.9993
LULUCF	Forest Land. Land converted to Forest L.	5A2 Conifers	CO2	0.0051	-0.0048	0.0001	0.9994
Energy	Stationary Combustion	1A1+1A2+1A4, LIQUID	CH4	0.0068	0.0043	0.0001	0.9994
Energy	Fugitive emissions	1B2biv, Gas distribution	CH4	0.0053	0.0037	0.0001	0.9995
Agriculture	Field Burning of Agricultural Residues		CH4+N2O	0.0025	0.0034	0.0001	0.9995
LULUCF	Forest Land. Land converted to Forest L.	5A2 Broadleaves	CO2	0.0033	-0.0031	< 0.0001	0.9996
Waste	Accidental fires - buildings		CH4	0.0024	0.0028	< 0.0001	0.9996
Energy	Fugitive emissions	1B2biii, Gas transmission	CH4	0.0036	0.0027	< 0.0001	0.9997
Energy	Mobile combustion	Civil Aviation	N2O	0.0032	0.0027	< 0.0001	0.9997
Industrial Proc.	Food and Drink		CO2	0.0045	0.0027	< 0.0001	0.9997
Industrial Proc.	Catalysts/Fertilizers and Pesticides		CO2	0.0008	0.0024	< 0.0001	0.9998
Energy	Mobile combustion	Railways	N2O	0.0025	0.0020	< 0.0001	0.9998
Industrial Proc.	Road paving with Asphalt		CO2	0.0018	0.0019	< 0.0001	0.9998
Energy	Mobile combustion	Agriculture	CH4	0.0022	0.0016	< 0.0001	0.9999
Energy	Mobile combustion	Household and Gardening	N2O	0.0005	0.0012	< 0.0001	0.9999
Energy	Mobile combustion	Military	N2O	0.0012	0.0011	< 0.0001	0.9999
Energy	Mobile combustion	Navigation small boats	N2O	0.0004	0.0011	< 0.0001	0.9999
Energy	Stationary Combustion	1A1+1A2+1A4, WASTE	CH4	0.0018	0.0009	< 0.0001	0.9999
Energy	Mobile combustion	Other Mobil and Machinery/Industry	CH4	0.0013	0.0009	< 0.0001	0.9999
Energy	Fugitive emissions	1B2c2ii, Flaring gas	CH4	0.0004	0.0008	< 0.0001	0.9999
Energy	Fugitive emissions	1B2c2ii, Flaring gas	N2O	0.0006	0.0008	< 0.0001	1.0000
Energy	Mobile combustion	Navigation small boats	CH4	0.0003	0.0005	< 0.0001	1.0000
Waste	Accidental fires - vehicles		CH4	0.0003	0.0005	< 0.0001	1.0000
LULUCF	N2O Disturbance, Land converted to cropland	5III Cropland	N2O	0.0032	0.0004	< 0.0001	1.0000
Energy	Mobile combustion	National Fishing	CH4	0.0003	0.0002	< 0.0001	1.0000
Waste	Incineration of corpses		N2O	0.0002	0.0002	< 0.0001	1.0000
Energy	Fugitive emissions	1B2c2i, Flaring oil	CH4	0.0013	0.0002	< 0.0001	1.0000
Energy	Mobile combustion	Forestry	N2O	0.0002	0.0002	< 0.0001	1.0000
Energy	Mobile combustion	Railways	CH4	0.0003	0.0002	< 0.0001	1.0000
Energy	Mobile combustion	Navigation large vessels	CH4	0.0003	0.0002	< 0.0001	1.0000
LULUCF	Non-CO2 drainage of soils and wetlands	5IID Wetlands. Peatland	N2O	0.0001	0.0001	< 0.0001	1.0000
Energy	Mobile combustion	Civil Aviation	CH4	0.0002	0.0001	< 0.0001	1.0000
Energy	Mobile combustion	Military	CH4	0.0001	0.0001	< 0.0001	1.0000
Waste	Incineration of carcasses		N2O	0.0000	0.0001	< 0.0001	1.0000
Energy	Mobile combustion	Forestry	CH4	0.0004	0.0001	< 0.0001	1.0000
Energy	Fugitive emissions	1B2c2i, Flaring oil	N2O	0.0001	0.0001	< 0.0001	1.0000
Industrial Proc.	Asphalt Roofing		CO2	0.0000	< 0.0001	< 0.0001	1.0000
Waste	Incineration of corpses		CH4	0.0000	< 0.0001	< 0.0001	1.0000
Waste	Incineration of carcasses		CH4	0.0000	< 0.0001	< 0.0001	1.0000
Solvent and Other Prod. Use	3B Degreasing and dry cleaning		CO2	0.0000	< 0.0001	< 0.0001	1.0000
Energy	Stationary Combustion	Brown Coal Bri.	CO2	0.0110	< 0.0001	< 0.0001	1.0000
Industrial Proc.	Iron and Steel Production		CO2	0.0284	< 0.0001	< 0.0001	1.0000
Industrial Proc.	Nitric Acid Production		N2O	1.0429	< 0.0001	< 0.0001	1.0000
Industrial Proc.	Magnesium Production		SF6	0.0359	< 0.0001	< 0.0001	1.0000
				68.3169	**65.3092**	1.00	

[1)] The Estimates include signs, where + : emission - : removal, although in the level analyses only the absolute values are used.

Table 1.5 Key Category Analysis for Denmark, years 1990-2008 excl LULUCF, trend assessment, tier 1.

Table 7.A2 (of Good Practice Guidance)

Tier 1 Analysis - Trend Assessment (DK-inventory)

A			B	C	D	E	F	G
IPCC Source Categories (LULUCF excluded)			Direct GHG	Base Yr Est Ex,o Mt CO_2-eq	Yr 2008 Est. Ex,t Mt CO_2-eq	Trend Assess-ment Tx,t	Contri-bution to Trend	Cumul. total of col. F
Energy	Stationary Combustion	Coal	CO_2	24.0771	16.0495	0.0891	0.2114	0.2114
Energy	Stationary Combustion	Natural Gas	CO_2	4.3195	9.7644	0.0835	0.1983	0.4097
Energy	Mobile combustion	Road Transportation	CO_2	9.2753	12.9485	0.0635	0.1507	0.5604
Energy	Stationary Combustion	Gas Oil	CO_2	4.5472	1.5441	0.0383	0.0909	0.6513
Agriculture	Agriculture soils, indirect	Nitrogen Leaching and Run-off	N_2O	3.3339	1.9927	0.0157	0.0372	0.6885
Energy	Stationary Combustion	Plastic Waste	CO_2	0.3937	1.3426	0.0142	0.0336	0.7221
Industrial Proc.	Nitric Acid Production		N_2O	1.0429	0.0000	0.0139	0.0330	0.7551
Energy	Stationary Combustion	Residual Oil	CO_2	2.5052	1.3593	0.0138	0.0327	0.7877
Agriculture	Agriculture soils, direct emissions	Synthetic Fertilizers	N_2O	2.3946	1.3177	0.0129	0.0306	0.8183
Industrial Proc.	Refrigeration and AC Equipment		HFC and PFC	0.0357	0.7392	0.0102	0.0242	0.8426
Energy	Stationary Combustion	Petroleum Coke	CO_2	0.4103	0.7545	0.0054	0.0129	0.8555
Energy	Mobile combustion	Other Mobil and Machin-ery/Industry	CO_2	0.8415	1.1186	0.0049	0.0117	0.8672
Industrial Proc.	Cement Production		CO_2	0.8824	1.1547	0.0049	0.0117	0.8789
Energy	Stationary Combustion	Kerosene	CO_2	0.3662	0.0086	0.0048	0.0113	0.8902
Energy	Mobile combustion	Navigation large vessels	CO_2	0.6656	0.3526	0.0038	0.0090	0.8991
Agriculture	Manure Management		CH_4	0.8692	1.0498	0.0036	0.0085	0.9076
Agriculture	Enteric Fermentation		CH_4	3.2612	2.8194	0.0027	0.0065	0.9141
Energy	Stationary Combustion	Natural gas fuelled en-gines, GAS	CH_4	0.0046	0.1849	0.0026	0.0062	0.9203
Agriculture	Agriculture soils, direct emissions	Animal Manure Applied to Soils	N_2O	1.0502	1.1235	0.0022	0.0053	0.9256
Energy	Mobile combustion	Household and Gardening	CO_2	0.1128	0.2390	0.0019	0.0046	0.9303
Agriculture	Agriculture soils, indirect	Atmospheric Deposition	N_2O	0.4414	0.2862	0.0017	0.0042	0.9344
Energy	Stationary Combustion	1A1+1A2+1A4, BIOMASS	CH_4	0.0829	0.1866	0.0016	0.0038	0.9382
Agriculture	Manure management		N_2O	0.6669	0.5053	0.0016	0.0038	0.9420
Energy	Stationary Combustion	Refinery Gas	CO_2	0.8062	0.8411	0.0014	0.0033	0.9453
Energy	Mobile combustion	National Fishing	CO_2	0.5907	0.4495	0.0014	0.0033	0.9486
Energy	Fugitive emissions	1B2c2ii, Flaring gas	CO_2	0.2762	0.3478	0.0013	0.0032	0.9518
Agriculture	Agriculture soils, pasture, range and paddock		N_2O	0.3141	0.2143	0.0011	0.0026	0.9544
Industrial Proc.	Foam Blowing		HFC	0.1826	0.1026	0.0010	0.0023	0.9566
Energy	Mobile combustion	Civil Aviation	CO_2	0.2427	0.1638	0.0009	0.0021	0.9587
Energy	Stationary Combustion	LPG	CO_2	0.1687	0.0960	0.0009	0.0020	0.9607
Energy	Mobile combustion	Navigation small boats	CO_2	0.0479	0.1005	0.0008	0.0019	0.9627
Energy	Mobile combustion	Agriculture	CO_2	1.2725	1.2301	0.0008	0.0019	0.9646
Agriculture	Agriculture soils, direct emissions	Other direct emissions (please specify)	N_2O	0.0279	0.0783	0.0008	0.0018	0.9664
Waste	N_2O direct, Domestic and Commercial Wastewater		N_2O	0.0240	0.0699	0.0007	0.0016	0.9680
Industrial Proc.	Other emissions of SF_6 i.e. from double glaze win-dows and laboratories		SF_6	0.0676	0.0154	0.0007	0.0016	0.9697
Energy	Stationary Combustion	1A1 + 1A2 + 1A4, BIO-MASS	N_2O	0.0386	0.0810	0.0007	0.0016	0.9712
Energy	Fugitive emissions	1B2aiv, Oil refining and storage	CH_4	0.0008	0.0459	0.0007	0.0015	0.9728
Waste	N_2O indirect from human sewage		N_2O	0.0822	0.0347	0.0006	0.0014	0.9742
Industrial Proc.	Lime Production		CO_2	0.1155	0.0656	0.0006	0.0014	0.9756
Solvent and Other Prod. Use	3D5 Other		CO_2	0.0857	0.0409	0.0006	0.0013	0.9769
Energy	Mobile combustion	Railways	CO_2	0.2967	0.2367	0.0005	0.0013	0.9782
Energy	Mobile combustion	Road Transportation	N_2O	0.0970	0.1256	0.0005	0.0012	0.9794

Continued								
Agriculture	Agriculture soils, direct emissions	N-fixing Crops	N_2O	0.2695	0.2127	0.0005	0.0012	0.9806
Energy	Stationary Combustion	1A1 + 1A2 + 1A4, GAS	N_2O	0.0278	0.0613	0.0005	0.0012	0.9819
Industrial Proc.	Magnesium Production		SF_6	0.0359	0.0000	0.0005	0.0011	0.9830
Waste	Solid Waste Disposal Sites		CH_4	1.1108	1.0567	0.0005	0.0011	0.9841
Energy	Mobile combustion	Road Transportation	CH_4	0.0551	0.0220	0.0004	0.0010	0.9851
Agriculture	Agriculture soils, direct emissions	Crop Residue	N_2O	0.3612	0.3051	0.0004	0.0010	0.9860
Solvent and Other Prod. Use	3D5 Other		N_2O	0.0000	0.0273	0.0004	0.0009	0.9870
Industrial Proc.	Iron and Steel Production		CO_2	0.0284	0.0000	0.0004	0.0009	0.9879
Industrial Proc.	Limestone and Dolomite use		CO_2	0.0137	0.0387	0.0004	0.0009	0.9888
Energy	Fugitive emissions	1B2aii, Oil production offshore	CH_4	0.0149	0.0386	0.0004	0.0009	0.9896
Energy	Stationary Combustion	1A1 + 1A2 + 1A4, SOLID	N_2O	0.0798	0.0490	0.0004	0.0008	0.9905
Energy	Stationary Combustion	1A1 + 1A2 + 1A4, LIQUID	N_2O	0.0757	0.0461	0.0003	0.0008	0.9913
Energy	Fugitive emissions	1B2aii, Oil production landbased	CH_4	0.0172	0.0366	0.0003	0.0007	0.9920
Waste	Waste Water Handling		CH_4	0.0304	0.0473	0.0003	0.0007	0.9927
Energy	Stationary Combustion	Biogas fuelled engines, BIOMASS	CH_4	0.0019	0.0209	0.0003	0.0007	0.9933
Industrial Proc.	Aerosols		HFC	NA,NO	0.0186	0.0003	0.0006	0.9939
Energy	Mobile combustion	Forestry	CO_2	0.0357	0.0172	0.0002	0.0005	0.9945
Energy	Stationary Combustion	Coke	CO_2	0.1378	0.1120	0.0002	0.0005	0.9950
Solvent and Other Prod. Use	3A Paint application		CO_2	0.0263	0.0092	0.0002	0.0005	0.9955
Industrial Proc.	Electrical equipment		SF_6	0.0039	0.0162	0.0002	0.0004	0.9960
Industrial Proc.	Other, lubricants		CO_2	0.0497	0.0340	0.0002	0.0004	0.9964
Energy	Stationary Combustion	Brown Coal Bri.	CO_2	0.0110	0.0000	0.0001	0.0003	0.9967
Agriculture	Agriculture soils, direct emissions	Cultivation of Histosols (2)	N_2O	0.1165	0.1167	0.0001	0.0003	0.9970
Energy	Stationary Combustion	1A1+1A2+1A4, GAS	CH_4	0.0084	0.0150	0.0001	0.0003	0.9973
Industrial Proc.	Yellow Bricks Production		CO_2	0.0230	0.0284	0.0001	0.0002	0.9975
Solvent and Other Prod. Use	3C Chemical products, manufacturing and processing		CO_2	0.0231	0.0146	0.0001	0.0002	0.9977
Energy	Fugitive emissions	1B2c2i, Flaring oil	CO_2	0.0234	0.0282	0.0001	0.0002	0.9980
Energy	Stationary Combustion	1A1+1A2+1A4, SOLID	CH_4	0.0149	0.0081	0.0001	0.0002	0.9982
Industrial Proc.	Other i.e Fibre Optics		HFC and PFC	NO	0.0052	0.0001	0.0002	0.9983
Waste	Accidental fires - vehicles		CO_2	0.0063	0.0109	0.0001	0.0002	0.9985
Energy	Mobile combustion	Navigation large vessels	N_2O	0.0130	0.0069	0.0001	0.0002	0.9987
Energy	Mobile combustion	Other Mobil and Machinery/Industry	N_2O	0.0106	0.0147	0.0001	0.0002	0.9989
Waste	Accidental fires - buildings		CO_2	0.0147	0.0176	0.0001	0.0001	0.9990
Energy	Stationary Combustion	1A1 + 1A2 + 1A4, WASTE	N_2O	0.0184	0.0194	<0.0001	0.0001	0.9991
Industrial Proc.	Expanded Clay		CO_2	0.0149	0.0161	<0.0001	0.0001	0.9992
Energy	Mobile combustion	Military	CO_2	0.1190	0.1076	<0.0001	0.0001	0.9992
Energy	Mobile combustion	Household and Gardening	CH_4	0.0031	0.0050	<0.0001	0.0001	0.9993
Energy	Mobile combustion	Agriculture	N_2O	0.0153	0.0161	<0.0001	0.0001	0.9994
Energy	Stationary Combustion	1A1+1A2+1A4, LIQUID	CH_4	0.0068	0.0043	<0.0001	0.0001	0.9995
Energy	Mobile combustion	National Fishing	N_2O	0.0115	0.0088	<0.0001	0.0001	0.9995
Industrial Proc.	Catalysts/Fertilizers and Pesticides		CO_2	0.0008	0.0024	<0.0001	0.0001	0.9996
Industrial Proc.	Food and Drink		CO_2	0.0045	0.0027	<0.0001	<0.0001	0.9996
Energy	Fugitive emissions	1B2biv, Gas distribution	CH_4	0.0053	0.0037	<0.0001	<0.0001	0.9997
Agriculture	Field Burning of Agricultural Residues		CH_4+ N_2O	0.0025	0.0034	<0.0001	<0.0001	0.9997
Energy	Fugitive emissions	1B2c2i, Flaring oil	CH_4	0.0013	0.0002	<0.0001	<0.0001	0.9997
Industrial Proc.	Glass/GlassWoll Production		CO_2	0.0174	0.0151	<0.0001	<0.0001	0.9998
Energy	Stationary Combustion	1A1+1A2+1A4, WASTE	CH_4	0.0018	0.0009	<0.0001	<0.0001	0.9998
Energy	Mobile combustion	Navigation small boats	N_2O	0.0004	0.0011	<0.0001	<0.0001	0.9998

Continued								
Energy	Mobile combustion	Household and Gardening	N_2O	0.0005	0.0012	<0.0001	<0.0001	0.9998
Waste	Accidental fires - buildings		CH_4	0.0024	0.0028	<0.0001	<0.0001	0.9999
Energy	Fugitive emissions	1B2biii, Gas transmission	CH_4	0.0036	0.0027	<0.0001	<0.0001	0.9999
Energy	Mobile combustion	Agriculture	CH_4	0.0022	0.0016	<0.0001	<0.0001	0.9999
Energy	Fugitive emissions	1B2c2ii, Flaring gas	CH_4	0.0004	0.0008	<0.0001	<0.0001	0.9999
Energy	Mobile combustion	Railways	N_2O	0.0025	0.0020	<0.0001	<0.0001	0.9999
Energy	Mobile combustion	Forestry	CH_4	0.0004	0.0001	<0.0001	<0.0001	0.9999
Energy	Mobile combustion	Other Mobil and Machin-ery/Industry	CH_4	0.0013	0.0009	<0.0001	<0.0001	0.9999
Industrial Proc.	Road paving with Asphalt		CO_2	0.0018	0.0019	<0.0001	<0.0001	1.0000
Energy	Mobile combustion	Civil Aviation	N_2O	0.0032	0.0027	<0.0001	<0.0001	1.0000
Waste	Accidental fires - vehicles		CH_4	0.0003	0.0005	<0.0001	<0.0001	1.0000
Energy	Mobile combustion	Navigation small boats	CH_4	0.0003	0.0005	<0.0001	<0.0001	1.0000
Energy	Fugitive emissions	1B2c2ii, Flaring gas	N_2O	0.0006	0.0008	<0.0001	<0.0001	1.0000
Energy	Mobile combustion	Navigation large vessels	CH_4	0.0003	0.0002	<0.0001	<0.0001	1.0000
Waste	Incineration of carcasses		N_2O	0.0000	0.0001	<0.0001	<0.0001	1.0000
Energy	Mobile combustion	Railways	CH_4	0.0003	0.0002	<0.0001	<0.0001	1.0000
Energy	Mobile combustion	Military	N_2O	0.0012	0.0011	<0.0001	<0.0001	1.0000
Energy	Fugitive emissions	1B2c2i, Flaring oil	N_2O	0.0001	0.0001	<0.0001	<0.0001	1.0000
Energy	Mobile combustion	National Fishing	CH_4	0.0003	0.0002	<0.0001	<0.0001	1.0000
Waste	Incineration of corpses		N_2O	0.0002	0.0002	<0.0001	<0.0001	1.0000
Energy	Mobile combustion	Civil Aviation	CH_4	0.0002	0.0001	<0.0001	<0.0001	1.0000
Energy	Mobile combustion	Forestry	N_2O	0.0002	0.0002	<0.0001	<0.0001	1.0000
Industrial Proc.	Asphalt Roofing		CO_2	0.0000	0.0000	<0.0001	<0.0001	1.0000
Waste	Incineration of carcasses		CH_4	0.0000	0.0000	<0.0001	<0.0001	1.0000
Waste	Incineration of corpses		CH_4	0.0000	0.0000	<0.0001	<0.0001	1.0000
Energy	Mobile combustion	Military	CH_4	0.0001	0.0001	<0.0001	<0.0001	1.0000
Solvent and Other Prod. Use	3B Degreasing and dry cleaning		CO_2	0.0000	0.0000	<0.0001	<0.0001	1.0000
Total (excl Lulucf)				**69.2041**	**63.8450**		**1.0000**	

Table 1.6 Key Category Analysis for Denmark, years 1990-2008 incl. LULUCF, trend assessment, tier 1.

Table 7.A2 (of Good Practice Guidance) Tier 1 Analysis - Trend Assessment (DK-inventory)									
A			B	C	D	E	F	G
IPCC Source Categories (LULUCF included)			Direct GHG	Base Yr Est Ex,o Mt CO_2-eq	Yr 2008 Est Ex,t Mt CO_2-eq	Trend Assess-ment Tx,t	Contri-bution to Trend	Cumul. total of col. F
Energy	Stationary Combustion	Coal	CO2	24.0771	16.0495	0.0934	0.2068	0.2068
Energy	Stationary Combustion	Natural Gas	CO2	4.3195	9.7644	0.0755	0.1673	0.3741
Energy	Mobile combustion	Road Transportation	CO2	9.2753	12.9485	0.0547	0.1211	0.4952
Energy	Stationary Combustion	Gas Oil	CO2	4.5472	1.5441	0.0376	0.0832	0.5784
LULUCF	Cropland	5B Cropland remaining Cr. Mineral soils	CO2	-2.0207	-0.5107	0.0214	0.0475	0.6258
Agriculture	Agriculture soils, indirect	Nitrogen Leaching and Run-off	N2O	3.3339	1.9927	0.0160	0.0355	0.6613
Energy	Stationary Combustion	Residual Oil	CO2	2.5052	1.3593	0.0139	0.0307	0.6920
Industrial Proc.	Nitric Acid Production		N2O	1.0429	0.0000	0.0134	0.0296	0.7216
Agriculture	Agriculture soils, direct emissions	Synthetic Fertilizers	N2O	2.3946	1.3177	0.0130	0.0288	0.7505
Energy	Stationary Combustion	Plastic Waste	CO2	0.3937	1.3426	0.0130	0.0287	0.7791
LULUCF	Forest Land remaining Forest L.	5A1 Broadleaves	CO2	-0.6487	0.1992	0.0117	0.0260	0.8052
Industrial Proc.	Refrigeration and AC Equipment		HFC and PFC	0.0357	0.7392	0.0095	0.0209	0.8261
LULUCF	Forest Land remaining Forest L.	5A1 Conifers	CO2	-0.2543	0.2387	0.0068	0.0150	0.8410
Energy	Stationary Combustion	Petroleum Coke	CO2	0.4103	0.7545	0.0049	0.0108	0.8518
Energy	Stationary Combustion	Kerosene	CO2	0.3662	0.0086	0.0046	0.0101	0.8619
Energy	Mobile combustion	Other Mobil and Machin-ery/Industry	CO2	0.8415	1.1186	0.0042	0.0093	0.8713
LULUCF	Agricultural lime application	5IV Cropland Limestone	CO2	0.5652	0.2288	0.0042	0.0092	0.8805
Industrial Proc.	Cement Production		CO2	0.8824	1.1547	0.0042	0.0092	0.8897
Agriculture	Enteric Fermentation		CH4	3.2612	2.8194	0.0040	0.0088	0.8986
Energy	Mobile combustion	Navigation large vessels	CO2	0.6656	0.3526	0.0038	0.0084	0.9070
Agriculture	Manure Management		CH4	0.8692	1.0498	0.0029	0.0065	0.9135
Energy	Stationary Combustion	Natural gas fuelled en-gines, GAS	CH4	0.0046	0.1849	0.0024	0.0054	0.9189
Agriculture	Agriculture soils, indirect	Atmospheric Deposition	N2O	0.4414	0.2862	0.0018	0.0040	0.9229
Agriculture	Manure management		N2O	0.6669	0.5053	0.0018	0.0039	0.9268
Energy	Mobile combustion	Household and Gardening	CO2	0.1128	0.2390	0.0018	0.0039	0.9307
Agriculture	Agriculture soils, direct emissions	Animal Manure Applied to Soils	N2O	1.0502	1.1235	0.0016	0.0035	0.9343
LULUCF	Grassland	5C Total Grassland. Living biomass	CO2	0.1826	0.0592	0.0015	0.0034	0.9377
Energy	Mobile combustion	National Fishing	CO2	0.5907	0.4495	0.0015	0.0034	0.9411
Energy	Stationary Combustion	1A1+1A2+1A4, BIOMASS	CH4	0.0829	0.1866	0.0014	0.0032	0.9443
LULUCF	Cropland	5B Cropland remaining Cr. Living biomass	CO2	-0.0530	0.0484	0.0014	0.0031	0.9474
Agriculture	Agriculture soils, pasture, range and paddock		N2O	0.3141	0.2143	0.0012	0.0026	0.9499
Energy	Fugitive emissions	1B2c2ii, Flaring gas	CO2	0.2762	0.3478	0.0011	0.0025	0.9524
Industrial Proc.	Foam Blowing		HFC	0.1826	0.1026	0.0010	0.0021	0.9545
Energy	Stationary Combustion	Refinery Gas	CO2	0.8062	0.8411	0.0009	0.0021	0.9566
Energy	Mobile combustion	Civil Aviation	CO2	0.2427	0.1638	0.0009	0.0020	0.9587
Energy	Stationary Combustion	LPG	CO2	0.1687	0.0960	0.0009	0.0019	0.9606
LULUCF	Cropland	5B Cropland remaining Cr. Organic soils	CO2	1.0555	1.0700	0.0008	0.0018	0.9624
Energy	Mobile combustion	Navigation small boats	CO2	0.0479	0.1005	0.0007	0.0016	0.9640
Agriculture	Agriculture soils, direct emissions	Other direct emissions (please specify)	N2O	0.0279	0.0783	0.0007	0.0015	0.9656
Industrial Proc.	Other emissions of SF_6 i.e. from double glaze windows and laboratories		SF6	0.0676	0.0154	0.0007	0.0015	0.9670
LULUCF	Wetlands	5D Wetlands remaining Wetlands (peat)	CO2	0.0861	0.0331	0.0007	0.0015	0.9685

Continued								
Energy	Mobile combustion	Railways	CO2	0.2967	0.2367	0.0006	0.0014	0.9699
Waste	N_2O direct, Domestic and Commercial Wastewater		N2O	0.0240	0.0699	0.0006	0.0014	0.9713
Energy	Fugitive emissions	1B2aiv, Oil refining and storage	CH4	0.0008	0.0459	0.0006	0.0013	0.9726
Agriculture	Agriculture soils, direct emissions	N-fixing Crops	N2O	0.2695	0.2127	0.0006	0.0013	0.9739
Industrial Proc.	Lime Production		CO2	0.1155	0.0656	0.0006	0.0013	0.9753
Energy	Stationary Combustion	1A1 + 1A2 + 1A4, BIO-MASS	N2O	0.0386	0.0810	0.0006	0.0013	0.9766
Waste	N_2O indirect from human sewage		N2O	0.0822	0.0347	0.0006	0.0013	0.9779
Solvent and Other Prod. Use	3D5 Other		CO2	0.0857	0.0409	0.0005	0.0012	0.9791
LULUCF	Wetlands	5D Land converted to wetlands	CO2	0.0004	-0.0404	0.0005	0.0012	0.9803
Agriculture	Agriculture soils, direct emissions	Crop Residue	N2O	0.3612	0.3051	0.0005	0.0012	0.9815
Energy	Stationary Combustion	1A1 + 1A2 + 1A4, GAS	N2O	0.0278	0.0613	0.0005	0.0010	0.9825
Industrial Proc.	Magnesium Production		SF6	0.0359	0.0000	0.0005	0.0010	0.9836
Energy	Mobile combustion	Road Transportation	N2O	0.0970	0.1256	0.0004	0.0010	0.9845
Energy	Mobile combustion	Road Transportation	CH4	0.0551	0.0220	0.0004	0.0009	0.9854
Solvent and Other Prod. Use	3D5 Other		N2O	0.0000	0.0273	0.0004	0.0008	0.9863
Energy	Stationary Combustion	1A1 + 1A2 + 1A4, SOLID	N2O	0.0798	0.0490	0.0004	0.0008	0.9871
Industrial Proc.	Iron and Steel Production		CO2	0.0284	0.0000	0.0004	0.0008	0.9879
Energy	Stationary Combustion	1A1 + 1A2 + 1A4, LIQUID	N2O	0.0757	0.0461	0.0004	0.0008	0.9887
Industrial Proc.	Limestone and Dolomite use		CO2	0.0137	0.0387	0.0003	0.0008	0.9894
Energy	Fugitive emissions	1B2aii, Oil production offshore	CH4	0.0149	0.0386	0.0003	0.0007	0.9901
LULUCF	Settlements	5E Total settlements. Living biomass	CO2	0.0796	0.0518	0.0003	0.0007	0.9909
Energy	Fugitive emissions	1B2aii, Oil production landbased	CH4	0.0172	0.0366	0.0003	0.0006	0.9915
Energy	Stationary Combustion	Coke	CO2	0.1378	0.1120	0.0003	0.0006	0.9920
Energy	Stationary Combustion	Biogas fuelled engines, BIOMASS	CH4	0.0019	0.0209	0.0003	0.0006	0.9926
Industrial Proc.	Aerosols		HFC	0.0000	0.0186	0.0002	0.0006	0.9932
Waste	Waste Water Handling		CH4	0.0304	0.0473	0.0002	0.0005	0.9937
Energy	Mobile combustion	Forestry	CO2	0.0357	0.0172	0.0002	0.0005	0.9942
Solvent and Other Prod. Use	3A Paint application		CO2	0.0263	0.0092	0.0002	0.0005	0.9947
Energy	Mobile combustion	Agriculture	CO2	1.2725	1.2301	0.0002	0.0004	0.9951
Industrial Proc.	Other, lubricants		CO2	0.0497	0.0340	0.0002	0.0004	0.9955
Industrial Proc.	Electrical equipment		SF6	0.0039	0.0162	0.0002	0.0004	0.9959
Energy	Stationary Combustion	Brown Coal Bri.	CO2	0.0110	0.0000	0.0001	0.0003	0.9962
LULUCF	Forest Land. Land converted to Forest L.	5A2 Conifers	CO2	0.0051	-0.0048	0.0001	0.0003	0.9965
LULUCF	Grassland	5C Grassland rem. Gra-sland. Organic soils	CO2	0.0929	0.0812	0.0001	0.0002	0.9967
Solvent and Other Prod. Use	3C Chemical products, manufacturing and processing		CO2	0.0231	0.0146	0.0001	0.0002	0.9969
Energy	Stationary Combustion	1A1+1A2+1A4, GAS	CH4	0.0084	0.0150	0.0001	0.0002	0.9971
Industrial Proc.	Yellow Bricks Production		CO2	0.0230	0.0284	0.0001	0.0002	0.9973
LULUCF	Forest Land. Land con-verted to Forest L.	5A2 Broadleaves	CO2	0.0033	-0.0031	0.0001	0.0002	0.9975
Energy	Stationary Combustion	1A1+1A2+1A4, SOLID	CH4	0.0149	0.0081	0.0001	0.0002	0.9977
Energy	Mobile combustion	Military	CO2	0.1190	0.1076	0.0001	0.0002	0.9979
Energy	Fugitive emissions	1B2c2i, Flaring oil	CO2	0.0234	0.0282	0.0001	0.0002	0.9980
Energy	Mobile combustion	Navigation large vessels	N2O	0.0130	0.0069	0.0001	0.0002	0.9982
Agriculture	Agriculture soils, direct emissions	Cultivation of Histosols (2)	N2O	0.1165	0.1167	0.0001	0.0002	0.9983
Waste	Solid Waste Disposal Sites		CH4	1.1108	1.0567	0.0001	0.0002	0.9985
Industrial Proc.	Other i.e Fibre Optics		HFC and PFC	0.0000	0.0052	0.0001	0.0002	0.9987

Continued								
Waste	Accidental fires - vehicles		CO2	0.0063	0.0109	0.0001	0.0001	0.9988
Energy	Mobile combustion	Other Mobil and Machin-ery/Industry	N2O	0.0106	0.0147	0.0001	0.0001	0.9989
Waste	Accidental fires - buildings		CO2	0.0147	0.0176	< 0.0001	0.0001	0.9990
LULUCF	Non-CO2 drainage of soils and wetlands	5IID Forest Land.	N2O	0.0157	0.0122	< 0.0001	0.0001	0.9991
LULUCF	N2O Disturbance, Land converted to cropland	5III Cropland	N2O	0.0032	0.0004	< 0.0001	0.0001	0.9992
Energy	Mobile combustion	National Fishing	N2O	0.0115	0.0088	< 0.0001	0.0001	0.9993
Energy	Stationary Combustion	1A1+1A2+1A4, LIQUID	CH4	0.0068	0.0043	< 0.0001	0.0001	0.9993
Energy	Mobile combustion	Household and Gardening	CH4	0.0031	0.0050	< 0.0001	0.0001	0.9994
Energy	Stationary Combustion	1A1 + 1A2 + 1A4, WASTE	N2O	0.0184	0.0194	< 0.0001	0.0001	0.9994
Industrial Proc.	Expanded Clay		CO2	0.0149	0.0161	< 0.0001	0.0001	0.9995
Industrial Proc.	Catalysts/Fertilizers and Pesticides		CO2	0.0008	0.0024	< 0.0001	< 0.0001	0.9995
Industrial Proc.	Food and Drink		CO2	0.0045	0.0027	< 0.0001	< 0.0001	0.9996
Industrial Proc.	Glass/GlassWoll Produc-tion		CO2	0.0174	0.0151	< 0.0001	< 0.0001	0.9996
Energy	Mobile combustion	Agriculture	N2O	0.0153	0.0161	< 0.0001	< 0.0001	0.9997
Energy	Fugitive emissions	1B2biv, Gas distribution	CH4	0.0053	0.0037	< 0.0001	< 0.0001	0.9997
Energy	Fugitive emissions	1B2c2i, Flaring oil	CH4	0.0013	0.0002	< 0.0001	< 0.0001	0.9998
Agriculture	Field Burning of Agricul-tural Residues		CH_4+N_2O	0.0025	0.0034	< 0.0001	< 0.0001	0.9998
Energy	Stationary Combustion	1A1+1A2+1A4, WASTE	CH4	0.0018	0.0009	< 0.0001	< 0.0001	0.9998
Energy	Mobile combustion	Navigation small boats	N2O	0.0004	0.0011	< 0.0001	< 0.0001	0.9998
Energy	Fugitive emissions	1B2biii, Gas transmission	CH4	0.0036	0.0027	< 0.0001	< 0.0001	0.9999
Energy	Mobile combustion	Household and Gardening	N2O	0.0005	0.0012	< 0.0001	< 0.0001	0.9999
Waste	Accidental fires - buildings		CH4	0.0024	0.0028	< 0.0001	< 0.0001	0.9999
Energy	Mobile combustion	Agriculture	CH4	0.0022	0.0016	< 0.0001	< 0.0001	0.9999
Energy	Mobile combustion	Railways	N2O	0.0025	0.0020	< 0.0001	< 0.0001	0.9999
Energy	Fugitive emissions	1B2c2ii, Flaring gas	CH4	0.0004	0.0008	< 0.0001	< 0.0001	0.9999
Energy	Mobile combustion	Civil Aviation	N2O	0.0032	0.0027	< 0.0001	< 0.0001	0.9999
Energy	Mobile combustion	Other Mobil and Machinery/Industry	CH4	0.0013	0.0009	< 0.0001	< 0.0001	1.0000
Energy	Mobile combustion	Forestry	CH4	0.0004	0.0001	< 0.0001	< 0.0001	1.0000
Industrial Proc.	Road paving with Asphalt		CO2	0.0018	0.0019	< 0.0001	< 0.0001	1.0000
Waste	Accidental fires - vehicles		CH4	0.0003	0.0005	< 0.0001	< 0.0001	1.0000
Energy	Mobile combustion	Navigation small boats	CH4	0.0003	0.0005	< 0.0001	< 0.0001	1.0000
Energy	Fugitive emissions	1B2c2ii, Flaring gas	N2O	0.0006	0.0008	< 0.0001	< 0.0001	1.0000
Energy	Mobile combustion	Navigation large vessels	CH4	0.0003	0.0002	< 0.0001	< 0.0001	1.0000
Waste	Incineration of carcasses		N2O	0.0000	0.0001	< 0.0001	< 0.0001	1.0000
Energy	Mobile combustion	Railways	CH4	0.0003	0.0002	< 0.0001	< 0.0001	1.0000
Energy	Fugitive emissions	1B2c2i, Flaring oil	N2O	0.0001	0.0001	< 0.0001	< 0.0001	1.0000
Energy	Mobile combustion	National Fishing	CH4	0.0003	0.0002	< 0.0001	< 0.0001	1.0000
Energy	Mobile combustion	Military	N2O	0.0012	0.0011	< 0.0001	< 0.0001	1.0000
Energy	Mobile combustion	Civil Aviation	CH4	0.0002	0.0001	< 0.0001	< 0.0001	1.0000
Waste	Incineration of corpses		N2O	0.0002	0.0002	< 0.0001	< 0.0001	1.0000
Industrial Proc.	Asphalt Roofing		CO2	0.0000	0.0000	< 0.0001	< 0.0001	1.0000
Waste	Incineration of carcasses		CH4	0.0000	0.0000	< 0.0001	< 0.0001	1.0000
LULUCF	Non-CO_2 drainage of soils and wetlands	5IID Wetlands. Peatland	N2O	0.0001	0.0001	< 0.0001	< 0.0001	1.0000
Energy	Mobile combustion	Military	CH4	0.0001	0.0001	< 0.0001	< 0.0001	1.0000
Energy	Mobile combustion	Forestry	N2O	0.0002	0.0002	< 0.0001	< 0.0001	1.0000
Waste	Incineration of corpses		CH4	0.0000	0.0000	< 0.0001	< 0.0001	1.0000
Solvent and Other Prod. Use	3B Degreasing and dry cleaning		CO2	0.0000	0.0000	< 0.0001	< 0.0001	1.0000
				68.3169	**65.3092**		**1.0000**	

Table 1.7 Key Category Analysis for Denmark, year 1990 excl. LULUCF, level assessment, tier 2.

Table 7.A1 (of Good Practice Guidance) Tier 2 Analysis - Level Assessment DK – inventory								
	A		B	C	D	E	F
IPCC Source Categories (LULUCF excluded)			Direct GHG	Base Yr Estimate Ex,o Mt CO_2-eq	Uncertainty Ux,o %	Base Yr Lx,o*Ux,o relative	Base Yr Cumulative total of Col. E
Agriculture	Agriculture soils, indirect	Nitrogen Leaching and Run-off	N_2O	3.3339	54	0.1470	0.1470
Waste	Solid Waste Disposal Sites		CH_4	1.1108	118	0.1076	0.2545
Agriculture	Agriculture soils, direct emissions	Synthetic Fertilizers	N_2O	2.3946	50	0.0982	0.3527
Agriculture	Manure Management		CH_4	0.8692	100	0.0715	0.4242
Agriculture	Manure management		N_2O	0.6669	100	0.0549	0.4791
Agriculture	Agriculture soils, direct emissions	Animal Manure Applied to Soils	N_2O	1.0502	51	0.0438	0.5229
Energy	Mobile combustion	Road Transportation	CO_2	9.2753	5	0.0409	0.5638
Agriculture	Enteric Fermentation		CH_4	3.2612	13	0.0342	0.5980
Energy	Stationary Combustion	Coal	CO_2	24.0771	2	0.0307	0.6286
Energy	Mobile combustion	Other Mobil and Machin-ery/Industry	CO_2	0.8415	41	0.0284	0.6571
Energy	Mobile combustion	Agriculture	CO_2	1.2725	25	0.0255	0.6826
Energy	Stationary Combustion	1A1 + 1A2 + 1A4, LIQUID	N_2O	0.0757	400	0.0248	0.7074
Industrial Proc.	Nitric Acid Production		N_2O	1.0429	25	0.0214	0.7288
Energy	Stationary Combustion	Gas Oil	CO_2	4.5472	6	0.0213	0.7501
Agriculture	Agriculture soils, indirect	Atmospheric Deposition	N_2O	0.4414	51	0.0184	0.7686
Agriculture	Agriculture soils, direct emissions	Crop Residue	N_2O	0.3612	54	0.0159	0.7845
Energy	Stationary Combustion	1A1 + 1A2 + 1A4, SOLID	N_2O	0.0798	200	0.0131	0.7976
Energy	Stationary Combustion	1A1 + 1A2 + 1A4, BIOMASS	N_2O	0.0386	400	0.0126	0.8102
Energy	Mobile combustion	Agriculture	N_2O	0.0153	1000	0.0125	0.8227
Agriculture	Agriculture soils, direct emissions	N-fixing Crops	N_2O	0.2695	54	0.0119	0.8346
Energy	Mobile combustion	Navigation large vessels	N_2O	0.0130	1000	0.0106	0.8452
Energy	Mobile combustion	National Fishing	N_2O	0.0115	1000	0.0094	0.8546
Energy	Mobile combustion	Other Mobil and Machin-ery/Industry	N_2O	0.0106	1001	0.0087	0.8633
Agriculture	Agriculture soils, pasture, range and paddock		N_2O	0.3141	32	0.0082	0.8715
Energy	Stationary Combustion	Plastic Waste	CO_2	0.3937	25	0.0082	0.8798
Industrial Proc.	Foam Blowing		HFC	0.1826	51	0.0076	0.8874
Energy	Stationary Combustion	Natural Gas	CO_2	4.3195	2	0.0070	0.8944
Energy	Stationary Combustion	1A1+1A2+1A4, BIOMASS	CH_4	0.0829	101	0.0069	0.9012
Energy	Stationary Combustion	1A1 + 1A2 + 1A4, GAS	N_2O	0.0278	300	0.0068	0.9081

Continued							
Energy	Mobile combustion	Navigation large vessels	CO_2	0.6656	12	0.0066	0.9146
Waste	Accidental fires - buildings		CO_2	0.0147	500	0.0060	0.9207
Agriculture	Agriculture soils, direct emissions	Cultivation of Histosols (2)	N_2O	0.1165	54	0.0051	0.9258
Energy	Stationary Combustion	Residual Oil	CO_2	2.5052	3	0.0051	0.9309
Waste	N_2O indirect from human sewage		N_2O	0.0822	71	0.0048	0.9357
Energy	Mobile combustion	Road Transportation	N_2O	0.0970	50	0.0040	0.9397
Energy	Stationary Combustion	Refinery Gas	CO_2	0.8062	5	0.0034	0.9430
Energy	Mobile combustion	Household and Gardening	CO_2	0.1128	35	0.0033	0.9463
Energy	Stationary Combustion	1A1 + 1A2 + 1A4, WASTE	N_2O	0.0184	200	0.0030	0.9493
Industrial Proc.	Other emissions of SF_6 i.e. from double glaze windows and laboratories		SF_6	0.0676	51	0.0028	0.9521
Energy	Mobile combustion	Civil Aviation	N_2O	0.0032	1000	0.0026	0.9547
Energy	Mobile combustion	National Fishing	CO_2	0.5907	5	0.0026	0.9573
Waste	Accidental fires - vehicles		CO_2	0.0063	500	0.0026	0.9599
Waste	Waste Water Handling		CH_4	0.0304	90	0.0022	0.9621
Energy	Mobile combustion	Civil Aviation	CO_2	0.2427	11	0.0022	0.9644
Energy	Mobile combustion	Railways	N_2O	0.0025	1000	0.0021	0.9664
Waste	N_2O direct, Domestic and Commercial Wastewater		N_2O	0.0240	105	0.0021	0.9685
Energy	Fugitive emissions	1B2c2ii, Flaring gas	CO_2	0.2762	9	0.0020	0.9705
Energy	Stationary Combustion	Petroleum Coke	CO_2	0.4103	5	0.0018	0.9724
Energy	Mobile combustion	Road Transportation	CH_4	0.0551	40	0.0018	0.9742
Energy	Stationary Combustion	Kerosene	CO_2	0.3662	6	0.0017	0.9759
Energy	Mobile combustion	Navigation small boats	CO_2	0.0479	41	0.0016	0.9775
Industrial Proc.	Cement Production		CO_2	0.8824	2	0.0016	0.9791
Solvent and Other Prod. Use	3D5 Other		CO_2	0.0857	22	0.0016	0.9807
Industrial Proc.	Magnesium Production		SF_6	0.0359	51	0.0015	0.9822
Industrial Proc.	Refrigeration and AC Equipment		HFC and PFC	0.0357	51	0.0015	0.9837
Waste	Accidental fires - buildings		CH_4	0.0024	700	0.0014	0.9850
Energy	Mobile combustion	Railways	CO_2	0.2967	5	0.0013	0.9864
Agriculture	Agriculture soils, direct emissions	Other direct emissions (please specify)	N_2O	0.0279	54	0.0012	0.9876
Energy	Stationary Combustion	1A1+1A2+1A4, SOLID	CH_4	0.0149	100	0.0012	0.9888
Energy	Mobile combustion	Military	N_2O	0.0012	1000	0.0009	0.9898
Energy	Mobile combustion	Forestry	CO_2	0.0357	30	0.0009	0.9906
Energy	Stationary Combustion	LPG	CO_2	0.1687	6	0.0008	0.9914
Energy	Stationary Combustion	1A1+1A2+1A4, GAS	CH_4	0.0084	100	0.0007	0.9921

Continued							
Industrial Proc.	Lime Production		CO_2	0.1155	7	0.0007	0.9928
Energy	Stationary Combustion	Coke	CO_2	0.1378	5	0.0006	0.9934
Energy	Fugitive emissions	1B2aii, Oil production landbased	CH_4	0.0172	40	0.0006	0.9939
Energy	Stationary Combustion	1A1+1A2+1A4, LIQUID	CH_4	0.0068	100	0.0006	0.9945
Energy	Mobile combustion	Military	CO_2	0.1190	5	0.0005	0.9950
Energy	Mobile combustion	Household and Gardening	N_2O	0.0005	1001	0.0004	0.9955
Solvent and Other Prod. Use	3A Paint application		CO_2	0.0263	18	0.0004	0.9959
Energy	Fugitive emissions	1B2aii, Oil production offshore	CH_4	0.0149	30	0.0004	0.9962
Solvent and Other Prod. Use	3C Chemical products, manufacturing and processing		CO_2	0.0231	18	0.0003	0.9966
Energy	Mobile combustion	Navigation small boats	N_2O	0.0004	1001	0.0003	0.9969
Energy	Mobile combustion	Household and Gardening	CH_4	0.0031	106	0.0003	0.9972
Energy	Fugitive emissions	1B2c2ii, Flaring gas	N_2O	0.0006	500	0.0003	0.9974
Energy	Fugitive emissions	1B2c2i, Flaring oil	CO_2	0.0234	12	0.0002	0.9976
Industrial Proc.	Other, lubricants		CO_2	0.0497	5	0.0002	0.9979
Energy	Mobile combustion	Agriculture	CH_4	0.0022	103	0.0002	0.9980
Industrial Proc.	Iron and Steel Production		CO_2	0.0284	7	0.0002	0.9982
Industrial Proc.	Electrical equipment		SF_6	0.0039	51	0.0002	0.9984
Waste	Accidental fires - vehicles		CH_4	0.0003	700	0.0002	0.9985
Energy	Stationary Combustion	1A1+1A2+1A4, WASTE	CH_4	0.0018	100	0.0002	0.9987
Energy	Mobile combustion	Forestry	N_2O	0.0002	1000	0.0001	0.9988
Energy	Fugitive emissions	1B2biv, Gas distribution	CH_4	0.0053	27	0.0001	0.9989
Energy	Mobile combustion	Other Mobil and Machin-ery/Industry	CH_4	0.0013	108	0.0001	0.9991
Industrial Proc.	Yellow Bricks Production		CO_2	0.0230	5	0.0001	0.9992
Agriculture	Field Burning of Agricultural Residues		CH_4+N_2O	0.0025	39	0.0001	0.9992
Energy	Fugitive emissions	1B2aiv, Oil refining and storage	CH_4	0.0008	125	0.0001	0.9993
Industrial Proc.	Limestone and Dolomite use		CO_2	0.0137	7	0.0001	0.9994
Industrial Proc.	Glass/GlassWoll Production		CO_2	0.0174	5	0.0001	0.9995
Industrial Proc.	Expanded Clay		CO_2	0.0149	5	0.0001	0.9995
Energy	Stationary Combustion	Brown Coal Bri.	CO_2	0.0110	6	0.0001	0.9996
Energy	Fugitive emissions	1B2c2i, Flaring oil	N_2O	0.0001	500	0.0001	0.9996
Energy	Fugitive emissions	1B2biii, Gas transmission	CH_4	0.0036	16	< 0,0001	0.9997
Energy	Mobile combustion	Forestry	CH_4	0.0004	104	< 0,0001	0.9997
Industrial Proc.	Road paving with Asphalt		CO_2	0.0018	25	< 0,0001	0.9998
Energy	Mobile combustion	Navigation small boats	CH_4	0.0003	108	< 0,0001	0.9998

Continued							
Industrial Proc.	Food and Drink		CO_2	0.0045	7	< 0,0001	0.9998
Energy	Mobile combustion	Navigation large vessels	CH_4	0.0003	101	< 0,0001	0.9998
Waste	Incineration of corpses		N_2O	0.0002	150	< 0,0001	0.9999
Energy	Mobile combustion	National Fishing	CH_4	0.0003	100	< 0,0001	0.9999
Energy	Mobile combustion	Railways	CH_4	0.0003	100	< 0,0001	0.9999
Energy	Fugitive emissions	1B2c2i, Flaring oil	CH_4	0.0013	19	< 0,0001	0.9999
Energy	Stationary Combustion	Natural gas fuelled engines, GAS	CH_4	0.0046	5	< 0,0001	1.0000
Energy	Stationary Combustion	Biogas fuelled engines, BIOMASS	CH_4	0.0019	10	< 0,0001	1.0000
Energy	Mobile combustion	Civil Aviation	CH_4	0.0002	100	< 0,0001	1.0000
Energy	Mobile combustion	Military	CH_4	0.0001	100	< 0,0001	1.0000
Industrial Proc.	Catalysts/Fertilizers and Pesticides		CO_2	0.0008	7	< 0,0001	1.0000
Energy	Fugitive emissions	1B2c2ii, Flaring gas	CH_4	0.0004	9	< 0,0001	1.0000
Waste	Incineration of corpses		CH_4	0.0000	300	< 0,0001	1.0000
Waste	Incineration of carcasses		N_2O	0.0000	150	< 0,0001	1.0000
Industrial Proc.	Asphalt Roofing		CO_2	0.0000	25	< 0,0001	1.0000
Waste	Incineration of carcasses		CH_4	0.0000	300	< 0,0001	1.0000
Solvent and Other Prod. Use	3B Degreasing and dry cleaning		CO_2	0.0000	18	< 0,0001	1.0000
Industrial Proc.	Aerosols		HFC	0.0000	51	< 0,0001	1.0000
Industrial Proc.	Other i.e Fibre Optics		HFC and PFC	0.0000	51	< 0,0001	1.0000
Solvent and Other Prod. Use	3D5 Other		N_2O	0.0000	7	< 0,0001	1.0000
Total (excl. LULUCF)				**69.2041**		**1.0000**	

Table 1.8 Key Category Analysis for Denmark, year 1990 incl. LULUCF, level assessment, tier 2.

Table 7.A1 (of Good Practice Guidance) Tier 2 Analysis - Level Assessment DK - inventory								
A IPCC Source Categories (LULUCF included)			B Direct GHG	C Base Year Estimate (1) Ex,o Mt CO_2-eq	D Uncertainty Ux,o %	E Base Year Lx,o*Ux,o relative	F Base Year Cumulative total of Col. E
Agriculture	Agriculture soils, indirect	Nitrogen Leaching and Run-off	N2O	3.3339	54	0.1296	0.1296
Waste	Solid Waste Disposal Sites		CH4	1.1108	118	0.0949	0.2244
Agriculture	Agriculture soils, direct emissions	Synthetic Fertilizers	N2O	2.3946	50	0.0866	0.3110
Agriculture	Manure Management		CH4	0.8692	100	0.0630	0.3740
Agriculture	Manure management		N2O	0.6669	100	0.0484	0.4224
LULUCF	Cropland	5B Cropland remaining Cr. Organic soils	CO2	1.0555	51	0.0388	0.4612
Agriculture	Agriculture soils, direct emissions	Animal Manure Applied to Soils	N2O	1.0502	51	0.0386	0.4999
Energy	Mobile combustion	Road Transportation	CO2	9.2753	5	0.0360	0.5359
LULUCF	Cropland	5B Cropland remaining Cr. Mineral soils	CO2	-2.0207	22	0.0326	0.5685
Agriculture	Enteric Fermentation		CH4	3.2612	13	0.0301	0.5986
Energy	Stationary Combustion	Coal	CO2	24.0771	2	0.0270	0.6257
Energy	Mobile combustion	Other Mobil and Machinery/Industry	CO2	0.8415	41	0.0251	0.6508
Energy	Mobile combustion	Agriculture	CO2	1.2725	25	0.0225	0.6733
Energy	Stationary Combustion	1A1 + 1A2 + 1A4, LIQUID	N2O	0.0757	400	0.0219	0.6951
LULUCF	Agricultural lime application	5IV Cropland Limestone	CO2	0.5652	50	0.0205	0.7156
Industrial Proc.	Nitric Acid Production		N2O	1.0429	25	0.0189	0.7345
Energy	Stationary Combustion	Gas Oil	CO2	4.5472	6	0.0188	0.7533
Agriculture	Agriculture soils, indirect	Atmospheric Deposition	N2O	0.4414	51	0.0162	0.7696
Agriculture	Agriculture soils, direct emissions	Crop Residue	N2O	0.3612	54	0.0140	0.7836
Energy	Stationary Combustion	1A1 + 1A2 + 1A4, SOLID	N2O	0.0798	200	0.0115	0.7951
Energy	Stationary Combustion	1A1 + 1A2 + 1A4, BIOMASS	N2O	0.0386	400	0.0111	0.8063
Energy	Mobile combustion	Agriculture	N2O	0.0153	1000	0.0110	0.8173
Agriculture	Agriculture soils, direct emissions	N-fixing Crops	N2O	0.2695	54	0.0105	0.8277
Energy	Mobile combustion	Navigation large vessels	N2O	0.0130	1000	0.0094	0.8371
LULUCF	Forest Land remaining Forest L.	5A1 Broadleaves	CO2	-0.6487	18	0.0084	0.8456
Energy	Mobile combustion	National Fishing	N2O	0.0115	1000	0.0083	0.8539
Energy	Mobile combustion	Other Mobil and Machinery/Industry	N2O	0.0106	1001	0.0077	0.8615
Agriculture	Agriculture soils, pasture, range and paddock		N2O	0.3141	32	0.0073	0.8688
Energy	Stationary Combustion	Plastic Waste	CO2	0.3937	25	0.0072	0.8760
Industrial Proc.	Foam Blowing		HFC	0.1826	51	0.0067	0.8828

Continued							
Energy	Stationary Combustion	Natural Gas	CO2	4.3195	2	0.0061	0.8889
Energy	Stationary Combustion	1A1+1A2+1A4, BIOMASS	CH4	0.0829	101	0.0061	0.8950
Energy	Stationary Combustion	1A1 + 1A2 + 1A4, GAS	N2O	0.0278	300	0.0060	0.9010
Energy	Mobile combustion	Navigation large vessels	CO2	0.6656	12	0.0058	0.9068
Waste	Accidental fires - buildings		CO2	0.0147	500	0.0053	0.9121
Agriculture	Agriculture soils, direct emissions	Cultivation of Histosols (2)	N2O	0.1165	54	0.0045	0.9166
Energy	Stationary Combustion	Residual Oil	CO2	2.5052	3	0.0045	0.9211
Waste	N2O indirect from human sewage		N2O	0.0822	71	0.0042	0.9253
Energy	Mobile combustion	Road Transportation	N2O	0.0970	50	0.0035	0.9288
LULUCF	Grassland	5C Grassland rem. Grasland. Organic soils	CO2	0.0929	51	0.0034	0.9323
LULUCF	Forest Land remaining Forest L.	5A1 Conifers	CO2	-0.2543	18	0.0033	0.9356
LULUCF	Wetlands	5D Wetlands remaining Wetlands (peat)	CO2	0.0861	51	0.0032	0.9387
Energy	Stationary Combustion	Refinery Gas	CO2	0.8062	5	0.0030	0.9417
LULUCF	Grassland	5C Total Grassland. Living biomass	CO2	0.1826	22	0.0029	0.9446
LULUCF	Settlements	5E Total settlements. Living biomass	CO2	0.0796	51	0.0029	0.9476
Energy	Mobile combustion	Household and Gardening	CO2	0.1128	35	0.0029	0.9505
Energy	Stationary Combustion	1A1 + 1A2 + 1A4, WASTE	N2O	0.0184	200	0.0027	0.9531
Industrial Proc.	Other emissions of SF6 i.e. from double glaze windows and laboratories		SF6	0.0676	51	0.0025	0.9556
Energy	Mobile combustion	Civil Aviation	N2O	0.0032	1000	0.0023	0.9579
Energy	Mobile combustion	National Fishing	CO2	0.5907	5	0.0023	0.9602
Waste	Accidental fires - vehicles		CO2	0.0063	500	0.0023	0.9625
Waste	Waste Water Handling		CH4	0.0304	90	0.0020	0.9644
Energy	Mobile combustion	Civil Aviation	CO2	0.2427	11	0.0020	0.9664
Energy	Mobile combustion	Railways	N2O	0.0025	1000	0.0018	0.9682
Waste	N2O direct, Domestic and Commercial Waste-water		N2O	0.0240	105	0.0018	0.9700
Energy	Fugitive emissions	1B2c2ii, Flaring gas	CO2	0.2762	9	0.0018	0.9718
Energy	Stationary Combustion	Petroleum Coke	CO2	0.4103	5	0.0016	0.9735
Energy	Mobile combustion	Road Transportation	CH4	0.0551	40	0.0016	0.9750
Energy	Stationary Combustion	Kerosene	CO2	0.3662	6	0.0015	0.9766
Energy	Mobile combustion	Navigation small boats	CO2	0.0479	41	0.0014	0.9780
Industrial Proc.	Cement Production		CO2	0.8824	2	0.0014	0.9794
Solvent and Other Prod. Use	3D5 Other		CO2	0.0857	22	0.0014	0.9808
Industrial Proc.	Magnesium Production		SF6	0.0359	51	0.0013	0.9821
Industrial Proc.	Refrigeration and AC Equipment		HFC and PFC	0.0357	51	0.0013	0.9834
Waste	Accidental fires - buildings		CH4	0.0024	700	0.0012	0.9846

Continued							
Energy	Mobile combustion	Railways	CO2	0.2967	5	0.0012	0.9858
Agriculture	Agriculture soils, direct emissions	Other direct emissions (please specify)	N2O	0.0279	54	0.0011	0.9869
Energy	Stationary Combustion	1A1+1A2+1A4, SOLID	CH4	0.0149	100	0.0011	0.9879
LULUCF	Non-CO2 drainage of soils and wetlands	5IID Forest Land.	N2O	0.0157	81	0.0009	0.9889
LULUCF	Cropland	5B Cropland remaining Cr. Living biomass	CO2	-0.0530	22	0.0009	0.9897
Energy	Mobile combustion	Military	N2O	0.0012	1000	0.0008	0.9905
Energy	Mobile combustion	Forestry	CO2	0.0357	30	0.0008	0.9913
Energy	Stationary Combustion	LPG	CO2	0.1687	6	0.0007	0.9920
Energy	Stationary Combustion	1A1+1A2+1A4, GAS	CH4	0.0084	100	0.0006	0.9926
Industrial Proc.	Lime Production		CO2	0.1155	7	0.0006	0.9932
Energy	Stationary Combustion	Coke	CO2	0.1378	5	0.0005	0.9938
Energy	Fugitive emissions	1B2aii, Oil production landbased	CH4	0.0172	40	0.0005	0.9942
Energy	Stationary Combustion	1A1+1A2+1A4, LIQUID	CH4	0.0068	100	0.0005	0.9947
Energy	Mobile combustion	Military	CO2	0.1190	5	0.0005	0.9952
Energy	Mobile combustion	Household and Gardening	N2O	0.0005	1001	0.0004	0.9956
Solvent and Other Prod. Use	3A Paint application		CO2	0.0263	18	0.0003	0.9959
Energy	Fugitive emissions	1B2aii, Oil production offshore	CH4	0.0149	30	0.0003	0.9962
Solvent and Other Prod. Use	3C Chemical products, manufacturing and processing		CO2	0.0231	18	0.0003	0.9965
Energy	Mobile combustion	Navigation small boats	N2O	0.0004	1001	0.0003	0.9968
Industrial Proc.	Other, lubricants		CO2	0.0497	7	0.0003	0.9971
Energy	Mobile combustion	Household and Gardening	CH4	0.0031	106	0.0002	0.9973
Energy	Fugitive emissions	1B2c2ii, Flaring gas	N2O	0.0006	500	0.0002	0.9976
LULUCF	N2O Disturbance, Land converted to cropland	5III Cropland	N2O	0.0032	90	0.0002	0.9978
Energy	Fugitive emissions	1B2c2i, Flaring oil	CO2	0.0234	12	0.0002	0.9980
Energy	Mobile combustion	Agriculture	CH4	0.0022	103	0.0002	0.9981
Industrial Proc.	Iron and Steel Production		CO2	0.0284	7	0.0001	0.9983
Industrial Proc.	Electrical equipment		SF6	0.0039	51	0.0001	0.9984
Waste	Accidental fires - vehicles		CH4	0.0003	700	0.0001	0.9986
Energy	Stationary Combustion	1A1+1A2+1A4, WASTE	CH4	0.0018	100	0.0001	0.9987
Energy	Mobile combustion	Forestry	N2O	0.0002	1000	0.0001	0.9988
Energy	Fugitive emissions	1B2biv, Gas distribution	CH4	0.0053	27	0.0001	0.9989
Energy	Mobile combustion	Other Mobil and Machinery/Industry	CH4	0.0013	108	0.0001	0.9990
Industrial Proc.	Yellow Bricks Production		CO2	0.0230	5	0.0001	0.9991
LULUCF	Forest Land. Land converted to Forest L.	5A2 Conifers	CO2	0.0051	21	0.0001	0.9992
Agriculture	Field Burning of Agricultural Residues		CH4+N2O	0.0025	39	0.0001	0.9993

Continued							
Energy	Fugitive emissions	1B2aiv, Oil refining and storage	CH4	0.0008	125	0.0001	0.9993
Industrial Proc.	Limestone and Dolomite use		CO2	0.0137	7	0.0001	0.9994
Industrial Proc.	Glass/GlassWoll Production		CO2	0.0174	5	0.0001	0.9995
Industrial Proc.	Expanded Clay		CO2	0.0149	5	0.0001	0.9995
LULUCF	Forest Land. Land converted to Forest L.	5A2 Broadleaves	CO2	0.0033	21	0.0001	0.9996
Energy	Stationary Combustion	Brown Coal Bri.	CO2	0.0110	6	< 0,0001	0.9996
Energy	Fugitive emissions	1B2c2i, Flaring oil	N2O	0.0001	500	< 0,0001	0.9997
Energy	Fugitive emissions	1B2biii, Gas transmission	CH4	0.0036	16	< 0,0001	0.9997
Energy	Mobile combustion	Forestry	CH4	0.0004	104	< 0,0001	0.9997
Industrial Proc.	Road paving with Asphalt		CO2	0.0018	25	< 0,0001	0.9998
Energy	Mobile combustion	Navigation small boats	CH4	0.0003	108	< 0,0001	0.9998
Industrial Proc.	Food and Drink		CO2	0.0045	7	< 0,0001	0.9998
Energy	Mobile combustion	Navigation large vessels	CH4	0.0003	101	< 0,0001	0.9998
Waste	Incineration of corpses		N2O	0.0002	150	< 0,0001	0.9999
Energy	Mobile combustion	National Fishing	CH4	0.0003	100	< 0,0001	0.9999
Energy	Mobile combustion	Railways	CH4	0.0003	100	< 0,0001	0.9999
Energy	Fugitive emissions	1B2c2i, Flaring oil	CH4	0.0013	19	< 0,0001	0.9999
Energy	Stationary Combustion	Natural gas fuelled engines, GAS	CH4	0.0046	5	< 0,0001	0.9999
Energy	Stationary Combustion	Biogas fuelled engines, BIOMASS	CH4	0.0019	10	< 0,0001	1.0000
LULUCF	Wetlands	5D Land converted to wetlands	CO2	0.0004	51	< 0,0001	1.0000
Energy	Mobile combustion	Civil Aviation	CH4	0.0002	100	< 0,0001	1.0000
LULUCF	Non-CO2 drainage of soils and wetlands	5IID Wetlands. Peatland	N2O	0.0001	100	< 0,0001	1.0000
Energy	Mobile combustion	Military	CH4	0.0001	100	< 0,0001	1.0000
Energy	Fugitive emissions	1B2c2ii, Flaring gas	CH4	0.0004	9	< 0,0001	1.0000
Waste	Incineration of corpses		CH4	0.0000	300	< 0,0001	1.0000
Industrial Proc.	Catalysts/Fertilizers and Pesticides		CO2	0.0008	2	< 0,0001	1.0000
Waste	Incineration of carcasses		N2O	0.0000	150	< 0,0001	1.0000
Industrial Proc.	Asphalt Roofing		CO2	0.0000	25	< 0,0001	1.0000
Waste	Incineration of carcasses		CH4	0.0000	300	< 0,0001	1.0000
Solvent and Other Prod. Use	3B Degreasing and dry cleaning		CO2	0.0000	18	< 0,0001	1.0000
Industrial Proc.	Aerosols		HFC	0.0000	51	< 0,0001	1.0000
Industrial Proc.	Other i.e Fibre Optics		HFC and PFC	0.0000	51	< 0,0001	1.0000
Solvent and Other Prod. Use	3D5 Other		N2O	0.0000	7	< 0,0001	1.0000
				68.3169		**1.0000**	

The Estimates include signs, where + : emission - : removal, allthough in the level analyses only the absolute values are used.

Table 1.9 Key Category Analysis for Denmark, year 2008 excl. LULUCF, level assessment, tier 2.

Table 7.A1 (of Good Practice Guidance)

Tier 2 Analysis - Level Assessment DK - inventory

A			B	C	D	E	F
IPCC Source Categories (LULUCF excluded)			Direct GHG	Yr 2008 Estimate Ex,t Mt CO_2-eq	Uncertainty Ux,t %	Yr 2008 Lx,t*Ux,t relative	Yr 2008 Cumulative total of Col. E
Waste	Solid Waste Disposal Sites		CH_4	1.0567	118	0.1096	0.1096
Agriculture	Agriculture soils, indirect	Nitrogen Leaching and Run-off	N_2O	1.9927	54	0.0941	0.2037
Agriculture	Manure Management		CH_4	1.0498	100	0.0925	0.2961
Energy	Mobile combustion	Road Transportation	CO_2	12.9485	5	0.0611	0.3573
Agriculture	Agriculture soils, direct emissions	Synthetic Fertilizers	N_2O	1.3177	50	0.0579	0.4151
Agriculture	Agriculture soils, direct emissions	Animal Manure Applied to Soils	N_2O	1.1235	51	0.0502	0.4653
Agriculture	Manure management		N_2O	0.5053	100	0.0445	0.5098
Energy	Mobile combustion	Other Mobil and Machinery/Industry	CO_2	1.1186	41	0.0405	0.5503
Industrial Proc.	Refrigeration and AC Equipment		HFC and PFC	0.7392	51	0.0330	0.5834
Agriculture	Enteric Fermentation		CH_4	2.8194	13	0.0316	0.6150
Energy	Stationary Combustion	Plastic Waste	CO_2	1.3426	25	0.0300	0.6450
Energy	Stationary Combustion	1A1 + 1A2 + 1A4, BIOMASS	N_2O	0.0810	400	0.0284	0.6735
Energy	Mobile combustion	Agriculture	CO_2	1.2301	25	0.0264	0.6999
Energy	Stationary Combustion	Coal	CO_2	16.0495	2	0.0219	0.7218
Energy	Stationary Combustion	Natural Gas	CO_2	9.7644	2	0.0169	0.7387
Energy	Stationary Combustion	1A1+1A2+1A4, BIOMASS	CH_4	0.1866	101	0.0166	0.7552
Energy	Stationary Combustion	1A1 + 1A2 + 1A4, LIQUID	N_2O	0.0461	400	0.0162	0.7714
Energy	Stationary Combustion	1A1 + 1A2 + 1A4, GAS	N_2O	0.0613	300	0.0161	0.7875
Agriculture	Agriculture soils, direct emissions	Crop Residue	N_2O	0.3051	54	0.0144	0.8019
Energy	Mobile combustion	Agriculture	N_2O	0.0161	1000	0.0141	0.8161
Energy	Mobile combustion	Other Mobil and Machinery/Industry	N_2O	0.0147	1001	0.0129	0.8289
Agriculture	Agriculture soils, indirect	Atmospheric Deposition	N_2O	0.2862	51	0.0128	0.8417
Agriculture	Agriculture soils, direct emissions	N-fixing Crops	N_2O	0.2127	54	0.0100	0.8518
Energy	Stationary Combustion	1A1 + 1A2 + 1A4, SOLID	N_2O	0.0490	200	0.0086	0.8604
Energy	Stationary Combustion	Gas Oil	CO_2	1.5441	6	0.0078	0.8681
Energy	Mobile combustion	National Fishing	N_2O	0.0088	1000	0.0077	0.8758
Waste	Accidental fires - buildings		CO_2	0.0176	500	0.0077	0.8835
Energy	Mobile combustion	Household and Gardening	CO_2	0.2390	35	0.0074	0.8909
Waste	N_2O direct, Domestic and Commercial Wastewater		N_2O	0.0699	105	0.0064	0.8974
Energy	Mobile combustion	Navigation large vessels	N_2O	0.0069	1000	0.0061	0.9034

Continued							
Agriculture	Agriculture soils, pasture, range and paddock		N_2O	0.2143	32	0.0060	0.9094
Agriculture	Agriculture soils, direct emissions	Cultivation of Histosols (2)	N_2O	0.1167	54	0.0055	0.9149
Energy	Mobile combustion	Road Transportation	N_2O	0.1256	50	0.0055	0.9204
Energy	Fugitive emissions	1B2aiv, Oil refining and storage	CH_4	0.0459	125	0.0050	0.9255
Waste	Accidental fires - vehicles		CO_2	0.0109	500	0.0048	0.9303
Industrial Proc.	Foam Blowing		HFC	0.1026	51	0.0046	0.9349
Energy	Stationary Combustion	Refinery Gas	CO_2	0.8411	5	0.0038	0.9386
Energy	Mobile combustion	Navigation large vessels	CO_2	0.3526	12	0.0037	0.9423
Waste	Waste Water Handling		CH_4	0.0473	90	0.0037	0.9461
Agriculture	Agriculture soils, direct emissions	Other direct emissions (please specify)	N_2O	0.0783	54	0.0037	0.9498
Energy	Mobile combustion	Navigation small boats	CO_2	0.1005	41	0.0036	0.9534
Energy	Stationary Combustion	Petroleum Coke	CO_2	0.7545	5	0.0036	0.9570
Energy	Stationary Combustion	1A1 + 1A2 + 1A4, WASTE	N_2O	0.0194	200	0.0034	0.9604
Energy	Stationary Combustion	Residual Oil	CO_2	1.3593	3	0.0030	0.9634
Energy	Fugitive emissions	1B2c2ii, Flaring gas	CO_2	0.3478	9	0.0027	0.9661
Energy	Mobile combustion	Civil Aviation	N_2O	0.0027	1000	0.0024	0.9685
Industrial Proc.	Cement Production		CO_2	1.1547	2	0.0023	0.9708
Waste	N_2O indirect from human sewage		N_2O	0.0347	71	0.0021	0.9729
Energy	Mobile combustion	National Fishing	CO_2	0.4495	5	0.0021	0.9750
Energy	Mobile combustion	Railways	N_2O	0.0020	1000	0.0018	0.9768
Waste	Accidental fires - buildings		CH_4	0.0028	700	0.0017	0.9785
Energy	Mobile combustion	Civil Aviation	CO_2	0.1638	11	0.0016	0.9801
Energy	Stationary Combustion	1A1+1A2+1A4, GAS	CH_4	0.0150	100	0.0013	0.9815
Energy	Fugitive emissions	1B2aii, Oil production landbased	CH_4	0.0366	40	0.0013	0.9828
Energy	Mobile combustion	Railways	CO_2	0.2367	5	0.0011	0.9839
Energy	Fugitive emissions	1B2aii, Oil production offshore	CH_4	0.0386	30	0.0010	0.9849
Energy	Mobile combustion	Household and Gardening	N_2O	0.0012	1001	0.0010	0.9859
Energy	Mobile combustion	Military	N_2O	0.0011	1000	0.0010	0.9869
Energy	Mobile combustion	Navigation small boats	N_2O	0.0011	1001	0.0009	0.9878
Industrial Proc.	Aerosols		HFC	0.0186	51	0.0008	0.9887
Energy	Stationary Combustion	Natural gas fuelled engines, GAS	CH_4	0.1849	5	0.0008	0.9895
Solvent and Other Prod. Use	3D5 Other		CO_2	0.0409	22	0.0008	0.9903
Energy	Mobile combustion	Road Transportation	CH_4	0.0220	40	0.0008	0.9911
Industrial Proc.	Electrical equipment		SF_6	0.0162	51	0.0007	0.9918
Energy	Stationary Combustion	1A1+1A2+1A4, SOLID	CH_4	0.0081	100	0.0007	0.9925
Industrial Proc.	Other emissions of SF_6 i.e. from double glaze windows and laboratories		SF_6	0.0154	51	0.0007	0.9932

Continued							
Energy	Stationary Combustion	Coke	CO_2	0.1120	5	0.0005	0.9937
Energy	Mobile combustion	Military	CO_2	0.1076	5	0.0005	0.9942
Energy	Stationary Combustion	LPG	CO_2	0.0960	6	0.0005	0.9947
Energy	Mobile combustion	Household and Gardening	CH_4	0.0050	106	0.0005	0.9952
Energy	Mobile combustion	Forestry	CO_2	0.0172	30	0.0005	0.9956
Industrial Proc.	Lime Production		CO_2	0.0656	7	0.0004	0.9960
Energy	Stationary Combustion	1A1+1A2+1A4, LIQUID	CH_4	0.0043	100	0.0004	0.9964
Energy	Fugitive emissions	1B2c2ii, Flaring gas	N_2O	0.0008	500	0.0003	0.9967
Energy	Fugitive emissions	1B2c2i, Flaring oil	CO_2	0.0282	12	0.0003	0.9970
Waste	Accidental fires - vehicles		CH_4	0.0005	700	0.0003	0.9973
Industrial Proc.	Limestone and Dolomite use		CO_2	0.0387	7	0.0002	0.9976
Solvent and Other Prod. Use	3C Chemical products, manufacturing and proc-essing		CO_2	0.0146	18	0.0002	0.9978
Industrial Proc.	Other i.e Fibre Optics		HFC and PFC	0.0052	51	0.0002	0.9980
Energy	Stationary Combustion	Biogas fuelled engines, BIOMASS	CH_4	0.0209	10	0.0002	0.9982
Solvent and Other Prod. Use	3D5 Other		N_2O	0.0273	7	0.0002	0.9984
Industrial Proc.	Other, lubricants		CO_2	0.0340	5	0.0002	0.9986
Energy	Mobile combustion	Forestry	N_2O	0.0002	1000	0.0001	0.9987
Solvent and Other Prod. Use	3A Paint application		CO_2	0.0092	18	0.0001	0.9989
Energy	Mobile combustion	Agriculture	CH_4	0.0016	103	0.0001	0.9990
Industrial Proc.	Yellow Bricks Production		CO_2	0.0284	5	0.0001	0.9991
Agriculture	Field Burning of Agricultural Residues		CH_4+N_2O	0.0034	39	0.0001	0.9992
Energy	Fugitive emissions	1B2biv, Gas distribution	CH_4	0.0037	27	0.0001	0.9993
Energy	Mobile combustion	Other Mobil and Machinery/Industry	CH_4	0.0009	108	0.0001	0.9994
Energy	Stationary Combustion	1A1+1A2+1A4, WASTE	CH_4	0.0009	100	0.0001	0.9995
Industrial Proc.	Expanded Clay		CO_2	0.0161	5	0.0001	0.9996
Industrial Proc.	Glass/GlassWoll Production		CO_2	0.0151	5	0.0001	0.9996
Energy	Mobile combustion	Navigation small boats	CH_4	0.0005	108	< 0,0001	0.9997
Energy	Stationary Combustion	Kerosene	CO_2	0.0086	6	< 0,0001	0.9997
Industrial Proc.	Road paving with Asphalt		CO_2	0.0019	25	< 0,0001	0.9998
Energy	Fugitive emissions	1B2biii, Gas transmission	CH_4	0.0027	16	< 0,0001	0.9998
Energy	Fugitive emissions	1B2c2i, Flaring oil	N_2O	0.0001	500	< 0,0001	0.9998
Waste	Incineration of corpses		N_2O	0.0002	150	< 0,0001	0.9999
Energy	Mobile combustion	National Fishing	CH_4	0.0002	100	< 0,0001	0.9999
Industrial Proc.	Food and Drink		CO_2	0.0027	7	< 0,0001	0.9999

Continued							
Industrial Proc.	Catalysts/Fertilizers and Pesticides		CO_2	0.0024	7	< 0,0001	0.9999
Energy	Mobile combustion	Railways	CH_4	0.0002	100	< 0,0001	0.9999
Energy	Mobile combustion	Navigation large vessels	CH_4	0.0002	101	< 0,0001	0.9999
Waste	Incineration of carcasses		N_2O	0.0001	150	< 0,0001	1.0000
Energy	Mobile combustion	Civil Aviation	CH_4	0.0001	100	< 0,0001	1.0000
Energy	Mobile combustion	Military	CH_4	0.0001	100	< 0,0001	1.0000
Energy	Mobile combustion	Forestry	CH_4	0.0001	104	< 0,0001	1.0000
Energy	Fugitive emissions	1B2c2ii, Flaring gas	CH_4	0.0008	9	< 0,0001	1.0000
Energy	Fugitive emissions	1B2c2i, Flaring oil	CH_4	0.0002	19	< 0,0001	1.0000
Waste	Incineration of corpses		CH_4	0.0000	300	< 0,0001	1.0000
Waste	Incineration of carcasses		CH_4	0.0000	300	< 0,0001	1.0000
Industrial Proc.	Asphalt Roofing		CO_2	0.0000	25	< 0,0001	1.0000
Solvent and Other Prod. Use	3B Degreasing and dry cleaning		CO_2	0.0000	18	< 0,0001	1.0000
Energy	Stationary Combustion	Brown Coal Bri.	CO_2	0.0000	6	< 0,0001	1.0000
Industrial Proc.	Iron and Steel Production		CO_2	NA,NO	7	< 0,0001	1.0000
Industrial Proc.	Nitric Acid Production		N_2O	0.0000	25	< 0,0001	1.0000
Industrial Proc.	Magnesium Production		SF_6	0.0000	51	< 0,0001	1.0000
Total (excl. LULUCF)				**63.8450**		**1.0000**	

Table 1.10 Key Category Analysis for Denmark, year 2008 incl. LULUCF, level assessment, tier 2.

Table 7.A1 (of Good Practice Guidance)

Tier 2 Analysis - Level Assessment DK - inventory

A			B	C	D	E	F
IPCC Source Categories (LULUCF included)			Direct GHG	Year 2008 Estimate (1) Ex,t Mt CO_2-eq	Uncertainty Ux,t %	Year 2008 Lx,t*Ux,t relative	Year 2008 Cumulative total of Col. E
Waste	Solid Waste Disposal Sites		CH4	1.0567	118	0.1008	0.1008
Agriculture	Agriculture soils, indirect	Nitrogen Leaching and Run-off	N2O	1.9927	54	0.0865	0.1873
Agriculture	Manure Management		CH4	1.0498	100	0.0851	0.2724
Energy	Mobile combustion	Road Transportation	CO2	12.9485	5	0.0562	0.3286
Agriculture	Agriculture soils, direct emissions	Synthetic Fertilizers	N2O	1.3177	50	0.0532	0.3818
Agriculture	Agriculture soils, direct emissions	Animal Manure Applied to Soils	N2O	1.1235	51	0.0462	0.4280
LULUCF	Cropland	5B Cropland remaining Cr. Organic soils	CO2	1.0700	51	0.0440	0.4720
Agriculture	Manure management		N2O	0.5053	100	0.0409	0.5129
Energy	Mobile combustion	Other Mobil and Machinery/Industry	CO2	1.1186	41	0.0372	0.5501
Industrial Proc.	Refrigeration and AC Equipment		HFC and PFC	0.7392	51	0.0304	0.5805
Agriculture	Enteric Fermentation		CH4	2.8194	13	0.0291	0.6096
Energy	Stationary Combustion	Plastic Waste	CO2	1.3426	25	0.0276	0.6372
Energy	Stationary Combustion	1A1 + 1A2 + 1A4, BIOMASS	N2O	0.0810	400	0.0262	0.6634
Energy	Mobile combustion	Agriculture	CO2	1.2301	25	0.0243	0.6877
Energy	Stationary Combustion	Coal	CO2	16.0495	2	0.0201	0.7078
Energy	Stationary Combustion	Natural Gas	CO2	9.7644	2	0.0155	0.7234
Energy	Stationary Combustion	1A1+1A2+1A4, BIOMASS	CH4	0.1866	101	0.0152	0.7386
Energy	Stationary Combustion	1A1 + 1A2 + 1A4, LIQUID	N2O	0.0461	400	0.0149	0.7535
Energy	Stationary Combustion	1A1 + 1A2 + 1A4, GAS	N2O	0.0613	300	0.0148	0.7683
Agriculture	Agriculture soils, direct emissions	Crop Residue	N2O	0.3051	54	0.0132	0.7815
Energy	Mobile combustion	Agriculture	N2O	0.0161	1000	0.0130	0.7945
Energy	Mobile combustion	Other Mobil and Machinery/Industry	N2O	0.0147	1001	0.0118	0.8064
Agriculture	Agriculture soils, indirect	Atmospheric Deposition	N2O	0.2862	51	0.0118	0.8182
LULUCF	Agricultural lime application	5IV Cropland Limestone	CO2	0.2288	50	0.0093	0.8274
Agriculture	Agriculture soils, direct emissions	N-fixing Crops	N2O	0.2127	54	0.0092	0.8367
LULUCF	Cropland	5B Cropland remaining Cr. Mineral soils	CO2	-0.5107	22	0.0092	0.8459
Energy	Stationary Combustion	1A1 + 1A2 + 1A4, SOLID	N2O	0.0490	200	0.0079	0.8538
Energy	Stationary Combustion	Gas Oil	CO2	1.5441	6	0.0071	0.8609
Energy	Mobile combustion	National Fishing	N2O	0.0088	1000	0.0071	0.8680
Waste	Accidental fires - buildings		CO2	0.0176	500	0.0071	0.8751

Continued							
Energy	Mobile combustion	Household and Gardening	CO2	0.2390	35	0.0068	0.8819
Waste	N2O direct, Domestic and Commercial Wastewa-ter		N2O	0.0699	105	0.0059	0.8878
Energy	Mobile combustion	Navigation large vessels	N2O	0.0069	1000	0.0056	0.8934
Agriculture	Agriculture soils, pasture, range and paddock		N2O	0.2143	32	0.0055	0.8989
Agriculture	Agriculture soils, direct emissions	Cultivation of Histosols (2)	N2O	0.1167	54	0.0051	0.9040
Energy	Mobile combustion	Road Transportation	N2O	0.1256	50	0.0051	0.9090
Energy	Fugitive emissions	1B2aiv, Oil refining and storage	CH4	0.0459	125	0.0046	0.9136
Waste	Accidental fires - vehicles		CO2	0.0109	500	0.0044	0.9181
Industrial Proc.	Foam Blowing		HFC	0.1026	51	0.0042	0.9223
LULUCF	Forest Land remaining Forest L.	5A1 Conifers	CO2	0.2387	18	0.0035	0.9257
Energy	Stationary Combustion	Refinery Gas	CO2	0.8411	5	0.0035	0.9292
Energy	Mobile combustion	Navigation large vessels	CO2	0.3526	12	0.0034	0.9326
Waste	Waste Water Handling		CH4	0.0473	90	0.0034	0.9361
Agriculture	Agriculture soils, direct emissions	Other direct emissions (please specify)	N2O	0.0783	54	0.0034	0.9395
Energy	Mobile combustion	Navigation small boats	CO2	0.1005	41	0.0033	0.9428
LULUCF	Grassland	5C Grassland rem. Grasland. Organic soils	CO2	0.0812	51	0.0033	0.9461
Energy	Stationary Combustion	Petroleum Coke	CO2	0.7545	5	0.0033	0.9495
Energy	Stationary Combustion	1A1 + 1A2 + 1A4, WASTE	N2O	0.0194	200	0.0031	0.9526
LULUCF	Forest Land remaining Forest L.	5A1 Broadleaves	CO2	0.1992	18	0.0029	0.9555
Energy	Stationary Combustion	Residual Oil	CO2	1.3593	3	0.0027	0.9582
Energy	Fugitive emissions	1B2c2ii, Flaring gas	CO2	0.3478	9	0.0025	0.9608
Energy	Mobile combustion	Civil Aviation	N2O	0.0027	1000	0.0022	0.9629
LULUCF	Settlements	5E Total settlements. Living biomass	CO2	0.0518	51	0.0021	0.9651
Industrial Proc.	Cement Production		CO2	1.1547	2	0.0021	0.9671
Waste	N2O indirect from human sewage		N2O	0.0347	71	0.0020	0.9691
Energy	Mobile combustion	National Fishing	CO2	0.4495	5	0.0020	0.9711
LULUCF	Wetlands	5D Land converted to wetlands	CO2	-0.0404	51	0.0017	0.9727
Energy	Mobile combustion	Railways	N2O	0.0020	1000	0.0016	0.9744
Waste	Accidental fires - buildings		CH4	0.0028	700	0.0016	0.9760
Energy	Mobile combustion	Civil Aviation	CO2	0.1638	11	0.0015	0.9774
LULUCF	Wetlands	5D Wetlands remaining Wetlands (peat)	CO2	0.0331	51	0.0014	0.9788
Energy	Stationary Combustion	1A1+1A2+1A4, GAS	CH4	0.0150	100	0.0012	0.9800
Energy	Fugitive emissions	1B2aii, Oil production landbased	CH4	0.0366	40	0.0012	0.9812
LULUCF	Grassland	5C Total Grassland. Living biomass	CO2	0.0592	22	0.0011	0.9823
Energy	Mobile combustion	Railways	CO2	0.2367	5	0.0010	0.9833
Energy	Fugitive emissions	1B2aii, Oil production offshore	CH4	0.0386	30	0.0009	0.9842

Continued							
Energy	Mobile combustion	Household and Gardening	N2O	0.0012	1001	0.0009	0.9851
Energy	Mobile combustion	Military	N2O	0.0011	1000	0.0009	0.9861
LULUCF	Cropland	5B Cropland remaining Cr. Living biomass	CO2	0.0484	22	0.0009	0.9869
Energy	Mobile combustion	Navigation small boats	N2O	0.0011	1001	0.0009	0.9878
LULUCF	Non-CO2 drainage of soils and wetlands	5IID Forest Land.	N2O	0.0122	81	0.0008	0.9886
Industrial Proc.	Aerosols		HFC	0.0186	51	0.0008	0.9894
Energy	Stationary Combustion	Natural gas fuelled engines, GAS	CH4	0.1849	5	0.0008	0.9901
Solvent and Other Prod. Use	3D5 Other		CO2	0.0409	22	0.0007	0.9909
Energy	Mobile combustion	Road Transportation	CH4	0.0220	40	0.0007	0.9916
Industrial Proc.	Electrical equipment		SF6	0.0162	51	0.0007	0.9922
Energy	Stationary Combustion	1A1+1A2+1A4, SOLID	CH4	0.0081	100	0.0007	0.9929
Industrial Proc.	Other emissions of SF6 i.e. from double glaze windows and laboratories		SF6	0.0154	51	0.0006	0.9935
Energy	Stationary Combustion	Coke	CO2	0.1120	5	0.0005	0.9940
Energy	Mobile combustion	Military	CO2	0.1076	5	0.0005	0.9945
Energy	Stationary Combustion	LPG	CO2	0.0960	6	0.0004	0.9949
Energy	Mobile combustion	Household and Gardening	CH4	0.0050	106	0.0004	0.9953
Energy	Mobile combustion	Forestry	CO2	0.0172	30	0.0004	0.9958
Industrial Proc.	Lime Production		CO2	0.0656	7	0.0004	0.9961
Energy	Stationary Combustion	1A1+1A2+1A4, LIQUID	CH4	0.0043	100	0.0003	0.9965
Energy	Fugitive emissions	1B2c2ii, Flaring gas	N2O	0.0008	500	0.0003	0.9968
Energy	Fugitive emissions	1B2c2i, Flaring oil	CO2	0.0282	12	0.0003	0.9971
Waste	Accidental fires - vehicles		CH4	0.0005	700	0.0003	0.9973
Industrial Proc.	Limestone and Dolomite use		CO2	0.0387	7	0.0002	0.9976
Solvent and Other Prod. Use	3C Chemical products, manufacturing and processing		CO2	0.0146	18	0.0002	0.9978
Industrial Proc.	Other i.e Fibre Optics		HFC and PFC	0.0052	51	0.0002	0.9980
Industrial Proc.	Other, lubricants		CO2	0.0340	7	0.0002	0.9982
Energy	Stationary Combustion	Biogas fuelled engines, BIOMASS	CH4	0.0209	10	0.0002	0.9984
Solvent and Other Prod. Use	3D5 Other		N2O	0.0273	7	0.0002	0.9985
Energy	Mobile combustion	Forestry	N2O	0.0002	1000	0.0001	0.9986
Solvent and Other Prod. Use	3A Paint application		CO2	0.0092	18	0.0001	0.9988
Energy	Mobile combustion	Agriculture	CH4	0.0016	103	0.0001	0.9989
Industrial Proc.	Yellow Bricks Production		CO2	0.0284	5	0.0001	0.9990
Agriculture	Field Burning of Agricultural Residues		CH4+N2O	0.0034	39	0.0001	0.9991
LULUCF	Forest Land. Land converted to Forest L.	5A2 Conifers	CO2	-0.0048	21	0.0001	0.9992

Continued							
Energy	Fugitive emissions	1B2biv, Gas distribution	CH4	0.0037	27	0.0001	0.9993
Energy	Mobile combustion	Other Mobil and Machinery/Industry	CH4	0.0009	108	0.0001	0.9994
Energy	Stationary Combustion	1A1+1A2+1A4, WASTE	CH4	0.0009	100	0.0001	0.9994
Industrial Proc.	Expanded Clay		CO2	0.0161	5	0.0001	0.9995
Industrial Proc.	Glass/GlassWoll Production		CO2	0.0151	5	0.0001	0.9996
LULUCF	Forest Land. Land converted to Forest L.	5A2 Broadleaves	CO2	-0.0031	21	0.0001	0.9996
Energy	Mobile combustion	Navigation small boats	CH4	0.0005	108	< 0,0001	0.9997
Energy	Stationary Combustion	Kerosene	CO2	0.0086	6	< 0,0001	0.9997
Industrial Proc.	Road paving with Asphalt		CO2	0.0019	25	< 0,0001	0.9998
Energy	Fugitive emissions	1B2biii, Gas transmission	CH4	0.0027	16	< 0,0001	0.9998
LULUCF	N2O Disturbance, Land converted to cropland	5III Cropland	N2O	0.0004	90	< 0,0001	0.9998
Energy	Fugitive emissions	1B2c2i, Flaring oil	N2O	0.0001	500	< 0,0001	0.9999
Waste	Incineration of corpses		N2O	0.0002	150	< 0,0001	0.9999
Energy	Mobile combustion	National Fishing	CH4	0.0002	100	< 0,0001	0.9999
Industrial Proc.	Food and Drink		CO2	0.0027	7	< 0,0001	0.9999
Energy	Mobile combustion	Railways	CH4	0.0002	100	< 0,0001	0.9999
Energy	Mobile combustion	Navigation large vessels	CH4	0.0002	101	< 0,0001	0.9999
Waste	Incineration of carcasses		N2O	0.0001	150	< 0,0001	0.9999
LULUCF	Non-CO2 drainage of soils and wetlands	5IID Wetlands. Peatland	N2O	0.0001	100	< 0,0001	1.0000
Energy	Mobile combustion	Civil Aviation	CH4	0.0001	100	< 0,0001	1.0000
Energy	Mobile combustion	Military	CH4	0.0001	100	< 0,0001	1.0000
Energy	Mobile combustion	Forestry	CH4	0.0001	104	< 0,0001	1.0000
Energy	Fugitive emissions	1B2c2ii, Flaring gas	CH4	0.0008	9	< 0,0001	1.0000
Industrial Proc.	Catalysts/Fertilizers and Pesticides		CO2	0.0024	2	< 0,0001	1.0000
Energy	Fugitive emissions	1B2c2i, Flaring oil	CH4	0.0002	19	< 0,0001	1.0000
Waste	Incineration of corpses		CH4	0.0000	300	< 0,0001	1.0000
Waste	Incineration of carcasses		CH4	0.0000	300	< 0,0001	1.0000
Industrial Proc.	Asphalt Roofing		CO2	0.0000	25	< 0,0001	1.0000
Solvent and Other Prod. Use	3B Degreasing and dry cleaning		CO2	0.0000	18	< 0,0001	1.0000
Energy	Stationary Combustion	Brown Coal Bri.	CO2	0.0000	6	< 0,0001	1.0000
Industrial Proc.	Iron and Steel Production		CO2	NA,NO	7	< 0,0001	1.0000
Industrial Proc.	Nitric Acid Production		N2O	0.0000	25	< 0,0001	1.0000
Industrial Proc.	Magnesium Production		SF6	0.0000	51	< 0,0001	1.0000
				65.3092		**1.0000**	

[1)] The Estimates include signs, where + : emission - : removal, allthough in the level analyses only the absolute values are used.

Table 1.11 Key Category Analysis for Denmark, years 1990-2008 excl. LULUCF, trend assessment, tier 2.

Table 7.A2 (of Good Practice Guidance)

Tier 2 Analysis - Trend Assessment (DK-inventory)

A IPCC Source Categories (LULUCF excluded)			B Direct GHG	C Base Year Estimate Ex,o Mt CO_2-eq	D Year 2008 Estimate Ex,t Mt CO_2-eq	E Uncert. Ux,t %	F Contri-bution to Trend	G Cumul. total of col. F
Agriculture	Agriculture soils, indirect	Nitrogen Leaching and Run-off	N_2O	3.3339	1.9927	54	0.1266	0.1266
Agriculture	Agriculture soils, direct emissions	Synthetic Fertilizers	N_2O	2.3946	1.3177	50	0.0969	0.2235
Industrial Proc.	Refrigeration and AC Equipment		HFC and PFC	0.0357	0.7392	51	0.0782	0.3017
Energy	Stationary Combustion	Plastic Waste	CO_2	0.3937	1.3426	25	0.0542	0.3559
Agriculture	Manure Management		CH_4	0.8692	1.0498	100	0.0541	0.4100
Industrial Proc.	Nitric Acid Production		N_2O	1.0429	0.0000	25	0.0524	0.4624
Energy	Mobile combustion	Road Transportation	CO_2	9.2753	12.9485	5	0.0513	0.5137
Energy	Stationary Combustion	1A1 + 1A2 + 1A4, BIOMASS	N_2O	0.0386	0.0810	400	0.0395	0.5533
Energy	Stationary Combustion	Gas Oil	CO_2	4.5472	1.5441	6	0.0330	0.5862
Energy	Mobile combustion	Other Mobil and Machinery/Industry	CO_2	0.8415	1.1186	41	0.0307	0.6169
Energy	Stationary Combustion	Natural Gas	CO_2	4.3195	9.7644	2	0.0247	0.6417
Energy	Stationary Combustion	1A1+1A2+1A4, BIOMASS	CH_4	0.0829	0.1866	101	0.0242	0.6659
Agriculture	Manure management		N_2O	0.6669	0.5053	100	0.0240	0.6899
Energy	Stationary Combustion	1A1 + 1A2 + 1A4, GAS	N_2O	0.0278	0.0613	300	0.0232	0.7131
Energy	Stationary Combustion	Coal	CO_2	24.0771	16.0495	2	0.0208	0.7339
Energy	Stationary Combustion	1A1 + 1A2 + 1A4, LIQUID	N_2O	0.0757	0.0461	400	0.0206	0.7545
Agriculture	Agriculture soils, direct emissions	Animal Manure Applied to Soils	N_2O	1.0502	1.1235	51	0.0171	0.7717
Agriculture	Agriculture soils, indirect	Atmospheric Deposition	N_2O	0.4414	0.2862	51	0.0134	0.7851
Energy	Fugitive emissions	1B2aiv, Oil refining and storage	CH_4	0.0008	0.0459	125	0.0123	0.7973
Energy	Mobile combustion	Navigation large vessels	N_2O	0.0130	0.0069	1000	0.0110	0.8083
Waste	N_2O direct, Domestic and Commercial Wastewa-ter		N_2O	0.0240	0.0699	105	0.0109	0.8192
Energy	Stationary Combustion	1A1 + 1A2 + 1A4, SOLID	N_2O	0.0798	0.0490	200	0.0107	0.8299
Energy	Mobile combustion	Other Mobil and Machinery/Industry	N_2O	0.0106	0.0147	1001	0.0106	0.8405
Energy	Mobile combustion	Household and Gardening	CO_2	0.1128	0.2390	35	0.0104	0.8509
Waste	Solid Waste Disposal Sites		CH_4	1.1108	1.0567	118	0.0082	0.8591
Industrial Proc.	Foam Blowing		HFC	0.1826	0.1026	51	0.0073	0.8663
Energy	Mobile combustion	Navigation large vessels	CO_2	0.6656	0.3526	12	0.0069	0.8732
Waste	N_2O indirect from human sewage		N_2O	0.0822	0.0347	71	0.0063	0.8795
Agriculture	Agriculture soils, direct emissions	Other direct emissions (please spec-ify)	N_2O	0.0279	0.0783	54	0.0061	0.8857

Continued								
Waste	Accidental fires - vehicles		CO_2	0.0063	0.0109	500	0.0056	0.8912
Agriculture	Enteric Fermentation		CH_4	3.2612	2.8194	13	0.0053	0.8965
Agriculture	Agriculture soils, pasture, range and paddock		N_2O	0.3141	0.2143	32	0.0053	0.9017
Industrial Proc.	Other emissions of SF_6 i.e. from double glaze windows and laboratories		SF_6	0.0676	0.0154	51	0.0052	0.9069
Energy	Stationary Combustion	Residual Oil	CO_2	2.5052	1.3593	3	0.0052	0.9121
Energy	Mobile combustion	Navigation small boats	CO_2	0.0479	0.1005	41	0.0050	0.9172
Energy	Stationary Combustion	Petroleum Coke	CO_2	0.4103	0.7545	5	0.0045	0.9216
Energy	Mobile combustion	Agriculture	N_2O	0.0153	0.0161	1000	0.0044	0.9260
Waste	Accidental fires - buildings		CO_2	0.0147	0.0176	500	0.0043	0.9304
Agriculture	Agriculture soils, direct emissions	N-fixing Crops	N_2O	0.2695	0.2127	54	0.0042	0.9346
Energy	Stationary Combustion	Kerosene	CO_2	0.3662	0.0086	6	0.0041	0.9387
Energy	Mobile combustion	Road Transportation	N_2O	0.0970	0.1256	50	0.0039	0.9426
Energy	Mobile combustion	National Fishing	N_2O	0.0115	0.0088	1000	0.0039	0.9465
Waste	Waste Water Handling		CH_4	0.0304	0.0473	90	0.0037	0.9503
Industrial Proc.	Magnesium Production		SF_6	0.0359	0.0000	51	0.0037	0.9540
Agriculture	Agriculture soils, direct emissions	Crop Residue	N_2O	0.3612	0.3051	54	0.0033	0.9572
Energy	Mobile combustion	Agriculture	CO_2	1.2725	1.2301	25	0.0030	0.9602
Energy	Mobile combustion	Road Transportation	CH_4	0.0551	0.0220	40	0.0025	0.9627
Industrial Proc.	Aerosols		HFC	NA,NO	0.0186	51	0.0021	0.9648
Energy	Stationary Combustion	Natural gas fuelled engines, GAS	CH_4	0.0046	0.1849	5	0.0020	0.9668
Solvent and Other Prod. Use	3D5 Other		CO_2	0.0857	0.0409	22	0.0019	0.9686
Energy	Fugitive emissions	1B2c2ii, Flaring gas	CO_2	0.2762	0.3478	9	0.0018	0.9705
Energy	Fugitive emissions	1B2aii, Oil production landbased	CH_4	0.0172	0.0366	40	0.0018	0.9723
Industrial Proc.	Cement Production		CO_2	0.8824	1.1547	2	0.0017	0.9739
Energy	Fugitive emissions	1B2aii, Oil production offshore	CH_4	0.0149	0.0386	30	0.0016	0.9756
Energy	Stationary Combustion	1A1+1A2+1A4, GAS	CH_4	0.0084	0.0150	100	0.0016	0.9771
Energy	Mobile combustion	Navigation small boats	N_2O	0.0004	0.0011	1001	0.0015	0.9787
Energy	Mobile combustion	Civil Aviation	CO_2	0.2427	0.1638	11	0.0015	0.9802
Energy	Mobile combustion	Household and Gardening	N_2O	0.0005	0.0012	1001	0.0014	0.9816
Industrial Proc.	Electrical equipment		SF_6	0.0039	0.0162	51	0.0014	0.9830
Energy	Stationary Combustion	1A1+1A2+1A4, SOLID	CH_4	0.0149	0.0081	100	0.0012	0.9842
Energy	Mobile combustion	National Fishing	CO_2	0.5907	0.4495	5	0.0011	0.9853
Energy	Stationary Combustion	1A1 + 1A2 + 1A4, WASTE	N_2O	0.0184	0.0194	200	0.0011	0.9864
Agriculture	Agriculture soils, direct emissions	Cultivation of Histosols (2)	N_2O	0.1165	0.1167	54	0.0011	0.9875
Energy	Stationary Combustion	Refinery Gas	CO_2	0.8062	0.8411	5	0.0011	0.9886

Continued

Energy	Mobile combustion	Forestry	CO_2	0.0357	0.0172	30	0.0010	0.9896
Waste	Accidental fires - buildings		CH_4	0.0024	0.0028	700	0.0010	0.9906
Energy	Stationary Combustion	LPG	CO_2	0.1687	0.0960	6	0.0007	0.9913
Energy	Mobile combustion	Railways	N_2O	0.0025	0.0020	1000	0.0007	0.9920
Industrial Proc.	Lime Production		CO_2	0.1155	0.0656	7	0.0006	0.9927
Solvent and Other Prod. Use	3A Paint application		CO_2	0.0263	0.0092	18	0.0006	0.9932
Industrial Proc.	Other i.e Fibre Optics		HFC and PFC	NO	0.0052	51	0.0006	0.9938
Energy	Mobile combustion	Civil Aviation	N_2O	0.0032	0.0027	1000	0.0006	0.9944
Energy	Mobile combustion	Household and Gardening	CH_4	0.0031	0.0050	106	0.0005	0.9949
Energy	Mobile combustion	Railways	CO_2	0.2967	0.2367	5	0.0004	0.9953
Energy	Stationary Combustion	Biogas fuelled engines, BIOMASS	CH_4	0.0019	0.0209	10	0.0004	0.9957
Energy	Stationary Combustion	1A1+1A2+1A4, LIQUID	CH_4	0.0068	0.0043	100	0.0004	0.9962
Solvent and Other Prod. Use	3D5 Other		N_2O	0.0000	0.0273	7	0.0004	0.9966
Industrial Proc.	Iron and Steel Production		CO_2	0.0284	0.0000	7	0.0004	0.9970
Industrial Proc.	Limestone and Dolomite use		CO_2	0.0137	0.0387	7	0.0004	0.9974
Waste	Accidental fires - vehicles		CH_4	0.0003	0.0005	700	0.0003	0.9977
Solvent and Other Prod. Use	3C Chemical products, manufacturing and processing		CO_2	0.0231	0.0146	18	0.0003	0.9980
Energy	Fugitive emissions	1B2c2ii, Flaring gas	N_2O	0.0006	0.0008	500	0.0002	0.9982
Energy	Stationary Combustion	1A1+1A2+1A4, WASTE	CH_4	0.0018	0.0009	100	0.0002	0.9984
Energy	Stationary Combustion	Coke	CO_2	0.1378	0.1120	5	0.0002	0.9985
Energy	Fugitive emissions	1B2c2i, Flaring oil	CO_2	0.0234	0.0282	12	0.0002	0.9987
Energy	Mobile combustion	Military	N_2O	0.0012	0.0011	1000	0.0001	0.9989
Industrial Proc.	Other, lubricants		CO_2	0.0497	0.0340	5	0.0001	0.9990
Energy	Stationary Combustion	Brown Coal Bri.	CO_2	0.0110	0.0000	6	0.0001	0.9991
Energy	Mobile combustion	Agriculture	CH_4	0.0022	0.0016	103	0.0001	0.9992
Agriculture	Field Burning of Agricultural Residues		CH_4+N_2O	0.0025	0.0034	39	0.0001	0.9993
Industrial Proc.	Yellow Bricks Production		CO_2	0.0230	0.0284	5	0.0001	0.9994
Energy	Fugitive emissions	1B2biv, Gas distribution	CH_4	0.0053	0.0037	27	0.0001	0.9995
Energy	Mobile combustion	Forestry	CH_4	0.0004	0.0001	104	0.0001	0.9995
Energy	Mobile combustion	Other Mobil and Machinery/Industry	CH_4	0.0013	0.0009	108	0.0001	0.9996
Energy	Fugitive emissions	1B2c2i, Flaring oil	N_2O	0.0001	0.0001	500	< 0,0001	0.9997
Energy	Mobile combustion	Navigation small boats	CH_4	0.0003	0.0005	108	< 0,0001	0.9997
Energy	Fugitive emissions	1B2c2i, Flaring oil	CH_4	0.0013	0.0002	19	< 0,0001	0.9997
Waste	Incineration of carcasses		N_2O	0.0000	0.0001	150	< 0,0001	0.9998

Continued								
Industrial Proc.	Expanded Clay		CO_2	0.0149	0.0161	5	< 0,0001	0.9998
Energy	Mobile combustion	Navigation large vessels	CH_4	0.0003	0.0002	101	< 0,0001	0.9998
Energy	Mobile combustion	Military	CO_2	0.1190	0.1076	5	< 0,0001	0.9998
Industrial Proc.	Catalysts/Fertilizers and Pesticides		CO_2	0.0008	0.0024	7	< 0,0001	0.9999
Industrial Proc.	Food and Drink		CO_2	0.0045	0.0027	7	< 0,0001	0.9999
Energy	Fugitive emissions	1B2biii, Gas transmission	CH_4	0.0036	0.0027	16	< 0,0001	0.9999
Industrial Proc.	Road paving with Asphalt		CO_2	0.0018	0.0019	25	< 0,0001	0.9999
Energy	Mobile combustion	Railways	CH_4	0.0003	0.0002	100	< 0,0001	0.9999
Energy	Mobile combustion	Forestry	N_2O	0.0002	0.0002	1000	< 0,0001	1.0000
Industrial Proc.	Glass/GlassWoll Production		CO_2	0.0174	0.0151	5	< 0,0001	1.0000
Energy	Fugitive emissions	1B2c2ii, Flaring gas	CH_4	0.0004	0.0008	9	< 0,0001	1.0000
Waste	Incineration of corpses		N_2O	0.0002	0.0002	150	< 0,0001	1.0000
Energy	Mobile combustion	National Fishing	CH_4	0.0003	0.0002	100	< 0,0001	1.0000
Waste	Incineration of carcasses		CH_4	0.0000	0.0000	300	< 0,0001	1.0000
Energy	Mobile combustion	Civil Aviation	CH_4	0.0002	0.0001	100	< 0,0001	1.0000
Waste	Incineration of corpses		CH_4	0.0000	0.0000	300	< 0,0001	1.0000
Industrial Proc.	Asphalt Roofing		CO_2	0.0000	0.0000	25	< 0,0001	1.0000
Energy	Mobile combustion	Military	CH_4	0.0001	0.0001	100	< 0,0001	1.0000
Solvent and Other Prod. Use	3B Degreasing and dry cleaning		CO_2	0.0000	0.0000	18	< 0,0001	1.0000
Total (incl Lulucf)				**69.2041**	**63.8450**		**1.0000**	

Table 1.12 Key Category Analysis for Denmark, years 1990-2008 incl. LULUCF, trend assessment, tier 2.

Table 7.A2 (of Good Practice Guidance)
Tier 2 Analysis
- Trend Assessment (DK-inventory)

A IPCC Source Categories (LULUCF included)			B Direct GHG	C Base Year Estimate Ex,o Mt CO_2-eq	D Year 2008 Estimate Ex,t Mt CO_2-eq	E Uncer-tainty Ux,t %	F Contri bution to Trend	G Cumul. total of col. F
Agriculture	Agriculture soils, indirect	Nitrogen Leaching and Run-off	N2O	3.3339	1.9927	54	0.1151	0.1151
Agriculture	Agriculture soils, direct emissions	Synthetic Fertilizers	N2O	2.3946	1.3177	50	0.0870	0.2021
Industrial Proc.	Refrigeration and AC Equipment		HFC and PFC	0.0357	0.7392	51	0.0643	0.2664
LULUCF	Cropland	5B Cropland remaining Cr. Mineral soils	CO2	-2.0207	-0.5107	22	0.0640	0.3303
Industrial Proc.	Nitric Acid Production		N2O	1.0429	0.0000	25	0.0447	0.3751
Energy	Stationary Combustion	Plastic Waste	CO2	0.3937	1.3426	25	0.0441	0.4191
Agriculture	Manure Management		CH4	0.8692	1.0498	100	0.0393	0.4585
Energy	Mobile combustion	Road Transportation	CO2	9.2753	12.9485	5	0.0393	0.4978
Energy	Stationary Combustion	1A1 + 1A2 + 1A4, BIOMASS	N2O	0.0386	0.0810	400	0.0316	0.5294
Energy	Stationary Combustion	Gas Oil	CO2	4.5472	1.5441	6	0.0287	0.5582
LULUCF	Forest Land remaining Forest L.	5A1 Broadleaves	CO2	-0.6487	0.1992	18	0.0283	0.5864
LULUCF	Agricultural lime application	5IV Cropland Limestone	CO2	0.5652	0.2288	50	0.0280	0.6144
Agriculture	Manure management		N2O	0.6669	0.5053	100	0.0238	0.6382
Energy	Mobile combustion	Other Mobil and Machinery/Industry	CO2	0.8415	1.1186	41	0.0232	0.6614
Energy	Stationary Combustion	Natural Gas	CO2	4.3195	9.7644	2	0.0199	0.6813
Energy	Stationary Combustion	1A1+1A2+1A4, BIOMASS	CH4	0.0829	0.1866	101	0.0194	0.7007
Energy	Stationary Combustion	Coal	CO2	24.0771	16.0495	2	0.0194	0.7201
Energy	Stationary Combustion	1A1 + 1A2 + 1A4, LIQUID	N2O	0.0757	0.0461	400	0.0188	0.7389
Energy	Stationary Combustion	1A1 + 1A2 + 1A4, GAS	N2O	0.0278	0.0613	300	0.0186	0.7576
LULUCF	Forest Land remaining Forest L.	5A1 Conifers	CO2	-0.2543	0.2387	18	0.0163	0.7738
Agriculture	Agriculture soils, indirect	Atmospheric Deposition	N2O	0.4414	0.2862	51	0.0124	0.7862
Agriculture	Agriculture soils, direct emissions	Animal Manure Applied to Soils	N2O	1.0502	1.1235	51	0.0109	0.7971
Energy	Fugitive emissions	1B2aiv, Oil refining and storage	CH4	0.0008	0.0459	125	0.0101	0.8072
Energy	Mobile combustion	Navigation large vessels	N2O	0.0130	0.0069	1000	0.0099	0.8171
Energy	Stationary Combustion	1A1 + 1A2 + 1A4, SOLID	N2O	0.0798	0.0490	200	0.0098	0.8268
Waste	N2O direct, Domestic and Commercial Wastewater		N2O	0.0240	0.0699	105	0.0088	0.8356
Energy	Mobile combustion	Household and Gardening	CO2	0.1128	0.2390	35	0.0083	0.8439
Energy	Mobile combustion	Other Mobil and Machinery/Industry	N2O	0.0106	0.0147	1001	0.0081	0.8520
Agriculture	Enteric Fermentation		CH4	3.2612	2.8194	13	0.0068	0.8589

Continued								
Industrial Proc.	Foam Blowing		HFC	0.1826	0.1026	51	0.0066	0.8654
Energy	Mobile combustion	Navigation large vessels	CO2	0.6656	0.3526	12	0.0061	0.8716
Waste	N_2O indirect from human sewage		N2O	0.0822	0.0347	71	0.0056	0.8771
LULUCF	Cropland	5B Cropland remaining Cr. Organic soils	CO2	1.0555	1.0700	51	0.0056	0.8827
Agriculture	Agriculture soils, direct emissions	Other direct emissions (please specify)	N2O	0.0279	0.0783	54	0.0050	0.8877
Agriculture	Agriculture soils, pasture, range and pad-dock		N2O	0.3141	0.2143	32	0.0049	0.8926
Energy	Stationary Combustion	Residual Oil	CO2	2.5052	1.3593	3	0.0046	0.8972
LULUCF	Grassland	5C Total Grassland. Living biomass	CO2	0.1826	0.0592	22	0.0046	0.9018
Industrial Proc.	Other emissions of SF6 i.e. from double glaze windows and laboratories		SF6	0.0676	0.0154	51	0.0045	0.9063
LULUCF	Wetlands	5D Wetlands remaining Wetlands (peat)	CO2	0.0861	0.0331	51	0.0045	0.9108
Waste	Accidental fires - vehicles		CO2	0.0063	0.0109	500	0.0044	0.9152
Agriculture	Agriculture soils, direct emissions	N-fixing Crops	N2O	0.2695	0.2127	54	0.0043	0.9195
LULUCF	Cropland	5B Cropland remaining Cr. Living bio-mass	CO2	-0.0530	0.0484	22	0.0042	0.9237
Energy	Mobile combustion	Navigation small boats	CO2	0.0479	0.1005	41	0.0040	0.9277
Energy	Mobile combustion	National Fishing	N2O	0.0115	0.0088	1000	0.0039	0.9316
Agriculture	Agriculture soils, direct emissions	Crop Residue	N2O	0.3612	0.3051	54	0.0039	0.9355
LULUCF	Wetlands	5D Land converted to wetlands	CO2	0.0004	-0.0404	51	0.0037	0.9392
Energy	Stationary Combustion	Petroleum Coke	CO2	0.4103	0.7545	5	0.0035	0.9428
Energy	Stationary Combustion	Kerosene	CO2	0.3662	0.0086	6	0.0035	0.9463
Waste	Accidental fires - buildings		CO2	0.0147	0.0176	500	0.0031	0.9494
Industrial Proc.	Magnesium Production		SF6	0.0359	0.0000	51	0.0031	0.9526
Energy	Mobile combustion	Road Transportation	N2O	0.0970	0.1256	50	0.0029	0.9555
Waste	Waste Water Handling		CH4	0.0304	0.0473	90	0.0029	0.9584
Energy	Mobile combustion	Agriculture	N2O	0.0153	0.0161	1000	0.0027	0.9612
LULUCF	Settlements	5E Total settlements. Living biomass	CO2	0.0796	0.0518	51	0.0022	0.9634
Energy	Mobile combustion	Road Transportation	CH4	0.0551	0.0220	40	0.0022	0.9656
Industrial Proc.	Aerosols		HFC	0.0000	0.0186	51	0.0017	0.9673
Energy	Stationary Combustion	Natural gas fuelled engines, GAS	CH4	0.0046	0.1849	5	0.0016	0.9689
Solvent and Other Prod. Use	3D5 Other		CO2	0.0857	0.0409	22	0.0016	0.9706
Energy	Fugitive emissions	1B2aii, Oil production landbased	CH4	0.0172	0.0366	40	0.0014	0.9720
Energy	Mobile combustion	Civil Aviation	CO2	0.2427	0.1638	11	0.0014	0.9734
Energy	Fugitive emissions	1B2c2ii, Flaring gas	CO2	0.2762	0.3478	9	0.0014	0.9747
Energy	Fugitive emissions	1B2aii, Oil production offshore	CH4	0.0149	0.0386	30	0.0013	0.9760
Energy	Stationary Combustion	1A1+1A2+1A4, GAS	CH4	0.0084	0.0150	100	0.0013	0.9773
Energy	Stationary Combustion	1A1+1A2+1A4, GAS	CH_4	0.0084	0.0150	100	0.0012	0.9792

Continued								
Energy	Mobile combustion	Navigation small boats	N2O	0.0004	0.0011	1001	0.0013	0.9785
Industrial Proc.	Cement Production		CO2	0.8824	1.1547	2	0.0012	0.9798
Energy	Mobile combustion	Household and Gardening	N2O	0.0005	0.0012	1001	0.0012	0.9809
Industrial Proc.	Electrical equipment		SF6	0.0039	0.0162	51	0.0011	0.9821
Waste	Solid Waste Disposal Sites		CH4	1.1108	1.0567	118	0.0011	0.9832
Energy	Stationary Combustion	1A1+1A2+1A4, SOLID	CH4	0.0149	0.0081	100	0.0011	0.9843
Energy	Mobile combustion	National Fishing	CO2	0.5907	0.4495	5	0.0011	0.9854
Energy	Mobile combustion	Forestry	CO2	0.0357	0.0172	30	0.0009	0.9863
Energy	Mobile combustion	Railways	N2O	0.0025	0.0020	1000	0.0007	0.9870
Waste	Accidental fires - buildings		CH4	0.0024	0.0028	700	0.0007	0.9877
LULUCF	Grassland	5C Grassland rem. Grasland. Organic soils	CO2	0.0929	0.0812	51	0.0007	0.9884
Energy	Stationary Combustion	1A1 + 1A2 + 1A4, WASTE	N2O	0.0184	0.0194	200	0.0007	0.9891
Energy	Stationary Combustion	LPG	CO2	0.1687	0.0960	6	0.0007	0.9898
Energy	Mobile combustion	Civil Aviation	N2O	0.0032	0.0027	1000	0.0007	0.9904
Energy	Stationary Combustion	Refinery Gas	CO2	0.8062	0.8411	5	0.0006	0.9911
Energy	Mobile combustion	Agriculture	CO2	1.2725	1.2301	25	0.0006	0.9917
Industrial Proc.	Lime Production		CO2	0.1155	0.0656	7	0.0006	0.9922
Agriculture	Agriculture soils, direct emissions	Cultivation of Histosols (2)	N2O	0.1165	0.1167	54	0.0005	0.9928
Solvent and Other Prod. Use	3A Paint application		CO2	0.0263	0.0092	18	0.0005	0.9933
Industrial Proc.	Other i.e Fibre Optics		HFC and PFC	0.0000	0.0052	51	0.0005	0.9937
Energy	Mobile combustion	Railways	CO2	0.2967	0.2367	5	0.0005	0.9942
LULUCF	N2O Disturbance, Land converted to crop-land	5III Cropland	N2O	0.0032	0.0004	90	0.0004	0.9946
LULUCF	Non-CO2 drainage of soils and wetlands	5IID Forest Land.	N2O	0.0157	0.0122	81	0.0004	0.9950
Energy	Stationary Combustion	1A1+1A2+1A4, LIQUID	CH4	0.0068	0.0043	100	0.0004	0.9954
Energy	Mobile combustion	Household and Gardening	CH4	0.0031	0.0050	106	0.0004	0.9958
LULUCF	Forest Land. Land converted to Forest L.	5A2 Conifers	CO2	0.0051	-0.0048	21	0.0004	0.9962
Energy	Stationary Combustion	Biogas fuelled engines, BIOMASS	CH4	0.0019	0.0209	10	0.0004	0.9965
Solvent and Other Prod. Use	3D5 Other		N2O	0.0000	0.0273	7	0.0003	0.9969
Industrial Proc.	Iron and Steel Production		CO2	0.0284	0.0000	7	0.0003	0.9972
Industrial Proc.	Limestone and Dolomite use		CO2	0.0137	0.0387	7	0.0003	0.9975
Waste	Accidental fires - vehicles		CH4	0.0003	0.0005	700	0.0003	0.9978
LULUCF	Forest Land. Land converted to Forest L.	5A2 Broadleaves	CO2	0.0033	-0.0031	21	0.0002	0.9980
Solvent and Other Prod. Use	3C Chemical products, manufacturing and processing		CO2	0.0231	0.0146	18	0.0002	0.9983
Energy	Stationary Combustion	Coke	CO2	0.1378	0.1120	5	0.0002	0.9985

Continued								
Energy	Stationary Combustion	1A1+1A2+1A4, WASTE	CH4	0.0018	0.0009	100	0.0002	0.9988
Energy	Fugitive emissions	1B2c2ii, Flaring gas	N2O	0.0006	0.0008	500	0.0001	0.9989
Energy	Fugitive emissions	1B2c2i, Flaring oil	CO2	0.0234	0.0282	12	0.0001	0.9991
Energy	Stationary Combustion	Brown Coal Bri.	CO2	0.0110	0.0000	6	0.0001	0.9992
Energy	Mobile combustion	Agriculture	CH4	0.0022	0.0016	103	0.0001	0.9993
Energy	Fugitive emissions	1B2biv, Gas distribution	CH4	0.0053	0.0037	27	0.0001	0.9993
Agriculture	Field Burning of Agricultural Residues		CH4+N2O	0.0025	0.0034	39	0.0001	0.9994
Energy	Mobile combustion	Other Mobil and Machinery/Industry	CH4	0.0013	0.0009	108	0.0001	0.9995
Energy	Mobile combustion	Forestry	CH4	0.0004	0.0001	104	0.0001	0.9995
Industrial Proc.	Yellow Bricks Production		CO2	0.0230	0.0284	5	0.0001	0.9996
Energy	Mobile combustion	Military	CO2	0.1190	0.1076	5	0.0001	0.9997
Energy	Mobile combustion	Military	N2O	0.0012	0.0011	1000	0.0001	0.9997
Energy	Fugitive emissions	1B2c2i, Flaring oil	N2O	0.0001	0.0001	500	< 0,0001	0.9998
Energy	Fugitive emissions	1B2c2i, Flaring oil	CH4	0.0013	0.0002	19	< 0,0001	0.9998
Energy	Mobile combustion	Navigation small boats	CH4	0.0003	0.0005	108	< 0,0001	0.9998
Energy	Mobile combustion	Navigation large vessels	CH4	0.0003	0.0002	101	< 0,0001	0.9998
Waste	Incineration of carcasses		N2O	0.0000	0.0001	150	< 0,0001	0.9999
Industrial Proc.	Food and Drink		CO2	0.0045	0.0027	7	< 0,0001	0.9999
Energy	Fugitive emissions	1B2biii, Gas transmission	CH4	0.0036	0.0027	16	< 0,0001	0.9999
Industrial Proc.	Expanded Clay		CO2	0.0149	0.0161	5	< 0,0001	0.9999
Industrial Proc.	Glass/GlassWoll Production		CO2	0.0174	0.0151	5	< 0,0001	0.9999
Energy	Mobile combustion	Railways	CH4	0.0003	0.0002	100	< 0,0001	1.0000
Industrial Proc.	Road paving with Asphalt		CO2	0.0018	0.0019	25	< 0,0001	1.0000
Energy	Fugitive emissions	1B2c2ii, Flaring gas	CH4	0.0004	0.0008	9	< 0,0001	1.0000
Energy	Mobile combustion	National Fishing	CH4	0.0003	0.0002	100	< 0,0001	1.0000
Industrial Proc.	Catalysts/Fertilizers and Pesticides		CO2	0.0008	0.0024	2	< 0,0001	1.0000
Energy	Mobile combustion	Civil Aviation	CH4	0.0002	0.0001	100	< 0,0001	1.0000
Waste	Incineration of corpses		N2O	0.0002	0.0002	150	< 0,0001	1.0000
Energy	Mobile combustion	Forestry	N2O	0.0002	0.0002	1000	< 0,0001	1.0000
Waste	Incineration of carcasses		CH4	0.0000	0.0000	300	< 0,0001	1.0000
LULUCF	Non-CO2 drainage of soils and wetlands	5IID Wetlands. Peatland	N2O	0.0001	0.0001	100	< 0,0001	1.0000
Energy	Mobile combustion	Military	CH4	0.0001	0.0001	100	< 0,0001	1.0000
Waste	Incineration of corpses		CH4	0.0000	0.0000	300	< 0,0001	1.0000
Industrial Proc.	Asphalt Roofing		CO2	0.0000	0.0000	25	< 0,0001	1.0000
Solvent and Other Prod. Use	3B Degreasing and dry cleaning		CO2	0.0000	0.0000	18	< 0,0001	1.0000
				68.3169	**65.3092**		**1.0000**	

Table 1.13 Summary of Key Category Analysis for Denmark, tier 1 and tier 2, for level assessment for year 2008 and for trend for years 1990-2008, excl. LULUCF.

Table 7.A3 (modified from Good Practice Guidence) Summary of Key Category analysis for Denmark

IPCC Source Categories (LULUCF excluded)			Greenh. Gas	Key categories with number according to ranking in analysis – Identification criteria					
				Level Tier1	Level Tier1	Trend Tier1	Level Tier2	Level Tier2	Trend Tier2
				1990/95	2008	1990-2008	1990/95	2008	1990-2008
Energy	Stationary Combustion	Coal	CO2	1	1	1	9	14	15
Energy	Stationary Combustion	Brown Coal Bri.	CO2						
Energy	Stationary Combustion	Coke	CO2						
Energy	Stationary Combustion	Petroleum Coke	CO2	21	17	11			
Energy	Stationary Combustion	Plastic Waste	CO2	22	8	6	25	11	4
Energy	Stationary Combustion	Residual Oil	CO2	7	7	8			
Energy	Stationary Combustion	Gas Oil	CO2	3	6	4	14	25	9
Energy	Stationary Combustion	Kerosene	CO2	23		14			
Energy	Stationary Combustion	Natural Gas	CO2	4	3	2	27	15	11
Energy	Stationary Combustion	LPG	CO2						
Energy	Stationary Combustion	Refinery Gas	CO2	16	16	24			
Energy	Mobile combustion	Civil Aviation	CO2						
Energy	Mobile combustion	Road Transportation	CO2	2	2	3	7	4	7
Energy	Mobile combustion	Railways	CO2						
Energy	Mobile combustion	Navigation small boats	CO2						
Energy	Mobile combustion	Navigation large vessels	CO2	18	21	15			27
Energy	Mobile combustion	Military	CO2						
Energy	Mobile combustion	National Fishing	CO2	19	20	25			
Energy	Mobile combustion	Agriculture	CO2	9	10		11	13	
Energy	Mobile combustion	Forestry	CO2						
Energy	Mobile combustion	Other Mobil and Machinery/Industry	CO2	15	13	12	10	8	10
Energy	Mobile combustion	Household and Gardening	CO2			20		28	24
Energy	Fugitive emissions	1B2c2i, Flaring oil	CO2						
Energy	Fugitive emissions	1B2c2ii, Flaring gas	CO2		22				
Energy	Stationary Combustion	1A1+1A2+1A4, BIOMASS	CH4			22		16	12
Energy	Stationary Combustion	Biogas fuelled engines, BIOMASS	CH4						
Energy	Stationary Combustion	1A1+1A2+1A4, GAS	CH4						
Energy	Stationary Combustion	Natural gas fuelled engines, GAS	CH4			18			
Energy	Stationary Combustion	1A1+1A2+1A4, LIQUID	CH4						
Energy	Stationary Combustion	1A1+1A2+1A4, WASTE	CH4						

Continued

Energy	Stationary Combustion	1A1+1A2+1A4, SOLID	CH4						
Energy	Mobile combustion	Civil Aviation	CH4						
Energy	Mobile combustion	Road Transportation	CH4						
Energy	Mobile combustion	Railways	CH4						
Energy	Mobile combustion	Navigation small boats	CH4						
Energy	Mobile combustion	Navigation large vessels	CH4						
Energy	Mobile combustion	Military	CH4						
Energy	Mobile combustion	National Fishing	CH4						
Energy	Mobile combustion	Agriculture	CH4						
Energy	Mobile combustion	Forestry	CH4						
Energy	Mobile combustion	Other Mobil and Machinery/Industry	CH4						
Energy	Mobile combustion	Household and Gardening	CH4						
Energy	Fugitive emissions	1B2aiv, Oil refining and storage	CH4						19
Energy	Fugitive emissions	1B2aii, Oil production landbased	CH4						
Energy	Fugitive emissions	1B2aii, Oil production offshore	CH4						
Energy	Fugitive emissions	1B2biii, Gas transmission	CH4						
Energy	Fugitive emissions	1B2biv, Gas distribution	CH4						
Energy	Fugitive emissions	1B2c2i, Flaring oil	CH4						
Energy	Fugitive emissions	1B2c2ii, Flaring gas	CH4						
Energy	Stationary Combustion	1A1 + 1A2 + 1A4, BIOMASS	N2O				18	12	8
Energy	Stationary Combustion	1A1 + 1A2 + 1A4, GAS	N2O					18	14
Energy	Stationary Combustion	1A1 + 1A2 + 1A4, LIQUID	N2O				12	17	16
Energy	Stationary Combustion	1A1 + 1A2 + 1A4, WASTE	N2O						
Energy	Stationary Combustion	1A1 + 1A2 + 1A4, SOLID	N2O				17	24	22
Energy	Mobile combustion	Civil Aviation	N2O						
Energy	Mobile combustion	Road Transportation	N2O						
Energy	Mobile combustion	Railways	N2O						
Energy	Mobile combustion	Navigation small boats	N2O						
Energy	Mobile combustion	Navigation large vessels	N2O				21		20
Energy	Mobile combustion	Military	N2O						
Energy	Mobile combustion	National Fishing	N2O				22	26	
Energy	Mobile combustion	Agriculture	N2O				19	20	
Energy	Mobile combustion	Forestry	N2O						
Energy	Mobile combustion	Other Mobil and Machinery/Industry	N2O				23	21	23
Energy	Mobile combustion	Household and Gardening	N2O						

Continued									
Energy	Fugitive emissions	1B2c2i, Flaring oil	N2O						
Energy	Fugitive emissions	1B2c2ii, Flaring gas	N2O						
Industrial Proc.	Cement Production		CO2	13	11	13			
Industrial Proc.	Lime Production		CO2						
Industrial Proc.	Limestone and Dolomite use		CO2						
Industrial Proc.	Asphalt Roofing		CO2						
Industrial Proc.	Road paving with Asphalt		CO2						
Industrial Proc.	Glass/GlassWoll Production		CO2						
Industrial Proc.	Yellow Bricks Production		CO2						
Industrial Proc.	Expanded Clay		CO2						
Industrial Proc.	Catalysts/Fertilizers and Pesticides		CO2						
Industrial Proc.	Food and Drink		CO2						
Industrial Proc.	Iron and Steel Production		CO2						
Industrial Proc.	Other, lubricants		CO2						
Industrial Proc.	Nitric Acid Production		N2O	12		7	13		6
Industrial Proc.	Magnesium Production		SF6						
Industrial Proc.	Electrical equipment		SF6						
Industrial Proc.	Other emissions of SF6 i.e. from double glaze windows and laboratories		SF6						
Industrial Proc.	Refrigeration and AC Equipment		HFC and PFC		18	10		9	3
Industrial Proc.	Foam Blowing		HFC				26		26
Industrial Proc.	Aerosols		HFC						
Industrial Proc.	Other i.e Fibre Optics		HFC and PFC						
Solvent and Other Prod. Use	3A Paint application		CO2						
Solvent and Other Prod. Use	3B Degreasing and dry cleaning		CO2						
Solvent and Other Prod. Use	3C Chemical products, manufacturing and processing		CO2						
Solvent and Other Prod. Use	3D5 Other		CO2						
Solvent and Other Prod. Use	3D5 Other		N2O						
Agriculture	Enteric Fermentation		CH4	6	4	17	8	10	31
Agriculture	Manure Management		CH4	14	15	16	4	3	5
Agriculture	Manure management		N2O	17	19	23	5	7	13
Agriculture	Agriculture soils, direct emissions	Synthetic Fertilizers	N2O	8	9	9	3	5	2

Continued

Agriculture	Agriculture soils, direct emissions	Animal Manure Applied to Soils	N2O	11	12	19	6	6	17
Agriculture	Agriculture soils, direct emissions	N-fixing Crops	N2O				20	23	
Agriculture	Agriculture soils, direct emissions	Crop Residue	N2O	24	23		16	19	
Agriculture	Agriculture soils, direct emissions	Cultivation of Histosols (2)	N2O						
Agriculture	Agriculture soils, direct emissions	Other direct emissions (please specify)	N2O						29
Agriculture	Agriculture soils, pasture, range and paddock		N2O				24		
Agriculture	Agriculture soils, indirect	Atmospheric Deposition	N2O	20	24	21	15	22	18
Agriculture	Agriculture soils, indirect	Nitrogen Leaching and Run-off	N2O	5	5	5	1	2	1
Agriculture	Field Burning of Agricultural Residues		CH4+N2O						
Waste	Solid Waste Disposal Sites		CH4	10	14		2	1	25
Waste	Waste Water Handling		CH4						
Waste	N2O direct, Domestic and Commercial Wastewater		N2O					29	21
Waste	N2O indirect from human sewage		N2O						28
Waste	Accidental fires - buildings		CO2					27	
Waste	Accidental fires - vehicles		CO2						30
Waste	Incineration of corpses		CH4						
Waste	Incineration of carcasses		CH4						
Waste	Accidental fires - buildings		CH4						
Waste	Accidental fires - vehicles		CH4						
Waste	Incineration of corpses		N2O						
Waste	Incineration of carcasses		N2O						

Table 1.14 Summary of Key Category Analysis for Denmark, tier 1 and tier 2, for level assessment for year 2008 and for trend for years 1990-2008, incl. LULUCF.

Table 7.A3 (modified from Good Practice Guidence) Summary of Key Category analysis for Denmark

IPCC Source Categories (LULUCF included)			GHG	Key categories with number according to ranking in analysis Identification criteria					
				Level Tier1 1990/95	Level Tier1 2008	Trend Tier1 1990-2008	Level Tier2 1990/95	Level Tier2 2008	Trend Tier2 1990-2008
Energy	Stationary Combustion	Coal	CO2	1	1	1	11	15	17
Energy	Stationary Combustion	Brown Coal Bri.	CO2						
Energy	Stationary Combustion	Coke	CO2						
Energy	Stationary Combustion	Petroleum Coke	CO2	25	18	14			
Energy	Stationary Combustion	Plastic Waste	CO2	26	8	10	29	12	6
Energy	Stationary Combustion	Residual Oil	CO2	7	7	7			36
Energy	Stationary Combustion	Gas Oil	CO2	3	6	4	17	28	10
Energy	Stationary Combustion	Kerosene	CO2	27		15			
Energy	Stationary Combustion	Natural Gas	CO2	4	3	2	31	16	15
Energy	Stationary Combustion	LPG	CO2						
Energy	Stationary Combustion	Refinery Gas	CO2	18	17				
Energy	Mobile combustion	Civil Aviation	CO2						
Energy	Mobile combustion	Road Transportation	CO2	2	2	3	8	4	8
Energy	Mobile combustion	Railways	CO2	30	29				
Energy	Mobile combustion	Navigation small boats	CO2						
Energy	Mobile combustion	Navigation large vessels	CO2	20	23	20			31
Energy	Mobile combustion	Military	CO2						
Energy	Mobile combustion	National Fishing	CO2	22	22	28			
Energy	Mobile combustion	Agriculture	CO2	10	10		13	14	
Energy	Mobile combustion	Forestry	CO2						
Energy	Mobile combustion	Other Mobil and Machinery/Industry	CO2	17	13	16	12	9	14
Energy	Mobile combustion	Household and Gardening	CO2		27	25		31	27
Energy	Fugitive emissions	1B2c2i, Flaring oil	CO2						
Energy	Fugitive emissions	1B2c2ii, Flaring gas	CO2		24				
Energy	Stationary Combustion	1A1+1A2+1A4, BIOMASS	CH4			29	32	17	16
Energy	Stationary Combustion	Biogas fuelled engines, BIOMASS	CH4						
Energy	Stationary Combustion	1A1+1A2+1A4, GAS	CH4						
Energy	Stationary Combustion	Natural gas fuelled engines, GAS	CH4			22			
Energy	Stationary Combustion	1A1+1A2+1A4, LIQUID	CH4						
Energy	Stationary Combustion	1A1+1A2+1A4, WASTE	CH4						

Continued

Energy	Stationary Combustion	1A1+1A2+1A4, SOLID	CH4				
Energy	Mobile combustion	Civil Aviation	CH4				
Energy	Mobile combustion	Road Transportation	CH4				
Energy	Mobile combustion	Railways	CH4				
Energy	Mobile combustion	Navigation small boats	CH4				
Energy	Mobile combustion	Navigation large vessels	CH4				
Energy	Mobile combustion	Military	CH4				
Energy	Mobile combustion	National Fishing	CH4				
Energy	Mobile combustion	Agriculture	CH4				
Energy	Mobile combustion	Forestry	CH4				
Energy	Mobile combustion	Other Mobil and Machinery/Industry	CH4				
Energy	Mobile combustion	Household and Gardening	CH4				
Energy	Fugitive emissions	1B2aiv, Oil refining and storage	CH4				23
Energy	Fugitive emissions	1B2aii, Oil production landbased	CH4				
Energy	Fugitive emissions	1B2aii, Oil production offshore	CH4				
Energy	Fugitive emissions	1B2biii, Gas transmission	CH4				
Energy	Fugitive emissions	1B2biv, Gas distribution	CH4				
Energy	Fugitive emissions	1B2c2i, Flaring oil	CH4				
Energy	Fugitive emissions	1B2c2ii, Flaring gas	CH4				
Energy	Stationary Combustion	1A1 + 1A2 + 1A4, BIOMASS	N2O		21	13	9
Energy	Stationary Combustion	1A1 + 1A2 + 1A4, GAS	N2O			19	19
Energy	Stationary Combustion	1A1 + 1A2 + 1A4, LIQUID	N2O		14	18	18
Energy	Stationary Combustion	1A1 + 1A2 + 1A4, WASTE	N2O				
Energy	Stationary Combustion	1A1 + 1A2 + 1A4, SOLID	N2O		20	27	25
Energy	Mobile combustion	Civil Aviation	N2O				
Energy	Mobile combustion	Road Transportation	N2O				
Energy	Mobile combustion	Railways	N2O				
Energy	Mobile combustion	Navigation small boats	N2O				
Energy	Mobile combustion	Navigation large vessels	N2O		24	33	24
Energy	Mobile combustion	Military	N2O				
Energy	Mobile combustion	National Fishing	N2O		26	29	
Energy	Mobile combustion	Agriculture	N2O		22	21	
Energy	Mobile combustion	Forestry	N2O				
Energy	Mobile combustion	Other Mobil and Machinery/Industry	N2O		27	22	28
Energy	Mobile combustion	Household and Gardening	N2O				

Continued									
Energy	Fugitive emissions	1B2c2i, Flaring oil	N2O						
Energy	Fugitive emissions	1B2c2ii, Flaring gas	N2O						
Industrial Proc.	Cement Production		CO2	15	11	18			
Industrial Proc.	Lime Production		CO2						
Industrial Proc.	Limestone and Dolomite use		CO2						
Industrial Proc.	Asphalt Roofing		CO2						
Industrial Proc.	Road paving with Asphalt		CO2						
Industrial Proc.	Glass/GlassWoll Production		CO2						
Industrial Proc.	Yellow Bricks Production		CO2						
Industrial Proc.	Expanded Clay		CO2						
Industrial Proc.	Catalysts/Fertilizers and Pesticides		CO2						
Industrial Proc.	Food and Drink		CO2						
Industrial Proc.	Iron and Steel Production		CO2						
Industrial Proc.	Other, lubricants		CO2						
Industrial Proc.	Nitric Acid Production		N2O	14		8	16		5
Industrial Proc.	Magnesium Production		SF6						
Industrial Proc.	Electrical equipment		SF6						
Industrial Proc.	Other emissions of SF_6 i.e. from double glaze windows and laboratories		SF6						
Industrial Proc.	Refrigeration and AC Equipment		HFC and PFC		19	12		10	3
Industrial Proc.	Foam Blowing		HFC				30		30
Industrial Proc.	Aerosols		HFC						
Industrial Proc.	Other i.e Fibre Optics		HFC and PFC						
Solvent and Other Prod. Use	3A Paint application		CO2						
Solvent and Other Prod. Use	3B Degreasing and dry cleaning		CO2						
Solvent and Other Prod. Use	3C Chemical products, manufacturing and processing		CO2						
Solvent and Other Prod. Use	3D5 Other		CO2						
Solvent and Other Prod. Use	3D5 Other		N2O						
Agriculture	Enteric Fermentation		CH4	6	4	19	10	11	29
Agriculture	Manure Management		CH4	16	16	21	4	3	7
Agriculture	Manure management		N2O	19	21	24	5	8	13
Agriculture	Agriculture soils, direct emissions	Synthetic Fertilizers	N2O	8	9	9	3	5	2

Continued									
Agriculture	Agriculture soils, direct emissions	Animal Manure Applied to Soils	N2O	13	12	26	7	6	22
Agriculture	Agriculture soils, direct emissions	N-fixing Crops	N2O				23	25	
Agriculture	Agriculture soils, direct emissions	Crop Residue	N2O	28	25		19	20	
Agriculture	Agriculture soils, direct emissions	Cultivation of Histosols (2)	N2O						
Agriculture	Agriculture soils, direct emissions	Other direct emissions (please specify)	N2O						34
Agriculture	Agriculture soils, pasture, range and paddock		N2O	29		31	28	34	35
Agriculture	Agriculture soils, indirect	Atmospheric Deposition	N2O	24	26	23	18	23	21
Agriculture	Agriculture soils, indirect	Nitrogen Leaching and Run-off	N2O	5	5	6	1	2	1
Agriculture	Field Burning of Agricultural Residues		CH4+N2O						
Waste	Solid Waste Disposal Sites		CH4	11	15		2	1	
Waste	Waste Water Handling		CH4						
Waste	N_2O direct, Domestic and Commercial Wastewater		N2O					32	26
Waste	N_2O indirect from human sewage		N2O						32
Waste	Accidental fires - buildings		CO2					30	
Waste	Accidental fires - vehicles		CO2						
Waste	Incineration of corpses		CH4						
Waste	Incineration of carcasses		CH4						
Waste	Accidental fires - buildings		CH4						
Waste	Accidental fires - vehicles		CH4						
Waste	Incineration of corpses		N2O						
Waste	Incineration of carcasses		N2O						
LULUCF	Forest Land remaining Forest L.	5A1 Broadleaves	CO2	21		11	25		11
LULUCF	Forest Land remaining Forest L.	5A1 Conifers	CO2		28	13			20
LULUCF	Forest Land. Cropl. converted to Forest L.	5A2 Broadleaves	CO2						
LULUCF	Forest Land. Cropl. converted to Forest L.	5A2 Conifers	CO2						
LULUCF	Non-CO_2 drainage of soils and wetlands	5IID Forest Land.	N2O						
LULUCF	Cropland	5B Cropland remaining Cr. Living biomass	CO2			30			
LULUCF	Cropland	5B Cropland remaining Cr. Mineral soils	CO2	9	20	5	9	26	4
LULUCF	Cropland	5B Cropland remaining Cr. Organic soils	CO2	12	14		6	7	33
LULUCF	N_2O Disturbance, Land converted to cropland	5III Cropland	N2O						
LULUCF	Grassland	5C Grassland rem. Grasland. Living biomass	CO2			27			
LULUCF	Grassland	5C Grassland rem. Grasland. Organic soils	CO2						

Continued									
LULUCF	Wetlands	5D Land converted to wetlands	CO2						
LULUCF	Wetlands	5D Wetlands remaining Wetlands (peat)	CO2						
LULUCF	Non-CO2 drainage of soils and wetlands	5IID Wetlands. Peatland	N2O						
LULUCF	Settlements	5E Total settlements. Living biomass	CO2						
LULUCF	Agricultural lime application	5IV Cropland Limestone	CO2	23	30	17	15	24	12

Annex 2 Detailed discussion of methodology and data for estimation of CO_2 emission from fossil fuel combustion

Please refer to Annex 3A and 3B.

Annex 3 Other detailed methodological descriptions for individual source or sink categories (where relevant)

Annex 3A Stationary combustion

Annex 3A-1:	IPCC/SNAP source correspondence list
Annex 3A-2:	Fuel rate
Annex 3A-3:	Lower Calorific Value (LCV) of fuels and fuel correspondence list
Annex 3A-4:	Emission factors
Annex 3A-5:	Large point sources
Annex 3A-6:	Adjustment of CO_2 emission
Annex 3A-7:	Uncertainty estimates
Annex 3A-8:	Emission inventory 2008 based on SNAP sectors
Annex 3A-9:	Description of the Danish energy statistics

Annes 3A Stationary combustion

Annex 3A-1 IPCC/SNAP source correspondence list

Table 3A-1.1 Correspondence list for IPCC source categories 1A1, 1A2 and 1A4 and SNAP (EEA 2007).

SNAP_id	SNAP_name	IPCC source
01	Combustion in energy and transformation industries	
010100	Public power	1A1a
010101	Combustion plants >= 300 MW (boilers)	1A1a
010102	Combustion plants >= 50 and < 300 MW (boilers)	1A1a
010103	Combustion plants < 50 MW (boilers)	1A1a
010104	Gas turbines	1A1a
010105	Stationary engines	1A1a
010200	District heating plants	1A1a
010201	Combustion plants >= 300 MW (boilers)	1A1a
010202	Combustion plants >= 50 and < 300 MW (boilers)	1A1a
010203	Combustion plants < 50 MW (boilers)	1A1a
010204	Gas turbines	1A1a
010205	Stationary engines	1A1a
010300	Petroleum refining plants	1A1b
010301	Combustion plants >= 300 MW (boilers)	1A1b
010302	Combustion plants >= 50 and < 300 MW (boilers)	1A1b
010303	Combustion plants < 50 MW (boilers)	1A1b
010304	Gas turbines	1A1b
010305	Stationary engines	1A1b
010306	Process furnaces	1A1b
010400	Solid fuel transformation plants	1A1c
010401	Combustion plants >= 300 MW (boilers)	1A1c
010402	Combustion plants >= 50 and < 300 MW (boilers)	1A1c
010403	Combustion plants < 50 MW (boilers)	1A1c
010404	Gas turbines	1A1c
010405	Stationary engines	1A1c
010406	Coke oven furnaces	1A1c
010407	Other (coal gasification, liquefaction, ...)	1A1c
010500	Coal mining, oil/gas extraction, pipeline compressors	
010501	Combustion plants >= 300 MW (boilers)	1A1c
010502	Combustion plants >= 50 and < 300 MW (boilers)	1A1c
010503	Combustion plants < 50 MW (boilers)	1A1c
010504	Gas turbines	1A1c
010505	Stationary engines	1A1c
02	Non-industrial combustion plants	
020100	Commercial and institutional plants (t)	1A4a
020101	Combustion plants >= 300 MW (boilers)	1A4a
020102	Combustion plants >= 50 and < 300 MW (boilers)	1A4a
020103	Combustion plants < 50 MW (boilers)	1A4a
020104	Stationary gas turbines	1A4a
020105	Stationary engines	1A4a
020106	Other stationary equipments (n)	1A4a
020200	Residential plants	1A4b
020201	Combustion plants >= 50 MW (boilers)	1A4b
020202	Combustion plants < 50 MW (boilers)	1A4b
020203	Gas turbines	1A4b
020204	Stationary engines	1A4b
020205 [2)]	Other equipments (stoves, fireplaces, cooking,...) [2)]	1A4b
020300	Plants in agriculture, forestry and aquaculture	1A4c
020301	Combustion plants >= 50 MW (boilers)	1A4c
020302	Combustion plants < 50 MW (boilers)	1A4c
020303	Stationary gas turbines	1A4c
020304	Stationary engines	1A4c
020305	Other stationary equipments (n)	1A4c
03	Combustion in manufacturing industry	
030100	Comb. in boilers, gas turbines and stationary	1A2
030101	Combustion plants >= 300 MW (boilers)	1A2
030102	Combustion plants >= 50 and < 300 MW (boilers)	1A2
030103	Combustion plants < 50 MW (boilers)	1A2
030104	Gas turbines	1A2
030105	Stationary engines	1A2
030106	Other stationary equipments (n)	1A2
030200	Process furnaces without contact	
030203	Blast furnace cowpers	1A2a
030204	Plaster furnaces	1A2f
030205	Other furnaces	1A2f

SNAP_id	SNAP_name	IPCC source
Continued		
0303	Processes with contact	
030301	Sinter and pelletizing plants	1A2a
030302	Reheating furnaces steel and iron	1A2a
030303	Gray iron foundries	1A2a
030304	Primary lead production	1A2b
030305	Primary zinc production	1A2b
030306	Primary copper production	1A2b
030307	Secondary lead production	1A2b
030308	Secondary zinc production	1A2b
030309	Secondary copper production	1A2b
030310	Secondary aluminium production	1A2b
030311	Cement (f)	1A2f
030312	Lime (includ. iron and steel and paper pulp industr.)(f)	1A2f
030313	Asphalt concrete plants	1A2f
030314	Flat glass (f)	1A2f
030315	Container glass (f)	1A2f
030316	Glass wool (except binding) (f)	1A2f
030317	Other glass (f)	1A2f
030318	Mineral wool (except binding)	1A2f
030319	Bricks and tiles	1A2f
030320	Fine ceramic materials	1A2f
030321	Paper-mill industry (drying processes)	1A2d
030322	Alumina production	1A2b
030323	Magnesium production (dolomite treatment)	1A2b
030324	Nickel production (thermal process)	1A2b
030325	Enamel production	1A2f
030326	Other	1A2f
08 1)	Other mobile sources and machinery	
0804 1)	Maritime activities	
080403 1)	National fishing	1A4c
0806 1)	Agriculture	1A4c
0807 1)	Forestry	1A4c
0808 1)	Industry	1A2f
0809 1)	Household and gardening	1A4b

1) Not stationary combustion. Included in a IPCC sector that also includes stationary combustion plants

2) Stoves, fireplaces and cooking is included in the sector 0202 or 020202 in the Danish inventory. It is not possible based on the Danish energy statistics to split the residential fuel consumption between stoves/fireplaces/cooking and residential boilers.

Annex 3A-2 Fuel rate

Table 3A-2.1 Fuel consumption rate of stationary combustion plants 2008, GJ.

fuel_type	fuel_gr_abbr	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
BIOMASS	BIO PROD GAS										
	BIOGAS	0.184	0.194	0.204	0.206	0.206	0.294	0.345	0.342	0.354	0.636
	FISH & RAPE OIL								1.972	1.860	1.302
	SEWAGE SLUDGE										
	STRAW	4.840	6.647	7.420	8.319	8.319	9.892	10.274	10.831	11.258	11.659
	WOOD	11.331	13.997	14.976	14.999	14.999	15.008	17.025	17.968	17.629	17.595
WASTE	MUNICIP. WASTES	10.639	11.259	11.883	12.573	12.573	13.834	14.366	14.349	14.465	15.125
GAS	NATURAL GAS	5.041	5.501	5.664	6.280	6.280	30.403	48.497	62.192	67.423	71.715
LIQUID	GAS OIL	147.198	121.179	107.794	99.565	99.565	109.918	102.702	101.129	83.420	71.248
	KEROSENE	3.925	3.571	3.610	3.554	3.554	4.611	3.886	3.005	1.947	1.765
	LPG	6.381	5.591	5.602	5.639	5.639	5.026	4.869	4.382	3.570	2.938
	NAPHTA							0.102			
	ORIMULSION										
	PETROLEUM COKE	1.143	2.626	6.101	7.230	7.230	8.627	9.747	8.198	5.901	4.550
	REFINERY GAS	11.029	11.672	10.581	11.858	11.858	11.520	13.168	13.253	13.619	14.632
	RESIDUAL OIL	177.766	138.192	117.466	96.629	95.487	84.784	74.195	55.385	44.543	38.303
SOLID	BROWN COAL BRI.	0.384	0.497	0.817	0.705	0.705	0.813	0.459	0.347	0.197	0.129
	COAL	245.685	195.560	238.415	232.978	232.978	301.615	305.999	300.366	280.932	231.283
	COKE OVEN COKE	3.540	2.815	2.948	2.540	2.540	1.960	1.587	1.522	1.255	1.030
Total		**629.086**	**519.300**	**533.480**	**503.075**	**501.934**	**598.306**	**607.221**	**595.240**	**548.371**	**483.911**

Continued

fuel_type	fuel_gr_abbr	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
BIOMASS	BIO PROD GAS										
	BIOGAS	0.752	0.910	0.899	1.077	1.279	1.754	1.985	2.390	2.635	2.613
	FISH & RAPE OIL	0.744	0.744	0.744	0.800	0.245	0.251	0.060	0.014	0.014	0.027
	SEWAGE SLUDGE										
	STRAW	12.481	13.306	13.880	13.366	12.662	13.053	13.546	13.912	13.904	13.668
	WOOD	18.247	20.042	21.031	22.220	21.940	21.845	23.389	23.459	22.938	24.403
WASTE	MUNICIP. WASTES	15.499	16.744	17.797	19.410	20.312	22.906	24.952	26.770	26.591	29.138
GAS	NATURAL GAS	76.092	86.107	90.467	102.475	114.586	132.699	156.277	164.489	178.707	187.877
LIQUID	GAS OIL	61.449	64.998	56.102	62.025	53.930	53.698	58.019	51.071	48.425	47.555
	KEROSENE	5.086	0.943	0.784	0.771	0.650	0.581	0.540	0.437	0.417	0.256
	LPG	2.596	2.549	2.315	2.371	2.398	2.638	2.870	2.363	2.413	2.177
	NAPHTA										
	ORIMULSION						19.913	36.767	40.488	32.580	34.191
	PETROLEUM COKE	4.460	4.404	4.814	6.179	4.309	4.850	6.381	6.523	5.798	7.284
	REFINERY GAS	14.169	14.537	14.865	15.405	16.360	20.838	21.476	16.945	15.225	15.724
	RESIDUAL OIL	32.118	38.252	38.505	32.823	46.229	33.009	37.766	26.580	29.985	23.696
SOLID	BROWN COAL BRI.	0.116	0.167	0.095	0.128	0.092	0.075	0.056	0.054	0.048	0.038
	COAL	253.444	344.300	286.838	300.799	323.397	270.346	371.908	276.277	234.285	196.472
	COKE OVEN COKE	1.276	1.450	1.181	1.155	1.226	1.273	1.226	1.253	1.346	1.423
Total		**498.529**	**609.453**	**550.318**	**581.004**	**619.616**	**599.728**	**757.218**	**653.026**	**615.310**	**586.540**

Continued

fuel_type	fuel_gr_abbr	2000	2001	2002	2003	2004	2005	2006	2007	2008
BIOMASS	BIO PROD GAS									0.087
	BIOGAS	2.871	3.020	3.332	3.545	3.452	4.030	4.094	4.012	3.928
	FISH & RAPE OIL	0.049	0.191	0.127	0.259	0.650	0.732	0.970	0.845	1.917
	SEWAGE SLUDGE	0.040	0.375	0.065	0.055	0.058	0.058			
	STRAW	12.220	13.698	15.651	16.719	17.939	18.483	18.625	18.331	15.363
	WOOD	27.522	30.867	31.630	39.002	43.649	49.797	51.476	59.936	62.584
WASTE	MUNICIP. WASTES	30.352	32.325	35.057	36.494	37.229	37.417	39.610	39.494	40.939
GAS	NATURAL GAS	186.122	193.827	193.609	196.322	194.678	187.701	191.122	170.875	172.002
LIQUID	GAS OIL	41.260	43.668	38.674	38.955	35.919	31.852	26.774	21.681	20.871
	KEROSENE	0.170	0.287	0.256	0.338	0.215	0.280	0.221	0.119	0.119
	LPG	1.885	1.610	1.477	1.554	1.669	1.671	1.720	1.388	1.477
	NAPHTA									
	ORIMULSION	34.148	30.244	23.846	1.921	0.019				
	PETROLEUM COKE	7.292	8.313	8.282	8.717	9.381	9.341	9.720	10.415	8.174
	REFINERY GAS	15.556	15.755	15.197	16.555	15.891	15.347	16.116	15.916	14.782
	RESIDUAL OIL	18.836	21.091	26.161	28.431	24.500	21.940	26.094	21.186	17.389
SOLID	BROWN COAL BRI.	0.026	0.033	0.019	0.003					
	COAL	164.708	174.309	174.654	238.978	182.497	154.008	231.966	194.146	170.753
	COKE OVEN COKE	1.187	1.110	1.068	0.995	1.143	0.980	1.011	1.122	1.037
Total		**544.243**	**570.722**	**569.105**	**628.843**	**568.886**	**533.637**	**619.518**	**559.465**	**531.422**

Table 3A-2.2 Detailed fuel consumption data for stationary combustion plants, PJ. 1990 – 2008

fuel_type	fuel_gr_abbr	NFR	nfr_name	snap_id	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
BIOMASS	BIOGAS	1A1	Electricity and heat production	010100	0.141	0.219	0.029	0.042						
				010101					0.017	0.000	0.024	0.020		
				010102					0.010		0.094	0.041	0.050	0.030
				010103					0.054	0.118	0.079	0.111	0.087	0.104
				010104			0.079	0.089	0.200	0.169	0.007			
				010105	0.095	0.175	0.251	0.406	0.415	0.599	0.826	1.230	1.549	1.500
				010200	0.030	0.030	0.053	0.053						
				010203					0.046	0.044	0.054	0.034	0.031	0.025
				010205					0.041					
			Other energy industries	010505	0.007	0.007	0.007	0.007	0.006	0.052	0.060	0.057	0.031	0.029
		1A2	Industry	030100					0.013	0.126	0.096	0.117	0.074	0.033
				030102					0.007	0.016	0.016	0.019	0.016	0.016
				030104						0.001	0.001	0.001		
				030105									0.000	0.000
		1A4	Agriculture/ Forestry	020300					0.003	0.004	0.132	0.026	0.035	0.030
				020304	0.010	0.010	0.010	0.010	0.007	0.016	0.017	0.018	0.026	0.041
			Commercial/ Institutional	020100	0.199	0.179	0.084	0.064	0.113	0.170	0.173	0.272	0.225	0.293
				020103							0.014	0.039	0.071	0.074
				020104						0.027				
				020105	0.270	0.290	0.387	0.406	0.349	0.411	0.390	0.405	0.439	0.437
	FISH & RAPE OIL	1A1	Electricity and heat production	010103					0.034	0.024	0.022	0.000	0.005	0.007
				010200	0.744	0.744	0.744	0.800						
				010203					0.212	0.227	0.039	0.014	0.008	0.020
	STRAW	1A1	Electricity and heat production	010100	0.479	0.985	1.487	1.643						
				010101					0.100	0.082	0.610	0.740	1.014	1.340
				010102					0.622	1.287	1.704	1.845	1.752	1.819
				010103					1.127	1.297	1.362	1.174	1.181	1.058
				010200	3.524	3.843	3.915	3.806						
				010201					0.022					
				010202					0.057	0.180	0.114	0.096	0.136	0.142
				010203					3.378	3.409	3.700	3.564	3.526	3.565
		1A2	Industry	030100									0.000	0.000
				030103						0.003				
		1A4	Agriculture/ Forestry	020300	3.391	3.391	3.391	3.167	2.942	2.718	2.422	2.595	2.515	2.295
				020302								0.006	0.006	0.006
			Residential	020200	5.087	5.087	5.087	4.750	4.414	4.077	3.633	3.892	3.773	3.443
	WOOD	1A1	Electricity and heat production	010100			0.172	0.515						
				010101					0.043				0.264	
				010102					1.053	0.865	0.862	1.001	1.372	2.377
				010103					0.624	0.672	0.578	0.645	0.575	0.732
				010104					0.079	0.004				
				010105										0.002
				010200	3.217	3.648	4.096	3.751						
				010201					0.009					
				010202					0.000	0.044	0.165	0.191	0.207	0.194
				010203					3.338	3.491	3.857	3.795	3.972	3.928
		1A2	Industry	030100	5.784	5.690	5.751	5.822	4.465	4.254	4.098	4.166	4.274	4.250
				030102									0.002	0.001
				030103					0.481	0.413	0.624	0.524	0.412	0.414

fuel_type	fuel_gr_abbr	NFR	nfr_name	snap_id	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
		1A4	Agriculture/ Forestry	020300	0.087	0.087	0.087	0.068	0.068	0.068	0.087	0.097	0.230	0.231
				020304									0.001	0.014
			Commercial/ Institutional	020100	0.204	0.204	0.204	0.204	0.216	0.273	0.449	0.471	0.493	0.642
				020105									0.002	0.002
			Residential	020200	8.954	10.412	10.720	11.860	11.564	11.761	12.669	12.569	11.134	11.615
WASTE	MUNICIP. WASTES	1A1	Electricity and heat production	010100	0.990	3.563	5.578	8.433						
				010101									1.288	1.278
				010102					5.110	6.527	7.153	10.832	11.715	16.938
				010103					2.910	3.755	5.003	3.074	1.957	4.039
				010104					1.665	2.028	3.192	3.025	2.806	2.453
				010200	13.567	12.142	11.111	9.839						
				010201					0.007					
				010202					3.472	3.703	4.646	4.649	4.618	
				010203					5.909	5.559	3.699	3.978	3.458	2.915
		1A2	Industry	030100	0.028	0.028	0.037	0.039	0.026	0.029	0.028	0.024	0.029	0.035
		1A4	Commercial/ Institutional	020100	0.914	1.011	1.071	1.099	1.182	1.275	1.222	1.180	0.710	1.473
				020103					0.031	0.031	0.010	0.008	0.010	0.007
GAS	NATURAL GAS	1A1	Electricity and heat production	010100								0.006	0.021	0.017
				010101	4.005	4.395	3.279	4.422	8.438	10.454	12.217	14.600	20.809	21.308
				010102					0.295	0.300	1.346	5.620	5.987	2.416
				010103					2.487	1.775	1.558	1.138	0.959	0.717
				010104	1.859	2.397	4.806	7.327	7.777	8.548	14.500	12.220	13.003	21.614
				010105	0.678	1.291	2.199	4.169	8.358	16.420	22.162	24.109	26.701	26.834
				010200	11.033	13.655	12.350	11.420						
				010202					1.072	1.017	0.844	0.661	0.539	0.282
				010203					6.160	5.525	3.803	2.420	1.989	1.874
				010205					0.132	0.339	0.377	0.230	0.236	0.226
			Other energy industries	010502						0.399	0.391	0.417	0.413	0.409
				010504	9.482	9.703	11.119	11.235	12.268	12.506	14.850	19.455	21.637	23.562
				010505	0.002	0.004	0.004	0.004	0.003	0.004	0.008	0.005	0.015	0.014
		1A2	Industry	030100	22.280	23.781	23.888	25.535	29.248	30.318	29.252	29.423	29.114	31.167
				030102					0.863	2.662	2.465	2.972	2.962	3.100
				030103					0.300	0.064	0.147	0.170	0.132	0.127
				030104	0.506	0.609	0.664	0.730	0.761	0.910	2.563	3.366	5.106	6.501
				030105	0.000	0.000	0.000	0.000	0.011	0.173	0.873	0.960	1.157	1.160
				030106	0.136	0.024	0.038	0.070	0.053	0.024	0.015	0.005	0.032	0.039
				030315								0.924	0.903	1.005
				030318						0.625	0.590	0.621	0.671	0.687
		1A4	Agriculture/ Forestry	020300	2.222	2.680	2.385	2.463	2.485	2.560	2.666	2.645	2.476	2.242
				020303							0.006	0.026	0.066	0.077
				020304	0.104	0.104	0.136	0.161	0.282	0.961	1.796	2.620	3.354	3.379
			Commercial/ Institutional	020100	6.376	6.934	7.382	8.909	7.343	8.437	11.247	9.107	8.662	7.525
				020103					0.002			0.002	0.049	0.011
				020104					0.012	0.026	0.031	0.026	0.023	0.031
				020105	0.046	0.089	0.278	0.350	0.474	0.609	0.681	0.866	0.959	0.986
			Residential	020200	17.362	20.433	21.440	24.904	24.737	26.947	30.412	28.362	29.138	28.982
				020202							0.026	0.025	0.018	0.031
				020204		0.008	0.499	0.776	1.023	1.095	1.448	1.488	1.576	1.554
LIQUID	GAS OIL	1A1	Electricity and heat production	010100	0.239	0.416	0.641	0.245						
				010101					0.012	0.051	0.042	0.195	0.109	0.258

fuel_type	fuel_gr_abbr	NFR	nfr_name	snap_id	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
				010102					0.043	0.030	0.153	0.114	0.082	0.159
				010103					0.059	0.040	0.078	0.042	0.044	0.061
				010104	0.044	0.044	0.044	0.044	0.044	0.076	0.081	0.054	0.147	0.060
				010105	0.017	0.033	0.035	0.035	0.116	0.137	0.099	0.100	0.134	0.108
				010200	1.941	0.813	0.744	0.947						
				010201					0.027	0.007				
				010202					0.174	0.361	0.800	0.515	0.418	0.258
				010203					0.844	0.444	0.555	0.510	0.652	0.296
				010205					0.001					0.001
			Petroleum refining	010306		0.040	0.044	0.029	0.049	0.033	0.022	0.087		
		1A2	Industry	030100	0.538	1.370	1.431	0.952	0.813	1.460	2.252	1.895	1.799	2.478
				030102						0.003			0.000	0.001
				030103					0.002	0.001	0.011	0.001	0.002	0.000
				030104								0.000	0.000	0.007
				030105			0.001	0.002	0.002					
				030106	0.006	0.007	0.009	0.003	0.009	0.007	0.007	0.008	0.016	0.070
				030315								0.001	0.001	0.005
		1A4	Agriculture/ Forestry	020300	0.406	1.014	1.176	0.794	0.708	1.182	1.940	1.799	1.675	2.297
				020302								0.000		
				020304							0.004	0.002		
			Commercial/ Institutional	020100	11.795	10.623	9.062	9.007	7.157	6.556	6.620	6.093	5.442	5.781
				020102					0.191		0.000		0.000	
				020103					0.000		0.058	0.058	0.054	0.039
				020105			0.001	0.001	0.001	0.020	0.002	0.000	0.000	0.000
			Residential	020200	46.463	50.638	42.914	49.967	43.679	43.288	45.296	39.595	37.850	35.675
	KEROSENE	1A2	Industry	030100	0.070	0.046	0.038	0.035	0.030	0.024	0.031	0.028	0.016	0.009
		1A4	Agriculture/ Forestry	020300	0.043	0.028	0.026	0.026	0.027	0.021	0.023	0.025	0.021	0.011
			Commercial/ Institutional	020100	0.569	0.210	0.207	0.189	0.155	0.124	0.103	0.096	0.128	0.117
			Residential	020200	4.405	0.660	0.512	0.521	0.438	0.411	0.383	0.287	0.252	0.119
	LPG	1A1	Electricity and heat production	010100		0.001	0.001	0.003						
				010103						0.001				
				010200	0.009	0.013	0.010							
				010203					0.003					0.000
			Petroleum refining	010306			0.005		0.008	0.015	0.021	0.018		
		1A2	Industry	030100	1.576	1.689	1.589	1.451	1.558	1.738	1.920	1.597	1.624	1.355
		1A4	Agriculture/ Forestry	020300	0.259	0.247	0.192	0.122	0.116	0.125	0.137	0.109	0.126	0.087
			Commercial/ Institutional	020100	0.083	0.077	0.077	0.122	0.125	0.131	0.138	0.128	0.116	0.110
				020103									0.000	
				020105									0.001	0.001
			Residential	020200	0.670	0.522	0.442	0.673	0.589	0.628	0.653	0.510	0.546	0.624
	ORIMULSION	1A1	Electricity and heat production	010101						19.913	36.767	40.488	32.580	34.191
	PETROLEUM COKE	1A1	Electricity and heat production	010100				1.239						
		1A2	Industry	030100	0.300		0.056	0.123		0.098	0.110	0.034	0.026	0.039
				030311	2.499	2.991	3.234	3.231	3.469	3.707	4.966	5.230	4.775	6.399
		1A4	Agriculture/ Forestry	020300	0.837	0.611	0.473	0.500		0.240	0.286	0.323	0.201	0.089
			Commercial/ Institutional	020100	0.062	0.104	0.090	0.096	0.092	0.070	0.091	0.098	0.071	0.050
			Residential	020200	0.761	0.697	0.961	0.990	0.748	0.734	0.929	0.839	0.726	0.706
	REFINERY GAS	1A1	Electricity and heat production	010101							0.035	0.040		
			Petroleum refining	010300	0.458	0.926	1.526	0.016						

fuel_type	fuel_gr_abbr	NFR	nfr_name	snap_id	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
				010304				2.067	2.355	2.290	5.070	4.082	2.996	4.173
				010306	13.520	13.486	13.237	13.214	14.005	18.548	16.337	12.771	12.203	11.551
		1A2	Industry	030100	0.191	0.125	0.102	0.108			0.035	0.053	0.027	
	RESIDUAL OIL	1A1	Electricity and heat production	010100	0.775	0.364	1.742	0.741						
				010101	7.172	10.053	8.691	8.420	22.142	11.174	16.072	7.736	11.557	7.214
				010102	0.042	0.017	0.027	0.024	0.180	0.254	0.443	0.421	0.510	0.763
				010103					0.252	0.173	0.201	0.159	0.116	0.102
				010104					0.320	0.347	0.237	0.302	0.355	0.118
				010105	0.009	0.009	0.009	0.009	0.012	0.004	0.005	0.002	0.006	0.004
				010200	2.006	2.236	1.141	0.879						
				010202					0.134	0.173	0.171	0.141	0.102	0.136
				010203					0.859	0.939	1.201	0.875	0.779	0.962
			Petroleum refining	010306	1.309	2.038	3.569	3.490	3.337	2.334	2.244	1.622	1.106	1.090
		1A2	Industry	030100	16.531	19.002	18.557	14.527	12.588	10.217	10.610	9.223	9.121	8.683
				030102					0.742	0.911	0.789	0.790	0.663	0.696
				030103					0.200	0.207	0.166	0.123	0.122	0.136
				030104								0.054		
				030311	1.763	2.153	2.367	2.397	2.619	2.840	1.771	1.864	2.539	0.886
		1A4	Agriculture/ Forestry	020300	1.224	1.296	1.634	1.687	1.942	2.617	3.071	2.492	2.563	2.396
				020302									0.009	0.001
				020304									0.009	0.011
			Commercial/ Institutional	020100	1.070	0.865	0.601	0.517	0.719	0.677	0.718	0.729	0.384	0.450
				020103					0.088	0.078				
			Residential	020200	0.217	0.219	0.168	0.130	0.095	0.063	0.066	0.046	0.043	0.050
SOLID	BROWN COAL BRI.	1A2	Industry	030100	0.004	0.007	0.004	0.018	0.003	0.002	0.001	0.001		
		1A4	Agriculture/ Forestry	020300	0.060	0.092	0.052	0.022	0.012	0.010	0.007	0.004	0.004	
			Commercial/ Institutional	020100	0.001	0.002		0.008	0.001	0.001	0.000	0.000		
			Residential	020200	0.051	0.067	0.039	0.080	0.076	0.062	0.047	0.049	0.044	0.038
	COAL	1A1	Electricity and heat production	010100	8.523	12.892	10.176	8.221						
				010101	219.781	303.105	252.745	269.459	295.430	244.510	347.252	252.648	211.429	176.641
				010102	2.119	2.654	2.250	2.269	8.605	8.381	9.033	8.671	9.023	8.238
				010103					0.837	0.526	0.149	0.039	0.024	0.034
				010104					0.272	0.270	0.301	0.074		
				010105					0.020					
				010200	6.017	6.635	5.173	3.581						
				010201					0.153	0.020				
				010202					1.112	0.790	0.200	0.065	0.018	0.000
				010203					0.378	0.317	0.228	0.049	0.048	0.007
		1A2	Industry	030100	8.850	8.977	6.751	7.699	5.867	4.833	4.461	4.494	4.676	3.715
				030102					0.615	1.051	1.450	1.467	1.406	1.412
				030103					0.190	0.183	0.193	0.192		
				030311	5.019	6.049	6.577	6.602	6.914	7.225	7.068	7.209	6.628	5.638
		1A4	Agriculture/ Forestry	020300	2.458	2.854	2.204	2.106	2.295	1.798	1.446	1.239	0.904	0.708
			Commercial/ Institutional	020100	0.088	0.009	0.096	0.076	0.090	0.066	0.041	0.043	0.002	
			Residential	020200	0.589	1.125	0.866	0.786	0.619	0.377	0.086	0.086	0.127	0.079
	COKE OVEN COKE	1A2	Industry	030100	1.169	1.351	1.078	1.073	1.163	0.287	0.304	0.295	0.319	0.381
				030318						0.937	0.886	0.931	1.007	1.030
		1A4	Residential	020200	0.107	0.099	0.103	0.081	0.063	0.049	0.037	0.027	0.020	0.011
Grand Total					**498.529**	**609.453**	**550.318**	**581.004**	**619.616**	**599.728**	**757.218**	**653.026**	**615.310**	**586.540**

Continued

fuel_type	fuel_gr_abbr	NFR	nfr_name	snap_id	2000	2001	2002	2003	2004	2005	2006	2007	2008
BIOMASS	BIO PROD GAS	1A1	Electricity and heat production	010105									0.085
		1A2	Industry	030105									0.000
		1A4	Commercial/ Institutional	020105									0.001
	BIOGAS	1A1	Electricity and heat production	010102	0.026	0.023	0.020	0.022	0.017	0.017	0.017	0.016	0.012
				010103	0.135	0.124	0.090	0.097	0.078	0.070	0.105	0.109	0.111
				010105	1.549	1.589	1.686	1.705	1.435	1.536	1.287	1.418	1.496
				010203	0.022	0.011	0.013	0.017	0.023	0.041	0.017	0.018	0.041
				010205					0.036	0.110	0.155	0.149	0.014
			Other energy industries	010505	0.033	0.029	0.031	0.032	0.061	0.100	0.116	0.098	
		1A2	Industry	030100	0.033	0.028	0.038	0.034	0.046	0.143	0.137	0.145	0.074
				030102	0.016	0.059	0.072	0.096	0.113	0.048	0.052	0.035	0.101
				030103									0.011
				030105	0.001	0.024	0.018	0.014	0.017		0.104	0.073	0.209
		1A4	Agriculture/ Forestry	020300	0.076	0.080	0.096	0.135	0.169	0.084	0.296	0.325	0.710
				020304	0.077	0.109	0.239	0.456	0.411	0.509	0.591	0.447	0.155
			Commercial/ Institutional	020100	0.311	0.355	0.425	0.322	0.426	0.474	0.578	0.658	0.464
				020103	0.087	0.085	0.074	0.085	0.101	0.355	0.138	0.102	0.114
				020105	0.507	0.504	0.528	0.531	0.517	0.544	0.501	0.421	0.417
	FISH & RAPE OIL	1A1	Electricity and heat production	010101								0.025	0.012
				010102					0.001	0.002		0.040	0.547
				010103				0.002	0.055	0.152	0.254	0.277	0.332
				010105					0.002				
				010202				0.019	0.005	0.021	0.024	0.033	0.090
				010203	0.049	0.191	0.126	0.238	0.589	0.557	0.692	0.469	0.624
		1A2	Industry	030100						0.000	0.000		
				030105			0.000	0.000		0.000	0.000	0.000	0.001
		1A4	Agriculture/ Forestry	020304	0.000	0.001	0.000						
			Commercial/ Institutional	020105								0.001	
			Residential	020200									0.312
	SEWAGE SLUDGE	1A2	Industry	030311	0.040	0.375	0.065	0.055	0.058	0.058			
	STRAW	1A1	Electricity and heat production	010101	1.120	1.588	2.643	3.192	4.366	4.088	4.422	4.474	3.187
				010102	1.827	1.746	1.641	1.712	1.815	1.765	1.489	1.448	1.456
				010103	0.640	1.905	1.754	1.928	1.336	1.394	1.358	1.259	1.676
				010104		0.102	1.216	1.707	2.477	3.118	3.175	3.099	0.815
				010202	0.151	0.098			0.095	0.096	0.082	0.088	0.090
				010203	3.291	3.418	3.556	3.339	3.007	3.180	3.258	3.122	3.298
		1A2	Industry	030105	0.000	0.000							
		1A4	Agriculture/ Forestry	020300	2.074	1.934	1.934	1.934	1.934	1.934	1.937	1.934	1.937
				020302	0.006	0.006	0.006	0.006	0.006	0.006		0.006	
			Residential	020200	3.112	2.901	2.901	2.901	2.901	2.901	2.905	2.901	2.905
	WOOD	1A1	Electricity and heat production	010101		0.001	0.066	0.305	0.231	1.247	0.695	0.622	0.532
				010102	2.275	2.187	3.176	5.855	5.627	5.966	6.355	6.086	5.773
				010103	0.670	0.747	0.780	0.446	1.062	1.079	1.129	0.897	0.462
				010104			0.120	1.657	4.488	4.479	2.609	3.758	5.947
				010105	0.053	0.060	0.062	0.000					
				010202	0.180	0.250	0.164	0.196	0.620	0.417	0.600	0.581	0.566
				010203	3.882	4.298	4.651	5.066	4.798	5.018	5.312	5.395	6.337

fuel_type	fuel_gr_abbr	NFR	nfr_name	snap_id	2000	2001	2002	2003	2004	2005	2006	2007	2008
		1A2	Industry	030100	4.450	4.596	3.313	3.534	3.426	3.763	3.784	4.179	5.117
				030102	0.001	0.001					0.009	1.063	1.184
				030103	0.440	0.431	0.411	0.295	0.342	0.527	0.521	0.147	
		1A4	Agriculture/ Forestry	020300	0.170	0.147	0.147	0.112	0.098	0.087	0.087	0.087	0.077
				020304	0.000	0.000							
			Commercial/ Institutional	020100	0.776	0.665	0.672	0.681	0.681	0.816	0.952	1.012	1.067
				020105		0.000	0.001		0.000	0.000	0.000	0.001	
			Residential	020200	14.625	17.484	18.067	20.855	22.274	26.400	29.424	36.108	35.523
WASTE	MUNICIP. WASTES	1A1	Electricity and heat production	010101	1.231	2.809	3.502	0.143					0.028
				010102	18.306	17.902	19.003	22.524	24.720	24.848	25.935	26.444	27.599
				010103	8.361	8.343	8.321	7.848	7.885	8.133	8.310	8.503	8.456
				010104	0.417			0.625			0.067		
				010105							0.740		
				010203	1.396	2.195	2.430	2.570	2.507	2.093	2.133	2.854	2.796
		1A2	Industry	030102				0.005	0.004	0.004	0.004		0.042
				030311	0.505	1.062	1.788	1.406	1.927	1.932	1.512	1.644	1.956
		1A4	Commercial/ Institutional	020100	0.122			1.296	0.110	0.234	0.726		
				020103	0.014	0.013	0.013	0.075	0.076	0.173	0.183	0.049	0.062
GAS	NATURAL GAS	1A1	Electricity and heat production	010100	0.015	0.011	0.000	0.001	0.002		0.006	0.027	
				010101	23.542	20.515	19.247	20.165	19.287	18.925	20.813	13.887	13.915
				010102	1.590	4.250	2.893	1.877	1.582	2.007	1.080	1.469	4.175
				010103	0.684	0.734	0.657	1.058	0.837	1.651	2.238	3.196	2.444
				010104	22.974	25.003	30.031	29.928	30.713	25.116	31.959	25.441	26.725
				010105	25.640	27.865	27.702	27.012	26.392	23.502	20.419	16.284	14.578
				010202	0.218	0.287	0.291	0.278	0.428	0.320	0.123	0.251	0.437
				010203	1.427	1.768	1.482	1.850	1.612	2.256	2.136	2.141	2.656
				010205	0.203	0.228	0.207	0.172	0.474	0.552	0.853	0.302	0.137
			Other energy industries	010502	0.341	0.353	0.379	0.323	0.361	0.325	0.379	0.348	0.354
				010504	25.016	24.413	26.180	26.247	27.067	27.791	28.342	28.131	27.972
				010505	0.014	0.012	0.011	0.012	0.012	0.009	0.008	0.005	0.002
		1A2	Industry	030100	28.608	30.958	29.348	28.370	26.869	27.737	27.625	29.222	29.104
				030102	2.690	2.869	1.190	2.274	2.296	2.200	2.293	1.573	1.498
				030103	0.116	0.118	0.015	0.119	0.124	0.190	0.131	0.172	0.478
				030104	6.756	6.139	6.724	6.526	6.633	5.965	4.711	4.396	3.735
				030105	1.556	1.642	1.545	1.544	1.570	1.256	0.952	0.465	0.485
				030106	0.051	0.054	0.026	0.017	0.022	0.002	0.003		
				030315	1.101	1.089	1.016	0.946	0.911	0.874	0.827	0.834	0.869
				030318	0.629	0.589	0.524	0.552	0.607	0.557	0.557	0.631	0.568
		1A4	Agriculture/ Forestry	020300	2.384	2.687	2.543	2.320	2.258	2.248	2.008	1.897	2.021
				020303	0.062	0.060	0.064	0.054	0.054	0.058	0.042	0.029	0.027
				020304	3.109	2.935	3.116	2.856	2.864	2.494	1.811	1.166	1.091
			Commercial/ Institutional	020100	7.234	7.323	7.624	9.215	9.200	9.745	10.728	10.221	9.983
				020103	0.043	0.067	0.165	0.011	0.050	0.036	0.025	0.017	0.038
				020104	0.023	0.031	0.043	0.034	0.022	0.013	0.040	0.024	
				020105	1.033	1.045	1.080	1.023	1.033	0.862	0.946	0.832	0.801
			Residential	020200	27.569	29.262	28.082	30.023	29.858	29.524	28.542	26.640	26.609
				020202	0.055	0.069	0.030	0.063	0.064	0.018	0.026	0.021	0.086
				020204	1.439	1.450	1.392	1.451	1.476	1.467	1.499	1.254	1.212
LIQUID	GAS OIL	1A1	Electricity and heat production	010101	0.136	0.123	0.092	0.957	0.220	0.186	0.476	0.563	0.939

fuel_type	fuel_gr_abbr	NFR	nfr_name	snap_id	2000	2001	2002	2003	2004	2005	2006	2007	2008
				010102	0.279	0.367	0.279	0.115	0.139	0.116	0.094	0.136	0.091
				010103		0.034	0.037	0.017	0.015	0.022	0.051	0.004	0.008
				010104	0.103	0.040	0.075	0.079	0.081	0.126	0.081	0.097	0.118
				010105	0.069	0.085	0.066	0.064	0.107	0.073	0.060	0.046	0.014
				010201					0.093	0.053	0.021	0.025	0.060
				010202	0.694	0.830	0.167	0.256	0.419	0.178	0.164	0.304	0.257
				010203	0.233	0.355	0.307	1.126	0.493	0.367	0.301	0.246	0.516
				010204						0.008	0.006	0.008	
				010205					0.005	0.001	0.001	0.001	0.001
			Other energy industries	010505			0.000	0.000	0.000	0.000	0.000	0.000	
			Petroleum refining	010306				0.003	0.009	0.002	0.010	0.008	0.004
		1A2	Industry	030100	2.184	3.011	2.369	2.666	2.551	1.694	0.652	0.002	0.001
				030102	0.003	0.005	0.000	0.004	0.003	0.003	0.013	0.011	0.018
				030103	0.082	0.000	0.000				0.000		0.000
				030104	0.000		0.001			0.002	0.000	0.000	0.000
				030105	0.000	0.001							0.018
				030106	0.008	0.010	0.007	0.007	0.009	0.009	0.007		
				030315	0.002	0.002	0.001	0.001	0.004	0.007	0.001	0.000	0.000
		1A4	Agriculture/ Forestry	020300	2.156	2.567	2.193	2.309	2.050	1.335	0.579		
				020304	0.005	0.003	0.005	0.006		0.002	0.000	0.004	
			Commercial/ Institutional	020100	4.958	4.685	4.031	4.289	4.411	3.755	3.029	1.653	1.919
				020103	0.071	0.044	0.044	0.030	0.019	0.048	0.032	0.016	0.033
				020105	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.001	0.008
			Residential	020200	30.276	31.506	28.998	27.027	25.291	23.863	21.197	18.554	16.857
				020204									0.010
	KEROSENE	1A2	Industry	030100	0.008	0.026	0.065	0.048	0.020	0.013	0.019	0.014	0.016
		1A4	Agriculture/ Forestry	020300	0.008	0.023	0.011	0.011	0.007	0.008	0.007	0.004	0.004
			Commercial/ Institutional	020100	0.063	0.080	0.070	0.074	0.077	0.101	0.059	0.015	0.011
			Residential	020200	0.091	0.159	0.110	0.205	0.111	0.158	0.136	0.086	0.088
	LPG	1A1	Electricity and heat production	010101							0.000		0.000
				010102									0.000
				010203	0.000					0.000			0.000
		1A2	Industry	030100	1.019	0.761	0.678	0.730	0.749	0.740	0.775	0.493	0.404
		1A4	Agriculture/ Forestry	020300	0.093	0.080	0.055	0.058	0.053	0.046	0.046	0.027	0.022
			Commercial/ Institutional	020100	0.122	0.119	0.137	0.170	0.215	0.218	0.211	0.199	0.268
				020105					0.000	0.000	0.000	0.000	0.000
			Residential	020200	0.651	0.649	0.608	0.596	0.651	0.667	0.689	0.669	0.782
	ORIMULSION	1A1	Electricity and heat production	010101	34.148	30.244	23.846	1.921	0.019				
	PETROLEUM COKE	1A1	Electricity and heat production	010102					0.007	0.002			
		1A2	Industry	030100	0.285	0.128	0.224	0.230	0.181	0.163	0.163		
				030311	6.475	7.657	7.543	7.714	8.188	7.796	8.284	9.109	6.835
		1A4	Agriculture/ Forestry	020300	0.006	0.003	0.000	0.001					
			Commercial/ Institutional	020100	0.012	0.012	0.005	0.009		0.065	0.009	0.014	0.025
			Residential	020200	0.513	0.513	0.509	0.762	1.005	1.315	1.264	1.292	1.314
	REFINERY GAS	1A1	Petroleum refining	010304	3.908	3.979	3.855	3.804	3.797	3.219	3.018	3.142	2.551
				010306	11.649	11.777	11.342	12.750	12.094	12.128	13.098	12.774	12.231
	RESIDUAL OIL	1A1	Electricity and heat production	010101	4.046	5.951	5.018	7.329	5.578	5.461	4.346	5.502	3.268
				010102	0.513	0.254	0.279	0.334	0.596	0.591	0.884	0.810	0.642

fuel_type	fuel_gr_abbr	NFR	nfr_name	snap_id	2000	2001	2002	2003	2004	2005	2006	2007	2008
				010103	0.109	0.117	0.120	0.106	0.017				0.108
				010104	0.117	1.768	6.695	9.359	7.484	6.336	8.397	4.501	4.469
				010105	0.017	0.001	0.001	0.006	0.002				
				010202	0.059	0.087	0.123	0.084	0.034	0.027	0.030	0.056	0.040
				010203	0.617	0.611	0.548	0.323	0.187	0.260	0.102	0.085	0.065
			Petroleum refining	010306	1.323	1.443	1.363	0.907	1.072	0.691	0.619	0.822	0.907
		1A2	Industry	030100	8.157	7.629	8.617	6.610	6.144	5.041	7.764	6.017	2.993
				030102	0.714	0.792	0.809	1.645	1.690	1.898	1.606	1.417	2.902
				030103	0.140	0.090							0.337
				030105		0.000	0.000	0.001	0.000	0.005	0.000		0.001
				030311	0.859	0.502	0.592	0.587	0.817	0.694	0.979	1.056	0.512
		1A4	Agriculture/ Forestry	020300	1.779	1.640	1.365	0.911	0.720	0.759	0.904	0.640	0.636
				020302	0.003	0.002	0.002	0.006	0.005	0.007	0.017	0.032	0.031
				020304	0.004	0.005	0.003	0.003					
			Commercial/ Institutional	020100	0.343	0.173	0.478	0.171	0.108	0.121	0.252	0.234	0.465
			Residential	020200	0.036	0.027	0.149	0.047	0.044	0.049	0.195	0.013	0.013
SOLID	BROWN COAL BRI.	1A4	Residential	020200	0.026	0.033	0.019	0.003					
	COAL	1A1	Electricity and heat production	010101	146.911	158.990	161.608	225.397	167.931	140.019	218.347	180.898	159.452
				010102	6.225	4.971	4.685	4.578	4.512	4.048	3.289	3.050	2.813
				010103	0.035	0.024	0.015	0.034	0.024				0.095
				010202	0.000	0.001	0.000	0.000	0.001	0.004		0.019	
				010203	0.004	0.000				0.000			
		1A2	Industry	030100	3.667	3.554	2.127	2.826	3.338	2.724	2.527	2.716	1.517
				030102	1.063	0.997	0.998	1.570	1.499	1.499	1.431	1.372	1.468
				030311	5.708	4.523	4.349	3.369	3.754	3.917	4.365	4.030	3.544
		1A4	Agriculture/ Forestry	020300	1.079	1.234	0.856	1.203	1.437	1.787	2.004	2.053	1.858
				020304						0.003			
			Commercial/ Institutional	020100					0.001				
			Residential	020200	0.014	0.013	0.015	0.000	0.000	0.008	0.004	0.007	0.005
	COKE OVEN COKE	1A2	Industry	030100	0.238	0.223	0.279	0.276	0.302	0.241	0.246	0.206	0.148
				030102								0.037	0.107
				030318	0.944	0.883	0.786	0.693	0.814	0.739	0.765	0.877	0.782
		1A4	Residential	020200	0.005	0.003	0.003	0.026	0.027	0.000	0.000	0.002	0.001
Grand Total					**544.243**	**570.722**	**569.105**	**628.843**	**568.886**	**533.637**	**619.518**	**559.465**	**531.422**

Annex 3A-3 Lower Calorific Value (LCV) of fuels and fuel correspondence list

Table 3A-3.1 Time-series for calorific values of fuels (DEA 2009b).

		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Crude Oil, Average	GJ pr tonnes	42.40	42.40	42.40	42.70	42.70	42.70	42.70	43.00	43.00	43.00
Crude Oil, Golf	GJ pr tonnes	41.80	41.80	41.80	41.80	41.80	41.80	41.80	41.80	41.80	41.80
Crude Oil, North Sea	GJ pr tonnes	42.70	42.70	42.70	42.70	42.70	42.70	42.70	43.00	43.00	43.00
Refinery Feedstocks	GJ pr tonnes	41.60	41.60	41.60	41.60	41.60	41.60	41.60	42.70	42.70	42.70
Refinery Gas	GJ pr tonnes	52.00	52.00	52.00	52.00	52.00	52.00	52.00	52.00	52.00	52.00
LPG	GJ pr tonnes	46.00	46.00	46.00	46.00	46.00	46.00	46.00	46.00	46.00	46.00
Naphtha (LVN)	GJ pr tonnes	44.50	44.50	44.50	44.50	44.50	44.50	44.50	44.50	44.50	44.50
Motor Gasoline	GJ pr tonnes	43.80	43.80	43.80	43.80	43.80	43.80	43.80	43.80	43.80	43.80
Aviation Gasoline	GJ pr tonnes	43.80	43.80	43.80	43.80	43.80	43.80	43.80	43.80	43.80	43.80
JP4	GJ pr tonnes	43.80	43.80	43.80	43.80	43.80	43.80	43.80	43.80	43.80	43.80
Other Kerosene	GJ pr tonnes	43.50	43.50	43.50	43.50	43.50	43.50	43.50	43.50	43.50	43.50
JP1	GJ pr tonnes	43.50	43.50	43.50	43.50	43.50	43.50	43.50	43.50	43.50	43.50
Gas/Diesel Oil	GJ pr tonnes	42.70	42.70	42.70	42.70	42.70	42.70	42.70	42.70	42.70	42.70
Fuel Oil	GJ pr tonnes	40.40	40.40	40.40	40.40	40.40	40.40	40.70	40.65	40.65	40.65
Orimulsion	GJ pr tonnes	27.60	27.60	27.60	27.60	27.60	28.13	28.02	27.72	27.84	27.58
Petroleum Coke	GJ pr tonnes	31.40	31.40	31.40	31.40	31.40	31.40	31.40	31.40	31.40	31.40
Waste Oil	GJ pr tonnes	41.90	41.90	41.90	41.90	41.90	41.90	41.90	41.90	41.90	41.90
White Spirit	GJ pr tonnes	43.50	43.50	43.50	43.50	43.50	43.50	43.50	43.50	43.50	43.50
Bitumen	GJ pr tonnes	39.80	39.80	39.80	39.80	39.80	39.80	39.80	39.80	39.80	39.80
Lubricants	GJ pr tonnes	41.90	41.90	41.90	41.90	41.90	41.90	41.90	41.90	41.90	41.90
Natural Gas	GJ pr 1000 Nm^3	39.00	39.00	39.00	39.30	39.30	39.30	39.30	39.60	39.90	40.00
Town Gas	GJ pr 1000 m^3							17.00	17.00	17.00	17.00
Electricity Plant Coal	GJ pr tonnes	25.30	25.40	25.80	25.20	24.50	24.50	24.70	24.96	25.00	25.00
Other Hard Coal	GJ pr tonnes	26.10	26.50	26.50	26.50	26.50	26.50	26.50	26.50	26.50	26.50
Coke	GJ pr tonnes	31.80	29.30	29.30	29.30	29.30	29.30	29.30	29.30	29.30	29.30
Brown Coal Briquettes	GJ pr tonnes	18.30	18.30	18.30	18.30	18.30	18.30	18.30	18.30	18.30	18.30
Straw	GJ pr tonnes	14.50	14.50	14.50	14.50	14.50	14.50	14.50	14.50	14.50	14.50
Wood Chips	GJ pr Cubic metre	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80
Wood Chips	GJ pr m^3	9.30	9.30	9.30	9.30	9.30	9.30	9.30	9.30	9.30	9.30
Firewood, Hardwood	GJ pr m^3	10.40	10.40	10.40	10.40	10.40	10.40	10.40	10.40	10.40	10.40
Firewood, Conifer	GJ pr tonnes	7.60	7.60	7.60	7.60	7.60	7.60	7.60	7.60	7.60	7.60
Wood Pellets	GJ pr tonnes	17.50	17.50	17.50	17.50	17.50	17.50	17.50	17.50	17.50	17.50
Wood Waste	GJ pr Cubic metre	14.70	14.70	14.70	14.70	14.70	14.70	14.70	14.70	14.70	14.70
Wood Waste	GJ pr 1000 m^3	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20
Biogas	GJ pr tonnes								23.00	23.00	23.00
Wastes	GJ pr tonnes	8.20	8.20	9.00	9.40	9.40	10.00	10.50	10.50	10.50	10.50
Bioethanol	GJ pr tonnes	26.70	26.70	26.70	26.70	26.70	26.70	26.70	26.70	26.70	26.70
Liquid Biofuels		37.60	37.60	37.60	37.60	37.60	37.60	37.60	37.60	37.60	37.60
Fish Oil	GJ pr tonnes	37.20	37.20	37.20	37.20	37.20	37.20	37.20	37.20	37.20	37.20

Continued		2000	2001	2002	2003	2004	2005	2006	2007	2008
Crude Oil, Average	GJ pr tonnes	43.00	43.00	43.00	43.00	43.00	43.00	43.00	43.00	43.00
Crude Oil, Golf	GJ pr tonnes	41.80	41.80	41.80	41.80	41.80	41.80	41.80	41.80	41.80
Crude Oil, North Sea	GJ pr tonnes	43.00	43.00	43.00	43.00	43.00	43.00	43.00	43.00	43.00
Refinery Feedstocks	GJ pr tonnes	42.70	42.70	42.70	42.70	42.70	42.70	42.70	42.70	42.70
Refinery Gas	GJ pr tonnes	52.00	52.00	52.00	52.00	52.00	52.00	52.00	52.00	52.00
LPG	GJ pr tonnes	46.00	46.00	46.00	46.00	46.00	46.00	46.00	46.00	46.00
Naphtha (LVN)	GJ pr tonnes	44.50	44.50	44.50	44.50	44.50	44.50	44.50	44.50	44.50
Motor Gasoline	GJ pr tonnes	43.80	43.80	43.80	43.80	43.80	43.80	43.80	43.80	43.80
Aviation Gasoline	GJ pr tonnes	43.80	43.80	43.80	43.80	43.80	43.80	43.80	43.80	43.80
JP4	GJ pr tonnes	43.80	43.80	43.80	43.80	43.80	43.80	43.80	43.80	43.80
Other Kerosene	GJ pr tonnes	43.50	43.50	43.50	43.50	43.50	43.50	43.50	43.50	43.50
JP1	GJ pr tonnes	43.50	43.50	43.50	43.50	43.50	43.50	43.50	43.50	43.50
Gas/Diesel Oil	GJ pr tonnes	42.70	42.70	42.70	42.70	42.70	42.70	42.70	42.70	42.70
Fuel Oil	GJ pr tonnes	40.65	40.65	40.65	40.65	40.65	40.65	40.65	40.65	40.65
Orimulsion	GJ pr tonnes	27.62	27.64	27.71	27.65	27.65	27.65	27.65	27.65	27.65
Petroleum Coke	GJ pr tonnes	31.40	31.40	31.40	31.40	31.40	31.40	31.40	31.40	31.40
Waste Oil	GJ pr tonnes	41.90	41.90	41.90	41.90	41.90	41.90	41.90	41.90	41.90
White Spirit	GJ pr tonnes	43.50	43.50	43.50	43.50	43.50	43.50	43.50	43.50	43.50
Bitumen	GJ pr tonnes	39.80	39.80	39.80	39.80	39.80	39.80	39.80	39.80	39.80
Lubricants	GJ pr tonnes	41.90	41.90	41.90	41.90	41.90	41.90	41.90	41.90	41.90
Natural Gas	GJ pr 1000 Nm^3	40.15	39.99	40.06	39.94	39.77	39.67	39.54	39.59	39.48
Town Gas	GJ p 1000 m^3	17.01	16.88	17.39	16.88	17.58	17.51	17.20	17.14	17.14
Electricity Plant Coal	GJ pr tonnes	24.80	24.90	25.15	24.73	24.60	24.40	24.80	24.40	24.30
Other Hard Coal	GJ pr tonnes	26.50	26.50	26.50	26.50	26.50	26.50	26.50	26.50	26.50
Coke	GJ pr tonnes	29.30	29.30	29.30	29.30	29.30	29.30	29.30	29.30	29.30
Brown Coal Briquettes	GJ pr tonnes	18.30	18.30	18.30	18.30	18.30	18.30	18.30	18.30	18.30
Straw	GJ pr tonnes	14.50	14.50	14.50	14.50	14.50	14.50	14.50	14.50	14.50
Wood Chips	GJ pr Cubic metre	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80
Wood Chips	GJ pr m^3	9.30	9.30	9.30	9.30	9.30	9.30	9.30	9.30	9.30
Firewood, Hardwood	GJ pr m^3	10.40	10.40	10.40	10.40	10.40	10.40	10.40	10.40	10.40

Continued										
Firewood, Conifer	GJ pr tonnes	7.60	7.60	7.60	7.60	7.60	7.60	7.60	7.60	7.60
Wood Pellets	GJ pr tonnes	17.50	17.50	17.50	17.50	17.50	17.50	17.50	17.50	17.50
Wood Waste	GJ pr Cubic metre	14.70	14.70	14.70	14.70	14.70	14.70	14.70	14.70	14.70
Wood Waste	GJ pr 1000 m^3	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20
Biogas	GJ pr tonnes	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00
Wastes	GJ pr tonnes	10.50	10.50	10.50	10.50	10.50	10.50	10.50	10.50	10.50
Bioethanol	GJ pr tonnes	26.70	26.70	26.70	26.70	26.70	26.70	26.70	26.70	26.70
Liquid Biofuels	GJ pr tonnes	37.60	37.60	37.60	37.60	37.60	37.60	37.60	37.60	37.60
Fish Oil	GJ pr tonnes	37.20	37.20	37.20	37.20	37.20	37.20	37.20	37.20	37.20

Table 3A-3.2 Fuel category correspondence list, DEA, NERI and Climate Convention reportings (IPCC).

Danish Energy Agency	NERI Emission database	IPCC fuel category
Other Hard Coal	Coal	Solid
Coke	Coke oven coke	Solid
Electricity Plant Coal	Coal	Solid
Brown Coal Briquettes	Brown coal briq.	Solid
Orimulsion	Orimulsion	Liquid
Petroleum Coke	Petroleum coke	Liquid
Fuel Oil	Residual oil	Liquid
Waste Oil	Residual oil	Liquid
Gas/Diesel Oil	Gas oil	Liquid
Other Kerosene	Kerosene	Liquid
LPG	LPG	Liquid
Refinery Gas	Refinery gas	Liquid
Town Gas	Natural gas	Gas
Natural Gas	Natural gas	Gas
Straw	Straw	Biomass
Wood Waste	Wood and simil.	Biomass
Wood Pellets	Wood and simil.	Biomass
Wood Chips	Wood and simil.	Biomass
Firewood, Hardwood & Conifer	Wood and simil.	Biomass
Waste Combustion	Municip. wastes	Biomass / Other fuel
Fish Oil	Fish & Rape oil	Biomass
Biogas	Biogas	Biomass
Biogas, other	Biogas	Biomass
Biogas, landfill	Biogas	Biomass
Biogas, sewage sludge	Biogas	Biomass
(Wood applied in gas engines)	Biomass producer gas	Biomass

Annex 3A-4 Emission factors

Table 3A-4.1 CO_2 emission factors 2008.

Fuel	Emission factor kg pr GJ		Reference type	IPCC fuel
	Biomass	Fossil fuel		Category
Coal		95 1)3)	Country specific	Solid
Brown coal briquettes		94.6 2)	IPCC 1996	Solid
Coke oven coke		108	IPCC 1996	Solid
Petroleum coke		92 3)	Country specific	Liquid
Wood	102		EEA 2002	Biomass
Municipal waste	79.6 3)4)	+ 32.5 3)4)	Country specific	Biomass and Other fuels
Straw	102		EEA 2002	Biomass
Residual oil		78 1)3)	EEA 2007	Liquid
Gas oil		74 1)	EEA 2007	Liquid
Kerosene		72	IPCC 1996	Liquid
Fish & rape oil	74		Country specific	Biomass
Orimulsion		80 2)	Country specific	Liquid
Natural gas		56.77	Country specific	Gas
LPG		65	EEA 2007	Liquid
Refinery gas		56.9	Country specific	Liquid
Biogas	83.6		Country specific	Biomass
Biomass producer gas	102 5)		Country specific	Biomass

1) Plant specific data from EU ETS incorporated for individual plants.

2) Not applied in 2008.

3) Plant specific data from EU ETS incorporated for cement production.

4) The emission factor for municipal waste is (76.6+32.5) kg CO_2 pr GJ municipal waste. The fuel consumption and the CO_2 emission have been disaggregated to the two IPCC fuel categories *Biomass* and *Other fuels* in CRF. The IEF for CO_2, Other fuels is 78.88 kg CO_2 pr GJ fossil municipal waste.

5) The CO_2 emission factor for wood has been applied. However the composition of the gas is well-known and the emission factor will be recalculated.

Time-series for natural gas and municipal waste are shown below. All other emission factors are the same for 1990-2008.

Table 3A-4.2 CO_2 emission factors, time-series.

Year	Natural gas, kg pr GJ	Municipal waste, plastic part, kg pr GJ	Municipal waste biomass part, kg pr GJ
1990	56.9	25.4	86.7
1991	56.9	25.4	86.7
1992	56.9	27.9	84.2
1993	56.9	29.1	83.0
1994	56.9	29.1	83.0
1995	56.9	31.0	81.1
1996	56.9	32.5	79.6
1997	56.9	32.5	79.6
1998	56.9	32.5	79.6
1999	56.9	32.5	79.6
2000	57.1	32.5	79.6
2001	57.25	32.5	79.6
2002	57.28	32.5	79.6
2003	57.19	32.5	79.6
2004	57.12	32.5	79.6
2005	56.96	32.5	79.6
2006	56.78	32.5	79.6
2007	56.78	32.5	79.6
2008	56.77	32.5	79.6

Table 3A-4.3 CH_4 emission factors and references 2008.

Fuel group	Fuel	CRF source category	CRF source category	SNAP	Emission factor, g pr GJ	Reference
BIOMASS	WOOD	1A1a	Electricity and heat production	010102, 010103, 010104	3.1	Nielsen et al. 2010c
				010202, 010203	32	EEA 2007
		1A2	Industry	030100, 030102	32	EEA 2007
		1A4a	Commercial/Institutional	020100	200	EEA 2007
		1A4b i	Residential	020200	200	EEA 2007
		1A4c i	Agriculture/Forestry	020300	200	EEA 2007
	STRAW	1A1a	Electricity and heat production	010101, 010102, 010103, 010104	0.47	Nielsen et al. 2010c
				010202, 010203	32	EEA 2007
		1A4b i	Residential	020200	200	EEA 2007
		1A4c i	Agriculture/Forestry	020300	200	EEA 2007
	FISH & RAPE OIL	1A1a	Electricity and heat production	010101, 010102, 010103, 010202, 010203	1.5	EEA 2007, assuming same emission factor as for gas oil
		1A2	Industry	030105	1.5	EEA 2007, assuming same emission factor as for gas oil
		1A4b i	Residential	020200	1.5	EEA 2007, assuming same emission factor as for gas oil
	BIOGAS	1A1a	Electricity and heat production	010102, 010103, 010203	4	EEA 2007
				010105, 010205	434	Nielsen et al. 2010c
		1A2	Industry	030100, 030102, 030103	4	EEA 2007
				030105	434	Nielsen et al. 2010c
		1A4a	Commercial/Institutional	020100, 020103	4	EEA 2007
				020105	434	Nielsen et al. 2010c
		1A4c i	Agriculture/Forestry	020300	4	EEA 2007
				020304	434	Nielsen et al. 2010c
	BIO PROD GAS	1A1a	Electricity and heat production	010105	13	Nielsen et al. 2010c
		1A2	Industry	030105	13	Nielsen et al. 2010c
		1A4a	Commercial/Institutional	020105	13	Nielsen et al. 2010c
OTHER 1	MUNICIP. WASTES	1A1a	Electricity and heat production	010102, 010103	0.34	Nielsen et al. 2010c
				010203	6	EEA 2007
		1A2	Industry	030102	6	EEA 2007
		1A4a	Commercial/Institutional	020103	6	EEA 2007
GAS	NATURAL GAS	1A1a	Electricity and heat production	010101, 010102, 010202	6	DGC 2001
				010103, 010203	15	Gruijthuijsen & Jensen 2000
				010104 (Gas turbines)	1.7	Nielsen et al. 2010c
				010105, 010205 (Gas engines)	481	Nielsen et al. 2010c
		1A1c	Other energy industries	010504 (Gas turbines)	1.5	Nielsen & Illerup 2003
				010505 (Gas engines)	481	Nielsen et al. 2010c
		1A2	Industry	030100	6	DGC 2001
				030103	15	Gruijthuijsen & Jensen 2000
				030104 (Gas turbines)	1.7	Nielsen et al. 2010c
				030105 (Gas engines)	481	Nielsen et al. 2010c
		1A4a	Commercial/Institutional	020100	6	DGC 2001
				020103	15	Gruijthuijsen & Jensen 2000
				020105 (Gas engines)	481	Nielsen et al. 2010c
		1A4b i	Residential	020200	6	DGC 2001
				020202	15	Gruijthuijsen & Jensen 2000
				020204 (Gas engines)	481	Nielsen et al. 2010c
		1A4c i	Agriculture/Forestry	020300	6	DGC 2001
				020303 (Gas turbines)	1.7	Nielsen et al. 2010c
				020304 (Gas engines)	481	Nielsen et al. 2010c
LIQUID	PETROLEUM COKE	1A4a	Commercial/Institutional	020100	15	EEA 2007
		1A4b i	Residential	020200	15	EEA 2007
	RESIDUAL OIL	1A1a	Electricity and heat production	010101, 010104, 010202, 010203	3	EEA 2007
				010102, 010203	1.3	Nielsen et al. 2010c
		1A1b	Petroleum refining	010306	3	EEA 2007
		1A2	Industry	030100, 030105	3	EEA 2007
				030102, 030103	1.3	Nielsen et al. 2010c
		1A4a	Commercial/Institutional	020100	3	EEA 2007
		1A4b i	Residential	020200	3	EEA 2007
		1A4c i	Agriculture/Forestry	020300, 020302	3	EEA 2007
	GAS OIL	1A1a	Electricity and heat production	010101, 010102, 010103, 010104, 010201, 010202, 010203	1.5	EEA 2007
				010105, 010205	24	Nielsen et al. 2010c
		1A1b	Petroleum refining	010306	1.5	EEA 2007
		1A2	Industry	030100, 030102, 030103, 030104	1.5	EEA 2007
				030105	24	Nielsen et al. 2010c
		1A4a	Commercial/Institutional	020100, 020103	1.5	EEA 2007
				020105	24	Nielsen et al. 2010c
		1A4b i	Residential	020200	1.5	EEA 2007
				020105	24	Nielsen et al. 2010c
	KEROSENE	1A2	Industry	030100	7	EEA 2007
		1A4a	Commercial/Institutional	020100	7	EEA 2007
		1A4b i	Residential	020200	7	EEA 2007
		1A4c i	Agriculture/Forestry	020300	7	EEA 2007

Fuel group	Fuel	CRF source category	CRF source category	SNAP	Emission factor, g pr GJ	Reference
	LPG	1A1a	Electricity and heat production	010102, 010203	1	EEA 2007
		1A2	Industry	030100	1	EEA 2007
		1A4a	Commercial/Institutional	020100, 020105	1	EEA 2007
		1A4b i	Residential	020200	1	EEA 2007
		1A4c i	Agriculture/Forestry	020300	1	EEA 2007
	REFINERY GAS	1A1b	Petroleum refining	010304, 010306	1.5	EEA 2007
SOLID	COAL	1A1a	Electricity and heat production	010101, 010102, 010103	1.5	EEA 2007
		1A2	Industry	030100	15	EEA 2007
		1A4b i	Residential	020200	15	EEA 2007
		1A4c i	Agriculture/Forestry	020300	15	EEA 2007
	COKE OVEN COKE	1A2	Industry	030100	15	EEA 2007, assuming same emission factor as for coal
		1A4b i	Residential	020200	15	EEA 2007, assuming same emission factor as for coal

Time-series for CH_4 emission factors for gas engines and MSW incineration plants are shown below. All other CH_4 emission factors are the same for 1990-2008.

Table 3A-4.4 CH_4 emission factors, time-series.

Year	Natural gas fuelled engines Emission factor, g pr GJ	Biogas fuelled engines Emission factor, g pr GJ	MSW Incineration g pr GJ
1990	266	239	0.59
1991	309	251	0.59
1992	359	264	0.59
1993	562	276	0.59
1994	623	289	0.59
1995	632	301	0.59
1996	616	305	0.59
1997	551	310	0.59
1998	542	314	0.59
1999	541	318	0.59
2000	537	323	0.59
2001	522	342	0.59
2002	508	360	0.59
2003	494	379	0.59
2004	479	397	0.51
2005	465	416	0.42
2006	473	434	0.34
2007	481	434	0.34
2008	481	434	0.34

Table 3A-4.5 N_2O emission factors and references 2008.

Fuel group	Fuel	CRF source category	CRF source category	SNAP	Emission factor g pr GJ	Reference
BIOMASS	WOOD	1A1a	Electricity and heat production	010102, 010103, 010104 010202, 010203	0.8 4	Nielsen et al. 2010c EEA 2007
		1A2	Industry	all	4	EEA 2007
		1A4a	Commercial/Institutional	020100	4	EEA 2007
		1A4b i	Residential	020200	4	EEA 2007
		1A4c i	Agriculture/Forestry	020300	4	EEA 2007
	STRAW	1A1a	Electricity and heat production	010101, 010102, 010103, 010104 010202, 010203	1.1 4	Nielsen et al. 2010c EEA 2007
		1A4b i	Residential	020200	4	EEA 2007
		1A4c i	Agriculture/Forestry	020300	4	EEA 2007
	FISH & RAPE OIL	1A1a	Electricity and heat production	All	2	EEA 2007, assuming same emission factor as gas oil
		1A2	Industry	030105	2	EEA 2007, assuming same emission factor as gas oil
		1A4b i	Residential	020200	2	EEA 2007, assuming same emission factor as gas oil
	BIOGAS	1A1a	Electricity and heat production	010102, 010103, 010203 010105, 010205 (Gas engines)	2 1.6	EEA 2007 Nielsen et al. 2010c
		1A2	Industry	030100, 030102, 030103 030105 (Gas engines)	2 1.6	EEA 2007 Nielsen et al. 2010c
		1A4a	Commercial/Institutional	020100, 020103 020105 (Gas engines)	2 1.6	EEA 2007 Nielsen et al. 2010c
		1A4c i	Agriculture/Forestry	020300 020304 (Gas engines)	2 1.6	EEA 2007 Nielsen et al. 2010c
	BIO PROD GAS	1A1a	Electricity and heat production	010105	2.7	Nielsen et al. 2010c
		1A2	Industry	030105	2.7	Nielsen et al. 2010c
		1A4a	Commercial/Institutional	020105	2.7	Nielsen et al. 2010c
OTHER 1	MUNICIP. WASTES	1A1a	Electricity and heat production	010102, 010103	1.2	Nielsen et al. 2010c
				010203	4	EEA 2007
		1A2	Industry	030102	4	EEA 2007
		1A4a	Commercial/Institutional	020103	4	EEA 2007
GAS	NATURAL GAS	1A1a	Electricity and heat production	010101, 010102, 010103, 010202, 010203	1	EEA 2007
				010104 (Gas turbines)	1	Nielsen et al. 2010c
				010105, 010205 (Gas engines)	0.58	Nielsen et al. 2010c
		1A1c	Other energy industries	010504 (Gas turbines)	2.2	Nielsen & Illerup 2003
				010505 (Gas engines)	0.58	Nielsen et al. 2010c
		1A2	Industry	030100, 030103	1	EEA 2007
				030104 (Gas turbines)	1	Nielsen et al. 2010c
				030105 (Gas engines)	0.58	Nielsen et al. 2010c
		1A4a	Commercial/Institutional	020100, 020103	1	EEA 2007
				020105 (Gas engines)	0.58	Nielsen et al. 2010c
		1A4b i	Residential	020200, 020202	1	EEA 2007
				020204 (Gas engines)	0.58	Nielsen et al. 2010c
		1A4c i	Agriculture/Forestry	020300, 020303	1	EEA 2007
				020303 (Gas turbines)	1	Nielsen et al. 2010c
				020304 (Gas engines)	0.58	Nielsen et al. 2010c
LIQUID	PETROLEUM COKE	1A4a	Commercial/Institutional	020100	3	EEA 2007
		1A4b i	Residential	020200	3	EEA 2007
	RESIDUAL OIL	1A1a	Electricity and heat production	010101, 010104, 010202, 010203	2	EEA 2007
				010102, 010103	5	Nielsen et al. 2010c
		1A1b	Petroleum refining	010306	2	EEA 2007
		1A2	Industry	030100, 030105	2	EEA 2007
				030102, 030103	5	Nielsen et al. 2010c
		1A4a	Commercial/Institutional	020100	2	EEA 2007
		1A4b i	Residential	020200	2	EEA 2007
		1A4c i	Agriculture/Forestry	020300, 020302	2	EEA 2007
	GAS OIL	1A1a	Electricity and heat production	010101, 010102, 010103, 010104, 010201, 010202, 010203	2	EEA 2007
				010105, 020105 (Engines)	2.1	Nielsen et al. 2010c
		1A1b	Petroleum refining	010306	2	EEA 2007
		1A1c	Other energy industries	010505	2	EEA 2007
		1A2	Industry	030100, 030102, 030103, 030104	2	EEA 2007
				030105 (Engines)	2.1	Nielsen et al. 2010c
		1A4a	Commercial/Institutional	020100, 020103	2	EEA 2007
				020105 (Engines)	2.1	Nielsen et al. 2010c
		1A4b i	Residential	020200	2	EEA 2007
				020104 (Engines)	2.1	
	KEROSENE	1A2	Industry	030100	2	EEA 2007
		1A4a	Commercial/Institutional	020100	2	EEA 2007
		1A4b i	Residential	020200	2	EEA 2007
		1A4c i	Agriculture/Forestry	020300	2	EEA 2007
	LPG	1A1a	Electricity and heat production	010102, 010203	2	EEA 2007
		1A2	Industry	030100	2	EEA 2007
		1A4a	Commercial/Institutional	020100, 020105	2	EEA 2007

Fuel group	Fuel	CRF source category	CRF source category	SNAP	Emission factor g pr GJ	Reference
		1A4b i	Residential	020200	2	EEA 2007
		1A4c i	Agriculture/Forestry	020300	2	EEA 2007
	REFINERY GAS	1A1b	Petroleum refining	010304, 010306	2.2	Nielsen & Illerup 2003, assuming same emission factor as for natural gas
SOLID	COAL	1A1a	Electricity and heat production	010101, 010102, 010103	0.8	Elsam 2005
		1A2	Industry	030100	3	EEA 2007
		1A4b i	Residential	020200	3	EEA 2007
		1A4c i	Agriculture/Forestry	020300	3	EEA 2007
	COKE OVEN COKE	1A2	Industry	030100	3	EEA 2007
		1A4b i	Residential	020200	3	EEA 2007

Time-series have been estimated for natural gas fuelled gas turbines. All other N_2O emission factors have been applied unchanged for 1990-2008.

Table 3A-4.6 N_2O emission factors, time-series.

Year	Natural gas fuelled gas turbines Emission factor, g pr GJ
1990	2.2
1991	2.2
1992	2.2
1993	2.2
1994	2.2
1995	2.2
1996	2.2
1997	2.2
1998	2.2
1999	2.2
2000	2.2
2001	2.0
2002	1.9
2003	1.7
2004	1.5
2005	1.4
2006	1.2
2007	1.0
2008	1.0

Table 3A-4.7 SO_2, NO_x, NMVOC and CO emission factors and references 2008.

					SO_2		NO_x		NMVOC		CO	
Fuel type	Fuel	NFR	NFR_name	snap	g/GJ	Ref.	g/GJ	Ref.	g/GJ	Ref.	g/GJ	Ref.
BIOMASS	WOOD	1A1a	Electricity and heat production	010102	1.9	12	81	12	5.1	12	90	12
				010103	1.9	12	81	12	5.1	12	90	12
				010104	1.9	12	81	12	5.1	12	90	12
				010202	25	22, 21	90	22, 21, 4	7.3	13	240	4
				010203	25	22, 21	90	22, 21, 4	7.3	13	240	4
		1A2	Industry	030100	25	22, 21	90	22, 21, 4	10	13	240	4
				030102	25	22, 21	90	22, 21, 4	10	13	240	4
		1A4a	Commercial/ Institutional	020100	25	22, 21	90	22, 21, 4	146	13	240	4
		1A4b i	Residential	020200	25	22, 21	120	22	476	39	3353	39
		1A4c i	Agriculture/ Forestry	020300	25	22, 21	90	22, 21, 4	146	13	240	4
	STRAW	1A1a	Electricity and heat production	010101	49	12	125	12	0.78	12	67	12
				010102	49	12	125	12	0.78	12	67	12
				010103	49	12	125	12	0.78	12	67	12
				010104	49	12	125	12	0.78	12	67	12
				010202	130	5	90	4, 28	7.3	13	325	4, 5
				010203	130	5	90	4, 28	7.3	13	325	4, 5
		1A4b i	Residential	020200	130	5	90	4, 28	400	13	4000	1, 6, 7
		1A4c i	Agriculture/ Forestry	020300	130	5	90	4, 28	146	13	4000	1, 6, 7
	FISH & RAPE OIL	1A1a	Electricity and heat production	010101	1	37	220	38	0.8	13	15	15
				010102	1	37	220	38	0.8	13	15	15
				010103	1	37	220	38	0.8	13	15	15
				010202	1	37	65	15	0.8	13	15	15
				010203	1	37	65	15	0.8	13	15	15
		1A2	Industry	030105	1	37	700	15	37	13	100	15
		1A4b i	Residential	020200	1	37	700	15	100	15	100	15
	BIOGAS	1A1a	Electricity and heat production	010102	25	26	28	4	2	16	36	4
				010103	25	26	28	4	2	16	36	4
				010105	19.2	31	202	12	10	12	310	12
				010203	25	26	28	4	2	16	36	4
				010205	19.2	31	202	12	10	12	310	12
		1A2	Industry	030100	25	26	28	4	2	16	36	4
				030102	25	26	59	4	2	16	36	4
				030103	25	26	59	4	(4)[1]	16	36	4
				030105	19.2	31	202	12	10	12	310	12
		1A4a	Commercial/ Institutional	020100	25	26	28	4	2	16	36	4
				020103	25	26	28	4	2	16	36	4
				020105	19.2	31	202	12	10	12	310	12
		1A4c i	Agriculture/ Forestry	020300	25	26	28	4	2	16	36	4
				020304	19.2	31	202	12	10	12	310	12
	BIO PROD GAS	1A1a	Electricity and heat production	010105	1.9	12	173	12	2	12	586	12
		1A2	Industry	030105	1.9	12	173	12	2	12	586	12
		1A4a	Commercial/ Institutional	020105	1.9	12	173	12	2	12	586	12
WASTE	MUNICIP. WASTES	1A1a	Electricity and heat production	010102	8.3	12	102	12	0.56	12	3.9	12
				010103	8.3	12	102	12	0.56	12	3.9	12
				010203	15	34	164	9	2	13	10	9
		1A2	Industry	030102	15	34	164	9	2	13	10	9
		1A4a	Commercial/ Institutional	020103	15	34	164	9	2	13	10	9
GAS	NATURAL GAS	1A1a	Electricity and heat production	010101	0.3	17	97	9	2	14	15	3
				010102	0.3	17	97	9	2	14	15	3
				010103	0.3	17	42	9	2	14	28	4
				010104	0.3	17	48	12	1.6	12	4.8	12
				010105	0.3	17	135	12	92	12	58	12
				010202	0.3	17	42	36	2	14	28	4
				010203	0.3	17	42	36	2	14	28	4
				010205	0.3	17	135	12	92	12	58	12
		1A1c	Other energy industries	010504	0.3	17	250	1, 8, 32	1.4	31	6.2	31
				010505	0.3	17	135	12	92	12	58	12
		1A2	Industry	030100	0.3	17	42	36	2	14	28	4
				030103	0.3	17	42	36	2	14	28	4
				030104	0.3	17	48	12	1.6	12	4.8	12
				030105	0.3	17	135	12	92	12	58	12
		1A4a	Commercial/ Institutional	020100	0.3	17	30	1,4,11	2	14	28	4
				020103	0.3	17	30	1,4,11	2	14	28	4
				020105	0.3	17	135	12	92	12	58	12
		1A4b i	Residential	020200	0.3	17	30	1,4,11	4	11	20	11
				020202	0.3	17	30	1,4,11	4	11	20	11
				020204	0.3	17	135	12	92	12	58	12
		1A4c i	Agriculture/ Forestry	020300	0.3	17	30	1,4,11	2	14	28	4
				020303	0.3	17	48	12	1.6	12	4.8	12
				020304	0.3	17	135	12	92	12	58	12
LIQUID	PETROLEUM COKE	1A4a	Commercial/ Institutional	020100	605	20	50	1	88.8	13	1000	1
		1A4b i	Residential	020200	605	20	50	1	484	13	1000	1
	RESIDUAL OIL	1A1a	Electricity and heat production	010101	82	18	1717	18	2.3	13	15	3
				010102	82	18	1717	18	0.8	12	2.8	12
				010103	82	18	1717	18	0.8	12	2.8	12
				010104	82	18	1717	18	2.3	13	15	3
				010202	344	25,10, 24	142	4	2.3	13	30	1
				010203	344	25,10, 24	142	4	2.3	13	30	1
		1A1b	Petroleum refining	010306	537	33	142	4	2.3	13	30	1

[1] Error. Should have been 2 g pr.GJ

Fuel type	Fuel	NFR	NFR_name	snap	SO_2 g/GJ	Ref.	NO_x g/GJ	Ref.	NMVOC g/GJ	Ref.	CO g/GJ	Ref.
		1A2	Industry	030100	344	25,10, 24	130	28	10	13	30	1
				030102	344	25,10, 24	136	12	0.8	12	2.8	12
				030103	344	25,10, 24	136	12	0.8	12	2.8	12
				030105	344	25,10, 24	130	28	10	13	100	1
		1A4a	Commercial/ Institutional	020100	344	25,10, 24	142	4	5	13	30	1
		1A4b i	Residential	020200	344	25,10, 24	142	4	15	13	30	1
		1A4c i	Agriculture/ Forestry	020300	344	25,10, 24	142	4	5	13	30	1
				020302	344	25,10, 24	142	4	5	13	30	1
	GAS OIL	1A1a	Electricity and heat production	010101	23	27	249	18	0.8	13	15	3
				010102	23	27	249	18	0.8	13	15	3
				010103	23	27	65	28	0.8	13	15	3
				010104	23	27	350	9	0.2	13	15	3
				010105	23	27	942	12	37	13	130	12
				010201	23	27	65	28	0.8	13	30	1
				010202	23	27	65	28	0.8	13	30	1
				010203	23	27	65	28	0.8	13	30	1
				010205	23	27	942	12	37	13	130	12
		1A1b	Petroleum refining	010306	23	27	65	28	0.8	13	30	1
		1A2	Industry	030100	23	27	65	28	10	13	30	1
				030102	23	27	65	28	5	13	30	1
				030103	23	27	65	28	10	13	30	1
				030104	23	27	350	9	0.2	13	15	3
				030105	23	27	942	12	37	13	130	12
		1A4a	Commercial/ Institutional	020100	23	27	52	4	5	13	30	1
				020103	23	27	52	4	5	13	30	1
				020105	23	27	942	12	37	13	130	12
		1A4b i	Residential	020200	23	27	52	4	15	13	43	1
				020204	23	27	942	12	37	13	130	12
	KEROSENE	1A2	Industry	030100	5	30	50	1	10	13	20	1
		1A4a	Commercial/ Institutional	020100	5	30	50	1	5	13	20	1
		1A4b i	Residential	020200	5	30	50	1	15	13	20	1
		1A4c i	Agriculture/ Forestry	020300	5	30	50	1	5	13	20	1
	LPG	1A1a	Electricity and heat production	010102	0.13	23	96	32	0.8	13	25	1
				010203	0.13	23	96	32	0.8	13	25	1
		1A2	Industry	030100	0.13	23	96	32	5	13	25	1
		1A4a	Commercial/ Institutional	020100	0.13	23	71	32	5	13	25	1
				020105	0.13	23	71	32	5	13	25	1
		1A4b i	Residential	020200	0.13	23	47	32	10	13	25	1
		1A4c i	Agriculture/ Forestry	020300	0.13	23	71	32	5	13	25	1
	REFINERY GAS	1A1b	Petroleum refining	010304	1	2	170	9	1.4	35	6.2	35
				010306	1	2	80	40	1.4	35	6.2	35
SOLID	COAL	1A1a	Electricity and heat production	010101	26	18	59	18	1.2	13	10	3
				010102	26	18	59	18	1.2	13	10	3
				010103	26	18	59	18	1.2	13	10	3
		1A2	Industry	030100	574	19	95	4	10	13	10	3
		1A4b i	Residential	020200	574	19	95	4	484	13	2000	32
		1A4c i	Agriculture/ Forestry	020300	574	19	95	4	88.8	13	931	13
	COKE OVEN COKE	1A2	Industry	030100	574	19	95	4	10	13	10	29
		1A4b i	Residential	020200	574	19	95	4	484	13	2000	29

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40. NERI calculation based on plant specific data.

Table 3A-4.8 SO_2, NO_x, NMVOC and CO emission factors time-series, g pr GJ.

pol_abbr	fuel_type	fuel_gr_abbr	nfr_id_EA	nfr_name	snap_id	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
SO_2	LIQUID	GAS OIL	1A1a	Electricity and heat production	010101					94	23	23	23	23	23
					010102					94	23	23	23	23	23
					010103					94	23	23	23	23	23
					010104	94	94	94	94	94	23	23	23	23	23
					010105	94	94	94	94	94	23	23	23	23	23
					010201					94	23				
					010202					94	23	23	23	23	23
					010203					94	23	23	23	23	23
					010205					94					23
			1A1b	Petroleum refining	010306		94	94	94	94	23	23	23		
			1A2	Industry	030100	94	94	94	94	94	23	23	23	23	23
					030103					94	23	23	23	23	23
					030105			94	94	94					
					030106	94	94	94	94	94	23	23	23	23	23
			1A4a	Commercial/ Institutional	020100	94	94	94	94	94	23	23	23	23	23
					020102					94		23		23	
					020103					94		23	23	23	23
					020105			94	94	94	23	23	23	23	23
			1A4b i	Residential	020200	94	94	94	94	94	23	23	23	23	23
			1A4c i	Agriculture/ Forestry	020300	94	94	94	94	94	23	23	23	23	23
		ORIMULSION	1A1a	Electricity and heat production	010101							147	149		
		PETROLEUM COKE	1A2	Industry	030100	787		787	787		787	787	787	787	787
			1A4a	Commercial/ Institutional	020100	787	787	787	787	787	787	787	787	787	787
			1A4b i	Residential	020200	787	787	787	787	787	787	787	787	787	787
			1A4c i	Agriculture/ Forestry	020300	787	787	787	787		787	787	787	787	787
		REFINERY GAS	1A1b	Petroleum refining	010306	190	190	190	190						
		RESIDUAL OIL	1A1a	Electricity and heat production	010100	446	470	490	475						
					010101						351	408	344	369	369
					010102	446	470	490	475	1564	351	408	344	369	369
					010103					1564	351	408	344	369	369
					010104					1564	351	408	344	369	369
					010105	446	470	490	475	1564	351	408	344	369	369
					010202					495	495	495	344	344	344
					010203					495	495	495	344	344	344
			1A1b	Petroleum refining	010306	643	38	222	389				537	537	537
			1A2	Industry	030100	495	495	495	495	495	495	495	344	344	344
					030102					495	495	495	344	344	344
					030103					495	495	495	344	344	344
			1A4a	Commercial/ Institutional	020100	495	495	495	495	495	495	495	344	344	344
			1A4b i	Residential	020200	495	495	495	495	495	495	495	344	344	344
			1A4c i	Agriculture/ Forestry	020300	495	495	495	495	495	495	495	344	344	344
	SOLID	COAL	1A1a	Electricity and heat production	010100	506	571	454	386						
					010101	506	571	454	386	343	312	420	215	263	193

						1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
					010102	506	571	454	386	343	312	420	215	263	193
					010103					343	312	420	215	263	193
					010104					343	312	420	215		
	WASTE	MUNICIP. WASTES	1A1a	Electricity and heat production	010100	138	116	95	73						
					010102					52	30			26	25
					010103					52	30	29	28	26	25
					010104					52	30	29	28	26	25
					010200	138	131	124	117						
					010202					110	103				
					010203					110	103	95	88	81	74
			1A2	Industry	030100	138	131	124	117	110	103	95	88	81	74
					030102										
			1A4a	Commercial/ Institutional	020100	138	131	124	117	110	103	95	88	81	74
					020103					110	103	95	88	81	74
NOX	BIOMASS	BIOGAS	1A1a	Electricity and heat production	010105	711	696	681	665	650	635	616	597	578	559
					010205					650					
			1A1c	Other energy industries	010505	711	696	681	665	650	635	616	597	578	559
			1A2	Industry	030105									578	559
			1A4a	Commercial/ Institutional	020105	711	696	681	665	650	635	616	597	578	559
			1A4c i	Agriculture/ Forestry	020304	711	696	681	665	650	635	616	597	578	559
		FISH & RAPE OIL	1A1a	Electricity and heat production	010200	100	95	90	85						
					010203					80	75	70	65	65	65
		WOOD	1A1a	Electricity and heat production	010202					130	130	130	130	130	90
					010203					130	130	130	130	130	90
			1A2	Industry	030100	130	130	130	130	130	130	130	130	130	90
					030102									130	90
					030103					130	130	130	130	130	90
			1A4a	Commercial/ Institutional	020100	130	130	130	130	130	130	130	130	130	90
					020105									130	90
			1A4c i	Agriculture/ Forestry	020300	130	130	130	130	130	130	130	130	130	90
					020304									130	90
	GAS	NATURAL GAS	1A1a	Electricity and heat production	010100								115	115	115
					010101					115			115		
					010102					115	115			115	115
					010104	161	157	153	149	145	141	138	134	131	127
					010105	276	241	235	214	199	194	193	170	167	167
					010205					199	194	193	170	167	167
			1A1c	Other energy industries	010505	276	241	235	214	199	194	193	170	167	167
			1A2	Industry	030104	161				145	141	138	134	131	127
					030105	276	241	235	214	199	194	193	170	167	167
			1A4a	Commercial/ Institutional	020104					145	141	138	134	131	127
					020105	276	241	235	214	199	194	193	170	167	167
			1A4b i	Residential	020204		241	235	214	199	194	193	170	167	167
			1A4c i	Agriculture/ Forestry	020303							138	134	131	127
					020304	276	241	235	214	199	194	193	170	167	167
	LIQUID	GAS OIL	1A1a	Electricity and heat production	010103					80	75	65	65	65	65

						1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
					010105	1450	1399	1348	1298	1247	1196	1145	1094	1044	993
					010200	100	95	90	85						
					010201					80	75				
					010202					80	75	70	65	65	65
					010203					80	75	70	65	65	65
					010205					1247					993
			1A1b	Petroleum refining	010306		95	90	85	80	75	70	65		
			1A2	Industry	030100	100	95	90	85	80	75	70	65	65	65
					030102						75			65	65
					030103					80	75	70	65	65	65
					030105			1348	1298	1247					
					030106	100	95	90	85	80	75	70	65	65	65
			1A4a	Commercial/ Institutional	020105			1348	1298	1247	1196	1145	1094	1044	993
			1A4c i	Agriculture/ Forestry	020304							1145	1094		
		ORIMULSION	1A1a	Electricity and heat production	010101							139	138		
		PETROLEUM COKE	1A2	Industry	030100	200		200	200		200	200	200	200	200
		REFINERY GAS	1A1b	Petroleum refining	010306	100	100	100	100						
		RESIDUAL OIL	1A1a	Electricity and heat production	010100	342	384	294	289						
					010101						239	250	200	177	152
					010102	342	384	294	289	267	239	250	200	177	152
					010103					267	239	250	200	177	152
					010104					267	239	250	200	177	152
					010105	342	384	294	289	267	239	250	200	177	152
	SOLID	BROWN COAL BRI.	1A4b i	Residential	020200	200	200	200	200	200	200	200	200	200	200
		COAL	1A1a	Electricity and heat production	010100	342	384	294	289						
					010101	342	384	294	289	267	239	250	200	177	152
					010102	342	384	294	289	267	239	250	200	177	152
					010103					267	239	250	200	177	152
					010104					267	239	250	200		
					010202					200	200	200	200	200	200
					010203					200	200	200	200	200	200
			1A2	Industry	030100	200	200	200	200	200	200	200	200	200	200
			1A4a	Commercial/ Institutional	020100	200	200	200	200	200	200	200	200	200	
			1A4b i	Residential	020200	200	200	200	200	200	200	200	200	200	200
			1A4c i	Agriculture/ Forestry	020300	200	200	200	200	200	200	200	200	200	200
		COKE OVEN COKE	1A2	Industry	030100	200	200	200	200	200	200	200	200	200	200
			1A4b i	Residential	020200	200	200	200	200	200	200	200	200	200	200
	WASTE	MUNICIP. WASTES	1A1a	Electricity and heat production	010102					134	134			134	129
					010103					134	134	134	134	134	129
					010104					134	134	134	134	134	129
NMVOC	BIOMASS	BIOGAS	1A1a	Electricity and heat production	010105	14	14	14	14	14	14	14	14	14	14
					010205					14					
			1A1c	Other energy industries	010505	14	14	14	14	14	14	14	14	14	14
			1A2	Industry	030105									14	14
			1A4a	Commercial/ Institutional	020105	14	14	14	14	14	14	14	14	14	14

						1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
			1A4c i	Agriculture/ Forestry	020304	14	14	14	14	14	14	14	14	14	14
		STRAW	1A2	Industry	030100									37	24
			1A4b i	Residential	020200	925	872.5	820	767	715	663	610	558	505	453
		WOOD	1A2	Industry	030100	146	132	119	105	92	78	64	51	37	24
					030103					92	78	64	51	37	24
			1A4b i	Residential	020200	650	650	650	650	650	650	650	650	650	650
	GAS	NATURAL GAS	1A1a	Electricity and heat production	010104	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4
					010105	60	69	81	127	140	142	138	124	122	122
					010205					140	142	138	124	122	122
			1A1c	Other energy industries	010505	60	69	81	127	140	142	138	124	122	122
			1A2	Industry	030104	1.4				1.4	1.4	1.4	1.4	1.4	1.4
					030105	60	69	81	127	140	142	138	124	122	122
			1A4a	Commercial/ Institutional	020104					1.4	1.4	1.4	1.4	1.4	1.4
					020105	60	69	81	127	140	142	138	124	122	122
			1A4b i	Residential	020204		69	81	127	140	142	138	124	122	122
			1A4c i	Agriculture/ Forestry	020303							1.4	1.4	1.4	1.4
					020304	60	69	81	127	140	142	138	124	122	122
	LIQUID	REFINERY GAS	1A1b	Petroleum refining	010306	4	4	4	4						
	WASTE	MUNICIP. WASTES	1A1a	Electricity and heat production	010102					0.98	0.98			0.98	0.98
					010103					0.98	0.98	0.98	0.98	0.98	0.98
					010104					0.98	0.98	0.98	0.98	0.98	0.98
CO	BIOMASS	BIOGAS	1A1a	Electricity and heat production	010105	230	234	239	243	248	252	256	260	265	269
					010205					248					
			1A1c	Other energy industries	010505	230	234	239	243	248	252	256	260	265	269
			1A2	Industry	030105									265	269
			1A4a	Commercial/ Institutional	020105	230	234	239	243	248	252	256	260	265	269
			1A4c i	Agriculture/ Forestry	020304	230	234	239	243	248	252	256	260	265	269
		STRAW	1A1a	Electricity and heat production	010200	600	554	508	463						
					010202					417	371	325	325	325	325
					010203					417	371	325	325	325	325
			1A4b i	Residential	020200	8500	8500	8500	8500	8500	7500	6500	5500	4500	4000
			1A4c i	Agriculture/ Forestry	020300	8500	8500	8500	8500	8500	7500	6500	5500	4500	4000
		WOOD	1A1a	Electricity and heat production	010200	400	373	347	320						
					010202					293	267	240	240	240	240
					010203					293	267	240	240	240	240
			1A2	Industry	030100	400	373	347	320	293	267	240	240	240	240
					030103					293	267	240	240	240	240
			1A4a	Commercial/ Institutional	020100	400	373	347	320	293	267	240	240	240	240
			1A4b i	Residential	020200	4146	4146	4146	4146	4146	4146	4146	4146	4146	4146
			1A4c i	Agriculture/ Forestry	020300	400	373	347	320	293	267	240	240	240	240
	GAS	NATURAL GAS	1A1a	Electricity and heat production	010104	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2
					010105	189	211	212	227	226	222	221	182	182	182
					010205					226	222	221	182	182	182
			1A1c	Other energy industries	010505	189	211	212	227	226	222	221	182	182	182
			1A2	Industry	030104	6.2				6.2	6.2	6.2	6.2	6.2	6.2

						1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
					030105	189	211	212	227	226	222	221	182	182	182
			1A4a	Commercial/ Institutional	020104					6.2	6.2	6.2	6.2	6.2	6.2
					020105	189	211	212	227	226	222	221	182	182	182
			1A4b i	Residential	020204		211	212	227	226	222	221	182	182	182
			1A4c i	Agriculture/ Forestry	020303							6.2	6.2	6.2	6.2
					020304	189	211	212	227	226	222	221	182	182	182
	LIQUID	REFINERY GAS	1A1b	Petroleum refining	010306	15	15	15	15						
	WASTE	MUNICIP. WASTES	1A1a	Electricity and heat production	010102					7.4	7.4			7.4	7.4
					010103					7.4	7.4	7.4	7.4	7.4	7.4
					010104					7.4	7.4	7.4	7.4	7.4	7.4
					010200	100	85	70	55						
					010202					40	25				
					010203					40	25	10	10	10	10
			1A2	Industry	030100	100	85	70	55	40	25	10	10	10	10
			1A4a	Commercial/ Institutional	020100	100	85	70	55	40	25	10	10	10	10
					020103					40	25	10	10	10	10

Continued

						2000	2001	2002	2003	2004	2005	2006	2007	2008
pol_abbr	fuel_type	fuel_gr_abbr	nfr_id_EA	nfr_name	snap_id									
SO_2	LIQUID	GAS OIL	1A1a	Electricity and heat production	010101	23	23	23	23	23	23	23	23	23
					010102	23	23	23	23	23	23	23	23	23
					010103		23	23	23	23	23	23	23	23
					010104	23	23	23	23	23	23	23	23	23
					010105	23	23	23	23	23	23	23	23	23
					010201					23	23	23	23	23
					010202	23	23	23	23	23	23	23	23	23
					010203	23	23	23	23	23	23	23	23	23
					010205					23	23	23	23	23
			1A1b	Petroleum refining	010306				23	23	23	23	23	23
			1A2	Industry	030100	23	23	23	23	23	23	23	23	23
					030103	23	23	23				23		23
					030105	23	23							23
					030106	23	23	23	23	23	23	23		
			1A4a	Commercial/ Institutional	020100	23	23	23	23	23	23	23	23	23
					020102									
					020103	23	23	23	23	23	23	23	23	23
					020105	23	23	23	23	23	23	23	23	23
			1A4b i	Residential	020200	23	23	23	23	23	23	23	23	23
			1A4c i	Agriculture/ Forestry	020300	23	23	23	23	23	23	23		
		ORIMULSION	1A1a	Electricity and heat production	010101		10	12	12	12				
		PETROLEUM COKE	1A2	Industry	030100	787	605	605	605	605	605	605		
			1A4a	Commercial/ Institutional	020100	787	605	605	605		605	605	605	605
			1A4b i	Residential	020200	787	605	605	605	605	605	605	605	605
			1A4c i	Agriculture/ Forestry	020300	787	605	605	605					

						2000	2001	2002	2003	2004	2005	2006	2007	2008
		REFINERY GAS	1A1b	Petroleum refining	010306						1	1	1	1
		RESIDUAL OIL	1A1a	Electricity and heat production	010100									
					010101	403	315	290	334	349	283	308	206	82
					010102	403	315	290	334	349	283	308	206	82
					010103	403	315	290	334	349				82
					010104	403	315	290	334	349	283	308	206	82
					010105	403	315	290	334	349				
					010202	344	344	344	344	344	344	344	344	344
					010203	344	344	344	344	344	344	344	344	344
			1A1b	Petroleum refining	010306	537	537	537	537	537	537	537	537	537
			1A2	Industry	030100	344	344	344	344	344	344	344	344	344
					030102	344	344	344	344	344	344	344	344	344
					030103	344	344							344
			1A4a	Commercial/ Institutional	020100	344	344	344	344	344	344	344	344	344
			1A4b i	Residential	020200	344	344	344	344	344	344	344	344	344
			1A4c i	Agriculture/ Forestry	020300	344	344	344	344	344	344	344	344	344
	SOLID	COAL	1A1a	Electricity and heat production	010100									
					010101	64	47	45	61	42	41	37	40	26
					010102	64	47	45	61	42	41	37	40	26
					010103	64	47	45	61	42				26
					010104									
	WASTE	MUNICIP. WASTES	1A1a	Electricity and heat production	010100									
					010102	24	24	24	24	19	14	8.3	8.3	8.3
					010103	24	24	24	24	19	14	8.3	8.3	8.3
					010104	24			24			8.3		
					010200									
					010202									
					010203	67	60	52	45	37	30	22	15	15
			1A2	Industry	030100									
					030102				45	37	30	22		15
			1A4a	Commercial/ Institutional	020100	67			45	37	30	22		
					020103	67	60	52	45	37	30	22	15	15
NO_X	BIOMASS	BIOGAS	1A1a	Electricity and heat production	010105	540	484	427	371	315	259	202	202	202
					010205					315	259	202	202	202
			1A1c	Other energy industries	010505	540	484	427	371	315	259	202	202	
			1A2	Industry	030105	540	484	427	371	315		202	202	202
			1A4a	Commercial/ Institutional	020105	540	484	427	371	315	259	202	202	202
			1A4c i	Agriculture/ Forestry	020304	540	484	427	371	315	259	202	202	202
		FISH & RAPE OIL	1A1a	Electricity and heat production	010200									
					010203	65	65	65	65	65	65	65	65	65
		WOOD	1A1a	Electricity and heat production	010202	90	90	90	90	90	90	90	90	90
					010203	90	90	90	90	90	90	90	90	90
			1A2	Industry	030100	90	90	90	90	90	90	90	90	90
					030102	90	90					90	90	90
					030103	90	90	90	90	90	90	90	90	

						2000	2001	2002	2003	2004	2005	2006	2007	2008
			1A4a	Commercial/ Institutional	020100	90	90	90	90	90	90	90	90	90
					020105		90	90		90	90	90	90	
			1A4c i	Agriculture/ Forestry	020300	90	90	90	90	90	90	90	90	90
					020304	90	90							
	GAS	NATURAL GAS	1A1a	Electricity and heat production	010100	115	115	115	115	97		97	97	
					010101		115	115	115	97	97	97	97	97
					010102	115	115	115	115	97	97	97	97	97
					010104	124	119	113	108	103	98	73	48	48
					010105	168	163	158	153	148	143	139	135	135
					010205	168	163	158	153	148	143	139	135	135
			1A1c	Other energy industries	010505	168	163	158	153	148	143	139	135	135
			1A2	Industry	030104	124	119	113	108	103	98	73	48	48
					030105	168	163	158	153	148	143	139	135	135
			1A4a	Commercial/ Institutional	020104	124	119	113	108	103	98	73	48	
					020105	168	163	158	153	148	143	139	135	135
			1A4b i	Residential	020204	168	163	158	153	148	143	139	135	135
			1A4c i	Agriculture/ Forestry	020303	124	119	113	108	103	98	73	48	48
					020304	168	163	158	153	148	143	139	135	135
	LIQUID	GAS OIL	1A1a	Electricity and heat production	010103		65	65	65	65	65	65	65	65
					010105	942	942	942	942	942	942	942	942	942
					010200									
					010201					65	65	65	65	65
					010202	65	65	65	65	65	65	65	65	65
					010203	65	65	65	65	65	65	65	65	65
					010205					942	942	942	942	942
			1A1b	Petroleum refining	010306				65	65	65	65	65	65
			1A2	Industry	030100	65	65	65	65	65	65	65	65	65
					030102	65	65	65	65	65	65	65	65	65
					030103	65	65	65				65		65
					030105	942	942							942
					030106	65	65	65	65	65	65	65		
			1A4a	Commercial/ Institutional	020105	942	942	942	942	942	942	942	942	942
			1A4c i	Agriculture/ Forestry	020304	942	942	942	942		942	942	942	
		ORIMULSION	1A1a	Electricity and heat production	010101		88	86	86	86				
		PETROLEUM COKE	1A2	Industry	030100	95	95	95	95	95	95	95		
		REFINERY GAS	1A1b	Petroleum refining	010306						80	80	80	80
		RESIDUAL OIL	1A1a	Electricity and heat production	010100									
					010101	129	122	130	144	131	127	109	98	1717
					010102	129	122	130	144	131	127	109	98	1717
					010103	129	122	130	144	131				1717
					010104	129	122	130	144	131	127	109	98	1717
					010105	129	122	130	144	131				
	SOLID	BROWN COAL BRI.	1A4b i	Residential	020200	95	95	95	95					
		COAL	1A1a	Electricity and heat production	010100									
					010101	129	122	130	144	131	127	109	98	59
					010102	129	122	130	144	131	127	109	98	59

						2000	2001	2002	2003	2004	2005	2006	2007	2008
					010103	129	122	130	144	131				59
					010104									
					010202	95	95	95	95	95	95		95	
					010203	95	95				95			
			1A2	Industry	030100	95	95	95	95	95	95	95	95	95
			1A4a	Commercial/ Institutional	020100					95				
			1A4b i	Residential	020200	95	95	95	95	95	95	95	95	95
			1A4c i	Agriculture/ Forestry	020300	95	95	95	95	95	95	95	95	95
		COKE OVEN COKE	1A2	Industry	030100	95	95	95	95	95	95	95	95	95
			1A4b i	Residential	020200	95	95	95	95	95	95	95	95	95
	WASTE	MUNICIP. WASTES	1A1a	Electricity and heat production	010102	124	124	124	124	117	110	102	102	102
					010103	124	124	124	124	117	110	102	102	102
					010104	124			124			102		
NMVOC	BIOMASS	BIOGAS	1A1a	Electricity and heat production	010105	14	13	13	12	11	10	10	10	10
					010205					11	10	10	10	10
			1A1c	Other energy industries	010505	14	13	13	12	11	10	10	10	
			1A2	Industry	030105	14	13	13	12	11		10	10	10
			1A4a	Commercial/ Institutional	020105	14	13	13	12	11	10	10	10	10
			1A4c i	Agriculture/ Forestry	020304	14	13	13	12	11	10	10	10	10
		STRAW	1A2	Industry	030100									
			1A4b i	Residential	020200	400	400	400	400	400	400	400	400	400
		WOOD	1A2	Industry	030100	10	10	10	10	10	10	10	10	10
					030103	10	10	10	10	10	10	10	10	
			1A4b i	Residential	020200	650	582	557	554	550	528	508	508	476
	GAS	NATURAL GAS	1A1a	Electricity and heat production	010104	1.4	1.4	1.5	1.5	1.6	1.6	1.6	1.6	1.6
					010105	121	114	108	101	95	88	90	92	92
					010205	121	114	108	101	95	88	90	92	92
			1A1c	Other energy industries	010505	121	114	108	101	95	88	90	92	92
			1A2	Industry	030104	1.4	1.4	1.5	1.5	1.6	1.6	1.6	1.6	1.6
					030105	121	114	108	101	95	88	90	92	92
			1A4a	Commercial/ Institutional	020104	1.4	1.4	1.5	1.5	1.6	1.6	1.6	1.6	
					020105	121	114	108	101	95	88	90	92	92
			1A4b i	Residential	020204	121	114	108	101	95	88	90	92	92
			1A4c i	Agriculture/ Forestry	020303	1.4	1.4	1.5	1.5	1.6	1.6	1.6	1.6	1.6
					020304	121	114	108	101	95	88	90	92	92
	LIQUID	REFINERY GAS	1A1b	Petroleum refining	010306						1.4	1.4	1.4	1.4
	WASTE	MUNICIP. WASTES	1A1a	Electricity and heat production	010102	1	1	1	1	0.85	0.71	0.56	0.56	0.56
					010103	1	1	1	1	0.85	0.71	0.56	0.56	0.56
					010104	1			1			0.56		
CO	BIOMASS	BIOGAS	1A1a	Electricity and heat production	010105	273	279	285	292	298	304	310	310	310
					010205					298	304	310	310	310
			1A1c	Other energy industries	010505	273	279	285	292	298	304	310	310	
			1A2	Industry	030105	273	279	285	292	298		310	310	310
			1A4a	Commercial/ Institutional	020105	273	279	285	292	298	304	310	310	310
			1A4c i	Agriculture/ Forestry	020304	273	279	285	292	298	304	310	310	310

						2000	2001	2002	2003	2004	2005	2006	2007	2008
		STRAW	1A1a	Electricity and heat production	010200									
					010202	325	325			325	325	325	325	325
					010203	325	325	325	325	325	325	325	325	325
			1A4b i	Residential	020200	4000	4000	4000	4000	4000	4000	4000	4000	4000
			1A4c i	Agriculture/ Forestry	020300	4000	4000	4000	4000	4000	4000	4000	4000	4000
		WOOD	1A1a	Electricity and heat production	010200									
					010202	240	240	240	240	240	240	240	240	240
					010203	240	240	240	240	240	240	240	240	240
			1A2	Industry	030100	240	240	240	240	240	240	240	240	240
					030103	240	240	240	240	240	240	240	240	
			1A4a	Commercial/ Institutional	020100	240	240	240	240	240	240	240	240	240
			1A4b i	Residential	020200	4146	3779	3656	3659	3657	3546	3436	3491	3353
			1A4c i	Agriculture/ Forestry	020300	240	240	240	240	240	240	240	240	240
	GAS	NATURAL GAS	1A1a	Electricity and heat production	010104	6.2	6.2	6.2	6.2	6.2	6.2	5.5	4.8	4.8
					010105	183	163	142	122	101	81	70	58	58
					010205	183	163	142	122	101	81	70	58	58
			1A1c	Other energy industries	010505	183	163	142	122	101	81	70	58	58
			1A2	Industry	030104	6.2	6.2	6.2	6.2	6.2	6.2	5.5	4.8	4.8
					030105	183	163	142	122	101	81	70	58	58
			1A4a	Commercial/ Institutional	020104	6.2	6.2	6.2	6.2	6.2	6.2	5.5	4.8	
					020105	183	163	142	122	101	81	70	58	58
			1A4b i	Residential	020204	183	163	142	122	101	81	70	58	58
			1A4c i	Agriculture/ Forestry	020303	6.2	6.2	6.2	6.2	6.2	6.2	5.5	4.8	4.8
					020304	183	163	142	122	101	81	70	58	58
	LIQUID	REFINERY GAS	1A1b	Petroleum refining	010306						6.2	6.2	6.2	6.2
	WASTE	MUNICIP. WASTES	1A1a	Electricity and heat production	010102	8	8	8	8	6.6	5.3	3.9	3.9	3.9
					010103	8	8	8	8	6.6	5.3	3.9	3.9	3.9
					010104	8			8			3.9		
					010200									
					010202									
					010203	10	10	10	10	10	10	10	10	10
			1A2	Industry	030100									
			1A4a	Commercial/ Institutional	020100	10			10	10	10	10		
					020103	10	10	10	10	10	10	10	10	10

Annex 3A-5 Large point sources

Table 3A-5.1 Large point sources, fuel consumption in 2008 (1A1, 1A2 and 1A4).

NFR_id	NFR_name	snap	lps	lps_name	part_id	Fuel	Fuel_rate_TJ
1A1a	Electricity and heat production	010101	001	Amagervaerket	02	WOOD	268
1A1a	Electricity and heat production	010101	001	Amagervaerket	02	STRAW	768
1A1a	Electricity and heat production	010101	001	Amagervaerket	02	RESIDUAL OIL	53
1A1a	Electricity and heat production	010101	001	Amagervaerket	03	COAL	11468
1A1a	Electricity and heat production	010101	001	Amagervaerket	03	RESIDUAL OIL	149
1A1a	Electricity and heat production	010101	003	H.C.Oerstedsvaerket	03	RESIDUAL OIL	65
1A1a	Electricity and heat production	010101	003	H.C.Oerstedsvaerket	03	GAS OIL	29
1A1a	Electricity and heat production	010101	003	H.C.Oerstedsvaerket	03	NATURAL GAS	487
1A1a	Electricity and heat production	010101	003	H.C.Oerstedsvaerket	07	RESIDUAL OIL	403
1A1a	Electricity and heat production	010101	003	H.C.Oerstedsvaerket	07	NATURAL GAS	3001
1A1a	Electricity and heat production	010101	004	Kyndbyvaerket	21	GAS OIL	530
1A1a	Electricity and heat production	010101	004	Kyndbyvaerket	22	GAS OIL	228
1A1a	Electricity and heat production	010101	004	Kyndbyvaerket	26	GAS OIL	15
1A1a	Electricity and heat production	010101	007	Stigsnaesvaerket	01	COAL	76
1A1a	Electricity and heat production	010101	007	Stigsnaesvaerket	01	RESIDUAL OIL	17
1A1a	Electricity and heat production	010101	007	Stigsnaesvaerket	02	COAL	5806
1A1a	Electricity and heat production	010101	007	Stigsnaesvaerket	02	RESIDUAL OIL	202
1A1a	Electricity and heat production	010101	008	Asnaesvaerket	02	COAL	5393
1A1a	Electricity and heat production	010101	008	Asnaesvaerket	02	RESIDUAL OIL	46
1A1a	Electricity and heat production	010101	008	Asnaesvaerket	05	COAL	20360
1A1a	Electricity and heat production	010101	008	Asnaesvaerket	05	RESIDUAL OIL	545
1A1a	Electricity and heat production	010101	010	Avedoerevaerket	01	COAL	10693
1A1a	Electricity and heat production	010101	010	Avedoerevaerket	01	RESIDUAL OIL	228
1A1a	Electricity and heat production	010101	010	Avedoerevaerket	01	GAS OIL	20
1A1a	Electricity and heat production	010101	011	Fynsvaerket+Odense kraftvarmevaerk	03	COAL	2913
1A1a	Electricity and heat production	010101	011	Fynsvaerket+Odense kraftvarmevaerk	03	RESIDUAL OIL	202
1A1a	Electricity and heat production	010101	011	Fynsvaerket+Odense kraftvarmevaerk	07	COAL	17725
1A1a	Electricity and heat production	010101	011	Fynsvaerket+Odense kraftvarmevaerk	07	RESIDUAL OIL	250
1A1a	Electricity and heat production	010101	012	Studstrupvaerket	03	COAL	12841
1A1a	Electricity and heat production	010101	012	Studstrupvaerket	03	STRAW	348
1A1a	Electricity and heat production	010101	012	Studstrupvaerket	03	RESIDUAL OIL	219
1A1a	Electricity and heat production	010101	012	Studstrupvaerket	04	COAL	16030
1A1a	Electricity and heat production	010101	012	Studstrupvaerket	04	STRAW	685
1A1a	Electricity and heat production	010101	012	Studstrupvaerket	04	RESIDUAL OIL	151
1A1a	Electricity and heat production	010101	014	Nordjyllandsvaerket	02	COAL	3355
1A1a	Electricity and heat production	010101	014	Nordjyllandsvaerket	02	RESIDUAL OIL	84
1A1a	Electricity and heat production	010101	014	Nordjyllandsvaerket	03	COAL	17917
1A1a	Electricity and heat production	010101	014	Nordjyllandsvaerket	03	RESIDUAL OIL	233
1A1a	Electricity and heat production	010101	018	Skaerbaekvaerket	03	GAS OIL	117
1A1a	Electricity and heat production	010101	018	Skaerbaekvaerket	03	NATURAL GAS	10428
1A1a	Electricity and heat production	010101	019	Enstedvaerket	03	COAL	22777
1A1a	Electricity and heat production	010101	019	Enstedvaerket	03	RESIDUAL OIL	109
1A1a	Electricity and heat production	010101	019	Enstedvaerket	04	WOOD	264
1A1a	Electricity and heat production	010101	019	Enstedvaerket	04	STRAW	1386
1A1a	Electricity and heat production	010101	019	Enstedvaerket	04	FISH & RAPE OIL	12
1A1a	Electricity and heat production	010101	020	Esbjergvaerket	03	COAL	12086
1A1a	Electricity and heat production	010101	020	Esbjergvaerket	03	MUNICIP. WASTES	28
1A1a	Electricity and heat production	010101	020	Esbjergvaerket	03	RESIDUAL OIL	312
1A1a	Electricity and heat production	010101	020	Esbjergvaerket	03	LPG	0
1A1a	Electricity and heat production	010102	005	Masnedoevaerket	12	WOOD	63
1A1a	Electricity and heat production	010102	005	Masnedoevaerket	12	STRAW	483
1A1a	Electricity and heat production	010102	011	Fynsvaerket+Odense kraftvarmevaerk	08	MUNICIP. WASTES	2741
1A1a	Electricity and heat production	010102	011	Fynsvaerket+Odense kraftvarmevaerk	08	GAS OIL	16
1A1a	Electricity and heat production	010102	022	Oestkraft	05	RESIDUAL OIL	3
1A1a	Electricity and heat production	010102	022	Oestkraft	06	COAL	592
1A1a	Electricity and heat production	010102	022	Oestkraft	06	WOOD	37
1A1a	Electricity and heat production	010102	022	Oestkraft	06	RESIDUAL OIL	43
1A1a	Electricity and heat production	010102	025	Horsens Kraftvarmevaerk	01	WOOD	9
1A1a	Electricity and heat production	010102	025	Horsens Kraftvarmevaerk	01	MUNICIP. WASTES	1055
1A1a	Electricity and heat production	010102	026	Herningvaerket	01	WOOD	2739
1A1a	Electricity and heat production	010102	026	Herningvaerket	01	RESIDUAL OIL	313
1A1a	Electricity and heat production	010102	026	Herningvaerket	01	NATURAL GAS	703
1A1a	Electricity and heat production	010102	027	I/S Vestforbraending	01	MUNICIP. WASTES	2217
1A1a	Electricity and heat production	010102	027	I/S Vestforbraending	01	GAS OIL	11
1A1a	Electricity and heat production	010102	027	I/S Vestforbraending	02	MUNICIP. WASTES	913
1A1a	Electricity and heat production	010102	027	I/S Vestforbraending	02	NATURAL GAS	22
1A1a	Electricity and heat production	010102	027	I/S Vestforbraending	03	MUNICIP. WASTES	2785
1A1a	Electricity and heat production	010102	027	I/S Vestforbraending	03	NATURAL GAS	25
1A1a	Electricity and heat production	010102	028	Amagerforbraending	01	MUNICIP. WASTES	4577
1A1a	Electricity and heat production	010102	029	Energi Randers Produktion	01	COAL	1627
1A1a	Electricity and heat production	010102	029	Energi Randers Produktion	01	WOOD	1093
1A1a	Electricity and heat production	010102	029	Energi Randers Produktion	01	BIOGAS	12
1A1a	Electricity and heat production	010102	029	Energi Randers Produktion	02	GAS OIL	29
1A1a	Electricity and heat production	010102	030	Grenaa Kraftvarmevaerk	01	COAL	594
1A1a	Electricity and heat production	010102	030	Grenaa Kraftvarmevaerk	01	STRAW	577
1A1a	Electricity and heat production	010102	030	Grenaa Kraftvarmevaerk	01	RESIDUAL OIL	14
1A1a	Electricity and heat production	010102	030	Grenaa Kraftvarmevaerk	01	GAS OIL	5
1A1a	Electricity and heat production	010102	037	Maabjergvaerket	02	WOOD	371
1A1a	Electricity and heat production	010102	037	Maabjergvaerket	02	MUNICIP. WASTES	1841
1A1a	Electricity and heat production	010102	037	Maabjergvaerket	02	STRAW	396
1A1a	Electricity and heat production	010102	037	Maabjergvaerket	02	NATURAL GAS	80
1A1a	Electricity and heat production	010102	038	Soenderborg Kraftvarmevaerk	01	WOOD	4
1A1a	Electricity and heat production	010102	038	Soenderborg Kraftvarmevaerk	01	MUNICIP. WASTES	715

Continued							
1A1a	Electricity and heat production	010102	039	I/S Kara Affaldsforbraendingsanlaeg	01	MUNICIP. WASTES	2493
1A1a	Electricity and heat production	010102	039	I/S Kara Affaldsforbraendingsanlaeg	01	NATURAL GAS	9
1A1a	Electricity and heat production	010102	042	I/S Nordforbraending	01	WOOD	170
1A1a	Electricity and heat production	010102	042	I/S Nordforbraending	01	MUNICIP. WASTES	1251
1A1a	Electricity and heat production	010102	046	Affaldscenter aarhus - Forbraendsanlaegget	01	MUNICIP. WASTES	2405
1A1a	Electricity and heat production	010102	053	Svendborg Kraftvarmevaerk	01	MUNICIP. WASTES	502
1A1a	Electricity and heat production	010102	053	Svendborg Kraftvarmevaerk	01	NATURAL GAS	3
1A1a	Electricity and heat production	010102	054	Kommunekemi	01	MUNICIP. WASTES	650
1A1a	Electricity and heat production	010102	054	Kommunekemi	01	RESIDUAL OIL	104
1A1a	Electricity and heat production	010102	054	Kommunekemi	01	GAS OIL	8
1A1a	Electricity and heat production	010102	054	Kommunekemi	02	MUNICIP. WASTES	533
1A1a	Electricity and heat production	010102	054	Kommunekemi	02	RESIDUAL OIL	68
1A1a	Electricity and heat production	010102	054	Kommunekemi	02	GAS OIL	10
1A1a	Electricity and heat production	010102	054	Kommunekemi	03	MUNICIP. WASTES	574
1A1a	Electricity and heat production	010102	054	Kommunekemi	03	RESIDUAL OIL	59
1A1a	Electricity and heat production	010102	054	Kommunekemi	03	GAS OIL	5
1A1a	Electricity and heat production	010102	085	L90 Affaldsforbraending	01	MUNICIP. WASTES	2347
1A1a	Electricity and heat production	010102	085	L90 Affaldsforbraending	01	GAS OIL	7
1A1a	Electricity and heat production	010102	087	Koege Kraftvarmevaerk	07	WOOD	1287
1A1a	Electricity and heat production	010102	087	Koege Kraftvarmevaerk	07	RESIDUAL OIL	39
1A1a	Electricity and heat production	010103	007	Stigsnaesvaerket	03	RESIDUAL OIL	108
1A1a	Electricity and heat production	010103	007	Stigsnaesvaerket	03	GAS OIL	0
1A1a	Electricity and heat production	010103	036	Kolding Forbraendingsanlaeg	01	WOOD	5
1A1a	Electricity and heat production	010103	036	Kolding Forbraendingsanlaeg	01	MUNICIP. WASTES	674
1A1a	Electricity and heat production	010103	047	I/S Reno Nord	01	MUNICIP. WASTES	1938
1A1a	Electricity and heat production	010103	047	I/S Reno Nord	01	GAS OIL	5
1A1a	Electricity and heat production	010103	051	AVV Forbraendingsanlaeg	01	MUNICIP. WASTES	872
1A1a	Electricity and heat production	010103	052	Affaldsforbraendingsanlaeg I/S REFA	01	MUNICIP. WASTES	1235
1A1a	Electricity and heat production	010103	058	I/S Reno Syd	01	MUNICIP. WASTES	635
1A1a	Electricity and heat production	010103	059	I/S Kraftvarmevaerk Thisted	01	WOOD	12
1A1a	Electricity and heat production	010103	059	I/S Kraftvarmevaerk Thisted	01	MUNICIP. WASTES	543
1A1a	Electricity and heat production	010103	059	I/S Kraftvarmevaerk Thisted	01	STRAW	1
1A1a	Electricity and heat production	010103	060	Knudmosevaerket	01	MUNICIP. WASTES	501
1A1a	Electricity and heat production	010103	060	Knudmosevaerket	01	NATURAL GAS	44
1A1a	Electricity and heat production	010103	061	Kavo I/S Energien+Slagelse Kraftvarmevaerk	01	MUNICIP. WASTES	211
1A1a	Electricity and heat production	010103	061	Kavo I/S Energien+Slagelse Kraftvarmevaerk	02	MUNICIP. WASTES	490
1A1a	Electricity and heat production	010103	061	Kavo I/S Energien+Slagelse Kraftvarmevaerk	02	STRAW	368
1A1a	Electricity and heat production	010103	065	Haderslev Kraftvarmevaerk	01	MUNICIP. WASTES	588
1A1a	Electricity and heat production	010103	065	Haderslev Kraftvarmevaerk	01	NATURAL GAS	16
1A1a	Electricity and heat production	010103	066	Frederiskhavn Affaldskraftvarmevaerk	01	MUNICIP. WASTES	397
1A1a	Electricity and heat production	010103	066	Frederiskhavn Affaldskraftvarmevaerk	01	GAS OIL	3
1A1a	Electricity and heat production	010103	067	Vejen Kraftvarmevaerk	01	WOOD	3
1A1a	Electricity and heat production	010103	067	Vejen Kraftvarmevaerk	01	MUNICIP. WASTES	373
1A1a	Electricity and heat production	010104	002	Svanemoellevaerket	07	GAS OIL	12
1A1a	Electricity and heat production	010104	002	Svanemoellevaerket	07	NATURAL GAS	3653
1A1a	Electricity and heat production	010104	003	H.C.Oerstedsvaerket	08	RESIDUAL OIL	242
1A1a	Electricity and heat production	010104	003	H.C.Oerstedsvaerket	08	NATURAL GAS	1800
1A1a	Electricity and heat production	010104	004	Kyndbyvaerket	51	GAS OIL	14
1A1a	Electricity and heat production	010104	004	Kyndbyvaerket	52	GAS OIL	12
1A1a	Electricity and heat production	010104	005	Masnedoevaerket	31	GAS OIL	31
1A1a	Electricity and heat production	010104	010	Avedoerevaerket	02	WOOD	5947
1A1a	Electricity and heat production	010104	010	Avedoerevaerket	02	STRAW	815
1A1a	Electricity and heat production	010104	010	Avedoerevaerket	02	RESIDUAL OIL	4227
1A1a	Electricity and heat production	010104	010	Avedoerevaerket	02	NATURAL GAS	9204
1A1a	Electricity and heat production	010104	025	Horsens Kraftvarmevaerk	02	NATURAL GAS	813
1A1a	Electricity and heat production	010104	031	Hilleroed Kraftvarmevaerk	01	NATURAL GAS	2065
1A1a	Electricity and heat production	010104	032	Helsingoer Kraftvarmevaerk	01	NATURAL GAS	1431
1A1a	Electricity and heat production	010104	038	Soenderborg Kraftvarmevaerk	02	NATURAL GAS	991
1A1a	Electricity and heat production	010104	040	Viborg Kraftvarme	01	NATURAL GAS	2051
1A1a	Electricity and heat production	010104	048	Silkeborg Kraftvarmevaerk	01	NATURAL GAS	3280
1A1a	Electricity and heat production	010104	069	DTU	01	NATURAL GAS	1319
1A1a	Electricity and heat production	010104	070	Naestved Kraftvarmevaerk	01	NATURAL GAS	106
1A1a	Electricity and heat production	010104	072	Hjoerring Varmeforsyning	01	NATURAL GAS	13
1A1a	Electricity and heat production	010105	004	Kyndbyvaerket	41	GAS OIL	3
1A1a	Electricity and heat production	010105	032	Helsingoer Kraftvarmevaerk	02	NATURAL GAS	7
1A1a	Electricity and heat production	010203	036	Kolding Forbraendingsanlaeg	05	MUNICIP. WASTES	633
1A1a	Electricity and heat production	010203	036	Kolding Forbraendingsanlaeg	05	GAS OIL	2
1A1a	Electricity and heat production	010203	050	Fasan+Naestved Kraftvarmevaerk	01	MUNICIP. WASTES	1147
1A1a	Electricity and heat production	010203	055	I/S Faelles Forbraending	01	MUNICIP. WASTES	330
1A1a	Electricity and heat production	010203	068	Bofa I/S	01	MUNICIP. WASTES	243
1A1a	Electricity and heat production	010203	072	Hjoerring Varmeforsyning	02	WOOD	362
1A1a	Electricity and heat production	010203	086	Hammel Fjernvarme	01	MUNICIP. WASTES	311
1A1a	Electricity and heat production	010203	086	Hammel Fjernvarme	01	FISH & RAPE OIL	3
1A1a	Electricity and heat production	010203	088	Skagen Forbraendingen	01	MUNICIP. WASTES	132
1A1b	Petroleum refining	010304	017	Shell Raffinaderi	05	REFINERY GAS	1834
1A1b	Petroleum refining	010306	009	Statoil Raffinaderi	01	GAS OIL	3
1A1b	Petroleum refining	010306	009	Statoil Raffinaderi	01	REFINERY GAS	8367
1A1b	Petroleum refining	010306	017	Shell Raffinaderi	01	RESIDUAL OIL	894
1A1b	Petroleum refining	010306	017	Shell Raffinaderi	01	REFINERY GAS	3865
1A1c	Other energy industries	010502	024	Nybro Gasbehandlingsanlaeg	01	NATURAL GAS	354
1A2	Industry	030100	081	Haldor Topsoee	02	GAS OIL	1
1A2	Industry	030100	081	Haldor Topsoee	02	NATURAL GAS	580
1A2	Industry	030100	081	Haldor Topsoee	02	LPG	0
1A2	Industry	030102	023	Danisco Grindsted	01	COAL	468
1A2	Industry	030102	023	Danisco Grindsted	01	GAS OIL	13
1A2	Industry	030102	023	Danisco Grindsted	01	NATURAL GAS	26
1A2	Industry	030102	033	DanSteel	01	NATURAL GAS	1361
1A2	Industry	030102	034	Dalum Papir	01	WOOD	1184
1A2	Industry	030102	034	Dalum Papir	01	NATURAL GAS	111

Continued							
1A2	Industry	030102	082	Danisco Sugar Nakskov	02	COAL	748
1A2	Industry	030102	082	Danisco Sugar Nakskov	02	COKE OVEN COKE	61
1A2	Industry	030102	082	Danisco Sugar Nakskov	02	RESIDUAL OIL	708
1A2	Industry	030102	082	Danisco Sugar Nakskov	02	GAS OIL	4
1A2	Industry	030102	082	Danisco Sugar Nakskov	02	BIOGAS	51
1A2	Industry	030102	083	Danisco Sugar Nykoebing	02	COAL	252
1A2	Industry	030102	083	Danisco Sugar Nykoebing	02	COKE OVEN COKE	46
1A2	Industry	030102	083	Danisco Sugar Nykoebing	02	RESIDUAL OIL	1005
1A2	Industry	030102	083	Danisco Sugar Nykoebing	02	BIOGAS	50
1A2	Industry	030102	089	AarhusKarlshamn Denmark A/S	01	MUNICIP. WASTES	42
1A2	Industry	030102	089	AarhusKarlshamn Denmark A/S	01	RESIDUAL OIL	1189
1A2	Industry	030102	089	AarhusKarlshamn Denmark A/S	01	GAS OIL	1
1A2	Industry	030104	071	Maricogen	01	NATURAL GAS	34
1A2	Industry	030311	045	Aalborg Portland	01	COAL	3544
1A2	Industry	030311	045	Aalborg Portland	01	PETROLEUM COKE	6835
1A2	Industry	030311	045	Aalborg Portland	01	MUNICIP. WASTES	1956
1A2	Industry	030311	045	Aalborg Portland	01	RESIDUAL OIL	512
1A2	Industry	030315	078	Rexam Glass Holmegaard A/S	01	GAS OIL	0
1A2	Industry	030315	078	Rexam Glass Holmegaard A/S	01	NATURAL GAS	869
1A2	Industry	030318	075	Rockwool A/S Hedehusene	01	NATURAL GAS	47
1A2	Industry	030318	076	Rockwool A/S Vamdrup	01	COKE OVEN COKE	410
1A2	Industry	030318	076	Rockwool A/S Vamdrup	01	NATURAL GAS	274
1A2	Industry	030318	077	Rockwool A/S Doense	01	COKE OVEN COKE	372
1A2	Industry	030318	077	Rockwool A/S Doense	01	NATURAL GAS	248
1A4a	Commercial/ Institutional	020103	049	Rensningsanlaegget Lynetten	01	MUNICIP. WASTES	62
1A4a	Commercial/ Institutional	020103	049	Rensningsanlaegget Lynetten	01	GAS OIL	15
1A4a	Commercial/ Institutional	020103	049	Rensningsanlaegget Lynetten	01	BIOGAS	114
1A1, 1A2 and 1A4	**Stationary combustion**						**309276**

Table 3A-5.2 Large point sources, plant specific emissions (IPCC 1A1, 1A2 and 1A4)[1)].

LPS id	LPS name	NFR	SNAP	SO_2	NO_x	NMVOC	CO
001	Amagervaerket	1A1a	010101	x	x		
002	Svanemoellevaerket	1A1a	010104	x	x		
003	H.C.Oerstedsvaerket	1A1a	010101	x	x	x	x
			010104	x	x		
004	Kyndbyvaerket	1A1a	010101	x	x	x	x
			010104				
			010105	x	x		
005	Masnedoevaerket	1A1a	010102	x	x		
			010104	x	x		
007	Stigsnaesvaerket	1A1a	010101	x	x		
008	Asnaesvaerket	1A1a	010101	x	x		
009	Statoil Raffinaderi	1A1b	010306	x	x		
010	Avedoerevaerket	1A1a	010101	x	x	x	x
			010104	x	x	x	x
011	Fynsvaerket+Odense kraftvarmevaerk	1A1a	010101	x	x		
			010102	x	x		x
012	Studstrupvaerket	1A1a	010101	x	x		
014	Nordjyllandsvaerket	1A1a	010101	x	x		
017	Shell Raffinaderi	1A1b	010304	x	x		
			010306	x	x		
018	Skaerbaekvaerket	1A1a	010101	x	x		x
019	Enstedvaerket	1A1a	010101	x	x		x
020	Esbjergvaerket	1A1a	010101	x	x		x
022	Oestkraft	1A1a	010102	x	x		x
023	Danisco Grindsted	1A2f	030102	x	x		
024	Nybro Gasbehandlingsanlaeg	1A1c	010502		x		
025	Horsens Kraftvarmevaerk	1A1a	010102	x	x		x
			010104		x		
026	Herningvaerket	1A1a	010102	x	x		x
027	I/S Vestforbraending	1A1a	010102	x	x		
028	Amagerforbraending	1A1a	010102	x	x		x
029	Energi Randers Produktion	1A1a	010102	x	x		
030	Grenaa Kraftvarmevaerk	1A1a	010102	x	x		x
031	Hilleroed Kraftvarmevaerk	1A1a	010104	x	x		
032	Helsingoer Kraftvarmevaerk	1A1a	010104	x	x		
			010105				
034	Dalum Papir	1A2f	030102		x		
036	Kolding Forbraendingsanlaeg	1A1a	010103	x	x	x	x
			010203	x	x	x	x
037	Maabjergvaerket	1A1a	010102	x	x	x	x
038	Soenderborg Kraftvarmevaerk	1A1a	010102	x	x		x
			010104		x		
039	I/S Kara Affaldsforbraendingsanlaeg	1A1a	010102	x			x
040	Viborg Kraftvarme	1A1a	010104		x		
042	I/S Nordforbraending	1A1a	010102	x	x		x
045	Aalborg Portland	1A2f	030311	x	x		x
046	Affaldscenter aarhus - Forbraendsanlaegget	1A1a	010102	x	x	x	
047	I/S Reno Nord	1A1a	010103	x	x		x
048	Silkeborg Kraftvarmevaerk	1A1a	010104		x		
049	Rensningsanlaegget Lynetten	1A4a	020103	x			
050	Fasan+Naestved Kraftvarmevaerk	1A1a	010203	x	x		x
051	AVV Forbraendingsanlaeg	1A1a	010103	x	x		x
052	Affaldsforbraendingsanlaeg I/S REFA	1A1a	010103	x	x		x
053	Svendborg Kraftvarmevaerk	1A1a	010102	x	x	x	x
054	Kommunekemi	1A1a	010102	x	x		x
055	I/S Faelles Forbraending	1A1a	010203				x
058	I/S Reno Syd	1A1a	010103	x			x
059	I/S Kraftvarmevaerk Thisted	1A1a	010103	x	x		x
060	Knudmosevaerket	1A1a	010103	x	x		x
061	Kavo I/S Energien+Slagelse Kraftvarmevaerk	1A1a	010103	x	x		x
065	Haderslev Kraftvarmevaerk	1A1a	010103	x	x		x
066	Frederiskhavn Affaldskraftvarmevaerk	1A1a	010103	x	x		x
067	Vejen Kraftvarmevaerk	1A1a	010103	x	x	x	x
068	Bofa I/S	1A1a	010203	x	x		x
069	DTU	1A1a	010104	x	x		
070	Naestved Kraftvarmevaerk	1A1a	010104		x		x
071	Maricogen	1A2f	030104	x	x		
072	Hjoerring Varmeforsyning	1A1a	010104		x		x
076	Rockwool A/S Vamdrup	1A2f	030318	x		x	x
077	Rockwool A/S Doense	1A2f	030318	x		x	x
078	Rexam Glass Holmegaard A/S	1A2f	030315		x		x
082	Danisco Sugar Nakskov	1A2f	030102	x			

083	Danisco Sugar Nykoebing	1A2f	030102	x			
085	L90 Affaldsforbraending	1A1a	010102	x	x		x
086	Hammel Fjernvarme	1A1a	010203	x	x		x
087	Koege Kraftvarmevaerk	1A1a	010102	x	x	x	x
088	Skagen Forbraendingen	1A1a	010203	x		x	
089	AarhusKarlshamn Denmark A/S	1A2f	030102	x	x		
Grand Total				**8903**	**26951**	**95**	**12015**
Share of total emission from stationary combustion, %				**55%**	**54%**	**0%**	**7%**

1) Emissions of the pollutants marked with “x” are plant specific. Emission of other pollutants is estimated based on emission factors. The total shown *in this table* only includes plant specific data.
2) Based on particle size distribution.

Annex 3A-6 Adjustment of CO_2 emission

Table 3A-6.1 Adjustment of CO_2 emission (ref. DEA, 2009b).

		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Actual Degree Days	Degree days	2857	3284	3 022	3 434	3 148	3 297	3 837	3 236	3 217	3 056
Normal Degree Days	Degree days	3379	3380	3 359	3 365	3 366	3 378	3 395	3 389	3 375	3 339
Net electricity import	TJ	25373	-7099	13486	4266	-17424	-2858	-55444	-26107	-15552	-8327
Actual CO_2 emission	1 000 000 tonnes	37.7	47.5	41.7	43.9	47.1	44.1	57.4	47.4	43.4	40.3
Adjusted CO_2 emission	1 000 000 tonnes	44.0	45.9	44.6	45.0	43.3	43.4	44.2	41.4	39.6	38.4

Continued		2000	2001	2002	2003	2004	2005	2006	2007	2008
Actual Degree Days	Degree days	2 902	3 279	3 011	3 150	3 113	3 068	2 908	2807	2853
Normal Degree Days	Degree days	3 304	3 289	3 273	3 271	3 261	3 224	3 188	3136	3120
Net electricity import	TJ	2394	-2071	-7453	-30760	-10340	4932	-24971	-3420	5234
Actual CO_2 emission	1 000 000 tonnes	36.3	37.9	37.5	42.3	36.3	32.6	40.1	34.6	31.9
Adjusted CO_2 emission	1 000 000 tonnes	37.0	37.5	35.9	35.5	34.0	33.7	34.5	33.9	33.1

Annex 3A-7 Uncertainty estimates

Table 3A-7.1 Uncertainty estimation, tier 1.

IPCC Source category	Gas	Base year emission	Year t emission	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in year t	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
		Input data	Input data	Input data	Input data							
		Gg CO_2 eq	Gg CO_2 eq	%	%	%	%	%	%	%	%	%
Stationary Combustion, Coal	CO_2	24077	16050	1.1	1.1	1.556	0.767	-0.118	0.421	-0.130	0.655	0.668
Stationary Combustion, BKB	CO_2	11		3.0	5	5.831		-0.000		-0.001		0.001
Stationary Combustion, Coke	CO_2	138	112	2.0	5	5.385	0.019	-0.000	0.003	-0.001	0.008	0.008
Stationary Combustion, Petroleum coke	CO_2	410	755	2.2	5	5.463	0.127	0.011	0.020	0.053	0.062	0.081
Stationary Combustion, Plastic waste	CO_2	394	1343	5.0	25	25.495	1.052	0.026	0.035	0.660	0.249	0.706
Stationary Combustion, Residual oil	CO_2	2505	1359	1.5	2	2.500	0.104	-0.020	0.036	-0.041	0.076	0.086
Stationary Combustion, Gas oil	CO_2	4547	1544	2.8	5	5.731	0.272	-0.061	0.041	-0.307	0.160	0.346
Stationary Combustion, Kerosene	CO_2	366	9	2.9	5	5.780	0.002	-0.008	0.000	-0.040	0.001	0.040
Stationary Combustion, Natural gas	CO_2	4320	9764	1.7	1	1.972	0.592	0.159	0.256	0.159	0.616	0.636
Stationary Combustion, LPG	CO_2	169	96	2.7	5	5.682	0.017	-0.001	0.003	-0.006	0.010	0.012
Stationary Combustion, Refinery gas	CO_2	806	841	1.0	5	5.099	0.132	0.004	0.022	0.020	0.031	0.037
1A1+1A2+1A4, BIOMASS	CH_4	83	187	15.9	100	101.256	0.580	0.003	0.005	0.304	0.110	0.323
Biogas fuelled engines, BIOMASS	CH_4	2	21	3.0	10	10.440	0.007	0.001	0.001	0.005	0.002	0.006
1A1+1A2+1A4, GAS	CH_4	8	15	1.7	100	100.014	0.046	0.000	0.000	0.021	0.001	0.021
Natural gas fuelled engines, GAS	CH_4	5	185	1.0	5	5.099	0.029	0.005	0.005	0.024	0.007	0.025
1A1+1A2+1A4, LIQUID	CH_4	7	4	1.9	100	100.018	0.013	-0.000	0.000	-0.004	0.000	0.004
1A1+1A2+1A4, WASTE	CH_4	2	1	5.0	100	100.125	0.003	-0.000	0.000	-0.002	0.000	0.002
1A1+1A2+1A4, SOLID	CH_4	15	8	1.1	100	100.006	0.025	-0.000	0.000	-0.012	0.000	0.012
1A1 + 1A2 + 1A4, BIOMASS	N_2O	39	81	15.9	400	400.316	0.997	0.001	0.002	0.505	0.048	0.507
1A1 + 1A2 + 1A4, GAS	N_2O	28	61	1.7	300	300.005	0.565	0.001	0.002	0.296	0.004	0.296
1A1 + 1A2 + 1A4, LIQUID	N_2O	76	46	1.9	400	400.005	0.567	-0.000	0.001	-0.195	0.003	0.195
1A1 + 1A2 + 1A4, WASTE	N_2O	18	19	5.0	200	200.062	0.120	0.000	0.001	0.020	0.004	0.020
1A1 + 1A2 + 1A4, SOLID	N_2O	80	49	1.1	200	200.003	0.301	-0.001	0.001	-0.101	0.002	0.101
Total		38104.774	32549.867				4.243					1.985
Total uncertainties					Overall uncertainty in the year (%):		2.060			Trend uncertainty (%):		1.409

IPCC Source category	Gas	Base year emission	Year t emission	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in year t	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
		Input data	Input data	Input data	Input data							
		Gg CO_2	Gg CO_2	%	%	%	%	%	%	%	%	%
Stationary Combustion, Coal	CO_2	24077	16050	1.1	1.1	1.556	0.783	-0.113	0.425	-0.124	0.662	0.673
Stationary Combustion, BKB	CO_2	11		3.0	5	5.831		-0.000		-0.001		0.001
Stationary Combustion, Coke	CO_2	138	112	2.0	5	5.385	0.019	-0.000	0.003	-0.001	0.008	0.008
Stationary Combustion, Petroleum coke	CO_2	410	755	2.2	5	5.463	0.129	0.011	0.020	0.054	0.062	0.082
Stationary Combustion, Plastic waste	CO_2	394	1343	5.0	25	25.495	1.074	0.027	0.036	0.669	0.252	0.715
Stationary Combustion, Residual oil	CO_2	2505	1359	1.5	2	2.500	0.107	-0.020	0.036	-0.040	0.076	0.086
Stationary Combustion, Gas oil	CO_2	4547	1544	2.8	5	5.731	0.278	-0.061	0.041	-0.304	0.162	0.344
Stationary Combustion, Kerosene	CO_2	366	9	2.9	5	5.780	0.002	-0.008	0.000	-0.040	0.001	0.040
Stationary Combustion, Natural gas	CO_2	4320	9764	1.7	1	1.972	0.604	0.162	0.259	0.162	0.622	0.643
Stationary Combustion, LPG	CO_2	169	96	2.7	5	5.682	0.017	-0.001	0.003	-0.006	0.010	0.012
Stationary Combustion, Refinery gas	CO_2	806	841	1.0	5	5.099	0.135	0.004	0.022	0.021	0.032	0.038
Total	CO_2	37743	31872				2.256					1.513
Total uncertainties					Overall uncertainty in the year (%):		1.502			Trend uncertainty (%):		1.230

IPCC Source category	Gas	Base year emission	Year t emission	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in year t	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
		Input data	Input data	Input data	Input data							
		Mg CH_4	Mg CH_4	%	%	%	%	%	%	%	%	%
1A1+1A2+1A4, Biomass	CH_4	3948	8886	15.9	100	101.256	44.913	-0.824	1.537	-82.437	34.565	89.390
Biogas fuelled engines, Biomass	CH_4	91	994	3.0	10	10.440	0.518	0.117	0.172	1.173	0.730	1.381
1A1+1A2+1A4, Natural gas	CH_4	398	717	1.7	100	100.014	3.577	-0.115	0.124	-11.483	0.298	11.487
Natural gas fuelled engines, Natural gas	CH_4	221	8806	1.0	5	5.099	2.241	1.390	1.523	6.952	2.154	7.278
1A1+1A2+1A4, Liquid fuels	CH_4	322	204	1.9	100	100.018	1.020	-0.158	0.035	-15.776	0.095	15.776
1A1+1A2+1A4, Municipal waste	CH_4	88	41	5.0	100	100.125	0.207	-0.045	0.007	-4.537	0.051	4.537
1A1+1A2+1A4, Solid fuels	CH_4	712	385	1.1	100	100.006	1.922	-0.360	0.067	-35.971	0.104	35.971
Total	CH_4	5781	20033				2040.030					9740.801
Total uncertainties					Overall uncertainty in the year (%):		45.167			Trend uncertainty (%):		98.695

IPCC Source category	Gas	Base year emission	Year t emission	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in year t	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
		Input data	Input data	Input data	Input data							
		Mg N_2O	Mg N_2O	%	%	%	%	%	%	%	%	%
1A1 + 1A2 + 1A4, Biomass	N_2O	124	261	15.9	400	400.316	126.248	0.165	0.337	66.168	7.582	66.601
1A1 + 1A2 + 1A4, Gaseous fuels	N_2O	90	198	1.7	300	300.005	71.616	0.131	0.255	39.379	0.614	39.384
1A1 + 1A2 + 1A4, Liquid fuels	N_2O	244	149	1.9	400	400.005	71.769	-0.145	0.192	-57.873	0.515	57.875
1A1 + 1A2 + 1A4, Municipal waste	N_2O	59	63	5.0	200	200.062	15.138	-0.001	0.081	-0.154	0.572	0.593
1A1 + 1A2 + 1A4, Solid fuels	N_2O	258	158	1.1	200	200.003	38.165	-0.151	0.204	-30.138	0.317	30.140
Total	N_2O	775	829				27904.077					10245.063
Total uncertainties					Overall uncertainty in the year (%):		167.045			Trend uncertainty (%):		101.218

SNAP	Gas	Base year emission	Year t emission	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in year t	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
		Input data	Input data	Input data	Input data							
		Mg SO_2	Mg SO_2	%	%	%	%	%	%	%	%	%
01	SO_2	129602	6606	2	10	10.198	4.133	-0.043	0.042	-0.426	0.118	0.442
02	SO_2	11491	4310	2	20	20.100	5.315	0.020	0.027	0.396	0.077	0.403
03	SO_2	16708	5383	2	10	10.198	3.368	0.023	0.034	0.232	0.096	0.251
Total	SO_2	157801	16299				56.678					0.421
Total uncertainties					Overall uncertainty in the year (%):		7.528			Trend uncertainty (%):		0.649

SNAP	Gas	Base year emission	Year t emission	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in year t	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
		Input data	Input data	Input data	Input data							
		Mg NO_x	Mg NO_x	%	%	%	%	%	%	%	%	%
01	NO_x	94758	32576	2	20	20.100	13.002	-0.075	0.282	-1.506	0.798	1.704
02	NO_x	7518	8228	2	50	50.040	8.176	0.043	0.071	2.142	0.202	2.151
03	NO_x	13167	9557	2	20	20.100	3.814	0.033	0.083	0.660	0.234	0.700
Total	NO_x	115442	50361				250.433					8.023
Total uncertainties					Overall uncertainty in the year (%):		15.825			Trend uncertainty (%):		2.832

SNAP	Gas	Base year emission	Year t emission	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in year t	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
		Input data	Input data	Input data	Input data							
		Mg NMVOC	Mg NMVOC	%	%	%	%	%	%	%	%	%
01	NMVOC	534	1879	2	50	50.040	4.213	0.072	0.126	3.623	0.358	3.640
02	NMVOC	13056	20063	2	50	50.040	44.994	0.031	1.350	1.533	3.818	4.115
03	NMVOC	1271	371	2	50	50.040	0.833	-0.103	0.025	-5.166	0.071	5.167
Total	NMVOC	14861	22313				2042.913					56.880
Total uncertainties					Overall uncertainty in the year (%):		45.199			Trend uncertainty (%):		7.542

SNAP	Gas	Base year emission	Year t emission	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in year t	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
		Input data	Input data	Input data	Input data							
		Mg CO	Mg CO	%	%	%	%	%	%	%	%	%
01	CO	8264	8211	2	20	20.100	1.000	-0.010	0.058	-0.193	0.163	0.253
02	CO	118173	143986	2	50	50.040	43.647	0.048	1.012	2.408	2.862	3.740
03	CO	15877	12879	2	20	20.100	1.568	-0.039	0.090	-0.777	0.256	0.818
Total	CO	142313	165077				1908.496					14.721
Total uncertainties					Overall uncertainty in the year (%):		43.686			Trend uncertainty (%):		3.837

Table 3A-7.2 Uncertainty estimation for GHG, tier 2.

		Activity			Emission Factor			Emissions			
Category	Source	Below 2.5%	Above 97.5%	Difference	Below 2.5%	Above 97.5%	Difference	Median	Below 2.5%	Above 97.5%	Difference
all	all							32734	31753	33934	2181
1A1+1A2+1A4 St.comb, CO_2	all							31890	30998	32857	1859
1A1+1A2+1A4 St.comb, N_2O	all							344	138	1108	970
1A1+1A2+1A4 St.comb, CH_4	all							424	317	654	338
1A1+1A2+1A4 St.comb, CO_2	Stationary Combustion, Coal, CO_2	168.9	172.5	3.6	89.5	98.7	9.2	16055.2	15265.1	16872.7	1607.6
1A1+1A2+1A4 St.comb, CO_2	Stationary Combustion, Plastic waste, CO_2	16.1	17.7	1.6	58.0	109.0	51.0	1340.3	971.1	1842.6	871.5
1A1+1A2+1A4 St.comb, N_2O	Stationary Combustion, BIOMASS, N_2O	72.3	97.8	25.5	0.1	8.4	8.3	80.0	9.1	694.4	685.3
1A1+1A2+1A4 St.comb, N_2O	Stationary Combustion, LIQUID, N_2O	61.7	64.0	2.3	0.1	6.4	6.3	46.3	5.4	403.3	397.9
1A1+1A2+1A4 St.comb, CO_2	Stationary Combustion, Natural gas, CO_2	169.2	174.9	5.8	56.2	57.3	1.1	9764.0	9580.7	9954.4	373.7
1A1+1A2+1A4 St.comb, N_2O	Stationary Combustion, GAS, N_2O	169.1	174.8	5.7	0.1	2.2	2.1	62.5	10.0	369.7	359.8
1A1+1A2+1A4 St.comb, CH_4	Stationary Combustion, BIOMASS, CH_4	70.0	94.7	24.7	1.0	5.1	4.0	186.4	83.5	415.5	332.0
1A1+1A2+1A4 St.comb, N_2O	Stationary Combustion, SOLID, N_2O	170.0	173.7	3.7	0.1	1.1	1.1	48.8	12.8	196.7	183.9
1A1+1A2+1A4 St.comb, CO_2	Stationary Combustion, Gas oil, CO_2	20.3	21.5	1.2	70.5	77.6	7.1	1544.4	1460.1	1631.2	171.1
1A1+1A2+1A4 St.comb, CO_2	Stationary Combustion, Refinery gas, CO_2	14.6	14.9	0.3	54.2	59.7	5.5	841.3	800.5	883.5	83.0
1A1+1A2+1A4 St.comb, CO_2	Stationary Combustion, Petroleum coke, CO_2	8.0	8.4	0.4	88.0	96.9	8.9	754.8	716.1	795.4	79.2
1A1+1A2+1A4 St.comb, N_2O	Stationary Combustion, WASTE, N_2O	39.0	43.0	4.0	0.1	1.8	1.7	19.3	5.0	75.5	70.5
1A1+1A2+1A4 St.comb, CO_2	Stationary Combustion, Residual oil, CO_2	17.1	17.6	0.5	76.6	79.7	3.1	1359.2	1326.5	1392.6	66.1
1A1+1A2+1A4 St.comb, CH_4	Natural gas fuelled engines, GAS, CH_4	18.1	18.5	0.4	9.2	11.1	1.9	185.0	167.8	203.3	35.4
1A1+1A2+1A4 St.comb, CH_4	Stationary Combustion, GAS, CH_4	151.2	156.2	5.1	0.0	0.2	0.2	15.1	6.7	33.2	26.5
1A1+1A2+1A4 St.comb, CH_4	Stationary Combustion, SOLID, CH_4	170.0	173.6	3.7	0.0	0.1	0.1	8.2	3.6	18.4	14.8
1A1+1A2+1A4 St.comb, CO_2	Stationary Combustion, Coke, CO_2	1.0	1.1	0.0	102.9	113.2	10.3	112.1	106.4	117.9	11.6
1A1+1A2+1A4 St.comb, CO_2	Stationary Combustion, LPG, CO_2	1.4	1.5	0.1	62.0	68.2	6.2	96.0	90.9	101.4	10.5
1A1+1A2+1A4 St.comb, CH_4	Biogas fuelled engines, BIOMASS, CH_4	2.2	2.4	0.1	7.5	11.0	3.5	20.9	17.3	25.3	8.1
1A1+1A2+1A4 St.comb, CH_4	Stationary Combustion, LIQUID, CH_4	61.7	64.0	2.3	0.0	0.2	0.1	4.3	2.0	9.5	7.5
1A1+1A2+1A4 St.comb, CH_4	Stationary Combustion, WASTE, CH_4	39.0	42.9	3.9	0.0	0.0	0.0	0.9	0.4	2.0	1.6
1A1+1A2+1A4 St.comb, CO_2	Stationary Combustion, Kerosene, CO_2	0.1	0.1	0.0	68.6	75.6	7.0	8.6	8.1	9.1	1.0
1A1+1A2+1A4 St.comb, CO_2	Stationary Combustion, BKB, CO_2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Annex 3A-8 Emission inventory 2008 based on SNAP sectors

Table 3A-8.1 Emission inventory 2008 based on SNAP sectors.

SNAP	SO_2	NO_x	NMVOC	CH_4	CO	CO_2 [1)]	N_2O
	Mg	Mg	Mg	Mg	Mg	Gg	Mg
Total 01	6606	32576	1879	8693	8211	29989	428
101	5582	22532	1738	8180	5003	25795	273
10100	0	0	0	0	0	0	0
10101	4415	10878	239	337	1914	16476	154
10102	788	5011	57	59	699	4435	50
10103	145	1536	14	43	289	1357	16
10104	201	2802	71	78	741	2564	42
10105	34	2305	1357	7663	1361	962	11
102	699	1524	100	463	2906	1674	59
10200	0	0	0	0	0	0	0
10201	1	4	0	0	2	4	0
10202	46	106	6	24	187	120	4
10203	652	1393	81	367	2704	1540	55
10204	0	0	0	0	0	0	0
10205	0	22	13	72	12	9	0
103	316	1490	1	4	119	912	34
10300	0	0	0	0	0	0	0
10301	0	0	0	0	0	0	0
10302	0	0	0	0	0	0	0
10303	0	0	0	0	0	0	0
10304	6	408	1	4	16	145	6
10305	0	0	0	0	0	0	0
10306	310	1082	0	0	103	767	29
104	0	0	0	0	0	0	0
10400	0	0	0	0	0	0	0
10401	0	0	0	0	0	0	0
10402	0	0	0	0	0	0	0
10403	0	0	0	0	0	0	0
10404	0	0	0	0	0	0	0
10405	0	0	0	0	0	0	0
10406	0	0	0	0	0	0	0
10407	0	0	0	0	0	0	0
105	9	7031	40	45	183	1608	62
10500	0	0	0	0	0	0	0
10501	0	0	0	0	0	0	0
10502	0	38	1	2	10	20	0
10503	0	0	0	0	0	0	0
10504	8	6993	39	42	173	1588	62
10505	0	0	0	1	0	0	0
10506	0	0	0	0	0	0	0
Total 2	4310	8228	20063	10365	143986	8656	263
201	273	811	271	848	839	1015	22
20100	260	595	192	280	655	913	21
20101	0	0	0	0	0	0	0
20102	0	0	0	0	0	0	0
20103	4	16	1	1	7	21	1
20104	0	0	0	0	0	0	0
20105	8	200	78	567	177	81	1
20106	0	0	0	0	0	0	0
202	2466	6702	19222	8477	133437	6955	221
20200	2465	6526	19110	7892	133364	6880	220

SNAP	SO_2	NO_x	NMVOC	CH_4	CO	CO_2 1)	N_2O
	Mg	Mg	Mg	Mg	Mg	Gg	Mg
20201	0	0	0	0	0	0	0
20202	0	3	0	1	2	5	0
20203	0	0	0	0	0	0	0
20204	1	173	112	583	72	70	1
20205	0	0	0	0	0	0	0
203	1572	715	570	1040	9709	686	19
20300	1558	530	468	448	9597	607	18
20301	0	0	0	0	0	0	0
20302	11	4	0	0	1	2	0
20303	0	1	0	0	0	2	0
20304	3	179	102	592	111	75	1
20305	0	0	0	0	0	0	0
Total 03	5383	9557	371	976	12879	4915	138
301	3508	3378	246	787	2645	3513	94
30100	2124	2272	158	373	2162	2601	62
30101	0	0	0	0	0	0	0
30102	1261	735	33	75	354	598	26
30103	116	67	1	8	15	54	2
30104	1	180	6	6	18	212	4
30105	5	125	47	325	96	47	1
30106	0	0	0	0	0	0	0
302	0	0	0	0	0	0	0
30200	0	0	0	0	0	0	0
30203	0	0	0	0	0	0	0
30204	0	0	0	0	0	0	0
30205	0	0	0	0	0	0	0
303	1875	6178	125	189	10234	1403	44
30300	0	0	0	0	0	0	0
30301	0	0	0	0	0	0	0
30302	0	0	0	0	0	0	0
30303	0	0	0	0	0	0	0
30304	0	0	0	0	0	0	0
30305	0	0	0	0	0	0	0
30306	0	0	0	0	0	0	0
30307	0	0	0	0	0	0	0
30308	0	0	0	0	0	0	0
30309	0	0	0	0	0	0	0
30310	0	0	0	0	0	0	0
30311	1397	5876	113	169	1792	1237	40
30312	0	0	0	0	0	0	0
30313	0	0	0	0	0	0	0
30314	0	0	0	0	0	0	0
30315	0	204	2	5	59	49	1
30316	0	0	0	0	0	0	0
30317	0	0	0	0	0	0	0
30318	478	98	11	15	8383	117	3
30319	0	0	0	0	0	0	0
30320	0	0	0	0	0	0	0
30321	0	0	0	0	0	0	0
30322	0	0	0	0	0	0	0
30323	0	0	0	0	0	0	0
30324	0	0	0	0	0	0	0
30325	0	0	0	0	0	0	0
30326	0	0	0	0	0	0	0

SNAP	SO_2	NO_x	NMVOC	CH_4	CO	CO_2 [1)]	N_2O
	Mg	Mg	Mg	Mg	Mg	Gg	Mg
30327	0	0	0	0	0	0	0

[1)] Including CO_2 emission from biomass

[2)] SNAP sector codes are shown in appendix 3

Annex 3A-9 Description of the Danish energy statistics

This description of the Danish energy statistics has been prepared by Denmark's National Environmental Research Institute (NERI) in cooperation with the Danish Energy Agency (DEA) as background information to the Danish National Inventory Report (NIR).

The Danish energy statistics system

DEA is responsible for the Danish energy balance. Main contributors to the energy statistics outside DEA are Statistics Denmark and Danish Energy Association (before Association of Danish Energy Companies). The statistics is performed using an integrated statistical system building on an Access database and Excel spreadsheets.

The DEA follows the recommendations of the International Energy Agency as well as Eurostat.

The national energy statistics is updated annually and all revisions are immediately included in the published statistics, which can be found on http://ens.dk/sw16508.asp. It is an easy task to check for breaks in a series because the statistics is 100% time-series oriented.

The national energy statistics does not include Greenland and Faroe Islands.

For historical reasons, DEA receive monthly information from the Danish oil companies regarding Danish deliveries of oil products to Greenland and Faroe Islands. But the monthly (MOS) and annual (AOS) reporting of oil statistics to Eurostat and IEA exclude Greenland and Faroe Islands. For all other energy products the Danish figures are also excluding Greenland and Faroe Islands.

Reporting to the Danish Energy Agency

The Danish Energy Agency receives monthly statistics for the following fuel groups:

- Crude oil and oil products
  - Monthly data from 46 oil companies, the main purpose is monitoring oil stocks according to the oil preparedness system
- Natural gas
  - Fuel/flare from platforms in the North Sea
  - Natural gas balance from the regulator Energinet.dk (National monopoly)
- Coal and coke
  - Power plants (94 %)
  - Industry companies (4 %)
  - Coal and coke traders (2 %)
- Electricity

    - Monthly reporting by e-mail from the regulator Energinet.dk (National monopoly)
    - The statistics covers:
    - Production by type of producer
    - Own use of electricity
    - Import and export by country
    - Domestic supply (consumption + distribution loss)
  - Town gas (quarterly) from two town gas producers

The large central power plants also report monthly consumption of biomass.

Annual data includes renewable energy including waste. The DEA conducts a biannual survey on wood pellets and wood fuel. Statistics Denmark conducts biannual surveys on the energy consumption in the service and industrial sectors. Statistics Denmark prepares annual surveys on forest (wood fuel) & straw.

Other annual data sources include:

- DEA
  - Survey on production of electricity and heat and fuels used
  - Survey on end use of oil
  - Survey on end use of natural gas
  - Survey on end use of coal and coke
- National Environmental Research Institute (NERI), Aarhus University
  - Energy consumption for domestic air transport
- Danish Energy Association (Association of Danish Energy companies)
  - Survey on electricity consumption
- Ministry of Taxation
  - Border trade
- Centre for Biomass Technology
  - Annual estimates of final consumption of straw and wood chips

Annual revisions

In general, DEA follows the same procedures as in the Danish national account. This means that normally only figures for the last two years are revised.

Aggregating the energy statistics on SNAP level

As part of the data delivery agreement between the DEA and NERI, the DEA supplies a version of the official energy statistics aggregated on SNAP level to be used in the emission calculation. In cooperation between DEA and NERI a fuel correspondence table has been developed mapping the fuels used by the DEA in the official energy statistics with the fuel codes used in the Danish national emission database. Similarly the sectors used in the official energy statistics have been mapped to SNAP categories, used in the Danish emission database. The fuel correspondence table between fuel categories used by the DEA, NERI and IPCC is presented in Appendix 3.

The mapping between the energy statistics and the SNAP and fuel codes used by NERI can be seen in the table below.

Table 3A-9.1 Correspondance between the Danish national energy statistics and the snap nomenclature.

Unit: TJ	Enduse			Transformation 1980-1993	
	Snap	Fuel *(in Danish)*	Fuel-code	Snap	Fuel-code
Foreign Trade					
- *Border Trade*					
- - Motor Gasoline					
- - Gas-/Diesel Oil					
- - Petroleum Coke	0202	Petrokoks	110A		
Vessels in Foreign Trade					
- *International Marine Bunkers*					
- - Gas-/Diesel Oil	080404	Gas & Dieselolie	204B		
- - Fuel Oil	080404	Fuelolie & Spildolie	203W		
- - Lubricants					
Energy Sector					
Extraction and Gasification					
- *Extraction*					
- - Natural Gas	010504	Naturgas	301A		
- *Gasification*					
- - Biogas, Landfill	091006	Biogas	309A		
- - Biogas, Other	091006	Biogas	309A		
Refineries					
- Own Use					
- - Refinery Gas	010306	Raffinaderigas	308A		
- - LPG	010306	LPG	303A		
- - Gas-/Diesel Oil	010306	Gas & Dieselolie	204A		
- - Fuel Oil	010306	Fuelolie & Spildolie	203A		
Transformation Sector					
Large-scale Power Units					
- *Fuels Used for Power Production*					
- - Gas-/Diesel Oil				0101	204A
- - Fuel Oil				0101	203A
- - Electricity Plant Coal				0101	102A
- - Straw				0101	117A
Large-Scale CHP Units					
- *Fuels Used for Power Production*					
- - Refinery Gas				0103	308A
- - LPG				0101	303A
- - Naphtha (LVN)				0101	210A
- - Gas-/Diesel Oil				0101	204A
- - Fuel Oil				0101	203A
- - Petroleum Coke				0101	110A
- - Orimulsion				0101	225A
- - Natural Gas				0101	301A
- - Electricity Plant Coal				0101	102A
- - Straw				0101	117A
- - Wood Chips				0101	111A
- - Wood Pellets				0101	111A
- - Wood Waste				0101	111A
- - Biogas, Landfill				0101	309A
- - Biogas, Others				0101	309A
- - Waste, Non-renewable				0101	114A
- - Wastes, Renewable				0101	114A
- *Fuels Used for Heat Production*					
- - Refinery Gas				0103	308A
- - LPG				0101	303A
- - Naphtha (LVN)				0101	210A
- - Gas-/Diesel Oil				0101	204A
- - Fuel Oil				0101	203A
- - Petroleum Coke				0101	110A
- - Orimulsion				0101	225A
- - Natural Gas				0101	301A
- - Electricity Plant Coal				0101	102A
- - Straw				0101	117A
- - Wood Chips				0101	111A
- - Wood Pellets				0101	111A
- - Wood Waste				0101	111A
- - Biogas, Landfill				0101	309A
- - Biogas, Other				0101	309A
- - Waste, Non-renewable				0101	114A
- - Wastes, Renewable				0101	114A
Small-Scale CHP Units					
- *Fuels Used for Power Production*					
- - Gas-/Diesel Oil				0101	204A

Continued		
- - Fuel Oil	0101	203A
- - Natural Gas	0101	301A
- - Hard Coal	0101	102A
- - Straw	0101	117A
- - Wood Chips	0101	111A
- - Wood Pellets	0101	111A
- - Wood Waste	0101	111A
- - Biogas, Landfill	0101	309A
- - Biogas, Other	0101	309A
- - Waste, Non-renewable	0101	114A
- - Wastes, Renewable	0101	114A
- *Fuels Used for Heat Production*		
- - Gas-/Diesel Oil	0101	204A
- - Fuel Oil	0101	203A
- - Natural Gas	0101	301A
- - Coal	0101	102A
- - Straw	0101	117A
- - Wood Chips	0101	111A
- - Wood Pellets	0101	111A
- - Wood Waste	0101	111A
- - Biogas, Landfill	0101	309A
- - Biogas, Other	0101	309A
- - Waste, Non-renewable	0101	114A
- - Wastes, Renewable	0101	114A
District Heating Units		
- *Fuels Used for Heat Production*		
- - Refinery Gas	0103	308A
- - LPG	0102	303A
- - Gas-/Diesel Oil	0102	204A
- - Fuel Oil	0102	203A
- - Waste Oil	0102	203A
- - Petroleum Coke	0102	110A
- - Natural Gas	0102	301A
- - Electricity Plant Coal	0102	102A
- - Coal	0102	102A
- - Straw	0102	117A
- - Wood Chips	0102	111A
- - Wood Pellets	0102	111A
- - Wood Waste	0102	111A
- - Biogas, Landfill	0102	309A
- - Biogas, Sludge	0102	309A
- - Biogas, Other	0102	309A
- - Waste, Non-renewable	0102	114A
- - Wastes, Renewable	0102	114A
- - Fish Oil	0102	215A
Autoproducers, Electricity Only		
- Fuels Used for Power Production		
- - Natural Gas	0301	301A
- - Biogas, Landfill	0301	309A
- - Biogas, Sewage Sludge	0301	309A
- - Biogas, Other	0301	309A
Autoproducers, CHP Units		
- *Fuels Used for Power Production*		
- - Refinery Gas	0103	308A
- - Gas-/Diesel Oil	0301	204A
- - Fuel Oil	0301	203A
- - Waste Oil	0301	203A
- - Natural Gas	0301	301A
- - Coal	0301	102A
- - Straw	0301	117A
- - Wood Chips	0301	111A
- - Wood Pellets	0301	111A
- - Wood Waste	0301	111A
- - Biogas, Landfill	0301	309A
- - Biogas, Sludge	0301	309A
- - Biogas, Other	0301	309A
- - Fish Oil	0301	215A
- - Waste, Non-renewable	0301	114A
- - Wastes, Renewable	0301	114A
- *Fuels Used for Heat Production*		
- - Refinery Gas	0103	308A
- - Gas-/Diesel Oil	0301	204A
- - Fuel Oil	0301	203A

Continued					
- - Waste Oil				0301	203A
- - Natural Gas				0301	301A
- - Coal				0301	102A
- - Wood Chips				0301	111A
- - Wood Waste				0301	111A
- - Biogas, Landfill				0301	309A
- - Biogas, Sludge				0301	309A
- - Biogas, Other				0301	309A
- - Waste, Non-renewable				0301	114A
- - Wastes, Renewable				0301	114A
Autoproducers, Heat Only					
- *Fuels Used for Heat Production*					
- - Gas-/Diesel Oil				0301	204A
- - Fuel Oil				0301	203A
- - Waste Oil				0301	203A
- - Natural Gas				0301	301A
- - Straw				0301	117A
- - Wood Chips				0301	111A
- - Wood Chips				0301	111A
- - Wood Waste				0301	111A
- - Biogas, Landfill				0301	309A
- - Biogas, Sludge				0301	309A
- - Biogas, Other				0301	309A
- - Waste, Non-renewable				0102	114A
- - Wastes, Renewable				0102	114A
Town Gas Units	030106	Naturgas	301A		
- Fuels Used for Production of District Heating	030106	Kul (-83) / Gasolie (84-)	102A / 204A		
Transport					
Military Transport					
- Aviation Gasoline	0801	Flyvebenzin	209A		
- Motor Gasoline	0801	Benzin og LVN	2080		
- JP4	0801	JP1 og JP4	207A		
- JP1	0801	JP1 og JP4	207A		
- Gas-/Diesel Oil	0801	Gas & Dieselolie	2050		
Road					
- LPG	07	LPG	3030		
- Motor Gasoline	07	Benzin og LVN	2080		
- Other Kerosene	0202	Petroleum	206A		
- Gas-/Diesel Oil	07	Gas & Dieselolie	2050		
- Fuel Oil	07	Fuelolie & Spildolie	203V		
Rail					
- Motor Gasoline	0802	Benzin og LVN	2080		
- Other Kerosene	0802	Petroleum	206A		
- Gas-/Diesel Oil	0802	Gas & Dieselolie	2050		
- Electricity					
Domestic Sea Transport					
- LPG	080402	LPG	3030		
- Other Kerosene	080402	Petroleum	206A		
- Gas-/Diesel Oil	080402	Gas & Dieselolie	204B		
- Fuel Oil	080402	Fuelolie & Spildolie	203V		
Air Transport, Domestic					
- LPG	080501/080503	LPG	3030		
- Aviation Gasoline	080501/080503	Flyvebenzin	209A		
- Motor Gasoline	080501/080503	Benzin og LVN	2080		
- Other Kerosene	0201	Petroleum	206A		
- JP1	080501/080503	JP1 og JP4	207A		
Air Transport, International					
- Aviation Gasoline	080502/080504	Flyvebenzin	209A		
- JP1	080502/080504	JP1 og JP4	207A		
Agriculture and Forestry					
- LPG	0806-09	LPG	303A		
- Motor Gasoline	0806-09	Benzin og LVN	2080		
- Other Kerosene	0203	Petroleum	206A		
- Gas-/Diesel Oil	0806-09	Gas & Dieselolie	204B		
- Fuel Oil	0203	Fuelolie & Spildolie	203A		
- Petroleum Coke	0203	Petrokoks	110A		
- Natural Gas	0203	Naturgas	301A		
- Coal	0203	Kul	102A		
- Brown Coal Briquettes	0203	Brunkul	106A		
- Straw	0203	Halm	117A		
- Wood Chips	0203	Træ	111A		

Continued			
- Wood Waste	0203	Træ	111A
- Biogas, Other	0203	Biogas	309A
Horticulture			
- LPG	0806-09	LPG	3030
- Motor Gasoline	0806-09	Benzin og LVN	2080
- Gas-/Diesel Oil	0806-09	Gas & Dieselolie	204B
- Fuel Oil	0203	Fuelolie & Spildolie	203A
- Petroleum Coke	0203	Petrokoks	110A
- Natural Gas	0203	Naturgas	301A
- Coal	0203	Kul	102A
- Wood Waste	0203	Træ	111A
Fishing			
- LPG	080403	LPG	3030
- Motor Gasoline	080403	Benzin og LVN	2080
- Other Kerosene	080403	Petroleum	206A
- Gas-/Diesel Oil	080403	Gas & Dieselolie	204B
- Fuel Oil	080403	Fuelolie & Spildolie	203V
Manufacturing Industry			
- Refinery Gas	0301	Raffinaderigas	308A
- LPG	0806-09	LPG	3030
- Naphtha (LVN)	0806-09	Benzin og LVN	2080
- Motor Gasoline	0806-09	Benzin og LVN	2080
- Other Kerosene	0301	Petroleum	206A
- Gas-/Diesel Oil	0806-09	Gas & Dieselolie	204B
- Fuel Oil	0301	Fuelolie & Spildolie	203A
- Waste Oil	0301	Fuelolie & Spildolie	203A
- Petroleum Coke	0301	Petrokoks	110A
- Natural Gas	0301	Naturgas	301A
- Coal	0301	Kul	102A
- Coke	0301	Koks	107A
- Brown Coal Briquettes	0301	Brunkul	106A
- Wood Pellets	0301	Træ	111A
- Wood Waste	0301	Træ	111A
- Biogas, Landfill	0301	Biogas	309A
- Biogas, Other	0301	Biogas	309A
- Wastes, Non-renewable	0301	Affald	114A
- Wastes, Renewable	0301	Affald	114A
- Town Gas	0301	Naturgas	301A
Construction			
- LPG	0301	LPG	303A
- Motor Gasoline	0806-09	Benzin og LVN	2080
- Other Kerosene	0301	Petroleum	206A
- Gas-/Diesel Oil	0806-09	Gas & Dieselolie	204B
- Fuel Oil	0301	Fuelolie & Spildolie	203A
- Natural Gas	0301	Naturgas	301A
Wholesale			
- LPG	0201	LPG	303A
- Motor Gasoline	0201	Petroleum	206A
- Other Kerosene	0201	Gas & Dieselolie	204A
- Gas-/Diesel Oil	0201	Fuelolie & Spildolie	203A
- Petroleum Coke	0201	Petrokoks	110A
- Natural Gas	0201	Naturgas	301A
- Wood Waste	0201	Træ	111A
Retail Trade			
- LPG	0201	LPG	303A
- Other Kerosene	0201	Petroleum	206A
- Gas-/Diesel Oil	0201	Gas & Dieselolie	204A
- Fuel Oil	0201	Fuelolie & Spildolie	203A
- Petroleum Coke	0201	Petrokoks	110A
- Natural Gas	0201	Naturgas	301A
Private Service			
- LPG	0201	LPG	303A
- Other Kerosene	0201	Petroleum	206A
- Gas-/Diesel Oil	0201	Gas & Dieselolie	204A
- Fuel Oil	0201	Fuelolie & Spildolie	203A
- Waste Oil	0201	Fuelolie & Spildolie	203A
- Petroleum Coke	0201	Petrokoks	110A
- Natural Gas	0201	Naturgas	301A
- Wood Chips	0201	Træ	111A
- Wood Waste	0201	Træ	111A
- Biogas, Landfill	0201	Biogas	309A
- Biogas, Sludge	0201	Biogas	309A
- Biogas, Other	0201	Biogas	309A

Continued			
- Wastes, Non-renewable	0201	Affald	114A
- Wastes, Renewable	0201	Affald	114A
- Town Gas	0201	Naturgas	301A
Public Service			
- LPG	0201	LPG	303A
- Other Kerosene	0201	Petroleum	206A
- Gas-/Diesel Oil	0201	Gas & Dieselolie	204A
- Fuel Oil	0201	Fuelolie & Spildolie	203A
- Petroleum Coke	0201	Petrokoks	110A
- Natural Gas	0201	Naturgas	301A
- Coal	0201	Kul	102A
- Brown Coal Briquettes	0201	Brunkul	106A
- Wood Chips	0201	Træ	111A
- Wood Pellets	0201	Træ	111A
- Town Gas	0201	Naturgas	301A
Single Family Houses			
- LPG	0202	LPG	303A
- Motor Gasoline	0806-09	Benzin og LVN	2080
- Other Kerosene	0202	Petroleum	206A
- Gas-/Diesel Oil	0202	Gas & Dieselolie	204A
- Fuel Oil	0202	Fuelolie & Spildolie	203A
- Petroleum Coke	0202	Petrokoks	110A
- Natural Gas	0202	Naturgas	301A
- Coal	0202	Kul	102A
- Coke	0202	koks	107A
- Brown Coal Briquettes	0202	Brunkul	106A
- Straw	0202	Halm	117A
- Firewood	0202	Træ	111A
- Wood Chips	0202	Træ	111A
- Wood Pellets	0202	Træ	111A
- Town Gas	0202	Naturgas	301A
Multi-family Houses			
- LPG	0202	LPG	303A
- Other Kerosene	0202	Petroleum	206A
- Gas-/Diesel Oil	0202	Gas & Dieselolie	204A
- Fuel Oil	0202	Fuelolie & Spildolie	203A
- Petroleum Coke	0202	Petrokoks	110A
- Natural Gas	0202	Naturgas	301A
- Coal	0202	Kul	102A
- Coke	0202	Koks	107A
- Brown Coal Briquettes	0202	Brunkul	106A
- Town Gas	0202	Naturgas	301A

Annex 3B Transport

List of content

Annex 3B-1 Fleet data 1985-2008 for road transport (No. vehicles)

Sector	Subsector	Tech 2	FYear	LYear	1985	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Passenger Cars	Gasoline <1,4 l	PRE ECE	0	1969	80570	46208	44014	42804	36466	39959	37597	37130	3434	2761	2103
Passenger Cars	Gasoline <1,4 l	ECE 15/00-01	1970	1978	333715	187911	161642	139010	119424	80741	67991	53302	44338	31104	22511
Passenger Cars	Gasoline <1,4 l	ECE 15/02	1979	1980	104223	86056	79240	72588	65797	49614	42976	34748	25889	17458	10806
Passenger Cars	Gasoline <1,4 l	ECE 15/03	1981	1985	345946	301692	295677	288944	280769	262502	250449	233656	215509	183239	147178
Passenger Cars	Gasoline <1,4 l	ECE 15/04	1986	1990		282011	280181	278685	278152	275859	272989	269953	275188	264791	254032
Passenger Cars	Gasoline <1,4 l	Euro I	1991	1996			39608	73527	101489	139813	169133	205235	210861	208281	206803
Passenger Cars	Gasoline <1,4 l	Euro II	1997	2000									38465	74495	108508
Passenger Cars	Gasoline <1,4 l	Euro III	2001	2005											
Passenger Cars	Gasoline <1,4 l	Euro IV	2006	2010											
Passenger Cars	Gasoline 1,4 - 2,0 l	PRE ECE	0	1969	61592	35940	34233	33292	28362	31079	29242	28879	2671	2148	1635
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/00-01	1970	1978	218180	127631	109640	94188	80844	54600	45991	36078	30465	21520	15647
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/02	1979	1980	60836	55062	50674	46402	42040	31712	27445	22173	16509	11141	6870
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/03	1981	1985	210574	174545	170749	166595	161591	150612	143385	133412	122642	103931	83270
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/04	1986	1990		190297	188949	187872	187524	186044	184194	182297	186155	179510	172582
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro I	1991	1996			35647	75763	119562	201007	288096	375253	383870	378063	375137
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro II	1997	2000									95358	196046	274022
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro III	2001	2005											
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro IV	2006	2010											
Passenger Cars	Gasoline >2,0 l	PRE ECE	0	1969	5923	3423	3260	3171	2701	2960	2785	2750	254	205	156
Passenger Cars	Gasoline >2,0 l	ECE 15/00-01	1970	1978	18532	10781	9234	7914	6781	4567	3849	3022	2619	1881	1366
Passenger Cars	Gasoline >2,0 l	ECE 15/02	1979	1980	8730	4392	4043	3702	3354	2531	2191	1770	1318	888	549
Passenger Cars	Gasoline >2,0 l	ECE 15/03	1981	1985	31066	24667	24157	23595	22912	21429	20432	19053	17571	14934	12016
Passenger Cars	Gasoline >2,0 l	ECE 15/04	1986	1990		25679	25524	25389	25338	25120	24844	24546	24977	23975	22975
Passenger Cars	Gasoline >2,0 l	Euro I	1991	1996			3961	8129	12434	20068	27915	35770	36617	36081	35808
Passenger Cars	Gasoline >2,0 l	Euro II	1997	2000									12432	27315	44923
Passenger Cars	Gasoline >2,0 l	Euro III	2001	2005											
Passenger Cars	Gasoline >2,0 l	Euro IV	2006	2010											
Passenger Cars	Diesel <2,0 l	Conventional	0	1990	75828	79714	75794	72294	68535	62144	58848	55004	48251	43893	43004
Passenger Cars	Diesel <2,0 l	Euro I	1991	1996			4042	8018	11872	18305	24557	31177	31314	31730	35118
Passenger Cars	Diesel <2,0 l	Euro II	1997	2000									7046	14640	23084
Passenger Cars	Diesel <2,0 l	Euro III	2001	2005											
Passenger Cars	Diesel <2,0 l	Euro IV	2006	2010											
Passenger Cars	Diesel >2,0 l	Conventional	0	1990	3451	3703	3556	3425	3281	3040	2906	2747	2461	2266	2237
Passenger Cars	Diesel >2,0 l	Euro I	1991	1996			213	437	668	1078	1499	1921	1928	1952	2161
Passenger Cars	Diesel >2,0 l	Euro II	1997	2000									655	1478	2711

Passenger Cars	Diesel >2,0 l	Euro III	2001	2005											
Passenger Cars	Diesel >2,0 l	Euro IV	2006	2010											
Passenger Cars	LPG	Conventional	0	1990	287	286	286	288	289	289	301	311	172	97	44
Passenger Cars	2-Stroke	Conventional	0	9999	4823	5417	4804	4308	3747	3029	2443	1824	1248	761	400
Light Duty Vehicles	Gasoline <3,5t	Conventional	0	1994	33049	42333	43215	44179	45486	47261	44601	41519	37209	34454	31489
Light Duty Vehicles	Gasoline <3,5t	Euro I	1995	1998							4259	8524	12645	17212	16632
Light Duty Vehicles	Gasoline <3,5t	Euro II	1999	2001											4705
Light Duty Vehicles	Gasoline <3,5t	Euro III	2002	2006											
Light Duty Vehicles	Gasoline <3,5t	Euro IV	2007	2011											
Light Duty Vehicles	Diesel <3,5 t	Conventional	0	1994	121431	155543	158781	162324	167129	173650	163877	152553	142109	131572	122992
Light Duty Vehicles	Diesel <3,5 t	Euro I	1995	1998							15648	31318	48292	65727	64964
Light Duty Vehicles	Diesel <3,5 t	Euro II	1999	2001											18376
Light Duty Vehicles	Diesel <3,5 t	Euro III	2002	2006											
Light Duty Vehicles	Diesel <3,5 t	Euro IV	2007	2011											
Heavy Duty Vehicles	Gasoline >3,5 t	Conventional	0	9999	251	250	255	260	268	279	288	295	261	274	253
Heavy Duty Vehicles	Diesel 3,5 - 7,5 t	Conventional	0	1993	5140	5108	5214	5330	5369	5087	4775	4418	3891	3585	2986
Heavy Duty Vehicles	Diesel 3,5 - 7,5 t	Euro I	1994	1996					120	616	1121	1488	1421	1415	1251
Heavy Duty Vehicles	Diesel 3,5 - 7,5 t	Euro II	1997	2001								132	655	1213	1598
Heavy Duty Vehicles	Diesel 3,5 - 7,5 t	Euro III	2002	2006											
Heavy Duty Vehicles	Diesel 3,5 - 7,5 t	Euro IV	2007	2009											
Heavy Duty Vehicles	Diesel 3,5 - 7,5 t	Euro V	2010	2014											
Heavy Duty Vehicles	Diesel 7,5 - 16 t	Conventional	0	1993	10350	10286	10500	10734	10811	10243	9615	8897	7590	6413	5443
Heavy Duty Vehicles	Diesel 7,5 - 16 t	Euro I	1994	1996					241	1240	2257	2997	2772	2531	2281
Heavy Duty Vehicles	Diesel 7,5 - 16 t	Euro II	1997	2001								265	1278	2171	2914
Heavy Duty Vehicles	Diesel 7,5 - 16 t	Euro III	2002	2006											
Heavy Duty Vehicles	Diesel 7,5 - 16 t	Euro IV	2007	2009											
Heavy Duty Vehicles	Diesel 7,5 - 16 t	Euro V	2010	2014											
Heavy Duty Vehicles	Diesel 16 - 32 t	Conventional	0	1993	13115	13034	13306	13602	13700	12981	12184	11274	10431	9548	8709
Heavy Duty Vehicles	Diesel 16 - 32 t	Euro I	1994	1996					305	1571	2860	3798	3810	3768	3649
Heavy Duty Vehicles	Diesel 16 - 32 t	Euro II	1997	2001								336	1757	3232	4662
Heavy Duty Vehicles	Diesel 16 - 32 t	Euro III	2002	2006											
Heavy Duty Vehicles	Diesel 16 - 32 t	Euro IV	2007	2009											
Heavy Duty Vehicles	Diesel 16 - 32 t	Euro V	2010	2014											
Heavy Duty Vehicles	Diesel >32t	Conventional	0	1993	11517	11446	11684	11944	12030	11398	10699	9900	9086	8469	7931
Heavy Duty Vehicles	Diesel >32t	Euro I	1994	1996					268	1379	2511	3335	3318	3342	3323
Heavy Duty Vehicles	Diesel >32t	Euro II	1997	2001								295	1530	2866	4246
Heavy Duty Vehicles	Diesel >32t	Euro III	2002	2006											
Heavy Duty Vehicles	Diesel >32t	Euro IV	2007	2009											

Heavy Duty Vehicles	Diesel >32t	Euro V	2010	2014											
Buses	Urban Buses	Conventional	0	1993	4712	4753	4561	4522	4490	4083	3635	3261	2946	2792	2542
Buses	Urban Buses	Euro I	1994	1996						390	746	1084	1060	972	913
Buses	Urban Buses	Euro II	1997	2001									390	729	1053
Buses	Urban Buses	Euro III	2002	2006											
Buses	Urban Buses	Euro IV	2007	2009											
Buses	Coaches	Conventional	0	1993	3298	3327	2868	3007	3086	2927	4507	4156	3662	3369	3007
Buses	Coaches	Euro I	1994	1996						280	925	1381	1318	1173	1080
Buses	Coaches	Euro II	1997	2001									485	879	1246
Buses	Coaches	Euro III	2002	2006											
Buses	Coaches	Euro IV	2007	2009											
Mopeds	<50 cm³	Conventional	0	1999	151000	120000	118000	113000	109000	105000	114167	123333	132500	141667	150833
Mopeds	<50 cm³	Euro I	2000	2003											
Mopeds	<50 cm³	Euro II	2004	9999											
Motorcycles	2-stroke >50 cm³	Conventional	0	1999	6209	6617	6804	6904	7111	7406	7672	8214	8980	9598	10385
Motorcycles	4-stroke <250 cm³	Conventional	0	1999	7037	7499	7712	7824	8059	8394	8695	9310	10177	10878	11769
Motorcycles	4-stroke <250 cm³	Euro I	2000	2003											
Motorcycles	4-stroke <250 cm³	Euro II	2004	2006											
Motorcycles	4-stroke <250 cm³	Euro III	2007	9999											
Motorcycles	4-stroke 250 - 750 cm³	Conventional	0	1999	19352	20622	21207	21516	22162	23083	23911	25602	27986	29914	32365
Motorcycles	4-stroke 250 - 750 cm³	Euro I	2000	2003											
Motorcycles	4-stroke 250 - 750 cm³	Euro II	2004	2006											
Motorcycles	4-stroke 250 - 750 cm³	Euro III	2007	9999											
Motorcycles	4-stroke >750 cm³	Conventional	0	1999	8796	9374	9639	9780	10074	10492	10869	11637	12721	13597	14712
Motorcycles	4-stroke >750 cm³	Euro I	2000	2003											
Motorcycles	4-stroke >750 cm³	Euro II	2004	2006											
Motorcycles	4-stroke >750 cm³	Euro III	2007	9999											

Continued

Sector	Subsector	Tech 2	FYear	LYear	2000	2001	2002	2003	2004	2005	2006	2007	2008
Passenger Cars	Gasoline <1,4 l	PRE ECE	0	1969	1744	1614	1475	1392	1313	1313	1313	1313	1313
Passenger Cars	Gasoline <1,4 l	ECE 15/00-01	1970	1978	17980	15837	14155	13149	12404	12335	12279	12102	11777
Passenger Cars	Gasoline <1,4 l	ECE 15/02	1979	1980	7298	5510	4178	3128	2433	2882	2869	2828	2746
Passenger Cars	Gasoline <1,4 l	ECE 15/03	1981	1985	118979	97964	79041	60723	45824	25489	14555	8865	6786
Passenger Cars	Gasoline <1,4 l	ECE 15/04	1986	1990	235890	219216	194543	171430	142490	133653	117770	97775	70786
Passenger Cars	Gasoline <1,4 l	Euro I	1991	1996	204184	201708	197423	192152	185488	183896	185747	175728	175378
Passenger Cars	Gasoline <1,4 l	Euro II	1997	2000	135030	132812	130153	128898	126400	133689	129230	130820	119275
Passenger Cars	Gasoline <1,4 l	Euro III	2001	2005		21858	47428	70311	99658	126777	128423	137270	143825

Passenger Cars	Gasoline <1,4 l	Euro IV	2006	2010							31558	54861	78115
Passenger Cars	Gasoline 1,4 - 2,0 l	PRE ECE	0	1969	1356	1255	1147	1083	1021	1021	1021	1021	1021
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/00-01	1970	1978	12537	11077	9923	9230	8707	8852	8964	8986	8876
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/02	1979	1980	4642	3500	2659	1987	1545	1858	1892	1908	1871
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/03	1981	1985	67222	55300	44572	34238	25810	14529	8564	5515	4331
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/04	1986	1990	160800	149915	133745	118448	99092	86463	72814	58779	41539
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro I	1991	1996	370803	367136	359959	351645	340424	286124	227403	169862	145690
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro II	1997	2000	326268	320971	314678	311808	305621	334798	342059	322170	270645
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro III	2001	2005		49700	105323	147067	195430	250309	274132	321955	346409
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro IV	2006	2010							52995	96186	147652
Passenger Cars	Gasoline >2,0 l	PRE ECE	0	1969	129	120	109	103	97	97	97	97	97
Passenger Cars	Gasoline >2,0 l	ECE 15/00-01	1970	1978	1110	986	885	825	778	807	836	856	839
Passenger Cars	Gasoline >2,0 l	ECE 15/02	1979	1980	371	280	212	159	123	147	148	147	168
Passenger Cars	Gasoline >2,0 l	ECE 15/03	1981	1985	9722	8009	6459	4964	3744	2045	1103	592	373
Passenger Cars	Gasoline >2,0 l	ECE 15/04	1986	1990	21251	19699	17377	15265	12607	12107	10565	8778	6439
Passenger Cars	Gasoline >2,0 l	Euro I	1991	1996	35388	35024	34329	33516	32431	27636	23084	18339	16598
Passenger Cars	Gasoline >2,0 l	Euro II	1997	2000	61899	60799	59506	58896	57815	48867	39683	32828	25049
Passenger Cars	Gasoline >2,0 l	Euro III	2001	2005		15179	30712	45080	65819	82828	77816	76346	70905
Passenger Cars	Gasoline >2,0 l	Euro IV	2006	2010							22245	36980	51240
Passenger Cars	Diesel <2,0 l	Conventional	0	1990	42604	42641	42100	40525	38619	38848	38848	38848	38848
Passenger Cars	Diesel <2,0 l	Euro I	1991	1996	39314	43578	48670	53462	59968	59968	59968	59968	59968
Passenger Cars	Diesel <2,0 l	Euro II	1997	2000	31541	34764	38842	43327	49262	49262	49262	49262	49262
Passenger Cars	Diesel <2,0 l	Euro III	2001	2005		5482	13338	21371	33648	63606	63606	63606	63606
Passenger Cars	Diesel <2,0 l	Euro IV	2006	2010							36794	120859	178360
Passenger Cars	Diesel >2,0 l	Conventional	0	1990	2228	2229	2187	2096	1978	1978	1978	1978	1978
Passenger Cars	Diesel >2,0 l	Euro I	1991	1996	2420	2683	2998	3295	3698	3698	3698	3698	3698
Passenger Cars	Diesel >2,0 l	Euro II	1997	2000	4232	4658	5196	5790	6592	6592	6592	6592	6592
Passenger Cars	Diesel >2,0 l	Euro III	2001	2005		1163	2682	4432	7505	10765	10765	10765	10765
Passenger Cars	Diesel >2,0 l	Euro IV	2006	2010							4004	13151	19408
Passenger Cars	LPG	Conventional	0	1990	32	63	21	15	15	15	15	10	12
Passenger Cars	2-Stroke	Conventional	0	9999	300	200	150	100	50				
Light Duty Vehicles	Gasoline <3,5t	Conventional	0	1994	28488	25423	21615	18838	14576	12300	9827	6041	3805
Light Duty Vehicles	Gasoline <3,5t	Euro I	1995	1998	15979	15527	15049	13949	14793	14462	13766	10509	8795
Light Duty Vehicles	Gasoline <3,5t	Euro II	1999	2001	9299	14017	13917	13805	14126	14061	13667	10693	9217
Light Duty Vehicles	Gasoline <3,5t	Euro III	2002	2006			5140	10719	16724	23033	29145	23176	20352
Light Duty Vehicles	Gasoline <3,5t	Euro IV	2007	2011								5439	9887
Light Duty Vehicles	Diesel <3,5 t	Conventional	0	1994	115695	105397	92990	82927	66760	59477	51497	37477	25323
Light Duty Vehicles	Diesel <3,5 t	Euro I	1995	1998	64894	64370	64743	61406	67753	69932	72140	65198	58535

Light Duty Vehicles	Diesel <3,5 t	Euro II	1999	2001	37766	58112	59870	60771	64697	67990	71620	66341	61339
Light Duty Vehicles	Diesel <3,5 t	Euro III	2002	2006			22112	47186	76596	111375	152728	143794	135446
Light Duty Vehicles	Diesel <3,5 t	Euro IV	2007	2011								33742	65803
Heavy Duty Vehicles	Gasoline >3,5 t	Conventional	0	9999	257	249	249	247	233	252	266	273	278
Heavy Duty Vehicles	Diesel 3,5 - 7,5 t	Conventional	0	1993	2329	1910	1671	1351	1007	766	542	343	197
Heavy Duty Vehicles	Diesel 3,5 - 7,5 t	Euro I	1994	1996	1042	936	938	796	883	803	711	624	730
Heavy Duty Vehicles	Diesel 3,5 - 7,5 t	Euro II	1997	2001	1682	1720	1788	1608	1768	1648	1504	1356	1564
Heavy Duty Vehicles	Diesel 3,5 - 7,5 t	Euro III	2002	2006	114	354	845	1279	1892	2309	2578	2387	2828
Heavy Duty Vehicles	Diesel 3,5 - 7,5 t	Euro IV	2007	2009						16	90	452	868
Heavy Duty Vehicles	Diesel 3,5 - 7,5 t	Euro V	2010	2014						5	32	169	530
Heavy Duty Vehicles	Diesel 7,5 - 16 t	Conventional	0	1993	4921	4063	3014	2468	1544	1142	826	531	204
Heavy Duty Vehicles	Diesel 7,5 - 16 t	Euro I	1994	1996	2201	1992	1692	1454	1354	1197	1083	967	759
Heavy Duty Vehicles	Diesel 7,5 - 16 t	Euro II	1997	2001	3556	3660	3226	2939	2711	2458	2291	2099	1625
Heavy Duty Vehicles	Diesel 7,5 - 16 t	Euro III	2002	2006	242	754	1525	2336	2901	3444	3926	3697	2938
Heavy Duty Vehicles	Diesel 7,5 - 16 t	Euro IV	2007	2009						24	136	700	901
Heavy Duty Vehicles	Diesel 7,5 - 16 t	Euro V	2010	2014						8	48	263	551
Heavy Duty Vehicles	Diesel 16 - 32 t	Conventional	0	1993	7677	6576	5309	4389	2930	2204	1601	1035	438
Heavy Duty Vehicles	Diesel 16 - 32 t	Euro I	1994	1996	3434	3224	2981	2585	2569	2311	2099	1884	1628
Heavy Duty Vehicles	Diesel 16 - 32 t	Euro II	1997	2001	5547	5923	5683	5225	5144	4745	4440	4089	3486
Heavy Duty Vehicles	Diesel 16 - 32 t	Euro III	2002	2006	377	1221	2686	4154	5505	6648	7609	7201	6304
Heavy Duty Vehicles	Diesel 16 - 32 t	Euro IV	2007	2009						47	264	1363	1934
Heavy Duty Vehicles	Diesel 16 - 32 t	Euro V	2010	2014						16	93	511	1181
Heavy Duty Vehicles	Diesel >32t	Conventional	0	1993	7123	6299	5272	4528	3092	2522	1942	1339	602
Heavy Duty Vehicles	Diesel >32t	Euro I	1994	1996	3186	3088	2960	2667	2711	2644	2547	2438	2236
Heavy Duty Vehicles	Diesel >32t	Euro II	1997	2001	5147	5673	5643	5391	5428	5428	5388	5293	4789
Heavy Duty Vehicles	Diesel >32t	Euro III	2002	2006	350	1169	2667	4286	5809	7605	9232	9320	8659
Heavy Duty Vehicles	Diesel >32t	Euro IV	2007	2009						53	321	1764	2657
Heavy Duty Vehicles	Diesel >32t	Euro V	2010	2014						18	113	662	1623
Buses	Urban Buses	Conventional	0	1993	2319	2159	1977	1859	1711	1551	1381	1210	1040
Buses	Urban Buses	Euro I	1994	1996	852	792	752	713	663	643	614	581	562
Buses	Urban Buses	Euro II	1997	2001	1345	1596	1525	1447	1345	1317	1273	1220	1170
Buses	Urban Buses	Euro III	2002	2006			346	670	951	1275	1585	1534	1487
Buses	Urban Buses	Euro IV	2007	2009								344	684
Buses	Coaches	Conventional	0	1993	2724	2444	2165	1962	1773	1542	1328	1119	922
Buses	Coaches	Euro I	1994	1996	1001	896	823	752	687	639	591	538	498
Buses	Coaches	Euro II	1997	2001	1579	1807	1670	1527	1394	1309	1224	1128	1037
Buses	Coaches	Euro III	2002	2006			379	706	986	1267	1524	1418	1318
Buses	Coaches	Euro IV	2007	2009								318	606

Mopeds	<50 cm³	Conventional	0	1999	143607	136249	128209	120305	112262	103829	94855	86621	78814
Mopeds	<50 cm³	Euro I	2000	2003	16393	28751	42791	48695	46069	43455	40746	37826	35231
Mopeds	<50 cm³	Euro II	2004	9999					10669	21715	33399	44553	50954
Motorcycles	2-stroke >50 cm³	Conventional	0	1999	11054	11367	11582	11850	12326	13158	14241	15400	15790
Motorcycles	4-stroke <250 cm³	Conventional	0	1999	11909	12331	12662	13098	13716	14486	15411	16311	16873
Motorcycles	4-stroke <250 cm³	Euro I	2000	2003	619	1074	1568	2088	2087	2144	2240	2373	2462
Motorcycles	4-stroke <250 cm³	Euro II	2004	2006					694	1791	3236	3221	3196
Motorcycles	4-stroke <250 cm³	Euro III	2007	9999								1798	3021
Motorcycles	4-stroke 250 - 750 cm³	Conventional	0	1999	32749	33910	34821	36019	37720	39837	42380	44855	46402
Motorcycles	4-stroke 250 - 750 cm³	Euro I	2000	2003	1703	2953	4311	5742	5739	5897	6159	6527	6769
Motorcycles	4-stroke 250 - 750 cm³	Euro II	2004	2006					1910	4925	8898	8857	8788
Motorcycles	4-stroke 250 - 750 cm³	Euro III	2007	9999								4945	8307
Motorcycles	4-stroke >750 cm³	Conventional	0	1999	14886	15414	15828	16372	17146	18108	19264	20388	21092
Motorcycles	4-stroke >750 cm³	Euro I	2000	2003	774	1342	1960	2610	2609	2681	2800	2967	3077
Motorcycles	4-stroke >750 cm³	Euro II	2004	2006					868	2239	4045	4026	3995
Motorcycles	4-stroke >750 cm³	Euro III	2007	9999								2248	3776

Annex 3B-2: Mileage data 1985-2008 for road transport (km)

Sector	Subsector	Tech 2	FYear	LYear	1985	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Passenger Cars	Gasoline <1,4 l	PRE ECE	0	1969	9564	10458	11285	12005	12412	12729	12405	12060	12050	11999	11794
Passenger Cars	Gasoline <1,4 l	ECE 15/00-01	1970	1978	12115	10458	11285	12005	12412	12729	12405	12060	12050	11999	11794
Passenger Cars	Gasoline <1,4 l	ECE 15/02	1979	1980	16052	13358	12280	12005	12412	12729	12405	12060	12050	11999	11794
Passenger Cars	Gasoline <1,4 l	ECE 15/03	1981	1985	18800	16553	17094	17157	16720	16142	14571	12958	12050	11999	11794
Passenger Cars	Gasoline <1,4 l	ECE 15/04	1986	1990		20257	20778	21152	20734	20113	18818	17553	16474	14970	13688
Passenger Cars	Gasoline <1,4 l	Euro I	1991	1996			24567	25667	25746	26068	24555	23306	22300	20949	19624
Passenger Cars	Gasoline <1,4 l	Euro II	1997	2000									26232	25674	24561
Passenger Cars	Gasoline <1,4 l	Euro III	2001	2005											
Passenger Cars	Gasoline <1,4 l	Euro IV	2006	2010											
Passenger Cars	Gasoline 1,4 - 2,0 l	PRE ECE	0	1969	9564	10458	11285	12005	12412	12729	12405	12060	12050	11999	11794
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/00-01	1970	1978	12033	10458	11285	12005	12412	12729	12405	12060	12050	11999	11794
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/02	1979	1980	16044	13352	12269	12005	12412	12729	12405	12060	12050	11999	11794
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/03	1981	1985	18883	16515	17059	17121	16659	16068	14525	12940	12050	11999	11794
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/04	1986	1990		20402	20935	21291	20886	20231	18942	17667	16584	15142	13875
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro I	1991	1996			24567	25726	25975	26475	25308	24084	23002	21643	20226
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro II	1997	2000									26232	25700	24547
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro III	2001	2005											
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro IV	2006	2010											
Passenger Cars	Gasoline >2,0 l	PRE ECE	0	1969	9564	10458	11285	12005	12412	12729	12405	12060	12050	11999	11794
Passenger Cars	Gasoline >2,0 l	ECE 15/00-01	1970	1978	12052	10458	11285	12005	12412	12729	12405	12060	12050	11999	11794
Passenger Cars	Gasoline >2,0 l	ECE 15/02	1979	1980	16050	13361	12285	12005	12412	12729	12405	12060	12050	11999	11794
Passenger Cars	Gasoline >2,0 l	ECE 15/03	1981	1985	18834	16582	17121	17200	16793	16180	14593	12966	12050	11999	11794
Passenger Cars	Gasoline >2,0 l	ECE 15/04	1986	1990		20101	20643	21047	20575	20005	18715	17452	16353	14779	13551
Passenger Cars	Gasoline >2,0 l	Euro I	1991	1996			24567	25712	25924	26398	25184	23952	22880	21524	20119
Passenger Cars	Gasoline >2,0 l	Euro II	1997	2000									26232	25727	24744
Passenger Cars	Gasoline >2,0 l	Euro III	2001	2005											
Passenger Cars	Gasoline >2,0 l	Euro IV	2006	2010											
Passenger Cars	Diesel <2,0 l	Conventional	0	1990	27507	35246	35790	34175	33593	35025	32972	31446	29830	28040	26792
Passenger Cars	Diesel <2,0 l	Euro I	1991	1996			53405	51886	51281	54547	52029	50542	47495	43929	41339
Passenger Cars	Diesel <2,0 l	Euro II	1997	2000									54758	52749	50715
Passenger Cars	Diesel <2,0 l	Euro III	2001	2005											
Passenger Cars	Diesel <2,0 l	Euro IV	2006	2010											
Passenger Cars	Diesel >2,0 l	Conventional	0	1990	28763	36599	37134	35390	34573	35795	33528	31812	29953	27902	26613
Passenger Cars	Diesel >2,0 l	Euro I	1991	1996			53405	51916	51388	54734	52350	50846	47761	44191	41559
Passenger Cars	Diesel >2,0 l	Euro II	1997	2000									54758	52819	51115

Passenger Cars	Diesel >2,0 l	Euro III	2001	2005											
Passenger Cars	Diesel >2,0 l	Euro IV	2006	2010											
Passenger Cars	LPG	Conventional	0	1990	18832	16538	17080	17144	16698	16113	14553	12950	12050	11999	11794
Passenger Cars	2-Stroke	Conventional	0	9999	18832	16538	17080	17144	16698	16113	14553	12950	12050	11999	11794
Light Duty Vehicles	Gasoline <3,5t	Conventional	0	1994	20184	17544	18019	18706	18894	18937	18138	17727	17852	17884	17453
Light Duty Vehicles	Gasoline <3,5t	Euro I	1995	1998							18138	17727	17852	17884	17453
Light Duty Vehicles	Gasoline <3,5t	Euro II	1999	2001											17453
Light Duty Vehicles	Gasoline <3,5t	Euro III	2002	2006											
Light Duty Vehicles	Gasoline <3,5t	Euro IV	2007	2011											
Light Duty Vehicles	Diesel <3,5 t	Conventional	0	1994	26671	28095	28152	27146	26917	28220	27099	27047	26803	26381	25789
Light Duty Vehicles	Diesel <3,5 t	Euro I	1995	1998							27099	27047	26803	26381	25789
Light Duty Vehicles	Diesel <3,5 t	Euro II	1999	2001											25789
Light Duty Vehicles	Diesel <3,5 t	Euro III	2002	2006											
Light Duty Vehicles	Diesel <3,5 t	Euro IV	2007	2011											
Heavy Duty Vehicles	Gasoline >3,5 t	Conventional	0	9999	38144	37941	38562	39503	37263	36784	36280	35574	32740	33082	33668
Heavy Duty Vehicles	Diesel 3,5 - 7,5 t	Conventional	0	1993	31320	40701	40359	38402	35562	36719	36309	36359	29998	30591	32927
Heavy Duty Vehicles	Diesel 3,5 - 7,5 t	Euro I	1994	1996					35562	36719	36309	36359	29998	30591	32927
Heavy Duty Vehicles	Diesel 3,5 - 7,5 t	Euro II	1997	2001								36359	29998	30591	32927
Heavy Duty Vehicles	Diesel 3,5 - 7,5 t	Euro III	2002	2006											
Heavy Duty Vehicles	Diesel 3,5 - 7,5 t	Euro IV	2007	2009											
Heavy Duty Vehicles	Diesel 3,5 - 7,5 t	Euro V	2010	2014											
Heavy Duty Vehicles	Diesel 7,5 - 16 t	Conventional	0	1993	43637	49199	48785	46420	42987	44385	43890	43950	42070	40727	38392
Heavy Duty Vehicles	Diesel 7,5 - 16 t	Euro I	1994	1996					42987	44385	43890	43950	42070	40727	38392
Heavy Duty Vehicles	Diesel 7,5 - 16 t	Euro II	1997	2001								43950	42070	40727	38392
Heavy Duty Vehicles	Diesel 7,5 - 16 t	Euro III	2002	2006											
Heavy Duty Vehicles	Diesel 7,5 - 16 t	Euro IV	2007	2009											
Heavy Duty Vehicles	Diesel 7,5 - 16 t	Euro V	2010	2014											
Heavy Duty Vehicles	Diesel 16 - 32 t	Conventional	0	1993	78794	92514	92692	88966	84356	87883	86776	87267	89143	88685	90421
Heavy Duty Vehicles	Diesel 16 - 32 t	Euro I	1994	1996					84356	87883	86776	87267	89143	88685	90421
Heavy Duty Vehicles	Diesel 16 - 32 t	Euro II	1997	2001								87267	89143	88685	90421
Heavy Duty Vehicles	Diesel 16 - 32 t	Euro III	2002	2006											
Heavy Duty Vehicles	Diesel 16 - 32 t	Euro IV	2007	2009											
Heavy Duty Vehicles	Diesel 16 - 32 t	Euro V	2010	2014											
Heavy Duty Vehicles	Diesel >32t	Conventional	0	1993	78794	92514	92692	88966	84356	87883	86776	87267	89143	88685	90421
Heavy Duty Vehicles	Diesel >32t	Euro I	1994	1996					84356	87883	86776	87267	89143	88685	90421
Heavy Duty Vehicles	Diesel >32t	Euro II	1997	2001								87267	89143	88685	90421
Heavy Duty Vehicles	Diesel >32t	Euro III	2002	2006											
Heavy Duty Vehicles	Diesel >32t	Euro IV	2007	2009											

Heavy Duty Vehicles	Diesel >32t	Euro V	2010	2014											
Buses	Urban Buses	Conventional	0	1993	80785	95104	98950	95563	97257	105266	104232	103899	101882	99194	97543
Buses	Urban Buses	Euro I	1994	1996						105266	104232	103899	101882	99194	97543
Buses	Urban Buses	Euro II	1997	2001									101882	99194	97543
Buses	Urban Buses	Euro III	2002	2006											
Buses	Urban Buses	Euro IV	2007	2009											
Buses	Coaches	Conventional	0	1993	50636	61288	71249	64953	66380	70950	51585	60972	61345	60215	59999
Buses	Coaches	Euro I	1994	1996						70950	51585	60972	61345	60215	59999
Buses	Coaches	Euro II	1997	2001									61345	60215	59999
Buses	Coaches	Euro III	2002	2006											
Buses	Coaches	Euro IV	2007	2009											
Mopeds	<50 cm³	Conventional	0	1999	2334	2182	2282	2393	2449	2510	2470	2439	2481	2498	2125
Mopeds	<50 cm³	Euro I	2000	2003											
Mopeds	<50 cm³	Euro II	2004	9999											
Motorcycles	2-stroke >50 cm³	Conventional	0	1999	6702	6471	6493	6824	6987	7148	7131	7033	7076	7168	7072
Motorcycles	4-stroke <250 cm³	Conventional	0	1999	6702	6471	6493	6824	6987	7148	7131	7033	7076	7168	7072
Motorcycles	4-stroke <250 cm³	Euro I	2000	2003											
Motorcycles	4-stroke <250 cm³	Euro II	2004	2006											
Motorcycles	4-stroke <250 cm³	Euro III	2007	9999											
Motorcycles	4-stroke 250 - 750 cm³	Conventional	0	1999	6702	6471	6493	6824	6987	7148	7131	7033	7076	7168	7072
Motorcycles	4-stroke 250 - 750 cm³	Euro I	2000	2003											
Motorcycles	4-stroke 250 - 750 cm³	Euro II	2004	2006											
Motorcycles	4-stroke 250 - 750 cm³	Euro III	2007	9999											
Motorcycles	4-stroke >750 cm³	Conventional	0	1999	6702	6471	6493	6824	6987	7148	7131	7033	7076	7168	7072
Motorcycles	4-stroke >750 cm³	Euro I	2000	2003											
Motorcycles	4-stroke >750 cm³	Euro II	2004	2006											
Motorcycles	4-stroke >750 cm³	Euro III	2007	9999											

Continued

Sector	Subsector	Tech 2	FYear	LYear	2000	2001	2002	2003	2004	2005	2006	2007	2008
Passenger Cars	Gasoline <1,4 l	PRE ECE	0	1969	11677	11504	11634	11765	11659	11083	10737	10686	10350
Passenger Cars	Gasoline <1,4 l	ECE 15/00-01	1970	1978	11677	11504	11634	11765	11659	11083	10737	10686	10350
Passenger Cars	Gasoline <1,4 l	ECE 15/02	1979	1980	11677	11504	11634	11765	11659	11083	10737	10686	10350
Passenger Cars	Gasoline <1,4 l	ECE 15/03	1981	1985	11677	11504	11634	11765	11659	11083	10737	10686	10350
Passenger Cars	Gasoline <1,4 l	ECE 15/04	1986	1990	12800	11951	11634	11765	11659	11083	10737	10686	10350
Passenger Cars	Gasoline <1,4 l	Euro I	1991	1996	18422	17424	16712	15589	14496	12881	11811	11033	10350
Passenger Cars	Gasoline <1,4 l	Euro II	1997	2000	23828	22163	21239	20530	19188	17538	16289	15389	14195
Passenger Cars	Gasoline <1,4 l	Euro III	2001	2005		25043	24947	24562	24024	22075	20086	19011	17449

Passenger Cars	Gasoline <1,4 l	Euro IV	2006	2010							23373	22929	21645
Passenger Cars	Gasoline 1,4 - 2,0 l	PRE ECE	0	1969	11677	11504	11634	11765	11659	11083	10737	10686	10350
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/00-01	1970	1978	11677	11504	11634	11765	11659	11083	10737	10686	10350
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/02	1979	1980	11677	11504	11634	11765	11659	11083	10737	10686	10350
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/03	1981	1985	11677	11504	11634	11765	11659	11083	10737	10686	10350
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/04	1986	1990	12961	12035	11634	11765	11659	11083	10737	10686	10350
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro I	1991	1996	18954	17941	17250	16312	15286	13748	12429	11245	10350
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro II	1997	2000	23722	22075	21111	20421	19139	17548	16296	15412	14344
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro III	2001	2005		25043	24938	24490	23880	21952	20013	18933	17390
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro IV	2006	2010							23373	22910	21545
Passenger Cars	Gasoline >2,0 l	PRE ECE	0	1969	11677	11504	11634	11765	11659	11083	10737	10686	10350
Passenger Cars	Gasoline >2,0 l	ECE 15/00-01	1970	1978	11677	11504	11634	11765	11659	11083	10737	10686	10350
Passenger Cars	Gasoline >2,0 l	ECE 15/02	1979	1980	11677	11504	11634	11765	11659	11083	10737	10686	10350
Passenger Cars	Gasoline >2,0 l	ECE 15/03	1981	1985	11677	11504	11634	11765	11659	11083	10737	10686	10350
Passenger Cars	Gasoline >2,0 l	ECE 15/04	1986	1990	12691	11880	11634	11765	11659	11083	10737	10686	10350
Passenger Cars	Gasoline >2,0 l	Euro I	1991	1996	18865	17852	17156	16192	15155	13644	12323	11196	10350
Passenger Cars	Gasoline >2,0 l	Euro II	1997	2000	24087	22507	21558	20798	19395	17838	16499	15494	14319
Passenger Cars	Gasoline >2,0 l	Euro III	2001	2005		25043	24920	24519	24050	22131	20188	19199	17771
Passenger Cars	Gasoline >2,0 l	Euro IV	2006	2010							23373	22950	21695
Passenger Cars	Diesel <2,0 l	Conventional	0	1990	24900	22211	21536	23170	23513	21355	20114	18181	16266
Passenger Cars	Diesel <2,0 l	Euro I	1991	1996	37589	33363	31580	31623	30267	25831	22614	19064	16266
Passenger Cars	Diesel <2,0 l	Euro II	1997	2000	47581	41523	39148	40281	38628	33547	30147	26011	22027
Passenger Cars	Diesel <2,0 l	Euro III	2001	2005		47051	46169	48325	48259	43896	39497	33853	29109
Passenger Cars	Diesel <2,0 l	Euro IV	2006	2010							43785	39174	34160
Passenger Cars	Diesel >2,0 l	Conventional	0	1990	24716	22091	21536	23170	23513	21355	20114	18181	16266
Passenger Cars	Diesel >2,0 l	Euro I	1991	1996	37788	33541	31759	31889	30564	26070	22752	19095	16266
Passenger Cars	Diesel >2,0 l	Euro II	1997	2000	48250	42286	39907	40960	39116	34134	30671	26328	22415
Passenger Cars	Diesel >2,0 l	Euro III	2001	2005		47051	46130	48338	48504	43228	38770	33378	28399
Passenger Cars	Diesel >2,0 l	Euro IV	2006	2010							43785	39174	34160
Passenger Cars	LPG	Conventional	0	1990	11677	11504	11634	11765	11659	11083	10737	10686	10350
Passenger Cars	2-Stroke	Conventional	0	9999	11677	11504	11634	11765	11659				
Light Duty Vehicles	Gasoline <3,5t	Conventional	0	1994	17612	17589	17730	17631	17251	17074	16553	17102	17422
Light Duty Vehicles	Gasoline <3,5t	Euro I	1995	1998	17612	17589	17730	17631	17251	17074	16553	17102	17422
Light Duty Vehicles	Gasoline <3,5t	Euro II	1999	2001	17612	17589	17730	17631	17251	17074	16553	17102	17422
Light Duty Vehicles	Gasoline <3,5t	Euro III	2002	2006			17730	17631	17251	17074	16553	17102	17422
Light Duty Vehicles	Gasoline <3,5t	Euro IV	2007	2011								17102	17422
Light Duty Vehicles	Diesel <3,5 t	Conventional	0	1994	25089	24880	24876	26109	26496	24965	23560	23799	24081
Light Duty Vehicles	Diesel <3,5 t	Euro I	1995	1998	25089	24880	24876	26109	26496	24965	23560	23799	24081

Light Duty Vehicles	Diesel <3,5 t	Euro II	1999	2001	25089	24880	24876	26109	26496	24965	23560	23799	24081
Light Duty Vehicles	Diesel <3,5 t	Euro III	2002	2006			24876	26109	26496	24965	23560	23799	24081
Light Duty Vehicles	Diesel <3,5 t	Euro IV	2007	2011								23799	24081
Heavy Duty Vehicles	Gasoline >3,5 t	Conventional	0	9999	34672	40092	40735	40942	40462	37521	36968	36240	33226
Heavy Duty Vehicles	Diesel 3,5 - 7,5 t	Conventional	0	1993	33637	44221	44620	48583	47955	47526	49499	51804	49929
Heavy Duty Vehicles	Diesel 3,5 - 7,5 t	Euro I	1994	1996	33637	44221	44620	48583	47955	47526	49499	51804	49929
Heavy Duty Vehicles	Diesel 3,5 - 7,5 t	Euro II	1997	2001	33637	44221	44620	48583	47955	47526	49499	51804	49929
Heavy Duty Vehicles	Diesel 3,5 - 7,5 t	Euro III	2002	2006	33637	44221	44620	48583	47955	47526	49499	51804	49929
Heavy Duty Vehicles	Diesel 3,5 - 7,5 t	Euro IV	2007	2009						47526	49499	51804	49929
Heavy Duty Vehicles	Diesel 3,5 - 7,5 t	Euro V	2010	2014						47526	49499	51804	49929
Heavy Duty Vehicles	Diesel 7,5 - 16 t	Conventional	0	1993	36880	21003	18250	19640	20268	20087	20921	21895	21103
Heavy Duty Vehicles	Diesel 7,5 - 16 t	Euro I	1994	1996	36880	21003	18250	19640	20268	20087	20921	21895	21103
Heavy Duty Vehicles	Diesel 7,5 - 16 t	Euro II	1997	2001	36880	21003	18250	19640	20268	20087	20921	21895	21103
Heavy Duty Vehicles	Diesel 7,5 - 16 t	Euro III	2002	2006	36880	21003	18250	19640	20268	20087	20921	21895	21103
Heavy Duty Vehicles	Diesel 7,5 - 16 t	Euro IV	2007	2009						20087	20921	21895	21103
Heavy Duty Vehicles	Diesel 7,5 - 16 t	Euro V	2010	2014						20087	20921	21895	21103
Heavy Duty Vehicles	Diesel 16 - 32 t	Conventional	0	1993	87591	93250	93824	99077	103628	103746	107309	112235	111773
Heavy Duty Vehicles	Diesel 16 - 32 t	Euro I	1994	1996	87591	93250	93824	99077	103628	103746	107309	112235	111773
Heavy Duty Vehicles	Diesel 16 - 32 t	Euro II	1997	2001	87591	93250	93824	99077	103628	103746	107309	112235	111773
Heavy Duty Vehicles	Diesel 16 - 32 t	Euro III	2002	2006	87591	93250	93824	99077	103628	103746	107309	112235	111773
Heavy Duty Vehicles	Diesel 16 - 32 t	Euro IV	2007	2009						103746	107309	112235	111773
Heavy Duty Vehicles	Diesel 16 - 32 t	Euro V	2010	2014						103746	107309	112235	111773
Heavy Duty Vehicles	Diesel >32t	Conventional	0	1993	87591	93250	93824	99077	103628	103746	107309	112235	111773
Heavy Duty Vehicles	Diesel >32t	Euro I	1994	1996	87591	93250	93824	99077	103628	103746	107309	112235	111773
Heavy Duty Vehicles	Diesel >32t	Euro II	1997	2001	87591	93250	93824	99077	103628	103746	107309	112235	111773
Heavy Duty Vehicles	Diesel >32t	Euro III	2002	2006	87591	93250	93824	99077	103628	103746	107309	112235	111773
Heavy Duty Vehicles	Diesel >32t	Euro IV	2007	2009						103746	107309	112235	111773
Heavy Duty Vehicles	Diesel >32t	Euro V	2010	2014						103746	107309	112235	111773
Buses	Urban Buses	Conventional	0	1993	95483	92967	92260	96890	98197	102087	106482	109874	112785
Buses	Urban Buses	Euro I	1994	1996	95483	92967	92260	96890	98197	102087	106482	109874	112785
Buses	Urban Buses	Euro II	1997	2001	95483	92967	92260	96890	98197	102087	106482	109874	112785
Buses	Urban Buses	Euro III	2002	2006			92260	96890	98197	102087	106482	109874	112785
Buses	Urban Buses	Euro IV	2007	2009								109874	112785
Buses	Coaches	Conventional	0	1993	58236	58686	60044	63380	68429	70932	74526	80282	82284
Buses	Coaches	Euro I	1994	1996	58236	58686	60044	63380	68429	70932	74526	80282	82284
Buses	Coaches	Euro II	1997	2001	58236	58686	60044	63380	68429	70932	74526	80282	82284
Buses	Coaches	Euro III	2002	2006			60044	63380	68429	70932	74526	80282	82284
Buses	Coaches	Euro IV	2007	2009								80282	82284

Mopeds	<50 cm^3	Conventional	0	1999	1919	1515	1536	1535	1505	1446	1404	1378	1318
Mopeds	<50 cm^3	Euro I	2000	2003	1919	1515	1536	1535	1505	1446	1404	1378	1318
Mopeds	<50 cm^3	Euro II	2004	9999					1505	1446	1404	1378	1318
Motorcycles	2-stroke >50 cm^3	Conventional	0	1999	7170	7178	7321	7373	7270	7021	6420	6300	6165
Motorcycles	4-stroke <250 cm^3	Conventional	0	1999	7170	7178	7321	7373	7270	7021	6420	6300	6165
Motorcycles	4-stroke <250 cm^3	Euro I	2000	2003	7170	7178	7321	7373	7270	7021	6420	6300	6165
Motorcycles	4-stroke <250 cm^3	Euro II	2004	2006					7270	7021	6420	6300	6165
Motorcycles	4-stroke <250 cm^3	Euro III	2007	9999								6300	6165
Motorcycles	4-stroke 250 - 750 cm^3	Conventional	0	1999	7170	7178	7321	7373	7270	7021	6420	6300	6165
Motorcycles	4-stroke 250 - 750 cm^3	Euro I	2000	2003	7170	7178	7321	7373	7270	7021	6420	6300	6165
Motorcycles	4-stroke 250 - 750 cm^3	Euro II	2004	2006					7270	7021	6420	6300	6165
Motorcycles	4-stroke 250 - 750 cm^3	Euro III	2007	9999								6300	6165
Motorcycles	4-stroke >750 cm^3	Conventional	0	1999	7170	7178	7321	7373	7270	7021	6420	6300	6165
Motorcycles	4-stroke >750 cm^3	Euro I	2000	2003	7170	7178	7321	7373	7270	7021	6420	6300	6165
Motorcycles	4-stroke >750 cm^3	Euro II	2004	2006					7270	7021	6420	6300	6165
Motorcycles	4-stroke >750 cm^3	Euro III	2007	9999								6300	6165

Annex 3B-3: EU directive emission limits for road transportation vehicles

Private cars and light duty vehicles I (<1305 kg).

G prkm		EURO 1	EURO 2	EURO 3[1)]	EURO 4	EURO 5	EURO 6
Normal temp.							
CO	Gasoline	2.72	2.2	2.3	1.0	1.0	1.0
	Diesel	2.72	1.0	0.64	0.5	0.5	0.5
HC	Gasoline	-	-	0.20	0.10	0.1	0.1
NMHC	Gasoline	-	-	-	-	0.068	0.068
NO_x	Gasoline	-	-	0.15	0.08	0.06	0.06
	Diesel	-	-	0.5	0.25	0.18	0.08
HC+NO_x	Gasoline	0.97	0.5	-	-		-
	Diesel	0.97	0.7/0.9[2)]	0.56	0.30	0.23	0.17
Particulates	Diesel	0.14	0.08/0.10[2)]	0.05	0.025	0.005	0.005
Low temp.							
CO	Gasoline	-	-	-	15	15	15
HC	Gasoline	-	-	-	1.8	1.8	1.8
Evaporation							
HC[3)]	Gasoline	2.0	2.0	2.0	2.0	2.0	2.0

[1)] Changed test procedure at normal temperatures (40 s warm-up phase omitted) and for evaporation measurements.

[2)] Less stringent emission limits for direct injection diesel engines.

[3)] Unit: g/test.

Light duty vehicles II (1305-1760 kg)

G pr km		EURO 1	EURO 2	EURO 3[1)]	EURO 4	EURO 5	EURO 6
Normal temp.							
CO	Gasoline	5.17	4.0	4.17	1.81	1.81	1.81
	Diesel	5.17	1.25	0.80	0.63	0.63	0.63
HC	Gasoline	-	-	0.25	0.13	0.13	0.13
NMHC	Gasoline	-	-	-	-	0.9	0.9
NO_x	Gasoline	-	-	0.18	0.10	0.75	0.75
	Diesel	-	-	0.65	0.33	0.235	0.105
HC+NO_x	Gasoline	1.4	0.6	-	-	-	-
	Diesel	1.4	1.0/1.3[2)]	0.72	0.39	0.295	0.195
Particulates	Gasoline					0.005	0.005
	Diesel	0.19	0.12/0.14[2)]	0.07	0.04	0.005	0.005
Low temp.							
CO	Gasoline	-	-	-	24	24	24
HC	Gasoline	-	-		2.7	2.7	2.7
Evaporation							
HC[3)]	Gasoline	2.0	2.0	2.0	2.0	2.0	2.0

[1)] Changed test procedure at normal temperatures (40 s warm-up phase omitted) and for evaporation measurements

[2)] Less stringent emission limits for direct injection diesel engines

[3)] Unit: g/test

Light duty vehicles III (>1760 kg)

G pr km		EURO 1	EURO 2	EURO 3[1)]	EURO 4	EURO 5	EURO 6
Normal temp.							
CO	Gasoline	6.9	5.0	5.22	2.27	2.27	2.27
	Diesel	6.9	1.5	0.95	0.74	0.74	0.74
HC	Gasoline	-	-	0.29	0.16	0.16	0.16
NMHC	Gasoline					0.108	0.108
NO_x	Gasoline	-	-	0.21	0.11	0.082	0.082
	Diesel	-	-	0.78	0.39	0.28	0.125
HC+NO_x	Gasoline	1.7	0.7	-	-	-	-
	Diesel	1.7	1.2/1.6[2)]	0.86	0.46	0.35	0.215
Particulates	Gasoline					0.005	0.005
	Diesel	0.25	0.17/0.20[2)]	0.10	0.06	0.005	0.005
Low temp.							
CO	Gasoline	-	-	-	30	30	30
HC	Gasoline	-	-	-	3.2	3.2	3.2
Evaporation							
HC[3)]	Gasoline	2.0	2.0	2.0	2.0	2.0	2.0

[1)] Changed test procedure at normal temperatures (40 s warm-up phase omitted) and for evaporation measurements

[2)] Less stringent emission limits for direct injection diesel engines

[3)] Unit: g/test

Heavy duty diesel vehicles

(g pr kWh)		EURO 1	EURO 2	EURO 3	EURO 4	EURO 5	EEV[2)]
	Test[1)]	1993	1996	2001	2006	2009	2000
CO	ECE/ESC	4.5	4.0	2.1	1.5	1.5	1.5
	ETC	-	-	(5.45)	4.0	4.0	3.0
HC	ECE/ESC	1.1	1.1	0.66	0.46	0.46	0.25
	ETC	-	-	(0.78)	0.55	0.55	0.40
NO_x	ECE/ESC	8.0	7.0	5.0	3.5	2.0	2.0
	ETC	-	-	(5.0)	3.5	2.0	2.0
Particulates[3)]	ECE/ESC	0.36/0.61	0.15/0.25	0.10/0.13	0.02	0.02	0.02
	ETC	-	-	(0.16/0.21)	0.03	0.03	0.02
	ELR	-	-	0.8	0.5	0.5	0.15

[1)] Test procedure: Euro 1 og Euro 2: ECE (stationary)
Euro 3: ESC (stationary) + ELR (load response)
Euro 4, Euro 5 og EEV: ESC (stationary) + ETC (transient) + ELR (load response)

[2)] EEV: Emission limits for extra environmental friendly vehicles, used as a basis for economical incitaments (gas fueled vehicles).

[3)] For Euro 1, Euro 2 og Euro 3 less stringent emission limits apply for small engines:
Euro 1: <85 kW
Euro 2: <0,7 l
Euro 3: <0,75 l

Annex 3B-4: Basis emission factors (g pr km)

Sector	Subsector	Tech 2	FYear	LYear	FCu	FCr	FCh	COu	COr	COh	PMu	PMr	PMh	NOxu	NOxr	NOxh
Passenger Cars	Gasoline <1,4 l	PRE ECE	0	1969	67,499	55,000	62,743	27,505	19,333	15,520	0,063	0,044	0,041	1,849	2,062	2,023
Passenger Cars	Gasoline <1,4 l	ECE 15/00-01	1970	1978	58,240	44,460	48,600	18,966	14,480	18,620	0,063	0,044	0,041	1,849	2,062	2,023
Passenger Cars	Gasoline <1,4 l	ECE 15/02	1979	1980	53,248	45,170	51,200	15,859	8,200	8,260	0,063	0,044	0,041	1,619	2,102	2,909
Passenger Cars	Gasoline <1,4 l	ECE 15/03	1981	1985	53,248	45,170	51,200	16,752	8,793	7,620	0,042	0,029	0,029	1,680	2,253	3,276
Passenger Cars	Gasoline <1,4 l	ECE 15/04	1986	1990	51,420	43,440	47,700	9,087	4,956	4,292	0,030	0,020	0,020	1,691	2,089	2,662
Passenger Cars	Gasoline <1,4 l	Euro I	1991	1996	47,399	41,954	46,055	1,765	1,372	1,765	0,003	0,002	0,002	0,273	0,281	0,458
Passenger Cars	Gasoline <1,4 l	Euro II	1997	2000	46,486	39,509	44,016	0,659	0,575	0,749	0,003	0,002	0,002	0,154	0,154	0,181
Passenger Cars	Gasoline <1,4 l	Euro III	2001	2005	48,687	42,255	45,323	0,519	0,691	1,148	0,001	0,001	0,001	0,076	0,060	0,052
Passenger Cars	Gasoline <1,4 l	Euro IV	2006	2010	50,038	44,193	48,285	0,195	0,287	0,529	0,001	0,001	0,001	0,054	0,030	0,019
Passenger Cars	Gasoline 1,4 - 2,0 l	PRE ECE	0	1969	79,277	67,000	76,386	27,505	19,333	15,520	0,063	0,044	0,041	2,164	2,683	3,130
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/00-01	1970	1978	67,779	51,090	60,300	18,966	14,480	18,620	0,063	0,044	0,041	2,164	2,683	3,130
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/02	1979	1980	61,731	50,686	59,680	15,859	8,200	8,260	0,063	0,044	0,041	1,831	2,377	3,283
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/03	1981	1985	61,731	50,686	59,680	16,752	8,793	7,620	0,042	0,029	0,029	1,917	2,580	3,472
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/04	1986	1990	61,652	49,112	52,052	9,087	4,956	4,292	0,030	0,020	0,020	2,122	2,757	3,524
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro I	1991	1996	57,521	48,522	51,518	1,765	1,372	1,765	0,003	0,002	0,002	0,273	0,281	0,458
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro II	1997	2000	56,324	47,687	48,786	0,659	0,575	0,749	0,003	0,002	0,002	0,154	0,154	0,181
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro III	2001	2005	58,259	49,897	53,092	0,519	0,691	1,148	0,001	0,001	0,001	0,076	0,060	0,052
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro IV	2006	2010	60,486	52,793	55,293	0,195	0,287	0,529	0,001	0,001	0,001	0,054	0,030	0,019
Passenger Cars	Gasoline >2,0 l	PRE ECE	0	1969	96,536	80,000	88,267	27,505	19,333	15,520	0,063	0,044	0,041	2,860	4,090	5,500
Passenger Cars	Gasoline >2,0 l	ECE 15/00-01	1970	1978	73,798	57,090	66,300	18,966	14,480	18,620	0,063	0,044	0,041	2,860	4,090	5,500
Passenger Cars	Gasoline >2,0 l	ECE 15/02	1979	1980	75,270	63,260	70,700	15,859	8,200	8,260	0,063	0,044	0,041	2,066	2,675	3,680
Passenger Cars	Gasoline >2,0 l	ECE 15/03	1981	1985	75,270	63,260	70,700	16,752	8,793	7,620	0,042	0,029	0,029	2,806	3,441	4,604
Passenger Cars	Gasoline >2,0 l	ECE 15/04	1986	1990	71,055	58,080	69,900	9,087	4,956	4,292	0,030	0,020	0,020	2,293	2,750	3,687
Passenger Cars	Gasoline >2,0 l	Euro I	1991	1996	74,616	61,902	65,020	1,765	1,372	1,765	0,003	0,002	0,002	0,273	0,281	0,458
Passenger Cars	Gasoline >2,0 l	Euro II	1997	2000	76,837	65,226	66,732	0,659	0,575	0,749	0,003	0,002	0,002	0,154	0,154	0,181
Passenger Cars	Gasoline >2,0 l	Euro III	2001	2005	70,798	57,424	56,826	0,519	0,691	1,148	0,001	0,001	0,001	0,076	0,060	0,052
Passenger Cars	Gasoline >2,0 l	Euro IV	2006	2010	86,099	67,877	65,859	0,195	0,287	0,529	0,001	0,001	0,001	0,054	0,030	0,019
Passenger Cars	Diesel <2,0 l	Conventional	0	1990	57,529	41,209	50,089	0,651	0,472	0,384	0,199	0,132	0,170	0,520	0,433	0,528
Passenger Cars	Diesel <2,0 l	Euro I	1991	1996	47,836	42,807	48,388	0,419	0,215	0,208	0,057	0,062	0,107	0,603	0,562	0,663
Passenger Cars	Diesel <2,0 l	Euro II	1997	2000	50,442	44,117	48,779	0,343	0,110	0,035	0,047	0,039	0,050	0,651	0,555	0,665
Passenger Cars	Diesel <2,0 l	Euro III	2001	2005	48,920	43,427	45,585	0,099	0,041	0,012	0,029	0,030	0,045	0,716	0,665	0,750
Passenger Cars	Diesel <2,0 l	Euro IV	2006	2010	48,920	43,427	45,585	0,083	0,034	0,021	0,029	0,024	0,026	0,539	0,424	0,576
Passenger Cars	Diesel >2,0 l	Conventional	0	1990	57,529	41,209	50,089	0,651	0,472	0,384	0,199	0,132	0,170	0,824	0,723	0,861
Passenger Cars	Diesel >2,0 l	Euro I	1991	1996	65,267	58,299	64,360	0,419	0,215	0,208	0,057	0,062	0,107	0,603	0,562	0,663

Passenger Cars	Diesel >2,0 l	Euro II	1997	2000	65,267	58,299	64,360	0,343	0,110	0,035	0,047	0,039	0,050	0,651	0,555	0,665
Passenger Cars	Diesel >2,0 l	Euro III	2001	2005	65,267	58,299	64,360	0,099	0,041	0,012	0,029	0,030	0,045	0,716	0,665	0,750
Passenger Cars	Diesel >2,0 l	Euro IV	2006	2010	65,267	58,299	64,360	0,083	0,034	0,021	0,029	0,024	0,026	0,539	0,424	0,576
Passenger Cars	LPG	Conventional	0	1990	59,000	45,000	54,000	2,043	2,373	9,723	0,040	0,030	0,025	2,203	2,584	2,861
Light Duty Vehicles	Gasoline <3,5t	Conventional	0	1994	82,270	59,883	56,470	14,925	6,075	7,389	0,040	0,040	0,040	2,671	3,118	3,387
Light Duty Vehicles	Gasoline <3,5t	Euro I	1995	1998	96,450	70,388	66,450	4,187	0,862	1,087	0,003	0,002	0,002	0,427	0,400	0,429
Light Duty Vehicles	Gasoline <3,5t	Euro II	1999	2001	96,450	70,388	66,450	2,554	0,526	0,663	0,003	0,002	0,002	0,145	0,136	0,146
Light Duty Vehicles	Gasoline <3,5t	Euro III	2002	2006	96,450	70,388	66,450	2,177	0,448	0,565	0,001	0,001	0,001	0,090	0,084	0,090
Light Duty Vehicles	Gasoline <3,5t	Euro IV	2007	2011	96,450	70,388	66,450	1,172	0,241	0,304	0,001	0,001	0,001	0,043	0,040	0,043
Light Duty Vehicles	Diesel <3,5 t	Conventional	0	1994	76,718	65,934	72,142	1,124	1,009	1,060	0,285	0,303	0,322	1,673	0,843	0,834
Light Duty Vehicles	Diesel <3,5 t	Euro I	1995	1998	68,860	58,185	63,660	0,393	0,328	0,423	0,070	0,066	0,090	1,138	0,975	1,022
Light Duty Vehicles	Diesel <3,5 t	Euro II	1999	2001	68,860	58,185	63,660	0,393	0,328	0,423	0,070	0,066	0,090	1,138	0,975	1,022
Light Duty Vehicles	Diesel <3,5 t	Euro III	2002	2006	68,860	58,185	63,660	0,322	0,269	0,347	0,047	0,044	0,061	0,740	0,634	0,664
Light Duty Vehicles	Diesel <3,5 t	Euro IV	2007	2011	68,860	58,185	63,660	0,255	0,213	0,275	0,024	0,023	0,032	0,319	0,273	0,286
Heavy Duty Vehicles	Gasoline >3,5 t	Conventional	0	9999	225,000	150,000	165,000	70,000	55,000	55,000	0,400	0,400	0,400	4,500	7,500	7,500
Heavy Duty Vehicles	Diesel 3,5 - 7,5 t	Conventional	0	1993	95,822	87,060	109,160	1,612	1,216	1,267	0,288	0,220	0,231	3,363	3,435	4,412
Heavy Duty Vehicles	Diesel 3,5 - 7,5 t	Euro I	1994	1996	77,226	74,990	96,471	0,533	0,417	0,496	0,111	0,085	0,090	2,343	2,497	3,204
Heavy Duty Vehicles	Diesel 3,5 - 7,5 t	Euro II	1997	2001	72,861	72,179	93,536	0,441	0,364	0,416	0,047	0,043	0,053	2,498	2,575	3,216
Heavy Duty Vehicles	Diesel 3,5 - 7,5 t	Euro III	2002	2006	77,798	76,111	97,038	0,528	0,372	0,375	0,051	0,037	0,037	1,955	1,896	2,330
Heavy Duty Vehicles	Diesel 3,5 - 7,5 t	Euro IV	2007	2009	72,942	71,399	91,133	0,042	0,030	0,031	0,010	0,007	0,006	1,186	1,206	1,520
Heavy Duty Vehicles	Diesel 3,5 - 7,5 t	Euro V	2010	2014	74,123	72,286	92,030	0,042	0,030	0,031	0,010	0,007	0,006	0,678	0,689	0,868
Heavy Duty Vehicles	Diesel 7,5 - 16 t	Conventional	0	1993	186,796	147,006	169,108	2,513	1,722	1,825	0,396	0,272	0,287	8,575	7,259	8,446
Heavy Duty Vehicles	Diesel 7,5 - 16 t	Euro I	1994	1996	157,382	126,707	149,418	1,190	0,822	0,874	0,235	0,160	0,170	5,118	4,333	5,002
Heavy Duty Vehicles	Diesel 7,5 - 16 t	Euro II	1997	2001	151,150	122,421	145,510	0,969	0,726	0,808	0,099	0,078	0,100	5,465	4,544	5,171
Heavy Duty Vehicles	Diesel 7,5 - 16 t	Euro III	2002	2006	158,817	127,460	150,203	1,163	0,780	0,821	0,104	0,071	0,076	4,431	3,535	3,915
Heavy Duty Vehicles	Diesel 7,5 - 16 t	Euro IV	2007	2009	148,977	119,369	139,890	0,085	0,058	0,059	0,020	0,013	0,013	2,649	2,173	2,456
Heavy Duty Vehicles	Diesel 7,5 - 16 t	Euro V	2010	2014	151,867	121,247	141,672	0,086	0,059	0,060	0,021	0,013	0,013	1,514	1,242	1,403
Heavy Duty Vehicles	Diesel 16 - 32 t	Conventional	0	1993	295,313	227,040	230,740	2,803	1,927	1,895	0,549	0,384	0,376	12,512	10,087	10,251
Heavy Duty Vehicles	Diesel 16 - 32 t	Euro I	1994	1996	255,466	198,864	203,490	1,975	1,387	1,365	0,389	0,264	0,255	8,507	6,835	6,905
Heavy Duty Vehicles	Diesel 16 - 32 t	Euro II	1997	2001	245,791	192,865	197,773	1,588	1,198	1,230	0,168	0,124	0,155	8,916	7,118	7,115
Heavy Duty Vehicles	Diesel 16 - 32 t	Euro III	2002	2006	255,628	198,692	202,461	1,886	1,298	1,279	0,168	0,114	0,111	7,153	5,549	5,512
Heavy Duty Vehicles	Diesel 16 - 32 t	Euro IV	2007	2009	238,931	185,357	188,314	0,134	0,092	0,087	0,032	0,021	0,019	4,345	3,428	3,456
Heavy Duty Vehicles	Diesel 16 - 32 t	Euro V	2010	2014	243,448	188,256	190,962	0,136	0,093	0,088	0,032	0,021	0,019	2,483	1,959	1,975
Heavy Duty Vehicles	Diesel >32t	Conventional	0	1993	392,838	311,460	297,380	3,143	2,293	2,190	0,683	0,506	0,478	16,482	13,628	12,693
Heavy Duty Vehicles	Diesel >32t	Euro I	1994	1996	346,235	276,687	264,125	2,662	2,009	1,913	0,524	0,373	0,347	11,621	9,581	8,935
Heavy Duty Vehicles	Diesel >32t	Euro II	1997	2001	336,196	270,809	257,607	2,161	1,731	1,720	0,237	0,175	0,223	12,060	9,895	9,161
Heavy Duty Vehicles	Diesel >32t	Euro III	2002	2006	346,156	276,262	262,095	2,497	1,841	1,759	0,219	0,155	0,143	9,625	7,809	7,238

Heavy Duty Vehicles	Diesel >32t	Euro IV	2007	2009	322,306	256,680	243,232	0,170	0,122	0,112	0,040	0,027	0,024	5,943	4,830	4,589
Heavy Duty Vehicles	Diesel >32t	Euro V	2010	2014	328,104	260,582	246,667	0,172	0,124	0,113	0,041	0,027	0,024	3,396	2,760	2,622
Buses	Urban Buses	Conventional	0	1993	315,796	253,287	219,035	4,741	3,178	2,375	0,751	0,498	0,374	14,511	12,324	10,937
Buses	Urban Buses	Euro I	1994	1996	268,961	219,461	190,892	2,274	1,532	1,059	0,407	0,290	0,211	8,836	7,474	6,391
Buses	Urban Buses	Euro II	1997	2001	259,715	216,150	190,405	2,004	1,359	0,914	0,187	0,141	0,118	9,441	7,809	6,730
Buses	Urban Buses	Euro III	2002	2006	273,102	224,893	195,747	2,218	1,456	0,988	0,176	0,127	0,101	7,997	6,112	4,916
Buses	Urban Buses	Euro IV	2007	2009	257,454	211,375	184,295	0,181	0,112	0,081	0,037	0,024	0,018	4,704	3,850	3,045
Buses	Coaches	Conventional	0	1993	281,771	214,600	198,320	2,640	1,684	1,409	0,538	0,364	0,312	10,938	8,865	8,559
Buses	Coaches	Euro I	1994	1996	259,336	198,133	182,616	2,140	1,405	1,179	0,425	0,277	0,227	8,372	6,741	6,409
Buses	Coaches	Euro II	1997	2001	258,542	198,791	182,581	1,787	1,213	1,071	0,183	0,134	0,119	9,357	7,401	6,978
Buses	Coaches	Euro III	2002	2006	276,957	213,400	197,945	2,202	1,453	1,231	0,202	0,140	0,117	8,039	6,015	5,526
Buses	Coaches	Euro IV	2007	2009	262,234	201,251	186,759	0,171	0,112	0,093	0,040	0,026	0,022	4,796	3,677	3,407
Mopeds	<50 cm^3	Conventional	0	1999	25,000	25,000	0,000	13,800	13,800	0,000	0,188	0,188	0,000	0,020	0,020	0,000
Mopeds	<50 cm^3	Euro I	2000	2003	15,000	15,000	0,000	5,600	5,600	0,000	0,076	0,076	0,000	0,020	0,020	0,000
Mopeds	<50 cm^3	Euro II	2004	9999	12,080	12,080	0,000	1,300	1,300	0,000	0,038	0,038	0,000	0,260	0,260	0,000
Motorcycles	2-stroke >50 cm^3	Conventional	0	1999	30,368	32,375	36,950	23,380	25,490	27,500	0,200	0,200	0,200	0,032	0,088	0,133
Motorcycles	4-stroke <250 cm^3	Conventional	0	1999	23,340	26,690	35,600	22,380	26,300	38,600	0,020	0,020	0,020	0,130	0,242	0,362
Motorcycles	4-stroke <250 cm^3	Euro I	2000	2003	22,060	29,470	52,000	12,901	14,597	15,450	0,020	0,020	0,020	0,245	0,416	0,725
Motorcycles	4-stroke <250 cm^3	Euro II	2004	2006	22,060	29,470	52,000	6,472	5,947	9,309	0,005	0,005	0,005	0,195	0,265	0,531
Motorcycles	4-stroke <250 cm^3	Euro III	2007	9999	22,060	29,470	52,000	4,705	1,581	2,241	0,005	0,005	0,005	0,126	0,150	0,329
Motorcycles	4-stroke 250 - 750 cm^3	Conventional	0	1999	28,580	28,640	34,700	20,440	21,517	25,810	0,020	0,020	0,020	0,136	0,251	0,374
Motorcycles	4-stroke 250 - 750 cm^3	Euro I	2000	2003	28,964	29,336	41,300	9,538	13,315	19,810	0,020	0,020	0,020	0,292	0,477	0,757
Motorcycles	4-stroke 250 - 750 cm^3	Euro II	2004	2006	28,964	29,336	41,300	6,472	5,947	9,309	0,005	0,005	0,005	0,195	0,265	0,531
Motorcycles	4-stroke 250 - 750 cm^3	Euro III	2007	9999	28,964	29,336	41,300	4,705	1,581	2,241	0,005	0,005	0,005	0,126	0,150	0,329
Motorcycles	4-stroke >750 cm^3	Conventional	0	1999	37,520	34,340	38,600	14,880	18,030	24,300	0,020	0,020	0,020	0,148	0,266	0,392
Motorcycles	4-stroke >750 cm^3	Euro I	2000	2003	44,952	36,378	40,800	7,884	6,831	10,800	0,020	0,020	0,020	0,210	0,522	1,092
Motorcycles	4-stroke >750 cm^3	Euro II	2004	2006	44,952	36,378	40,800	6,472	5,947	9,309	0,005	0,005	0,005	0,195	0,265	0,531
Motorcycles	4-stroke >750 cm^3	Euro III	2007	9999	44,952	36,378	40,800	4,705	1,581	2,241	0,005	0,005	0,005	0,126	0,150	0,329

Continued

Sector	Subsector	Tech 2	FYear	LYear	CH4u	CH4r	CH4h	N2Ou	N2Or	N2Oh	NH3u	NH3r	NH3h	VOCu	VOCr	VOCh
Passenger Cars	Gasoline <1,4 l	PRE ECE	0	1969	0,092	0,029	0,026	0,010	0,007	0,007	0,002	0,002	0,002	2,354	1,597	1,247
Passenger Cars	Gasoline <1,4 l	ECE 15/00-01	1970	1978	0,092	0,029	0,026	0,010	0,007	0,007	0,002	0,002	0,002	1,862	1,256	1,121
Passenger Cars	Gasoline <1,4 l	ECE 15/02	1979	1980	0,092	0,029	0,026	0,010	0,007	0,007	0,002	0,002	0,002	1,849	1,061	0,950
Passenger Cars	Gasoline <1,4 l	ECE 15/03	1981	1985	0,092	0,029	0,026	0,010	0,007	0,007	0,002	0,002	0,002	1,849	1,061	0,950
Passenger Cars	Gasoline <1,4 l	ECE 15/04	1986	1990	0,092	0,029	0,026	0,010	0,007	0,007	0,002	0,002	0,002	1,480	0,895	0,698
Passenger Cars	Gasoline <1,4 l	Euro I	1991	1996	0,026	0,016	0,014	0,024	0,009	0,005	0,070	0,132	0,074	0,177	0,121	0,111
Passenger Cars	Gasoline <1,4 l	Euro II	1997	2000	0,017	0,013	0,011	0,012	0,005	0,003	0,163	0,149	0,084	0,071	0,047	0,042

Passenger Cars	Gasoline <1,4 l	Euro III	2001	2005	0,003	0,002	0,004	0,001	0,000	0,000	0,002	0,029	0,065	0,015	0,015	0,025
Passenger Cars	Gasoline <1,4 l	Euro IV	2006	2010	0,002	0,002	0,000	0,002	0,000	0,000	0,002	0,029	0,065	0,012	0,014	0,017
Passenger Cars	Gasoline 1,4 - 2,0 l	PRE ECE	0	1969	0,092	0,029	0,026	0,010	0,007	0,007	0,002	0,002	0,002	2,354	1,597	1,247
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/00-01	1970	1978	0,092	0,029	0,026	0,010	0,007	0,007	0,002	0,002	0,002	1,862	1,256	1,121
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/02	1979	1980	0,092	0,029	0,026	0,010	0,007	0,007	0,002	0,002	0,002	1,849	1,061	0,950
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/03	1981	1985	0,092	0,029	0,026	0,010	0,007	0,007	0,002	0,002	0,002	1,849	1,061	0,950
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/04	1986	1990	0,092	0,029	0,026	0,010	0,007	0,007	0,002	0,002	0,002	1,480	0,895	0,698
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro I	1991	1996	0,026	0,016	0,014	0,024	0,009	0,005	0,070	0,132	0,074	0,177	0,121	0,111
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro II	1997	2000	0,017	0,013	0,011	0,012	0,005	0,003	0,163	0,149	0,084	0,071	0,047	0,042
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro III	2001	2005	0,003	0,002	0,004	0,001	0,000	0,000	0,002	0,030	0,065	0,015	0,015	0,025
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro IV	2006	2010	0,002	0,002	0,000	0,002	0,000	0,000	0,002	0,029	0,065	0,012	0,014	0,017
Passenger Cars	Gasoline >2,0 l	PRE ECE	0	1969	0,092	0,029	0,026	0,010	0,007	0,007	0,002	0,002	0,002	2,354	1,597	1,247
Passenger Cars	Gasoline >2,0 l	ECE 15/00-01	1970	1978	0,092	0,029	0,026	0,010	0,007	0,007	0,002	0,002	0,002	1,862	1,256	1,121
Passenger Cars	Gasoline >2,0 l	ECE 15/02	1979	1980	0,092	0,029	0,026	0,010	0,007	0,007	0,002	0,002	0,002	1,849	1,061	0,950
Passenger Cars	Gasoline >2,0 l	ECE 15/03	1981	1985	0,092	0,029	0,026	0,010	0,007	0,007	0,002	0,002	0,002	1,849	1,061	0,950
Passenger Cars	Gasoline >2,0 l	ECE 15/04	1986	1990	0,092	0,029	0,026	0,010	0,007	0,007	0,002	0,002	0,002	1,480	0,895	0,698
Passenger Cars	Gasoline >2,0 l	Euro I	1991	1996	0,026	0,016	0,014	0,024	0,009	0,005	0,070	0,132	0,074	0,177	0,121	0,111
Passenger Cars	Gasoline >2,0 l	Euro II	1997	2000	0,017	0,013	0,011	0,012	0,005	0,003	0,163	0,149	0,084	0,071	0,047	0,042
Passenger Cars	Gasoline >2,0 l	Euro III	2001	2005	0,003	0,002	0,004	0,001	0,000	0,000	0,002	0,029	0,065	0,015	0,015	0,025
Passenger Cars	Gasoline >2,0 l	Euro IV	2006	2010	0,002	0,002	0,000	0,002	0,000	0,000	0,002	0,029	0,065	0,012	0,014	0,017
Passenger Cars	Diesel <2,0 l	Conventional	0	1990	0,028	0,012	0,008	0,000	0,000	0,000	0,001	0,001	0,001	0,145	0,086	0,062
Passenger Cars	Diesel <2,0 l	Euro I	1991	1996	0,011	0,009	0,003	0,002	0,004	0,004	0,001	0,001	0,001	0,053	0,031	0,026
Passenger Cars	Diesel <2,0 l	Euro II	1997	2000	0,007	0,003	0,002	0,004	0,006	0,006	0,001	0,001	0,001	0,034	0,021	0,015
Passenger Cars	Diesel <2,0 l	Euro III	2001	2005	0,003	0,000	0,000	0,009	0,004	0,004	0,001	0,001	0,001	0,018	0,011	0,009
Passenger Cars	Diesel <2,0 l	Euro IV	2006	2010	0,000	0,000	0,000	0,009	0,004	0,004	0,001	0,001	0,001	0,038	0,017	0,012
Passenger Cars	Diesel >2,0 l	Conventional	0	1990	0,028	0,012	0,008	0,000	0,000	0,000	0,001	0,001	0,001	0,145	0,086	0,062
Passenger Cars	Diesel >2,0 l	Euro I	1991	1996	0,011	0,009	0,003	0,002	0,004	0,004	0,001	0,001	0,001	0,080	0,046	0,034
Passenger Cars	Diesel >2,0 l	Euro II	1997	2000	0,007	0,003	0,002	0,004	0,006	0,006	0,001	0,001	0,001	0,098	0,058	0,038
Passenger Cars	Diesel >2,0 l	Euro III	2001	2005	0,003	0,000	0,000	0,009	0,004	0,004	0,001	0,001	0,001	0,038	0,017	0,012
Passenger Cars	Diesel >2,0 l	Euro IV	2006	2010	0,000	0,000	0,000	0,009	0,004	0,004	0,001	0,001	0,001	0,011	0,006	0,006
Passenger Cars	LPG	Conventional	0	1990	0,080	0,035	0,025	0,000	0,000	0,000	0,000	0,000	0,000	1,082	0,667	0,490
Light Duty Vehicles	Gasoline <3,5t	Conventional	0	1994	0,150	0,040	0,025	0,010	0,007	0,007	0,002	0,002	0,002	1,877	0,729	0,446
Light Duty Vehicles	Gasoline <3,5t	Euro I	1995	1998	0,026	0,016	0,014	0,034	0,020	0,010	0,070	0,132	0,074	0,220	0,109	0,078
Light Duty Vehicles	Gasoline <3,5t	Euro II	1999	2001	0,017	0,013	0,011	0,023	0,013	0,008	0,163	0,149	0,084	0,053	0,026	0,019
Light Duty Vehicles	Gasoline <3,5t	Euro III	2002	2006	0,003	0,002	0,004	0,007	0,001	0,001	0,002	0,030	0,065	0,031	0,015	0,011
Light Duty Vehicles	Gasoline <3,5t	Euro IV	2007	2011	0,002	0,002	0,000	0,001	0,000	0,000	0,002	0,030	0,065	0,013	0,007	0,005
Light Duty Vehicles	Diesel <3,5 t	Conventional	0	1994	0,028	0,012	0,008	0,000	0,000	0,000	0,001	0,001	0,001	0,131	0,106	0,101

Light Duty Vehicles	Diesel <3,5 t	Euro I	1995	1998	0,011	0,009	0,003	0,002	0,004	0,004	0,001	0,001	0,001	0,131	0,106	0,101
Light Duty Vehicles	Diesel <3,5 t	Euro II	1999	2001	0,007	0,003	0,002	0,004	0,006	0,006	0,001	0,001	0,001	0,131	0,106	0,101
Light Duty Vehicles	Diesel <3,5 t	Euro III	2002	2006	0,003	0,000	0,000	0,009	0,004	0,004	0,001	0,001	0,001	0,081	0,065	0,063
Light Duty Vehicles	Diesel <3,5 t	Euro IV	2007	2011	0,000	0,000	0,000	0,009	0,004	0,004	0,001	0,001	0,001	0,030	0,024	0,023
Heavy Duty Vehicles	Gasoline >3,5 t	Conventional	0	9999	0,140	0,110	0,070	0,006	0,006	0,006	0,002	0,002	0,002	7,000	5,500	3,500
Heavy Duty Vehicles	Diesel 3,5 - 7,5 t	Conventional	0	1993	0,085	0,023	0,020	0,030	0,030	0,030	0,003	0,003	0,003	1,088	0,683	0,584
Heavy Duty Vehicles	Diesel 3,5 - 7,5 t	Euro I	1994	1996	0,085	0,023	0,020	0,030	0,030	0,030	0,003	0,003	0,003	0,217	0,146	0,139
Heavy Duty Vehicles	Diesel 3,5 - 7,5 t	Euro II	1997	2001	0,054	0,020	0,019	0,030	0,030	0,030	0,003	0,003	0,003	0,139	0,093	0,087
Heavy Duty Vehicles	Diesel 3,5 - 7,5 t	Euro III	2002	2006	0,048	0,021	0,018	0,030	0,030	0,030	0,003	0,003	0,003	0,126	0,083	0,074
Heavy Duty Vehicles	Diesel 3,5 - 7,5 t	Euro IV	2007	2009	0,003	0,002	0,001	0,030	0,030	0,030	0,003	0,003	0,003	0,007	0,004	0,003
Heavy Duty Vehicles	Diesel 3,5 - 7,5 t	Euro V	2010	2014	0,003	0,002	0,001	0,030	0,030	0,030	0,003	0,003	0,003	0,007	0,004	0,003
Heavy Duty Vehicles	Diesel 7,5 - 16 t	Conventional	0	1993	0,085	0,023	0,020	0,030	0,030	0,030	0,003	0,003	0,003	1,084	0,677	0,649
Heavy Duty Vehicles	Diesel 7,5 - 16 t	Euro I	1994	1996	0,085	0,023	0,020	0,030	0,030	0,030	0,003	0,003	0,003	0,453	0,296	0,294
Heavy Duty Vehicles	Diesel 7,5 - 16 t	Euro II	1997	2001	0,054	0,020	0,019	0,030	0,030	0,030	0,003	0,003	0,003	0,292	0,188	0,184
Heavy Duty Vehicles	Diesel 7,5 - 16 t	Euro III	2002	2006	0,048	0,021	0,018	0,030	0,030	0,030	0,003	0,003	0,003	0,259	0,166	0,165
Heavy Duty Vehicles	Diesel 7,5 - 16 t	Euro IV	2007	2009	0,003	0,002	0,001	0,030	0,030	0,030	0,003	0,003	0,003	0,013	0,008	0,008
Heavy Duty Vehicles	Diesel 7,5 - 16 t	Euro V	2010	2014	0,003	0,002	0,001	0,030	0,030	0,030	0,003	0,003	0,003	0,014	0,008	0,008
Heavy Duty Vehicles	Diesel 16 - 32 t	Conventional	0	1993	0,175	0,080	0,070	0,030	0,030	0,030	0,003	0,003	0,003	1,014	0,639	0,569
Heavy Duty Vehicles	Diesel 16 - 32 t	Euro I	1994	1996	0,175	0,080	0,070	0,030	0,030	0,030	0,003	0,003	0,003	0,711	0,465	0,425
Heavy Duty Vehicles	Diesel 16 - 32 t	Euro II	1997	2001	0,112	0,070	0,065	0,030	0,030	0,030	0,003	0,003	0,003	0,456	0,296	0,264
Heavy Duty Vehicles	Diesel 16 - 32 t	Euro III	2002	2006	0,098	0,074	0,064	0,030	0,030	0,030	0,003	0,003	0,003	0,404	0,261	0,237
Heavy Duty Vehicles	Diesel 16 - 32 t	Euro IV	2007	2009	0,005	0,006	0,004	0,030	0,030	0,030	0,003	0,003	0,003	0,021	0,013	0,012
Heavy Duty Vehicles	Diesel 16 - 32 t	Euro V	2010	2014	0,005	0,006	0,004	0,030	0,030	0,030	0,003	0,003	0,003	0,021	0,013	0,012
Heavy Duty Vehicles	Diesel >32t	Conventional	0	1993	0,175	0,080	0,070	0,030	0,030	0,030	0,003	0,003	0,003	0,958	0,626	0,539
Heavy Duty Vehicles	Diesel >32t	Euro I	1994	1996	0,175	0,080	0,070	0,030	0,030	0,030	0,003	0,003	0,003	0,888	0,606	0,528
Heavy Duty Vehicles	Diesel >32t	Euro II	1997	2001	0,112	0,070	0,065	0,030	0,030	0,030	0,003	0,003	0,003	0,563	0,383	0,323
Heavy Duty Vehicles	Diesel >32t	Euro III	2002	2006	0,098	0,074	0,064	0,030	0,030	0,030	0,003	0,003	0,003	0,492	0,332	0,290
Heavy Duty Vehicles	Diesel >32t	Euro IV	2007	2009	0,005	0,006	0,004	0,030	0,030	0,030	0,003	0,003	0,003	0,025	0,016	0,014
Heavy Duty Vehicles	Diesel >32t	Euro V	2010	2014	0,005	0,006	0,004	0,030	0,030	0,030	0,003	0,003	0,003	0,025	0,017	0,015
Buses	Urban Buses	Conventional	0	1993	0,175	0,080	0,070	0,030	0,030	0,030	0,003	0,003	0,003	1,791	1,159	0,848
Buses	Urban Buses	Euro I	1994	1996	0,175	0,080	0,070	0,030	0,030	0,030	0,003	0,003	0,003	0,738	0,507	0,387
Buses	Urban Buses	Euro II	1997	2001	0,114	0,052	0,046	0,030	0,030	0,030	0,003	0,003	0,003	0,480	0,330	0,257
Buses	Urban Buses	Euro III	2002	2006	0,103	0,047	0,041	0,030	0,030	0,030	0,003	0,003	0,003	0,428	0,294	0,226
Buses	Urban Buses	Euro IV	2007	2009	0,005	0,002	0,002	0,030	0,030	0,030	0,003	0,003	0,003	0,022	0,015	0,011
Buses	Coaches	Conventional	0	1993	0,175	0,080	0,070	0,030	0,030	0,030	0,003	0,003	0,003	0,927	0,559	0,415
Buses	Coaches	Euro I	1994	1996	0,175	0,080	0,070	0,030	0,030	0,030	0,003	0,003	0,003	0,860	0,545	0,434
Buses	Coaches	Euro II	1997	2001	0,114	0,052	0,046	0,030	0,030	0,030	0,003	0,003	0,003	0,573	0,368	0,285

Buses	Coaches	Euro III	2002	2006	0,103	0,047	0,041	0,030	0,030	0,030	0,003	0,003	0,003	0,529	0,342	0,284
Buses	Coaches	Euro IV	2007	2009	0,005	0,002	0,002	0,030	0,030	0,030	0,003	0,003	0,003	0,028	0,017	0,014
Mopeds	<50 cm³	Conventional	0	1999	0,219	0,219	0,000	0,001	0,001	0,001	0,001	0,001	0,001	13,910	13,910	0,000
Mopeds	<50 cm³	Euro I	2000	2003	0,044	0,044	0,000	0,001	0,001	0,001	0,001	0,001	0,001	2,730	2,730	0,000
Mopeds	<50 cm³	Euro II	2004	9999	0,024	0,024	0,000	0,001	0,001	0,001	0,001	0,001	0,001	1,560	1,560	0,000
Motorcycles	2-stroke >50 cm³	Conventional	0	1999	0,150	0,150	0,150	0,002	0,002	0,002	0,002	0,002	0,002	9,340	8,402	8,360
Motorcycles	4-stroke <250 cm³	Conventional	0	1999	0,200	0,200	0,200	0,002	0,002	0,002	0,002	0,002	0,002	1,550	0,960	1,320
Motorcycles	4-stroke <250 cm³	Euro I	2000	2003	0,142	0,144	0,132	0,002	0,002	0,002	0,002	0,002	0,002	1,103	0,870	0,870
Motorcycles	4-stroke <250 cm³	Euro II	2004	2006	0,136	0,092	0,092	0,002	0,002	0,002	0,002	0,002	0,002	1,053	0,557	0,612
Motorcycles	4-stroke <250 cm³	Euro III	2007	9999	0,082	0,032	0,028	0,002	0,002	0,002	0,002	0,002	0,002	0,628	0,193	0,179
Motorcycles	4-stroke 250 - 750 cm³	Conventional	0	1999	0,200	0,200	0,200	0,002	0,002	0,002	0,002	0,002	0,002	1,350	0,944	1,010
Motorcycles	4-stroke 250 - 750 cm³	Euro I	2000	2003	0,148	0,174	0,156	0,002	0,002	0,002	0,002	0,002	0,002	1,002	0,753	0,790
Motorcycles	4-stroke 250 - 750 cm³	Euro II	2004	2006	0,156	0,120	0,122	0,002	0,002	0,002	0,002	0,002	0,002	1,053	0,557	0,612
Motorcycles	4-stroke 250 - 750 cm³	Euro III	2007	9999	0,094	0,042	0,036	0,002	0,002	0,002	0,002	0,002	0,002	0,628	0,193	0,179
Motorcycles	4-stroke >750 cm³	Conventional	0	1999	0,200	0,200	0,200	0,002	0,002	0,002	0,002	0,002	0,002	2,520	1,610	1,190
Motorcycles	4-stroke >750 cm³	Euro I	2000	2003	0,092	0,092	0,154	0,002	0,002	0,002	0,002	0,002	0,002	1,170	0,742	0,920
Motorcycles	4-stroke >750 cm³	Euro II	2004	2006	0,084	0,062	0,102	0,002	0,002	0,002	0,002	0,002	0,002	1,053	0,557	0,612
Motorcycles	4-stroke >750 cm³	Euro III	2007	9999	0,050	0,022	0,030	0,002	0,002	0,002	0,002	0,002	0,002	0,628	0,193	0,179

Annex 3B-5: Reduction factors

Sector	Subsector	Tech 2	FYear	LYear	FCuR	FCrR	FChR	COuR	COrR	COhR	PMuR	PMrR	PMhR	NOxuR	NOxrR	NOxhR	VOCuR	VOCrR	VOChR
Passenger Cars	Gasoline <1,4 l	PRE ECE	0	1969	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Passenger Cars	Gasoline <1,4 l	ECE 15/00-01	1970	1978	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Passenger Cars	Gasoline <1,4 l	ECE 15/02	1979	1980	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Passenger Cars	Gasoline <1,4 l	ECE 15/03	1981	1985	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Passenger Cars	Gasoline <1,4 l	ECE 15/04	1986	1990	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Passenger Cars	Gasoline <1,4 l	Euro I	1991	1996	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Passenger Cars	Gasoline <1,4 l	Euro II	1997	2000	1,93	5,83	4,43	62,65	58,10	57,55	0,00	0,00	0,00	43,59	45,20	60,45	60,19	61,27	62,09
Passenger Cars	Gasoline <1,4 l	Euro III	2001	2005	-2,72	-0,72	1,59	70,59	49,62	34,95	60,25	54,57	37,37	72,16	78,49	88,69	91,74	87,53	77,02
Passenger Cars	Gasoline <1,4 l	Euro IV	2006	2010	-5,57	-5,34	-4,84	88,95	79,10	70,06	60,25	54,57	37,37	80,12	89,24	95,86	93,34	88,71	84,51
Passenger Cars	Gasoline 1,4 - 2,0 l	PRE ECE	0	1969	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/00-01	1970	1978	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/02	1979	1980	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/03	1981	1985	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/04	1986	1990	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro I	1991	1996	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro II	1997	2000	2,08	1,72	5,30	62,65	58,10	57,55	0,00	0,00	0,00	43,59	45,20	60,45	60,19	61,27	62,09
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro III	2001	2005	-1,28	-2,83	-3,05	70,59	49,62	34,95	60,25	54,57	37,37	72,16	78,49	88,69	91,74	87,53	77,02
Passenger Cars	Gasoline 1,4 - 2,0 l	Euro IV	2006	2010	-5,15	-8,80	-7,33	88,95	79,10	70,06	60,25	54,57	37,37	80,12	89,24	95,86	93,34	88,71	84,51
Passenger Cars	Gasoline >2,0 l	PRE ECE	0	1969	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Passenger Cars	Gasoline >2,0 l	ECE 15/00-01	1970	1978	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Passenger Cars	Gasoline >2,0 l	ECE 15/02	1979	1980	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Passenger Cars	Gasoline >2,0 l	ECE 15/03	1981	1985	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Passenger Cars	Gasoline >2,0 l	ECE 15/04	1986	1990	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Passenger Cars	Gasoline >2,0 l	Euro I	1991	1996	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Passenger Cars	Gasoline >2,0 l	Euro II	1997	2000	-2,98	-5,37	-2,63	62,65	58,10	57,55	0,00	0,00	0,00	43,59	45,20	60,45	60,19	61,27	62,09
Passenger Cars	Gasoline >2,0 l	Euro III	2001	2005	5,12	7,23	12,60	70,59	49,62	34,95	60,25	54,57	37,37	72,16	78,49	88,69	91,74	87,53	77,02
Passenger Cars	Gasoline >2,0 l	Euro IV	2006	2010	-15,39	-9,65	-1,29	88,95	79,10	70,06	60,25	54,57	37,37	80,12	89,24	95,86	93,34	88,71	84,51
Passenger Cars	Diesel <2,0 l	Conventional	0	1990	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Passenger Cars	Diesel <2,0 l	Euro I	1991	1996	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Passenger Cars	Diesel <2,0 l	Euro II	1997	2000	-5,45	-3,06	-0,81	18,08	48,77	83,05	17,92	36,92	53,22	-7,94	1,18	-0,20	34,81	33,43	41,61
Passenger Cars	Diesel <2,0 l	Euro III	2001	2005	-2,27	-1,45	5,79	76,38	81,12	94,30	48,53	51,90	58,32	-18,71	-18,46	-12,98	65,94	63,35	66,25
Passenger Cars	Diesel <2,0 l	Euro IV	2006	2010	-2,27	-1,45	5,79	80,09	84,22	89,72	49,02	60,57	75,83	10,60	24,53	13,19	27,61	44,26	51,85
Passenger Cars	Diesel >2,0 l	Conventional	0	1990	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Passenger Cars	Diesel >2,0 l	Euro I	1991	1996	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Passenger Cars	Diesel >2,0 l	Euro II	1997	2000	0,00	0,00	0,00	18,08	48,77	83,05	17,92	36,92	53,22	-7,94	1,18	-0,20	-22,14	-25,38	-11,51

Passenger Cars	Diesel >2,0 l	Euro III	2001	2005	0,00	0,00	0,00	76,38	81,12	94,30	48,53	51,90	58,32	-18,71	-18,46	-12,98	52,23	62,67	63,93
Passenger Cars	Diesel >2,0 l	Euro IV	2006	2010	0,00	0,00	0,00	80,09	84,22	89,72	49,02	60,57	75,83	10,60	24,53	13,19	86,39	86,10	83,20
Passenger Cars	LPG	Conventional	0	1990	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Light Duty Vehicles	Gasoline <3,5t	Conventional	0	1994	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Light Duty Vehicles	Gasoline <3,5t	Euro I	1995	1998	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Light Duty Vehicles	Gasoline <3,5t	Euro II	1999	2001	0,00	0,00	0,00	39,00	39,00	39,00	0,00	0,00	0,00	66,00	66,00	66,00	76,00	76,00	76,00
Light Duty Vehicles	Gasoline <3,5t	Euro III	2002	2006	0,00	0,00	0,00	48,00	48,00	48,00	60,25	54,57	37,37	79,00	79,00	79,00	86,00	86,00	86,00
Light Duty Vehicles	Gasoline <3,5t	Euro IV	2007	2011	0,00	0,00	0,00	72,00	72,00	72,00	60,25	54,57	37,37	90,00	90,00	90,00	94,00	94,00	94,00
Light Duty Vehicles	Diesel <3,5 t	Conventional	0	1994	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Light Duty Vehicles	Diesel <3,5 t	Euro I	1995	1998	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Light Duty Vehicles	Diesel <3,5 t	Euro II	1999	2001	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Light Duty Vehicles	Diesel <3,5 t	Euro III	2002	2006	0,00	0,00	0,00	18,00	18,00	18,00	33,00	33,00	33,00	35,00	35,00	35,00	38,00	38,00	38,00
Light Duty Vehicles	Diesel <3,5 t	Euro IV	2007	2011	0,00	0,00	0,00	35,00	35,00	35,00	65,00	65,00	65,00	72,00	72,00	72,00	77,00	77,00	77,00
Heavy Duty Vehicles	Gasoline >3,5 t	Conventional	0	9999	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Heavy Duty Vehicles	Diesel 3,5 - 7,5 t	Conventional	0	1993	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Heavy Duty Vehicles	Diesel 3,5 - 7,5 t	Euro I	1994	1996	19,41	13,86	11,62	66,97	65,69	60,81	61,51	61,35	61,09	30,34	27,31	27,37	80,08	78,62	76,18
Heavy Duty Vehicles	Diesel 3,5 - 7,5 t	Euro II	1997	2001	23,96	17,09	14,31	72,63	70,07	67,15	83,57	80,45	77,17	25,72	25,03	27,10	87,19	86,41	85,11
Heavy Duty Vehicles	Diesel 3,5 - 7,5 t	Euro III	2002	2006	18,81	12,58	11,10	67,25	69,42	70,43	82,21	83,12	84,01	41,88	44,80	47,19	88,42	87,82	87,33
Heavy Duty Vehicles	Diesel 3,5 - 7,5 t	Euro IV	2007	2009	23,88	17,99	16,51	97,42	97,51	97,57	96,62	96,96	97,24	64,74	64,88	65,56	99,40	99,41	99,42
Heavy Duty Vehicles	Diesel 3,5 - 7,5 t	Euro V	2010	2014	22,65	16,97	15,69	97,40	97,51	97,58	96,59	96,94	97,22	79,85	79,93	80,32	99,39	99,41	99,42
Heavy Duty Vehicles	Diesel 7,5 - 16 t	Conventional	0	1993	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Heavy Duty Vehicles	Diesel 7,5 - 16 t	Euro I	1994	1996	15,75	13,81	11,64	52,63	52,23	52,12	40,69	40,89	40,76	40,32	40,30	40,77	58,19	56,28	54,74
Heavy Duty Vehicles	Diesel 7,5 - 16 t	Euro II	1997	2001	19,08	16,72	13,95	61,42	57,82	55,75	74,97	71,26	65,26	36,26	37,39	38,77	73,08	72,27	71,62
Heavy Duty Vehicles	Diesel 7,5 - 16 t	Euro III	2002	2006	14,98	13,30	11,18	53,72	54,72	55,01	73,67	73,70	73,60	48,32	51,30	53,65	76,12	75,48	74,58
Heavy Duty Vehicles	Diesel 7,5 - 16 t	Euro IV	2007	2009	20,25	18,80	17,28	96,62	96,62	96,74	94,89	95,15	95,40	69,11	70,06	70,92	98,78	98,79	98,76
Heavy Duty Vehicles	Diesel 7,5 - 16 t	Euro V	2010	2014	18,70	17,52	16,22	96,58	96,59	96,71	94,81	95,08	95,34	82,35	82,89	83,38	98,75	98,77	98,74
Heavy Duty Vehicles	Diesel 16 - 32 t	Conventional	0	1993	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Heavy Duty Vehicles	Diesel 16 - 32 t	Euro I	1994	1996	13,49	12,41	11,81	29,54	28,01	27,98	29,18	31,39	32,13	32,01	32,24	32,64	29,83	27,16	25,37
Heavy Duty Vehicles	Diesel 16 - 32 t	Euro II	1997	2001	16,77	15,05	14,29	43,36	37,86	35,12	69,41	67,64	58,86	28,74	29,44	30,59	55,02	53,74	53,55
Heavy Duty Vehicles	Diesel 16 - 32 t	Euro III	2002	2006	13,44	12,49	12,26	32,72	32,65	32,53	69,35	70,19	70,49	42,83	44,99	46,23	60,19	59,21	58,26
Heavy Duty Vehicles	Diesel 16 - 32 t	Euro IV	2007	2009	19,09	18,36	18,39	95,20	95,21	95,42	94,19	94,63	94,93	65,27	66,01	66,29	97,97	97,98	97,94
Heavy Duty Vehicles	Diesel 16 - 32 t	Euro V	2010	2014	17,56	17,08	17,24	95,14	95,16	95,37	94,10	94,56	94,87	80,15	80,58	80,74	97,93	97,94	97,90
Heavy Duty Vehicles	Diesel >32t	Conventional	0	1993	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Heavy Duty Vehicles	Diesel >32t	Euro I	1994	1996	11,86	11,16	11,18	15,30	12,36	12,65	23,20	26,41	27,51	29,49	29,70	29,61	7,28	3,19	1,99
Heavy Duty Vehicles	Diesel >32t	Euro II	1997	2001	14,42	13,05	13,37	31,26	24,51	21,44	65,22	65,44	53,40	26,83	27,39	27,83	41,17	38,76	39,97
Heavy Duty Vehicles	Diesel >32t	Euro III	2002	2006	11,88	11,30	11,87	20,56	19,71	19,69	67,96	69,43	70,02	41,60	42,70	42,97	48,58	46,91	46,17
Heavy Duty Vehicles	Diesel >32t	Euro IV	2007	2009	17,95	17,59	18,21	94,59	94,67	94,89	94,14	94,70	94,98	63,94	64,56	63,85	97,40	97,39	97,34
Heavy Duty Vehicles	Diesel >32t	Euro V	2010	2014	16,48	16,34	17,05	94,52	94,60	94,86	94,04	94,62	94,91	79,40	79,75	79,34	97,35	97,34	97,29

Buses	Urban Buses	Conventional	0	1993	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Buses	Urban Buses	Euro I	1994	1996	14,83	13,35	12,85	52,04	51,79	55,42	45,74	41,81	43,69	39,11	39,36	41,56	58,81	56,29	54,39
Buses	Urban Buses	Euro II	1997	2001	17,76	14,66	13,07	57,73	57,23	61,50	75,04	71,66	68,52	34,94	36,64	38,47	73,19	71,52	69,69
Buses	Urban Buses	Euro III	2002	2006	13,52	11,21	10,63	53,21	54,20	58,38	76,57	74,49	72,92	44,89	50,41	55,05	76,10	74,64	73,35
Buses	Urban Buses	Euro IV	2007	2009	18,47	16,55	15,86	96,18	96,48	96,59	95,01	95,23	95,20	67,58	68,76	72,16	98,77	98,75	98,71
Buses	Coaches	Conventional	0	1993	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Buses	Coaches	Euro I	1994	1996	7,96	7,67	7,92	18,93	16,53	16,34	20,89	23,78	27,11	23,46	23,96	25,12	7,21	2,52	-4,41
Buses	Coaches	Euro II	1997	2001	8,24	7,37	7,94	32,32	27,97	24,04	65,98	63,06	61,68	14,45	16,52	18,47	38,19	34,08	31,34
Buses	Coaches	Euro III	2002	2006	1,71	0,56	0,19	16,59	13,73	12,65	62,34	61,58	62,41	26,50	32,15	35,43	42,96	38,70	31,67
Buses	Coaches	Euro IV	2007	2009	6,93	6,22	5,83	93,52	93,34	93,37	92,49	92,91	92,91	56,15	58,53	60,19	97,02	96,87	96,57
Mopeds	<50 cm³	Conventional	0	1999	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Mopeds	<50 cm³	Euro I	2000	2003	40,00	40,00	0,00	59,42	59,42	0,00	59,84	59,84	0,00	0,00	0,00	0,00	80,37	80,37	0,00
Mopeds	<50 cm³	Euro II	2004	9999	51,68	51,68	0,00	90,58	90,58	0,00	80,00	80,00	0,00	-1200,00	-1200,00	0,00	88,79	88,79	0,00
Motorcycles	2-stroke >50 cm³	Conventional	0	1999	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Motorcycles	4-stroke <250 cm³	Conventional	0	1999	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Motorcycles	4-stroke <250 cm³	Euro I	2000	2003	5,48	-10,42	-46,07	42,35	44,50	59,97	0,00	0,00	0,00	-88,74	-72,00	-100,28	28,85	9,38	34,09
Motorcycles	4-stroke <250 cm³	Euro II	2004	2006	5,48	-10,42	-46,07	71,08	77,39	75,88	75,00	75,00	75,00	-50,00	-9,50	-46,69	32,06	41,98	53,64
Motorcycles	4-stroke <250 cm³	Euro III	2007	9999	5,48	-10,42	-46,07	78,98	93,99	94,19	75,00	75,00	75,00	3,08	38,02	9,12	59,48	79,90	86,44
Motorcycles	4-stroke 250 - 750 cm³	Conventional	0	1999	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Motorcycles	4-stroke 250 - 750 cm³	Euro I	2000	2003	-1,34	-2,43	-19,02	53,34	38,12	23,25	0,00	0,00	0,00	-114,62	-90,19	-102,41	25,75	20,22	21,78
Motorcycles	4-stroke 250 - 750 cm³	Euro II	2004	2006	-1,34	-2,43	-19,02	68,34	72,36	63,93	75,00	75,00	75,00	-43,38	-5,58	-41,98	22,00	41,00	39,41
Motorcycles	4-stroke 250 - 750 cm³	Euro III	2007	9999	-1,34	-2,43	-19,02	76,98	92,65	91,32	75,00	75,00	75,00	7,35	40,24	12,03	53,48	79,56	82,28
Motorcycles	4-stroke >750 cm³	Conventional	0	1999	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Motorcycles	4-stroke >750 cm³	Euro I	2000	2003	-19,81	-5,93	-5,70	47,02	62,11	55,56	0,00	0,00	0,00	-41,89	-96,35	-178,57	53,59	53,89	22,69
Motorcycles	4-stroke >750 cm³	Euro II	2004	2006	-19,81	-5,93	-5,70	56,51	67,02	61,69	75,00	75,00	75,00	-31,76	0,38	-35,46	58,21	65,40	48,57
Motorcycles	4-stroke >750 cm³	Euro III	2007	9999	-19,81	-5,93	-5,70	68,38	91,23	90,78	75,00	75,00	75,00	14,86	43,61	16,07	75,08	88,01	84,96

Annex 3B-6: Fuel consumption factors (MJ pr km) and emission factors (g pr km)

Sector	ForecastYear	FCu (MJ)	FCr (MJ)	FCh (MJ)	CO_2u	CO_2r	CO_2h	CH_4u	CH_4r	CH_4h	N_2Ou	N_2Or	N_2Oh	SO_2u	SO_2r	SO_2h	NO_xu	NO_xr	NO_xh
Passenger Cars	1985	3,233	2,102	2,411	236	154	176	0,143	0,028	0,024	0,009	0,006	0,006	0,067	0,041	0,050	1,862	2,206	2,823
Passenger Cars	1986	3,199	2,090	2,391	234	153	175	0,141	0,027	0,024	0,009	0,006	0,006	0,046	0,028	0,034	1,847	2,195	2,819
Passenger Cars	1987	3,187	2,080	2,370	233	152	173	0,142	0,027	0,024	0,009	0,006	0,006	0,046	0,029	0,034	1,849	2,192	2,816
Passenger Cars	1988	3,116	2,067	2,345	228	151	171	0,140	0,027	0,024	0,009	0,006	0,006	0,046	0,029	0,035	1,826	2,182	2,809
Passenger Cars	1989	3,086	2,061	2,333	226	151	171	0,138	0,027	0,024	0,009	0,006	0,006	0,034	0,021	0,026	1,813	2,174	2,806
Passenger Cars	1990	3,071	2,057	2,324	224	150	170	0,138	0,027	0,024	0,009	0,006	0,006	0,034	0,022	0,026	1,809	2,172	2,811
Passenger Cars	1991	3,088	2,053	2,311	226	150	169	0,133	0,026	0,023	0,010	0,006	0,006	0,034	0,021	0,026	1,726	2,036	2,641
Passenger Cars	1992	3,082	2,052	2,302	225	150	168	0,128	0,026	0,023	0,010	0,006	0,006	0,023	0,015	0,017	1,647	1,916	2,494
Passenger Cars	1993	3,093	2,049	2,291	226	150	167	0,122	0,025	0,022	0,011	0,006	0,006	0,013	0,008	0,010	1,581	1,801	2,355
Passenger Cars	1994	3,067	2,050	2,279	224	150	167	0,110	0,024	0,021	0,012	0,007	0,005	0,013	0,008	0,010	1,449	1,604	2,112
Passenger Cars	1995	3,101	2,052	2,271	227	150	166	0,104	0,023	0,020	0,012	0,007	0,005	0,013	0,008	0,010	1,370	1,459	1,932
Passenger Cars	1996	3,141	2,053	2,262	230	150	165	0,097	0,022	0,019	0,013	0,007	0,005	0,013	0,009	0,010	1,299	1,321	1,761
Passenger Cars	1997	3,070	2,040	2,230	224	149	163	0,086	0,020	0,017	0,013	0,007	0,005	0,013	0,008	0,010	1,176	1,158	1,561
Passenger Cars	1998	3,067	2,043	2,218	224	149	162	0,079	0,019	0,016	0,013	0,007	0,005	0,013	0,009	0,010	1,079	1,020	1,380
Passenger Cars	1999	3,047	2,045	2,210	223	149	162	0,071	0,018	0,015	0,013	0,006	0,004	0,010	0,007	0,008	0,998	0,906	1,227
Passenger Cars	2000	3,033	2,048	2,207	222	150	161	0,066	0,017	0,014	0,013	0,006	0,004	0,007	0,005	0,005	0,941	0,824	1,115
Passenger Cars	2001	3,065	2,054	2,208	224	150	161	0,061	0,016	0,013	0,012	0,006	0,004	0,007	0,005	0,005	0,897	0,765	1,031
Passenger Cars	2002	3,037	2,057	2,208	222	150	161	0,055	0,014	0,012	0,011	0,006	0,004	0,007	0,005	0,005	0,834	0,695	0,931
Passenger Cars	2003	3,043	2,059	2,206	223	151	161	0,050	0,013	0,011	0,011	0,005	0,003	0,007	0,005	0,005	0,788	0,640	0,850
Passenger Cars	2004	2,996	2,061	2,205	219	151	161	0,044	0,011	0,010	0,010	0,005	0,003	0,007	0,005	0,005	0,725	0,576	0,757
Passenger Cars	2005	3,014	2,055	2,193	221	150	161	0,040	0,010	0,009	0,010	0,004	0,003	0,001	0,001	0,001	0,680	0,524	0,675
Passenger Cars	2006	2,997	2,061	2,193	219	151	160	0,035	0,009	0,008	0,009	0,004	0,003	0,001	0,001	0,001	0,616	0,463	0,592
Passenger Cars	2007	2,970	2,062	2,190	217	151	160	0,029	0,007	0,006	0,009	0,003	0,003	0,001	0,001	0,001	0,559	0,408	0,519
Passenger Cars	2008	2,985	2,068	2,194	218	151	160	0,025	0,006	0,005	0,008	0,003	0,002	0,001	0,001	0,001	0,519	0,365	0,464
Light Duty Vehicles	1985	3,951	2,783	2,977	292	205	220	0,051	0,017	0,011	0,002	0,001	0,001	0,748	0,548	0,599	2,056	1,231	1,270
Light Duty Vehicles	1986	3,929	2,785	2,984	290	206	220	0,049	0,016	0,011	0,002	0,001	0,001	0,454	0,334	0,365	2,035	1,203	1,238
Light Duty Vehicles	1987	3,938	2,785	2,985	291	206	221	0,049	0,016	0,011	0,002	0,001	0,001	0,456	0,334	0,366	2,039	1,200	1,235
Light Duty Vehicles	1988	3,886	2,785	2,986	287	206	221	0,049	0,016	0,011	0,002	0,001	0,001	0,451	0,335	0,366	2,008	1,197	1,232
Light Duty Vehicles	1989	3,864	2,787	2,990	285	206	221	0,048	0,016	0,011	0,001	0,001	0,001	0,302	0,225	0,247	1,990	1,181	1,213
Light Duty Vehicles	1990	3,858	2,787	2,992	285	206	221	0,047	0,016	0,010	0,001	0,001	0,001	0,303	0,226	0,247	1,984	1,173	1,205
Light Duty Vehicles	1991	3,890	2,787	2,990	287	206	221	0,047	0,016	0,011	0,001	0,001	0,001	0,304	0,225	0,247	2,005	1,180	1,213
Light Duty Vehicles	1992	3,891	2,785	2,985	287	206	220	0,049	0,016	0,011	0,002	0,001	0,001	0,196	0,145	0,159	2,008	1,202	1,237
Light Duty Vehicles	1993	3,924	2,785	2,983	290	206	220	0,049	0,016	0,011	0,002	0,001	0,001	0,077	0,056	0,061	2,028	1,208	1,243
Light Duty Vehicles	1994	3,962	2,786	2,987	292	206	221	0,049	0,016	0,011	0,002	0,001	0,001	0,078	0,057	0,062	2,031	1,194	1,228
Light Duty Vehicles	1995	3,956	2,768	2,966	292	204	219	0,046	0,016	0,010	0,002	0,001	0,001	0,078	0,056	0,061	1,973	1,171	1,206

Light Duty Vehicles	1996	3,995	2,750	2,947	295	203	218	0,043	0,015	0,010	0,003	0,002	0,002	0,078	0,056	0,061	1,937	1,145	1,181
Light Duty Vehicles	1997	3,926	2,733	2,929	290	202	216	0,040	0,015	0,009	0,003	0,002	0,002	0,077	0,055	0,060	1,845	1,120	1,157
Light Duty Vehicles	1998	3,913	2,716	2,908	289	201	215	0,038	0,014	0,009	0,004	0,003	0,002	0,076	0,055	0,060	1,787	1,104	1,143
Light Duty Vehicles	1999	3,879	2,700	2,892	286	199	214	0,035	0,013	0,008	0,004	0,003	0,003	0,042	0,030	0,033	1,715	1,077	1,115
Light Duty Vehicles	2000	3,850	2,686	2,876	284	198	212	0,033	0,012	0,008	0,005	0,004	0,003	0,009	0,006	0,007	1,650	1,055	1,093
Light Duty Vehicles	2001	3,867	2,671	2,860	285	197	211	0,030	0,011	0,007	0,005	0,004	0,003	0,009	0,006	0,007	1,609	1,031	1,071
Light Duty Vehicles	2002	3,816	2,654	2,842	282	196	210	0,027	0,010	0,006	0,006	0,004	0,004	0,009	0,006	0,007	1,490	0,977	1,015
Light Duty Vehicles	2003	3,804	2,638	2,828	281	195	209	0,023	0,009	0,005	0,007	0,004	0,004	0,009	0,006	0,007	1,403	0,923	0,960
Light Duty Vehicles	2004	3,724	2,615	2,806	275	193	207	0,019	0,007	0,004	0,007	0,004	0,004	0,009	0,006	0,007	1,274	0,870	0,906
Light Duty Vehicles	2005	3,751	2,604	2,793	277	192	206	0,017	0,006	0,004	0,008	0,004	0,004	0,002	0,001	0,001	1,213	0,831	0,866
Light Duty Vehicles	2006	3,719	2,590	2,780	275	191	205	0,015	0,005	0,003	0,009	0,004	0,004	0,002	0,001	0,001	1,140	0,794	0,829
Light Duty Vehicles	2007	3,677	2,574	2,768	271	190	204	0,012	0,004	0,003	0,009	0,004	0,004	0,002	0,001	0,001	1,034	0,732	0,764
Light Duty Vehicles	2008	3,681	2,562	2,758	272	189	204	0,010	0,004	0,002	0,010	0,004	0,004	0,002	0,001	0,001	0,945	0,674	0,704
Heavy Duty Vehicles	1985	11,910	9,912	10,595	881	733	784	0,144	0,066	0,064	0,030	0,030	0,030	2,777	2,315	2,478	11,844	10,349	10,884
Heavy Duty Vehicles	1986	11,896	9,904	10,591	880	733	784	0,144	0,066	0,064	0,030	0,030	0,030	1,665	1,388	1,486	11,834	10,341	10,880
Heavy Duty Vehicles	1987	11,905	9,909	10,594	881	733	784	0,144	0,066	0,064	0,030	0,030	0,030	1,666	1,389	1,487	11,842	10,346	10,883
Heavy Duty Vehicles	1988	11,927	9,923	10,600	883	734	784	0,144	0,066	0,064	0,030	0,030	0,030	1,669	1,391	1,488	11,863	10,359	10,888
Heavy Duty Vehicles	1989	11,936	9,929	10,603	883	735	785	0,144	0,066	0,064	0,030	0,030	0,030	1,114	0,928	0,992	11,873	10,365	10,891
Heavy Duty Vehicles	1990	11,876	9,897	10,587	879	732	783	0,144	0,066	0,064	0,030	0,030	0,030	1,108	0,925	0,991	11,801	10,325	10,871
Heavy Duty Vehicles	1991	12,017	9,910	10,560	889	733	781	0,145	0,066	0,063	0,030	0,030	0,030	1,122	0,926	0,988	11,936	10,337	10,846
Heavy Duty Vehicles	1992	12,031	9,919	10,564	890	734	782	0,146	0,066	0,064	0,030	0,030	0,030	0,730	0,603	0,642	11,948	10,345	10,850
Heavy Duty Vehicles	1993	11,868	9,962	10,532	878	737	779	0,144	0,067	0,063	0,030	0,030	0,030	0,277	0,233	0,246	11,741	10,339	10,771
Heavy Duty Vehicles	1994	11,698	9,825	10,404	866	727	770	0,144	0,066	0,063	0,030	0,030	0,030	0,273	0,230	0,243	11,381	10,022	10,454
Heavy Duty Vehicles	1995	11,565	9,770	10,247	856	723	758	0,144	0,067	0,063	0,030	0,030	0,030	0,270	0,228	0,240	11,066	9,790	10,122
Heavy Duty Vehicles	1996	11,532	9,653	10,150	853	714	751	0,144	0,066	0,063	0,030	0,030	0,030	0,269	0,226	0,237	10,867	9,520	9,862
Heavy Duty Vehicles	1997	11,676	9,715	10,130	864	719	750	0,142	0,067	0,063	0,030	0,030	0,030	0,273	0,227	0,237	10,880	9,447	9,694
Heavy Duty Vehicles	1998	11,621	9,672	10,057	860	716	744	0,139	0,067	0,063	0,030	0,030	0,030	0,271	0,226	0,235	10,699	9,275	9,482
Heavy Duty Vehicles	1999	11,667	9,690	10,025	863	717	742	0,137	0,068	0,063	0,030	0,030	0,030	0,150	0,125	0,129	10,631	9,179	9,328
Heavy Duty Vehicles	2000	11,604	9,638	9,960	859	713	737	0,133	0,067	0,063	0,030	0,030	0,030	0,027	0,023	0,023	10,432	8,990	9,117
Heavy Duty Vehicles	2001	11,819	9,764	9,983	875	723	739	0,133	0,069	0,064	0,030	0,030	0,030	0,028	0,023	0,023	10,380	8,885	8,913
Heavy Duty Vehicles	2002	11,782	9,736	9,929	872	720	735	0,128	0,069	0,064	0,030	0,030	0,030	0,028	0,023	0,023	10,028	8,565	8,564
Heavy Duty Vehicles	2003	11,751	9,713	9,894	870	719	732	0,123	0,069	0,063	0,030	0,030	0,030	0,028	0,023	0,023	9,721	8,285	8,268
Heavy Duty Vehicles	2004	11,620	9,621	9,794	860	712	725	0,117	0,069	0,063	0,030	0,030	0,030	0,027	0,023	0,023	9,257	7,876	7,847
Heavy Duty Vehicles	2005	11,676	9,659	9,802	864	715	725	0,113	0,068	0,063	0,030	0,030	0,030	0,005	0,005	0,005	9,041	7,669	7,612
Heavy Duty Vehicles	2006	11,705	9,674	9,791	866	716	725	0,108	0,067	0,061	0,030	0,030	0,030	0,005	0,005	0,005	8,778	7,425	7,348
Heavy Duty Vehicles	2007	11,695	9,652	9,740	865	714	721	0,096	0,061	0,056	0,030	0,030	0,030	0,005	0,005	0,005	8,274	6,982	6,894
Heavy Duty Vehicles	2008	11,467	9,520	9,633	848	704	713	0,085	0,055	0,050	0,030	0,030	0,030	0,005	0,004	0,005	7,579	6,430	6,370
Buses	1985	13,144	10,264	8,850	973	760	655	0,175	0,080	0,070	0,030	0,030	0,030	3,078	2,404	2,073	13,673	11,169	9,586

Buses	1986	13,142	10,261	8,849	973	759	655	0,175	0,080	0,070	0,030	0,030	0,030	1,847	1,442	1,243	13,669	11,164	9,582
Buses	1987	13,148	10,269	8,853	973	760	655	0,175	0,080	0,070	0,030	0,030	0,030	1,847	1,443	1,244	13,683	11,181	9,595
Buses	1988	13,157	10,282	8,861	974	761	656	0,175	0,080	0,070	0,030	0,030	0,030	1,849	1,445	1,245	13,705	11,207	9,615
Buses	1989	13,153	10,276	8,858	973	760	655	0,175	0,080	0,070	0,030	0,030	0,030	1,232	0,963	0,830	13,695	11,195	9,606
Buses	1990	13,137	10,253	8,844	972	759	654	0,175	0,080	0,070	0,030	0,030	0,030	1,231	0,961	0,828	13,656	11,148	9,569
Buses	1991	13,133	10,262	8,843	972	759	654	0,175	0,080	0,070	0,030	0,030	0,030	1,230	0,961	0,828	13,646	11,165	9,567
Buses	1992	13,143	10,245	8,844	973	758	654	0,175	0,080	0,070	0,030	0,030	0,030	0,800	0,624	0,538	13,672	11,130	9,568
Buses	1993	13,114	10,263	8,848	970	759	655	0,175	0,080	0,070	0,030	0,030	0,030	0,307	0,240	0,207	13,599	11,167	9,580
Buses	1994	12,998	10,108	8,772	962	748	649	0,175	0,080	0,070	0,030	0,030	0,030	0,304	0,237	0,205	13,260	10,722	9,310
Buses	1995	12,794	9,930	8,658	947	735	641	0,175	0,080	0,070	0,030	0,030	0,030	0,300	0,233	0,203	12,710	10,244	8,947
Buses	1996	12,605	9,778	8,555	933	724	633	0,175	0,080	0,070	0,030	0,030	0,030	0,295	0,229	0,200	12,202	9,832	8,623
Buses	1997	12,445	9,683	8,486	921	717	628	0,170	0,078	0,068	0,030	0,030	0,030	0,291	0,227	0,199	11,889	9,585	8,429
Buses	1998	12,349	9,632	8,447	914	713	625	0,165	0,075	0,066	0,030	0,030	0,030	0,289	0,226	0,198	11,726	9,459	8,328
Buses	1999	12,234	9,566	8,398	905	708	621	0,161	0,073	0,064	0,030	0,030	0,030	0,158	0,123	0,108	11,511	9,289	8,194
Buses	2000	12,134	9,511	8,357	898	704	618	0,157	0,072	0,063	0,030	0,030	0,030	0,028	0,022	0,020	11,327	9,147	8,080
Buses	2001	12,054	9,465	8,324	892	700	616	0,153	0,070	0,061	0,030	0,030	0,030	0,028	0,022	0,019	11,184	9,033	7,991
Buses	2002	12,011	9,449	8,323	889	699	616	0,149	0,068	0,060	0,030	0,030	0,030	0,028	0,022	0,019	10,907	8,781	7,766
Buses	2003	11,991	9,451	8,332	887	699	617	0,146	0,067	0,058	0,030	0,030	0,030	0,028	0,022	0,020	10,698	8,589	7,587
Buses	2004	11,961	9,432	8,332	885	698	617	0,143	0,065	0,057	0,030	0,030	0,030	0,028	0,022	0,020	10,485	8,387	7,413
Buses	2005	11,921	9,424	8,332	882	697	617	0,139	0,064	0,056	0,030	0,030	0,030	0,006	0,004	0,004	10,246	8,176	7,218
Buses	2006	11,882	9,411	8,330	879	696	616	0,136	0,062	0,054	0,030	0,030	0,030	0,006	0,004	0,004	10,014	7,968	7,030
Buses	2007	11,796	9,355	8,292	873	692	614	0,125	0,057	0,050	0,030	0,030	0,030	0,006	0,004	0,004	9,557	7,601	6,705
Buses	2008	11,714	9,308	8,257	867	689	611	0,115	0,053	0,046	0,030	0,030	0,030	0,005	0,004	0,004	9,119	7,254	6,392
Mopeds	1985	1,095	1,095		80	80		0,219	0,219		0,001	0,001		0,003	0,003		0,020	0,020	
Mopeds	1986	1,095	1,095		80	80		0,219	0,219		0,001	0,001		0,003	0,003		0,020	0,020	
Mopeds	1987	1,095	1,095		80	80		0,219	0,219		0,001	0,001		0,003	0,003		0,020	0,020	
Mopeds	1988	1,095	1,095		80	80		0,219	0,219		0,001	0,001		0,003	0,003		0,020	0,020	
Mopeds	1989	1,095	1,095		80	80		0,219	0,219		0,001	0,001		0,003	0,003		0,020	0,020	
Mopeds	1990	1,095	1,095		80	80		0,219	0,219		0,001	0,001		0,003	0,003		0,020	0,020	
Mopeds	1991	1,095	1,095		80	80		0,219	0,219		0,001	0,001		0,003	0,003		0,020	0,020	
Mopeds	1992	1,095	1,095		80	80		0,219	0,219		0,001	0,001		0,003	0,003		0,020	0,020	
Mopeds	1993	1,095	1,095		80	80		0,219	0,219		0,001	0,001		0,003	0,003		0,020	0,020	
Mopeds	1994	1,095	1,095		80	80		0,219	0,219		0,001	0,001		0,003	0,003		0,020	0,020	
Mopeds	1995	1,095	1,095		80	80		0,219	0,219		0,001	0,001		0,003	0,003		0,020	0,020	
Mopeds	1996	1,095	1,095		80	80		0,219	0,219		0,001	0,001		0,003	0,003		0,020	0,020	
Mopeds	1997	1,095	1,095		80	80		0,219	0,219		0,001	0,001		0,003	0,003		0,020	0,020	
Mopeds	1998	1,095	1,095		80	80		0,219	0,219		0,001	0,001		0,003	0,003		0,020	0,020	
Mopeds	1999	1,095	1,095		80	80		0,219	0,219		0,001	0,001		0,003	0,003		0,020	0,020	

Mopeds	2000	1,050	1,050		77	77		0,201	0,201		0,001	0,001		0,002	0,002		0,020	0,020	
Mopeds	2001	1,019	1,019		74	74		0,188	0,188		0,001	0,001		0,002	0,002		0,020	0,020	
Mopeds	2002	0,985	0,985		72	72		0,175	0,175		0,001	0,001		0,002	0,002		0,020	0,020	
Mopeds	2003	0,969	0,969		71	71		0,169	0,169		0,001	0,001		0,002	0,002		0,020	0,020	
Mopeds	2004	0,940	0,940		69	69		0,159	0,159		0,001	0,001		0,002	0,002		0,035	0,035	
Mopeds	2005	0,910	0,910		66	66		0,149	0,149		0,001	0,001		0,000	0,000		0,051	0,051	
Mopeds	2006	0,876	0,876		64	64		0,138	0,138		0,001	0,001		0,000	0,000		0,067	0,067	
Mopeds	2007	0,848	0,848		62	62		0,128	0,128		0,001	0,001		0,000	0,000		0,083	0,083	
Mopeds	2008	0,827	0,827		60	60		0,121	0,121		0,001	0,001		0,000	0,000		0,094	0,094	
Motorcycles	1985	1,308	1,318	1,578	95	96	115	0,193	0,193	0,193	0,002	0,002	0,002	0,003	0,003	0,004	0,122	0,228	0,340
Motorcycles	1986	1,308	1,318	1,578	95	96	115	0,193	0,193	0,193	0,002	0,002	0,002	0,003	0,003	0,004	0,122	0,228	0,340
Motorcycles	1987	1,308	1,318	1,578	95	96	115	0,193	0,193	0,193	0,002	0,002	0,002	0,003	0,003	0,004	0,122	0,228	0,340
Motorcycles	1988	1,308	1,318	1,578	95	96	115	0,193	0,193	0,193	0,002	0,002	0,002	0,003	0,003	0,004	0,122	0,228	0,340
Motorcycles	1989	1,308	1,318	1,578	95	96	115	0,193	0,193	0,193	0,002	0,002	0,002	0,003	0,003	0,004	0,122	0,228	0,340
Motorcycles	1990	1,308	1,318	1,578	95	96	115	0,193	0,193	0,193	0,002	0,002	0,002	0,003	0,003	0,004	0,122	0,228	0,340
Motorcycles	1991	1,308	1,318	1,578	95	96	115	0,193	0,193	0,193	0,002	0,002	0,002	0,003	0,003	0,004	0,122	0,228	0,340
Motorcycles	1992	1,308	1,318	1,578	95	96	115	0,193	0,193	0,193	0,002	0,002	0,002	0,003	0,003	0,004	0,122	0,228	0,340
Motorcycles	1993	1,308	1,318	1,578	95	96	115	0,193	0,193	0,193	0,002	0,002	0,002	0,003	0,003	0,004	0,122	0,228	0,340
Motorcycles	1994	1,308	1,318	1,578	95	96	115	0,193	0,193	0,193	0,002	0,002	0,002	0,003	0,003	0,004	0,122	0,228	0,340
Motorcycles	1995	1,308	1,318	1,578	95	96	115	0,193	0,193	0,193	0,002	0,002	0,002	0,003	0,003	0,004	0,122	0,228	0,340
Motorcycles	1996	1,308	1,318	1,578	95	96	115	0,193	0,193	0,193	0,002	0,002	0,002	0,003	0,003	0,004	0,122	0,228	0,340
Motorcycles	1997	1,308	1,318	1,578	95	96	115	0,193	0,193	0,193	0,002	0,002	0,002	0,003	0,003	0,004	0,122	0,228	0,340
Motorcycles	1998	1,308	1,318	1,578	95	96	115	0,193	0,193	0,193	0,002	0,002	0,002	0,003	0,003	0,004	0,122	0,228	0,340
Motorcycles	1999	1,308	1,318	1,578	95	96	115	0,193	0,193	0,193	0,002	0,002	0,002	0,003	0,003	0,004	0,122	0,228	0,340
Motorcycles	2000	1,311	1,320	1,591	96	96	116	0,190	0,190	0,190	0,002	0,002	0,002	0,003	0,003	0,004	0,127	0,238	0,359
Motorcycles	2001	1,313	1,321	1,600	96	96	117	0,188	0,189	0,189	0,002	0,002	0,002	0,003	0,003	0,004	0,131	0,244	0,372
Motorcycles	2002	1,315	1,322	1,608	96	97	117	0,187	0,188	0,188	0,002	0,002	0,002	0,003	0,003	0,004	0,135	0,251	0,385
Motorcycles	2003	1,317	1,323	1,616	96	97	118	0,185	0,187	0,187	0,002	0,002	0,002	0,003	0,003	0,004	0,138	0,257	0,398
Motorcycles	2004	1,319	1,324	1,625	96	97	119	0,184	0,184	0,185	0,002	0,002	0,002	0,003	0,003	0,004	0,140	0,257	0,401
Motorcycles	2005	1,322	1,326	1,638	97	97	120	0,181	0,180	0,181	0,002	0,002	0,002	0,001	0,001	0,001	0,142	0,256	0,406
Motorcycles	2006	1,324	1,327	1,649	96	97	120	0,179	0,175	0,177	0,002	0,002	0,002	0,001	0,001	0,001	0,145	0,256	0,411
Motorcycles	2007	1,329	1,331	1,666	97	97	121	0,172	0,166	0,168	0,002	0,002	0,002	0,001	0,001	0,001	0,143	0,248	0,404
Motorcycles	2008	1,331	1,332	1,674	97	97	122	0,169	0,161	0,163	0,002	0,002	0,002	0,001	0,001	0,001	0,142	0,244	0,401

Sector	ForecastYear	NMVOCu (exh)	NMVOCr (exh)	NMVOCh (exh)	NMVOCu (tot)	NMVOCr (tot)	NMVOCh (tot)	COu	COr	COh	NH3u	NH3r	NH3h	TSPu	TSPr	TSPh
Passenger Cars	1985	3,123	1,055	0,930	5,012	1,447	1,005	37,032	10,189	10,610	0,002	0,002	0,002	0,081	0,045	0,047
Passenger Cars	1986	3,004	1,027	0,899	4,889	1,418	0,975	34,691	9,625	9,913	0,002	0,002	0,002	0,081	0,045	0,047
Passenger Cars	1987	2,967	1,003	0,870	4,832	1,390	0,945	33,230	9,054	9,244	0,002	0,002	0,002	0,080	0,043	0,046
Passenger Cars	1988	2,724	0,970	0,830	4,655	1,371	0,907	28,925	8,272	8,307	0,002	0,002	0,002	0,075	0,042	0,044
Passenger Cars	1989	2,615	0,948	0,806	4,560	1,351	0,883	27,096	7,843	7,749	0,002	0,002	0,002	0,074	0,041	0,044
Passenger Cars	1990	2,557	0,931	0,786	4,489	1,331	0,863	26,019	7,501	7,295	0,002	0,002	0,002	0,073	0,040	0,044
Passenger Cars	1991	2,551	0,867	0,731	4,358	1,225	0,802	26,050	6,987	6,770	0,005	0,010	0,007	0,070	0,037	0,041
Passenger Cars	1992	2,450	0,811	0,683	4,246	1,149	0,741	24,895	6,554	6,343	0,009	0,019	0,011	0,063	0,034	0,038
Passenger Cars	1993	2,438	0,755	0,636	4,041	1,057	0,687	24,716	6,112	5,934	0,012	0,026	0,015	0,060	0,032	0,035
Passenger Cars	1994	2,222	0,662	0,557	3,698	0,927	0,603	22,134	5,398	5,208	0,016	0,039	0,022	0,053	0,029	0,032
Passenger Cars	1995	2,188	0,595	0,500	3,564	0,829	0,536	21,617	4,921	4,801	0,020	0,048	0,027	0,049	0,026	0,030
Passenger Cars	1996	2,198	0,530	0,445	3,399	0,733	0,473	21,552	4,469	4,410	0,023	0,057	0,033	0,047	0,023	0,027
Passenger Cars	1997	1,848	0,443	0,374	2,901	0,621	0,398	17,531	3,693	3,769	0,033	0,070	0,040	0,038	0,020	0,023
Passenger Cars	1998	1,696	0,380	0,321	2,552	0,525	0,340	16,126	3,245	3,354	0,041	0,080	0,045	0,034	0,017	0,021
Passenger Cars	1999	1,484	0,326	0,276	2,225	0,452	0,292	13,999	2,858	3,002	0,048	0,087	0,049	0,031	0,016	0,020
Passenger Cars	2000	1,359	0,288	0,244	1,857	0,373	0,255	12,812	2,594	2,770	0,053	0,093	0,052	0,029	0,015	0,019
Passenger Cars	2001	1,319	0,260	0,221	1,752	0,334	0,231	12,650	2,428	2,652	0,050	0,089	0,053	0,029	0,014	0,018
Passenger Cars	2002	1,149	0,228	0,195	1,526	0,292	0,203	11,120	2,216	2,477	0,048	0,084	0,054	0,027	0,014	0,018
Passenger Cars	2003	1,064	0,201	0,172	1,385	0,255	0,179	10,462	2,009	2,289	0,045	0,080	0,053	0,028	0,014	0,018
Passenger Cars	2004	0,881	0,170	0,147	1,151	0,216	0,153	8,751	1,784	2,083	0,041	0,074	0,053	0,027	0,014	0,019
Passenger Cars	2005	0,841	0,144	0,124	1,084	0,185	0,130	8,677	1,570	1,877	0,038	0,069	0,052	0,027	0,014	0,019
Passenger Cars	2006	0,709	0,119	0,104	0,921	0,155	0,109	7,369	1,348	1,644	0,034	0,062	0,051	0,027	0,013	0,018
Passenger Cars	2007	0,584	0,095	0,084	0,749	0,123	0,087	6,176	1,117	1,395	0,028	0,053	0,048	0,027	0,013	0,017
Passenger Cars	2008	0,533	0,079	0,070	0,664	0,101	0,073	5,790	0,979	1,254	0,023	0,047	0,046	0,027	0,013	0,016
Light Duty Vehicles	1985	0,753	0,195	0,149	1,056	0,254	0,162	7,147	1,874	2,141	0,001	0,001	0,001	0,455	0,258	0,274
Light Duty Vehicles	1986	0,702	0,188	0,145	0,986	0,243	0,157	6,639	1,812	2,063	0,001	0,001	0,001	0,452	0,262	0,277
Light Duty Vehicles	1987	0,706	0,187	0,145	0,986	0,241	0,156	6,667	1,806	2,055	0,001	0,001	0,001	0,458	0,262	0,278
Light Duty Vehicles	1988	0,660	0,186	0,144	0,949	0,242	0,156	6,246	1,799	2,047	0,001	0,001	0,001	0,424	0,262	0,278
Light Duty Vehicles	1989	0,624	0,182	0,142	0,904	0,236	0,154	5,899	1,762	2,001	0,001	0,001	0,001	0,416	0,264	0,280
Light Duty Vehicles	1990	0,611	0,180	0,141	0,884	0,233	0,152	5,768	1,745	1,979	0,001	0,001	0,001	0,414	0,265	0,281
Light Duty Vehicles	1991	0,644	0,182	0,142	0,919	0,235	0,153	6,075	1,761	1,999	0,001	0,001	0,001	0,433	0,264	0,280
Light Duty Vehicles	1992	0,664	0,188	0,145	0,968	0,245	0,156	6,303	1,809	2,060	0,001	0,001	0,001	0,421	0,262	0,277
Light Duty Vehicles	1993	0,698	0,189	0,146	0,993	0,245	0,157	6,614	1,822	2,075	0,001	0,001	0,001	0,440	0,261	0,277
Light Duty Vehicles	1994	0,697	0,185	0,144	1,025	0,238	0,154	6,604	1,791	2,038	0,001	0,001	0,001	0,449	0,263	0,278
Light Duty Vehicles	1995	0,682	0,178	0,140	0,982	0,226	0,149	6,487	1,687	1,926	0,002	0,003	0,002	0,429	0,245	0,261
Light Duty Vehicles	1996	0,693	0,170	0,135	0,960	0,212	0,143	6,582	1,577	1,807	0,003	0,004	0,003	0,431	0,228	0,245
Light Duty Vehicles	1997	0,624	0,163	0,131	0,871	0,201	0,138	5,957	1,468	1,688	0,003	0,006	0,004	0,374	0,211	0,229

Light Duty Vehicles	1998	0,610	0,158	0,128	0,828	0,191	0,135	5,878	1,385	1,601	0,004	0,008	0,005	0,346	0,195	0,212
Light Duty Vehicles	1999	0,560	0,150	0,124	0,759	0,181	0,129	5,379	1,280	1,485	0,005	0,009	0,006	0,315	0,180	0,198
Light Duty Vehicles	2000	0,524	0,143	0,120	0,663	0,165	0,124	5,053	1,192	1,389	0,006	0,011	0,006	0,286	0,167	0,185
Light Duty Vehicles	2001	0,517	0,137	0,116	0,636	0,155	0,119	4,950	1,098	1,287	0,007	0,012	0,007	0,278	0,153	0,172
Light Duty Vehicles	2002	0,451	0,126	0,108	0,551	0,142	0,111	4,338	0,976	1,149	0,007	0,012	0,008	0,238	0,136	0,155
Light Duty Vehicles	2003	0,411	0,116	0,101	0,491	0,128	0,103	3,897	0,859	1,016	0,006	0,011	0,008	0,222	0,123	0,141
Light Duty Vehicles	2004	0,337	0,104	0,093	0,395	0,113	0,095	3,168	0,722	0,862	0,006	0,010	0,008	0,176	0,104	0,122
Light Duty Vehicles	2005	0,331	0,098	0,088	0,381	0,105	0,089	3,122	0,647	0,779	0,006	0,010	0,008	0,168	0,092	0,110
Light Duty Vehicles	2006	0,296	0,091	0,083	0,336	0,097	0,084	2,752	0,571	0,694	0,005	0,009	0,008	0,148	0,081	0,099
Light Duty Vehicles	2007	0,251	0,081	0,075	0,277	0,085	0,076	2,222	0,487	0,597	0,004	0,008	0,007	0,127	0,071	0,088
Light Duty Vehicles	2008	0,229	0,073	0,068	0,247	0,076	0,069	1,981	0,425	0,527	0,004	0,007	0,007	0,115	0,060	0,077
Heavy Duty Vehicles	1985	0,910	0,597	0,506	0,910	0,597	0,506	3,087	2,178	2,092	0,003	0,003	0,003	0,526	0,395	0,405
Heavy Duty Vehicles	1986	0,908	0,596	0,506	0,908	0,596	0,506	3,056	2,160	2,084	0,003	0,003	0,003	0,526	0,395	0,405
Heavy Duty Vehicles	1987	0,907	0,596	0,506	0,907	0,596	0,506	3,053	2,159	2,083	0,003	0,003	0,003	0,526	0,395	0,405
Heavy Duty Vehicles	1988	0,906	0,595	0,506	0,906	0,595	0,506	3,049	2,156	2,081	0,003	0,003	0,003	0,527	0,395	0,405
Heavy Duty Vehicles	1989	0,904	0,594	0,505	0,904	0,594	0,505	3,031	2,146	2,076	0,003	0,003	0,003	0,527	0,396	0,405
Heavy Duty Vehicles	1990	0,905	0,595	0,505	0,905	0,595	0,505	3,023	2,143	2,075	0,003	0,003	0,003	0,525	0,395	0,405
Heavy Duty Vehicles	1991	0,901	0,595	0,506	0,901	0,595	0,506	3,027	2,147	2,079	0,003	0,003	0,003	0,530	0,395	0,404
Heavy Duty Vehicles	1992	0,902	0,596	0,507	0,902	0,596	0,507	3,050	2,160	2,086	0,003	0,003	0,003	0,530	0,395	0,404
Heavy Duty Vehicles	1993	0,899	0,590	0,504	0,899	0,590	0,504	3,041	2,149	2,078	0,003	0,003	0,003	0,523	0,395	0,401
Heavy Duty Vehicles	1994	0,867	0,575	0,494	0,867	0,575	0,494	2,953	2,097	2,034	0,003	0,003	0,003	0,508	0,383	0,389
Heavy Duty Vehicles	1995	0,837	0,559	0,486	0,837	0,559	0,486	2,881	2,052	1,998	0,003	0,003	0,003	0,494	0,374	0,377
Heavy Duty Vehicles	1996	0,802	0,542	0,472	0,802	0,542	0,472	2,798	2,003	1,954	0,003	0,003	0,003	0,481	0,361	0,365
Heavy Duty Vehicles	1997	0,751	0,510	0,446	0,751	0,510	0,446	2,679	1,931	1,892	0,003	0,003	0,003	0,459	0,344	0,349
Heavy Duty Vehicles	1998	0,710	0,484	0,423	0,710	0,484	0,423	2,606	1,888	1,851	0,003	0,003	0,003	0,432	0,324	0,332
Heavy Duty Vehicles	1999	0,671	0,460	0,401	0,671	0,460	0,401	2,522	1,840	1,808	0,003	0,003	0,003	0,410	0,307	0,318
Heavy Duty Vehicles	2000	0,639	0,438	0,382	0,639	0,438	0,382	2,478	1,811	1,779	0,003	0,003	0,003	0,386	0,289	0,302
Heavy Duty Vehicles	2001	0,607	0,416	0,361	0,607	0,416	0,361	2,482	1,810	1,761	0,003	0,003	0,003	0,369	0,275	0,287
Heavy Duty Vehicles	2002	0,567	0,390	0,338	0,567	0,390	0,338	2,438	1,779	1,729	0,003	0,003	0,003	0,341	0,254	0,265
Heavy Duty Vehicles	2003	0,534	0,366	0,318	0,534	0,366	0,318	2,389	1,746	1,698	0,003	0,003	0,003	0,317	0,237	0,247
Heavy Duty Vehicles	2004	0,485	0,334	0,292	0,485	0,334	0,292	2,286	1,682	1,643	0,003	0,003	0,003	0,284	0,211	0,222
Heavy Duty Vehicles	2005	0,459	0,315	0,276	0,459	0,315	0,276	2,261	1,663	1,623	0,003	0,003	0,003	0,265	0,197	0,206
Heavy Duty Vehicles	2006	0,430	0,295	0,259	0,430	0,295	0,259	2,208	1,624	1,582	0,003	0,003	0,003	0,246	0,182	0,190
Heavy Duty Vehicles	2007	0,381	0,261	0,229	0,381	0,261	0,229	2,010	1,477	1,436	0,003	0,003	0,003	0,217	0,160	0,168
Heavy Duty Vehicles	2008	0,328	0,226	0,198	0,328	0,226	0,198	1,790	1,322	1,286	0,003	0,003	0,003	0,186	0,138	0,145
Buses	1985	1,413	0,879	0,532	1,413	0,879	0,532	4,248	2,679	1,826	0,003	0,003	0,003	0,701	0,453	0,339
Buses	1986	1,412	0,878	0,531	1,412	0,878	0,531	4,245	2,677	1,825	0,003	0,003	0,003	0,700	0,453	0,339
Buses	1987	1,416	0,881	0,534	1,416	0,881	0,534	4,254	2,684	1,830	0,003	0,003	0,003	0,701	0,454	0,339

Buses	1988	1,421	0,885	0,537	1,421	0,885	0,537	4,266	2,695	1,838	0,003	0,003	0,003	0,702	0,455	0,339
Buses	1989	1,419	0,883	0,536	1,419	0,883	0,536	4,261	2,690	1,835	0,003	0,003	0,003	0,702	0,454	0,339
Buses	1990	1,409	0,875	0,529	1,409	0,875	0,529	4,237	2,670	1,820	0,003	0,003	0,003	0,700	0,452	0,338
Buses	1991	1,407	0,878	0,529	1,407	0,878	0,529	4,232	2,677	1,819	0,003	0,003	0,003	0,699	0,453	0,338
Buses	1992	1,413	0,872	0,529	1,413	0,872	0,529	4,247	2,662	1,819	0,003	0,003	0,003	0,701	0,452	0,338
Buses	1993	1,395	0,878	0,531	1,395	0,878	0,531	4,204	2,678	1,824	0,003	0,003	0,003	0,696	0,453	0,338
Buses	1994	1,346	0,823	0,516	1,346	0,823	0,516	4,083	2,531	1,766	0,003	0,003	0,003	0,676	0,435	0,328
Buses	1995	1,246	0,762	0,483	1,246	0,762	0,483	3,836	2,369	1,669	0,003	0,003	0,003	0,644	0,415	0,316
Buses	1996	1,156	0,713	0,456	1,156	0,713	0,456	3,611	2,235	1,587	0,003	0,003	0,003	0,615	0,398	0,305
Buses	1997	1,078	0,671	0,433	1,078	0,671	0,433	3,436	2,137	1,528	0,003	0,003	0,003	0,573	0,373	0,287
Buses	1998	1,029	0,644	0,419	1,029	0,644	0,419	3,332	2,080	1,492	0,003	0,003	0,003	0,544	0,355	0,274
Buses	1999	0,973	0,613	0,403	0,973	0,613	0,403	3,206	2,009	1,450	0,003	0,003	0,003	0,513	0,336	0,260
Buses	2000	0,923	0,587	0,388	0,923	0,587	0,388	3,098	1,949	1,413	0,003	0,003	0,003	0,485	0,319	0,248
Buses	2001	0,884	0,565	0,377	0,884	0,565	0,377	3,011	1,900	1,384	0,003	0,003	0,003	0,462	0,306	0,239
Buses	2002	0,836	0,538	0,363	0,836	0,538	0,363	2,932	1,856	1,359	0,003	0,003	0,003	0,437	0,290	0,227
Buses	2003	0,801	0,520	0,353	0,801	0,520	0,353	2,882	1,830	1,345	0,003	0,003	0,003	0,419	0,279	0,219
Buses	2004	0,765	0,499	0,342	0,765	0,499	0,342	2,822	1,794	1,327	0,003	0,003	0,003	0,400	0,267	0,210
Buses	2005	0,723	0,476	0,331	0,723	0,476	0,331	2,754	1,758	1,305	0,003	0,003	0,003	0,378	0,254	0,200
Buses	2006	0,682	0,454	0,319	0,682	0,454	0,319	2,686	1,721	1,284	0,003	0,003	0,003	0,357	0,241	0,191
Buses	2007	0,618	0,413	0,293	0,618	0,413	0,293	2,475	1,588	1,188	0,003	0,003	0,003	0,326	0,220	0,175
Buses	2008	0,558	0,376	0,268	0,558	0,376	0,268	2,274	1,463	1,096	0,003	0,003	0,003	0,296	0,201	0,160
Mopeds	1985	13,691	13,691		14,001	14,001		13,800	13,800		0,001	0,001		0,188	0,188	
Mopeds	1986	13,691	13,691		14,008	14,008		13,800	13,800		0,001	0,001		0,188	0,188	
Mopeds	1987	13,691	13,691		14,006	14,006		13,800	13,800		0,001	0,001		0,188	0,188	
Mopeds	1988	13,691	13,691		14,027	14,027		13,800	13,800		0,001	0,001		0,188	0,188	
Mopeds	1989	13,691	13,691		14,041	14,041		13,800	13,800		0,001	0,001		0,188	0,188	
Mopeds	1990	13,691	13,691		14,034	14,034		13,800	13,800		0,001	0,001		0,188	0,188	
Mopeds	1991	13,691	13,691		14,019	14,019		13,800	13,800		0,001	0,001		0,188	0,188	
Mopeds	1992	13,691	13,691		14,022	14,022		13,800	13,800		0,001	0,001		0,188	0,188	
Mopeds	1993	13,691	13,691		14,001	14,001		13,800	13,800		0,001	0,001		0,188	0,188	
Mopeds	1994	13,691	13,691		14,013	14,013		13,800	13,800		0,001	0,001		0,188	0,188	
Mopeds	1995	13,691	13,691		14,014	14,014		13,800	13,800		0,001	0,001		0,188	0,188	
Mopeds	1996	13,691	13,691		14,001	14,001		13,800	13,800		0,001	0,001		0,188	0,188	
Mopeds	1997	13,691	13,691		14,017	14,017		13,800	13,800		0,001	0,001		0,188	0,188	
Mopeds	1998	13,691	13,691		14,002	14,002		13,800	13,800		0,001	0,001		0,188	0,188	
Mopeds	1999	13,691	13,691		14,037	14,037		13,800	13,800		0,001	0,001		0,188	0,188	
Mopeds	2000	12,563	12,563		12,849	12,849		12,960	12,960		0,001	0,001		0,176	0,176	
Mopeds	2001	11,773	11,773		12,085	12,085		12,371	12,371		0,001	0,001		0,168	0,168	

Mopeds	2002	10,937	10,937		11,258	11,258		11,748	11,748		0,001	0,001		0,160	0,160	
Mopeds	2003	10,520	10,520		10,838	10,838		11,437	11,437		0,001	0,001		0,156	0,156	
Mopeds	2004	9,924	9,924		10,244	10,244		10,776	10,776		0,001	0,001		0,148	0,148	
Mopeds	2005	9,299	9,299		9,652	9,652		10,085	10,085		0,001	0,001		0,140	0,140	
Mopeds	2006	8,636	8,636		9,006	9,006		9,353	9,353		0,001	0,001		0,131	0,131	
Mopeds	2007	8,023	8,023		8,389	8,389		8,669	8,669		0,001	0,001		0,123	0,123	
Mopeds	2008	7,588	7,588		7,952	7,952		8,189	8,189		0,001	0,001		0,118	0,118	
Motorcycles	1985	2,639	2,014	2,011	3,494	2,239	2,039	20,029	22,185	27,917	0,002	0,002	0,002	0,047	0,047	0,047
Motorcycles	1986	2,639	2,014	2,011	3,502	2,242	2,039	20,029	22,185	27,917	0,002	0,002	0,002	0,047	0,047	0,047
Motorcycles	1987	2,639	2,014	2,011	3,497	2,240	2,039	20,029	22,185	27,917	0,002	0,002	0,002	0,047	0,047	0,047
Motorcycles	1988	2,639	2,014	2,011	3,533	2,250	2,040	20,029	22,185	27,917	0,002	0,002	0,002	0,047	0,047	0,047
Motorcycles	1989	2,639	2,014	2,011	3,554	2,255	2,041	20,029	22,185	27,917	0,002	0,002	0,002	0,047	0,047	0,047
Motorcycles	1990	2,639	2,014	2,011	3,547	2,253	2,041	20,029	22,185	27,917	0,002	0,002	0,002	0,047	0,047	0,047
Motorcycles	1991	2,639	2,014	2,011	3,409	2,276	2,046	20,029	22,185	27,917	0,002	0,002	0,002	0,047	0,047	0,047
Motorcycles	1992	2,639	2,014	2,011	3,538	2,239	2,044	20,029	22,185	27,917	0,002	0,002	0,002	0,047	0,047	0,047
Motorcycles	1993	2,639	2,014	2,011	3,367	2,267	2,048	20,029	22,185	27,917	0,002	0,002	0,002	0,047	0,047	0,047
Motorcycles	1994	2,639	2,014	2,011	3,490	2,242	2,046	20,029	22,185	27,917	0,002	0,002	0,002	0,047	0,047	0,047
Motorcycles	1995	2,639	2,014	2,011	3,544	2,254	2,037	20,029	22,185	27,917	0,002	0,002	0,002	0,047	0,047	0,047
Motorcycles	1996	2,639	2,014	2,011	3,459	2,234	2,045	20,029	22,185	27,917	0,002	0,002	0,002	0,047	0,047	0,047
Motorcycles	1997	2,639	2,014	2,011	3,496	2,244	2,047	20,029	22,185	27,917	0,002	0,002	0,002	0,047	0,047	0,047
Motorcycles	1998	2,639	2,014	2,011	3,467	2,236	2,045	20,029	22,185	27,917	0,002	0,002	0,002	0,047	0,047	0,047
Motorcycles	1999	2,639	2,014	2,011	3,496	2,244	2,046	20,029	22,185	27,917	0,002	0,002	0,002	0,047	0,047	0,047
Motorcycles	2000	2,615	2,002	2,001	3,292	2,183	2,029	19,624	21,779	27,442	0,002	0,002	0,002	0,047	0,047	0,047
Motorcycles	2001	2,562	1,958	1,959	3,229	2,137	1,986	19,349	21,505	27,145	0,002	0,002	0,002	0,046	0,046	0,046
Motorcycles	2002	2,509	1,914	1,916	3,188	2,096	1,944	19,076	21,232	26,851	0,002	0,002	0,002	0,045	0,045	0,045
Motorcycles	2003	2,457	1,870	1,874	3,131	2,050	1,902	18,824	20,979	26,580	0,002	0,002	0,002	0,044	0,044	0,044
Motorcycles	2004	2,403	1,819	1,825	3,089	2,003	1,853	18,415	20,472	25,998	0,002	0,002	0,002	0,043	0,043	0,043
Motorcycles	2005	2,342	1,763	1,770	3,073	1,959	1,800	17,846	19,773	25,189	0,002	0,002	0,002	0,041	0,041	0,041
Motorcycles	2006	2,279	1,705	1,714	3,042	1,909	1,745	17,234	19,024	24,318	0,002	0,002	0,002	0,040	0,040	0,040
Motorcycles	2007	2,189	1,626	1,634	2,941	1,828	1,665	16,489	17,967	22,957	0,002	0,002	0,002	0,038	0,038	0,038
Motorcycles	2008	2,122	1,566	1,572	2,866	1,765	1,603	16,052	17,353	22,179	0,002	0,002	0,002	0,037	0,037	0,037

Annex 3B-7: Fuel use (GJ) and emissions (tonnes) pr vehicle category and as totals

Sector	Year	FC (PJ)	SO_2	NO_x	NMVOC	CH_4	CO	CO_2	N_2O	NH_3	TSP
Passenger Cars	1985	64,0	1299	52344	70562	1846	525966	4675	177	47	1485
Passenger Cars	1986	64,8	909	53218	70422	1870	504501	4739	180	48	1503
Passenger Cars	1987	65,2	925	53763	70143	1892	485678	4766	182	48	1484
Passenger Cars	1988	66,1	952	54936	69895	1927	440498	4831	187	49	1455
Passenger Cars	1989	65,5	705	54585	68434	1908	412887	4791	185	49	1436
Passenger Cars	1990	69,7	765	58210	71898	2030	422280	5095	197	52	1512
Passenger Cars	1991	74,1	799	58676	72452	2055	436147	5418	218	230	1509
Passenger Cars	1992	77,5	572	59061	71442	2026	425553	5666	238	423	1430
Passenger Cars	1993	79,6	326	57420	69137	1991	425998	5817	254	605	1382
Passenger Cars	1994	82,8	344	54306	64712	1882	392949	6051	278	927	1291
Passenger Cars	1995	83,7	348	51140	59841	1743	370186	6117	288	1171	1189
Passenger Cars	1996	84,7	355	47817	55346	1622	357307	6189	297	1394	1108
Passenger Cars	1997	86,7	360	44171	48990	1523	304314	6338	305	1821	954
Passenger Cars	1998	88,5	369	40307	43590	1428	282512	6466	305	2176	858
Passenger Cars	1999	89,1	298	36664	38252	1322	249033	6512	301	2433	807
Passenger Cars	2000	88,5	203	33606	31763	1227	226509	6468	294	2588	760
Passenger Cars	2001	87,2	200	30815	28987	1114	216346	6373	275	2459	717
Passenger Cars	2002	88,3	202	28665	25707	1019	195675	6457	262	2392	696
Passenger Cars	2003	90,2	207	27125	23597	951	186235	6596	252	2315	735
Passenger Cars	2004	90,9	208	24919	19989	851	161037	6651	238	2196	730
Passenger Cars	2005	89,2	41	22410	18048	758	151928	6530	217	2033	715
Passenger Cars	2006	89,7	41	20107	15404	659	130527	6558	201	1866	700
Passenger Cars	2007	94,8	43	19016	13232	579	115970	6929	199	1709	733
Passenger Cars	2008	93,4	43	16927	11316	485	105072	6827	185	1497	720
Light Duty Vehicles	1985	12,8	2484	6147	2232	118	15890	947	5	5	1331
Light Duty Vehicles	1986	14,3	1688	6754	2344	127	16665	1056	5	5	1489
Light Duty Vehicles	1987	14,7	1738	6939	2404	130	17157	1086	6	5	1542
Light Duty Vehicles	1988	15,1	1786	7092	2413	134	16887	1113	6	5	1529
Light Duty Vehicles	1989	15,5	1239	7241	2389	135	16650	1147	6	5	1567
Light Duty Vehicles	1990	16,6	1331	7717	2507	144	17498	1227	6	6	1677
Light Duty Vehicles	1991	17,1	1367	7990	2653	149	18677	1265	6	6	1761
Light Duty Vehicles	1992	17,0	876	8000	2734	150	19043	1257	7	6	1714
Light Duty Vehicles	1993	17,5	349	8254	2855	155	20208	1292	7	6	1794
Light Duty Vehicles	1994	18,8	377	8692	2953	157	20621	1385	7	7	1924
Light Duty Vehicles	1995	18,5	372	8424	2804	149	19833	1369	10	14	1801

Light Duty Vehicles	1996	18,8	378	8366	2716	142	19709	1391	12	21	1767
Light Duty Vehicles	1997	19,1	382	8266	2554	137	18413	1407	15	28	1624
Light Duty Vehicles	1998	19,4	386	8268	2486	134	18325	1432	19	36	1532
Light Duty Vehicles	1999	19,6	218	8154	2343	126	17138	1448	22	45	1437
Light Duty Vehicles	2000	20,1	47	8153	2139	121	16531	1481	25	54	1356
Light Duty Vehicles	2001	20,7	48	8225	2109	115	16422	1528	29	64	1324
Light Duty Vehicles	2002	21,5	50	8077	1949	106	15143	1585	33	66	1214
Light Duty Vehicles	2003	23,4	54	8333	1909	101	14785	1725	38	66	1219
Light Duty Vehicles	2004	25,3	59	8489	1746	92	13346	1869	45	71	1102
Light Duty Vehicles	2005	26,7	12	8533	1754	85	13488	1971	50	72	1066
Light Duty Vehicles	2006	28,0	13	8557	1662	76	12576	2069	54	71	998
Light Duty Vehicles	2007	27,5	13	7752	1390	61	10224	2031	55	61	857
Light Duty Vehicles	2008	27,6	13	7151	1247	51	9111	2037	57	57	756
Heavy Duty Vehicles	1985	27,2	6357	27900	1670	218	6117	2014	77	8	1106
Heavy Duty Vehicles	1986	30,7	4297	31427	1879	246	6842	2269	86	9	1246
Heavy Duty Vehicles	1987	30,2	4228	30924	1847	242	6723	2232	85	9	1226
Heavy Duty Vehicles	1988	29,6	4156	30391	1811	238	6592	2194	83	8	1204
Heavy Duty Vehicles	1989	30,9	2884	31626	1880	248	6824	2283	87	9	1253
Heavy Duty Vehicles	1990	31,7	2961	32450	1938	255	7019	2344	89	9	1288
Heavy Duty Vehicles	1991	32,4	3031	33210	1984	262	7190	2400	91	9	1319
Heavy Duty Vehicles	1992	31,8	1931	32550	1945	257	7083	2352	89	9	1293
Heavy Duty Vehicles	1993	30,8	720	31396	1867	248	6834	2279	87	9	1246
Heavy Duty Vehicles	1994	32,6	762	32718	1914	256	7072	2412	94	9	1289
Heavy Duty Vehicles	1995	33,0	770	32515	1900	261	7068	2438	96	10	1282
Heavy Duty Vehicles	1996	33,6	786	32660	1896	270	7114	2490	98	10	1279
Heavy Duty Vehicles	1997	34,4	804	32915	1811	275	6958	2544	100	10	1239
Heavy Duty Vehicles	1998	35,0	817	33011	1752	278	6944	2587	102	10	1197
Heavy Duty Vehicles	1999	36,3	467	33852	1722	287	7006	2685	106	11	1181
Heavy Duty Vehicles	2000	35,2	82	32329	1600	276	6722	2603	104	10	1087
Heavy Duty Vehicles	2001	36,3	85	32586	1547	285	6841	2689	106	11	1057
Heavy Duty Vehicles	2002	36,1	85	31309	1442	281	6700	2671	106	11	975
Heavy Duty Vehicles	2003	38,0	89	31957	1432	291	6938	2811	112	11	956
Heavy Duty Vehicles	2004	39,2	92	31676	1363	298	6969	2902	116	12	893
Heavy Duty Vehicles	2005	40,4	19	31652	1322	301	7071	2989	120	12	855
Heavy Duty Vehicles	2006	43,3	20	32840	1327	314	7396	3207	128	13	847
Heavy Duty Vehicles	2007	46,5	22	33245	1263	307	7241	3443	138	14	803
Heavy Duty Vehicles	2008	44,4	21	29660	1058	265	6273	3289	134	13	669
Buses	1985	6,3	1480	6707	607	68	1843	468	16	2	308

Buses	1986	6,9	967	7302	660	74	2006	509	18	2	336
Buses	1987	6,8	954	7211	653	74	1983	502	18	2	332
Buses	1988	6,8	962	7275	661	74	2005	506	18	2	335
Buses	1989	7,0	659	7471	678	76	2057	520	18	2	344
Buses	1990	7,6	708	8018	724	82	2200	559	20	2	368
Buses	1991	7,5	705	7989	718	81	2182	557	20	2	366
Buses	1992	7,2	440	7665	692	78	2102	535	19	2	352
Buses	1993	7,4	173	7809	700	80	2131	545	19	2	358
Buses	1994	7,9	184	8187	717	85	2203	583	21	2	372
Buses	1995	8,1	190	8231	693	89	2159	602	22	2	371
Buses	1996	8,5	200	8430	685	94	2160	632	24	2	378
Buses	1997	8,4	196	8157	637	91	2045	620	23	2	350
Buses	1998	8,2	192	7938	602	87	1960	608	23	2	329
Buses	1999	8,0	103	7670	562	83	1860	593	23	2	305
Buses	2000	7,8	18	7358	522	79	1756	574	22	2	282
Buses	2001	7,6	18	7118	491	76	1674	559	22	2	264
Buses	2002	7,6	18	6949	467	74	1638	560	22	2	251
Buses	2003	8,0	19	7193	475	77	1705	591	23	2	254
Buses	2004	8,2	19	7234	468	77	1717	606	24	2	250
Buses	2005	8,6	4	7387	465	79	1758	633	25	2	248
Buses	2006	8,9	4	7548	462	80	1799	661	26	3	246
Buses	2007	9,2	4	7498	438	77	1728	684	27	3	234
Buses	2008	9,4	4	7299	405	73	1623	694	28	3	218
Mopeds	1985	0,4	1	7	4935	77	4864	28	0	0	66
Mopeds	1986	0,3	1	6	4403	69	4337	25	0	0	59
Mopeds	1987	0,3	1	6	4055	63	3995	23	0	0	54
Mopeds	1988	0,3	1	5	3820	60	3758	22	0	0	51
Mopeds	1989	0,3	1	5	3621	56	3559	21	0	0	48
Mopeds	1990	0,3	1	5	3674	57	3613	21	0	0	49
Mopeds	1991	0,3	1	5	3775	59	3717	22	0	0	51
Mopeds	1992	0,3	1	5	3791	59	3731	22	0	0	51
Mopeds	1993	0,3	1	5	3737	58	3684	21	0	0	50
Mopeds	1994	0,3	1	5	3694	58	3638	21	0	0	50
Mopeds	1995	0,3	1	6	3952	62	3891	23	0	0	53
Mopeds	1996	0,3	1	6	4212	66	4152	24	0	0	57
Mopeds	1997	0,4	1	7	4608	72	4536	26	0	0	62
Mopeds	1998	0,4	1	7	4956	78	4884	28	0	0	67
Mopeds	1999	0,4	1	6	4498	70	4423	26	0	0	60

Mopeds	2000	0,3	1	6	3946	62	3980	24	0	0	54
Mopeds	2001	0,3	1	5	3021	47	3093	19	0	0	42
Mopeds	2002	0,3	1	5	2957	46	3086	19	0	0	42
Mopeds	2003	0,3	1	5	2812	44	2967	18	0	0	40
Mopeds	2004	0,2	1	9	2605	40	2740	17	0	0	38
Mopeds	2005	0,2	0	12	2358	36	2464	16	0	0	34
Mopeds	2006	0,2	0	16	2137	33	2219	15	0	0	31
Mopeds	2007	0,2	0	19	1954	30	2019	14	0	0	29
Mopeds	2008	0,2	0	20	1729	26	1780	13	0	0	26
Motorcycles	1985	0,4	1	55	768	53	6156	27	1	1	13
Motorcycles	1986	0,4	1	55	765	53	6119	27	1	1	13
Motorcycles	1987	0,4	1	53	741	51	5933	26	1	1	13
Motorcycles	1988	0,4	1	54	757	52	6014	27	1	1	13
Motorcycles	1989	0,4	1	53	747	51	5914	26	1	1	13
Motorcycles	1990	0,4	1	57	799	55	6333	28	1	1	13
Motorcycles	1991	0,4	1	56	834	57	6440	29	1	1	14
Motorcycles	1992	0,4	1	62	878	60	6933	31	1	1	15
Motorcycles	1993	0,4	1	62	935	64	7217	33	1	1	16
Motorcycles	1994	0,5	1	68	989	68	7755	35	1	1	17
Motorcycles	1995	0,5	1	74	1014	70	8143	36	1	1	17
Motorcycles	1996	0,5	1	75	1072	74	8463	38	1	1	18
Motorcycles	1997	0,6	1	82	1188	82	9308	42	1	1	20
Motorcycles	1998	0,6	1	89	1279	88	10078	45	1	1	22
Motorcycles	1999	0,7	2	95	1373	94	10759	48	1	1	23
Motorcycles	2000	0,7	2	107	1418	100	11392	52	1	1	25
Motorcycles	2001	0,8	2	118	1479	106	11975	56	1	1	26
Motorcycles	2002	0,8	2	130	1567	114	12722	60	1	1	27
Motorcycles	2003	0,9	2	143	1642	121	13430	64	1	1	29
Motorcycles	2004	0,9	2	153	1718	127	13977	69	1	1	30
Motorcycles	2005	1,0	0	165	1818	134	14504	74	1	1	30
Motorcycles	2006	1,0	0	172	1843	135	14418	76	2	2	30
Motorcycles	2007	1,2	1	186	1964	143	15162	85	2	2	32
Motorcycles	2008	1,2	1	193	2000	146	15414	89	2	2	32
Total	1985	111,1	11621	93160	80775	2381	560836	8160	277	61	4311
Total	1986	117,4	7862	98763	80473	2439	540471	8625	290	64	4645
Total	1987	117,6	7847	98895	79843	2453	521469	8636	291	64	4650
Total	1988	118,3	7857	99754	79356	2484	475754	8694	294	66	4587
Total	1989	119,6	5488	100981	77749	2475	447890	8789	297	66	4660

Total	1990	126,2	5767	106456	81541	2623	458943	9275	313	70	4908
Total	1991	131,9	5903	107926	82416	2662	474352	9690	336	248	5019
Total	1992	134,3	3820	107343	81482	2631	464445	9863	354	441	4854
Total	1993	136,0	1569	104946	79230	2596	466072	9987	367	622	4845
Total	1994	142,8	1669	103977	74979	2506	434238	10487	400	946	4943
Total	1995	144,1	1682	100389	70204	2374	411281	10585	416	1198	4713
Total	1996	146,6	1721	97354	65927	2268	398904	10764	433	1428	4606
Total	1997	149,5	1744	93597	59788	2179	345574	10978	445	1862	4248
Total	1998	152,0	1768	89621	54665	2093	324704	11166	450	2226	4004
Total	1999	154,0	1088	86441	48751	1983	290218	11312	453	2491	3813
Total	2000	152,5	352	81559	41387	1865	266890	11202	447	2656	3565
Total	2001	152,8	353	78866	37635	1744	256351	11223	433	2537	3430
Total	2002	154,5	357	75136	34090	1640	234964	11352	424	2472	3205
Total	2003	160,6	371	74757	31867	1584	226060	11806	425	2396	3234
Total	2004	164,8	381	72479	27888	1484	199785	12115	424	2282	3042
Total	2005	166,1	77	70161	25766	1393	191213	12214	413	2122	2948
Total	2006	171,3	79	69240	22835	1298	168936	12587	412	1954	2852
Total	2007	179,5	83	67717	20241	1197	152344	13186	421	1788	2688
Total	2008	176,2	82	61250	17754	1046	139272	12948	405	1572	2421

Annex 3B-8: COPERT IV:DEA statistics fuel use ratios and mileage adjustment factors

Sales			1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Fuel ratio	Gasoline	DEA:COPERT IV	1,04	1,00	0,97	0,95	0,92	0,97	1,01	1,06	1,09	1,11	1,10	1,08	1,10	1,11	1,09	1,09	1,09	1,10	1,10	1,08	1,04	1,01	0,99	0,94
	Diesel	DEA:COPERT IV	1,08	1,15	1,12	1,11	1,14	1,23	1,25	1,22	1,23	1,32	1,30	1,31	1,31	1,30	1,27	1,24	1,22	1,22	1,28	1,31	1,35	1,39	1,45	1,46
Consumption																										
Fuel ratio	Gasoline	DEA:COPERT IV	1,08	1,08	1,07	1,08	1,07	1,06	1,06	1,07	1,07	1,08	1,09	1,09	1,11	1,11	1,13	1,15	1,13	1,13	1,12	1,10	1,06	1,02	0,99	0,94
	Diesel	DEA:COPERT IV	1,01	1,04	1,01	1,01	1,04	1,12	1,19	1,17	1,17	1,22	1,19	1,19	1,19	1,18	1,17	1,15	1,14	1,12	1,15	1,18	1,22	1,26	1,33	1,34

Annex 3B-9: Basis fuel consumption and emission factors, deterioration factors, transient factors and specific operational data for non road working machinery and equipment, and recreational craft

Basis factors for diesel fuelled non road machinery.

Engine size [P=kW]	Emission Level	NO_x	VOC	CO	N_2O [g pr kWh]	NH_3	TSP	Fuel
P<19	<1981	12.0	5.0	7	0.035	0.002	2.8	300
P<19	1981-1990	11.5	3.8	6	0.035	0.002	2.3	285
P<19	1991-Stage I	11.2	2.5	5	0.035	0.002	1.6	270
P<19	Stage I	11.2	2.5	5	0.035	0.002	1.6	270
P<19	Stage II	11.2	2.5	5	0.035	0.002	1.6	270
P<19	Stage IIIA	11.2	2.5	5	0.035	0.002	1.6	270
P<19	Stage IIIB	11.2	2.5	5	0.035	0.002	1.6	270
P<19	Stage IV	11.2	2.5	5	0.035	0.002	1.6	270
19<=P<37	<1981	18.0	2.5	6.5	0.035	0.002	2	300
19<=P<37	1981-1990	18.0	2.2	5.5	0.035	0.002	1.4	281
19<=P<37	1991-Stage I	9.8	1.8	4.5	0.035	0.002	1.4	262
19<=P<37	Stage I	9.8	1.8	4.5	0.035	0.002	1.4	262
19<=P<37	Stage II	6.5	0.6	2.2	0.035	0.002	0.4	262
19<=P<37	Stage IIIA	6.2	0.6	2.2	0.035	0.002	0.4	262
19<=P<37	Stage IIIB	6.2	0.6	2.2	0.035	0.002	0.4	262
19<=P<37	Stage IV	6.2	0.6	2.2	0.035	0.002	0.4	262
37<=P<56	<1981	7.7	2.4	6	0.035	0.002	1.8	290
37<=P<56	1981-1990	8.6	2.0	5.3	0.035	0.002	1.2	275
37<=P<56	1991-Stage I	11.5	1.5	4.5	0.035	0.002	0.8	260
37<=P<56	Stage I	7.7	0.6	2.2	0.035	0.002	0.4	260
37<=P<56	Stage II	5.5	0.4	2.2	0.035	0.002	0.2	260
37<=P<56	Stage IIIA	3.9	0.4	2.2	0.035	0.002	0.2	260
37<=P<56	Stage IIIB	3.9	0.4	2.2	0.035	0.002	0.0225	260
37<=P<56	Stage IV	3.9	0.4	2.2	0.035	0.002	0.0225	260
56<=P<75	<1981	7.7	2.0	5	0.035	0.002	1.4	290
56<=P<75	1981-1990	8.6	1.6	4.3	0.035	0.002	1	275
56<=P<75	1991-Stage I	11.5	1.2	3.5	0.035	0.002	0.4	260
56<=P<75	Stage I	7.7	0.4	1.5	0.035	0.002	0.2	260
56<=P<75	Stage II	5.5	0.3	1.5	0.035	0.002	0.2	260
56<=P<75	Stage IIIA	4.0	0.3	1.5	0.035	0.002	0.2	260
56<=P<75	Stage IIIB	3.0	0.2	1.5	0.035	0.002	0.0225	260
56<=P<75	Stage IV	0.4	0.2	1.5	0.035	0.002	0.0225	260
75<=P<130	<1981	10.5	2.0	5	0.035	0.002	1.4	280
75<=P<130	1981-1990	11.8	1.6	4.3	0.035	0.002	1	268
75<=P<130	1991-Stage I	13.3	1.2	3.5	0.035	0.002	0.4	255
75<=P<130	Stage I	8.1	0.4	1.5	0.035	0.002	0.2	255
75<=P<130	Stage II	5.2	0.3	1.5	0.035	0.002	0.2	255
75<=P<130	Stage IIIA	3.4	0.3	1.5	0.035	0.002	0.2	255
75<=P<130	Stage IIIB	3.0	0.2	1.5	0.035	0.002	0.0225	255
75<=P<130	Stage IV	0.4	0.2	1.5	0.035	0.002	0.0225	255
130<=P<560	<1981	17.8	1.5	2.5	0.035	0.002	0.9	270
130<=P<560	1981-1990	12.4	1.0	2.5	0.035	0.002	0.8	260
130<=P<560	1991-Stage I	11.2	0.5	2.5	0.035	0.002	0.4	250
130<=P<560	Stage I	7.6	0.3	1.5	0.035	0.002	0.2	250
130<=P<560	Stage II	5.2	0.3	1.5	0.035	0.002	0.1	250
130<=P<560	Stage IIIA	3.4	0.3	1.5	0.035	0.002	0.1	250
130<=P<560	Stage IIIB	3.0	0.2	1.5	0.035	0.002	0.0225	250
130<=P<560	Stage IV	0.4	0.2	1.5	0.035	0.002	0.0225	250

Basis factors for 4-stroke gasoline non road machinery.

Engine	Size code	Size classe [S=ccm]	Emission Level	NO_x	VOC	CO	N_2O [g pr kWh]	NH_3	TSP	Fuel
4-stroke	SH2	20<=S<50	<1981	2.4	33	198	0.002	0.03	0.08	496
4-stroke	SH2	20<=S<50	1981-1990	3.5	27.5	165	0.002	0.03	0.08	474
4-stroke	SH2	20<=S<50	1991-Stage I	4.7	22	132	0.002	0.03	0.08	451
4-stroke	SH2	20<=S<50	Stage I	4.7	22	132	0.002	0.03	0.08	406
4-stroke	SH2	20<=S<50	Stage II	4.7	22	132	0.002	0.03	0.08	406
4-stroke	SH3	S>=50	<1981	2.4	33	198	0.002	0.03	0.08	496
4-stroke	SH3	S>=50	1981-1990	3.5	27.5	165	0.002	0.03	0.08	474
4-stroke	SH3	S>=50	1991-Stage I	4.7	22	132	0.002	0.03	0.08	451
4-stroke	SH3	S>=50	Stage I	4.7	22	132	0.002	0.03	0.08	406
4-stroke	SH3	S>=50	Stage II	4.7	22	132	0.002	0.03	0.08	406
4-stroke	SN1	S<66	<1981	1.2	26.9	822	0.002	0.03	0.08	603
4-stroke	SN1	S<66	1981-1990	1.8	22.5	685	0.002	0.03	0.08	603
4-stroke	SN1	S<66	1991-Stage I	2.4	18	548	0.002	0.03	0.08	603
4-stroke	SN1	S<66	Stage I	4.3	16.1	411	0.002	0.03	0.08	475
4-stroke	SN1	S<66	Stage II	4.3	16.1	411	0.002	0.03	0.08	475
4-stroke	SN2	66<=S<100	<1981	2.3	10.5	822	0.002	0.03	0.08	627
4-stroke	SN2	66<=S<100	1981-1990	3.5	8.7	685	0.002	0.03	0.08	599
4-stroke	SN2	66<=S<100	1991-Stage I	4.7	7	548	0.002	0.03	0.08	570
4-stroke	SN2	66<=S<100	Stage I	4.7	7	467	0.002	0.03	0.08	450
4-stroke	SN2	66<=S<100	Stage II	4.7	7	467	0.002	0.03	0.08	450
4-stroke	SN3	100<=S<225	<1981	2.6	19.1	525	0.002	0.03	0.08	601
4-stroke	SN3	100<=S<225	1981-1990	3.8	15.9	438	0.002	0.03	0.08	573
4-stroke	SN3	100<=S<225	1991-Stage I	5.1	12.7	350	0.002	0.03	0.08	546
4-stroke	SN3	100<=S<225	Stage I	5.1	11.6	350	0.002	0.03	0.08	546
4-stroke	SN3	100<=S<225	Stage II	5.1	9.4	350	0.002	0.03	0.08	546
4-stroke	SN4	S>=225	<1981	1.3	11.1	657	0.002	0.03	0.08	539
4-stroke	SN4	S>=225	1981-1990	2	9.3	548	0.002	0.03	0.08	514
4-stroke	SN4	S>=225	1991-Stage I	2.6	7.4	438	0.002	0.03	0.08	490
4-stroke	SN4	S>=225	Stage I	2.6	7.4	438	0.002	0.03	0.08	490
4-stroke	SN4	S>=225	Stage II	2.6	7.4	438	0.002	0.03	0.08	490

Basis factors for 2-stroke gasoline non road machinery.

Engine	Size code	Size classe [ccm]	Emission Level	NO_x	VOC	CO	N_2O [g pr kWh]	NH_3	TSP	Fuel
2-stroke	SH2	20<=S<50	<1981	1	305	695	0.002	0.01	7	882
2-stroke	SH2	20<=S<50	1981-1990	1	300	579	0.002	0.01	5.3	809
2-stroke	SH2	20<=S<50	1991-Stage I	1.1	203	463	0.002	0.01	3.5	735
2-stroke	SH2	20<=S<50	Stage I	1.5	188	379	0.002	0.01	3.5	720
2-stroke	SH2	20<=S<50	Stage II	1.5	44	379	0.002	0.01	3.5	500
2-stroke	SH3	S>=50	<1981	1.1	189	510	0.002	0.01	3.6	665
2-stroke	SH3	S>=50	1981-1990	1.1	158	425	0.002	0.01	2.7	609
2-stroke	SH3	S>=50	1991-Stage I	1.2	126	340	0.002	0.01	1.8	554
2-stroke	SH3	S>=50	Stage I	2	126	340	0.002	0.01	1.8	529
2-stroke	SH3	S>=50	Stage II	1.2	64	340	0.002	0.01	1.8	500
2-stroke	SN1	S<66	<1981	0.5	155	418	0.002	0.01	2.6	652
2-stroke	SN1	S<66	1981-1990	0.5	155	418	0.002	0.01	2.6	652
2-stroke	SN1	S<66	1991-Stage I	0.5	155	418	0.002	0.01	2.6	652
2-stroke	SN1	S<66	Stage I	0.5	155	418	0.002	0.01	2.6	652
2-stroke	SN1	S<66	Stage II	0.5	155	418	0.002	0.01	2.6	652
2-stroke	SN2	66<=S<100	<1981	0.5	155	418	0.002	0.01	2.6	652
2-stroke	SN2	66<=S<100	1981-1990	0.5	155	418	0.002	0.01	2.6	652
2-stroke	SN2	66<=S<100	1991-Stage I	0.5	155	418	0.002	0.01	2.6	652
2-stroke	SN2	66<=S<100	Stage I	0.5	155	418	0.002	0.01	2.6	652
2-stroke	SN2	66<=S<100	Stage II	0.5	155	418	0.002	0.01	2.6	652
2-stroke	SN3	100<=S<225	<1981	0.5	155	418	0.002	0.01	2.6	652
2-stroke	SN3	100<=S<225	1981-1990	0.5	155	418	0.002	0.01	2.6	652
2-stroke	SN3	100<=S<225	1991-Stage I	0.5	155	418	0.002	0.01	2.6	652
2-stroke	SN3	100<=S<225	Stage I	0.5	155	418	0.002	0.01	2.6	652
2-stroke	SN3	100<=S<225	Stage II	0.5	155	418	0.002	0.01	2.6	652
2-stroke	SN4	S>=225	<1981	0.5	155	418	0.002	0.01	2.6	652
2-stroke	SN4	S>=225	1981-1990	0.5	155	418	0.002	0.01	2.6	652
2-stroke	SN4	S>=225	1991-Stage I	0.5	155	418	0.002	0.01	2.6	652
2-stroke	SN4	S>=225	Stage I	0.5	155	418	0.002	0.01	2.6	652
2-stroke	SN4	S>=225	Stage II	0.5	155	418	0.002	0.01	2.6	652

Fuel consumption and emission factors LPG fork lifts.

NO_x [g pr kWh]	VOC [g pr kWh]	CO [g pr kWh]	NH_3 [g pr kWh]	N_2O [g pr kWh]	TSP [g pr kWh]	FC [g pr kWh]
19	2.2	1.5	0.003	0.05	0.07	311

Fuel consumption and emission factors for All Terrain Vehicles (ATV's).

ATV type	NO_x [g pr GJ]	VOC [g pr GJ]	CO [g pr GJ]	NH_3 [g pr GJ]	N_2O [g pr GJ]	TSP [g pr GJ]	Fuel [kg pr hour]
Professional	108	1077	16306	2	2	32	1.125
Private	128	1527	22043	2	2	39	0.75

Fuel consumption and emission factors for recreational craft.

Fuel type	Vessel type	Engine	Engine type	Direktiv	Engine size [kW]	CO [g pr kWh]	VOC	N_2O	NH_3	NO_x	TSP	Fuel
Gasoline	Other boats (< 20 ft)	Out board	2-stroke	2003/44	8	202.5	45.9	0.01	0.002	2	10	791
Gasoline	Other boats (< 20 ft)	Out board	2-stroke	Konv.	8	427	257.0	0.01	0.002	2	10	791
Gasoline	Other boats (< 20 ft)	Out board	4-stroke	2003/44	8	202.5	24.0	0.03	0.002	7	0.08	426
Gasoline	Other boats (< 20 ft)	Out board	4-stroke	Konv.	8	520	24.0	0.03	0.002	7	0.08	426
Gasoline	Yawls and cabin boats	Out board	2-stroke	2003/44	20	162	36.5	0.01	0.002	3	10	791
Gasoline	Yawls and cabin boats	Out board	2-stroke	Konv.	20	374	172.0	0.01	0.002	3	10	791
Gasoline	Yawls and cabin boats	Out board	4-stroke	2003/44	20	162	14.0	0.03	0.002	10	0.08	426
Gasoline	Yawls and cabin boats	Out board	4-stroke	Konv.	20	390	14.0	0.03	0.002	10	0.08	426
Gasoline	Sailing boats (< 26 ft)	Out board	2-stroke	2003/44	10	189	43.0	0.01	0.002	2	10	791
Gasoline	Sailing boats (< 26 ft)	Out board	2-stroke	Konv.	10	427	257.0	0.01	0.002	2	10	791
Gasoline	Sailing boats (< 26 ft)	Out board	4-stroke	2003/44	10	189	24.0	0.03	0.002	7	0.08	426
Gasoline	Sailing boats (< 26 ft)	Out board	4-stroke	Konv.	10	520	24.0	0.03	0.002	7	0.08	426
Gasoline	Speed boats	In board	4-stroke	2003/44	90	141	10.0	0.03	0.002	12	0.08	426
Gasoline	Speed boats	In board	4-stroke	Konv.	90	346	10.0	0.03	0.002	12	0.08	426
Gasoline	Speed boats	Out board	2-stroke	2003/44	50	145.8	31.8	0.01	0.002	3	10	791
Gasoline	Speed boats	Out board	2-stroke	Konv.	50	374	172.0	0.01	0.002	3	10	791
Gasoline	Speed boats	Out board	4-stroke	2003/44	50	145.8	14.0	0.03	0.002	10	0.08	426
Gasoline	Speed boats	Out board	4-stroke	Konv.	50	390	14.0	0.03	0.002	10	0.08	426
Gasoline	Water scooters	Built in	2-stroke	2003/44	45	147	32.2	0.01	0.002	3	10	791
Gasoline	Water scooters	Built in	2-stroke	Konv.	45	374	172.0	0.01	0.002	3	10	791
Gasoline	Water scooters	Built in	4-stroke	2003/44	45	147	14.0	0.03	0.002	10	0.08	426
Gasoline	Water scooters	Built in	4-stroke	Konv.	45	390	14.0	0.03	0.002	10	0.08	426
Diesel	Motor boats (27-34 ft)	In board		2003/44	150	5	1.7	0.035	0.002	8.6	1	275
Diesel	Motor boats (27-34 ft)	In board		Konv.	150	5.3	2.0	0.035	0.002	8.6	1.2	275
Diesel	Motor boats (> 34 ft)	In board		2003/44	250	5	1.6	0.035	0.002	8.6	1	275
Diesel	Motor boats (> 34 ft)	In board		Konv.	250	5.3	2.0	0.035	0.002	8.6	1.2	275
Diesel	Motor boats (< 27 ft)	In board		2003/44	40	5	1.8	0.035	0.002	9.8	1	281
Diesel	Motor boats (< 27 ft)	In board		Konv.	40	5.5	2.2	0.035	0.002	18	1.4	281
Diesel	Motor sailors	In board		2003/44	30	5	1.9	0.035	0.002	9.8	1	281
Diesel	Motor sailors	In board		Konv.	30	5.5	2.2	0.035	0.002	18	1.4	281
Diesel	Sailing boats (> 26 ft)	In board		2003/44	30	5	1.9	0.035	0.002	9.8	1	281
Diesel	Sailing boats (> 26 ft)	In board		Konv.	30	5.5	2.2	0.035	0.002	18	1.4	281

CH_4 shares of VOC for diesel, gasoline and LPG.

Fuel type	CH_4 share of VOC
Diesel	0.016
Gasoline 4-stroke	0.1
Gasoline 2-stroke	0.009
LPG	0.05

Deterioration factors for diesel machinery.

Emission Level	NO_x	VOC	CO	TSP
<1981	0.024	0.047	0.185	0.473
1981-1990	0.024	0.047	0.185	0.473
1991-Stage I	0.024	0.047	0.185	0.473
Stage I	0.024	0.036	0.101	0.473
Stage II	0.009	0.034	0.101	0.473
Stage IIIA	0.008	0.027	0.151	0.473
Stage IIIB	0.008	0.027	0.151	0.473
Stage IV	0.008	0.027	0.151	0.473

Deterioration factors for gasoline 2-stroke machinery.

Engine	Size code	Size classe	Emission Level	NO_x	VOC	CO	TSP
2-stroke	SH2	20<=S<50	<1981	0	0.2	0.2	0
2-stroke	SH2	20<=S<50	1981-1990	0	0.2	0.2	0
2-stroke	SH2	20<=S<50	1991-Stage I	0	0.2	0.2	0
2-stroke	SH2	20<=S<50	Stage I	0	0.29	0.24	0
2-stroke	SH2	20<=S<50	Stage II	0	0.29	0.24	0
2-stroke	SH3	S>=50	<1981	-0.031	0.2	0.2	0
2-stroke	SH3	S>=50	1981-1990	-0.031	0.2	0.2	0
2-stroke	SH3	S>=50	1991-Stage I	-0.031	0.2	0.2	0
2-stroke	SH3	S>=50	Stage I	0	0.266	0.231	0
2-stroke	SH3	S>=50	Stage II	0	0.266	0.231	0
2-stroke	SN1	S<66	<1981	-0.6	0.201	0.9	1.1
2-stroke	SN1	S<66	1981-1990	-0.6	0.201	0.9	1.1
2-stroke	SN1	S<66	1991-Stage I	-0.6	0.201	0.9	1.1
2-stroke	SN1	S<66	Stage I	-0.33	0.266	1.109	5.103
2-stroke	SN1	S<66	Stage II	-0.33	0	1.109	5.103
2-stroke	SN2	66<=S<100	<1981	-0.6	0.201	0.9	1.1
2-stroke	SN2	66<=S<100	1981-1990	-0.6	0.201	0.9	1.1
2-stroke	SN2	66<=S<100	1991-Stage I	-0.6	0.201	0.9	1.1
2-stroke	SN2	66<=S<100	Stage I	-0.33	0.266	1.109	5.103
2-stroke	SN2	66<=S<100	Stage II	-0.33	0	1.109	5.103
2-stroke	SN3	100<=S<225	<1981	-0.6	0.201	0.9	1.1
2-stroke	SN3	100<=S<225	1981-1990	-0.6	0.201	0.9	1.1
2-stroke	SN3	100<=S<225	1991-Stage I	-0.6	0.201	0.9	1.1
2-stroke	SN3	100<=S<225	Stage I	-0.33	0.266	1.109	5.103
2-stroke	SN3	100<=S<225	Stage II	-0.33	0	1.109	5.103
2-stroke	SN4	S>=225	<1981	-0.6	0.201	0.9	1.1
2-stroke	SN4	S>=225	1981-1990	-0.6	0.201	0.9	1.1
2-stroke	SN4	S>=225	1991-Stage I	-0.6	0.201	0.9	1.1
2-stroke	SN4	S>=225	Stage I	-0.274	0	0.887	1.935
2-stroke	SN4	S>=225	Stage II	-0.274	0	0.887	1.935

Deterioration factors for gasoline 4-stroke machinery.

Engine	Size code	Size classe	Emission Level	NO_x	VOC	CO	TSP
4-stroke	SN1	S<66	<1981	-0.6	1.1	0.9	1.1
4-stroke	SN1	S<66	1981-1990	-0.6	1.1	0.9	1.1
4-stroke	SN1	S<66	1991-Stage I	-0.6	1.1	0.9	1.1
4-stroke	SN1	S<66	Stage I	-0.3	1.753	1.051	1.753
4-stroke	SN1	S<66	Stage II	-0.3	1.753	1.051	1.753
4-stroke	SN2	66<=S<100	<1981	-0.6	1.1	0.9	1.1
4-stroke	SN2	66<=S<100	1981-1990	-0.6	1.1	0.9	1.1
4-stroke	SN2	66<=S<100	1991-Stage I	-0.6	1.1	0.9	1.1
4-stroke	SN2	66<=S<100	Stage I	-0.3	1.753	1.051	1.753
4-stroke	SN2	66<=S<100	Stage II	-0.3	1.753	1.051	1.753
4-stroke	SN3	100<=S<225	<1981	-0.6	1.1	0.9	1.1
4-stroke	SN3	100<=S<225	1981-1990	-0.6	1.1	0.9	1.1
4-stroke	SN3	100<=S<225	1991-Stage I	-0.6	1.1	0.9	1.1
4-stroke	SN3	100<=S<225	Stage I	-0.3	1.753	1.051	1.753
4-stroke	SN3	100<=S<225	Stage II	-0.3	1.753	1.051	1.753
4-stroke	SN4	S>=225	<1981	-0.6	1.1	0.9	1.1
4-stroke	SN4	S>=225	1981-1990	-0.6	1.1	0.9	1.1
4-stroke	SN4	S>=225	1991-Stage I	-0.6	1.1	0.9	1.1
4-stroke	SN4	S>=225	Stage I	-0.599	1.095	1.307	1.095
4-stroke	SN4	S>=225	Stage II	-0.599	1.095	1.307	1.095
4-stroke	SH2	20<=S<50	<1981	0	0	0	0
4-stroke	SH2	20<=S<50	1981-1990	0	0	0	0
4-stroke	SH2	20<=S<50	1991-Stage I	0	0	0	0
4-stroke	SH2	20<=S<50	Stage I	0	0	0	0
4-stroke	SH2	20<=S<50	Stage II	0	0	0	0
4-stroke	SH3	S>=50	<1981	0	0	0	0
4-stroke	SH3	S>=50	1981-1990	0	0	0	0
4-stroke	SH3	S>=50	1991-Stage I	0	0	0	0
4-stroke	SH3	S>=50	Stage I	0	0	0	0
4-stroke	SH3	S>=50	Stage II	0	0	0	0

Transient factors for diesel machinery.

Emission Level	Load	NO_x	VOC	CO	TSP	Fuel
<1981	High	0.95	1.05	1.53	1.23	1.01
1981-1990	High	0.95	1.05	1.53	1.23	1.01
1991-Stage I	High	0.95	1.05	1.53	1.23	1.01
Stage I	High	0.95	1.05	1.53	1.23	1.01
Stage II	High	0.95	1.05	1.53	1.23	1.01
Stage IIIA	High	0.95	1.05	1.53	1.23	1.01
Stage IIIB	High	1	1	1	1	1
Stage IV	High	1	1	1	1	1
<1981	Low	1.1	2.29	2.57	1.97	1.18
1981-1990	Low	1.1	2.29	2.57	1.97	1.18
1991-Stage I	Low	1.1	2.29	2.57	1.97	1.18
Stage I	Low	1.1	2.29	2.57	1.97	1.18
Stage II	Low	1.1	2.29	2.57	1.97	1.18
Stage IIIA	Low	1.1	2.29	2.57	1.97	1.18
Stage IIIB	Low	1	1	1	1	1
Stage IV	Low	1	1	1	1	1

Annual working hours, load factors and lifetimes for agricultural tractors.

Tractor type	Annual working hours	Load factor	Lifetime (yrs)
Diesel	500 (0-7 years) 500-100 (7-16 years) 100 (>16 years)	0.5	30
Gasoline (certified)	100	0.4	37
Gasoline (non certified)	50	0.4	37

Annual working hours, load factors and lifetimes for harvesters.

Annual working hours	Load factor	Lifetime (yrs)
250-100 (linear decrease 0-24 years)	0.8	25

Annual working hours, load factors and lifetime for machine pool machinery.

Tractor type	Hours pr yr	Load factor	Lifetime (yrs)
Tractors	750	0.5	7
Harvesters	100	0.8	11
Self-propelled vehicles	500	0.75	6

Operational data for other machinery types in agriculture.

Machinery type	Fuel type	Load factor	Lifetime (yrs)	Hours	Size (kW)
ATV private	Gasoline	-	6	250	-
ATV professional	Gasoline	-	8	400	-
Bedding machines	Gasoline	0.3	10	50	3
Fodder trucks	Gasoline	0.4	10	200	8
Other (gasoline)	Gasoline	0.4	10	50	5
Scrapers	Gasoline	0.3	10	50	3
Self-propelled vehicles	Diesel	0.75	15	150	60
Sweepers	Gasoline	0.3	10	50	3

Annual working hours, load factors and lifetimes for forestry machinery.

Machinery type	Hours	Load factors	Lifetime
Chippers	1200	0.5	6
Tractors (other)	100 (1990) 400 (2004)	0.5	15
Tractors (silvicultural)	800	0.5	6
Harvesters	1200	0.5	8
Forwarders	1200	0.5	8
Chain saws (forestry)	800	0.4	3

Annual working hours, load factors and lifetime for fork lifts.

Hours pr yr	Load factor	Lifetime (yrs)
1200 (>=50 kW and <=10 years old) 650 (>=50 kW and >10 years old) 650 (<50 kW)	0.27	20

Operational data for construction machinery.

Machinery type	Load factor	Lifetime	Hours	Size
Track type dozers	0.5	10	1100	140
Track type loaders	0.5	10	1100	100 (1990) 150 (2004)
Wheel loaders (0-5 tonnes)	0.5	10	1200	20
Wheel loaders (> 5,1 tonnes)	0.5	10	1200	120
Wheel type excavators	0.6	10	1200	100
Track type excavators (0-5 tonnes)	0.6	10	1100	20
Track type excavators (>5,1 tonnes)	0.6	10	1100	120
Excavators/Loaders	0.45	10	700	50
Dump trucks	0.4	10	900 (1990) 1200 (2004)	60 (1990) 180 (2004)
Mini loaders	0.5	14	700	30
Telescopic loaders	0.5	14	1000	35

Stock and operational data for other machinery types in industry.

Sector	Fuel type	Machinery type	Size (kW)	No	Load Factor	Hours
Construction machinery	Diesel	Tampers/Land rollers	30	2800	0.45	600
Construction machinery	Diesel	Generators (diesel)	45	5000	0.5	200
Construction machinery	Diesel	Kompressors (diesel)	45	5000	0.5	500
Construction machinery	Diesel	Pumps (diesel)	75	1000	0.5	5
Construction machinery	Diesel	Asphalt pavers	80	300	0.35	700
Construction machinery	Diesel	Motor graders	100	100	0.4	700
Construction machinery	Diesel	Refuse compressors	160	100	0.25	1300
Construction machinery	Gasoline	Generators (gasoline)	2.5	11000	0.4	80
Construction machinery	Gasoline	Pumps (gasoline)	4	10000	0.4	300
Construction machinery	Gasoline	Kompressors (gasoline)	4	500	0.35	15
Industry	Diesel	Refrigerating units (distribution)	8	3000	0.5	1250
Industry	Diesel	Refrigerating units (long distance)	15	3500	0.5	200
Industry	Diesel	Tractors (transport, industry)	50	3000	0.4	500
Airport GSE and other	Diesel	Airport GSE and other (light duty)	100	500	0.5	400
Airport GSE and other	Diesel	Airport GSE and other (medium duty)	125	350	0.5	300
Airport GSE and other	Diesel	Airport GSE and other (Heavy duty)	175	650	0.5	200
Building and construction	Diesel	Vibratory plates	6	3500	0.6	300
Building and construction	Diesel	Aereal lifts (diesel)	30	150	0.4	400
Building and construction	Diesel	Sweepers (diesel)	30	200	0.4	300
Building and construction	Diesel	High pressure cleaners (diesel)	30	50	0.8	500
Building and construction	Gasoline	Rammers	2.5	3000	0.4	80
Building and construction	Gasoline	Drills	3	100	0.4	10
Building and construction	Gasoline	Vibratory plates (gasoline)	4	2500	0.5	200
Building and construction	Gasoline	Cutters	4	800	0.5	50
Building and construction	Gasoline	Other (gasoline)	5	1000	0.5	40
Building and construction	Gasoline	High pressure cleaners (gasoline)	5	500	0.6	200
Building and construction	Gasoline	Sweepers (gasoline)	10	500	0.4	150
Building and construction	Gasoline	Slicers	10	100	0.7	150
Building and construction	Gasoline	Aereal lifts (gasoline)	20	50	0.4	400

Operational data for the most important types of household and gardening machinery.

Machinery type	Engine	Size (kW)	Hours	Load factor	Lifetime (yrs)
Chain saws (private)	2-stroke	2	5	0.3	10
Chain saws (professional)	2-stroke	3	270	0.4	3
Cultivators (private-large)	4-stroke	3.7	5	0.6	5
Cultivators (private-small)	4-stroke	1	5	0.6	15
Cultivators (professional)	4-stroke	7	360	0.6	8
Hedge cutters (private)	2-stroke	0.9	10	0.5	10
Hedge cutters (professional)	2-stroke	2	300	0.5	4
Lawn movers (private)	4-stroke	2.5 (2000) 3.5 (2004)	25	0.4	8
Lawn movers (professional)	4-stroke	2.5 (2000) 3.5 (2004)	250	0.4	4
Riders (private)	4-stroke	11	50	0.5	12
Riders (professional)	4-stroke	13	330	0.5	5
Shrub clearers (private)	2-stroke	1	15	0.6	10
Shrub clearers (professional)	2-stroke	2	300	0.6	4
Trimmers (private)	2-stroke	0.9	20	0.5	10
Trimmers (professional)	2-stroke	0.9	200	0.5	4

Stock and operational data for other machines in household and gardening.

Machinery type	Engine	No.	Size (kW)	Hours	Load factor	Lifetime (yrs)
Chippers	2-stroke	200	10	100	0.7	10
Garden shredders	2-stroke	500	3	20	0.7	10
Other (gasoline)	2-stroke	200	2	20	0.5	10
Suction machines	2-stroke	300	4	80	0.5	10
Wood cutters	4-stroke	100	4	15	0.5	10

Operational data for recreational craft.

Fuel type	Vessel type	Engine type	Stroke	Hours	Lifetime	Load factor
Gasoline	Other boats (<20 ft)	Out board engine	2-stroke	30	10	0.5
Gasoline	Other boats (<20 ft)	Out board engine	4-stroke	30	10	0.5
Gasoline	Yawls and cabin boats	Out board engine	2-stroke	50	10	0.5
Gasoline	Yawls and cabin boats	Out board engine	4-stroke	50	10	0.5
Gasoline	Sailing boats (<26ft)	Out board engine	2-stroke	5	10	0.5
Gasoline	Sailing boats (<26ft)	Out board engine	4-stroke	5	10	0.5
Gasoline	Speed boats	In board engine	4-stroke	75	10	0.5
Gasoline	Speed boats	Out board engine	2-stroke	50	10	0.5
Gasoline	Speed boats	Out board engine	4-stroke	50	10	0.5
Gasoline	Water scooters	Built in	2-stroke	10	10	0.5
Gasoline	Water scooters	Built in	4-stroke	10	10	0.5
Diesel	Motor boats (27-34 ft)	In board engine		150	15	0.5
Diesel	Motor boats (>34 ft)	In board engine		100	15	0.5
Diesel	Motor boats (<27 ft)	In board engine		75	15	0.5
Diesel	Motor sailors	In board engine		75	15	0.5
Diesel	Sailing boats (<26ft)	In board engine		25	15	0.5

Annex 3B-10: Stock data for non-road working machinery and equipment

Stock data for diesel tractors 1985-2008.

Size (kW)	Emission Level	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
37	<1981	3882	3792	3542	3543	3403	3234	3106	2922	2861	2610	2605	2273	2193	1918	1796
37	1981-1990	635	731	760	835	855	879	889	883	915	887	945	883	918	869	888
37	1991-Stage I							25	107	153	201	278	354	445	496	554
37	Stage I															
37	Stage II															
37	Stage IIIA															
45	<1981	25988	25387	23709	23718	22781	21650	20796	19563	19154	17475	17441	15219	14684	12840	12025
45	1981-1990	5740	6808	7263	8075	8476	8770	8867	8805	9128	8848	9419	8807	9151	8668	8856
45	1991-Stage I							203	202	209	203	216	202	210	199	203
49	1991-Stage I								154	281	485	602	618	702	749	765
52	1991-Stage I															247
52	Stage I															
52	Stage II															
52	Stage IIIA															
56	1991-Stage I								201	338	428	747	943	1181	1280	1307
60	<1981	54651	53387	49857	49877	47907	45529	43732	41140	40278	36747	36676	32004	30879	27001	25287
60	1981-1990	11751	14613	15795	17797	19395	20542	20770	20624	21380	20725	22063	20628	21434	20304	20744
60	1991-Stage I							863	857	888	861	917	857	891	844	862
63	1991-Stage I								468	855	1325	2014	2384	2837	3011	3076
67	1991-Stage I															671
67	Stage I															
67	Stage II															
67	Stage IIIA															
71	1991-Stage I								411	715	1179	1949	2507	3344	3594	3672
78	<1981	14558	14221	13281	13286	12761	12128	11649	10959	10729	9789	9770	8525	8226	7192	6736
78	1981-1990	4592	6152	7196	8559	10026	11323	11448	11368	11785	11424	12162	11371	11815	11192	11434
78	1991-Stage I							1233	1503	1713	1945	2429	2561	2946	2994	3287
78	Stage I															
78	Stage II															
78	Stage IIIA															
86	1991-Stage I								108	193	333	589	880	1364	1532	1718
86	Stage I															
86	Stage II															

86	Stage IIIA															
93	1991-Stage I															149
93	Stage I															
93	Stage II															
93	Stage IIIA															
97	1991-Stage I								71	175	443	962	1556	2327	2638	2695
101	<1981	4659	4551	4250	4252	4084	3881	3728	3507	3433	3132	3126	2728	2632	2302	2156
101	1981-1990	1158	1434	1618	1921	2156	2377	2403	2387	2474	2398	2553	2387	2480	2350	2400
101	1991-Stage I							266	264	274	266	283	264	275	260	696
101	Stage I															
101	Stage II															
101	Stage IIIA															
112	1991-Stage I								63	114	166	252	422	690	790	978
112	Stage I															
112	Stage II															
112	Stage IIIA															
127	1991-Stage I								12	36	81	193	279	408	457	590
127	Stage I															
127	Stage II															
127	Stage IIIA															
131	<1981	798	780	728	728	700	665	639	601	588	537	536	467	451	394	369
131	1981-1990	288	421	500	651	753	887	897	890	923	895	952	890	925	876	895
131	1991-Stage I							97	97	100	97	103	97	100	95	97
157	1981-1990		2	3	6	11	15	15	15	16	15	16	15	16	15	15
157	1991-Stage I							9	23	39	102	232	357	545	648	784
157	Stage I															
157	Stage II															
157	Stage IIIA															
186	1991-Stage I															23
186	Stage I															
186	Stage II															
186	Stage IIIA															

Size (kW)	Emission Level	2000	2001	2002	2003	2004	2005	2006	2007	2008
37	<1981	1601	1449	1298	1148	993	833	664	504	342
37	1981-1990	871	876	882	892	900	906	903	914	930
37	1991-Stage I	568	572	576	582	587	592	590	597	607
37	Stage I		33	56	83	84	84	84	85	86
37	Stage II					23	53	162	324	330
37	Stage IIIA									109
45	<1981	10715	9700	8690	7685	6646	5577	4447	3376	2290
45	1981-1990	8681	8731	8800	8894	8974	9037	9006	9116	9274
45	1991-Stage I	199	200	202	204	206	207	207	209	213
49	1991-Stage I	750	754	760	768	775	780	778	787	801
52	1991-Stage I	358	360	363	367	370	373	372	376	383
52	Stage I		132	242	377	381	383	382	387	393
52	Stage II					68	147	241	347	353
52	Stage IIIA									86
56	1991-Stage I	1281	1289	1299	1313	1325	1334	1329	1346	1369
60	<1981	22533	20397	18273	16162	13976	11729	9351	7099	4815
60	1981-1990	20333	20451	20612	20834	21019	21167	21096	21353	21723
60	1991-Stage I	845	850	856	866	873	879	876	887	903
63	1991-Stage I	3015	3033	3057	3090	3117	3139	3128	3167	3221
67	1991-Stage I	1343	1351	1361	1376	1388	1398	1393	1410	1435
67	Stage I		533	835	1113	1123	1131	1127	1141	1161
67	Stage II					375	729	1144	1524	1550
67	Stage IIIA									303
71	1991-Stage I	3600	3620	3649	3688	3721	3747	3735	3780	3846
78	<1981	6002	5433	4868	4305	3723	3124	2491	1891	1283
78	1981-1990	11208	11273	11361	11484	11586	11668	11628	11770	11974
78	1991-Stage I	3436	3727	3756	3797	3830	3857	3844	3891	3959
78	Stage I			325	329	332	334	333	337	343
78	Stage II				227	310	400	463	469	477
78	Stage IIIA								63	121
86	1991-Stage I	1876	2023	2039	2061	2079	2094	2087	2112	2149
86	Stage I			134	136	137	138	137	139	142
86	Stage II				91	343	530	760	769	783
86	Stage IIIA								226	434
93	1991-Stage I	245	325	327	331	334	336	335	339	345
93	Stage I			114	115	116	117	116	118	120

93	Stage II				107	186	313	512	518	527
93	Stage IIIA								264	470
97	1991-Stage I	2642	2657	2678	2707	2731	2750	2741	2774	2822
101	<1981	1921	1739	1558	1378	1191	1000	797	605	410
101	1981-1990	2353	2367	2385	2411	2432	2449	2441	2471	2514
101	1991-Stage I	1116	1567	1579	1596	1611	1622	1616	1636	1664
101	Stage I			232	234	236	238	237	240	244
101	Stage II				136	357	635	776	785	799
101	Stage IIIA								188	336
112	1991-Stage I	1265	1626	1639	1656	1671	1683	1677	1698	1727
112	Stage I			465	470	474	478	476	482	490
112	Stage II				337	732	1170	1763	1785	1815
112	Stage IIIA								378	663
127	1991-Stage I	707	847	854	863	871	877	874	884	900
127	Stage I			152	154	155	156	156	158	161
127	Stage II				78	268	453	591	599	609
127	Stage IIIA								292	675
131	<1981	329	298	267	236	204	171	137	104	70
131	1981-1990	878	883	890	899	907	914	911	922	938
131	1991-Stage I	95	96	96	97	98	99	99	100	102
157	1981-1990	15	15	15	15	16	16	16	16	16
157	1991-Stage I	900	905	912	922	930	937	934	945	961
157	Stage I		89	89	90	91	92	91	92	94
157	Stage II			149	415	695	1089	1085	1098	1117
157	Stage IIIA							623	1453	2140
186	1991-Stage I	53	54	54	55	55	56	55	56	57
186	Stage I		47	48	48	49	49	49	49	50
186	Stage II			68	207	320	481	480	486	494
186	Stage IIIA							272	685	1103

Stock data for gasoline tractors 1985-2005.

Size (kW)	Emission Level	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Certified	<1981	13176	12541	11906	11270	10635	10000	9053	8148	7285	6465	5687	4951	4258	3607	2998
Non certified	<1981	26352	25082	23811	22541	21270	20000	19042	18041	16998	15913	14785	13616	12403	11149	9852

Size (kW)	Emission Level	2000	2001	2002	2003	2004	2005
Certified	<1981	2432	1908	1427	987	591	236
Non certified	<1981	8512	7131	5707	4240	2732	1180

Stock data for harvesters 1985-2008.

Size Group	Emission Level	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
0<S<=50	<1981	26601	24394	22599	22144	19842	18915	17241	15607	14575	12673	10700	9491	6966	5446	3589
0<S<=50	1981-1990	519	534	550	582	566	591	594	601	635	636	633	683	641	686	672
50<S<=60	<1981	2703	2648	2634	2785	2711	2828	2847	2876	3040	3044	3029	3271	3068	2930	2235
50<S<=60	1981-1990	853	1102	1164	1275	1258	1333	1341	1355	1432	1434	1427	1541	1446	1548	1516
50<S<=60	1991-Stage I							8	8	8	8	8	9	9	9	9
60<S<=70	<1981	1786	1750	1741	1841	1792	1869	1881	1901	2009	2012	2002	2162	2028	2171	2127
60<S<=70	1981-1990	1138	1679	1943	2237	2213	2348	2363	2388	2524	2527	2515	2716	2547	2727	2671
60<S<=70	1991-Stage I							8	16	18	21	22	24	23	24	24
70<S<=80	<1981	929	910	905	958	932	972	979	989	1045	1046	1041	1125	1055	1129	1106
70<S<=80	1981-1990	383	699	1026	1165	1318	1493	1502	1518	1604	1606	1598	1726	1619	1733	1698
70<S<=80	1991-Stage I							72	77	83	86	87	96	91	98	96
70<S<=80	Stage I															1
80<S<=90	<1981	323	317	315	333	324	338	340	344	363	364	362	391	367	393	385
80<S<=90	1981-1990	383	562	645	967	1107	1466	1475	1491	1575	1577	1570	1695	1590	1702	1667
80<S<=90	1991-Stage I							61	158	181	200	200	217	207	222	217
80<S<=90	Stage I															1
90<S<=100	1981-1990	89	175	235	387	515	670	674	681	720	721	717	775	726	778	762
90<S<=100	1991-Stage I							180	257	320	329	351	382	367	393	385
90<S<=100	Stage I															1
100<S<=120	1981-1990		54	106	219	334	589	592	599	633	634	630	681	639	684	670
100<S<=120	1991-Stage I							129	253	316	375	440	567	586	673	660
100<S<=120	Stage I															2
120<S<=140	1981-1990				4	69	183	184	186	197	197	196	212	199	213	208
120<S<=140	1991-Stage I							70	148	189	215	319	484	626	804	860
120<S<=140	Stage I															21
120<S<=140	Stage II															

120<S<=140	Stage IIIA															
140<S<=160	1991-Stage I								8	36	69	112	271	354	554	632
140<S<=160	Stage II															
140<S<=160	Stage IIIA															
160<S<=180	1991-Stage I											26	69	200	374	440
160<S<=180	Stage II															
160<S<=180	Stage IIIA															
180<S<=200	1991-Stage I												20	67	117	193
180<S<=200	Stage II															
180<S<=200	Stage IIIA															
200<S<=220	1991-Stage I														45	92
200<S<=220	Stage II															
200<S<=220	Stage IIIA															
220<S<=240	1991-Stage I															3
220<S<=240	Stage II															
220<S<=240	Stage IIIA															
240<S<=260	1991-Stage I															3
240<S<=260	Stage II															
240<S<=260	Stage IIIA															
260<S<=280	1991-Stage I															14
260<S<=280	Stage II															
260<S<=280	Stage IIIA															
280<S<=300	1991-Stage I															
280<S<=300	Stage II															
280<S<=300	Stage IIIA															
300<S<=320	Stage II															
300<S<=320	Stage IIIA															

Continued

Size Group	Emission Level	2000	2001	2002	2003	2004	2005	2006	2007	2008
0<S<=50	<1981	2873	1828	1236	718	251				
0<S<=50	1981-1990	715	748	754	777	826	840	703	580	423
50<S<=60	<1981	1999	1549	1222	854	366				
50<S<=60	1981-1990	1612	1687	1702	1752	1863	1894	1675	1519	1261
50<S<=60	1991-Stage I	10	10	10	10	11	11	11	11	11
60<S<=70	<1981	2073	1626	1299	934	451				
60<S<=70	1981-1990	2841	2973	2999	3087	3282	3338	3018	2827	2513
60<S<=70	1991-Stage I	25	26	27	27	29	30	29	29	30

70<S<=80	<1981	1176	1231	1071	699	202				
70<S<=80	1981-1990	1806	1890	1906	1963	2086	2122	1953	1886	1832
70<S<=80	1991-Stage I	102	107	108	111	118	120	118	119	124
70<S<=80	Stage I	1	1	1	1	1	1	1	1	1
80<S<=90	<1981	409	428	432	445	202				
80<S<=90	1981-1990	1773	1856	1872	1927	2049	2083	1916	1848	1792
80<S<=90	1991-Stage I	231	242	244	251	267	272	265	270	279
80<S<=90	Stage I	1	1	1	1	1	1	1	1	1
90<S<=100	1981-1990	810	848	855	881	936	952	930	945	932
90<S<=100	1991-Stage I	410	429	433	445	473	481	471	478	494
90<S<=100	Stage I	1	1	1	1	1	1	1	1	1
100<S<=120	1981-1990	712	745	752	774	823	837	818	830	859
100<S<=120	1991-Stage I	702	734	740	762	811	824	805	818	846
100<S<=120	Stage I	2	2	2	2	3	3	3	3	3
120<S<=140	1981-1990	222	232	234	241	256	260	255	258	267
120<S<=140	1991-Stage I	918	964	972	1001	1064	1082	1057	1074	1111
120<S<=140	Stage I	26	30	31	32	34	34	33	34	35
120<S<=140	Stage II					3	3	3	3	3
120<S<=140	Stage IIIA							1	1	1
140<S<=160	1991-Stage I	715	784	791	814	866	880	860	874	904
140<S<=160	Stage II			22	38	50	57	56	56	58
140<S<=160	Stage IIIA							5	8	11
160<S<=180	1991-Stage I	533	594	599	617	655	666	651	661	684
160<S<=180	Stage II			44	76	95	107	105	106	110
160<S<=180	Stage IIIA							8	13	19
180<S<=200	1991-Stage I	249	296	299	308	327	333	325	330	341
180<S<=200	Stage II			66	99	120	132	129	131	135
180<S<=200	Stage IIIA							8	13	19
200<S<=220	1991-Stage I	142	185	186	192	204	207	203	206	213
200<S<=220	Stage II			44	76	95	107	105	106	110
200<S<=220	Stage IIIA							8	13	19
220<S<=240	1991-Stage I	48	149	150	154	164	167	163	166	171
220<S<=240	Stage II			78	124	170	220	215	218	226
220<S<=240	Stage IIIA							55	113	185
240<S<=260	1991-Stage I	71	140	141	145	154	157	153	156	161
240<S<=260	Stage II			78	137	207	295	289	293	303
240<S<=260	Stage IIIA							102	214	350

260<S<=280	1991-Stage I	61	129	130	134	142	145	141	143	148
260<S<=280	Stage II			78	137	207	295	289	293	303
260<S<=280	Stage IIIA							102	214	350
280<S<=300	1991-Stage I		33	33	34	36	37	36	36	38
280<S<=300	Stage II			78	137	207	295	289	293	303
280<S<=300	Stage IIIA							102	214	350
300<S<=320	Stage II				28	61	104	102	103	107
300<S<=320	Stage IIIA							51	107	175

Stock data for fork lifts 1985-2008.

FuelCode	Size (kW)	Emission Level	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
205B	35	<1981	387	361	336	311	285	260	234	209	183	158	133	107	84	58	30
205B	35	1981-1990	120	162	202	239	270	297	297	297	297	297	297	297	297	297	297
205B	35	1991-Stage I							26	49	65	93	131	168	218	247	275
205B	35	Stage II															
205B	35	Stage IIIA															
205B	45	<1981	1612	1506	1400	1294	1188	1082	976	870	764	658	552	446	349	243	126
205B	45	1981-1990	499	674	839	994	1122	1233	1233	1233	1233	1233	1233	1233	1233	1233	1233
205B	45	1991-Stage I							108	203	270	386	544	699	905	1063	1063
205B	45	Stage I															151
205B	45	Stage II															
205B	45	Stage IIIA															
205B	50	<1981	2173	2031	1888	1745	1602	1459	1316	1174	1031	888	745	602	471	328	170
205B	50	1981-1990	673	909	1131	1340	1512	1662	1662	1662	1662	1662	1662	1662	1662	1662	1662
205B	50	1991-Stage I							145	273	363	519	732	940	1217	1469	1469
205B	50	Stage I															240
205B	50	Stage II															
205B	50	Stage IIIA															
205B	75	<1981	497	465	432	399	367	334	301	269	236	203	170	138	108	75	39
205B	75	1981-1990	154	208	259	307	347	382	382	382	382	382	382	382	382	382	382
205B	75	1991-Stage I							33	63	84	120	169	217	281	354	354
205B	75	Stage I															70
205B	75	Stage II															
205B	75	Stage IIIA															
205B	120	<1981	111	103	96	89	81	74	67	60	52	45	38	31	24	17	9
205B	120	1981-1990	34	46	57	68	77	85	85	85	85	85	85	85	85	85	85
205B	120	1991-Stage I							7	14	19	27	38	49	63	97	97
205B	120	Stage I															32
205B	120	Stage II															
205B	120	Stage IIIA															
3030	33		5420	5427	5390	5323	5265	5215	5156	5068	4947	4863	4835	4792	4732	4765	4712
3030	40		4917	4923	4889	4828	4775	4730	4676	4596	4486	4410	4384	4344	4289	4295	4223
3030	50		2149	2151	2137	2110	2087	2067	2044	2008	1960	1926	1915	1897	1874	1926	1941
3030	78		97	97	96	95	94	93	92	91	89	88	88	87	86	90	92
3030	120															1	2

Continued

FuelCode	Size (kW)	Emission Level	2000	2001	2002	2003	2004	2005	2006	2007	2008
205B	35	<1981									
205B	35	1981-1990	297	277	249	232	198	177	135	95	58
205B	35	1991-Stage I	304	304	304	304	304	304	304	304	304
205B	35	Stage II		23	53	75	89	117	152	152	152
205B	35	Stage IIIA								41	76
205B	45	<1981									
205B	45	1981-1990	1233	1151	1036	964	820	734	559	394	239
205B	45	1991-Stage I	1063	1063	1063	1063	1063	1063	1063	1063	1063
205B	45	Stage I	303	422	524	664	664	664	664	664	664
205B	45	Stage II					104	232	452	612	612
205B	45	Stage IIIA									126
205B	50	<1981									
205B	50	1981-1990	1662	1551	1396	1299	1105	989	753	531	322
205B	50	1991-Stage I	1469	1469	1469	1469	1469	1469	1469	1469	1469
205B	50	Stage I	461	682	897	1135	1135	1135	1135	1135	1135
205B	50	Stage II					187	447	818	1134	1134
205B	50	Stage IIIA									181
205B	75	<1981									
205B	75	1981-1990	382	357	321	299	255	228	174	123	75
205B	75	1991-Stage I	354	354	354	354	354	354	354	354	354
205B	75	Stage I	162	234	311	311	311	311	311	311	311
205B	75	Stage II				58	129	208	326	326	326
205B	75	Stage IIIA								142	213
205B	120	<1981									
205B	120	1981-1990	85	80	72	67	57	51	39	28	17
205B	120	1991-Stage I	97	97	97	97	97	97	97	97	97
205B	120	Stage I	71	89	118	118	118	118	118	118	118
205B	120	Stage II				16	38	58	112	112	112
205B	120	Stage IIIA								58	70
3030	33		4718	4677	4655	4595	4494	4345	4220	4154	4043
3030	40		4218	4214	4244	4224	4166	4116	4048	4005	3951
3030	50		1897	1938	2003	2020	2018	2029	2061	2136	2198
3030	78		88	95	98	99	104	104	114	123	147
3030	120		2	2	3	3	3	3	3	3	3

Stock data for construction machinery 1985-2008.

EquipmentName (Eng)	Emission Level	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Track type dozers	<1981	125	100	75	50	25										
Track type dozers	1981-1990	125	150	175	200	225	250	221	193	166	139	114	89	66	43	21
Track type dozers	1991-Stage I							25	48	71	93	114	134	153	172	189
Track type dozers	Stage II															
Track type dozers	Stage IIIA															
Track type loaders	<1981	50	40	30	20	10										
Track type loaders	1981-1990	50	60	70	80	90	100	89	79	68	58	48	38	28	19	9
Track type loaders	1991-Stage I							10	20	29	39	48	57	66	75	83
Track type loaders	Stage II															
Track type loaders	Stage IIIA															
Wheel loaders (0-5 tonnes)	1981-1990							186	331	434	496	517	496	434	331	186
Wheel loaders (0-5 tonnes)	1991-Stage I							21	83	186	331	517	744	1013	1323	1674
Wheel loaders (0-5 tonnes)	Stage II															
Wheel loaders (0-5 tonnes)	Stage IIIA															
Wheel loaders (> 5,1 tonnes)	<1981	1250	1000	750	500	250										
Wheel loaders (> 5,1 tonnes)	1981-1990	1250	1500	1750	2000	2250	2500	2228	1960	1698	1441	1188	941	698	460	228
Wheel loaders (> 5,1 tonnes)	1991-Stage I							248	490	728	960	1188	1411	1629	1841	1822
Wheel loaders (> 5,1 tonnes)	Stage I															228
Wheel loaders (> 5,1 tonnes)	Stage II															
Wheel loaders (> 5,1 tonnes)	Stage IIIA															
Wheel type excavators	<1981	500	400	300	200	100										
Wheel type excavators	1981-1990	500	600	700	800	900	1000	862	732	611	498	394	298	211	132	62
Wheel type excavators	1991-Stage I							96	183	262	332	394	447	491	528	493
Wheel type excavators	Stage I															62
Wheel type excavators	Stage II															
Wheel type excavators	Stage IIIA															
Track type excavators (0-5 tonnes)	1981-1990							459	816	1071	1224	1275	1224	1071	816	459
Track type excavators (0-5 tonnes)	1991-Stage I							51	204	459	816	1275	1837	2500	3265	4132
Track type excavators (0-5 tonnes)	Stage II															
Track type excavators (0-5 tonnes)	Stage IIIA															
Track type excavators (>5,1 tonnes)	<1981	1000	800	600	400	200										
Track type excavators (>5,1 tonnes)	1981-1990	1000	1200	1400	1600	1800	2000	1798	1596	1394	1194	993	794	594	396	198
Track type excavators (>5,1 tonnes)	1991-Stage I							200	399	598	796	993	1190	1387	1583	1581
Track type excavators (>5,1 tonnes)	Stage I															198
Track type excavators (>5,1 tonnes)	Stage II															

Track type excavators (>5,1 tonnes)	Stage IIIA															
Excavators/Loaders	<1981	2100	1680	1260	840	420										
Excavators/Loaders	1981-1990	2100	2520	2940	3360	3780	4200	3807	3408	3003	2592	2175	1752	1323	888	447
Excavators/Loaders	1991-Stage I							423	852	1287	1728	2175	2628	3087	3552	3575
Excavators/Loaders	Stage I															447
Excavators/Loaders	Stage II															
Excavators/Loaders	Stage IIIA															
Dump trucks	<1981	250	200	150	100	50										
Dump trucks	1981-1990	250	300	350	400	450	500	489	469	441	404	358	304	241	169	89
Dump trucks	1991-Stage I							54	117	189	269	358	455	561	676	711
Dump trucks	Stage I															89
Dump trucks	Stage II															
Dump trucks	Stage IIIA															
Mini loaders	<1981	1800	1600	1400	1200	1000	800	635	447	235						
Mini loaders	1981-1990	1000	1200	1400	1600	1800	2000	2118	2237	2355	2473	2332	2168	1980	1768	1532
Mini loaders	1991-Stage I							212	447	706	989	1296	1626	1980	2357	2758
Mini loaders	Stage II															
Mini loaders	Stage IIIA															
Telescopic loaders	1981-1990											149	265	348	398	414
Telescopic loaders	1991-Stage I											83	199	348	530	746
Telescopic loaders	Stage II															
Telescopic loaders	Stage IIIA															

Continued

EquipmentName (Eng)	Emission Level	2000	2001	2002	2003	2004	2005	2006	2007	2008
Track type dozers	<1981									
Track type dozers	1981-1990									
Track type dozers	1991-Stage I	206	201	177	154	132	128	125	116	95
Track type dozers	Stage II			20	38	56	86	100	116	126
Track type dozers	Stage IIIA							25	58	95
Track type loaders	<1981									
Track type loaders	1981-1990									
Track type loaders	1991-Stage I	91	91	81	71	62	61	71	68	55
Track type loaders	Stage II			9	18	26	40	56	68	73
Track type loaders	Stage IIIA							14	34	55
Wheel loaders (0-5 tonnes)	1981-1990									
Wheel loaders (0-5 tonnes)	1991-Stage I	2067	2046	1984	1881	1736	1444	1269	1045	726
Wheel loaders (0-5 tonnes)	Stage II		227	496	806	1158	1444	1903	2090	2177

Wheel loaders (0-5 tonnes)	Stage IIIA								348	726
Wheel loaders (> 5,1 tonnes)	<1981									
Wheel loaders (> 5,1 tonnes)	1981-1990									
Wheel loaders (> 5,1 tonnes)	1991-Stage I	1802	1559	1322	1089	861	677	485	273	
Wheel loaders (> 5,1 tonnes)	Stage I	450	668	881	871	861	902	969	1092	1174
Wheel loaders (> 5,1 tonnes)	Stage II				218	431	677	969	1092	1174
Wheel loaders (> 5,1 tonnes)	Stage IIIA								273	587
Wheel type excavators	<1981									
Wheel type excavators	1981-1990									
Wheel type excavators	1991-Stage I	459	372	293	223	162	118	74	38	
Wheel type excavators	Stage I	115	160	196	179	162	157	148	152	146
Wheel type excavators	Stage II				45	81	118	148	152	146
Wheel type excavators	Stage IIIA								38	73
Track type excavators (0-5 tonnes)	1981-1990									
Track type excavators (0-5 tonnes)	1991-Stage I	5101	5050	4897	4642	4285	3889	3599	3027	2073
Track type excavators (0-5 tonnes)	Stage II		561	1224	1990	2857	3889	5399	6054	6220
Track type excavators (0-5 tonnes)	Stage IIIA								1009	2073
Track type excavators (>5,1 tonnes)	<1981									
Track type excavators (>5,1 tonnes)	1981-1990									
Track type excavators (>5,1 tonnes)	1991-Stage I	1579	1380	1181	983	785	683	536	313	
Track type excavators (>5,1 tonnes)	Stage I	395	591	787	786	785	910	1073	1251	1338
Track type excavators (>5,1 tonnes)	Stage II				197	393	683	1073	1251	1338
Track type excavators (>5,1 tonnes)	Stage IIIA								313	669
Excavators/Loaders	<1981									
Excavators/Loaders	1981-1990									
Excavators/Loaders	1991-Stage I	3599	3170	2735	2295	1848	1370	938	481	
Excavators/Loaders	Stage I	900	1359	1824	2295	2310	2283	2344	2403	2314
Excavators/Loaders	Stage II					462	913	1406	1922	1851
Excavators/Loaders	Stage IIIA									463
Dump trucks	<1981									
Dump trucks	1981-1990									
Dump trucks	1991-Stage I	745	682	611	530	442	385	301	176	
Dump trucks	Stage I	186	292	407	530	552	642	752	880	943
Dump trucks	Stage II					110	257	451	704	754
Dump trucks	Stage IIIA									189
Mini loaders	<1981									
Mini loaders	1981-1990	1273	990	684	354					

Mini loaders	1991-Stage I	3183	3301	3419	3537	3656	2756	2294	1077	715
Mini loaders	Stage II		330	684	1061	1462	1531	1720	923	715
Mini loaders	Stage IIIA								154	238
Telescopic loaders	1981-1990	398	348	265	149					
Telescopic loaders	1991-Stage I	994	1160	1326	1491	1657	1740	1837	1846	1687
Telescopic loaders	Stage II		116	265	447	663	966	1378	1582	1687
Telescopic loaders	Stage IIIA								264	562

Stock data for machine pools 1985-2008.

EquipmentName (Eng)	Emission Level	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Tractors (machine pools)	<1981	1236	627													
Tractors (machine pools)	1981-1990	3091	3763	4575	4515	4370	4100	3643	2808	2368	1786	1214	604			
Tractors (machine pools)	1991-Stage I							607	1123	1776	2382	3035	3624	4324	4210	4336
Tractors (machine pools)	Stage I															
Tractors (machine pools)	Stage II															
Tractors (machine pools)	Stage IIIA															
Harvesters (machine pools)	<1981	969	776	661	472	287	139									
Harvesters (machine pools)	1981-1990	807	932	1157	1257	1294	1385	1385	1197	927	794	712	512	421	282	162
Harvesters (machine pools)	1991-Stage I							139	266	348	454	593	615	737	751	729
Harvesters (machine pools)	Stage II															
Harvesters (machine pools)	Stage IIIA															
Self-propelled vehicles (machine pools)	1981-1990									72	61	38				
Self-propelled vehicles (machine pools)	1991-Stage I									72	122	190	263	278	277	295
Self-propelled vehicles (machine pools)	Stage II															
Self-propelled vehicles (machine pools)	Stage IIIA															

EquipmentName (Eng)	Emission Level	2000	2001	2002	2003	2004	2005	2006	2007	2008
Tractors (machine pools)	<1981									
Tractors (machine pools)	1981-1990									
Tractors (machine pools)	1991-Stage I	3956	4069	3323	2566	2066	1421	927	487	
Tractors (machine pools)	Stage I			554	513	517	474	464	487	487
Tractors (machine pools)	Stage II				513	1033	1421	1855	1946	1946
Tractors (machine pools)	Stage IIIA								487	973
Harvesters (machine pools)	<1981									
Harvesters (machine pools)	1981-1990	78								
Harvesters (machine pools)	1991-Stage I	778	779	651	531	472	300	257	211	169
Harvesters (machine pools)	Stage II			65	118	177	171	172	169	169
Harvesters (machine pools)	Stage IIIA							43	85	127
Self-propelled vehicles (machine pools)	1981-1990									
Self-propelled vehicles (machine pools)	1991-Stage I	289	314	237	203	153	99	49		
Self-propelled vehicles (machine pools)	Stage II			47	102	153	199	194	189	142
Self-propelled vehicles (machine pools)	Stage IIIA							49	94	142

Stock data for household and gardening 1985-2008.

EquipmentName (Eng)	Emission Level	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Lawn movers (private)	<1981	253125	168750	84375												
Lawn movers (private)	1981-1990	421875	506250	590625	675000	675000	675000	590625	506250	421875	337500	253125	168750	84375		
Lawn movers (private)	1991-Stage I							84375	168750	253125	337500	421875	506250	590625	675000	675000
Lawn movers (private)	Stage I															
Lawn movers (private)	Stage II															
Lawn movers (professional)	1981-1990	25000	25000	25000	25000	25000	25000	18750	12500	6250						
Lawn movers (professional)	1991-Stage I							6250	12500	18750	25000	25000	25000	25000	25000	25000
Lawn movers (professional)	Stage I															
Lawn movers (professional)	Stage II															
Cultivators (private-large)	<1981	73333	66000	58667	51333	44000	36667	29333	22000	14667	7333					
Cultivators (private-large)	1981-1990	36667	44000	51333	58667	66000	73333	73333	73333	73333	73333	73333	66000	58667	51333	44000
Cultivators (private-large)	1991-Stage I							7333	14667	22000	29333	36667	44000	51333	58667	66000
Cultivators (private-large)	Stage II															
Cultivators (private-small)	1981-1990	10000	10000	10000	10000	10000	10000	8000	6000	4000	2000					
Cultivators (private-small)	1991-Stage I							2000	4000	6000	8000	10000	10000	10000	10000	10000
Cultivators (private-small)	Stage II															
Cultivators (professional)	<1981	3750	2500	1250												
Cultivators (professional)	1981-1990	6250	7500	8750	10000	10000	10000	8750	7500	6250	5000	3750	2500	1250		
Cultivators (professional)	1991-Stage I							1250	2500	3750	5000	6250	7500	8750	10000	10000
Cultivators (professional)	Stage I															
Cultivators (professional)	Stage II															
Chain saws (private)	<1981	125000	100000	75000	50000	25000										
Chain saws (private)	1981-1990	125000	150000	175000	200000	225000	250000	227250	204000	180250	156000	131250	106000	80250	54000	27250
Chain saws (private)	1991-Stage I							25250	51000	77250	104000	131250	159000	187250	216000	245250
Chain saws (private)	Stage I															
Chain saws (private)	Stage II															
Chain saws (professional)	1981-1990	10000	10000	10000	10000	10000	10000	7333	4000							
Chain saws (professional)	1991-Stage I							3667	8000	13000	14000	15000	16000	17000	18000	19000
Chain saws (professional)	Stage I															
Riders (private)	<1981	40950	35100	29250	23400	17550	11700	5880								
Riders (private)	1981-1990	29250	35100	40950	46800	52650	58500	58796	59388	54248	49167	44056	38828	33392	27660	21544
Riders (private)	1991-Stage I							5880	11878	18083	24583	31469	38828	46748	55320	64631
Riders (private)	Stage I															
Riders (private)	Stage II															
Riders (professional)	1981-1990	4800	4800	4800	4800	4800	4800	3878	2966	2035	1056					
Riders (professional)	1991-Stage I							970	1978	3053	4224	5520	5760	6000	6240	6480

Riders (professional)	Stage I															
Riders (professional)	Stage II															
Shrub clearers (private)	<1981	24000	19200	14400	9600	4800										
Shrub clearers (private)	1981-1990	24000	28800	33600	38400	43200	48000	47520	46080	43680	40320	36000	30720	24480	17280	9120
Shrub clearers (private)	1991-Stage I							5280	11520	18720	26880	36000	46080	57120	69120	82080
Shrub clearers (private)	Stage I															
Shrub clearers (private)	Stage II															
Shrub clearers (professional)	1981-1990	2000	2000	2000	2000	2000	2000	1650	1200	650						
Shrub clearers (professional)	1991-Stage I							550	1200	1950	2800	3000	3200	3400	3600	3800
Shrub clearers (professional)	Stage I															
Shrub clearers (professional)	Stage II															
Hedge cutters (private)	<1981	6850	5480	4110	2740	1370										
Hedge cutters (private)	1981-1990	6850	8220	9590	10960	12330	13700	15237	16128	16373	15972	14925	13232	10893	7908	4277
Hedge cutters (private)	1991-Stage I							1693	4032	7017	10648	14925	19848	25417	31632	38493
Hedge cutters (private)	Stage I															
Hedge cutters (private)	Stage II															
Hedge cutters (professional)	1981-1990	1300	1300	1300	1300	1300	1300	1178	920	528						
Hedge cutters (professional)	1991-Stage I							393	920	1583	2380	2650	2920	3190	3460	3730
Hedge cutters (professional)	Stage I															
Hedge cutters (professional)	Stage II															
Trimmers (private)	<1981	25500	20400	15300	10200	5100										
Trimmers (private)	1981-1990	25500	30600	35700	40800	45900	51000	48086	44686	40800	36429	31571	26229	20400	14086	7286
Trimmers (private)	1991-Stage I							5343	11171	17486	24286	31571	39343	47600	56343	65571
Trimmers (private)	Stage I															
Trimmers (private)	Stage II															
Trimmers (professional)	1981-1990	9000	9000	9000	9000	9000	9000	7071	4929	2571						
Trimmers (professional)	1991-Stage I							2357	4929	7714	10714	11143	11571	12000	12429	12857
Trimmers (professional)	Stage I															
Trimmers (professional)	Stage II															

Continued

EquipmentName (Eng)	Emission Level	2000	2001	2002	2003	2004	2005	2006	2007	2008
Lawn movers (private)	<1981									
Lawn movers (private)	1981-1990									
Lawn movers (private)	1991-Stage I	675000	675000	675000	675000	675000	595000	513750	428125	342500
Lawn movers (private)	Stage I						85000	171250	256875	256875
Lawn movers (private)	Stage II									85625
Lawn movers (professional)	1981-1990									
Lawn movers (professional)	1991-Stage I	25000	25000	25000	25000	25000	18750	12500	6250	

Lawn movers (professional)	Stage I						6250	12500	18750	18750
Lawn movers (professional)	Stage II									6250
Cultivators (private-large)	<1981									
Cultivators (private-large)	1981-1990	36667	29333	22000	14667	7333				
Cultivators (private-large)	1991-Stage I	73333	80667	88000	95333	102667	102667	95333	88000	80667
Cultivators (private-large)	Stage II						7333	14667	22000	29333
Cultivators (private-small)	1981-1990									
Cultivators (private-small)	1991-Stage I	10000	10000	10000	10000	10000	8000	6000	4000	2000
Cultivators (private-small)	Stage II						2000	4000	6000	8000
Cultivators (professional)	<1981									
Cultivators (professional)	1981-1990									
Cultivators (professional)	1991-Stage I	10000	10000	10000	10000	10000	8750	7500	6250	5000
Cultivators (professional)	Stage I						1250	2500	3750	3750
Cultivators (professional)	Stage II									1250
Chain saws (private)	<1981									
Chain saws (private)	1981-1990									
Chain saws (private)	1991-Stage I	275000	280750	286500	292250	298000	268200	238400	208600	178800
Chain saws (private)	Stage I						29800	59600	89400	89400
Chain saws (private)	Stage II									29800
Chain saws (professional)	1981-1990									
Chain saws (professional)	1991-Stage I	20000	27500	35000	42500	50000	33333	16667		
Chain saws (professional)	Stage I						16667	33333	50000	50000
Riders (private)	<1981									
Riders (private)	1981-1990	14954	7910							
Riders (private)	1991-Stage I	74771	87015	101775	109920	119360	117741	114313	107663	99047
Riders (private)	Stage I						10704	22863	23925	24762
Riders (private)	Stage II								11963	24762
Riders (professional)	1981-1990									
Riders (professional)	1991-Stage I	6720	7802	9726	12492	16100	15728	13398	9444	4800
Riders (professional)	Stage I						3932	8932	9444	9600
Riders (professional)	Stage II								4722	9600
Shrub clearers (private)	<1981									
Shrub clearers (private)	1981-1990									
Shrub clearers (private)	1991-Stage I	96000	107000	118000	129000	140000	126000	112000	98000	84000
Shrub clearers (private)	Stage I						14000	28000	42000	42000
Shrub clearers (private)	Stage II									14000
Shrub clearers (professional)	1981-1990									
Shrub clearers (professional)	1991-Stage I	4000	5500	7000	8500	10000	7500	5000	2500	

Shrub clearers (professional)	Stage I						2500	5000	7500	7500
Shrub clearers (professional)	Stage II									2500
Hedge cutters (private)	<1981									
Hedge cutters (private)	1981-1990									
Hedge cutters (private)	1991-Stage I	46000	52900	59800	66700	73600	66240	58880	51520	44160
Hedge cutters (private)	Stage I						7360	14720	22080	22080
Hedge cutters (private)	Stage II									7360
Hedge cutters (professional)	1981-1990									
Hedge cutters (professional)	1991-Stage I	4000	4600	5200	5800	6400	4800	3200	1600	
Hedge cutters (professional)	Stage I						1600	3200	4800	4800
Hedge cutters (professional)	Stage II									1600
Trimmers (private)	<1981									
Trimmers (private)	1981-1990									
Trimmers (private)	1991-Stage I	75286	77714	80143	82571	85000	76500	68000	59500	51000
Trimmers (private)	Stage I						8500	17000	25500	25500
Trimmers (private)	Stage II									8500
Trimmers (professional)	1981-1990									
Trimmers (professional)	1991-Stage I	13286	13714	14143	14571	15000	11250	7500	3750	
Trimmers (professional)	Stage I						3750	7500	11250	11250
Trimmers (professional)	Stage II									3750

Stock data for small boats and pleasure crafts 1985-2008.

Brændstof	Motortakt	Boat type	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Diesel		Motor boats (27-34 ft)	1550	1550	1719	1889	2058	2228	2397	2567	2736	2906	3075	3244	3414	3583	3753
Diesel		Motor boats (> 34 ft)	450	450	503	556	608	661	714	767	819	872	925	978	1031	1083	1136
Diesel		Motor boats <(27 ft)	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000
Diesel		Motor sailors	3500	3500	3583	3667	3750	3833	3917	4000	4083	4167	4250	4333	4417	4500	4583
Diesel		Sailing boats (> 26 ft)	7500	7500	7917	8333	8750	9167	9583	10000	10417	10833	11250	11667	12083	12500	12917
Benzin	2-takt	Other boats (< 20 ft)	4000	4000	4056	4111	4167	4222	4278	4333	4389	4444	4500	4556	4565	4527	4439
Benzin	2-takt	Yawls and cabin boats	4000	4000	4056	4111	4167	4222	4278	4333	4389	4444	4500	4556	4565	4527	4439
Benzin	2-takt	Sailing boats (< 26 ft)	19000	19000	18778	18556	18333	18111	17889	17667	17444	17222	17000	16778	16390	15843	15144
Benzin	2-takt	Speed boats	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	2970	2910	2820
Benzin	2-takt	Water scooters	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	990	970	940
Benzin	4-takt	Other boats (< 20 ft)													46	140	283
Benzin	4-takt	Yawls and cabin boats													46	140	283
Benzin	4-takt	Sailing boats (< 26 ft)													166	490	967
Benzin	4-takt	Speed boats	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000
Benzin	4-takt	Speed boats													30	90	180
Benzin	4-takt	Water scooters													10	30	60

Continued

Brændstof	Motortakt	Boat type	2000	2001	2002	2003	2004	2005	2006	2007	2008
Diesel		Motor boats (27-34 ft)	3922	4092	4261	4431	4600	4600	4600	4600	4600
Diesel		Motor boats (> 34 ft)	1189	1242	1294	1347	1400	1400	1400	1400	1400
Diesel		Motor boats <(27 ft)	3000	3000	3000	3000	3000	3000	3000	3000	3000
Diesel		Motor sailors	4667	4750	4833	4917	5000	5000	5000	5000	5000
Diesel		Sailing boats (> 26 ft)	13333	13750	14167	14583	15000	15000	15000	15000	15000
Benzin	2-takt	Other boats (< 20 ft)	4300	4108	3862	3560	3200	2750	2250	1800	1400
Benzin	2-takt	Yawls and cabin boats	4300	4108	3862	3560	3200	2750	2250	1800	1400
Benzin	2-takt	Sailing boats (< 26 ft)	14300	13317	12201	10960	9600	8250	6750	5400	4200
Benzin	2-takt	Speed boats	2700	2550	2370	2160	1920	1650	1350	1080	840
Benzin	2-takt	Water scooters	900	850	790	720	640	550	450	360	280
Benzin	4-takt	Other boats (< 20 ft)	478	725	1027	1384	1800	2250	2750	3200	3600
Benzin	4-takt	Yawls and cabin boats	478	725	1027	1384	1800	2250	2750	3200	3600
Benzin	4-takt	Sailing boats (< 26 ft)	1589	2350	3243	4262	5400	6750	8250	9600	10800
Benzin	4-takt	Speed boats	3000	3000	3000	3000	3000	3000	3000	3000	3000
Benzin	4-takt	Speed boats	300	450	630	840	1080	1350	1650	1920	2160
Benzin	4-takt	Water scooters	100	150	210	280	360	450	550	640	720

Engine sizes (kW) for recreational craft 1985-2008.

Motor type	Boat type	1985	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004-2008
2-takt	Other boats (< 20 ft)	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
2-takt	Yawls and cabin boats	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
2-takt	Sailing boats (< 26 ft)	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
2-takt	Speed boats	25	31	32	33	35	36	38	39	40	42	43	44	46	47	49	50
2-takt	Water scooters	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
4-takt	Other boats (< 20 ft)									8	8	8	8	8	8	8	8
4-takt	Yawls and cabin boats									20	20	20	20	20	20	20	20
4-takt	Sailing boats (< 26 ft)									10	10	10	10	10	10	10	10
4-takt	Speed boats (in board eng.)	45	55	58	60	63	65	68	70	73	75	78	80	83	85	88	90
4-takt	Speed boats (out board eng.)									40	42	43	44	46	47	49	50
4-takt	Water scooters									45	45	45	45	45	45	45	45
Diesel	Motor boats (27-34 ft)	70	88	92	97	101	106	110	114	119	123	128	132	137	141	146	150
Diesel	Motor boats (> 34 ft)	120	149	156	163	171	178	185	192	199	207	214	221	228	236	243	250
Diesel	Motor boats <(27 ft)	20	24	26	27	28	29	30	31	32	33	34	36	37	38	39	40
Diesel	Motor sailors	20	22	23	23	24	24	25	26	26	27	27	28	28	29	29	30
Diesel	Sailing boats (> 26 ft)	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30

Annex 3B-11: Traffic data and different technical and operational data for Danish domestic ferries

Annual traffic data for ferries (no. of round trips) for Danish domestic ferries.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Korsør-Nyborg, DSB	9305	9167	9237	8959	8813	8789	8746	3258	0	0
Korsør-Nyborg, Vognmandsruten	7512	7363	7468	7496	7502	7828	7917	8302	3576	0
Halsskov-Knudshoved	10601	10582	11701	11767	12420	12970	13539	13612	5732	0
Kalundborg-Juelsminde	0	1326	1733	1542	1541	1508	856	0	0	0
Kalundborg-Århus	1907	2400	3162	2921	2913	3540	4962	4888	4483	1454
Sjællands Odde-Ebeltoft	3908	3978	4008	3988	4325	4569	5712	8153	7851	7720
Sjællands Odde-Århus	0	0	0	0	0	0	0	0	0	2339
Hundested-Grenaa	1026	1025	1032	1030	718	602	67	0	0	0
København-Rønne	558	545	484	412	427	426	437	465	458	506
Køge-Rønne	0	0	0	0	0	0	0	0	0	0
Kalundborg-Samsø	873	873	860	881	826	811	813	823	824	850
Tårs-Spodsbjerg	7656	8835	9488	9535	9402	9562	9000	9129	7052	6442
Local ferries	176891	179850	181834	178419	202445	209129	182750	197489	200027	202054

Continued

	2000	2001	2002	2003	2004	2005	2006	2007	2008
Korsør-Nyborg, DSB	0	0	0	0	0	0	0	0	0
Korsør-Nyborg, Vognmandsruten	0	0	0	0	0	0	0	0	0
Halsskov-Knudshoved	0	0	0	0	0	0	0	0	0
Kalundborg-Juelsminde	0	0	0	0	0	0	0	0	0
Kalundborg-Århus	1870	1804	2037	1800	1750	1725	1724	1695	1694
Sjællands Odde-Ebeltoft	4775	4226	3597	3191	2906	2889	2690	2670	2577
Sjællands Odde-Århus	1799	1817	1825	2359	2863	2795	2853	2810	2814
Hundested-Grenaa	0	0	0	0	0	0	0	0	0
København-Rønne	491	430	413	397	293	0	0	0	0
Køge-Rønne	0	0	0	0	154	488	436	399	428
Kalundborg-Samsø	828	817	833	831	841	867	862	887	921
Tårs-Spodsbjerg	6477	6498	6468	6516	6497	6494	6460	6493	6504
Local ferries	201833	200130	208396	208501	206297	205564	203413	205260	210089

Ferry data: Service, name, engine year, main engine MCR (kW), engine type, specific fuel consumption (sfc), aux. engine (kW).

Ferry service	Ferry name	Engine year	Main engine MCR (kW)	Engine type	Sfc (g/kWh)	Fuel type	Aux engine (kW)
Halsskov-Knudshoved	ARVEPRINS KNUD	1963	8238	Slow speed (2-stroke)	220	Fuel	1666
Halsskov-Knudshoved	DRONNING MARGRETHE II	1973	8826	Medium speed (4-stroke)	230	Diesel	1692
Halsskov-Knudshoved	HEIMDAL	1983	8309	Medium speed (4-stroke)	220	Diesel	740
Halsskov-Knudshoved	KNUDSHOVED	1961	6400	Slow speed (2-stroke)	220	Fuel	1840
Halsskov-Knudshoved	KONG FREDERIK IX	1954	6767	Slow speed (2-stroke)	225	Fuel	1426
Halsskov-Knudshoved	KRAKA	1982	8309	Medium speed (4-stroke)	220	Diesel	740
Halsskov-Knudshoved	LODBROG	1982	8309	Medium speed (4-stroke)	220	Diesel	740
Halsskov-Knudshoved	PRINSESSE ANNE-MARIE	1960	8238	Slow speed (2-stroke)	220	Fuel	1360
Halsskov-Knudshoved	PRINSESSE ELISABETH	1964	8238	Slow speed (2-stroke)	220	Fuel	1360
Halsskov-Knudshoved	ROMSØ	1973	8826	Medium speed (4-stroke)	230	Diesel	1728
Halsskov-Knudshoved	SPROGØ	1962	6400	Slow speed (2-stroke)	220	Fuel	1840
Hundested-Grenaa	DJURSLAND	1974	9856	Medium speed (4-stroke)	230	Diesel	900
Hundested-Grenaa	KATTEGAT	1995	23200	High speed (4-stroke)	205	Diesel	1223
Hundested-Grenaa	KONG FREDERIK IX	1954	6767	Slow speed (2-stroke)	235	Fuel	1375
Hundested-Grenaa	PRINSESSE ANNE-MARIE	1960	8238	Slow speed (2-stroke)	220	Fuel	1360
Kalundborg-Juelsminde	Mercandia I	1989	2950	High speed (4-stroke)	220	Diesel	0
Kalundborg-Juelsminde	Mercandia II	1989	2950	High speed (4-stroke)	220	Diesel	0
Kalundborg-Juelsminde	Mercandia III	1989	2950	High speed (4-stroke)	220	Diesel	0
Kalundborg-Juelsminde	Mercandia IV	1989	2950	High speed (4-stroke)	220	Diesel	0
Kalundborg-Samsø	HOLGER DANSKE	1976	2354	High speed (4-stroke)	225	Diesel	600
Kalundborg-Samsø	KALUNDBORG	1952	3825	Slow speed (2-stroke)	235	Fuel	570
Kalundborg-Samsø	KYHOLM	1998	2940	High speed (4-stroke)	195	Diesel	864
Kalundborg-Samsø	VESBORG	1995	1770	High speed (4-stroke)	200	Diesel	494
Kalundborg-Århus	ASK	1984	8826	Medium speed (4-stroke)	215	Diesel	2220
Kalundborg-Århus	ASK	1984	8826	Medium speed (4-stroke)	215	Diesel	3000
Kalundborg-Århus	ASK	1984	9840	Medium speed (4-stroke)	215	Diesel	3000
Kalundborg-Århus	CAT-LINK I	1995	17280	High speed (4-stroke)	205	Diesel	1160
Kalundborg-Århus	CAT-LINK I	1995	17280	High speed (4-stroke)	205	Diesel	1160
Kalundborg-Århus	CAT-LINK I	1995	17280	High speed (4-stroke)	205	Diesel	1160
Kalundborg-Århus	CAT-LINK I	1995	17280	High speed (4-stroke)	205	Diesel	1160
Kalundborg-Århus	CAT-LINK II	1995	17280	High speed (4-stroke)	205	Diesel	1160
Kalundborg-Århus	CAT-LINK II	1995	17280	High speed (4-stroke)	205	Diesel	1160
Kalundborg-Århus	CAT-LINK II	1995	17280	High speed (4-stroke)	205	Diesel	1160
Kalundborg-Århus	CAT-LINK II	1995	17280	High speed (4-stroke)	205	Diesel	1160
Kalundborg-Århus	CAT-LINK III	1995	22000	High speed (4-stroke)	205	Diesel	800
Kalundborg-Århus	CAT-LINK III	1995	22000	High speed (4-stroke)	205	Diesel	801

Kalundborg-Århus	CAT-LINK III	1995	22000	High speed (4-stroke)	205	Diesel	802
Kalundborg-Århus	CAT-LINK IV	1998	28320	High speed (4-stroke)	205	Diesel	920
Kalundborg-Århus	CAT-LINK V	1998	28320	High speed (4-stroke)	205	Diesel	920
Kalundborg-Århus	KATTEGAT SYD	1979	7650	Medium speed (4-stroke)	225	Diesel	1366
Kalundborg-Århus	KNUDSHOVED	1961	6400	Slow speed (2-stroke)	220	Fuel	1840
Kalundborg-Århus	KONG FREDERIK IX	1954	6767	Slow speed (2-stroke)	225	Fuel	1426
Kalundborg-Århus	KRAKA	1982	8309	Medium speed (4-stroke)	220	Diesel	740
Kalundborg-Århus	MAREN MOLS	1996	11700	Slow speed (2-stroke)	180	Diesel	2530
Kalundborg-Århus	MAREN MOLS	1996	11700	Slow speed (2-stroke)	180	Diesel	2530
Kalundborg-Århus	MAREN MOLS	1996	11700	Slow speed (2-stroke)	180	Diesel	2530
Kalundborg-Århus	MAREN MOLS	1996	11700	Slow speed (2-stroke)	180	Diesel	2530
Kalundborg-Århus	METTE MOLS	1996	11700	Slow speed (2-stroke)	180	Diesel	2530
Kalundborg-Århus	METTE MOLS	1996	11700	Slow speed (2-stroke)	180	Diesel	2530
Kalundborg-Århus	METTE MOLS	1996	11700	Slow speed (2-stroke)	180	Diesel	2530
Kalundborg-Århus	METTE MOLS	1996	11700	Slow speed (2-stroke)	180	Diesel	2530
Kalundborg-Århus	NIELS KLIM	1986	12474	Slow speed (2-stroke)	215	Fuel	4440
Kalundborg-Århus	PEDER PAARS	1985	12474	Slow speed (2-stroke)	215	Fuel	4440
Kalundborg-Århus	PRINSESSE ELISABETH	1964	8238	Slow speed (2-stroke)	220	Fuel	1360
Kalundborg-Århus	ROSTOCK LINK	1975	8385	Medium speed (4-stroke)	230	Diesel	2500
Kalundborg-Århus	SØLØVEN/SØBJØRNEN	1992	4000	High speed (4-stroke)	210	Diesel	272
Kalundborg-Århus	URD	1981	8826	Medium speed (4-stroke)	215	Diesel	2220
Kalundborg-Århus	URD	1981	8826	Medium speed (4-stroke)	215	Diesel	3000
Kalundborg-Århus	URD	1981	9840	Medium speed (4-stroke)	215	Diesel	3000
Korsør-Nyborg, DSB	ASA-THOR	1965	6472	Slow speed (2-stroke)	220	Fuel	1305
Korsør-Nyborg, DSB	DRONNING INGRID	1980	18720	Medium speed (4-stroke)	220	Diesel	2932
Korsør-Nyborg, DSB	DRONNING MARGRETHE II	1973	8826	Medium speed (4-stroke)	230	Diesel	1692
Korsør-Nyborg, DSB	KONG FREDERIK IX	1954	6767	Slow speed (2-stroke)	225	Fuel	1426
Korsør-Nyborg, DSB	KRONPRINS FREDERIK	1981	18720	Medium speed (4-stroke)	220	Diesel	2932
Korsør-Nyborg, DSB	PRINS JOACHIM	1980	18720	Medium speed (4-stroke)	220	Diesel	2932
Korsør-Nyborg, DSB	SPROGØ/KNUDSHOVED	1962	6400	Slow speed (2-stroke)	220	Fuel	1840
Korsør-Nyborg, Vognmandsruten	Superflex Alfa	1989	2950	High speed (4-stroke)	220	Diesel	0
Korsør-Nyborg, Vognmandsruten	Superflex Bravo	1989	2950	High speed (4-stroke)	220	Diesel	0
Korsør-Nyborg, Vognmandsruten	Superflex Charlie	1988	2950	High speed (4-stroke)	220	Diesel	0
København-Rønne	JENS KOFOED	1979	12950	Medium speed (4-stroke)	232,58	Fuel	2889
København-Rønne	POVL ANKER	1979	12950	Medium speed (4-stroke)	232,58	Fuel	2889
Køge-Rønne	DUEODDE	2005	8640	Medium speed (4-stroke)	189,9	Fuel	1545
Køge-Rønne	DUEODDE	2005	8640	Medium speed (4-stroke)	189,9	Fuel	1545
Køge-Rønne	HAMMERODDE	2005	8640	Medium speed (4-stroke)	189,9	Fuel	1545

Køge-Rønne	HAMMERODDE	2005	8640	Medium speed (4-stroke)	189,9	Fuel	1545
Køge-Rønne	HAMMERODDE	2005	8640	Medium speed (4-stroke)	189,9	Fuel	1545
Køge-Rønne	JENS KOFOED	1979	12950	Medium speed (4-stroke)	232,58	Fuel	2889
Køge-Rønne	POVL ANKER	1979	12950	Medium speed (4-stroke)	232,58	Fuel	2889
Køge-Rønne	POVL ANKER	1979	12950	Medium speed (4-stroke)	232,58	Fuel	2889
Køge-Rønne	POVL ANKER	1979	12950	Medium speed (4-stroke)	232,58	Fuel	2889
Sjællands Odde-Ebeltoft	MAI MOLS	1996	24800	Gas turbine	240	Diesel	752
Sjællands Odde-Ebeltoft	MAI MOLS	1996	24800	Gas turbine	240	Diesel	752
Sjællands Odde-Ebeltoft	MAI MOLS	1996	24800	Gas turbine	240	Diesel	752
Sjællands Odde-Ebeltoft	MAREN MOLS	1975	12062	Medium speed (4-stroke)	230	Fuel	1986
Sjællands Odde-Ebeltoft	MAREN MOLS 2	1996	11700	Slow speed (2-stroke)	180	Diesel	2530
Sjællands Odde-Ebeltoft	MAREN MOLS 2	1996	11700	Slow speed (2-stroke)	180	Diesel	2530
Sjællands Odde-Ebeltoft	METTE MOLS	1975	12062	Medium speed (4-stroke)	230	Fuel	1986
Sjællands Odde-Ebeltoft	METTE MOLS 2	1996	11700	Slow speed (2-stroke)	180	Diesel	2530
Sjællands Odde-Ebeltoft	METTE MOLS 2	1996	11700	Slow speed (2-stroke)	180	Diesel	2530
Sjællands Odde-Ebeltoft	MIE MOLS	1971	5884	Medium speed (4-stroke)	230	Diesel	
Sjællands Odde-Ebeltoft	MIE MOLS 2	1996	24800	Gas turbine	240	Diesel	752
Sjællands Odde-Ebeltoft	MIE MOLS 2	1996	24800	Gas turbine	240	Diesel	752
Sjællands Odde-Ebeltoft	MIE MOLS 2	1996	24800	Gas turbine	240	Diesel	752
Sjællands Odde-Århus	MADS MOLS	1998	28320	High speed (4-stroke)	205	Diesel	920
Sjællands Odde-Århus	MADS MOLS	1998	28320	High speed (4-stroke)	205	Diesel	920
Sjællands Odde-Århus	MADS MOLS	1998	28320	High speed (4-stroke)	205	Diesel	920
Sjællands Odde-Århus	MAI MOLS	1996	24800	Gas turbine	240	Diesel	752
Sjællands Odde-Århus	MAI MOLS	1996	24800	Gas turbine	240	Diesel	752
Sjællands Odde-Århus	MAX MOLS	1998	28320	High speed (4-stroke)	205	Diesel	920
Sjællands Odde-Århus	MAX MOLS	1998	28320	High speed (4-stroke)	205	Diesel	920
Sjællands Odde-Århus	MAX MOLS	1998	28320	High speed (4-stroke)	205	Diesel	920
Sjællands Odde-Århus	MIE MOLS	1996	24800	Gas turbine	240	Diesel	752
Sjællands Odde-Århus	MIE MOLS	1996	24800	Gas turbine	240	Diesel	752
Tårs-Spodsbjerg	FRIGG SYDFYEN	1984	1300	Medium speed (4-stroke)	220	Diesel	780
Tårs-Spodsbjerg	ODIN SYDFYEN	1982	1180	Medium speed (4-stroke)	220	Diesel	780
Tårs-Spodsbjerg	SPODSBJERG	1972	1530	Medium speed (4-stroke)	225	Diesel	300
Tårs-Spodsbjerg	SPODSBJERG	1972	1531	Medium speed (4-stroke)	225	Diesel	300
Tårs-Spodsbjerg	SPODSBJERG	1972	1532	Medium speed (4-stroke)	225	Diesel	300
Tårs-Spodsbjerg	SPODSBJERG	1972	1533	Medium speed (4-stroke)	225	Diesel	300
Tårs-Spodsbjerg	SPODSBJERG	1972	1534	Medium speed (4-stroke)	225	Diesel	300
Tårs-Spodsbjerg	SPODSBJERG	1972	1535	Medium speed (4-stroke)	225	Diesel	300
Tårs-Spodsbjerg	SPODSBJERG	1972	1536	Medium speed (4-stroke)	225	Diesel	300

Tårs-Spodsbjerg	SPODSBJERG	1972	1537	Medium speed (4-stroke)	225	Diesel	300
Tårs-Spodsbjerg	SPODSBJERG	1972	1538	Medium speed (4-stroke)	225	Diesel	300
Tårs-Spodsbjerg	SPODSBJERG	1972	1539	Medium speed (4-stroke)	225	Diesel	300
Tårs-Spodsbjerg	SPODSBJERG	1972	1540	Medium speed (4-stroke)	225	Diesel	300
Tårs-Spodsbjerg	SPODSBJERG	1972	1541	Medium speed (4-stroke)	225	Diesel	300
Tårs-Spodsbjerg	SPODSBJERG	1972	1542	Medium speed (4-stroke)	225	Diesel	300
Tårs-Spodsbjerg	SPODSBJERG	1972	1543	Medium speed (4-stroke)	225	Diesel	300
Tårs-Spodsbjerg	SPODSBJERG	1972	1544	Medium speed (4-stroke)	225	Diesel	300
Tårs-Spodsbjerg	SPODSBJERG	1972	1545	Medium speed (4-stroke)	225	Diesel	300
Tårs-Spodsbjerg	SPODSBJERG	2006	1545	Medium speed (4-stroke)	189,9038	Diesel	300
Tårs-Spodsbjerg	THOR SYDFYEN	1978	1176	Medium speed (4-stroke)	225	Diesel	300
Tårs-Spodsbjerg	THOR SYDFYEN	1978	1176	Medium speed (4-stroke)	225	Diesel	300
Tårs-Spodsbjerg	THOR SYDFYEN	2008	1176	Medium speed (4-stroke)	189,9038	Diesel	300

Ferry data: Sailing time (single trip).

Ferry service	Ferry name	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Halsskov-Knudshoved	ARVEPRINS KNUD	60	60	60	60	60	60	60	60	60	
Halsskov-Knudshoved	DRONNING MARGRETHE II	60	60	60	60	60	60	60	60	60	
Halsskov-Knudshoved	HEIMDAL	60	60	60	60	60	60	60	60	60	
Halsskov-Knudshoved	KNUDSHOVED	60	60	60	60	60	60	60	60	60	
Halsskov-Knudshoved	KONG FREDERIK IX	60	60	60	60	60	60	60	60	60	
Halsskov-Knudshoved	KRAKA	60	60	60	60	60	60	60	60	60	
Halsskov-Knudshoved	LODBROG	60	60	60	60	60	60	60	60	60	
Halsskov-Knudshoved	PRINSESSE ANNE-MARIE	60	60	60	60	60	60	60	60	60	
Halsskov-Knudshoved	PRINSESSE ELISABETH	60	60	60	60	60	60	60	60	60	
Halsskov-Knudshoved	ROMSØ	60	60	60	60	60	60	60	60	60	
Halsskov-Knudshoved	SPROGØ	60	60	60	60	60	60	60	60	60	
Hundested-Grenaa	DJURSLAND	160	160	160	160	160					
Hundested-Grenaa	KATTEGAT						90	90			
Hundested-Grenaa	KONG FREDERIK IX					170					
Hundested-Grenaa	PRINSESSE ANNE-MARIE					165					
Kalundborg-Juelsminde	Mercandia I	160	160	160	160	160	160	160			
Kalundborg-Juelsminde	Mercandia II	160	160	160	160	160	160	160			
Kalundborg-Juelsminde	Mercandia III	160	160	160	160	160	160	160			
Kalundborg-Juelsminde	Mercandia IV	160	160	160	160	160	160	160			
Kalundborg-Samsø	HOLGER DANSKE			120	120	120	120	120	120	120	
Kalundborg-Samsø	KALUNDBORG	120	120	120							
Kalundborg-Samsø	KYHOLM									110	110
Kalundborg-Samsø	VESBORG									120	
Kalundborg-Århus	ASK		195	195	195	195	195	195	195	195	195
Kalundborg-Århus	CAT-LINK I						80	85	90	95	
Kalundborg-Århus	CAT-LINK II						80	85	90	95	
Kalundborg-Århus	CAT-LINK III							85	90	95	
Kalundborg-Århus	CAT-LINK IV									80	80
Kalundborg-Århus	CAT-LINK V									80	80
Kalundborg-Århus	KATTEGAT SYD										195
Kalundborg-Århus	KNUDSHOVED		190								
Kalundborg-Århus	KONG FREDERIK IX		190	190	190	190	190	190			
Kalundborg-Århus	KRAKA									195	
Kalundborg-Århus	MAREN MOLS										
Kalundborg-Århus	METTE MOLS										
Kalundborg-Århus	NIELS KLIM	185	185								
Kalundborg-Århus	PEDER PAARS	185	185								
Kalundborg-Århus	PRINSESSE ELISABETH		185								
Kalundborg-Århus	ROSTOCK LINK										195
Kalundborg-Århus	SØLØVEN/SØBJØRNEN		90	90	90	90	90	90			
Kalundborg-Århus	URD		195	195	195	195	195	195	195	195	195
Korsør-Nyborg, DSB	ASA-THOR	65	65	65	65	65	65	65	65		
Korsør-Nyborg, DSB	DRONNING INGRID	65	65	65	65	65	65	65	65		
Korsør-Nyborg, DSB	DRONNING MARGRETHE II	65	65	65	65	65	65	65	65		
Korsør-Nyborg, DSB	KONG FREDERIK IX	75	75	75	75	75	75	75	75		
Korsør-Nyborg, DSB	KRONPRINS FREDERIK	65	65	65	65	65	65	65	65		
Korsør-Nyborg, DSB	PRINS JOACHIM	65	65	65	65	65	65	65	65		
Korsør-Nyborg, DSB	SPROGØ/KNUDSHOVED	75	75	75	75	75	75	75	75		
Korsør-Nyborg, Vognmandsruten	Superflex Alfa	70	70	70	70	70	70	70	70	70	
Korsør-Nyborg, Vognmandsruten	Superflex Bravo	70	70	70	70	70	70	70	70	70	
Korsør-Nyborg, Vognmandsruten	Superflex Charlie	70	70	70	70	70	70	70	70	70	
København-Rønne	JENS KOFOED	420	420	420	420	420	420	420	420	420	420
København-Rønne	POVL ANKER	420	420	420	420	420	420	420	420	420	420
Køge-Rønne	DUEODDE										
Køge-Rønne	HAMMERODDE										
Køge-Rønne	JENS KOFOED										
Køge-Rønne	POVL ANKER										

Sjællands Odde-Ebeltoft	MAI MOLS							45	45	45	45
Sjællands Odde-Ebeltoft	MAREN MOLS	100	100	100	100	100	100	100			
Sjællands Odde-Ebeltoft	MAREN MOLS 2							100	100	100	95
Sjællands Odde-Ebeltoft	METTE MOLS	100	100	100	100	100	100	100			
Sjællands Odde-Ebeltoft	METTE MOLS 2							100	100	100	95
Sjællands Odde-Ebeltoft	MIE MOLS	105	105	105	105	105	105	105			
Sjællands Odde-Ebeltoft	MIE MOLS 2							45	45	45	45
Sjællands Odde-Århus	MADS MOLS										60
Sjællands Odde-Århus	MAI MOLS										
Sjællands Odde-Århus	MAX MOLS										60
Sjællands Odde-Århus	MIE MOLS										
Tårs-Spodsbjerg	FRIGG SYDFYEN	45	45	45	45	45	45	45	45	45	45
Tårs-Spodsbjerg	ODIN SYDFYEN	45	45	45	45	45	45	45	45	45	45
Tårs-Spodsbjerg	SPODSBJERG	45	45	45	45	45	45	45	45	45	45
Tårs-Spodsbjerg	THOR SYDFYEN	45	45	45	45	45	17	45	45	45	45

Continued

Ferry service	Ferry name	2000	2001	2002	2003	2004	2005	2006	2007	2008
Halsskov-Knudshoved	ARVEPRINS KNUD									
Halsskov-Knudshoved	DRONNING MARGRETHE II									
Halsskov-Knudshoved	HEIMDAL									
Halsskov-Knudshoved	KNUDSHOVED									
Halsskov-Knudshoved	KONG FREDERIK IX									
Halsskov-Knudshoved	KRAKA									
Halsskov-Knudshoved	LODBROG									
Halsskov-Knudshoved	PRINSESSE ANNE-MARIE									
Halsskov-Knudshoved	PRINSESSE ELISABETH									
Halsskov-Knudshoved	ROMSØ									
Halsskov-Knudshoved	SPROGØ									
Hundested-Grenaa	DJURSLAND									
Hundested-Grenaa	KATTEGAT									
Hundested-Grenaa	KONG FREDERIK IX									
Hundested-Grenaa	PRINSESSE ANNE-MARIE									
Kalundborg-Juelsminde	Mercandia I									
Kalundborg-Juelsminde	Mercandia II									
Kalundborg-Juelsminde	Mercandia III									
Kalundborg-Juelsminde	Mercandia IV									
Kalundborg-Samsø	HOLGER DANSKE									
Kalundborg-Samsø	KALUNDBORG									
Kalundborg-Samsø	KYHOLM	110	110	110	110	110	110	110	110	110
Kalundborg-Samsø	VESBORG									
Kalundborg-Århus	ASK									
Kalundborg-Århus	CAT-LINK I									
Kalundborg-Århus	CAT-LINK II									
Kalundborg-Århus	CAT-LINK III									
Kalundborg-Århus	CAT-LINK IV									
Kalundborg-Århus	CAT-LINK V									
Kalundborg-Århus	KATTEGAT SYD									
Kalundborg-Århus	KNUDSHOVED									
Kalundborg-Århus	KONG FREDERIK IX									
Kalundborg-Århus	KRAKA									
Kalundborg-Århus	MAREN MOLS	160	160	155	155	155	155	165	165	165
Kalundborg-Århus	METTE MOLS	160	160	155	155	155	155	165	165	165
Kalundborg-Århus	NIELS KLIM									
Kalundborg-Århus	PEDER PAARS									
Kalundborg-Århus	PRINSESSE ELISABETH									
Kalundborg-Århus	ROSTOCK LINK									
Kalundborg-Århus	SØLØVEN/SØBJØRNEN									
Kalundborg-Århus	URD									

Korsør-Nyborg, DSB	ASA-THOR									
Korsør-Nyborg, DSB	DRONNING INGRID									
Korsør-Nyborg, DSB	DRONNING MARGRETHE II									
Korsør-Nyborg, DSB	KONG FREDERIK IX									
Korsør-Nyborg, DSB	KRONPRINS FREDERIK									
Korsør-Nyborg, DSB	PRINS JOACHIM									
Korsør-Nyborg, DSB	SPROGØ/KNUDSHOVED									
Korsør-Nyborg, Vognmandsruten	Superflex Alfa									
Korsør-Nyborg, Vognmandsruten	Superflex Bravo									
Korsør-Nyborg, Vognmandsruten	Superflex Charlie									
København-Rønne	JENS KOFOED	420	420	420	420	420	420	420	420	420
København-Rønne	POVL ANKER	420	420	420	420	420	420	420	420	420
Køge-Rønne	DUEODDE						375	375	375	375
Køge-Rønne	HAMMERODDE						375	375	375	375
Køge-Rønne	JENS KOFOED					375	375			
Køge-Rønne	POVL ANKER					375	375	375	375	375
Sjællands Odde-Ebeltoft	MAI MOLS	45	45	45	45	45	45	50	50	50
Sjællands Odde-Ebeltoft	MAREN MOLS									
Sjællands Odde-Ebeltoft	MAREN MOLS 2									
Sjællands Odde-Ebeltoft	METTE MOLS									
Sjællands Odde-Ebeltoft	METTE MOLS 2									
Sjællands Odde-Ebeltoft	MIE MOLS									
Sjællands Odde-Ebeltoft	MIE MOLS 2	45	45	45	45	45	45	50	50	50
Sjællands Odde-Århus	MADS MOLS	65	65	65	65	65	65	70	70	70
Sjællands Odde-Århus	MAI MOLS			65	65	65	65	68	68	68
Sjællands Odde-Århus	MAX MOLS	65	65	65	65	65	65	70	70	70
Sjællands Odde-Århus	MIE MOLS			65	65	65	65	68	68	68
Tårs-Spodsbjerg	FRIGG SYDFYEN	45	45	45	45	45	45	45	45	45
Tårs-Spodsbjerg	ODIN SYDFYEN	45	45	45	45	45	45	45	45	45
Tårs-Spodsbjerg	SPODSBJERG	45	45	45	45	45	45	45	45	45
Tårs-Spodsbjerg	THOR SYDFYEN	45	45	45	45	45	45	45	45	45

Ferry data: Load factor (% MCR).

Ferry service	Ferry name	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Halsskov-Knudshoved	ARVEPRINS KNUD	85	85	85	85	85	85	85	85	85	
Halsskov-Knudshoved	DRONNING MARGRETHE II	85	85	85	85	85	85	85	85	85	
Halsskov-Knudshoved	HEIMDAL	85	85	85	85	85	85	85	85	85	
Halsskov-Knudshoved	KNUDSHOVED	85	85	85	85	85	85	85	85	85	
Halsskov-Knudshoved	KONG FREDERIK IX	85	85	85	85	85	85	85	85	85	
Halsskov-Knudshoved	KRAKA	85	85	85	85	85	85	85	85	85	
Halsskov-Knudshoved	LODBROG	85	85	85	85	85	85	85	85	85	
Halsskov-Knudshoved	PRINSESSE ANNE-MARIE	85	85	85	85	85	85	85	85	85	
Halsskov-Knudshoved	PRINSESSE ELISABETH	85	85	85	85	85	85	85	85	85	
Halsskov-Knudshoved	ROMSØ	85	85	85	85	85	85	85	85	85	
Halsskov-Knudshoved	SPROGØ	85	85	85	85	85	85	85	85	85	
Hundested-Grenaa	DJURSLAND	80	80	80	80	80					
Hundested-Grenaa	KATTEGAT						85	85			
Hundested-Grenaa	KONG FREDERIK IX					65					
Hundested-Grenaa	PRINSESSE ANNE-MARIE					85					
Kalundborg-Juelsminde	Mercandia I	75	75	75	75	75	75	75			
Kalundborg-Juelsminde	Mercandia II	70	70	70	70	70	70	70			
Kalundborg-Juelsminde	Mercandia III	70	70	70	70	70	70	70			
Kalundborg-Juelsminde	Mercandia IV	70	70	70	70	70	70	70			
Kalundborg-Samsø	HOLGER DANSKE			85	85	85	85	85	85	85	
Kalundborg-Samsø	KALUNDBORG	80	80	80							
Kalundborg-Samsø	KYHOLM									85	85
Kalundborg-Samsø	VESBORG									95	

Kalundborg-Århus	ASK		85	85	85	80	80	80	80	80	80
Kalundborg-Århus	CAT-LINK I						95	90	90	85	
Kalundborg-Århus	CAT-LINK II						95	90	90	85	
Kalundborg-Århus	CAT-LINK III							95	95	90	
Kalundborg-Århus	CAT-LINK IV									95	95
Kalundborg-Århus	CAT-LINK V									95	95
Kalundborg-Århus	KATTEGAT SYD										85
Kalundborg-Århus	KNUDSHOVED		85								
Kalundborg-Århus	KONG FREDERIK IX		85	85	85	85	85	85			
Kalundborg-Århus	KRAKA									85	
Kalundborg-Århus	MAREN MOLS										
Kalundborg-Århus	METTE MOLS										
Kalundborg-Århus	NIELS KLIM	85	85								
Kalundborg-Århus	PEDER PAARS	85	85								
Kalundborg-Århus	PRINSESSE ELISABETH		80								
Kalundborg-Århus	ROSTOCK LINK										80
Kalundborg-Århus	SØLØVEN/SØBJØRNEN		90	90	90	90	90	90			
Kalundborg-Århus	URD		85	85	85	85	85	85	85	80	80
Korsør-Nyborg, DSB	ASA-THOR	85	85	85	85	85	85	85	85		
Korsør-Nyborg, DSB	DRONNING INGRID	60	60	60	60	60	60	60	60		
Korsør-Nyborg, DSB	DRONNING MARGRETHE II	85	85	85	85	85	85	85	85		
Korsør-Nyborg, DSB	KONG FREDERIK IX	70	70	70	70	70	70	70	70		
Korsør-Nyborg, DSB	KRONPRINS FREDERIK	60	60	60	60	60	60	60	60		
Korsør-Nyborg, DSB	PRINS JOACHIM	60	60	60	60	60	60	60	60		
Korsør-Nyborg, DSB	SPROGØ/KNUDSHOVED	70	70	70	70	70	70	70	70		
Korsør-Nyborg, Vognmandsruten	Superflex Alfa	70	70	70	70	70	70	70	70	70	
Korsør-Nyborg, Vognmandsruten	Superflex Bravo	70	70	70	70	70	70	70	70	70	
Korsør-Nyborg, Vognmandsruten	Superflex Charlie	70	70	70	70	70	70	70	70	70	
København-Rønne	JENS KOFOED	30,8	30,8	30,8	30,8	30,8	30,8	30,8	30,8	30,8	30,8
København-Rønne	POVL ANKER	30,8	30,8	30,8	30,8	30,8	30,8	30,8	30,8	30,8	30,8
Køge-Rønne	DUEODDE										
Køge-Rønne	HAMMERODDE										
Køge-Rønne	JENS KOFOED										
Køge-Rønne	POVL ANKER										
Sjællands Odde-Ebeltoft	MAI MOLS							80	80	80	80
Sjællands Odde-Ebeltoft	MAREN MOLS	75	75	75	75	75	75	75			
Sjællands Odde-Ebeltoft	MAREN MOLS 2							80	80	80	85
Sjællands Odde-Ebeltoft	METTE MOLS	75	75	75	75	75	75	75			
Sjællands Odde-Ebeltoft	METTE MOLS 2							80	80	80	85
Sjællands Odde-Ebeltoft	MIE MOLS	85	85	85	85	85	85	85			
Sjællands Odde-Ebeltoft	MIE MOLS 2							80	80	80	80
Sjællands Odde-Århus	MADS MOLS										90
Sjællands Odde-Århus	MAI MOLS										
Sjællands Odde-Århus	MAX MOLS										90
Sjællands Odde-Århus	MIE MOLS										
Tårs-Spodsbjerg	FRIGG SYDFYEN	80	80	80	80	80	80	80	80	80	80
Tårs-Spodsbjerg	ODIN SYDFYEN	80	80	80	80	80	80	80	80	80	80
Tårs-Spodsbjerg	SPODSBJERG	75	80	80	80	80	80	80	80	80	80
Tårs-Spodsbjerg	THOR SYDFYEN	80	80	80	80	80	80	80	80	80	80

Continued

Ferry service	Ferry name	2000	2001	2002	2003	2004	2005	2006	2007	2008
Halsskov-Knudshoved	ARVEPRINS KNUD									
Halsskov-Knudshoved	DRONNING MARGRETHE II									
Halsskov-Knudshoved	HEIMDAL									
Halsskov-Knudshoved	KNUDSHOVED									
Halsskov-Knudshoved	KONG FREDERIK IX									
Halsskov-Knudshoved	KRAKA									
Halsskov-Knudshoved	LODBROG									

Halsskov-Knudshoved	PRINSESSE ANNE-MARIE									
Halsskov-Knudshoved	PRINSESSE ELISABETH									
Halsskov-Knudshoved	ROMSØ									
Halsskov-Knudshoved	SPROGØ									
Hundested-Grenaa	DJURSLAND									
Hundested-Grenaa	KATTEGAT									
Hundested-Grenaa	KONG FREDERIK IX									
Hundested-Grenaa	PRINSESSE ANNE-MARIE									
Kalundborg-Juelsminde	Mercandia I									
Kalundborg-Juelsminde	Mercandia II									
Kalundborg-Juelsminde	Mercandia III									
Kalundborg-Juelsminde	Mercandia IV									
Kalundborg-Samsø	HOLGER DANSKE									
Kalundborg-Samsø	KALUNDBORG									
Kalundborg-Samsø	KYHOLM	85	85	85	85	85	85	85	85	85
Kalundborg-Samsø	VESBORG									
Kalundborg-Århus	ASK									
Kalundborg-Århus	CAT-LINK I									
Kalundborg-Århus	CAT-LINK II									
Kalundborg-Århus	CAT-LINK III									
Kalundborg-Århus	CAT-LINK IV									
Kalundborg-Århus	CAT-LINK V									
Kalundborg-Århus	KATTEGAT SYD									
Kalundborg-Århus	KNUDSHOVED									
Kalundborg-Århus	KONG FREDERIK IX									
Kalundborg-Århus	KRAKA									
Kalundborg-Århus	MAREN MOLS	85	85	85	85	85	85	82	80	80
Kalundborg-Århus	METTE MOLS	85	85	85	85	85	85	82	80	80
Kalundborg-Århus	NIELS KLIM									
Kalundborg-Århus	PEDER PAARS									
Kalundborg-Århus	PRINSESSE ELISABETH									
Kalundborg-Århus	ROSTOCK LINK									
Kalundborg-Århus	SØLØVEN/SØBJØRNEN									
Kalundborg-Århus	URD									
Korsør-Nyborg, DSB	ASA-THOR									
Korsør-Nyborg, DSB	DRONNING INGRID									
Korsør-Nyborg, DSB	DRONNING MARGRETHE II									
Korsør-Nyborg, DSB	KONG FREDERIK IX									
Korsør-Nyborg, DSB	KRONPRINS FREDERIK									
Korsør-Nyborg, DSB	PRINS JOACHIM									
Korsør-Nyborg, DSB	SPROGØ/KNUDSHOVED									
Korsør-Nyborg, Vognmandsruten	Superflex Alfa									
Korsør-Nyborg, Vognmandsruten	Superflex Bravo									
Korsør-Nyborg, Vognmandsruten	Superflex Charlie									
København-Rønne	JENS KOFOED	30,8	30,8	30,8	30,8	30,8	30,8	30,8	30,8	30,8
København-Rønne	POVL ANKER	30,8	30,8	30,8	30,8	30,8	30,8	30,8	30,8	30,8
Køge-Rønne	DUEODDE						69,1	65	65	65
Køge-Rønne	HAMMERODDE						69,1	65	66	66
Køge-Rønne	JENS KOFOED					31,3	31,3			
Køge-Rønne	POVL ANKER					31,3	31,3	45	49	49
Sjællands Odde-Ebeltoft	MAI MOLS	80	80	80	80	80	80	79	78	78
Sjællands Odde-Ebeltoft	MAREN MOLS									
Sjællands Odde-Ebeltoft	MAREN MOLS 2									
Sjællands Odde-Ebeltoft	METTE MOLS									
Sjællands Odde-Ebeltoft	METTE MOLS 2									
Sjællands Odde-Ebeltoft	MIE MOLS									
Sjællands Odde-Ebeltoft	MIE MOLS 2	80	80	80	80	80	80	79	78	78
Sjællands Odde-Århus	MADS MOLS	85	85	85	85	85	85	67	67	67
Sjællands Odde-Århus	MAI MOLS			75	75	75	75	69	69	69

Sjællands Odde-Århus	MAX MOLS	85	85	85	85	85	85	67	67	67
Sjællands Odde-Århus	MIE MOLS			75	75	75	75	69	69	69
Tårs-Spodsbjerg	FRIGG SYDFYEN	80	80	80	80	80	80	80	80	80
Tårs-Spodsbjerg	ODIN SYDFYEN	80	80	80	80	80	80	80	80	80
Tårs-Spodsbjerg	SPODSBJERG	80	80	80	80	80	80	80	80	80
Tårs-Spodsbjerg	THOR SYDFYEN	80	80	80	80	80	80	80	80	80

Ferry data: Round trip shares (%).

Ferry service	Ferry name	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Halsskov-Knudshoved	ARVEPRINS KNUD	21,1	20,2	19,7	19,8	20,6	18,6	18,8	17,6	20,0	
Halsskov-Knudshoved	DRONNING MARGRETHE II	2,4	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	
Halsskov-Knudshoved	HEIMDAL	22,5	23,8	22,3	24,3	23,4	21,3	21,1	19,3	21,5	
Halsskov-Knudshoved	KNUDSHOVED	0,0	0,0	0,0	0,0	0,0	0,0	2,4	4,6	0,0	
Halsskov-Knudshoved	KONG FREDERIK IX	0,0	0,0	0,0	0,0	0,0	0,3	0,0	0,0	0,0	
Halsskov-Knudshoved	KRAKA	24,3	25,4	22,7	23,4	21,1	20,4	20,3	19,9	21,0	
Halsskov-Knudshoved	LODBROG	0,0	0,0	0,0	0,0	0,0	0,0	0,0	7,1	14,0	
Halsskov-Knudshoved	PRINSESSE ANNE-MARIE	0,0	0,0	0,0	0,0	0,0	5,5	2,4	0,0	0,0	
Halsskov-Knudshoved	PRINSESSE ELISABETH	0,0	0,0	0,0	2,5	0,1	0,0	0,0	0,0	0,0	
Halsskov-Knudshoved	ROMSØ	20,6	21,6	20,5	16,2	20,1	19,0	21,1	20,5	22,9	
Halsskov-Knudshoved	SPROGØ	9,1	9,0	14,8	13,8	14,7	14,9	13,9	11,0	0,6	
Hundested-Grenaa	DJURSLAND	100,0	100,0	100,0	100,0	50,0					
Hundested-Grenaa	KATTEGAT						100,0	100,0			
Hundested-Grenaa	KONG FREDERIK IX					5,0					
Hundested-Grenaa	PRINSESSE ANNE-MARIE					45,0					
Kalundborg-Juelsminde	Mercandia I	25,0	25,0	25,0	25,0	25,0	25,0	25,0			
Kalundborg-Juelsminde	Mercandia II	25,0	25,0	25,0	25,0	25,0	25,0	25,0			
Kalundborg-Juelsminde	Mercandia III	25,0	25,0	25,0	25,0	25,0	25,0	25,0			
Kalundborg-Juelsminde	Mercandia IV	25,0	25,0	25,0	25,0	25,0	25,0	25,0			
Kalundborg-Samsø	HOLGER DANSKE			95,0	100,0	100,0	100,0	100,0	100,0	92,0	
Kalundborg-Samsø	KALUNDBORG	100,0	100,0	5,0							
Kalundborg-Samsø	KYHOLM									6,0	100,0
Kalundborg-Samsø	VESBORG									2,0	
Kalundborg-Århus	ASK		15,8	31,8	26,3	32,8	26,8	18,5	10,7	11,8	2,4
Kalundborg-Århus	CAT-LINK I						17,2	25,4	27,5	11,4	
Kalundborg-Århus	CAT-LINK II						0,9	22,6	27,5	7,6	
Kalundborg-Århus	CAT-LINK III							8,5	23,6	19,1	
Kalundborg-Århus	CAT-LINK IV									22,9	25,8
Kalundborg-Århus	CAT-LINK V									15,3	25,8
Kalundborg-Århus	KATTEGAT SYD										2,4
Kalundborg-Århus	KNUDSHOVED		4,0								
Kalundborg-Århus	KONG FREDERIK IX		4,0	0,0	6,6	0,0	0,0	1,5			
Kalundborg-Århus	KRAKA									2,4	
Kalundborg-Århus	MAREN MOLS										
Kalundborg-Århus	METTE MOLS										
Kalundborg-Århus	NIELS KLIM	50,0	19,8								
Kalundborg-Århus	PEDER PAARS	50,0	15,8								
Kalundborg-Århus	PRINSESSE ELISABETH		4,0								
Kalundborg-Århus	ROSTOCK LINK										21,8
Kalundborg-Århus	SØLØVEN/SØBJØRNEN		20,8	36,4	34,2	34,3	28,2	5,0			
Kalundborg-Århus	URD		15,8	31,8	32,9	32,8	26,8	18,5	10,7	9,5	21,8
Korsør-Nyborg, DSB	ASA-THOR	12,6	13,4	13,1	11,1	9,3	8,9	9,2	6,3		
Korsør-Nyborg, DSB	DRONNING INGRID	26,2	27,6	25,9	28,3	28,0	28,8	28,2	31,0		
Korsør-Nyborg, DSB	DRONNING MARGRETHE II	3,0	0,0	3,4	0,9	2,8	0,5	2,3	0,0		
Korsør-Nyborg, DSB	KONG FREDERIK IX	0,1	0,0	0,0	0,2	3,4	4,4	0,7	0,0		
Korsør-Nyborg, DSB	KRONPRINS FREDERIK	26,8	28,1	26,9	28,8	28,2	29,3	28,6	31,9		
Korsør-Nyborg, DSB	PRINS JOACHIM	25,2	26,6	25,4	26,9	26,9	27,4	27,1	27,8		
Korsør-Nyborg, DSB	SPROGØ/KNUDSHOVED	6,1	4,3	5,3	3,8	1,4	0,7	3,9	3,0		

Korsør-Nyborg, Vognmandsruten	Superflex Alfa	33,0	33,0	33,0	33,0	33,0	33,0	33,0	33,0	33,0	
Korsør-Nyborg, Vognmandsruten	Superflex Bravo	33,0	33,0	33,0	33,0	33,0	33,0	33,0	33,0	33,0	
Korsør-Nyborg, Vognmandsruten	Superflex Charlie	34,0	34,0	34,0	34,0	34,0	34,0	34,0	34,0	34,0	
København-Rønne	JENS KOFOED	50,0	50,0	50,0	50,0	50,0	50,0	50,0	50,0	50,0	50,0
København-Rønne	POVL ANKER	50,0	50,0	50,0	50,0	50,0	50,0	50,0	50,0	50,0	50,0
Køge-Rønne	DUEODDE										
Køge-Rønne	HAMMERODDE										
Køge-Rønne	JENS KOFOED										
Køge-Rønne	POVL ANKER										
Sjællands Odde-Ebeltoft	MAI MOLS							21,0	35,0	35,0	35,0
Sjællands Odde-Ebeltoft	MAREN MOLS	40,0	40,0	40,0	40,0	40,0	40,0	15,0			
Sjællands Odde-Ebeltoft	MAREN MOLS 2							18,0	15,0	15,0	15,0
Sjællands Odde-Ebeltoft	METTE MOLS	40,0	40,0	40,0	40,0	40,0	40,0	17,0			
Sjællands Odde-Ebeltoft	METTE MOLS 2							15,0	15,0	15,0	15,0
Sjællands Odde-Ebeltoft	MIE MOLS	20,0	20,0	20,0	20,0	20,0	20,0	5,0			
Sjællands Odde-Ebeltoft	MIE MOLS 2							9,0	35,0	35,0	35,0
Sjællands Odde-Århus	MADS MOLS										50,0
Sjællands Odde-Århus	MAI MOLS										
Sjællands Odde-Århus	MAX MOLS										50,0
Sjællands Odde-Århus	MIE MOLS										
Tårs-Spodsbjerg	FRIGG SYDFYEN	41,0	40,0	39,0	38,0	36,0	36,0	36,0	32,0	33,0	45,0
Tårs-Spodsbjerg	ODIN SYDFYEN	41,0	40,0	39,0	38,0	36,0	36,0	36,0	32,0	33,0	45,0
Tårs-Spodsbjerg	SPODSBJERG	4,0	2,0	8,0	8,0	9,0	8,0	8,0	19,0	20,0	10,0
Tårs-Spodsbjerg	THOR SYDFYEN	14,0	18,0	14,0	16,0	19,0	20,0	20,0	17,0	14,0	0,0

Continued

Ferry service	Ferry name	2000	2001	2002	2003	2004	2005	2006	2007	2008
Halsskov-Knudshoved	ARVEPRINS KNUD									
Halsskov-Knudshoved	DRONNING MARGRETHE II									
Halsskov-Knudshoved	HEIMDAL									
Halsskov-Knudshoved	KNUDSHOVED									
Halsskov-Knudshoved	KONG FREDERIK IX									
Halsskov-Knudshoved	KRAKA									
Halsskov-Knudshoved	LODBROG									
Halsskov-Knudshoved	PRINSESSE ANNE-MARIE									
Halsskov-Knudshoved	PRINSESSE ELISABETH									
Halsskov-Knudshoved	ROMSØ									
Halsskov-Knudshoved	SPROGØ									
Hundested-Grenaa	DJURSLAND									
Hundested-Grenaa	KATTEGAT									
Hundested-Grenaa	KONG FREDERIK IX									
Hundested-Grenaa	PRINSESSE ANNE-MARIE									
Kalundborg-Juelsminde	Mercandia I									
Kalundborg-Juelsminde	Mercandia II									
Kalundborg-Juelsminde	Mercandia III									
Kalundborg-Juelsminde	Mercandia IV									
Kalundborg-Samsø	HOLGER DANSKE									
Kalundborg-Samsø	KALUNDBORG									
Kalundborg-Samsø	KYHOLM	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0
Kalundborg-Samsø	VESBORG									
Kalundborg-Århus	ASK									
Kalundborg-Århus	CAT-LINK I									
Kalundborg-Århus	CAT-LINK II									
Kalundborg-Århus	CAT-LINK III									
Kalundborg-Århus	CAT-LINK IV									
Kalundborg-Århus	CAT-LINK V									
Kalundborg-Århus	KATTEGAT SYD									
Kalundborg-Århus	KNUDSHOVED									
Kalundborg-Århus	KONG FREDERIK IX									

Kalundborg-Århus	KRAKA									
Kalundborg-Århus	MAREN MOLS	50,0	50,0	50,0	50,0	50,0	50,0	50,0	50,0	50,0
Kalundborg-Århus	METTE MOLS	50,0	50,0	50,0	50,0	50,0	50,0	50,0	50,0	50,0
Kalundborg-Århus	NIELS KLIM									
Kalundborg-Århus	PEDER PAARS									
Kalundborg-Århus	PRINSESSE ELISABETH									
Kalundborg-Århus	ROSTOCK LINK									
Kalundborg-Århus	SØLØVEN/SØBJØRNEN									
Kalundborg-Århus	URD									
Korsør-Nyborg, DSB	ASA-THOR									
Korsør-Nyborg, DSB	DRONNING INGRID									
Korsør-Nyborg, DSB	DRONNING MARGRETHE II									
Korsør-Nyborg, DSB	KONG FREDERIK IX									
Korsør-Nyborg, DSB	KRONPRINS FREDERIK									
Korsør-Nyborg, DSB	PRINS JOACHIM									
Korsør-Nyborg, DSB	SPROGØ/KNUDSHOVED									
Korsør-Nyborg, Vognmandsruten	Superflex Alfa									
Korsør-Nyborg, Vognmandsruten	Superflex Bravo									
Korsør-Nyborg, Vognmandsruten	Superflex Charlie									
København-Rønne	JENS KOFOED	50,0	50,0	50,0	50,0	50,0	50,0	50,0	50,0	50,0
København-Rønne	POVL ANKER	50,0	50,0	50,0	50,0	50,0	50,0	50,0	50,0	50,0
Køge-Rønne	DUEODDE						25,0	48,7	46,9	46,9
Køge-Rønne	HAMMERODDE						35,0	48,5	52,6	52,6
Køge-Rønne	JENS KOFOED					50,0	20,0			
Køge-Rønne	POVL ANKER					50,0	20,0	2,7	0,5	0,5
Sjællands Odde-Ebeltoft	MAI MOLS	50,0	50,0	50,0	50,0	50,0	50,0	50,0	50,0	50,0
Sjællands Odde-Ebeltoft	MAREN MOLS									
Sjællands Odde-Ebeltoft	MAREN MOLS 2									
Sjællands Odde-Ebeltoft	METTE MOLS									
Sjællands Odde-Ebeltoft	METTE MOLS 2									
Sjællands Odde-Ebeltoft	MIE MOLS									
Sjællands Odde-Ebeltoft	MIE MOLS 2	50,0	50,0	50,0	50,0	50,0	50,0	50,0	50,0	50,0
Sjællands Odde-Århus	MADS MOLS	95,0	90,0	95,0	60,0	60,0	35,0	30,0	31,0	31,0
Sjællands Odde-Århus	MAI MOLS			1,0	10,0	15,0	15,0	20,0	19,0	19,0
Sjællands Odde-Århus	MAX MOLS	5,0	10,0	3,0	20,0	10,0	35,0	30,0	31,0	31,0
Sjællands Odde-Århus	MIE MOLS			1,0	10,0	15,0	15,0	20,0	19,0	19,0
Tårs-Spodsbjerg	FRIGG SYDFYEN	45,0	45,0	45,0	45,0	45,0	45,0	45,0	45,0	45,0
Tårs-Spodsbjerg	ODIN SYDFYEN	45,0	45,0	45,0	45,0	45,0	45,0	45,0	45,0	45,0
Tårs-Spodsbjerg	SPODSBJERG	10,0	10,0	10,0	10,0	10,0	10,0	10,0	10,0	10,0
Tårs-Spodsbjerg	THOR SYDFYEN	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0

Annex 3B-12 Fuel consumption and emission factors, engine specific (NO_x, CO, VOC (NMVOC and CH_4)), and fuel type specific (S-%, SO_2, PM) for ship engines

Specific fuel consumption and NO_x emission factors (g pr kWh) pr engine year for diesel ship engines.

Year	High speed 4-stroke sfc (g pr kWh)	Medium speed 4-stroke sfc (g pr kWh)	Slow speed 2-stroke sfc (g pr kWh)	High speed 4-stroke NO_X (g pr kWh)	Medium speed 4-stroke NO_X (g pr kWh)	Slow speed 2-stroke NO_X (g pr kWh)
1949	265.5	255.5	235.5	7.3	8.0	14.5
1950	265.0	255.0	235.0	7.3	8.0	14.5
1951	264.5	254.5	234.5	7.3	8.0	14.5
1952	264.0	254.0	234.0	7.3	8.0	14.5
1953	263.5	253.5	233.5	7.3	8.0	14.5
1954	263.0	253.0	233.0	7.3	8.0	14.5
1955	262.4	252.4	232.4	7.3	8.0	14.5
1956	261.9	251.9	231.9	7.4	8.1	14.6
1957	261.3	251.3	231.3	7.5	8.2	14.7
1958	260.7	250.7	230.7	7.6	8.3	14.8
1959	260.1	250.1	230.1	7.7	8.4	14.9
1960	259.5	249.5	229.5	7.8	8.5	15.0
1961	258.9	248.9	228.9	7.9	8.6	15.1
1962	258.2	248.2	228.2	8.0	8.7	15.1
1963	257.6	247.6	227.6	8.1	8.8	15.2
1964	256.9	246.9	226.9	8.2	8.9	15.3
1965	256.1	246.1	226.1	8.3	9.0	15.4
1966	255.4	245.4	225.4	8.3	9.1	15.5
1967	254.6	244.6	224.6	8.4	9.2	15.6
1968	253.8	243.8	223.8	8.5	9.3	15.7
1969	253.0	243.0	223.0	8.6	9.4	15.8
1970	252.1	242.1	222.1	8.7	9.5	15.9
1971	251.2	241.2	221.2	8.8	9.6	16.0
1972	250.3	240.3	220.3	8.9	9.7	16.1
1973	249.3	239.3	219.3	9.0	9.8	16.2
1974	248.3	238.3	218.3	9.1	9.9	16.3
1975	247.3	237.3	217.3	9.2	10.0	16.4
1976	246.2	236.2	216.2	9.3	10.1	16.4
1977	245.0	235.0	215.0	9.3	10.2	16.5
1978	243.8	233.8	213.8	9.4	10.3	16.6
1979	242.6	232.6	212.6	9.5	10.4	16.7
1980	241.3	231.3	211.3	9.6	10.5	16.8
1981	239.9	229.9	209.9	9.7	10.6	16.9
1982	238.5	228.5	208.5	9.8	10.7	17.0
1983	237.0	227.0	207.0	9.9	10.8	17.4
1984	235.5	225.5	205.5	10.0	10.9	17.8
1985	233.9	223.9	203.9	10.1	11.0	18.2
1986	232.2	222.2	202.2	10.2	11.1	18.6
1987	230.5	220.5	200.5	10.3	11.3	19.0
1988	228.6	218.6	198.6	10.5	11.4	19.3
1989	226.7	216.7	196.7	10.6	11.6	19.5
1990	224.8	214.8	194.8	10.7	11.7	19.8
1991	222.7	212.7	192.7	10.9	11.9	20.0
1992	220.5	210.5	190.5	11.0	12.0	19.8
1993	218.3	208.3	188.3	11.1	12.1	19.6
1994	216.0	206.0	186.0	11.3	12.3	19.4
1995	213.6	203.6	183.6	11.4	12.4	19.3
1996	211.0	201.0	181.0	11.5	12.6	19.1
1997	208.4	198.4	178.4	11.7	12.7	18.9
1998	205.7	195.7	175.7	11.8	12.9	18.7

Continued						
Year	High speed 4-stroke sfc (g pr kWh)	Medium speed 4-stroke sfc (g pr kWh)	Slow speed 2-stroke sfc (g pr kWh)	High speed 4-stroke NO_X (g pr kWh)	Medium speed 4-stroke NO_X (g pr kWh)	Slow speed 2-stroke NO_X (g pr kWh)
1999	202.9	192.9	172.9	11.9	13.0	18.5
2000	199.9	189.9	169.9	11.0	12.0	16.0

CO, VOC, NMVOC and CH_4 emission factors (g/kg fuel) for ship engines

	High speed 4-stroke CO	Medium speed 4-stroke CO	Slow speed 2-stroke CO	High speed 4-stroke VOC	Medium speed 4-stroke VOC	Slow speed 2-stroke VOC
1949	6.03	6.26	6.79	1.88	1.96	2.12
1950	6.04	6.27	6.81	1.89	1.96	2.13
1951	6.05	6.29	6.82	1.89	1.96	2.13
1952	6.06	6.30	6.84	1.89	1.97	2.14
1953	6.07	6.31	6.85	1.90	1.97	2.14
1954	6.08	6.33	6.87	1.90	1.98	2.15
1955	6.10	6.34	6.88	1.91	1.98	2.15
1956	6.11	6.35	6.90	1.91	1.99	2.16
1957	6.12	6.37	6.92	1.91	1.99	2.16
1958	6.14	6.38	6.93	1.92	1.99	2.17
1959	6.15	6.40	6.95	1.92	2.00	2.17
1960	6.17	6.41	6.97	1.93	2.00	2.18
1961	6.18	6.43	6.99	1.93	2.01	2.18
1962	6.20	6.45	7.01	1.94	2.01	2.19
1963	6.21	6.46	7.03	1.94	2.02	2.20
1964	6.23	6.48	7.05	1.95	2.03	2.20
1965	6.25	6.50	7.08	1.95	2.03	2.21
1966	6.26	6.52	7.10	1.96	2.04	2.22
1967	6.28	6.54	7.12	1.96	2.04	2.23
1968	6.30	6.56	7.15	1.97	2.05	2.23
1969	6.32	6.58	7.17	1.98	2.06	2.24
1970	6.35	6.61	7.20	1.98	2.06	2.25
1971	6.37	6.63	7.23	1.99	2.07	2.26
1972	6.39	6.66	7.26	2.00	2.08	2.27
1973	6.42	6.69	7.29	2.01	2.09	2.28
1974	6.44	6.71	7.33	2.01	2.10	2.29
1975	6.47	6.74	7.36	2.02	2.11	2.30
1976	6.50	6.77	7.40	2.03	2.12	2.31
1977	6.53	6.81	7.44	2.04	2.13	2.33
1978	6.56	6.84	7.48	2.05	2.14	2.34
1979	6.60	6.88	7.53	2.06	2.15	2.35
1980	6.63	6.92	7.57	2.07	2.16	2.37
1981	6.67	6.96	7.62	2.08	2.17	2.38
1982	6.71	7.00	7.67	2.10	2.19	2.40
1983	6.75	7.05	7.73	2.11	2.20	2.42
1984	6.79	7.10	7.79	2.12	2.22	2.43
1985	6.84	7.15	7.85	2.14	2.23	2.45
1986	6.89	7.20	7.91	2.15	2.25	2.47
1987	6.94	7.26	7.98	2.17	2.27	2.49
1988	7.00	7.32	8.05	2.19	2.29	2.52
1989	7.06	7.38	8.13	2.21	2.31	2.54
1990	7.12	7.45	8.22	2.22	2.33	2.57
1991	7.18	7.52	8.30	2.25	2.35	2.59
1992	7.25	7.60	8.40	2.27	2.37	2.62
1993	7.33	7.68	8.50	2.29	2.40	2.66
1994	7.41	7.77	8.60	2.31	2.43	2.69
1995	7.49	7.86	8.72	2.34	2.46	2.72
1996	7.58	7.96	8.84	2.37	2.49	2.76
1997	7.68	8.06	8.97	2.40	2.52	2.80
1998	7.78	8.18	9.11	2.43	2.56	2.85
1999	7.89	8.30	9.26	2.46	2.59	2.89
2000	8.00	8.43	9.42	2.50	2.63	2.94

	High speed 4-stroke NMVOC	Medium speed 4-stroke NMVOC	Slow speed 2-stroke NMVOC	High speed 4-stroke CH_4	Medium speed 4-stroke CH_4	Slow speed 2-stroke CH_4
1949	1.83	1.90	2.06	0.06	0.06	0.06
1950	1.83	1.90	2.06	0.06	0.06	0.06
1951	1.83	1.91	2.07	0.06	0.06	0.06
1952	1.84	1.91	2.07	0.06	0.06	0.06
1953	1.84	1.91	2.08	0.06	0.06	0.06
1954	1.84	1.92	2.08	0.06	0.06	0.06
1955	1.85	1.92	2.09	0.06	0.06	0.06
1956	1.85	1.93	2.09	0.06	0.06	0.06
1957	1.86	1.93	2.10	0.06	0.06	0.06
1958	1.86	1.93	2.10	0.06	0.06	0.07
1959	1.86	1.94	2.11	0.06	0.06	0.07
1960	1.87	1.94	2.11	0.06	0.06	0.07
1961	1.87	1.95	2.12	0.06	0.06	0.07
1962	1.88	1.95	2.13	0.06	0.06	0.07
1963	1.88	1.96	2.13	0.06	0.06	0.07
1964	1.89	1.96	2.14	0.06	0.06	0.07
1965	1.89	1.97	2.14	0.06	0.06	0.07
1966	1.90	1.98	2.15	0.06	0.06	0.07
1967	1.90	1.98	2.16	0.06	0.06	0.07
1968	1.91	1.99	2.17	0.06	0.06	0.07
1969	1.92	2.00	2.17	0.06	0.06	0.07
1970	1.92	2.00	2.18	0.06	0.06	0.07
1971	1.93	2.01	2.19	0.06	0.06	0.07
1972	1.94	2.02	2.20	0.06	0.06	0.07
1973	1.95	2.03	2.21	0.06	0.06	0.07
1974	1.95	2.04	2.22	0.06	0.06	0.07
1975	1.96	2.04	2.23	0.06	0.06	0.07
1976	1.97	2.05	2.24	0.06	0.06	0.07
1977	1.98	2.06	2.26	0.06	0.06	0.07
1978	1.99	2.07	2.27	0.06	0.06	0.07
1979	2.00	2.09	2.28	0.06	0.06	0.07
1980	2.01	2.10	2.30	0.06	0.06	0.07
1981	2.02	2.11	2.31	0.06	0.07	0.07
1982	2.03	2.12	2.33	0.06	0.07	0.07
1983	2.05	2.14	2.34	0.06	0.07	0.07
1984	2.06	2.15	2.36	0.06	0.07	0.07
1985	2.07	2.17	2.38	0.06	0.07	0.07
1986	2.09	2.18	2.40	0.06	0.07	0.07
1987	2.10	2.20	2.42	0.07	0.07	0.07
1988	2.12	2.22	2.44	0.07	0.07	0.08
1989	2.14	2.24	2.47	0.07	0.07	0.08
1990	2.16	2.26	2.49	0.07	0.07	0.08
1991	2.18	2.28	2.52	0.07	0.07	0.08
1992	2.20	2.30	2.55	0.07	0.07	0.08
1993	2.22	2.33	2.58	0.07	0.07	0.08
1994	2.25	2.35	2.61	0.07	0.07	0.08
1995	2.27	2.38	2.64	0.07	0.07	0.08
1996	2.30	2.41	2.68	0.07	0.07	0.08
1997	2.33	2.44	2.72	0.07	0.08	0.08
1998	2.36	2.48	2.76	0.07	0.08	0.09
1999	2.39	2.51	2.81	0.07	0.08	0.09
2000	2.43	2.55	2.85	0.08	0.08	0.09

S-%, SO_2 and PM emission factors (g/kg fuel and g/GJ) pr fuel type for diesel ship engines

Fuel type	SNAPCode	Year	S %	SO_2 (g/kg)	TSP (g/kg)	PM_{10} (g/kg)	$PM_{2,5}$ (g/kg)	SO_2 (g/GJ)	TSP (g/GJ)	PM_{10} (g/GJ)	$PM_{2,5}$ (g/GJ)
Fuel	National sea	1990	2.64	52.8	6.1	6.0	6.0	1291.0	149.2	147.8	147.0
Fuel	National sea	1991	2.35	47	4.9	4.9	4.8	1149.1	120.2	119.0	118.4
Fuel	National sea	1992	1.8	36	3.3	3.2	3.2	880.2	79.8	79.0	78.6
Fuel	National sea	1993	2.39	47.8	5.1	5.0	5.0	1168.7	123.9	122.6	122.0
Fuel	National sea	1994	2.62	52.4	6.0	6.0	5.9	1281.2	147.0	145.6	144.8
Fuel	National sea	1995	2.95	59	7.7	7.6	7.6	1442.5	188.0	186.1	185.2
Fuel	National sea	1996	2.57	51.4	5.8	5.7	5.7	1256.7	141.7	140.2	139.5
Fuel	National sea	1997	2.74	54.8	6.6	6.5	6.5	1339.9	160.8	159.2	158.4
Fuel	National sea	1998	1.97	39.4	3.7	3.7	3.6	963.3	90.6	89.7	89.2
Fuel	National sea	1999	1.97	39.4	3.7	3.7	3.6	963.3	90.6	89.7	89.2
Fuel	National sea	2000	1.81	36.2	3.3	3.3	3.2	885.1	80.4	79.6	79.2
Fuel	National sea	2001	1.7	34	3.0	3.0	3.0	831.3	74.1	73.4	73.0
Fuel	National sea	2002	1.51	30.2	2.6	2.6	2.6	738.4	64.3	63.7	63.3
Fuel	National sea	2003	1.62	32.4	2.9	2.8	2.8	792.2	69.8	69.1	68.8
Fuel	National sea	2004	1.98	39.6	3.7	3.7	3.7	968.2	91.3	90.4	89.9
Fuel	National sea	2005	2	40	3.8	3.8	3.7	978.0	92.6	91.7	91.3
Fuel	National sea	2006	1.94	38.8	3.6	3.6	3.6	948.7	88.6	87.7	87.3
Fuel	National sea	2007	1.2	24	2.1	2.1	2.1	586.8	51.0	50.5	50.3
Fuel	National sea	2008	1.2	24	2.1	2.1	2.1	586.8	51.0	50.5	50.3
Fuel	International sea	1990	2.96	59.2	7.7	7.7	7.6	1447.4	189.4	187.5	186.6
Fuel	International sea	1991	2.89	57.8	7.4	7.3	7.2	1413.2	179.8	178.0	177.1
Fuel	International sea	1992	2.88	57.6	7.3	7.2	7.2	1408.3	178.5	176.7	175.8
Fuel	International sea	1993	3.2	64	9.3	9.2	9.1	1564.8	226.5	224.2	223.1
Fuel	International sea	1994	3.03	60.6	8.2	8.1	8.0	1481.7	199.6	197.6	196.6
Fuel	International sea	1995	3.3	66	10.0	9.9	9.8	1613.7	244.0	241.6	240.4
Fuel	International sea	1996	3.42	68.4	10.9	10.8	10.8	1672.4	266.9	264.2	262.9
Fuel	International sea	1997	3.45	69	11.2	11.0	11.0	1687.0	272.9	270.2	268.8
Fuel	International sea	1998	3.42	68.4	10.9	10.8	10.8	1672.4	266.9	264.2	262.9
Fuel	International sea	1999	3.45	69	11.2	11.0	11.0	1687.0	272.9	270.2	268.8
Fuel	International sea	2000	3.36	67.2	10.4	10.3	10.3	1643.0	255.2	252.6	251.4
Fuel	International sea	2001	3.42	68.4	10.9	10.8	10.8	1672.4	266.9	264.2	262.9
Fuel	International sea	2002	3.44	68.8	11.1	11.0	10.9	1682.2	270.9	268.2	266.8
Fuel	International sea	2003	3.11	62.2	8.7	8.6	8.5	1520.8	211.8	209.7	208.6
Fuel	International sea	2004	3.2	64	9.3	9.2	9.1	1564.8	226.5	224.2	223.1
Fuel	International sea	2005	3.5	70	11.6	11.5	11.4	1711.5	283.2	280.4	279.0
Fuel	International sea	2006	3.35	67	10.4	10.3	10.2	1638.1	253.3	250.8	249.5
Fuel	International sea	2007	1.5	30	2.6	2.6	2.6	733.5	63.8	63.2	62.9
Fuel	International sea	2008	1.5	30	2.6	2.6	2.6	733.5	63.8	63.2	62.9
Diesel	-	1990	0.2	4.0	1.0	1.0	1.0	93.7	23.2	23.0	22.9
Diesel	-	1991	0.2	4.0	1.0	1.0	1.0	93.7	23.2	23.0	22.9
Diesel	-	1992	0.2	4.0	1.0	1.0	1.0	93.7	23.2	23.0	22.9
Diesel	-	1993	0.2	4.0	1.0	1.0	1.0	93.7	23.2	23.0	22.9
Diesel	-	1994	0.2	4.0	1.0	1.0	1.0	93.7	23.2	23.0	22.9
Diesel	-	1995	0.2	4.0	1.0	1.0	1.0	93.7	23.2	23.0	22.9
Diesel	-	1996	0.2	4.0	1.0	1.0	1.0	93.7	23.2	23.0	22.9
Diesel	-	1997	0.2	4.0	1.0	1.0	1.0	93.7	23.2	23.0	22.9
Diesel	-	1998	0.2	4.0	1.0	1.0	1.0	93.7	23.2	23.0	22.9
Diesel	-	1999	0.2	4.0	1.0	1.0	1.0	93.7	23.2	23.0	22.9
Diesel	-	2000	0.2	4.0	1.0	1.0	1.0	93.7	23.2	23.0	22.9
Diesel	-	2001	0.2	4.0	1.0	1.0	1.0	93.7	23.2	23.0	22.9
Diesel	-	2002	0.2	4.0	1.0	1.0	1.0	93.7	23.2	23.0	22.9
Diesel	-	2003	0.2	4.0	1.0	1.0	1.0	93.7	23.2	23.0	22.9
Diesel	-	2004	0.2	4.0	1.0	1.0	1.0	93.7	23.2	23.0	22.9
Diesel	-	2005	0.2	4.0	1.0	1.0	1.0	93.7	23.2	23.0	22.9

Continued

Fuel type	SNAPCode	Year	S %	SO_2 (g/kg)	TSP (g/kg)	PM_{10} (g/kg)	$PM_{2,5}$ (g/kg)	SO_2 (g/GJ)	TSP (g/GJ)	PM_{10} (g/GJ)	$PM_{2,5}$ (g/GJ)
Diesel	-	2006	0.2	4.0	1.0	1.0	1.0	93.7	23.2	23.0	22.9
Diesel	-	2007	0.2	4.0	1.0	1.0	1.0	93.7	23.2	23.0	22.9
Diesel	-	2008	0.1	2.0	0.9	0.9	0.9	46.8	21.5	21.3	21.2

Annex 3B-13: Fuel sales figures from DEA, and further processed fuel consumption data suited for the Danish inventory

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Agriculture and forestry, DEA statistics															
- LPG	88	84	354	311	457	438	412	359	234	205	204	212	184	219	162
- gasoline	425	184	315	317	304	274	251	240	208	166	161	191	70	61	56
- gas/diesel oil	9199	9634	9498	9520	10605	10528	10700	11028	11423	11494	11585	13088	13875	13310	13909
Gartneri, DEA statistics															
- LPG	8	5	47	47	53	50	47	39	26	23	23	22	20	24	17
- gasoline	10	3	6	6	11	10	10	12	23	18	18	19	7	6	6
- gas/diesel oil	1705	1270	1405	1383	1231	1409	1687	1887	1205	963	1138	487	356	341	347
Fishery, DEA statistics															
- LPG	0	0	34	29	50	42	34	30	12	18	16	36	5	1	16
- gasoline	0	1	2	2	9	9	10	8	7	7	8	7	6	6	60
- kerosene	7	2	9	5	12	26	9	5	4	3	4	3	3	2	0
- gas/diesel oil	9152	10248	8390	9499	10038	10422	10809	10868	8843	8796	8277	8750	8748	9186	9282
- fuel oil	27	5	82	68	251	285	113	231	146	8	19	219	260	27	0
Manufacturing industry, DEA statistics															
- LPG	2860	2839	2688	2553	2080	2032	2076	1827	1858	2029	2234	2404	2106	2017	1917
- gasoline	262	273	453	326	136	177	161	158	145	138	110	86	82	137	80
- gas/diesel oil	15576	15441	14743	13346	12670	12259	12934	11901	11323	10154	10401	10184	8921	8720	8852
- fuel oil	29465	29451	21518	19056	16741	15989	17133	16694	14600	15438	14000	12632	11009	10943	8704
Building and construction, DEA statistics															
- LPG	305	343	500	451	575	500	573	708	579	522	501	509	471	575	422
- gasoline	19	85	52	48	36	34	26	24	20	23	25	34	27	23	27
- gas/diesel oil	5313	4962	4378	4220	3945	3548	3797	3839	3871	4145	5317	5572	6079	5947	6556
Housing, DEA statistics															
- gasoline	1006	1046	1073	1114	1128	1131	1146	1158	1168	1194	1233	1258	1299	1317	1357
Road transport, DEA statistics															
- gasoline	66 037	68 670	70 502	73 151	74 152	74 326	75 290	76 084	76 697	78 425	80 998	82 656	85 341	86 520	89 129
- gas/diesel oil	45 609	49 738	49 626	49 686	51 854	54 746	58 427	57 511	56 796	58 755	58 561	59 851	60 528	61 072	63 619
- bioethanol	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
- biodiesel	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Non-road, DEA statistics															
- LPG	2 955	2 929	3 089	2 911	2 590	2 520	2 535	2 224	2 118	2 257	2 461	2 638	2 310	2 260	2 097
- gasoline	1 722	1 590	1 898	1 810	1 616	1 626	1 595	1 592	1 563	1 540	1 547	1 589	1 485	1 545	1 526

- gas/diesel oil	31 793	31 307	30 025	28 469	28 451	27 744	29 118	28 655	27 822	26 755	28 441	29 331	29 231	28 319	29 665
Non-road, NERI model															
- LPG	1232	1233	1225	1209	1196	1185	1172	1151	1124	1105	1099	1088	1075	1086	1077
- gasoline	2998	2950	2903	2856	2813	2770	2702	2641	2587	2550	2521	2499	2479	2463	2456
- gas/diesel oil	26357	26895	26577	27075	26940	26800	26734	26046	26073	25235	25798	25139	25536	24844	24885
Recreational craft, NERI model															
- gasoline	270	270	279	289	299	309	319	329	339	348	358	368	377	385	391
- gas/diesel oil	219	219	247	277	309	343	378	415	454	495	537	581	628	676	726
Non-road, added 0203 and 0301															
- gas/diesel oil	5436	4412	3448	1395	1510	944	2384	2609	1748	1521	2642	4192	3695	3475	4780
- LPG	1724	1696	1864	1701	1393	1335	1363	1073	994	1152	1362	1549	1235	1175	1020
Non-road, added 0203															
- gas/diesel oil	1864	1537	1252	534	628	406	1014	1176	794	708	1182	1940	1799	1675	2297
- LPG	56	52	242	209	274	259	247	192	122	116	125	137	109	126	87
Non-road, added 0301															
- gas/diesel oil	3572	2875	2196	860	882	538	1370	1433	955	813	1460	2252	1896	1800	2483
- LPG	1668	1644	1622	1492	1119	1076	1116	881	872	1036	1237	1412	1126	1048	933
Non-road, added road transport															
- gasoline	-1276	-1360	-1005	-1046	-1197	-1145	-1107	-1049	-1023	-1010	-975	-909	-994	-918	-931
Fisheries, added national sea transport															
- fuel oil	27	5	82	68	251	285	113	231	146	8	19	219	260	27	0
Fisheries, consumed by recreational craft															
- gasoline	0	1	2	2	9	9	10	8	7	7	8	7	6	6	60
National sea transport, input NERI model															
- LPG	3	1	3	-	2	2	2	3	16	1	2	1	2	3	1
- kerosene	5	-	5	3	1	0	2	1	1	1	1	1	0	1	0
- gas/diesel oil	3 074	3 045	3 032	3 230	2 669	2 782	3 313	3 501	4 971	5 035	6 049	6 764	5 899	4 113	3 409
- fuel oil	2 541	3 424	3 922	2 795	4 228	3 845	4 429	3 646	2 797	2 160	1 592	1 379	1 210	1 367	1 435

Fisheries, input NERI model															
- LPG	-	-	34	29	50	42	34	30	12	18	16	36	5	1	16
- gasoline	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
- kerosene	7	2	9	5	12	26	9	5	4	3	4	3	3	2	0
- gas/diesel oil	8 932	10 029	8 143	9 222	9 729	10 080	10 431	10 453	8 389	8 301	7 740	8 169	8 120	8 510	8 556
International sea transport, input NERI model															
- gas/diesel oil	7 171	7 867	8 547	9 743	10 514	11 633	12 590	16 881	19 114	24 123	26 743	27 231	25 325	31 243	26 085
- fuel oil	10 123	12 236	20 883	27 532	27 667	28 543	23 470	20 998	36 988	39 024	39 509	35 739	32 427	26 952	28 526
National sea transport, output NERI model															
- gas/diesel oil	4942	4942	4942	4942	4942	4942	5575	6472	6285	6238	6655	8189	8691	7057	5590
- fuel oil	3843	3843	3843	3843	3843	3843	3197	2473	2473	2633	2653	2097	1324	862	726
- kerosene	5	0	5	3	1	0	2	1	1	1	1	1	0	1	0
- LPG	3	1	3	0	2	2	2	3	16	1	2	1	2	3	1
Fisheries, output NERI model															
- gas/diesel oil	7064	8131	6233	7509	7455	7920	8170	7482	7075	7097	7134	6744	5328	5566	6375
- kerosene	7	2	9	5	12	26	9	5	4	3	4	3	3	2	0
- LPG	0	0	34	29	50	42	34	30	12	18	16	36	5	1	16
National sea transport, added 0301															
- fuel oil	-1 302	- 419	80	-1 048	386	3	1 233	1 174	325	- 473	-1 061	- 718	- 113	506	709
Road transport, NERI excl. traded fuels															
- gasoline	64 492	67 041	69 220	71 819	72 664	72 882	73 874	74 714	75 342	77 074	79 674	81 385	83 976	85 223	87 867
- gas/diesel oil	45 609	49 738	49 626	49 686	51 854	54 746	58 427	57 511	56 796	58 755	58 561	59 851	60 528	61 072	63 619
- bioethanol	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
- biodiesel	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Road transport, input NERI model incl. traded fuels															
- gasoline	62 077	62 442	62 716	63 442	62 546	66 279	70 589	74 320	76 459	79 209	80 101	80 958	83 089	84 832	84 506
- gas/diesel oil	49 016	54 939	54 827	54 887	57 055	59 947	61 296	59 950	59 522	63 561	64 013	65 590	66 374	67 206	69 501
- bioethanol	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
- biodiesel	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008
Agriculture and forestry, DEA statistics									
- LPG	179	190	159	153	138	121	116	110	103
- gasoline	38	39	28	42	51	52	20	21	20
- gas/diesel oil	13689	13437	13706	13463	12934	12464	13047	12590	13803
Gartneri, DEA statistics									
- LPG	19	20	17	16	14	12	12	11	10
- gasoline	4	4	3	5	6	6	2	2	2
- gas/diesel oil	698	581	529	556	488	407	391	309	338
Fishery, DEA statistics									
- LPG	13	19	21	20	18	20	20	18	12
- gasoline	67	3	3	0	0	0	1	1	1
- kerosene	25	1	1	1	1	1	0	0	0
- gas/diesel oil	9347	8908	8888	8428	7337	7340	7362	6854	6501
- fuel oil	0	0	4	84	35	126	86	13	14
Manufacturing industry, DEA statistics									
- LPG	1819	1526	1405	1472	1488	1478	1482	1216	1178
- gasoline	97	69	42	26	30	21	32	16	15
- gas/diesel oil	8635	10099	9155	9964	10515	10022	9132	8168	7986
- fuel oil	8221	7395	7818	6916	6940	6055	8527	6422	5664
Building and construction, DEA statistics									
- LPG	165	179	236	226	228	224	248	222	172
- gasoline	33	24	26	27	27	27	27	28	26
- gas/diesel oil	5950	6356	6226	6226	6227	6338	6187	6410	6518
Housing, DEA statistics									
- gasoline	1355	1317	1313	1303	1288	1250	1216	1193	1148
Road transport, DEA statistics									
- gasoline	88 975	86 474	86 247	85 611	84 629	82 118	79 822	78 325	75 361
- gas/diesel oil	64 282	66 254	66 814	70 875	75 422	79 476	86 223	95 084	94 846
- bioethanol	-	-	-	-	-	-	151	252	210
- biodiesel	-	-	-	-	-	-	-	-	10
Non-road, DEA statistics									
- LPG	2 018	1 736	1 581	1 641	1 640	1 612	1 610	1 337	1 292
- gasoline	1 525	1 453	1 412	1 404	1 402	1 356	1 296	1 259	1 211
- gas/diesel oil	28 972	30 473	29 616	30 209	30 164	29 232	28 757	27 478	28 645

Non-road, NERI model									
- LPG	1071	1073	1084	1079	1065	1049	1038	1040	1037
- gasoline	2458	2622	2833	3090	3391	3604	3807	3873	3889
- gas/diesel oil	24630	24893	25053	25233	25558	26199	27518	29329	30454
Recreational craft, NERI model									
- gasoline	396	400	403	404	404	393	382	371	361
- gas/diesel oil	777	831	886	944	1002	1002	1002	1002	1002
Non-road, added 0203 and 0301									
- gas/diesel oil	4342	5580	4563	4976	4606	3033	1239	-1852	-1809
- LPG	947	662	497	563	575	562	572	298	255
Non-road, added 0203									
- gas/diesel oil	2156	2567	2193	2309	2050	1335	579	-869	-893
- LPG	93	80	55	58	53	46	46	27	22
Non-road, added 0301									
- gas/diesel oil	2186	3013	2370	2667	2557	1697	660	-982	-916
- LPG	854	582	442	505	522	516	526	271	232
Non-road, added road transport									
- gasoline	-932	-1169	-1421	-1686	-1990	-2248	-2511	-2613	-2678
Fisheries, added national sea transport									
- fuel oil	0	0	4	84	35	126	86	13	14
Fisheries, consumed by recreational craft									
- gasoline	67	3	3	0	0	0	1	1	1
National sea transport, input NERI model									
- LPG	0	-	-	0	0	0	0	0	-
- kerosene	1	1	1	1	1	1	0	-	-
- gas/diesel oil	3 367	3 240	3 780	3 828	3 463	4 358	3 699	3 411	4 667
- fuel oil	1 509	1 513	2 068	1 907	1 704	1 506	1 367	1 110	1 174
Fisheries, input NERI model									
- LPG	13	19	21	20	18	20	20	18	12

- gasoline	-	-	-	-	-	-	-	-	-
- kerosene	25	1	1	1	1	1	0	0	0
- gas/diesel oil	8 570	8 077	8 001	7 484	6 335	6 338	6 360	5 852	5 499
International sea transport, input NERI model									
- gas/diesel oil	22 872	21 389	21 579	20 730	16 152	13 917	13 116	10 947	13 504
- fuel oil	33 165	25 924	17 547	20 462	17 298	20 591	31 565	35 243	27 164
National sea transport, output NERI model									
- gas/diesel oil	4515	4301	4192	4199	4308	4260	4180	4119	4103
- fuel oil	715	671	659	647	673	679	633	610	628
- kerosene	1	1	1	1	1	1	0	0	0
- LPG	0	0	0	0	0	0	0	0	0
Fisheries, output NERI model									
- gas/diesel oil	7422	7016	7590	7113	5490	6437	5879	5144	6063
- kerosene	25	1	1	1	1	1	0	0	0
- LPG	13	19	21	20	18	20	20	18	12
National sea transport, added 0301									
- fuel oil	794	842	1 409	1 260	1 032	826	734	500	546
Road transport, NERI excl. traded fuels									
- gasoline	87 713	84 907	84 426	83 521	82 235	79 477	76 930	75 342	72 323
- gas/diesel oil	64 282	66 254	66 814	70 875	75 422	79 476	86 223	95 084	94 846
- bioethanol	-	-	-	-	-	-	151	252	210
- biodiesel	-	-	-	-	-	-	-	-	10
Road transport, input NERI model incl. traded fuels									
- gasoline	83 312	81 852	81 963	81 878	80 593	77 835	76 109	75 342	72 323
- gas/diesel oil	69 196	70 916	72 552	78 766	84 209	88 264	95 010	103 871	103 633
- bioethanol	-	-	-	-	-	-	151	252	210
- biodiesel	-	-	-	-	-	-	-	-	10

Annex 3B-14: Emission factors and total emissions in CollectER format

1990 emission factors for CO_2, CH_4, N_2O, SO_2, NO_x; NMVOC, NH_3 and TSP.

Year	SNAP ID	Category		Fuel type	SO_2	NO_x	NMVOC	CH_4	CO	CO_2	N_2O	NH_3	TSP
					g pr GJ	g pr GJ	g pr GJ	g pr GJ	g pr GJ	g pr GJ	g pr GJ	g pr GJ	g pr GJ
1990	070101	Passenger cars	Highway	Diesel	93,68	254,03	25,07	3,74	179,70	74,00	0,00	0,47	79,48
1990	070101	Passenger cars	Highway	Gasoline	2,28	1313,15	372,27	11,08	3460,04	73,00	2,77	0,85	12,23
1990	070101	Passenger cars	Highway	LPG	0,00	1151,70	187,09	10,06	3914,25	65,00	0,00	0,00	10,06
1990	070102	Passenger cars	Rural	Diesel	93,68	253,60	42,09	6,82	268,08	74,00	0,00	0,57	75,13
1990	070102	Passenger cars	Rural	Gasoline	2,28	1136,14	493,47	13,92	3985,27	73,00	3,11	0,96	14,07
1990	070102	Passenger cars	Rural	LPG	0,00	1248,46	305,18	16,91	1146,38	65,00	0,00	0,00	14,49
1990	070103	Passenger cars	Urban	Diesel	93,68	208,50	79,41	8,78	310,69	74,00	0,00	0,36	117,16
1990	070103	Passenger cars	Urban	Gasoline	2,28	630,07	914,35	48,81	9356,56	73,00	3,22	0,64	13,76
1990	070103	Passenger cars	Urban	LPG	0,00	642,80	431,03	24,31	1249,98	65,00	0,00	0,00	12,16
1990	070201	Light duty vehicles	Highway	Diesel	93,68	270,67	30,19	2,60	344,14	74,00	0,00	0,32	104,48
1990	070201	Light duty vehicles	Highway	Gasoline	2,28	1369,26	170,29	10,11	2987,40	73,00	2,63	0,81	16,17
1990	070202	Light duty vehicles	Rural	Diesel	93,68	299,25	33,22	4,26	358,42	74,00	0,00	0,36	107,73
1990	070202	Light duty vehicles	Rural	Gasoline	2,28	1188,86	262,59	15,25	2316,18	73,00	2,48	0,76	15,25
1990	070203	Light duty vehicles	Urban	Diesel	93,68	489,77	53,27	6,54	403,83	74,00	0,00	0,27	126,74
1990	070203	Light duty vehicles	Urban	Gasoline	2,28	638,11	689,36	40,67	7008,46	73,00	2,28	0,46	9,12
1990	070301	Heavy duty vehicles	Highway	Diesel	93,68	1029,48	47,87	6,11	188,44	74,00	2,86	0,29	38,21
1990	070301	Heavy duty vehicles	Highway	Gasoline	2,28	1037,78	474,61	9,69	7610,35	73,00	0,83	0,28	55,35
1990	070302	Heavy duty vehicles	Rural	Diesel	93,68	1050,89	63,23	6,84	209,56	74,00	3,01	0,30	40,60
1990	070302	Heavy duty vehicles	Rural	Gasoline	2,28	1141,55	820,40	16,74	8371,39	73,00	0,91	0,30	60,88
1990	070303	Heavy duty vehicles	Urban	Diesel	93,68	1009,50	84,32	12,48	257,98	74,00	2,45	0,24	47,07
1990	070303	Heavy duty vehicles	Urban	Gasoline	2,28	456,62	696,09	14,21	7102,99	73,00	0,61	0,20	40,59
1990	070400	Mopeds	Urban	Gasoline	2,28	18,26	12503,20	200,00	12602,74	73,00	0,91	0,91	171,69
1990	070501	Motorcycles	Highway	Gasoline	2,28	215,28	1274,65	122,02	17695,34	73,00	1,27	1,27	29,79
1990	070502	Motorcycles	Rural	Gasoline	2,28	173,21	1528,99	146,11	16838,71	73,00	1,52	1,52	35,67
1990	070503	Motorcycles	Urban	Gasoline	2,28	93,24	2017,69	147,20	15315,93	73,00	1,53	1,53	35,94
1990	080100	Military		Diesel	93,68	790,81	60,12	7,64	264,47	74,00	1,82	0,30	65,87
1990	080100	Military		Jet fuel	22,99	250,57	24,94	2,65	229,89	72,00	2,30	0,00	1,16
1990	080100	Military		Gasoline	2,28	890,75	1175,82	32,66	6684,91	73,00	3,08	0,78	14,48
1990	080100	Military		AvGas	22,83	859,00	1242,60	21,90	6972,00	73,00	2,00	1,60	10,00
1990	080200	Railways		Diesel	93,68	1225,13	79,94	3,07	223,21	74,00	2,04	0,20	50,26
1990	080200	Railways		Kerosene	5,00	50,00	3,00	7,00	20,00	72,00	2,00	0,00	121,95
1990	080300	Inland waterways		Diesel	93,68	983,64	171,79	2,79	453,65	74,00	2,96	0,17	106,93
1990	080300	Inland waterways		Gasoline	2,28	291,33	3606,55	50,38	13853,27	73,00	0,78	0,08	182,44

1990	080402	National sea traffic		Residual oil	1290,95	1601,17	53,33	1,65	175,95	78,00	4,89	0,00	149,25
1990	080402	National sea traffic		Diesel	93,68	1100,31	50,67	1,57	167,17	74,00	4,68	0,00	23,21
1990	080402	National sea traffic		Kerosene	2,30	50,00	3,00	7,00	20,00	72,00	0,00	0,00	5,00
1990	080402	National sea traffic		LPG	0,00	1249,00	384,94	20,26	443,00	65,00	0,00	0,00	0,20
1990	080403	Fishing		Diesel	93,68	1052,12	49,13	1,52	162,08	74,00	4,68	0,00	23,21
1990	080403	Fishing		Kerosene	2,30	50,00	3,00	7,00	20,00	72,00	0,00	0,00	5,00
1990	080403	Fishing		LPG	0,00	1249,00	384,94	20,26	443,00	65,00	0,00	0,00	0,20
1990	080404	International sea traffic		Residual oil	1447,43	1689,57	53,98	1,67	178,09	78,00	4,89	0,00	189,43
1990	080404	International sea traffic		Diesel	93,68	1208,60	49,46	1,53	163,17	74,00	4,68	0,00	23,21
1990	080501	Air traffic, Dom. < 3000 ft.	Other airports	Jet fuel	22,99	314,51	14,93	1,59	90,41	72,00	5,70	0,00	1,16
1990	080501	Air traffic, Dom. < 3000 ft.	Other airports	AvGas	22,83	859,00	1242,60	21,90	6972,00	73,00	2,00	1,60	10,00
1990	080502	Air traffic, Int. < 3000 ft.	Other airports	Jet fuel	22,99	309,25	16,47	1,75	168,98	72,00	7,10	0,00	1,16
1990	080502	Air traffic, Int. < 3000 ft.	Other airports	AvGas	22,83	859,00	1242,60	21,90	6972,00	73,00	2,00	1,60	10,00
1990	080503	Air traffic, Dom. > 3000 ft.	Other airports	Jet fuel	22,99	330,11	12,36	1,31	90,75	72,00	2,30	0,00	1,16
1990	080504	Air traffic, Int. > 3000 ft.	Other airports	Jet fuel	22,99	244,20	6,48	0,69	54,10	72,00	2,30	0,00	1,16
1990	080600	Agriculture		Diesel	93,68	758,87	156,85	2,55	635,53	74,00	2,93	0,17	144,45
1990	080600	Agriculture		Gasoline	2,28	31,60	949,55	88,42	47524,17	73,00	1,28	0,09	6,56
1990	080700	Forestry		Diesel	93,68	857,48	156,47	2,54	645,65	74,00	2,97	0,17	149,05
1990	080700	Forestry		Gasoline	2,28	40,39	7206,91	60,42	18057,40	73,00	0,37	0,07	101,22
1990	080800	Industry		Diesel	93,68	933,58	178,23	2,90	655,80	74,00	2,94	0,17	154,50
1990	080800	Industry		Gasoline	2,28	136,27	1610,77	120,61	14797,46	73,00	1,33	0,09	12,40
1990	080800	Industry		LPG	0,00	1328,11	146,09	7,69	104,85	65,00	3,50	0,21	4,89
1990	080900	Household and gardening		Gasoline	2,28	67,15	2656,60	96,95	30931,24	73,00	1,11	0,08	22,88
1990	080501	Air traffic, Dom. < 3000 ft.	Copenhagen	Jet fuel	22,99	283,87	20,73	2,20	129,70	72,00	4,58	0,00	1,16
1990	080501	Air traffic, Dom. < 3000 ft.	Copenhagen	AvGas	22,83	859,00	1242,60	21,90	6972,00	73,00	2,00	1,60	10,00
1990	080502	Air traffic, Int. < 3000 ft.	Copenhagen	Jet fuel	22,99	324,87	34,25	3,64	157,15	72,00	3,79	0,00	1,16
1990	080502	Air traffic, Int. < 3000 ft.	Copenhagen	AvGas	22,83	859,00	1242,60	21,90	6972,00	73,00	2,00	1,60	10,00
1990	080503	Air traffic, Dom. > 3000 ft.	Copenhagen	Jet fuel	22,99	314,86	11,78	1,25	84,05	72,00	2,30	0,00	1,16
1990	080504	Air traffic, Int. > 3000 ft.	Copenhagen	Jet fuel	22,99	290,20	10,08	1,07	37,65	72,00	2,30	0,00	1,16

2008 emission factors for CO_2, CH_4, N_2O, SO_2, NO_x; NMVOC, NH_3 and TSP.

Year	SNAP ID	Category		Fuel type	SO_2	NO_x	NMVOC	CH_4	CO	CO_2	N_2O	NH_3	TSP
					g pr GJ	g pr GJ	g pr GJ	g pr GJ	g pr GJ	g pr GJ	g pr GJ	g pr GJ	g pr GJ
2008	070101	Passenger cars	Highway	Diesel	0,47	302,40	7,32	0,45	28,01	73,99	1,93	0,49	22,84
2008	070101	Passenger cars	Highway	Gasoline	0,46	174,91	41,80	3,24	791,07	72,79	0,75	29,46	1,27
2008	070101	Passenger cars	Highway	LPG	0,00	1151,70	187,09	10,06	3914,25	65,00	0,00	0,00	10,06
2008	070102	Passenger cars	Rural	Diesel	0,47	258,76	10,42	0,93	43,68	73,99	2,08	0,52	18,89
2008	070102	Passenger cars	Rural	Gasoline	0,46	143,76	48,85	3,70	643,60	72,79	1,30	31,60	1,25
2008	070102	Passenger cars	Rural	LPG	0,00	1248,46	305,18	16,91	1146,38	65,00	0,00	0,00	14,49
2008	070103	Passenger cars	Urban	Diesel	0,47	257,64	29,19	1,52	97,20	73,99	3,99	0,39	30,93
2008	070103	Passenger cars	Urban	Gasoline	0,46	143,62	232,30	10,85	2602,34	72,79	2,32	10,51	1,31
2008	070103	Passenger cars	Urban	LPG	0,00	613,63	451,14	23,33	1361,56	65,00	0,00	0,00	11,66
2008	070201	Light duty vehicles	Highway	Diesel	0,47	265,54	25,42	0,53	150,05	73,99	1,48	0,36	30,78
2008	070201	Light duty vehicles	Highway	Gasoline	0,46	165,58	19,58	2,68	549,69	72,79	1,46	22,64	1,48
2008	070202	Light duty vehicles	Rural	Diesel	0,47	278,53	28,50	1,17	132,75	73,99	1,62	0,40	26,53
2008	070202	Light duty vehicles	Rural	Gasoline	0,46	144,76	28,98	2,98	416,66	72,79	2,23	21,62	1,33
2008	070203	Light duty vehicles	Urban	Diesel	0,47	278,93	48,38	1,91	160,87	73,99	2,41	0,29	36,05
2008	070203	Light duty vehicles	Urban	Gasoline	0,46	120,86	147,59	7,09	2844,03	72,79	3,80	5,79	0,91
2008	070301	Heavy duty vehicles	Highway	Diesel	0,47	668,12	20,93	5,22	126,84	73,99	3,15	0,31	15,28
2008	070301	Heavy duty vehicles	Highway	Gasoline	0,46	1037,78	474,61	9,69	7610,35	72,79	0,83	0,28	55,35
2008	070302	Heavy duty vehicles	Rural	Diesel	0,47	691,61	25,39	5,75	131,55	73,99	3,16	0,32	15,55
2008	070302	Heavy duty vehicles	Rural	Gasoline	0,46	1141,55	820,40	16,74	8371,39	72,79	0,91	0,30	60,88
2008	070303	Heavy duty vehicles	Urban	Diesel	0,47	697,71	33,17	8,14	154,48	73,99	2,60	0,26	18,98
2008	070303	Heavy duty vehicles	Urban	Gasoline	0,46	456,62	696,09	14,21	7102,99	72,79	0,61	0,20	40,59
2008	070400	Mopeds	Urban	Gasoline	0,46	113,84	9177,91	146,85	9905,34	72,79	1,21	1,21	142,17
2008	070501	Motorcycles	Highway	Gasoline	0,46	239,44	938,89	97,21	13244,99	72,79	1,19	1,19	21,83
2008	070502	Motorcycles	Rural	Gasoline	0,46	183,54	1175,67	121,25	13028,29	72,79	1,50	1,50	27,44
2008	070503	Motorcycles	Urban	Gasoline	0,46	106,67	1594,63	126,87	12062,59	72,79	1,50	1,50	27,47
2008	080100	Military		Diesel	0,47	486,62	26,51	3,84	120,80	74,00	2,71	0,35	21,90
2008	080100	Military		Jet fuel	22,99	250,57	24,94	2,65	229,89	72,00	2,30	0,00	1,16
2008	080100	Military		Gasoline	0,46	149,10	206,88	8,94	1747,51	73,00	1,71	21,17	2,10
2008	080100	Military		AvGas	22,99	859,00	1242,60	21,90	6972,00	73,00	2,00	1,60	10,00
2008	080200	Railways		Diesel	0,47	912,90	63,95	2,46	164,49	74,00	2,04	0,20	31,64
2008	080300	Inland waterways		Diesel	93,68	851,39	164,23	2,67	446,96	74,00	2,97	0,17	100,90
2008	080300	Inland waterways		Gasoline	0,46	495,52	1576,18	60,27	14675,43	73,00	1,34	0,10	61,17
2008	080402	National sea traffic		Residual oil	586,80	1853,24	61,96	1,92	204,41	78,00	4,89	0,00	51,05
2008	080402	National sea traffic		Diesel	46,84	923,31	51,92	1,49	79,00	74,00	4,68	0,00	21,55
2008	080403	Fishing		Diesel	46,84	1365,96	56,98	1,76	187,98	74,00	4,68	0,00	21,55

2008	080403	Fishing		Kerosene	2,30	50,00	3,00	7,00	20,00	72,00	0,00	0,00	5,00
2008	080403	Fishing		LPG	0,00	1249,00	384,94	20,26	443,00	65,00	0,00	0,00	0,20
2008	080404	International sea traffic		Residual oil	733,50	2085,30	61,67	1,91	203,45	78,00	4,89	0,00	63,83
2008	080404	International sea traffic		Diesel	46,84	1547,73	56,16	1,74	185,25	74,00	4,68	0,00	21,55
2008	080501	Air traffic, Dom. < 3000 ft.	Other airports	Jet fuel	22,99	307,88	22,64	2,40	139,67	72,00	11,93	0,00	1,16
2008	080501	Air traffic, Dom. < 3000 ft.	Other airports	AvGas	22,83	859,00	1242,60	21,90	6972,00	73,00	2,00	1,60	10,00
2008	080502	Air traffic, Int. < 3000 ft.	Other airports	Jet fuel	22,99	294,41	28,63	3,04	179,88	72,00	7,97	0,00	1,16
2008	080502	Air traffic, Int. < 3000 ft.	Other airports	AvGas	22,83	859,00	1242,60	21,90	6972,00	73,00	2,00	1,60	10,00
2008	080503	Air traffic, Dom. > 3000 ft.	Other airports	Jet fuel	22,99	283,13	15,67	1,66	116,30	72,00	2,30	0,00	1,16
2008	080504	Air traffic, Int. > 3000 ft.	Other airports	Jet fuel	22,99	238,25	7,21	0,77	52,58	72,00	2,30	0,00	1,16
2008	080600	Agriculture		Diesel	2,34	659,21	66,65	1,08	365,48	74,00	3,16	0,18	51,55
2008	080600	Agriculture		Gasoline	0,46	107,65	1143,24	152,40	22029,44	73,00	1,68	1,41	29,26
2008	080700	Forestry		Diesel	2,34	510,08	38,83	0,63	261,75	74,00	3,21	0,18	29,45
2008	080700	Forestry		Gasoline	0,46	86,32	6899,22	57,62	16933,82	73,00	0,43	0,09	77,69
2008	080800	Industry		Diesel	2,34	618,51	69,85	1,14	341,87	74,00	3,10	0,18	60,74
2008	080800	Industry		Gasoline	0,46	204,01	1523,99	107,34	13519,54	73,00	1,46	0,10	15,48
2008	080800	Industry		LPG	0,00	1328,11	146,09	7,69	104,85	65,00	3,50	0,21	4,89
2008	080900	Household and gardening		Gasoline	0,46	92,92	2429,63	73,44	29136,13	73,00	1,14	0,09	24,64
2008	080501	Air traffic, Dom. < 3000 ft.	Copenhagen	Jet fuel	22,99	296,09	28,55	3,03	181,39	72,00	7,10	0,00	1,16
2008	080501	Air traffic, Dom. < 3000 ft.	Copenhagen	AvGas	22,83	859,00	1242,60	21,90	6972,00	73,00	2,00	1,60	10,00
2008	080502	Air traffic, Int. < 3000 ft.	Copenhagen	Jet fuel	22,99	338,31	42,63	4,53	239,83	72,00	3,82	0,00	1,16
2008	080502	Air traffic, Int. < 3000 ft.	Copenhagen	AvGas	22,83	859,00	1242,60	21,90	6972,00	73,00	2,00	1,60	10,00
2008	080503	Air traffic, Dom. > 3000 ft.	Copenhagen	Jet fuel	22,99	283,56	15,44	1,64	61,39	72,00	2,30	0,00	1,16
2008	080504	Air traffic, Int. > 3000 ft.	Copenhagen	Jet fuel	22,99	313,19	10,58	1,12	33,66	72,00	2,30	0,00	1,16

1990 emissions for CO_2, CH_4, N_2O, SO_2, NO_x; NMVOC, NH_3 and TSP.

Year	SNAP ID	Category		Fuel type	Fuel PJ	SO_2 tonnes	NO_x tonnes	NMVOC tonnes	CH_4 tonnes	CO tonnes	CO_2 ktonnes	N_2O tonnes	NH_3 tonnes	TSP tonnes
1990	070101	Passenger cars	Highway	Diesel	0,819	77	208	21	3	147	61	0	0	65
1990	070101	Passenger cars	Highway	Gasoline	7,544	17	9907	2808	84	26103	551	21	6	92
1990	070101	Passenger cars	Highway	LPG	0,002	0	2	0	0	6	0	0	0	0
1990	070102	Passenger cars	Rural	Diesel	2,332	218	591	98	16	625	173	0	1	175
1990	070102	Passenger cars	Rural	Gasoline	23,293	53	26465	11495	324	92831	1700	72	22	328
1990	070102	Passenger cars	Rural	LPG	0,004	0	6	1	0	5	0	0	0	0
1990	070103	Passenger cars	Urban	Diesel	3,484	326	726	277	31	1082	258	0	1	408
1990	070103	Passenger cars	Urban	Gasoline	32,220	74	20301	29461	1573	301473	2352	104	21	443
1990	070103	Passenger cars	Urban	LPG	0,007	0	4	3	0	8	0	0	0	0
1990	070201	Light duty vehicles	Highway	Diesel	1,615	151	437	49	4	556	120	0	1	169
1990	070201	Light duty vehicles	Highway	Gasoline	0,220	1	302	38	2	659	16	1	0	4
1990	070202	Light duty vehicles	Rural	Diesel	5,782	542	1730	192	25	2073	428	0	2	623
1990	070202	Light duty vehicles	Rural	Gasoline	0,916	2	1088	240	14	2121	67	2	1	14
1990	070203	Light duty vehicles	Urban	Diesel	6,750	632	3306	360	44	2726	500	0	2	856
1990	070203	Light duty vehicles	Urban	Gasoline	1,336	3	853	921	54	9364	98	3	1	12
1990	070301	Heavy duty vehicles	Highway	Diesel	9,522	892	9802	456	58	1794	705	27	3	364
1990	070301	Heavy duty vehicles	Highway	Gasoline	0,010	0	11	5	0	78	1	0	0	1
1990	070302	Heavy duty vehicles	Rural	Diesel	16,444	1540	17280	1040	112	3446	1217	49	5	668
1990	070302	Heavy duty vehicles	Rural	Gasoline	0,030	0	34	24	0	250	2	0	0	2
1990	070303	Heavy duty vehicles	Urban	Diesel	13,199	1236	13325	1113	165	3405	977	32	3	621
1990	070303	Heavy duty vehicles	Urban	Gasoline	0,035	0	16	24	0	245	3	0	0	1
1990	070400	Mopeds	Urban	Gasoline	0,287	1	5	3584	57	3613	21	0	0	49
1990	070501	Motorcycles	Highway	Gasoline	0,077	0	16	98	9	1355	6	0	0	2
1990	070502	Motorcycles	Rural	Gasoline	0,143	0	25	218	21	2406	10	0	0	5
1990	070503	Motorcycles	Urban	Gasoline	0,168	0	16	339	25	2573	12	0	0	6
1990	080100	Military		Diesel	0,146	14	116	9	1	39	11	0	0	10
1990	080100	Military		Jet fuel	1,497	34	375	37	4	344	108	3		2
1990	080100	Military		Gasoline	0,001	0	1	1	0	7	0	0	0	0
1990	080100	Military		AvGas	0,005	0	4	6	0	34	0	0	0	0
1990	080200	Railways		Diesel	4,010	376	4913	321	12	895	297	8	1	202
1990	080200	Railways		Kerosene	0,000	0	0	0	0	0	0	0		0
1990	080300	Inland waterways		Diesel	0,343	32	337	59	1	155	25	1	0	37
1990	080300	Inland waterways		Gasoline	0,309	1	90	1115	16	4283	23	0	0	56
1990	080402	National sea traffic		Residual oil	3,843	4961	6153	205	6	676	300	19		573
1990	080402	National sea traffic		Diesel	4,942	463	5438	250	8	826	366	23		115

1990	080402	National sea traffic		Kerosene	0,000	0	0	0	0	0	0	0		0
1990	080402	National sea traffic		LPG	0,002		2	1	0	1	0	0		0
1990	080403	Fishing		Diesel	7,920	742	8333	389	12	1284	586	37		184
1990	080403	Fishing		Kerosene	0,026	0	1	0	0	1	2	0		0
1990	080403	Fishing		LPG	0,042		53	16	1	19	3	0		0
1990	080404	International sea traffic		Residual oil	28,543	41315	48226	1541	48	5083	2226	140		5407
1990	080404	International sea traffic		Diesel	11,633	1090	14059	575	18	1898	861	54		270
1990	080501	Air traffic, Dom. < 3000 ft.	Other airports	Jet fuel	0,422	10	133	6	1	38	30	2		0
1990	080501	Air traffic, Dom. < 3000 ft.	Other airports	AvGas	0,105	2	90	130	2	732	8	0	0	1
1990	080502	Air traffic, Int. < 3000 ft.	Other airports	Jet fuel	0,132	3	41	2	0	22	10	1		0
1990	080502	Air traffic, Int. < 3000 ft.	Other airports	AvGas	0,031	1	26	38	1	214	2	0	0	0
1990	080503	Air traffic, Dom. > 3000 ft.	Other airports	Jet fuel	1,026	24	339	13	1	93	74	2		1
1990	080504	Air traffic, Int. > 3000 ft.	Other airports	Jet fuel	1,612	37	394	10	1	87	116	4		2
1990	080600	Agriculture		Diesel	16,496	1545	12518	2587	42	10484	1221	48	3	2383
1990	080600	Agriculture		Gasoline	0,709	2	22	673	63	33688	52	1	0	5
1990	080700	Forestry		Diesel	0,145	14	125	23	0	94	11	0	0	22
1990	080700	Forestry		Gasoline	0,341	1	14	2461	21	6165	25	0	0	35
1990	080800	Industry		Diesel	10,158	952	9484	1811	29	6662	752	30	2	1569
1990	080800	Industry		Gasoline	0,175	0	24	282	21	2593	13	0	0	2
1990	080800	Industry		LPG	1,185	0	1574	173	9	124	77	4	0	6
1990	080900	Household and gardening		Gasoline	1,545	4	104	4104	150	47787	113	2	0	35
1990	080501	Air traffic, Dom. < 3000 ft.	Copenhagen	Jet fuel	0,502	12	143	10	1	65	36	2		1
1990	080501	Air traffic, Dom. < 3000 ft.	Copenhagen	AvGas	0,009	0	7	11	0	60	1	0	0	0
1990	080502	Air traffic, Int. < 3000 ft.	Copenhagen	Jet fuel	2,001	46	650	69	7	314	144	8		2
1990	080502	Air traffic, Int. < 3000 ft.	Copenhagen	AvGas	0,006	0	5	7	0	39	0	0	0	0
1990	080503	Air traffic, Dom. > 3000 ft.	Copenhagen	Jet fuel	1,305	30	411	15	2	110	94	3		2
1990	080504	Air traffic, Int. > 3000 ft.	Copenhagen	Jet fuel	20,330	467	5900	205	22	765	1464	47		24

2008 emissions for CO_2, CH_4, N_2O, SO_2, NO_x; NMVOC, NH_3 and TSP.

Year	SNAP ID	Category		Fuel type	Fuel	SO_2	NO_x	NMVOC	CH_4	CO	CO_2	N_2O	NH_3	TSP
					PJ	tonnes	tonnes	tonnes	tonnes	tonnes	ktonnes	tonnes	tonnes	tonnes
2008	070101	Passenger cars	Highway	Diesel	4,635	2	1402	34	2	130	343	9	2	106
2008	070101	Passenger cars	Highway	Gasoline	11,495	5	2011	480	37	9093	837	9	339	15
2008	070101	Passenger cars	Highway	LPG	0,000	0	0	0	0	0	0	0	0	0
2008	070102	Passenger cars	Rural	Diesel	10,422	5	2697	109	10	455	771	22	5	197
2008	070102	Passenger cars	Rural	Gasoline	26,383	12	3793	1289	98	16980	1920	34	834	33
2008	070102	Passenger cars	Rural	LPG	0,000	0	0	0	0	0	0	0	0	0
2008	070103	Passenger cars	Urban	Diesel	10,695	5	2755	312	16	1040	791	43	4	331
2008	070103	Passenger cars	Urban	Gasoline	29,732	14	4270	6907	323	77373	2164	69	312	39
2008	070103	Passenger cars	Urban	LPG	0,000	0	0	0	0	0	0	0	0	0
2008	070201	Light duty vehicles	Highway	Diesel	3,435	2	912	87	2	515	254	5	1	106
2008	070201	Light duty vehicles	Highway	Gasoline	0,392	0	65	8	1	215	29	1	9	1
2008	070202	Light duty vehicles	Rural	Diesel	10,465	5	2915	298	12	1389	774	17	4	278
2008	070202	Light duty vehicles	Rural	Gasoline	1,383	1	200	40	4	576	101	3	30	2
2008	070203	Light duty vehicles	Urban	Diesel	10,240	5	2856	495	20	1647	758	25	3	369
2008	070203	Light duty vehicles	Urban	Gasoline	1,676	1	203	247	12	4767	122	6	10	2
2008	070301	Heavy duty vehicles	Highway	Diesel	15,748	7	10522	330	82	1998	1165	50	5	241
2008	070301	Heavy duty vehicles	Highway	Gasoline	0,014	0	15	7	0	107	1	0	0	1
2008	070302	Heavy duty vehicles	Rural	Diesel	22,894	11	15834	581	132	3012	1694	72	7	356
2008	070302	Heavy duty vehicles	Rural	Gasoline	0,029	0	33	23	0	239	2	0	0	2
2008	070303	Heavy duty vehicles	Urban	Diesel	15,111	7	10543	501	123	2334	1118	39	4	287
2008	070303	Heavy duty vehicles	Urban	Gasoline	0,029	0	13	20	0	207	2	0	0	1
2008	070400	Mopeds	Urban	Gasoline	0,180	0	20	1650	26	1780	13	0	0	26
2008	070501	Motorcycles	Highway	Gasoline	0,207	0	50	195	20	2748	15	0	0	5
2008	070502	Motorcycles	Rural	Gasoline	0,460	0	84	540	56	5989	33	1	1	13
2008	070503	Motorcycles	Urban	Gasoline	0,553	0	59	883	70	6677	40	1	1	15
2008	080100	Military		Diesel	0,630	0	307	17	2	76	47	2	0	14
2008	080100	Military		Jet fuel	0,832	19	208	21	2	191	60	2	0	1
2008	080100	Military		Gasoline	0,012	0	2	2	0	20	1	0	0	0
2008	080100	Military		AvGas	0,003	0	3	4	0	21	0	0	0	0
2008	080200	Railways		Diesel	3,199	1	2920	205	8	526	237	7	1	101
2008	080300	Inland waterways		Diesel	1,002	94	853	165	3	448	74	3	0	101
2008	080300	Inland waterways		Gasoline	0,361	0	179	569	22	5302	26	0	0	22
2008	080402	National sea traffic		Residual oil	0,628	369	1164	39	1	128	49	3		32
2008	080402	National sea traffic		Diesel	4,103	192	3789	213	6	324	304	19	0	88
2008	080403	Fishing		Diesel	6,063	284	8282	345	11	1140	449	28	0	131

2008	080403	Fishing		Kerosene	0,000	0	0	0	0	0	0	0		0
2008	080403	Fishing		LPG	0,012	0	15	5	0	5	1	0	0	0
2008	080404	International sea traffic		Residual oil	27,164	19924	56644	1675	52	5526	2119	133		1734
2008	080404	International sea traffic		Diesel	13,504	633	20901	758	23	2502	999	63		291
2008	080501	Air traffic, Dom. < 3000 ft.	Other airports	Jet fuel	0,221	5	68	5	1	31	16	3		0
2008	080501	Air traffic, Dom. < 3000 ft.	Other airports	AvGas	0,087	2	75	108	2	605	6	0	0	1
2008	080502	Air traffic, Int. < 3000 ft.	Other airports	Jet fuel	0,303	7	89	9	1	55	22	2		0
2008	080502	Air traffic, Int. < 3000 ft.	Other airports	AvGas	0,007	0	6	9	0	51	1	0	0	0
2008	080503	Air traffic, Dom. > 3000 ft.	Other airports	Jet fuel	0,605	14	171	9	1	70	44	1		1
2008	080504	Air traffic, Int. > 3000 ft.	Other airports	Jet fuel	3,529	81	841	25	3	186	254	8		4
2008	080600	Agriculture		Diesel	16,246	38	10710	1083	18	5938	1202	51	3	837
2008	080600	Agriculture		Gasoline	0,382	0	41	437	58	8422	28	1	1	11
2008	080700	Forestry		Diesel	0,159	0	81	6	0	42	12	1	0	5
2008	080700	Forestry		Gasoline	0,074	0	6	512	4	1256	5	0	0	6
2008	080800	Industry		Diesel	14,049	33	8689	981	16	4803	1040	43	2	853
2008	080800	Industry		Gasoline	0,159	0	32	242	17	2149	12	0	0	2
2008	080800	Industry		LPG	1,037	0	1378	152	8	109	67	4	0	5
2008	080900	Household and gardening		Gasoline	3,274	1	304	7954	240	95382	239	4	0	81
2008	080501	Air traffic, Dom. < 3000 ft.	Copenhagen	Jet fuel	0,277	6	82	8	1	50	20	2		0
2008	080501	Air traffic, Dom. < 3000 ft.	Copenhagen	AvGas	0,001	0	1	1	0	5	0	0	0	0
2008	080502	Air traffic, Int. < 3000 ft.	Copenhagen	Jet fuel	2,905	67	983	124	13	697	209	11	0	3
2008	080502	Air traffic, Int. < 3000 ft.	Copenhagen	AvGas	0,001	0	1	1	0	7	0	0	0	0
2008	080503	Air traffic, Dom. > 3000 ft.	Copenhagen	Jet fuel	1,084	25	307	17	2	67	78	2	0	1
2008	080504	Air traffic, Int. > 3000 ft.	Copenhagen	Jet fuel	29,948	688	9379	317	34	1008	2156	69	0	35

Non-exhaust emission factors, activity data and total non-exhaust emissions of TSP, PM_{10} and $PM_{2.5}$ in 2008.

Year	Source	Category	Mileage kmkveh	TSP mg pr km	PM_{10} mg pr km	$PM_{2.5}$ mg pr km	TSP tonnes	PM_{10} tonnes	$PM_{2.5}$ tonnes
2008	Brake wear	1	38696576	7.6	7.5	3.0	295	289	115
2008	Brake wear	2	9249795	13.7	13.4	5.3	127	124	49
2008	Brake wear	3	4463993	34.5	33.9	13.5	154	151	60
2008	Brake wear	4	917786	47.4	46.4	18.5	43	43	17
2008	Brake wear	5	217400	6.2	6.1	2.4	1	1	1
2008	Brake wear	6	884995	4.2	4.2	1.7	4	4	1
2008	Road abrasion	1	38696576	15.0	7.5	4.1	580	290	157
2008	Road abrasion	2	9249795	15.0	7.5	4.1	139	69	37
2008	Road abrasion	3	4463993	76.0	38.0	20.5	339	170	92
2008	Road abrasion	4	917786	76.0	38.0	20.5	70	35	19
2008	Road abrasion	5	217400	6.0	3.0	1.6	1	1	0
2008	Road abrasion	6	884995	6.0	3.0	1.6	5	3	1
2008	Tyre wear	1	38696576	12.4	7.5	5.2	482	289	202
2008	Tyre wear	2	9249795	20.5	12.3	8.6	189	114	79
2008	Tyre wear	3	4463993	62.9	37.8	26.4	281	169	118
2008	Tyre wear	4	917786	29.4	17.7	12.4	27	16	11
2008	Tyre wear	5	217400	6.4	3.8	2.7	1	1	1
2008	Tyre wear	6	884995	5.6	3.3	2.3	5	3	2
2008	Total	1	38696576	35.1	22.4	12.2	1357	868	474
2008	Total	2	9249795	49.1	33.2	18.0	455	307	166
2008	Total	3	4463993	173.5	109.6	60.4	774	489	270
2008	Total	4	917786	152.8	102.1	51.4	140	94	47
2008	Total	5	217400	18.6	12.9	6.7	4	3	1
2008	Total	6	884995	15.8	10.5	5.6	14	9	5

Heavy metal emission factors for 1990 and 2008 in CollectER format.

Year	SNAP ID	Category		Fuel type	Arsenic	Cadmium	Chromium	Copper	Mercury	Nickel	Lead	Selenium	Zinc
					mg pr GJ	mg pr GJ	mg pr GJ	mg pr GJ	mg pr GJ	mg pr GJ	mg pr GJ	mg pr GJ	mg pr GJ
1990	070101	Passenger cars	Highway	Diesel	0,000	0,234	1,171	39,812	0,000	1,639	0,000	0,234	23,419
1990	070101	Passenger cars	Highway	Gasoline	0,000	0,225	1,125	38,263	0,000	1,575	1471,201	0,225	22,508
1990	070101	Passenger cars	Highway	LPG	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
1990	070102	Passenger cars	Rural	Diesel	0,000	0,234	1,171	39,812	0,000	1,639	0,000	0,234	23,419
1990	070102	Passenger cars	Rural	Gasoline	0,000	0,225	1,124	38,207	0,000	1,573	1471,201	0,225	22,475
1990	070102	Passenger cars	Rural	LPG	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
1990	070103	Passenger cars	Urban	Diesel	0,000	0,234	1,171	39,812	0,000	1,639	0,000	0,234	23,419
1990	070103	Passenger cars	Urban	Gasoline	0,000	0,226	1,129	38,405	0,000	1,581	1471,201	0,226	22,591
1990	070103	Passenger cars	Urban	LPG	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
1990	070201	Light duty vehicles	Highway	Diesel	0,000	0,234	1,171	39,812	0,000	1,639	0,000	0,234	23,419
1990	070201	Light duty vehicles	Highway	Gasoline	0,000	0,297	1,486	50,529	0,000	2,081	1471,201	0,297	29,723
1990	070202	Light duty vehicles	Rural	Diesel	0,000	0,234	1,171	39,812	0,000	1,639	0,000	0,234	23,419
1990	070202	Light duty vehicles	Rural	Gasoline	0,000	0,297	1,486	50,529	0,000	2,081	1471,201	0,297	29,723
1990	070203	Light duty vehicles	Urban	Diesel	0,000	0,234	1,171	39,812	0,000	1,639	0,000	0,234	23,419
1990	070203	Light duty vehicles	Urban	Gasoline	0,000	0,297	1,486	50,529	0,000	2,081	1471,201	0,297	29,723
1990	070301	Heavy duty vehicles	Highway	Diesel	0,000	0,234	1,171	39,812	0,000	1,639	0,000	0,234	23,419
1990	070301	Heavy duty vehicles	Highway	Gasoline	0,000	0,297	1,486	50,529	0,000	2,081	1471,201	0,297	29,723
1990	070302	Heavy duty vehicles	Rural	Diesel	0,000	0,234	1,171	39,812	0,000	1,639	0,000	0,234	23,419
1990	070302	Heavy duty vehicles	Rural	Gasoline	0,000	0,297	1,486	50,529	0,000	2,081	1471,201	0,297	29,723
1990	070303	Heavy duty vehicles	Urban	Diesel	0,000	0,234	1,171	39,812	0,000	1,639	0,000	0,234	23,419
1990	070303	Heavy duty vehicles	Urban	Gasoline	0,000	0,297	1,486	50,529	0,000	2,081	1471,201	0,297	29,723
1990	070400	Mopeds	Urban	Gasoline	0,000	0,297	1,486	50,529	0,000	2,081	1471,201	0,297	29,723
1990	070501	Motorcycles	Highway	Gasoline	0,000	0,297	1,486	50,529	0,000	2,081	1471,201	0,297	29,723
1990	070502	Motorcycles	Rural	Gasoline	0,000	0,297	1,486	50,529	0,000	2,081	1471,201	0,297	29,723
1990	070503	Motorcycles	Urban	Gasoline	0,000	0,297	1,486	50,529	0,000	2,081	1471,201	0,297	29,723
1990	080100	Military		Diesel	0,000	0,234	1,171	39,813	0,000	1,639	0,000	0,234	23,419
1990	080100	Military		Jet fuel	0,000	0,228	1,142	38,813	0,000	1,598	0,000	0,228	22,831
1990	080100	Military		Gasoline	0,000	0,228	1,142	38,813	0,000	1,598	1471,201	0,228	22,831
1990	080100	Military		AvGas	0,000	0,228	1,142	38,813	0,000	1,598	12785,388	0,228	22,831
1990	080200	Railways		Diesel	0,000	0,234	1,171	39,813	0,000	1,639	0,000	0,234	23,419
1990	080200	Railways		Kerosene	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
1990	080300	Inland waterways		Diesel	0,000	0,234	1,171	39,813	0,000	1,639	0,000	0,234	23,419
1990	080300	Inland waterways		Gasoline	0,000	0,228	1,142	38,813	0,000	1,598	1471,201	0,228	22,831
1990	080402	National sea traffic		Residual oil	12,225	0,733	4,890	12,225	0,490	733,496	4,890	9,780	22,005
1990	080402	National sea traffic		Diesel	1,171	0,234	0,937	1,171	1,170	1,639	2,340	4,684	11,710

1990	080402	National sea traffic		Kerosene	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
1990	080402	National sea traffic		LPG	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
1990	080403	Fishing		Diesel	1,171	0,234	0,937	1,171	1,170	1,639	2,340	4,684	11,710
1990	080403	Fishing		Kerosene	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
1990	080403	Fishing		LPG	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
1990	080404	International sea traffic		Residual oil	12,225	0,733	4,890	12,225	0,490	733,496	4,890	9,780	22,005
1990	080404	International sea traffic		Diesel	1,171	0,234	0,937	1,171	1,170	1,639	2,340	4,684	11,710
1990	080501	Air traffic, Dom. < 3000 ft.	Other airports	Jet fuel	0,000	0,228	1,142	38,813	0,000	1,598	0,000	0,228	22,831
1990	080501	Air traffic, Dom. < 3000 ft.	Other airports	AvGas	0,000	0,228	1,142	38,813	0,000	1,598	13505,692	0,228	22,831
1990	080502	Air traffic, Int. < 3000 ft.	Other airports	Jet fuel	0,000	0,228	1,142	38,813	0,000	1,598	0,000	0,228	22,831
1990	080502	Air traffic, Int. < 3000 ft.	Other airports	AvGas	0,000	0,228	1,142	38,813	0,000	1,598	13505,692	0,228	22,831
1990	080503	Air traffic, Dom. > 3000 ft.	Other airports	Jet fuel	0,000	0,228	1,142	38,813	0,000	1,598	0,000	0,228	22,831
1990	080504	Air traffic, Int. > 3000 ft.	Other airports	Jet fuel	0,000	0,228	1,142	38,813	0,000	1,598	0,000	0,228	22,831
1990	080600	Agriculture		Diesel	0,000	0,234	1,171	39,813	0,000	1,639	0,000	0,234	23,419
1990	080600	Agriculture		Gasoline	0,000	0,228	1,142	38,813	0,000	1,598	1471,201	0,228	22,831
1990	080700	Forestry		Diesel	0,000	0,234	1,171	39,813	0,000	1,639	0,000	0,234	23,419
1990	080700	Forestry		Gasoline	0,000	0,228	1,142	38,813	0,000	1,598	1471,201	0,228	22,831
1990	080800	Industry		Diesel	0,000	0,234	1,171	39,813	0,000	1,639	0,000	0,234	23,419
1990	080800	Industry		Gasoline	0,000	0,228	1,142	38,813	0,000	1,598	1471,201	0,228	22,831
1990	080800	Industry		LPG	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
1990	080900	Household and gardening		Gasoline	0,000	0,228	1,142	38,813	0,000	1,598	1471,201	0,228	22,831
1990	080501	Air traffic, Dom. < 3000 ft.	Copenhagen	Jet fuel	0,000	0,228	1,142	38,813	0,000	1,598	0,000	0,228	22,831
1990	080501	Air traffic, Dom. < 3000 ft.	Copenhagen	AvGas	0,000	0,228	1,142	38,813	0,000	1,598	13505,692	0,228	22,831
1990	080502	Air traffic, Int. < 3000 ft.	Copenhagen	Jet fuel	0,000	0,228	1,142	38,813	0,000	1,598	0,000	0,228	22,831
1990	080502	Air traffic, Int. < 3000 ft.	Copenhagen	AvGas	0,000	0,228	1,142	38,813	0,000	1,598	13505,692	0,228	22,831
1990	080503	Air traffic, Dom. > 3000 ft.	Copenhagen	Jet fuel	0,000	0,228	1,142	38,813	0,000	1,598	0,000	0,228	22,831
1990	080504	Air traffic, Int. > 3000 ft.	Copenhagen	Jet fuel	0,000	0,228	1,142	38,813	0,000	1,598	0,000	0,228	22,831

Continued

Year	SNAP ID	Category		Fuel type	Arsenic	Cadmium	Chromium	Copper	Mercury	Nickel	Lead	Selenium	Zinc
					mg pr GJ	mg pr GJ	mg pr GJ	mg pr GJ	mg pr GJ	mg pr GJ	mg pr GJ	mg pr GJ	mg pr GJ
2008	070101	Passenger cars	Highway	Diesel	0,000	0,234	1,171	39,813	0,000	1,639	0,000	0,234	23,419
2008	070101	Passenger cars	Highway	Gasoline	0,000	0,228	1,142	38,813	0,000	1,598	0,685	0,228	22,831
2008	070101	Passenger cars	Highway	LPG	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
2008	070102	Passenger cars	Rural	Diesel	0,000	0,234	1,171	39,813	0,000	1,639	0,000	0,234	23,419
2008	070102	Passenger cars	Rural	Gasoline	0,000	0,228	1,142	38,813	0,000	1,598	0,685	0,228	22,831
2008	070102	Passenger cars	Rural	LPG	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
2008	070103	Passenger cars	Urban	Diesel	0,000	0,234	1,171	39,813	0,000	1,639	0,000	0,234	23,419

2008	070103	Passenger cars	Urban	Gasoline	0,000	0,228	1,142	38,813	0,000	1,598	0,685	0,228	22,831
2008	070103	Passenger cars	Urban	LPG	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
2008	070201	Light duty vehicles	Highway	Diesel	0,000	0,234	1,171	39,813	0,000	1,639	0,000	0,234	23,419
2008	070201	Light duty vehicles	Highway	Gasoline	0,000	0,228	1,142	38,813	0,000	1,598	0,685	0,228	22,831
2008	070202	Light duty vehicles	Rural	Diesel	0,000	0,234	1,171	39,813	0,000	1,639	0,000	0,234	23,419
2008	070202	Light duty vehicles	Rural	Gasoline	0,000	0,228	1,142	38,813	0,000	1,598	0,685	0,228	22,831
2008	070203	Light duty vehicles	Urban	Diesel	0,000	0,234	1,171	39,813	0,000	1,639	0,000	0,234	23,419
2008	070203	Light duty vehicles	Urban	Gasoline	0,000	0,228	1,142	38,813	0,000	1,598	0,685	0,228	22,831
2008	070301	Heavy duty vehicles	Highway	Diesel	0,000	0,234	1,171	39,813	0,000	1,639	0,000	0,234	23,419
2008	070301	Heavy duty vehicles	Highway	Gasoline	0,000	0,228	1,142	38,813	0,000	1,598	0,685	0,228	22,831
2008	070302	Heavy duty vehicles	Rural	Diesel	0,000	0,234	1,171	39,813	0,000	1,639	0,000	0,234	23,419
2008	070302	Heavy duty vehicles	Rural	Gasoline	0,000	0,228	1,142	38,813	0,000	1,598	0,685	0,228	22,831
2008	070303	Heavy duty vehicles	Urban	Diesel	0,000	0,234	1,171	39,813	0,000	1,639	0,000	0,234	23,419
2008	070303	Heavy duty vehicles	Urban	Gasoline	0,000	0,228	1,142	38,813	0,000	1,598	0,685	0,228	22,831
2008	070400	Mopeds	Urban	Gasoline	0,000	0,228	1,142	38,813	0,000	1,598	0,685	0,228	22,831
2008	070501	Motorcycles	Highway	Gasoline	0,000	0,228	1,142	38,813	0,000	1,598	0,685	0,228	22,831
2008	070502	Motorcycles	Rural	Gasoline	0,000	0,228	1,142	38,813	0,000	1,598	0,685	0,228	22,831
2008	070503	Motorcycles	Urban	Gasoline	0,000	0,228	1,142	38,813	0,000	1,598	0,685	0,228	22,831
2008	080100	Military		Diesel	0,000	0,230	1,170	39,810	0,000	1,640	0,000	0,230	23,420
2008	080100	Military		Jet fuel	0,000	0,230	1,140	38,810	0,000	1,600	0,000	0,230	22,830
2008	080100	Military		Gasoline	0,000	0,230	1,140	38,810	0,000	1,600	0,680	0,230	22,830
2008	080100	Military		AvGas	0,000	0,230	1,140	38,810	0,000	1,600	12785,390	0,230	22,830
2008	080200	Railways		Diesel	0,000	0,230	1,170	39,810	0,000	1,640	0,000	0,230	23,420
2008	080300	Inland waterways		Diesel	0,000	0,230	1,170	39,810	0,000	1,640	0,000	0,230	23,420
2008	080300	Inland waterways		Gasoline	0,000	0,230	1,140	38,810	0,000	1,600	0,685	0,230	22,830
2008	080402	National sea traffic		Residual oil	12,220	0,730	4,890	12,220	0,490	733,500	4,890	9,780	22,000
2008	080402	National sea traffic		Diesel	1,170	0,230	0,940	1,170	1,170	1,640	2,340	4,680	11,710
2008	080403	Fishing		Diesel	1,170	0,230	0,940	1,170	1,170	1,640	2,340	4,680	11,710
2008	080403	Fishing		Kerosene	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
2008	080403	Fishing		LPG	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
2008	080404	International sea traffic		Residual oil	12,220	0,730	4,890	12,220	0,490	733,500	4,890	9,780	22,000
2008	080404	International sea traffic		Diesel	1,170	0,230	0,940	1,170	1,170	1,640	2,340	4,680	11,710
2008	080501	Air traffic, Dom. < 3000 ft.	Other airports	Jet fuel	0,000	0,230	1,140	38,810	0,000	1,600	0,000	0,230	22,830
2008	080501	Air traffic, Dom. < 3000 ft.	Other airports	AvGas	0,000	0,230	1,140	38,810	0,000	1,600	13505,692	0,230	22,830
2008	080502	Air traffic, Int. < 3000 ft.	Other airports	Jet fuel	0,000	0,230	1,140	38,810	0,000	1,600	0,000	0,230	22,830

2008	080502	Air traffic, Int. < 3000 ft.	Other airports	AvGas	0,000	0,230	1,140	38,810	0,000	1,600	13505,692	0,230	22,830
2008	080503	Air traffic, Dom. > 3000 ft.	Other airports	Jet fuel	0,000	0,230	1,140	38,810	0,000	1,600	0,000	0,230	22,830
2008	080504	Air traffic, Int. > 3000 ft.	Other airports	Jet fuel	0,000	0,230	1,140	38,810	0,000	1,600	0,000	0,230	22,830
2008	080600	Agriculture		Diesel	0,000	0,230	1,170	39,810	0,000	1,640	0,000	0,230	23,420
2008	080600	Agriculture		Gasoline	0,000	0,230	1,140	38,810	0,000	1,600	0,685	0,230	22,830
2008	080700	Forestry		Diesel	0,000	0,230	1,170	39,810	0,000	1,640	0,000	0,230	23,420
2008	080700	Forestry		Gasoline	0,000	0,230	1,140	38,810	0,000	1,600	0,685	0,230	22,830
2008	080800	Industry		Diesel	0,000	0,230	1,170	39,810	0,000	1,640	0,000	0,230	23,420
2008	080800	Industry		Gasoline	0,000	0,230	1,140	38,810	0,000	1,600	0,685	0,230	22,830
2008	080800	Industry		LPG	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
2008	080900	Household and gardening		Gasoline	0,000	0,230	1,140	38,810	0,000	1,600	0,685	0,230	22,830
2008	080501	Air traffic, Dom. < 3000 ft.	Copenhagen	Jet fuel	0,000	0,228	1,142	38,813	0,000	1,598	0,000	0,228	22,831
2008	080501	Air traffic, Dom. < 3000 ft.	Copenhagen	AvGas	0,000	0,228	1,142	38,813	0,000	1,598	13505,692	0,228	22,831
2008	080502	Air traffic, Int. < 3000 ft.	Copenhagen	Jet fuel	0,000	0,230	1,140	38,810	0,000	1,600	0,000	0,230	22,830
2008	080502	Air traffic, Int. < 3000 ft.	Copenhagen	AvGas	0,000	0,230	1,140	38,810	0,000	1,600	13505,692	0,230	22,830
2008	080503	Air traffic, Dom. > 3000 ft.	Copenhagen	Jet fuel	0,000	0,230	1,140	38,810	0,000	1,600	0,000	0,230	22,830
2008	080504	Air traffic, Int. > 3000 ft.	Copenhagen	Jet fuel	0,000	0,230	1,140	38,810	0,000	1,600	0,000	0,230	22,830

Heavy metal emissions for 1990 and 2008 in CollectER format.

Year	SNAP ID	Category		Fuel type	Arsenic	Cadmium	Chromium	Copper	Mercury	Nickel	Lead	Selenium	Zinc
					kg	kg	kg	kg	kg	kg	kg	kg	kg
1990	070101	Passenger cars	Highway	Diesel		0	1	33		1	0	0	19
1990	070101	Passenger cars	Highway	Gasoline		2	8	289		12	11099	2	170
1990	070101	Passenger cars	Highway	LPG		0	0	0		0	0	0	0
1990	070102	Passenger cars	Rural	Diesel		1	3	93		4	0	1	55
1990	070102	Passenger cars	Rural	Gasoline		5	26	890		37	34269	5	524
1990	070102	Passenger cars	Rural	LPG		0	0	0		0	0	0	0
1990	070103	Passenger cars	Urban	Diesel		1	4	139		6	0	1	82
1990	070103	Passenger cars	Urban	Gasoline		7	36	1237		51	47403	7	728
1990	070103	Passenger cars	Urban	LPG		0	0	0		0	0	0	0
1990	070201	Light duty vehicles	Highway	Diesel		0	2	64		3	0	0	38
1990	070201	Light duty vehicles	Highway	Gasoline		0	0	11		0	324	0	7
1990	070202	Light duty vehicles	Rural	Diesel		1	7	230		9	0	1	135
1990	070202	Light duty vehicles	Rural	Gasoline		0	1	46		2	1347	0	27
1990	070203	Light duty vehicles	Urban	Diesel		2	8	269		11	0	2	158

1990	070203	Light duty vehicles	Urban	Gasoline		0	2	68		3	1966	0	40
1990	070301	Heavy duty vehicles	Highway	Diesel		2	11	379		16	0	2	223
1990	070301	Heavy duty vehicles	Highway	Gasoline		0	0	1		0	15	0	0
1990	070302	Heavy duty vehicles	Rural	Diesel		4	19	655		27	0	4	385
1990	070302	Heavy duty vehicles	Rural	Gasoline		0	0	2		0	44	0	1
1990	070303	Heavy duty vehicles	Urban	Diesel		3	15	525		22	0	3	309
1990	070303	Heavy duty vehicles	Urban	Gasoline		0	0	2		0	51	0	1
1990	070400	Mopeds	Urban	Gasoline		0	0	14		1	422	0	9
1990	070501	Motorcycles	Highway	Gasoline		0	0	4		0	113	0	2
1990	070502	Motorcycles	Rural	Gasoline		0	0	7		0	210	0	4
1990	070503	Motorcycles	Urban	Gasoline		0	0	8		0	247	0	5
1990	080100	Military		Diesel		0	0	6		0		0	3
1990	080100	Military		Jet fuel		0	2	58		2		0	34
1990	080100	Military		Gasoline		0	0	0		0	1	0	0
1990	080100	Military		AvGas		0	0	0		0	63	0	0
1990	080200	Railways		Diesel		1	5	160		7		1	94
1990	080200	Railways		Kerosene									
1990	080300	Inland waterways		Diesel		0	0	14		1		0	8
1990	080300	Inland waterways		Gasoline		0	0	12		0	455	0	7
1990	080402	National sea traffic		Residual oil	47	3	19	47	2	2818	19	38	85
1990	080402	National sea traffic		Diesel	6	1	5	6	6	8	12	23	58
1990	080402	National sea traffic		Kerosene									
1990	080402	National sea traffic		LPG									
1990	080403	Fishing		Diesel	9	2	7	9	9	13	19	37	93
1990	080403	Fishing		Kerosene									
1990	080403	Fishing		LPG									
1990	080404	International sea traffic		Residual oil	349	21	140	349	14	20936	140	279	628
1990	080404	International sea traffic		Diesel	14	3	11	14	14	19	27	54	136
1990	080501	Air traffic, Dom. < 3000 ft.	Other airports	Jet fuel		0	0	16		1		0	10
1990	080501	Air traffic, Dom. < 3000 ft.	Other airports	AvGas		0	0	4		0	1417	0	2
1990	080502	Air traffic, Int. < 3000 ft.	Other airports	Jet fuel		0	0	5		0		0	3
1990	080502	Air traffic, Int. < 3000 ft.	Other airports	AvGas		0	0	1		0	414	0	1
1990	080503	Air traffic, Dom. > 3000 ft.	Other airports	Jet fuel		0	1	40		2		0	23
1990	080504	Air traffic, Int. > 3000 ft.	Other airports	Jet fuel		0	2	63		3		0	37
1990	080600	Agriculture		Diesel		4	19	657		27		4	386
1990	080600	Agriculture		Gasoline		0	1	28		1	1043	0	16
1990	080700	Forestry		Diesel		0	0	6		0		0	3

1990	080700	Forestry		Gasoline		0	0	13		1	502	0	8
1990	080800	Industry		Diesel		2	12	404		17		2	238
1990	080800	Industry		Gasoline		0	0	7		0	258	0	4
1990	080800	Industry		LPG									
1990	080900	Household and gardening		Gasoline		0	2	60		2	2273	0	35
1990	080501	Air traffic, Dom. < 3000 ft.	Copenhagen	Jet fuel		0	1	19		1		0	11
1990	080501	Air traffic, Dom. < 3000 ft.	Copenhagen	AvGas		0	0	0		0	117	0	0
1990	080502	Air traffic, Int. < 3000 ft.	Copenhagen	Jet fuel		0	2	78		3		0	46
1990	080502	Air traffic, Int. < 3000 ft.	Copenhagen	AvGas		0	0	0		0	76	0	0
1990	080503	Air traffic, Dom. > 3000 ft.	Copenhagen	Jet fuel		0	1	51		2		0	30
1990	080504	Air traffic, Int. > 3000 ft.	Copenhagen	Jet fuel		5	23	789		32		5	464

Continued

Year	SNAP ID	Category		Fuel type	Arsenic	Cadmium	Chromium	Copper	Mercury	Nickel	Lead	Selenium	Zinc
					kg	kg	kg	kg	kg	kg	kg	kg	kg
2008	070101	Passenger cars	Highway	Diesel		1	5	185		8	0	1	109
2008	070101	Passenger cars	Highway	Gasoline		3	13	446		18	8	3	262
2008	070101	Passenger cars	Highway	LPG		0	0	0		0	0	0	0
2008	070102	Passenger cars	Rural	Diesel		2	12	415		17	0	2	244
2008	070102	Passenger cars	Rural	Gasoline		6	30	1024		42	18	6	602
2008	070102	Passenger cars	Rural	LPG		0	0	0		0	0	0	0
2008	070103	Passenger cars	Urban	Diesel		3	13	426		18	0	3	250
2008	070103	Passenger cars	Urban	Gasoline		7	34	1154		48	20	7	679
2008	070103	Passenger cars	Urban	LPG		0	0	0		0	0	0	0
2008	070201	Light duty vehicles	Highway	Diesel		1	4	137		6	0	1	80
2008	070201	Light duty vehicles	Highway	Gasoline		0	0	15		1	0	0	9
2008	070202	Light duty vehicles	Rural	Diesel		2	12	417		17	0	2	245
2008	070202	Light duty vehicles	Rural	Gasoline		0	2	54		2	1	0	32
2008	070203	Light duty vehicles	Urban	Diesel		2	12	408		17	0	2	240
2008	070203	Light duty vehicles	Urban	Gasoline		0	2	65		3	1	0	38
2008	070301	Heavy duty vehicles	Highway	Diesel		4	18	627		26	0	4	369
2008	070301	Heavy duty vehicles	Highway	Gasoline		0	0	1		0	0	0	0
2008	070302	Heavy duty vehicles	Rural	Diesel		5	27	911		38	0	5	536
2008	070302	Heavy duty vehicles	Rural	Gasoline		0	0	1		0	0	0	1
2008	070303	Heavy duty vehicles	Urban	Diesel		4	18	602		25	0	4	354
2008	070303	Heavy duty vehicles	Urban	Gasoline		0	0	1		0	0	0	1
2008	070400	Mopeds	Urban	Gasoline		0	0	7		0	0	0	4
2008	070501	Motorcycles	Highway	Gasoline		0	0	8		0	0	0	5

2008	070502	Motorcycles	Rural	Gasoline		0	1	18		1	0	0	10
2008	070503	Motorcycles	Urban	Gasoline		0	1	21		1	0	0	13
2008	080100	Military		Diesel		0	1	25		1		0	15
2008	080100	Military		Jet fuel	0	0	1	32	0	1	0	0	19
2008	080100	Military		Gasoline		0	0	0		0	0	0	0
2008	080100	Military		AvGas	0	0	0	0	0	0	39	0	0
2008	080200	Railways		Diesel		1	4	127		5		1	75
2008	080300	Inland waterways		Diesel		0	1	40		2		0	23
2008	080300	Inland waterways		Gasoline		0	0	14		1	0	0	8
2008	080402	National sea traffic		Residual oil	8	0	3	8	0	461	3	6	14
2008	080402	National sea traffic		Diesel	5	1	4	5	5	7	10	19	48
2008	080403	Fishing		Diesel	7	1	6	7	7	10	14	28	71
2008	080403	Fishing		Kerosene									
2008	080403	Fishing		LPG									
2008	080404	International sea traffic		Residual oil	332	20	133	332	13	19924	133	266	598
2008	080404	International sea traffic		Diesel	16	3	13	16	16	22	32	63	158
2008	080501	Air traffic, Dom. < 3000 ft.	Other airports	Jet fuel		0	0	9		0	0	0	5
2008	080501	Air traffic, Dom. < 3000 ft.	Other airports	AvGas		0	0	3		0	1172	0	2
2008	080502	Air traffic, Int. < 3000 ft.	Other airports	Jet fuel		0	0	12		0	0	0	7
2008	080502	Air traffic, Int. < 3000 ft.	Other airports	AvGas		0	0	0		0	99	0	0
2008	080503	Air traffic, Dom. > 3000 ft.	Other airports	Jet fuel		0	1	23		1	0	0	14
2008	080504	Air traffic, Int. > 3000 ft.	Other airports	Jet fuel		1	4	137		6	0	1	81
2008	080600	Agriculture		Diesel		4	19	647		27		4	380
2008	080600	Agriculture		Gasoline		0	0	15		1	0	0	9
2008	080700	Forestry		Diesel		0	0	6		0		0	4
2008	080700	Forestry		Gasoline		0	0	3		0	0	0	2
2008	080800	Industry		Diesel		3	16	559		23		3	329
2008	080800	Industry		Gasoline		0	0	6		0	0	0	4
2008	080800	Industry		LPG									
2008	080900	Household and gardening		Gasoline		1	4	127		5	2	1	75
2008	080501	Air traffic, Dom. < 3000 ft.	Copenhagen	Jet fuel		0	0	11		0		0	6
2008	080501	Air traffic, Dom. < 3000 ft.	Copenhagen	AvGas		0	0	0		0	9	0	0
2008	080502	Air traffic, Int. < 3000 ft.	Copenhagen	Jet fuel	0	1	3	113	0	5	0	1	66
2008	080502	Air traffic, Int. < 3000 ft.	Copenhagen	AvGas	0	0	0	0	0	0	14	0	0
2008	080503	Air traffic, Dom. > 3000 ft.	Copenhagen	Jet fuel	0	0	1	42	0	2	0	0	25
2008	080504	Air traffic, Int. > 3000 ft.	Copenhagen	Jet fuel	0	7	34	1162	0	48	0	7	684

PAH emission factors for 1990 and 2008 in CollectER format.

Year	SNAP ID	Category		Fuel type	Dioxins/	Flouranthene	Benzo(b)	Benzo(k)	Benzo(a)	Benzo(g,h,i)	indeno(1,2,3-c,d)
							Furans		flouranthene	flouranthene	pyrene
1990	070101	Passenger cars	Highway	Diesel	0,001	12,250	0,748	0,678	0,818	1,589	0,771
1990	070101	Passenger cars	Highway	Gasoline	0,013	8,503	0,553	0,425	0,468	1,105	0,425
1990	070101	Passenger cars	Highway	LPG	0,000	0,000	0,000	0,000	0,000	0,000	0,000
1990	070102	Passenger cars	Rural	Diesel	0,001	14,889	0,909	0,824	0,994	1,932	0,937
1990	070102	Passenger cars	Rural	Gasoline	0,015	9,536	0,620	0,477	0,524	1,240	0,477
1990	070102	Passenger cars	Rural	LPG	0,000	0,000	0,000	0,000	0,000	0,000	0,000
1990	070103	Passenger cars	Urban	Diesel	0,001	9,303	0,568	0,515	0,621	1,207	0,586
1990	070103	Passenger cars	Urban	Gasoline	0,010	6,423	0,417	0,321	0,353	0,835	0,321
1990	070103	Passenger cars	Urban	LPG	0,000	0,000	0,000	0,000	0,000	0,000	0,000
1990	070201	Light duty vehicles	Highway	Diesel	0,000	8,505	0,519	0,470	0,568	1,104	0,536
1990	070201	Light duty vehicles	Highway	Gasoline	0,013	8,086	0,526	0,404	0,445	1,051	0,404
1990	070202	Light duty vehicles	Rural	Diesel	0,001	9,306	0,568	0,515	0,622	1,207	0,586
1990	070202	Light duty vehicles	Rural	Gasoline	0,012	7,625	0,495	0,381	0,419	0,991	0,381
1990	070203	Light duty vehicles	Urban	Diesel	0,000	6,954	0,425	0,385	0,464	0,902	0,438
1990	070203	Light duty vehicles	Urban	Gasoline	0,007	4,558	0,296	0,228	0,251	0,592	0,228
1990	070301	Heavy duty vehicles	Highway	Diesel	0,001	2,086	0,526	0,780	0,097	0,078	0,136
1990	070301	Heavy duty vehicles	Highway	Gasoline	0,000	0,000	0,000	0,000	0,000	0,000	0,000
1990	070302	Heavy duty vehicles	Rural	Diesel	0,001	2,208	0,557	0,825	0,103	0,082	0,144
1990	070302	Heavy duty vehicles	Rural	Gasoline	0,000	0,000	0,000	0,000	0,000	0,000	0,000
1990	070303	Heavy duty vehicles	Urban	Diesel	0,001	1,788	0,451	0,668	0,083	0,067	0,117
1990	070303	Heavy duty vehicles	Urban	Gasoline	0,000	0,000	0,000	0,000	0,000	0,000	0,000
1990	070400	Mopeds	Urban	Gasoline	0,000	0,000	0,000	0,000	0,000	0,000	0,000
1990	070501	Motorcycles	Highway	Gasoline	0,020	12,673	0,824	0,634	0,697	1,647	0,634
1990	070502	Motorcycles	Rural	Gasoline	0,024	15,176	0,986	0,759	0,834	1,973	0,759
1990	070503	Motorcycles	Urban	Gasoline	0,024	15,300	0,994	0,765	0,841	1,989	0,765
1990	080100	Military		Diesel	0,001	4,391	0,571	0,568	0,290	0,550	0,290
1990	080100	Military		Jet fuel	0,000	0,000	0,000	0,000	0,000	0,000	0,000
1990	080100	Military		Gasoline	0,006	5,257	0,277	0,116	0,142	0,825	0,300
1990	080100	Military		AvGas	0,005	4,329	0,209	0,071	0,114	0,689	0,245
1990	080200	Railways		Diesel	0,001	1,366	0,348	0,389	0,057	0,049	0,089
1990	080200	Railways		Kerosene	0,000	0,000	0,000	0,000	0,000	0,000	0,000
1990	080300	Inland waterways		Diesel	0,001	4,391	0,571	0,568	0,290	0,550	0,290
1990	080300	Inland waterways		Gasoline	0,005	4,329	0,209	0,071	0,114	0,689	0,245
1990	080402	National sea traffic		Residual oil	0,013	5,190	0,270	0,050	0,020	0,070	0,030
1990	080402	National sea traffic		Diesel	0,012	7,420	0,640	0,300	0,150	1,430	1,180

1990	080402	National sea traffic		Kerosene	0,000	0,000	0,000	0,000	0,000	0,000	0,000
1990	080402	National sea traffic		LPG	0,000	0,000	0,000	0,000	0,000	0,000	0,000
1990	080403	Fishing		Diesel	0,012	7,420	0,640	0,300	0,150	1,430	1,180
1990	080403	Fishing		Kerosene	0,000	0,000	0,000	0,000	0,000	0,000	0,000
1990	080403	Fishing		LPG	0,000	0,000	0,000	0,000	0,000	0,000	0,000
1990	080404	International sea traffic		Residual oil	0,013	4,120	0,200	0,090	0,070	0,260	0,200
1990	080404	International sea traffic		Diesel	0,012	7,420	0,640	0,300	0,150	1,430	1,180
1990	080501	Air traffic, Dom. < 3000 ft.	Other airports	Jet fuel	0,000	0,000	0,000	0,000	0,000	0,000	0,000
1990	080501	Air traffic, Dom. < 3000 ft.	Other airports	AvGas	0,005	4,329	0,209	0,071	0,114	0,689	0,245
1990	080502	Air traffic, Int. < 3000 ft.	Other airports	Jet fuel	0,000	0,000	0,000	0,000	0,000	0,000	0,000
1990	080502	Air traffic, Int. < 3000 ft.	Other airports	AvGas	0,005	4,329	0,209	0,071	0,114	0,689	0,245
1990	080503	Air traffic, Dom. > 3000 ft.	Other airports	Jet fuel	0,000	0,000	0,000	0,000	0,000	0,000	0,000
1990	080504	Air traffic, Int. > 3000 ft.	Other airports	Jet fuel	0,000	0,000	0,000	0,000	0,000	0,000	0,000
1990	080600	Agriculture		Diesel	0,001	4,391	0,571	0,568	0,290	0,550	0,290
1990	080600	Agriculture		Gasoline	0,005	4,329	0,209	0,071	0,114	0,689	0,245
1990	080700	Forestry		Diesel	0,001	4,391	0,571	0,568	0,290	0,550	0,290
1990	080700	Forestry		Gasoline	0,005	4,329	0,209	0,071	0,114	0,689	0,245
1990	080800	Industry		Diesel	0,001	4,391	0,571	0,568	0,290	0,550	0,290
1990	080800	Industry		Gasoline	0,005	4,329	0,209	0,071	0,114	0,689	0,245
1990	080800	Industry		LPG	0,000	0,000	0,000	0,000	0,000	0,000	0,000
1990	080900	Household and gardening		Gasoline	0,005	4,329	0,209	0,071	0,114	0,689	0,245
1990	080501	Air traffic, Dom. < 3000 ft.	Copenhagen	Jet fuel	0,000	0,000	0,000	0,000	0,000	0,000	0,000
1990	080501	Air traffic, Dom. < 3000 ft.	Copenhagen	AvGas	0,005	4,329	0,209	0,071	0,114	0,689	0,245
1990	080502	Air traffic, Int. < 3000 ft.	Copenhagen	Jet fuel	0,000	0,000	0,000	0,000	0,000	0,000	0,000
1990	080502	Air traffic, Int. < 3000 ft.	Copenhagen	AvGas	0,005	4,329	0,209	0,071	0,114	0,689	0,245
1990	080503	Air traffic, Dom. > 3000 ft.	Copenhagen	Jet fuel	0,000	0,000	0,000	0,000	0,000	0,000	0,000
1990	080504	Air traffic, Int. > 3000 ft.	Copenhagen	Jet fuel	0,000	0,000	0,000	0,000	0,000	0,000	0,000

Continued

Year	SNAP ID	Category		Fuel type	Dioxins/	Flouranthene	Benzo(b)	Benzo(k)	Benzo(a)	Benzo(g,h,i)	indeno(1,2,3-c,d)
							Furans		flouranthene	flouranthene	pyrene
2008	070101	Passenger cars	Highway	Diesel	0,000	12,815	0,782	0,709	0,856	1,663	0,807
2008	070101	Passenger cars	Highway	Gasoline	0,001	1,373	0,220	0,257	0,214	0,439	0,304
2008	070101	Passenger cars	Highway	LPG	0,000	0,000	0,000	0,000	0,000	0,000	0,000
2008	070102	Passenger cars	Rural	Diesel	0,001	14,593	0,891	0,807	0,975	1,894	0,919
2008	070102	Passenger cars	Rural	Gasoline	0,001	1,502	0,244	0,287	0,238	0,487	0,338
2008	070102	Passenger cars	Rural	LPG	0,000	0,000	0,000	0,000	0,000	0,000	0,000
2008	070103	Passenger cars	Urban	Diesel	0,001	9,684	0,591	0,536	0,647	1,257	0,610
2008	070103	Passenger cars	Urban	Gasoline	0,001	0,895	0,137	0,160	0,134	0,275	0,188

2008	070103	Passenger cars	Urban	LPG	0,000	0,000	0,000	0,000	0,000	0,000	0,000
2008	070201	Light duty vehicles	Highway	Diesel	0,001	9,234	0,564	0,511	0,617	1,198	0,581
2008	070201	Light duty vehicles	Highway	Gasoline	0,001	1,087	0,162	0,186	0,157	0,323	0,218
2008	070202	Light duty vehicles	Rural	Diesel	0,001	10,103	0,617	0,559	0,675	1,311	0,636
2008	070202	Light duty vehicles	Rural	Gasoline	0,001	1,026	0,153	0,176	0,148	0,305	0,206
2008	070203	Light duty vehicles	Urban	Diesel	0,000	7,261	0,443	0,402	0,485	0,942	0,457
2008	070203	Light duty vehicles	Urban	Gasoline	0,000	0,593	0,088	0,102	0,085	0,176	0,119
2008	070301	Heavy duty vehicles	Highway	Diesel	0,001	2,030	0,512	0,759	0,095	0,076	0,133
2008	070301	Heavy duty vehicles	Highway	Gasoline	0,000	0,000	0,000	0,000	0,000	0,000	0,000
2008	070302	Heavy duty vehicles	Rural	Diesel	0,001	2,066	0,521	0,772	0,096	0,077	0,135
2008	070302	Heavy duty vehicles	Rural	Gasoline	0,000	0,000	0,000	0,000	0,000	0,000	0,000
2008	070303	Heavy duty vehicles	Urban	Diesel	0,001	1,676	0,423	0,626	0,078	0,063	0,110
2008	070303	Heavy duty vehicles	Urban	Gasoline	0,000	0,000	0,000	0,000	0,000	0,000	0,000
2008	070400	Mopeds	Urban	Gasoline	0,000	0,000	0,000	0,000	0,000	0,000	0,000
2008	070501	Motorcycles	Highway	Gasoline	0,020	12,799	0,832	0,640	0,704	1,664	0,640
2008	070502	Motorcycles	Rural	Gasoline	0,024	15,331	0,996	0,766	0,843	1,993	0,766
2008	070503	Motorcycles	Urban	Gasoline	0,024	15,500	1,007	0,775	0,852	2,015	0,775
2008	080100	Military		Diesel	0,001	4,350	0,510	0,496	0,256	0,464	0,264
2008	080100	Military		Jet fuel	0,000	0,000	0,000	0,000	0,000	0,000	0,000
2008	080100	Military		Gasoline	0,007	2,152	0,180	0,115	0,118	0,358	0,179
2008	080100	Military		AvGas	0,005	4,329	0,209	0,071	0,114	0,689	0,245
2008	080200	Railways		Diesel	0,001	1,411	0,360	0,402	0,059	0,051	0,092
2008	080300	Inland waterways		Diesel	0,001	4,350	0,510	0,496	0,256	0,464	0,264
2008	080300	Inland waterways		Gasoline	0,005	4,329	0,209	0,071	0,114	0,689	0,245
2008	080402	National sea traffic		Residual oil	0,013	5,190	0,270	0,050	0,020	0,070	0,030
2008	080402	National sea traffic		Diesel	0,012	7,420	0,640	0,300	0,150	1,430	1,180
2008	080403	Fishing		Diesel	0,012	7,420	0,640	0,300	0,150	1,430	1,180
2008	080403	Fishing		Kerosene	0,000	0,000	0,000	0,000	0,000	0,000	0,000
2008	080403	Fishing		LPG	0,000	0,000	0,000	0,000	0,000	0,000	0,000
2008	080404	International sea traffic		Residual oil	0,013	4,120	0,200	0,090	0,070	0,260	0,200
2008	080404	International sea traffic		Diesel	0,012	7,420	0,640	0,300	0,150	1,430	1,180
2008	080501	Air traffic, Dom. < 3000 ft.	Other airports	Jet fuel	0,000	0,000	0,000	0,000	0,000	0,000	0,000
2008	080501	Air traffic, Dom. < 3000 ft.	Other airports	AvGas	0,005	4,329	0,209	0,071	0,114	0,689	0,245
2008	080502	Air traffic, Int. < 3000 ft.	Other airports	Jet fuel	0,000	0,000	0,000	0,000	0,000	0,000	0,000
2008	080502	Air traffic, Int. < 3000 ft.	Other airports	AvGas	0,005	4,329	0,209	0,071	0,114	0,689	0,245

2008	080503	Air traffic, Dom. > 3000 ft.	Other air-ports	Jet fuel	0,000	0,000	0,000	0,000	0,000	0,000	0,000
2008	080504	Air traffic, Int. > 3000 ft.	Other air-ports	Jet fuel	0,000	0,000	0,000	0,000	0,000	0,000	0,000
2008	080600	Agriculture		Diesel	0,001	4,350	0,510	0,496	0,256	0,464	0,264
2008	080600	Agriculture		Gasoline	0,005	4,329	0,209	0,071	0,114	0,689	0,245
2008	080700	Forestry		Diesel	0,001	4,350	0,510	0,496	0,256	0,464	0,264
2008	080700	Forestry		Gasoline	0,005	4,329	0,209	0,071	0,114	0,689	0,245
2008	080800	Industry		Diesel	0,001	4,350	0,510	0,496	0,256	0,464	0,264
2008	080800	Industry		Gasoline	0,005	4,329	0,209	0,071	0,114	0,689	0,245
2008	080800	Industry		LPG	0,000	0,000	0,000	0,000	0,000	0,000	0,000
2008	080900	Household and gardening		Gasoline	0,005	4,329	0,209	0,071	0,114	0,689	0,245
2008	080501	Air traffic, Dom. < 3000 ft.	Copenhagen	Jet fuel	0,000	0,000	0,000	0,000	0,000	0,000	0,000
2008	080501	Air traffic, Dom. < 3000 ft.	Copenhagen	AvGas	0,005	4,329	0,209	0,071	0,114	0,689	0,245
2008	080502	Air traffic, Int. < 3000 ft.	Copenhagen	Jet fuel	0,000	0,000	0,000	0,000	0,000	0,000	0,000
2008	080502	Air traffic, Int. < 3000 ft.	Copenhagen	AvGas	0,005	4,329	0,209	0,071	0,114	0,689	0,245
2008	080503	Air traffic, Dom. > 3000 ft.	Copenhagen	Jet fuel	0,000	0,000	0,000	0,000	0,000	0,000	0,000
2008	080504	Air traffic, Int. > 3000 ft.	Copenhagen	Jet fuel	0,000	0,000	0,000	0,000	0,000	0,000	0,000

PAH emissions for 1990 and 2008 in CollectER format.

Year	SNAP ID	Category		Fuel type	Dioxins/ Furans	Flouranthene	Benzo(b)	Benzo(k) flouranthene	Benzo(a) flouranthene	Benzo(g,h,i)	indeno(1,2,3-c,d) pyrene
1990	070101	Passenger cars	Highway	Diesel	0	10	1	1	1	1	1
1990	070101	Passenger cars	Highway	Gasoline	0	64	4	3	4	8	3
1990	070101	Passenger cars	Highway	LPG							
1990	070102	Passenger cars	Rural	Diesel	0	35	2	2	2	5	2
1990	070102	Passenger cars	Rural	Gasoline	0	222	14	11	12	29	11
1990	070102	Passenger cars	Rural	LPG							
1990	070103	Passenger cars	Urban	Diesel	0	32	2	2	2	4	2
1990	070103	Passenger cars	Urban	Gasoline	0	207	13	10	11	27	10
1990	070103	Passenger cars	Urban	LPG							
1990	070201	Light duty vehicles	Highway	Diesel	0	14	1	1	1	2	1
1990	070201	Light duty vehicles	Highway	Gasoline	0	2	0	0	0	0	0
1990	070202	Light duty vehicles	Rural	Diesel	0	54	3	3	4	7	3
1990	070202	Light duty vehicles	Rural	Gasoline	0	7	0	0	0	1	0
1990	070203	Light duty vehicles	Urban	Diesel	0	47	3	3	3	6	3
1990	070203	Light duty vehicles	Urban	Gasoline	0	6	0	0	0	1	0

1990	070301	Heavy duty vehicles	Highway	Diesel	0	20	5	7	1	1	1
1990	070301	Heavy duty vehicles	Highway	Gasoline							
1990	070302	Heavy duty vehicles	Rural	Diesel	0	36	9	14	2	1	2
1990	070302	Heavy duty vehicles	Rural	Gasoline							
1990	070303	Heavy duty vehicles	Urban	Diesel	0	24	6	9	1	1	2
1990	070303	Heavy duty vehicles	Urban	Gasoline							
1990	070400	Mopeds	Urban	Gasoline							
1990	070501	Motorcycles	Highway	Gasoline	0	1	0	0	0	0	0
1990	070502	Motorcycles	Rural	Gasoline	0	2	0	0	0	0	0
1990	070503	Motorcycles	Urban	Gasoline	0	3	0	0	0	0	0
1990	080100	Military		Diesel	0	1	0	0	0	0	0
1990	080100	Military		Jet fuel	0	0	0	0	0	0	0
1990	080100	Military		Gasoline	0	0	0	0	0	0	0
1990	080100	Military		AvGas	0	0	0	0	0	0	0
1990	080200	Railways		Diesel	0	5	1	2	0	0	0
1990	080200	Railways		Kerosene							
1990	080300	Inland waterways		Diesel	0	2	0	0	0	0	0
1990	080300	Inland waterways		Gasoline	0	1	0	0	0	0	0
1990	080402	National sea traffic		Residual oil	0	20	1	0	0	0	0
1990	080402	National sea traffic		Diesel	0	37	3	1	1	7	6
1990	080402	National sea traffic		Kerosene							
1990	080402	National sea traffic		LPG							
1990	080403	Fishing		Diesel	0	59	5	2	1	11	9
1990	080403	Fishing		Kerosene							
1990	080403	Fishing		LPG							
1990	080404	International sea traffic		Residual oil	0	118	6	3	2	7	6
1990	080404	International sea traffic		Diesel	0	86	7	3	2	17	14
1990	080501	Air traffic, Dom. < 3000 ft.	Other air-ports	Jet fuel	0	0	0	0	0	0	0
1990	080501	Air traffic, Dom. < 3000 ft.	Other air-ports	AvGas	0	0	0	0	0	0	0
1990	080502	Air traffic, Int. < 3000 ft.	Other air-ports	Jet fuel	0	0	0	0	0	0	0
1990	080502	Air traffic, Int. < 3000 ft.	Other air-ports	AvGas	0	0	0	0	0	0	0
1990	080503	Air traffic, Dom. > 3000 ft.	Other air-ports	Jet fuel	0	0	0	0	0	0	0
1990	080504	Air traffic, Int. > 3000 ft.	Other air-ports	Jet fuel	0	0	0	0	0	0	0
1990	080600	Agriculture		Diesel	0	72	9	9	5	9	5
1990	080600	Agriculture		Gasoline	0	3	0	0	0	0	0

1990	080700	Forestry		Diesel	0	1	0	0	0	0	0
1990	080700	Forestry		Gasoline	0	1	0	0	0	0	0
1990	080800	Industry		Diesel	0	45	6	6	3	6	3
1990	080800	Industry		Gasoline	0	1	0	0	0	0	0
1990	080800	Industry		LPG							
1990	080900	Household and gardening		Gasoline	0	7	0	0	0	1	0
1990	080501	Air traffic, Dom. < 3000 ft.	Copenhagen	Jet fuel	0	0	0	0	0	0	0
1990	080501	Air traffic, Dom. < 3000 ft.	Copenhagen	AvGas	0	0	0	0	0	0	0
1990	080502	Air traffic, Int. < 3000 ft.	Copenhagen	Jet fuel	0	0	0	0	0	0	0
1990	080502	Air traffic, Int. < 3000 ft.	Copenhagen	AvGas	0	0	0	0	0	0	0
1990	080503	Air traffic, Dom. > 3000 ft.	Copenhagen	Jet fuel	0	0	0	0	0	0	0
1990	080504	Air traffic, Int. > 3000 ft.	Copenhagen	Jet fuel	0	0	0	0	0	0	0

Continued

Year	SNAP ID	Category		Fuel type	Dioxins/	Flouranthene	Benzo(b) Furans	Benzo(k)	Benzo(a) flouranthene	Benzo(g,h,i) flouranthene	indeno(1,2,3-c,d) pyrene
2008	070101	Passenger cars	Highway	Diesel	0	59	4	3	4	8	4
2008	070101	Passenger cars	Highway	Gasoline	0	16	3	3	2	5	3
2008	070101	Passenger cars	Highway	LPG							
2008	070102	Passenger cars	Rural	Diesel	0	152	9	8	10	20	10
2008	070102	Passenger cars	Rural	Gasoline	0	40	6	8	6	13	9
2008	070102	Passenger cars	Rural	LPG							
2008	070103	Passenger cars	Urban	Diesel	0	104	6	6	7	13	7
2008	070103	Passenger cars	Urban	Gasoline	0	27	4	5	4	8	6
2008	070103	Passenger cars	Urban	LPG							
2008	070201	Light duty vehicles	Highway	Diesel	0	32	2	2	2	4	2
2008	070201	Light duty vehicles	Highway	Gasoline	0	0	0	0	0	0	0
2008	070202	Light duty vehicles	Rural	Diesel	0	106	6	6	7	14	7
2008	070202	Light duty vehicles	Rural	Gasoline	0	1	0	0	0	0	0
2008	070203	Light duty vehicles	Urban	Diesel	0	74	5	4	5	10	5
2008	070203	Light duty vehicles	Urban	Gasoline	0	1	0	0	0	0	0
2008	070301	Heavy duty vehicles	Highway	Diesel	0	32	8	12	1	1	2
2008	070301	Heavy duty vehicles	Highway	Gasoline							
2008	070302	Heavy duty vehicles	Rural	Diesel	0	47	12	18	2	2	3
2008	070302	Heavy duty vehicles	Rural	Gasoline							
2008	070303	Heavy duty vehicles	Urban	Diesel	0	25	6	9	1	1	2
2008	070303	Heavy duty vehicles	Urban	Gasoline							
2008	070400	Mopeds	Urban	Gasoline							

2008	070501	Motorcycles	Highway	Gasoline	0	3	0	0	0	0	0
2008	070502	Motorcycles	Rural	Gasoline	0	7	0	0	0	1	0
2008	070503	Motorcycles	Urban	Gasoline	0	9	1	0	0	1	0
2008	080100	Military		Diesel	0	3	0	0	0	0	0
2008	080100	Military		Jet fuel	0	0	0	0	0	0	0
2008	080100	Military		Gasoline	0	0	0	0	0	0	0
2008	080100	Military		AvGas	0	0	0	0	0	0	0
2008	080200	Railways		Diesel	0	5	1	1	0	0	0
2008	080300	Inland waterways		Diesel	0	4	1	0	0	0	0
2008	080300	Inland waterways		Gasoline	0	2	0	0	0	0	0
2008	080402	National sea traffic		Residual oil	0	3	0	0	0	0	0
2008	080402	National sea traffic		Diesel	0	30	3	1	1	6	5
2008	080403	Fishing		Diesel	0	45	4	2	1	9	7
2008	080403	Fishing		Kerosene							
2008	080403	Fishing		LPG							
2008	080404	International sea traffic		Residual oil	0	112	5	2	2	7	5
2008	080404	International sea traffic		Diesel	0	100	9	4	2	19	16
2008	080501	Air traffic, Dom. < 3000 ft.	Other air-ports	Jet fuel	0	0	0	0	0	0	0
2008	080501	Air traffic, Dom. < 3000 ft.	Other air-ports	AvGas	0	0	0	0	0	0	0
2008	080502	Air traffic, Int. < 3000 ft.	Other air-ports	Jet fuel	0	0	0	0	0	0	0
2008	080502	Air traffic, Int. < 3000 ft.	Other air-ports	AvGas	0	0	0	0	0	0	0
2008	080503	Air traffic, Dom. > 3000 ft.	Other air-ports	Jet fuel	0	0	0	0	0	0	0
2008	080504	Air traffic, Int. > 3000 ft.	Other air-ports	Jet fuel	0	0	0	0	0	0	0
2008	080600	Agriculture		Diesel	0	71	8	8	4	8	4
2008	080600	Agriculture		Gasoline	0	2	0	0	0	0	0
2008	080700	Forestry		Diesel	0	1	0	0	0	0	0
2008	080700	Forestry		Gasoline	0	0	0	0	0	0	0
2008	080800	Industry		Diesel	0	61	7	7	4	7	4
2008	080800	Industry		Gasoline	0	1	0	0	0	0	0
2008	080800	Industry		LPG							
2008	080900	Household and gardening		Gasoline	0	14	1	0	0	2	1
2008	080501	Air traffic, Dom. < 3000 ft.	Copenhagen	Jet fuel	0	0	0	0	0	0	0
2008	080501	Air traffic, Dom. < 3000 ft.	Copenhagen	AvGas	0	0	0	0	0	0	0
2008	080502	Air traffic, Int. < 3000 ft.	Copenhagen	Jet fuel	0	0	0	0	0	0	0
2008	080502	Air traffic, Int. < 3000 ft.	Copenhagen	AvGas	0	0	0	0	0	0	0

2008	080503	Air traffic, Dom. > 3000 ft.	Copenhagen	Jet fuel	0	0	0	0	0	0	0
2008	080504	Air traffic, Int. > 3000 ft.	Copenhagen	Jet fuel	0	0	0	0	0	0	0

Annex 3B-15: Fuel consumption and emissions in CRF format

Fuel

IPCC ID	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Industry-Other (1A2f)	11,7	11,7	11,6	11,6	11,6	11,5	11,5	11,5	11,5	11,5	11,6	11,7	11,7	11,9	11,9
Civil Aviation (1A3a)	3,6	3,3	3,7	3,8	3,6	3,4	2,8	2,7	2,6	2,7	2,8	2,8	2,9	2,7	2,4
Road (1A3b)	111,1	117,4	117,6	118,3	119,6	126,2	131,9	134,3	136,0	142,8	144,1	146,6	149,5	152,0	154,0
Railways (1A3c)	4,9	4,9	4,4	4,6	4,2	4,0	4,1	4,3	4,5	4,1	4,1	4,1	4,0	3,3	3,1
Navigation (1A3d)	9,3	9,3	9,3	9,4	9,4	9,4	9,5	9,7	9,6	9,7	10,2	11,2	11,0	9,0	7,4
Residential (1A4b)	1,6	1,6	1,6	1,5	1,5	1,5	1,6	1,6	1,6	1,6	1,6	1,6	1,7	1,7	1,7
Ag./for./fish. (1A4c)	24,4	26,0	23,8	25,5	25,3	25,7	25,7	24,3	23,8	22,9	23,4	22,2	21,0	20,4	21,1
Military (1A5)	5,5	4,3	5,0	2,7	2,3	1,6	3,9	1,9	3,3	3,5	3,4	2,4	2,3	2,8	2,5
Navigation int. (1A3d)	17,3	20,1	29,4	37,3	38,2	40,2	36,1	37,9	56,1	63,1	66,3	63,0	57,8	58,2	54,6
Civil Aviation int. (1A3a)	19,3	20,9	22,4	24,0	25,1	24,1	22,7	23,5	23,0	25,2	25,9	27,4	27,9	30,0	31,8

Continued

IPCC ID	2000	2001	2002	2003	2004	2005	2006	2007	2008
Industry-Other (1A2f)	12,0	12,1	12,3	12,4	12,5	13,0	13,9	14,8	15,2
Civil Aviation (1A3a)	2,1	2,3	2,0	1,9	1,8	1,9	2,0	2,2	2,3
Road (1A3b)	152,5	152,8	154,5	160,6	164,8	166,1	171,3	179,5	176,2
Railways (1A3c)	3,1	2,9	2,8	3,0	2,9	3,1	3,1	3,1	3,2
Navigation (1A3d)	6,4	6,2	6,1	6,2	6,4	6,3	6,2	6,1	6,1
Residential (1A4b)	1,8	2,0	2,2	2,5	2,8	3,0	3,2	3,3	3,3
Ag./for./fish. (1A4c)	21,8	21,5	22,1	21,7	20,3	21,3	21,1	21,3	22,9
Military (1A5)	1,5	1,3	1,2	1,3	3,3	3,7	1,7	2,4	1,5
Navigation int. (1A3d)	56,0	47,3	39,1	41,2	33,5	34,5	44,7	46,2	40,7
Civil Aviation int. (1A3a)	32,6	33,1	28,6	29,7	34,0	35,8	35,9	36,8	36,7

Emissions

pol_name	IPCC ID	Unit	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
SO_2	Industry-Other (1A2f)	[tonnes]	2402	1441	1440	1438	956	952	955	957	957	959	968	244	246	249	251
SO_2	Civil Aviation (1A3a)	[tonnes]	82	77	85	86	83	77	64	62	61	63	63	65	68	62	56
SO_2	Road (1A3b)	[tonnes]	11621	7862	7847	7857	5488	5767	5903	3820	1569	1669	1682	1721	1744	1768	1088
SO_2	Railways (1A3c)	[tonnes]	1152	695	618	641	393	376	382	263	105	95	96	95	93	78	40
SO_2	Navigation (1A3d)	[tonnes]	6363	6363	6367	6127	6130	5456	4232	2822	3522	4005	4502	3458	2647	1555	1292
SO_2	Residential (1A4b)	[tonnes]	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
SO_2	Ag./for./fish. (1A4c)	[tonnes]	4766	3484	3173	3073	2269	2303	2317	2186	2150	2072	2120	978	853	856	931
SO_2	Military (1A5)	[tonnes]	408	260	193	72	70	48	206	82	76	80	80	56	54	65	47
SO_2	Navigation int. (1A3d)	[tonnes]	18333	22047	36943	48034	48337	42404	34348	31152	59669	60081	66260	62320	57078	48000	50568
SO_2	Civil Aviation int. (1A3a)	[tonnes]	444	480	515	551	578	554	521	541	530	580	596	629	642	689	731
NO_x	Industry-Other (1A2f)	[tonnes]	10903	10964	11011	11044	11065	11081	11282	11440	11558	11677	11882	12080	12248	12425	12262
NO_x	Civil Aviation (1A3a)	[tonnes]	1203	1132	1237	1252	1208	1123	920	902	900	940	958	971	998	911	815
NO_x	Road (1A3b)	[tonnes]	93160	98763	98895	99754	100981	106456	107926	107343	104946	103977	100389	97354	93597	89621	86441
NO_x	Railways (1A3c)	[tonnes]	6025	6063	5391	5589	5145	4913	4995	5284	5485	4971	5015	4977	4846	4089	3730
NO_x	Navigation (1A3d)	[tonnes]	11778	11798	11852	11902	11962	12020	11433	11104	11007	11236	11898	13043	11805	9411	6608
NO_x	Residential (1A4b)	[tonnes]	96	99	101	103	103	104	111	118	125	130	136	140	144	149	151
NO_x	Ag./for./fish. (1A4c)	[tonnes]	18159	19915	18153	20143	20342	21066	21722	20824	20763	20524	21442	21138	20176	20119	21495
NO_x	Military (1A5)	[tonnes]	2356	2032	1632	982	876	496	1875	1021	1302	1279	1778	970	1230	1428	1103
NO_x	Navigation int. (1A3d)	[tonnes]	23987	28474	43643	56580	58561	62285	55731	57636	89632	101094	106928	102221	94977	94125	91400
NO_x	Civil Aviation int. (1A3a)	[tonnes]	5663	6129	6569	7035	7313	7016	6586	6846	6702	7317	7517	7904	8058	8662	9204
NMVOC	Industry-Other (1A2f)	[tonnes]	2422	2395	2368	2339	2304	2266	2231	2191	2147	2107	2088	2095	2083	2074	1997
NMVOC	Civil Aviation (1A3a)	[tonnes]	216	213	190	198	193	186	168	164	161	191	206	194	186	169	162
NMVOC	Road (1A3b)	[tonnes]	80775	80473	79843	79356	77749	81541	82416	81482	79230	74979	70204	65927	59788	54665	48751
NMVOC	Railways (1A3c)	[tonnes]	393	396	352	365	336	321	326	345	358	324	327	325	316	267	276
NMVOC	Navigation (1A3d)	[tonnes]	1505	1505	1536	1566	1598	1630	1658	1699	1727	1761	1819	1920	1913	1817	1704
NMVOC	Residential (1A4b)	[tonnes]	4191	4166	4139	4112	4108	4104	4111	4094	4054	4070	4147	4231	4314	4395	4499
NMVOC	Ag./for./fish. (1A4c)	[tonnes]	6357	6417	6216	6284	6207	6149	5777	5298	4944	4638	4516	4208	3966	3691	3563
NMVOC	Military (1A5)	[tonnes]	595	463	172	489	313	53	165	89	124	120	151	92	105	118	108
NMVOC	Navigation int. (1A3d)	[tonnes]	880	1029	1527	1948	2003	2116	1900	1990	2993	3378	3560	3398	3138	3158	3003
NMVOC	Civil Aviation int. (1A3a)	[tonnes]	261	288	313	342	361	331	309	316	309	308	343	360	365	386	395
CH_4	Industry-Other (1A2f)	[tonnes]	63	63	62	61	61	60	58	57	56	54	53	53	53	53	51
CH_4	Civil Aviation (1A3a)	[tonnes]	8	8	8	8	8	7	6	6	6	7	7	7	7	7	6
CH_4	Road (1A3b)	[tonnes]	2381	2439	2453	2484	2475	2623	2662	2631	2596	2506	2374	2268	2179	2093	1983
CH_4	Railways (1A3c)	[tonnes]	15	15	14	14	13	12	13	13	14	12	13	12	12	10	11
CH_4	Navigation (1A3d)	[tonnes]	28	28	29	29	30	31	31	32	33	33	35	37	36	33	31
CH_4	Residential (1A4b)	[tonnes]	158	156	153	150	150	150	147	144	140	138	136	135	134	134	135
CH_4	Ag./for./fish. (1A4c)	[tonnes]	155	154	147	146	142	139	132	123	116	110	106	100	94	89	88
CH_4	Military (1A5)	[tonnes]	31	26	17	18	14	5	19	10	13	13	18	10	12	14	11
CH_4	Navigation int. (1A3d)	[tonnes]	27	32	47	60	62	65	59	62	93	104	110	105	97	98	93
CH_4	Civil Aviation int. (1A3a)	[tonnes]	25	27	30	32	33	31	29	30	29	31	35	37	38	40	41
CO	Industry-Other (1A2f)	[tonnes]	9863	9784	9702	9611	9502	9379	9294	9188	9070	8956	8910	8963	8939	8907	8647

CO	Civil Aviation (1A3a)	[tonnes]	1256	1241	1118	1167	1140	1098	989	955	930	1098	1180	1117	1085	973	932
CO	Road (1A3b)	[tonnes]	560836	540471	521469	475754	447890	458943	474352	464445	466072	434238	411281	398904	345574	324704	290218
CO	Railways (1A3c)	[tonnes]	1098	1105	982	1018	937	895	910	963	999	906	914	907	883	745	717
CO	Navigation (1A3d)	[tonnes]	5291	5291	5453	5613	5777	5941	6095	6287	6428	6610	6861	7065	6967	6799	6541
CO	Residential (1A4b)	[tonnes]	50434	49697	48935	48149	47970	47787	46848	45867	45027	44365	43997	44112	44229	44347	45103
CO	Ag./for./fish. (1A4c)	[tonnes]	61165	59707	57256	55768	53717	51734	48771	45427	42608	39735	37673	34858	32455	29823	27820
CO	Military (1A5)	[tonnes]	4156	3086	1309	3125	1945	424	1010	514	849	871	885	619	604	691	697
CO	Navigation int. (1A3d)	[tonnes]	2903	3396	5038	6427	6608	6981	6268	6566	9873	11143	11745	11211	10351	10417	9905
CO	Civil Aviation int. (1A3a)	[tonnes]	1103	1207	1289	1416	1564	1442	1357	1399	1388	1342	1421	1502	1564	1662	1743
CO_2	Industry-Other (1A2f)	[ktonnes]	852	852	851	849	845	842	843	843	842	841	848	853	860	867	873
CO_2	Civil Aviation (1A3a)	[ktonnes]	256	241	268	271	262	243	199	193	190	196	199	205	212	194	174
CO_2	Road (1A3b)	[ktonnes]	8160	8625	8636	8694	8789	9275	9690	9863	9987	10487	10585	10764	10978	11166	11312
CO_2	Railways (1A3c)	[ktonnes]	364	366	326	338	311	297	302	319	331	300	303	301	293	247	232
CO_2	Navigation (1A3d)	[ktonnes]	702	701	705	707	710	714	713	727	717	729	766	840	820	668	553
CO_2	Residential (1A4b)	[ktonnes]	114	114	113	113	113	113	113	114	115	116	118	120	122	124	127
CO_2	Ag./for./fish. (1A4c)	[ktonnes]	1806	1922	1758	1887	1874	1899	1903	1794	1760	1695	1728	1642	1554	1510	1564
CO_2	Military (1A5)	[ktonnes]	402	316	361	196	165	119	287	141	237	252	252	176	171	204	182
CO_2	Navigation int. (1A3d)	[ktonnes]	1320	1537	2261	2869	2936	3087	2762	2887	4300	4829	5061	4803	4403	4414	4155
CO_2	Civil Aviation int. (1A3a)	[ktonnes]	1391	1503	1613	1725	1809	1736	1632	1693	1659	1818	1867	1971	2010	2159	2290
N_2O	Industry-Other (1A2f)	[tonnes]	34	34	34	34	34	34	34	35	35	35	35	36	36	36	37
N_2O	Civil Aviation (1A3a)	[tonnes]	10	10	11	11	11	10	9	9	9	9	10	11	11	9	9
N_2O	Road (1A3b)	[tonnes]	277	290	291	294	297	313	336	354	367	400	416	433	445	450	453
N_2O	Railways (1A3c)	[tonnes]	10	10	9	9	9	8	8	9	9	8	8	8	8	7	6
N_2O	Navigation (1A3d)	[tonnes]	43	43	43	43	43	43	43	44	43	44	46	51	49	40	32
N_2O	Residential (1A4b)	[tonnes]	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
N_2O	Ag./for./fish. (1A4c)	[tonnes]	81	87	78	85	85	87	88	83	81	79	81	77	71	70	74
N_2O	Military (1A5)	[tonnes]	12	10	11	6	5	4	8	4	7	8	7	5	5	6	6
N_2O	Navigation int. (1A3d)	[tonnes]	83	97	142	180	185	194	174	182	270	304	318	302	277	278	262
N_2O	Civil Aviation int. (1A3a)	[tonnes]	47	50	54	58	61	59	56	58	57	63	64	69	70	75	80
NH_3	Industry-Other (1A2f)	[tonnes]	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
NH_3	Civil Aviation (1A3a)	[tonnes]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NH_3	Road (1A3b)	[tonnes]	61	64	64	66	66	70	248	441	622	946	1198	1428	1862	2226	2491
NH_3	Railways (1A3c)	[tonnes]	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
NH_3	Navigation (1A3d)	[tonnes]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NH_3	Residential (1A4b)	[tonnes]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NH_3	Ag./for./fish. (1A4c)	[tonnes]	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
NH_3	Military (1A5)	[tonnes]	1	1	0	0	0	0	1	0	0	0	1	0	0	0	1
NH_3	Navigation int. (1A3d)	[tonnes]		0						0	0						
NH_3	Civil Aviation int. (1A3a)	[tonnes]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TSP	Industry-Other (1A2f)	[tonnes]	1823	1778	1733	1686	1634	1577	1533	1484	1433	1383	1349	1317	1284	1249	1193
TSP	Civil Aviation (1A3a)	[tonnes]	5	5	5	5	5	5	4	4	4	4	4	4	4	4	4
TSP	Road (1A3b)	[tonnes]	4311	4645	4650	4587	4660	4908	5019	4854	4845	4943	4713	4606	4248	4004	3813
TSP	Railways (1A3c)	[tonnes]	247	249	222	229	211	202	205	217	225	204	206	204	199	168	146
TSP	Navigation (1A3d)	[tonnes]	948	948	953	948	953	781	612	451	561	646	773	613	546	378	337

TSP	Residential (1A4b)	[tonnes]	37	36	36	36	36	35	35	34	33	34	35	36	38	39	40
TSP	Ag./for./fish. (1A4c)	[tonnes]	2783	2820	2673	2723	2665	2628	2534	2362	2300	2119	2087	1892	1783	1633	1576
TSP	Military (1A5)	[tonnes]	100	100	49	17	26	11	112	66	63	54	114	46	74	80	50
TSP	Navigation int. (1A3d)	[tonnes]	3047	3663	6129	8024	8081	5677	4512	4139	8822	8348	10262	10169	9437	7917	8390
TSP	Civil Aviation int. (1A3a)	[tonnes]	23	24	26	28	30	28	27	28	27	29	30	32	32	35	37
PM_{10}	Industry-Other (1A2f)	[tonnes]	1823	1778	1733	1686	1634	1577	1533	1484	1433	1383	1349	1317	1284	1249	1193
PM_{10}	Civil Aviation (1A3a)	[tonnes]	5	5	5	5	5	5	4	4	4	4	4	4	4	4	4
PM_{10}	Road (1A3b)	[tonnes]	4311	4645	4650	4587	4660	4908	5019	4854	4845	4943	4713	4606	4248	4004	3813
PM_{10}	Railways (1A3c)	[tonnes]	247	249	222	229	211	202	205	217	225	204	206	204	199	168	146
PM_{10}	Navigation (1A3d)	[tonnes]	940	939	944	939	944	774	607	447	556	641	767	608	542	376	335
PM_{10}	Residential (1A4b)	[tonnes]	37	36	36	36	36	35	35	34	33	34	35	36	38	39	40
PM_{10}	Ag./for./fish. (1A4c)	[tonnes]	2781	2818	2671	2721	2663	2626	2532	2360	2298	2117	2086	1891	1782	1632	1575
PM_{10}	Military (1A5)	[tonnes]	100	100	49	17	26	11	112	66	63	54	114	46	74	80	50
PM_{10}	Navigation int. (1A3d)	[tonnes]	3016	3626	6068	7944	8000	5620	4467	4098	8734	8264	10160	10068	9342	7838	8306
PM_{10}	Civil Aviation int. (1A3a)	[tonnes]	23	24	26	28	30	28	27	28	27	29	30	32	32	35	37
$PM_{2.5}$	Industry-Other (1A2f)	[tonnes]	1823	1778	1733	1686	1634	1577	1533	1484	1433	1383	1349	1317	1284	1249	1193
$PM_{2.5}$	Civil Aviation (1A3a)	[tonnes]	5	5	5	5	5	5	4	4	4	4	4	4	4	4	4
$PM_{2.5}$	Road (1A3b)	[tonnes]	4311	4645	4650	4587	4660	4908	5019	4854	4845	4943	4713	4606	4248	4004	3813
$PM_{2.5}$	Railways (1A3c)	[tonnes]	247	249	222	229	211	202	205	217	225	204	206	204	199	168	146
$PM_{2.5}$	Navigation (1A3d)	[tonnes]	935	935	939	935	940	771	604	446	554	638	764	606	540	375	334
$PM_{2.5}$	Residential (1A4b)	[tonnes]	37	36	36	36	36	35	35	34	33	34	35	36	38	39	40
$PM_{2.5}$	Ag./for./fish. (1A4c)	[tonnes]	2780	2817	2670	2720	2662	2625	2531	2359	2297	2116	2085	1890	1781	1631	1574
$PM_{2.5}$	Military (1A5)	[tonnes]	100	100	49	17	26	11	112	66	63	54	114	46	74	80	50
$PM_{2.5}$	Navigation int. (1A3d)	[tonnes]	3001	3608	6037	7904	7959	5592	4445	4077	8690	8223	10108	10017	9295	7799	8264
$PM_{2.5}$	Civil Aviation int. (1A3a)	[tonnes]	23	24	26	28	30	28	27	28	27	29	30	32	32	35	37
Arsenic	Civil Aviation (1A3a)	[kg]															0
Arsenic	Navigation (1A3d)	[kg]						53	46	38	38	39	40	35	26	19	15
Arsenic	Ag./for./fish. (1A4c)	[kg]						9	10	9	8	8	8	8	6	7	7
Arsenic	Military (1A5)	[kg]										0					0
Arsenic	Navigation int. (1A3d)	[kg]						363	302	276	475	505	514	332	426	366	379
Arsenic	Civil Aviation int. (1A3a)	[kg]															0
Cadmium	Industry-Other (1A2f)	[kg]						2	2	2	2	2	2	2	2	3	2
Cadmium	Civil Aviation (1A3a)	[kg]						1	1	1	1	1	1	1	1	1	1
Cadmium	Road (1A3b)	[kg]						29	30	31	31	33	33	34	34	35	36
Cadmium	Railways (1A3c)	[kg]						1	1	1	1	1	1	1	1	1	1
Cadmium	Navigation (1A3d)	[kg]						4	4	4	3	4	4	4	3	3	2
Cadmium	Residential (1A4b)	[kg]						0	0	0	0	0	0	0	0	0	0
Cadmium	Ag./for./fish. (1A4c)	[kg]						6	6	6	6	5	5	5	5	5	5
Cadmium	Military (1A5)	[kg]						0	1	0	1	1	1	1	1	1	1
Cadmium	Navigation int. (1A3d)	[kg]						24	20	19	32	34	35	20	30	27	27
Cadmium	Civil Aviation int. (1A3a)	[kg]						6	5	5	5	6	6	6	6	7	7
Chromium	Industry-Other (1A2f)	[kg]						12	12	12	12	12	12	12	12	13	13
Chromium	Civil Aviation (1A3a)	[kg]						4	3	3	3	3	3	3	3	3	3
Chromium	Road (1A3b)	[kg]						146	152	155	157	165	166	169	173	176	178

Chromium	Railways (1A3c)	[kg]	5	5	5	5	5	5	5	5	4	4
Chromium	Navigation (1A3d)	[kg]	24	22	19	19	20	20	19	16	12	10
Chromium	Residential (1A4b)	[kg]	2	2	2	2	2	2	2	2	2	2
Chromium	Ag./for./fish. (1A4c)	[kg]	28	28	27	26	25	26	24	23	23	23
Chromium	Military (1A5)	[kg]	2	5	2	4	4	4	3	3	3	3
Chromium	Navigation int. (1A3d)	[kg]	150	127	118	199	213	218	133	182	161	164
Chromium	Civil Aviation int. (1A3a)	[kg]	28	26	27	26	29	30	31	32	34	36
Copper	Industry-Other (1A2f)	[kg]	411	413	413	413	414	418	421	425	429	432
Copper	Civil Aviation (1A3a)	[kg]	131	107	104	102	106	107	110	114	104	94
Copper	Road (1A3b)	[kg]	4965	5184	5273	5337	5605	5657	5754	5867	5968	6047
Copper	Railways (1A3c)	[kg]	160	162	172	178	162	163	162	157	133	125
Copper	Navigation (1A3d)	[kg]	78	73	67	69	73	76	73	66	61	60
Copper	Residential (1A4b)	[kg]	60	60	61	61	62	63	64	65	66	67
Copper	Ag./for./fish. (1A4c)	[kg]	713	706	674	672	636	653	623	630	597	594
Copper	Military (1A5)	[kg]	64	154	76	128	136	136	95	92	110	98
Copper	Navigation int. (1A3d)	[kg]	363	302	276	475	505	514	332	426	366	379
Copper	Civil Aviation int. (1A3a)	[kg]	936	880	913	894	980	1006	1063	1084	1164	1234
Mercury	Civil Aviation (1A3a)	[kg]										0
Mercury	Navigation (1A3d)	[kg]	8	8	9	9	9	9	11	11	9	7
Mercury	Ag./for./fish. (1A4c)	[kg]	9	10	9	8	8	8	8	6	7	7
Mercury	Military (1A5)	[kg]					0					0
Mercury	Navigation int. (1A3d)	[kg]	28	26	30	40	47	51	14	46	50	44
Mercury	Civil Aviation int. (1A3a)	[kg]										0
Nickel	Industry-Other (1A2f)	[kg]	17	17	17	17	17	17	17	17	18	18
Nickel	Civil Aviation (1A3a)	[kg]	5	4	4	4	4	4	5	5	4	4
Nickel	Road (1A3b)	[kg]	204	213	217	220	231	233	237	242	246	249
Nickel	Railways (1A3c)	[kg]	7	7	7	7	7	7	7	6	5	5
Nickel	Navigation (1A3d)	[kg]	2828	2355	1826	1825	1943	1958	1553	987	645	543
Nickel	Residential (1A4b)	[kg]	2	2	2	3	3	3	3	3	3	3
Nickel	Ag./for./fish. (1A4c)	[kg]	42	42	40	39	37	38	36	34	33	35
Nickel	Military (1A5)	[kg]	3	6	3	5	6	6	4	4	5	4
Nickel	Navigation int. (1A3d)	[kg]	20956	17236	15429	27162	28664	29023	19856	23826	19820	20967
Nickel	Civil Aviation int. (1A3a)	[kg]	39	36	38	37	40	41	44	45	48	51
Lead	Industry-Other (1A2f)	[kg]	258	187	160	67	12	12	12	0	0	0
Lead	Civil Aviation (1A3a)	[kg]	1534	1423	1378	1328	1639	1788	1640	1559	1399	1387
Lead	Road (1A3b)	[kg]	97510	75857	68775	29818	54	55	55	57	58	58
Lead	Railways (1A3c)	[kg]	0	0	0	0		0	0	0	0	0
Lead	Navigation (1A3d)	[kg]	485	371	331	159	51	53	55	27	21	17
Lead	Residential (1A4b)	[kg]	2273	1666	1442	612	109	110	112	1	1	1
Lead	Ag./for./fish. (1A4c)	[kg]	1564	1069	859	346	71	67	63	13	13	15
Lead	Military (1A5)	[kg]	64	80	62	120	86	102	98	123	116	78
Lead	Navigation int. (1A3d)	[kg]	167	144	142	226	247	256	134	218	205	201
Lead	Civil Aviation int. (1A3a)	[kg]	490	465	452	456	153	175	126	145	145	124
Selenium	Industry-Other (1A2f)	[kg]	2	2	2	2	2	2	2	2	3	2

Selenium	Civil Aviation (1A3a)	[kg]	1	1	1	1	1	1	1	1	1	1
Selenium	Road (1A3b)	[kg]	29	30	31	31	33	33	34	34	35	36
Selenium	Railways (1A3c)	[kg]	1	1	1	1	1	1	1	1	1	1
Selenium	Navigation (1A3d)	[kg]	61	58	55	54	55	57	59	54	42	34
Selenium	Residential (1A4b)	[kg]	0	0	0	0	0	0	0	0	0	0
Selenium	Ag./for./fish. (1A4c)	[kg]	41	42	39	37	37	37	35	29	30	33
Selenium	Military (1A5)	[kg]	0	1	0	1	1	1	1	1	1	1
Selenium	Navigation int. (1A3d)	[kg]	334	289	284	451	495	512	269	436	410	401
Selenium	Civil Aviation int. (1A3a)	[kg]	6	5	5	5	6	6	6	6	7	7
Zinc	Industry-Other (1A2f)	[kg]	242	243	243	243	243	246	248	250	252	254
Zinc	Civil Aviation (1A3a)	[kg]	77	63	61	60	62	63	65	67	61	55
Zinc	Road (1A3b)	[kg]	2921	3050	3102	3140	3297	3328	3384	3451	3511	3557
Zinc	Railways (1A3c)	[kg]	94	95	101	105	95	96	95	93	78	73
Zinc	Navigation (1A3d)	[kg]	158	152	147	146	151	157	164	154	126	107
Zinc	Residential (1A4b)	[kg]	35	35	36	36	36	37	37	38	39	40
Zinc	Ag./for./fish. (1A4c)	[kg]	506	505	479	474	453	463	441	429	412	420
Zinc	Military (1A5)	[kg]	38	91	45	75	80	80	56	54	65	58
Zinc	Navigation int. (1A3d)	[kg]	764	664	660	1038	1141	1183	607	1010	959	933
Zinc	Civil Aviation int. (1A3a)	[kg]	551	518	537	526	576	592	625	638	685	726
Dioxins/furans	Industry-Other (1A2f)	[g]	0	0	0	0	0	0	0	0	0	0
Dioxins/furans	Civil Aviation (1A3a)	[g]	0	0	0	0	0	0	0	0	0	0
Dioxins/furans	Road (1A3b)	[g]	1	1	1	1	1	1	1	1	0	0
Dioxins/furans	Railways (1A3c)	[g]	0	0	0	0	0	0	0	0	0	0
Dioxins/furans	Navigation (1A3d)	[g]	0	0	0	0	0	0	0	0	0	0
Dioxins/furans	Residential (1A4b)	[g]	0	0	0	0	0	0	0	0	0	0
Dioxins/furans	Ag./for./fish. (1A4c)	[g]	0	0	0	0	0	0	0	0	0	0
Dioxins/furans	Military (1A5)	[g]	0	0	0	0	0	0	0	0	0	0
Dioxins/furans	Navigation int. (1A3d)	[g]	1	0	0	1	1	1	1	1	1	1
Dioxins/furans	Civil Aviation int. (1A3a)	[g]	0	0	0	0	0	0	0	0	0	0
Flouranthene	Industry-Other (1A2f)	[kg]	45	44	45	46	45	46	46	46	46	46
Flouranthene	Civil Aviation (1A3a)	[kg]	0	0	0	0	1	1	1	0	0	0
Flouranthene	Road (1A3b)	[kg]	785	792	784	766	755	715	680	647	617	596
Flouranthene	Railways (1A3c)	[kg]	5	5	6	6	6	6	6	6	5	4
Flouranthene	Navigation (1A3d)	[kg]	59	61	64	63	64	67	76	76	61	50
Flouranthene	Residential (1A4b)	[kg]	7	7	7	7	7	7	7	7	7	8
Flouranthene	Ag./for./fish. (1A4c)	[kg]	136	135	128	127	121	124	117	107	104	110
Flouranthene	Military (1A5)	[kg]	1	7	4	4	3	8	3	6	6	4
Flouranthene	Navigation int. (1A3d)	[kg]	204	190	212	294	340	361	349	322	343	311
Flouranthene	Civil Aviation int. (1A3a)	[kg]	0	0	0	0	0	0	0	0	0	0
Benzo(b) flouranthene	Industry-Other (1A2f)	[kg]	6	6	6	6	6	6	6	6	6	6
Benzo(b) flouranthene	Civil Aviation (1A3a)	[kg]	0	0	0	0	0	0	0	0	0	0
Benzo(b) flouranthene	Road (1A3b)	[kg]	65	66	66	65	67	65	64	63	62	61
Benzo(b) flouranthene	Railways (1A3c)	[kg]	1	1	1	2	1	1	1	1	1	1
Benzo(b) flouranthene	Navigation (1A3d)	[kg]	4	5	5	5	5	5	6	6	5	4

Benzo(b) flouranthene	Residential (1A4b)	[kg]	0	0	0	0	0	0	0	0	0	0
Benzo(b) flouranthene	Ag./for./fish. (1A4c)	[kg]	15	15	14	14	13	13	13	12	11	12
Benzo(b) flouranthene	Military (1A5)	[kg]	0	1	1	1	0	1	0	1	1	1
Benzo(b) flouranthene	Navigation int. (1A3d)	[kg]	13	13	15	20	23	25	25	23	25	22
Benzo(b) flouranthene	Civil Aviation int. (1A3a)	[kg]	0	0	0	0	0	0	0	0	0	0
Benzo(k) flouranthene	Industry-Other (1A2f)	[kg]	6	6	6	6	6	6	6	6	6	6
Benzo(k) flouranthene	Civil Aviation (1A3a)	[kg]	0	0	0	0	0	0	0	0	0	0
Benzo(k) flouranthene	Road (1A3b)	[kg]	66	68	68	67	70	70	70	70	69	70
Benzo(k) flouranthene	Railways (1A3c)	[kg]	2	2	2	2	2	2	2	2	1	1
Benzo(k) flouranthene	Navigation (1A3d)	[kg]	2	2	2	2	2	2	3	3	3	2
Benzo(k) flouranthene	Residential (1A4b)	[kg]	0	0	0	0	0	0	0	0	0	0
Benzo(k) flouranthene	Ag./for./fish. (1A4c)	[kg]	12	12	11	11	11	11	10	10	9	9
Benzo(k) flouranthene	Military (1A5)	[kg]	0	1	1	1	0	1	0	1	1	1
Benzo(k) flouranthene	Navigation int. (1A3d)	[kg]	6	6	7	9	11	12	11	11	12	10
Benzo(k) flouranthene	Civil Aviation int. (1A3a)	[kg]	0	0	0	0	0	0	0	0	0	0
Benzo(a) pyrene	Industry-Other (1A2f)	[kg]	3	3	3	3	3	3	3	3	3	3
Benzo(a) pyrene	Civil Aviation (1A3a)	[kg]	0	0	0	0	0	0	0	0	0	0
Benzo(a) pyrene	Road (1A3b)	[kg]	45	46	46	46	46	45	44	43	43	42
Benzo(a) pyrene	Railways (1A3c)	[kg]	0	0	0	0	0	0	0	0	0	0
Benzo(a) pyrene	Navigation (1A3d)	[kg]	1	1	1	1	1	1	1	2	1	1
Benzo(a) pyrene	Residential (1A4b)	[kg]	0	0	0	0	0	0	0	0	0	0
Benzo(a) pyrene	Ag./for./fish. (1A4c)	[kg]	6	6	6	6	5	5	5	5	5	5
Benzo(a) pyrene	Military (1A5)	[kg]	0	0	0	0	0	1	0	0	0	0
Benzo(a) pyrene	Navigation int. (1A3d)	[kg]	4	4	4	5	6	7	7	6	7	6
Benzo(a) pyrene	Civil Aviation int. (1A3a)	[kg]	0	0	0	0	0	0	0	0	0	0
Benzo(g,h,i) perylene	Industry-Other (1A2f)	[kg]	6	6	6	6	5	6	5	5	5	5
Benzo(g,h,i) perylene	Civil Aviation (1A3a)	[kg]	0	0	0	0	0	0	0	0	0	0
Benzo(g,h,i) perylene	Road (1A3b)	[kg]	95	97	97	96	96	92	89	87	85	83
Benzo(g,h,i) perylene	Railways (1A3c)	[kg]	0	0	0	0	0	0	0	0	0	0
Benzo(g,h,i) perylene	Navigation (1A3d)	[kg]	8	9	10	10	10	10	12	13	11	9
Benzo(g,h,i) perylene	Residential (1A4b)	[kg]	1	1	1	1	1	1	1	1	1	1
Benzo(g,h,i) perylene	Ag./for./fish. (1A4c)	[kg]	21	21	20	19	19	19	18	16	15	16
Benzo(g,h,i) perylene	Military (1A5)	[kg]	0	1	1	1	0	1	0	1	1	0
Benzo(g,h,i) perylene	Navigation int. (1A3d)	[kg]	24	24	30	37	45	49	48	45	52	45
Benzo(g,h,i) perylene	Civil Aviation int. (1A3a)	[kg]	0	0	0	0	0	0	0	0	0	0
indeno(1,2,3-c,d) pyrene	Industry-Other (1A2f)	[kg]	3	3	3	3	3	3	3	3	3	3
indeno(1,2,3-c,d) pyrene	Civil Aviation (1A3a)	[kg]	0	0	0	0	0	0	0	0	0	0
indeno(1,2,3-c,d) pyrene	Road (1A3b)	[kg]	43	44	45	45	47	46	46	46	47	47
indeno(1,2,3-c,d) pyrene	Railways (1A3c)	[kg]	0	0	0	0	0	0	0	0	0	0
indeno(1,2,3-c,d) pyrene	Navigation (1A3d)	[kg]	6	7	8	8	8	8	10	11	9	7
indeno(1,2,3-c,d) pyrene	Residential (1A4b)	[kg]	0	0	0	0	0	0	0	0	0	0
indeno(1,2,3-c,d) pyrene	Ag./for./fish. (1A4c)	[kg]	14	15	14	13	13	13	12	11	11	11
indeno(1,2,3-c,d) pyrene	Military (1A5)	[kg]	0	0	0	0	0	1	0	0	0	0
indeno(1,2,3-c,d) pyrene	Navigation int. (1A3d)	[kg]	19	20	24	30	36	39	39	36	42	36

indeno(1,2,3-c,d) pyrene	Civil Aviation int. (1A3a)	[kg]						0	0	0	0	0	0	0	0	0	0

Continued

pol_name	IPCC ID	Unit	2000	2001	2002	2003	2004	2005	2006	2007	2008
SO_2	Industry-Other (1A2f)	[tonnes]	253	256	258	261	263	28	30	32	33
SO_2	Civil Aviation (1A3a)	[tonnes]	49	52	45	44	41	43	46	51	52
SO_2	Road (1A3b)	[tonnes]	352	353	357	371	381	77	79	83	82
SO_2	Railways (1A3c)	[tonnes]	7	7	7	7	7	1	1	1	1
SO_2	Navigation (1A3d)	[tonnes]	1129	1039	963	995	1150	1157	1086	838	655
SO_2	Residential (1A4b)	[tonnes]	4	4	5	6	6	1	1	1	1
SO_2	Ag./for./fish. (1A4c)	[tonnes]	1021	986	1041	997	851	637	585	519	323
SO_2	Military (1A5)	[tonnes]	27	12	19	17	46	57	26	40	19
SO_2	Navigation int. (1A3d)	[tonnes]	56634	45358	31538	33060	28581	36544	52936	26876	20557
SO_2	Civil Aviation int. (1A3a)	[tonnes]	750	761	657	683	781	822	824	845	844
NO_x	Industry-Other (1A2f)	[tonnes]	12096	11869	11617	11214	10744	10664	10807	10667	10100
NO_x	Civil Aviation (1A3a)	[tonnes]	723	752	641	595	551	583	601	692	704
NO_x	Road (1A3b)	[tonnes]	81559	78866	75136	74757	72479	70161	69240	67717	61250
NO_x	Railways (1A3c)	[tonnes]	3727	3396	3396	3540	3478	3724	3542	3555	2920
NO_x	Navigation (1A3d)	[tonnes]	5830	5741	5900	5827	5939	6026	5997	5929	5985
NO_x	Residential (1A4b)	[tonnes]	153	167	183	202	223	249	275	293	304
NO_x	Ag./for./fish. (1A4c)	[tonnes]	22807	22699	23269	22322	19933	20776	19532	18266	19135
NO_x	Military (1A5)	[tonnes]	554	724	489	544	1323	1360	635	793	520
NO_x	Navigation int. (1A3d)	[tonnes]	96911	81585	66095	71376	58906	62825	84716	89720	77545
NO_x	Civil Aviation int. (1A3a)	[tonnes]	9446	9605	8731	9091	10475	11031	11168	11412	11299
NMVOC	Industry-Other (1A2f)	[tonnes]	1926	1873	1815	1754	1676	1620	1583	1498	1375
NMVOC	Civil Aviation (1A3a)	[tonnes]	156	155	151	144	158	165	156	164	148
NMVOC	Road (1A3b)	[tonnes]	41387	37635	34090	31867	27888	25766	22835	20241	17754
NMVOC	Railways (1A3c)	[tonnes]	253	248	243	223	217	235	230	231	205
NMVOC	Navigation (1A3d)	[tonnes]	1652	1614	1575	1513	1446	1334	1206	1087	986
NMVOC	Residential (1A4b)	[tonnes]	4602	5328	6082	6869	7685	7859	8037	8156	7954
NMVOC	Ag./for./fish. (1A4c)	[tonnes]	3414	3246	3079	2858	2586	2568	2513	2413	2388
NMVOC	Military (1A5)	[tonnes]	57	58	47	48	107	113	54	72	44
NMVOC	Navigation int. (1A3d)	[tonnes]	3126	2651	2190	2334	1914	2005	2643	2767	2433
NMVOC	Civil Aviation int. (1A3a)	[tonnes]	407	406	390	399	451	468	492	505	485
CH_4	Industry-Other (1A2f)	[tonnes]	50	49	48	47	46	45	44	43	41
CH_4	Civil Aviation (1A3a)	[tonnes]	5	6	5	5	6	7	6	7	6
CH_4	Road (1A3b)	[tonnes]	1865	1744	1640	1584	1484	1393	1298	1197	1046
CH_4	Railways (1A3c)	[tonnes]	10	10	9	9	8	9	9	9	8
CH_4	Navigation (1A3d)	[tonnes]	30	31	31	32	32	32	32	32	32
CH_4	Residential (1A4b)	[tonnes]	137	149	164	183	204	219	233	240	240
CH_4	Ag./for./fish. (1A4c)	[tonnes]	88	86	86	85	82	86	93	91	91
CH_4	Military (1A5)	[tonnes]	6	7	5	5	13	13	6	8	5
CH_4	Navigation int. (1A3d)	[tonnes]	97	82	68	72	59	62	82	86	75
CH_4	Civil Aviation int. (1A3a)	[tonnes]	42	42	41	42	47	49	52	54	51

CO	Industry-Other (1A2f)	[tonnes]	8395	8227	8030	7842	7600	7497	7515	7383	7060
CO	Civil Aviation (1A3a)	[tonnes]	895	891	863	835	858	861	842	901	828
CO	Road (1A3b)	[tonnes]	266890	256351	234964	226060	199785	191213	168936	152344	139272
CO	Railways (1A3c)	[tonnes]	694	637	627	611	599	648	626	629	526
CO	Navigation (1A3d)	[tonnes]	6572	6742	6934	7116	7312	7339	6955	6573	6202
CO	Residential (1A4b)	[tonnes]	45873	50280	56144	63688	72683	80610	87744	92236	95382
CO	Ag./for./fish. (1A4c)	[tonnes]	25842	24006	22167	20229	18183	17153	16884	16718	16802
CO	Military (1A5)	[tonnes]	404	322	319	312	727	816	387	541	309
CO	Navigation int. (1A3d)	[tonnes]	10313	8745	7225	7701	6316	6615	8719	9129	8028
CO	Civil Aviation int. (1A3a)	[tonnes]	1790	1796	1610	1669	1844	1914	1870	1933	2003
CO_2	Industry-Other (1A2f)	[ktonnes]	879	888	897	907	912	950	1021	1089	1119
CO_2	Civil Aviation (1A3a)	[ktonnes]	154	163	141	138	128	135	143	161	164
CO_2	Road (1A3b)	[ktonnes]	11202	11223	11352	11806	12115	12214	12587	13186	12948
CO_2	Railways (1A3c)	[ktonnes]	228	211	210	218	216	232	227	228	237
CO_2	Navigation (1A3d)	[ktonnes]	476	461	457	461	475	471	461	454	453
CO_2	Residential (1A4b)	[ktonnes]	129	143	161	182	205	220	233	238	239
CO_2	Ag./for./fish. (1A4c)	[ktonnes]	1615	1592	1636	1602	1498	1577	1563	1576	1697
CO_2	Military (1A5)	[ktonnes]	111	97	89	92	239	271	126	175	108
CO_2	Navigation int. (1A3d)	[ktonnes]	4279	3605	2966	3130	2545	2636	3433	3559	3118
CO_2	Civil Aviation int. (1A3a)	[ktonnes]	2350	2384	2058	2141	2447	2574	2582	2647	2642
N_2O	Industry-Other (1A2f)	[tonnes]	37	38	38	38	39	40	43	46	47
N_2O	Civil Aviation (1A3a)	[tonnes]	8	8	8	8	8	8	8	9	9
N_2O	Road (1A3b)	[tonnes]	447	433	424	425	424	413	412	421	405
N_2O	Railways (1A3c)	[tonnes]	6	6	6	6	6	6	6	6	7
N_2O	Navigation (1A3d)	[tonnes]	27	26	26	26	27	27	26	26	26
N_2O	Residential (1A4b)	[tonnes]	2	2	2	3	3	3	4	4	4
N_2O	Ag./for./fish. (1A4c)	[tonnes]	78	77	80	78	71	76	75	74	81
N_2O	Military (1A5)	[tonnes]	3	3	3	3	8	9	4	6	4
N_2O	Navigation int. (1A3d)	[tonnes]	269	227	187	197	160	166	216	224	196
N_2O	Civil Aviation int. (1A3a)	[tonnes]	82	82	72	75	85	89	89	91	90
NH_3	Industry-Other (1A2f)	[tonnes]	2	2	2	2	2	2	2	3	3
NH_3	Civil Aviation (1A3a)	[tonnes]	0	0	0	0	0	0	0	0	0
NH_3	Road (1A3b)	[tonnes]	2656	2537	2472	2396	2282	2122	1954	1788	1572
NH_3	Railways (1A3c)	[tonnes]	1	1	1	1	1	1	1	1	1
NH_3	Navigation (1A3d)	[tonnes]	0	0	0	0	0	0	0	0	0
NH_3	Residential (1A4b)	[tonnes]	0	0	0	0	0	0	0	0	0
NH_3	Ag./for./fish. (1A4c)	[tonnes]	3	3	3	3	3	3	3	3	4
NH_3	Military (1A5)	[tonnes]	0	0	0	0	1	1	0	0	0
NH_3	Navigation int. (1A3d)	[tonnes]									
NH_3	Civil Aviation int. (1A3a)	[tonnes]	0	0	0	0	0	0	0	0	0
TSP	Industry-Other (1A2f)	[tonnes]	1135	1121	1098	1075	1037	1002	991	938	861
TSP	Civil Aviation (1A3a)	[tonnes]	3	4	3	3	3	3	3	3	3
TSP	Road (1A3b)	[tonnes]	3565	3430	3205	3234	3042	2948	2852	2688	2421
TSP	Railways (1A3c)	[tonnes]	141	125	124	119	115	124	120	120	101

TSP	Navigation (1A3d)	[tonnes]	307	298	290	295	315	309	292	257	244
TSP	Residential (1A4b)	[tonnes]	41	50	58	67	76	78	79	80	81
TSP	Ag./for./fish. (1A4c)	[tonnes]	1507	1440	1374	1291	1191	1146	1074	1020	990
TSP	Military (1A5)	[tonnes]	18	39	18	23	49	42	19	18	15
TSP	Navigation int. (1A3d)	[tonnes]	8994	7414	5254	4816	4293	6155	8300	2504	2025
TSP	Civil Aviation int. (1A3a)	[tonnes]	38	38	33	35	40	42	42	43	43
PM_{10}	Industry-Other (1A2f)	[tonnes]	1135	1121	1098	1075	1037	1002	991	938	861
PM_{10}	Civil Aviation (1A3a)	[tonnes]	3	4	3	3	3	3	3	3	3
PM_{10}	Road (1A3b)	[tonnes]	3565	3430	3205	3234	3042	2948	2852	2688	2421
PM_{10}	Railways (1A3c)	[tonnes]	141	125	124	119	115	124	120	120	101
PM_{10}	Navigation (1A3d)	[tonnes]	306	296	289	294	314	307	290	256	242
PM_{10}	Residential (1A4b)	[tonnes]	41	50	58	67	76	78	79	80	81
PM_{10}	Ag./for./fish. (1A4c)	[tonnes]	1505	1439	1372	1290	1190	1145	1073	1019	988
PM_{10}	Military (1A5)	[tonnes]	18	39	18	23	49	42	19	18	15
PM_{10}	Navigation int. (1A3d)	[tonnes]	8904	7340	5201	4767	4250	6094	8217	2479	2005
PM_{10}	Civil Aviation int. (1A3a)	[tonnes]	38	38	33	35	40	42	42	43	43
$PM_{2.5}$	Industry-Other (1A2f)	[tonnes]	1135	1121	1098	1075	1037	1002	991	938	861
$PM_{2.5}$	Civil Aviation (1A3a)	[tonnes]	3	4	3	3	3	3	3	3	3
$PM_{2.5}$	Road (1A3b)	[tonnes]	3565	3430	3205	3234	3042	2948	2852	2688	2421
$PM_{2.5}$	Railways (1A3c)	[tonnes]	141	125	124	119	115	124	120	120	101
$PM_{2.5}$	Navigation (1A3d)	[tonnes]	305	295	288	293	313	307	289	255	242
$PM_{2.5}$	Residential (1A4b)	[tonnes]	41	50	58	67	76	78	79	80	81
$PM_{2.5}$	Ag./for./fish. (1A4c)	[tonnes]	1504	1438	1372	1289	1189	1144	1072	1018	988
$PM_{2.5}$	Military (1A5)	[tonnes]	18	39	18	23	49	42	19	18	15
$PM_{2.5}$	Navigation int. (1A3d)	[tonnes]	8859	7303	5175	4743	4229	6063	8175	2466	1995
$PM_{2.5}$	Civil Aviation int. (1A3a)	[tonnes]	38	38	33	35	40	42	42	43	43
Arsenic	Civil Aviation (1A3a)	[kg]	0	0	0	0	0	0	0	0	0
Arsenic	Navigation (1A3d)	[kg]	14	13	13	13	13	13	13	12	12
Arsenic	Ag./for./fish. (1A4c)	[kg]	9	8	9	8	6	8	7	6	7
Arsenic	Military (1A5)	[kg]	0	0	0	0	0	0	0	0	0
Arsenic	Navigation int. (1A3d)	[kg]	432	342	240	274	230	268	401	443	348
Arsenic	Civil Aviation int. (1A3a)	[kg]	0	0	0	0	0	0	0	0	0
Cadmium	Industry-Other (1A2f)	[kg]	3	3	3	3	3	3	3	3	3
Cadmium	Civil Aviation (1A3a)	[kg]	0	1	0	0	0	0	0	1	1
Cadmium	Road (1A3b)	[kg]	35	35	36	37	38	38	40	42	41
Cadmium	Railways (1A3c)	[kg]	1	1	1	1	1	1	1	1	1
Cadmium	Navigation (1A3d)	[kg]	2	2	2	2	2	2	2	2	2
Cadmium	Residential (1A4b)	[kg]	0	0	1	1	1	1	1	1	1
Cadmium	Ag./for./fish. (1A4c)	[kg]	5	5	5	5	5	5	5	5	5
Cadmium	Military (1A5)	[kg]	0	0	0	0	1	1	0	1	0
Cadmium	Navigation int. (1A3d)	[kg]	29	24	18	20	16	18	26	28	23
Cadmium	Civil Aviation int. (1A3a)	[kg]	8	8	7	7	8	8	8	8	8
Chromium	Industry-Other (1A2f)	[kg]	13	13	13	13	13	14	15	16	17
Chromium	Civil Aviation (1A3a)	[kg]	2	3	2	2	2	2	2	3	3

Chromium	Road (1A3b)	[kg]	176	176	179	186	191	192	198	208	204
Chromium	Railways (1A3c)	[kg]	4	3	3	3	3	4	4	4	4
Chromium	Navigation (1A3d)	[kg]	9	9	9	9	9	9	9	8	9
Chromium	Residential (1A4b)	[kg]	2	2	3	3	3	3	4	4	4
Chromium	Ag./for./fish. (1A4c)	[kg]	24	24	24	24	22	23	23	24	25
Chromium	Military (1A5)	[kg]	2	2	1	1	4	4	2	3	2
Chromium	Navigation int. (1A3d)	[kg]	184	147	106	120	100	114	167	183	146
Chromium	Civil Aviation int. (1A3a)	[kg]	37	38	33	34	39	41	41	42	42
Copper	Industry-Other (1A2f)	[kg]	435	440	445	450	454	474	513	549	565
Copper	Civil Aviation (1A3a)	[kg]	83	88	76	74	69	73	77	87	88
Copper	Road (1A3b)	[kg]	5989	6001	6072	6314	6481	6535	6742	7069	6942
Copper	Railways (1A3c)	[kg]	123	114	113	117	116	125	122	122	127
Copper	Navigation (1A3d)	[kg]	60	62	64	66	69	68	67	67	66
Copper	Residential (1A4b)	[kg]	69	76	86	96	109	117	124	126	127
Copper	Ag./for./fish. (1A4c)	[kg]	581	584	586	586	593	599	613	648	678
Copper	Military (1A5)	[kg]	60	52	48	50	129	146	68	94	58
Copper	Navigation int. (1A3d)	[kg]	432	342	240	274	230	268	401	443	348
Copper	Civil Aviation int. (1A3a)	[kg]	1267	1285	1109	1154	1319	1387	1392	1427	1424
Mercury	Civil Aviation (1A3a)	[kg]	0	0	0	0	0	0	0	0	0
Mercury	Navigation (1A3d)	[kg]	6	5	5	5	5	5	5	5	5
Mercury	Ag./for./fish. (1A4c)	[kg]	9	8	9	8	6	8	7	6	7
Mercury	Military (1A5)	[kg]	0	0	0	0	0	0	0	0	0
Mercury	Navigation int. (1A3d)	[kg]	43	38	34	34	27	26	31	30	29
Mercury	Civil Aviation int. (1A3a)	[kg]	0	0	0	0	0	0	0	0	0
Nickel	Industry-Other (1A2f)	[kg]	18	18	18	19	19	20	21	23	23
Nickel	Civil Aviation (1A3a)	[kg]	3	4	3	3	3	3	3	4	4
Nickel	Road (1A3b)	[kg]	247	247	250	260	267	269	278	291	286
Nickel	Railways (1A3c)	[kg]	5	5	5	5	5	5	5	5	5
Nickel	Navigation (1A3d)	[kg]	534	501	492	484	503	508	474	456	470
Nickel	Residential (1A4b)	[kg]	3	3	4	4	4	5	5	5	5
Nickel	Ag./for./fish. (1A4c)	[kg]	36	35	36	35	33	35	35	35	38
Nickel	Military (1A5)	[kg]	2	2	2	2	5	6	3	4	2
Nickel	Navigation int. (1A3d)	[kg]	24364	19050	12906	15043	12715	15126	23174	25869	19947
Nickel	Civil Aviation int. (1A3a)	[kg]	52	53	46	48	54	57	57	59	59
Lead	Industry-Other (1A2f)	[kg]	0	0	0	0	0	0	0	0	0
Lead	Civil Aviation (1A3a)	[kg]	1369	1343	1328	1252	1304	1297	1245	1329	1182
Lead	Road (1A3b)	[kg]	57	56	56	56	55	53	52	52	50
Lead	Railways (1A3c)	[kg]	0	0	0						
Lead	Navigation (1A3d)	[kg]	14	14	13	13	14	14	13	13	13
Lead	Residential (1A4b)	[kg]	1	1	2	2	2	2	2	2	2
Lead	Ag./for./fish. (1A4c)	[kg]	18	17	18	17	13	15	14	12	14
Lead	Military (1A5)	[kg]	114	88	106	78	82	59	47	81	39
Lead	Navigation int. (1A3d)	[kg]	216	177	136	149	122	133	185	198	164
Lead	Civil Aviation int. (1A3a)	[kg]	118	114	113	106	111	117	22	10	113

Selenium	Industry-Other (1A2f)	[kg]	3	3	3	3	3	3	3	3	3
Selenium	Civil Aviation (1A3a)	[kg]	0	1	0	0	0	0	0	1	1
Selenium	Road (1A3b)	[kg]	35	35	36	37	38	38	40	42	41
Selenium	Railways (1A3c)	[kg]	1	1	1	1	1	1	1	1	1
Selenium	Navigation (1A3d)	[kg]	28	27	26	26	27	27	26	26	26
Selenium	Residential (1A4b)	[kg]	0	0	1	1	1	1	1	1	1
Selenium	Ag./for./fish. (1A4c)	[kg]	38	36	39	37	29	34	31	28	32
Selenium	Military (1A5)	[kg]	0	0	0	0	1	1	0	1	0
Selenium	Navigation int. (1A3d)	[kg]	431	354	273	297	245	267	370	396	329
Selenium	Civil Aviation int. (1A3a)	[kg]	8	8	7	7	8	8	8	8	8
Zinc	Industry-Other (1A2f)	[kg]	256	259	262	265	267	279	302	323	333
Zinc	Civil Aviation (1A3a)	[kg]	49	52	45	44	41	43	45	51	52
Zinc	Road (1A3b)	[kg]	3523	3530	3572	3714	3812	3844	3966	4158	4083
Zinc	Railways (1A3c)	[kg]	72	67	67	69	68	73	72	72	75
Zinc	Navigation (1A3d)	[kg]	96	94	94	95	98	97	95	94	94
Zinc	Residential (1A4b)	[kg]	40	45	50	57	64	69	73	74	75
Zinc	Ag./for./fish. (1A4c)	[kg]	423	421	428	423	409	423	425	438	466
Zinc	Military (1A5)	[kg]	35	31	28	29	76	86	40	55	34
Zinc	Navigation int. (1A3d)	[kg]	997	821	639	693	570	616	848	904	756
Zinc	Civil Aviation int. (1A3a)	[kg]	745	756	653	679	776	816	819	839	838
Dioxins/furans	Industry-Other (1A2f)	[g]	0	0	0	0	0	0	0	0	0
Dioxins/furans	Civil Aviation (1A3a)	[g]	0	0	0	0	0	0	0	0	0
Dioxins/furans	Road (1A3b)	[g]	0	0	0	0	0	0	0	0	0
Dioxins/furans	Railways (1A3c)	[g]	0	0	0	0	0	0	0	0	0
Dioxins/furans	Navigation (1A3d)	[g]	0	0	0	0	0	0	0	0	0
Dioxins/furans	Residential (1A4b)	[g]	0	0	0	0	0	0	0	0	0
Dioxins/furans	Ag./for./fish. (1A4c)	[g]	0	0	0	0	0	0	0	0	0
Dioxins/furans	Military (1A5)	[g]	0	0	0	0	0	0	0	0	0
Dioxins/furans	Navigation int. (1A3d)	[g]	1	1	0	1	0	0	1	1	1
Dioxins/furans	Civil Aviation int. (1A3a)	[g]	0	0	0	0	0	0	0	0	0
Flouranthene	Industry-Other (1A2f)	[kg]	48	48	49	49	50	52	56	60	62
Flouranthene	Civil Aviation (1A3a)	[kg]	0	0	0	0	0	0	0	0	0
Flouranthene	Road (1A3b)	[kg]	577	561	565	596	623	636	667	731	735
Flouranthene	Railways (1A3c)	[kg]	4	4	4	4	4	4	4	4	5
Flouranthene	Navigation (1A3d)	[kg]	42	41	40	40	42	41	40	40	40
Flouranthene	Residential (1A4b)	[kg]	8	9	10	11	12	13	14	14	14
Flouranthene	Ag./for./fish. (1A4c)	[kg]	118	115	119	116	105	112	110	108	118
Flouranthene	Military (1A5)	[kg]	2	4	2	3	6	6	3	3	3
Flouranthene	Navigation int. (1A3d)	[kg]	306	266	232	238	191	188	227	226	212
Flouranthene	Civil Aviation int. (1A3a)	[kg]	0	0	0	0	0	0	0	0	0
Benzo(b) flouranthene	Industry-Other (1A2f)	[kg]	6	6	6	6	6	6	7	7	7
Benzo(b) flouranthene	Civil Aviation (1A3a)	[kg]	0	0	0	0	0	0	0	0	0
Benzo(b) flouranthene	Road (1A3b)	[kg]	60	59	59	62	64	66	69	74	73
Benzo(b) flouranthene	Railways (1A3c)	[kg]	1	1	1	1	1	1	1	1	1

Benzo(b) flouranthene	Navigation (1A3d)	[kg]	4	3	3	3	4	4	3	3	3
Benzo(b) flouranthene	Residential (1A4b)	[kg]	0	0	0	1	1	1	1	1	1
Benzo(b) flouranthene	Ag./for./fish. (1A4c)	[kg]	12	12	12	12	11	12	11	11	12
Benzo(b) flouranthene	Military (1A5)	[kg]	0	0	0	0	1	1	0	0	0
Benzo(b) flouranthene	Navigation int. (1A3d)	[kg]	21	19	17	17	14	13	15	14	14
Benzo(b) flouranthene	Civil Aviation int. (1A3a)	[kg]	0	0	0	0	0	0	0	0	0
Benzo(k) flouranthene	Industry-Other (1A2f)	[kg]	6	5	5	6	6	6	6	7	7
Benzo(k) flouranthene	Civil Aviation (1A3a)	[kg]	0	0	0	0	0	0	0	0	0
Benzo(k) flouranthene	Road (1A3b)	[kg]	68	68	69	72	75	76	80	86	85
Benzo(k) flouranthene	Railways (1A3c)	[kg]	1	1	1	1	1	1	1	1	1
Benzo(k) flouranthene	Navigation (1A3d)	[kg]	2	2	2	2	2	2	2	2	2
Benzo(k) flouranthene	Residential (1A4b)	[kg]	0	0	0	0	0	0	0	0	0
Benzo(k) flouranthene	Ag./for./fish. (1A4c)	[kg]	9	9	9	9	9	9	9	9	10
Benzo(k) flouranthene	Military (1A5)	[kg]	0	0	0	0	1	1	0	0	0
Benzo(k) flouranthene	Navigation int. (1A3d)	[kg]	10	9	8	8	6	6	7	6	6
Benzo(k) flouranthene	Civil Aviation int. (1A3a)	[kg]	0	0	0	0	0	0	0	0	0
Benzo(a) pyrene	Industry-Other (1A2f)	[kg]	3	3	3	3	3	3	3	4	4
Benzo(a) pyrene	Civil Aviation (1A3a)	[kg]	0	0	0	0	0	0	0	0	0
Benzo(a) pyrene	Road (1A3b)	[kg]	42	41	42	44	47	47	50	54	54
Benzo(a) pyrene	Railways (1A3c)	[kg]	0	0	0	0	0	0	0	0	0
Benzo(a) pyrene	Navigation (1A3d)	[kg]	1	1	1	1	1	1	1	1	1
Benzo(a) pyrene	Residential (1A4b)	[kg]	0	0	0	0	0	0	0	0	0
Benzo(a) pyrene	Ag./for./fish. (1A4c)	[kg]	5	5	5	5	5	5	5	5	5
Benzo(a) pyrene	Military (1A5)	[kg]	0	0	0	0	0	0	0	0	0
Benzo(a) pyrene	Navigation int. (1A3d)	[kg]	6	5	4	5	4	4	4	4	4
Benzo(a) pyrene	Civil Aviation int. (1A3a)	[kg]	0	0	0	0	0	0	0	0	0
Benzo(g,h,i) perylene	Industry-Other (1A2f)	[kg]	5	5	5	5	5	6	6	6	7
Benzo(g,h,i) perylene	Civil Aviation (1A3a)	[kg]	0	0	0	0	0	0	0	0	0
Benzo(g,h,i) perylene	Road (1A3b)	[kg]	82	80	81	85	89	90	93	101	102
Benzo(g,h,i) perylene	Railways (1A3c)	[kg]	0	0	0	0	0	0	0	0	0
Benzo(g,h,i) perylene	Navigation (1A3d)	[kg]	7	7	7	7	7	7	7	7	7
Benzo(g,h,i) perylene	Residential (1A4b)	[kg]	1	1	2	2	2	2	2	2	2
Benzo(g,h,i) perylene	Ag./for./fish. (1A4c)	[kg]	18	17	18	17	15	16	16	15	17
Benzo(g,h,i) perylene	Military (1A5)	[kg]	0	0	0	0	1	1	0	0	0
Benzo(g,h,i) perylene	Navigation int. (1A3d)	[kg]	41	37	35	35	28	25	27	25	26
Benzo(g,h,i) perylene	Civil Aviation int. (1A3a)	[kg]	0	0	0	0	0	0	0	0	0
indeno(1,2,3-c,d) pyrene	Industry-Other (1A2f)	[kg]	3	3	3	3	3	3	3	4	4
indeno(1,2,3-c,d) pyrene	Civil Aviation (1A3a)	[kg]	0	0	0	0	0	0	0	0	0
indeno(1,2,3-c,d) pyrene	Road (1A3b)	[kg]	47	46	47	50	52	53	55	59	59
indeno(1,2,3-c,d) pyrene	Railways (1A3c)	[kg]	0	0	0	0	0	0	0	0	0
indeno(1,2,3-c,d) pyrene	Navigation (1A3d)	[kg]	6	5	5	5	5	5	5	5	5
indeno(1,2,3-c,d) pyrene	Residential (1A4b)	[kg]	0	0	1	1	1	1	1	1	1
indeno(1,2,3-c,d) pyrene	Ag./for./fish. (1A4c)	[kg]	13	12	13	12	10	12	11	10	12
indeno(1,2,3-c,d) pyrene	Military (1A5)	[kg]	0	0	0	0	0	0	0	0	0

indeno(1,2,3-c,d) pyrene	Navigation int. (1A3d)	[kg]	34	30	29	29	23	21	22	20	21
indeno(1,2,3-c,d) pyrene	Civil Aviation int. (1A3a)	[kg]	0	0	0	0	0	0	0	0	0

Annex 3B-16: Percentage distribution of new sold heavy duty trucks into Euro classes

1. reg. year	Conv.	I	II	III	IV	V	VI	Total
1991	100	0	0	0	0	0	0	100
1992	100	0	0	0	0	0	0	100
1993	75	25	0	0	0	0	0	100
1994	0	100	0	0	0	0	0	100
1995	0	100	0	0	0	0	0	100
1996	0	75	25	0	0	0	0	100
1997	0	0	100	0	0	0	0	100
1998	0	0	100	0	0	0	0	100
1999	0	0	100	0	0	0	0	100
2000	0	0	75	25	0	0	0	100
2001	0	0	43	57	0	0	0	100
2002	0	0	2	98	0	0	0	100
2003	0	0	1	99	0	0	0	100
2004	0	0	1	99	0	0	0	100
2005	0	0	0	96	3	1	0	100
2006	0	0	0	81	14	5	0	100
2007	0	0	0	2	71	27	0	100
2008	0	0	0	0	50	50	0	100
2009	0	0	0	0	25	75	0	100
2010	0	0	0	0	0	100	0	100
2011	0	0	0	0	0	100	0	100
2012	0	0	0	0	0	100	0	100
2013	0	0	0	0	0	100	0	100
2014	0	0	0	0	0	75	25	100
2015	0	0	0	0	0	0	100	100

Annex 3B-17: Uncertainty estimates

Uncertainty estimation, CO_2

	Gas	Base year emission	Year t emission	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in year t	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
		Input data	Input data	Input data	Input data							
		Gg	Gg	%	%	%	%	%	%	%	%	%
Road transport	CO_2	9275	12948	2	5	5,385	4,110	0,095154	0,9591	0,4758	2,7128	2,7542
Military	CO_2	119	108	2	5	5,385	0,034	-0,0031055	0,0080	-0,0155	0,0225	0,0274
Railways	CO_2	297	237	2	5	5,385	0,075	-0,0100855	0,0175	-0,0504	0,0496	0,0707
Navigation (small boats)	CO_2	48	101	41	5	41,304	0,245	0,00298619	0,0074	0,0149	0,4318	0,4320
Navigation (large vessels)	CO_2	666	353	11	5	12,083	0,251	-0,0358132	0,0261	-0,1791	0,4063	0,4440
Fisheries	CO_2	591	449	2	5	5,385	0,143	-0,0216771	0,0333	-0,1084	0,0942	0,1436
Agriculture	CO_2	1272	1230	24	5	24,515	1,778	-0,0272924	0,0911	-0,1365	3,0927	3,0957
Forestry	CO_2	36	17	30	5	30,414	0,031	-0,0020481	0,0013	-0,0102	0,0540	0,0550
Industry (mobile)	CO_2	842	1119	41	5	41,304	2,724	0,00453053	0,0829	0,0227	4,8045	4,8045
Residential	CO_2	113	239	35	5	35,355	0,498	0,0072036	0,0177	0,0360	0,8762	0,8769
Civil aviation	CO_2	243	164	10	5	11,180	0,108	-0,0104526	0,0121	-0,0523	0,1716	0,1794
		13.500	16964				27,885					41,4667
				Year (%):			**5,281**			**Trend (%):**		**6,439**

Uncertainty estimation, CH_4

	Gas	Base year emission	Year t emission	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in year t	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
		Input data	Input data	Input data	Input data							
		Mg	Mg	%	%	%	%	%	%	%	%	%
Road transport	CH_4	2623	1046	2	40	40,050	28,519	-0,074379	0,3458	-2,9752	0,9780	3,1318
Military	CH_4	5	5	2	100	100,020	0,327	0,00074807	0,0016	0,0748	0,0045	0,0749
Railways	CH_4	12	8	2	100	100,020	0,535	0,00062059	0,0026	0,0621	0,0073	0,0625
Navigation (small boats)	CH_4	17	24	41	100	108,079	1,798	0,00542618	0,0081	0,5426	0,4684	0,7168
Navigation (large vessels)	CH_4	14	7	11	100	100,603	0,501	0,00015152	0,0024	0,0152	0,0376	0,0405
Fisheries	CH_4	13	11	2	100	100,020	0,744	0,0015152	0,0036	0,1515	0,0102	0,1519
Agriculture	CH_4	105	76	24	100	102,840	5,309	0,00826014	0,0251	0,8260	0,8509	1,1859
Forestry	CH_4	21	4	30	100	104,403	0,311	-0,0019241	0,0014	-0,1924	0,0613	0,2019
Industry (mobile)	CH_4	60	41	41	100	108,079	3,015	0,00396863	0,0135	0,3969	0,7854	0,8800
Residential	CH_4	150	240	35	100	105,948	17,334	0,05538191	0,0794	5,5382	3,9322	6,7922
Civil aviation	CH_4	7	6	10	100	100,499	0,415	0,00084405	0,0020	0,0844	0,0284	0,0890
		3026	1470				1155,788					58,7190
				Year (%):			**33,997**		**Trend (%):**			**7,663**

Uncertainty estimation, N_2O

	Gas	Base year emission	Year t emission	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in year t	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
		Input data	Input data	Input data	Input data							
		Mg	Mg	%	%	%	%	%	%	%	%	%
Road transport	N_2O	313	405	2	50	50,040	34,850	0,08308086	0,8084	4,1540	2,2866	4,7418
Military	N_2O	4	4	2	1000	1000,002	6,273	-0,0013322	0,0073	-1,3322	0,0206	1,3323
Railways	N_2O	8	7	2	1000	1000,002	11,215	-0,0059207	0,0130	-5,9207	0,0368	5,9208
Navigation (small boats)	N_2O	1	3	41	1000	1000,840	5,953	0,00399614	0,0069	3,9961	0,4003	4,0161
Navigation (large vessels)	N_2O	42	22	11	1000	1000,060	38,314	-0,0526099	0,0445	-52,6099	0,6918	52,6144
Fisheries	N_2O	37	28	2	1000	1000,002	48,808	-0,0292325	0,0567	-29,2325	0,1602	29,2329
Agriculture	N_2O	49	52	24	1000	1000,288	89,409	-0,010301	0,1038	-10,3010	3,5216	10,8863
Forestry	N_2O	1	1	30	1000	1000,450	0,932	-0,0002163	0,0011	-0,2163	0,0459	0,2211
Industry (mobile)	N_2O	34	47	41	1000	1000,840	81,458	0,01516444	0,0945	15,1644	5,4780	16,1235
Residential	N_2O	2	4	35	1000	1000,612	6,417	0,0034708	0,0074	3,4708	0,3685	3,4903
Civil aviation	N_2O	10	9	10	1000	1000,050	14,883	-0,0065509	0,0173	-6,5509	0,2443	6,5555
		501	582				20158,101					4131,9715
				Year (%):			**141,979**			**Trend (%):**		**64,280**

Annex 3C Industry Processes

No annexes for industrial processes in this submission.

Annex 3D Agriculture

Background data for estimation of CH_4 emission from Enteric Fermentation

Table 3D.1 Grassing animals 1990 – 2008, number of days on grass pr year.

Livestock category	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Dairy cattle	55	55	55	55	55	55	55	55	55	55
Heifer > ½ year	165	171	177	184	190	196	196	196	196	196
Suckling cattle	184	192	200	208	216	224	224	224	224	224
Sheep and gotas	265	265	265	265	265	265	265	265	265	265
Horses	183	183	183	183	183	183	183	183	183	183
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
Dairy cattle	55	55	55	46	39	32	25	18	18	
Heifer > ½ year	196	196	196	180	168	156	144	132	132	
Suckling cattle	224	224	224	224	224	224	224	224	224	
Sheep and gotas	265	265	265	265	265	265	265	265	265	
Horses	183	183	183	183	183	183	183	183	183	

Table 3D.2a Average gross energy intake (GE) 1990 – 2008, MJ pr head pr year.

Livestock category	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Dairy cattle	278.2	282.4	286.7	290.9	295.3	295.6	295.8	295.9	297.9	297.8
Non-dairy cattle (heifer)	107.3	106.9	106.5	106.1	105.7	105.3	105.3	105.5	105.4	105.3
Sheep (mother sheep incl. lambs)	43.6	43.6	43.6	43.6	43.6	43.6	43.6	43.6	43.6	43.6
Goats (mother goats incl. kids)	40.1	40.1	40.1	40.1	40.1	40.1	40.1	40.1	40.1	40.1
Horses (600 kg)	130.1	130.1	130.1	130.1	130.1	130.1	130.1	130.1	130.1	130.1
Swine (slaughtering pig)	43.3	42.2	41.4	40.8	38.9	38.9	38.9	38.9	38.1	38.1
Poultry (broilers)	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
Other:										
Deer	34.5	34.5	34.5	34.5	34.5	34.5	34.5	34.5	34.5	34.5
Fur farming (mink)	6.3	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
Dairy cattle	297.9	304.2	310.5	317.8	323.5	328.7	331.9	335.1	335.3	
Non-dairy cattle (heifer)	105.3	105.3	105.8	107.3	108.3	115.6	123.1	130.5	130.5	
Sheep (mother sheep incl. lambs)	43.6	43.6	43.6	43.6	43.6	43.6	43.6	43.6	43.6	
Goats (mother goats incl. kids)	40.1	40.1	40.1	40.1	40.1	40.1	40.1	39.1	39.8	
Horses (600 kg)	130.1	130.1	130.1	130.1	130.1	130.1	130.1	133.0	133.0	
Swine (slaughtering pig)	38.1	39.2	39.2	38.9	39.1	38.9	39.9	40.7	39.9	
Poultry (broilers)	1.3	1.3	1.3	1.4	1.4	1.5	1.5	1.3	1.3	
Other:										
Deer	34.5	34.5	34.5	34.5	34.5	34.5	34.5	34.5	34.5	
Fur farming (mink)	6.2	6.2	6.2	6.3	6.3	6.8	6.7	6.7	6.9	

Table 3D.2b Average gross energy intake (GE) 1990 – 2008, MJ pr head pr year – Subcategories for cattle and swine.

Subcategories for cattle and swine	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Cattle										
Dairy, large breed	285.8	289.9	294.1	298.3	302.4	302.4	302.4	302.4	304.1	304.1
Dairy, Jersey	237.2	240.6	244.0	247.4	250.7	250.7	250.7	250.7	253.2	253.2
Calves, bull	59.6	59.8	59.9	60.0	60.1	60.2	60.2	60.3	60.4	60.4
Calves, heifer	86.2	86.3	86.5	86.6	86.7	87.0	87.1	87.0	86.3	86.3
Bulls > ½ year	113.6	113.7	113.9	114.0	114.2	114.3	114.4	114.5	114.6	114.6
Heifer > ½ year	107.3	106.9	106.5	106.1	105.7	105.3	105.3	105.5	105.4	105.3
Suckling cattle	181.7	179.4	177.1	174.8	172.5	170.2	170.2	170.2	170.2	170.2
Swine										
Sows (incl. pigs < 7.5 kg)	62.3	62.3	62.3	62.3	62.3	62.3	62.3	62.3	64.2	64.2
Piglets (7.5 – 30 kg)	11.1	11.7	12.2	12.7	13.2	13.2	13.2	13.2	13.8	13.8
Slaughtering pigs (30 – 104 kg)	43.3	42.2	41.4	40.8	38.9	38.9	38.9	38.9	38.1	38.1
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
Cattle										
Dairy, large breed	304.1	310.6	317.1	324.9	330.6	335.9	338.7	341.5	341.8	
Dairy, Jersey	253.2	258.1	262.9	269.1	274.7	278.8	284.7	290.5	290.6	
Calves, bull	60.4	61.5	61.5	61.4	61.5	61.6	61.4	61.5	61.7	
Calves, heifer	86.3	85.6	85.7	85.6	85.6	91.3	96.8	102.4	102.4	
Bulls > ½ year	114.7	115.6	115.6	115.8	115.6	115.8	115.9	115.8	116.0	
Heifer > ½ year	105.3	105.3	105.8	107.3	108.3	115.6	123.1	130.5	130.5	
Suckling cattle	170.2	170.2	170.2	170.2	160.9	160.9	160.9	163.6	163.6	
Swine										
Sows (incl. pigs < 7.5 kg)	64.2	66.6	66.6	69.3	69.1	69.5	70.5	71.4	71.1	
Piglets (7.5 – 30 kg)	13.8	13.8	13.8	13.2	13.6	13.8	14.4	14.6	15.2	
Slaughtering pigs (30 – 104 kg)	38.1	39.2	39.2	38.9	39.1	38.9	39.9	40.7	39.9	

Table 3D.3a Average CH_4 conversion rate (Y_m) – national factor used for dairy cattle and heifer > ½ year 1990 – 2008, %.

Dairy cattle + Heifer > ½ year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Ym - average	6.39	6.35	6.29	6.24	6.19	6.16	6.11	6.09	6.06	6.02
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
Ym - average	6.00	5.98	5.96	5.95	5.95	5.94	5.93	5.93	5.94	

Table 3D.3b Area grown with sugar beet and maize for feeding.

Area, ha	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Sugar beet for feeding	102 347	93 170	80 979	70 993	60 380	52 927	41 347	37 414	32 188	22 917
Maize for feeding	18 735	19 164	20 245	26 187	31 269	36 583	41 652	42 701	46 992	48 452
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
Sugar beet for feeding	17 577	13 302	9 953	7 991	6 233	4 974	4 035	3 819	5 206	
Maize for feeding	61 493	78 814	95 741	118 267	129 317	131 027	135 245	144 869	159 030	

Background data for estimation of CH_4 emission from Manure Management

Table 3D.4a VS daily excretion (average) 1990 – 2008, kg dm pr head pr day – CRF categories.

365 stable days	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Livestock category										
Dairy cattle	5.46	5.49	5.51	5.54	5.57	5.59	5.62	5.68	5.75	5.75
Non-dairy cattle (weighted average)	1.78	1.82	1.85	1.90	1.90	1.93	1.95	1.97	1.98	2.00
Sheep (mother sheep incl. lambs)	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12
Goats (mother goats incl. kids)	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06
Horses	3.93	3.93	3.93	3.93	3.93	3.93	3.93	3.93	3.93	3.93
Swine (weighted average)	0.23	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.21	0.21
Poultry (weighted average)	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003
Fur farming	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
Deer	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72

Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008
Livestock category									
Dairy cattle	5.69	5.69	5.90	6.02	6.14	6.37	6.28	6.13	6.13
Non-dairy cattle (weighted average)	2.04	2.10	2.12	2.65	2.66	2.70	2.73	2.87	2.82
Sheep (mother sheep incl. lambs)	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12
Goats (mother goats incl. kids)	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.05	1.07
Horses	3.93	3.93	3.93	3.93	3.93	3.93	3.93	3.65	3.65
Swine (weighted average)	0.21	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22
Poultry (weighted average)	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003
Fur farming	0.09	0.09	0.08	0.08	0.08	0.08	0.08	0.08	0.08
Deer	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72

Table 3D.4b VS daily excretion (average) 1990 – 2008, kg dm pr head pr day – Subcategories.

365 stable days	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Cattle:										
Dairy cattle	5.46	5.49	5.51	5.54	5.57	5.59	5.62	5.68	5.75	5.75
Calves, bull	1.49	1.49	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
Bulls > ½ year	1.95	2.03	2.12	2.21	2.29	2.38	2.46	2.55	2.64	2.68
Calves, heifer	1.29	1.29	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30
Heifer > ½ year	1.90	1.94	1.98	2.02	2.06	2.10	2.14	2.17	2.16	2.15
Suckling cattle	6.72	6.51	6.30	6.09	5.88	5.67	5.65	5.63	5.61	5.61
Swine:										
Sows (incl. pigs < 7.5 kg)	0.44	0.43	0.44	0.44	0.44	0.45	0.46	0.47	0.48	0.49
Piglets (7.5 – 30 kg)	0.11	0.11	0.11	0.11	0.11	0.11	0.10	0.10	0.10	0.10
Slaughtering pigs (30 – 104 kg)	0.34	0.34	0.34	0.33	0.33	0.33	0.33	0.32	0.32	0.32
Poultry:										
Hens	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Pullet	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003
Broilers	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
Turkeys, geeses and ducks	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.01

Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008
Cattle:									
Dairy cattle	5.69	5.69	5.90	6.02	6.14	6.37	6.28	6.13	6.13
Calves, bull	1.51	1.53	1.53	1.52	1.53	1.53	1.53	1.53	1.53
Bulls > ½ year	2.79	2.92	3.02	3.07	3.20	3.60	3.61	4.02	3.84
Calves, heifer	1.30	1.30	1.30	1.69	1.69	1.69	1.70	1.80	1.80
Heifer > ½ year	2.18	2.18	2.18	2.58	2.69	2.70	2.75	2.99	2.99
Suckling cattle	5.64	5.66	5.95	6.04	5.52	4.91	4.91	4.14	4.14
Swine:									
Sows (incl. pigs < 7.5 kg)	0.51	0.52	0.56	0.59	0.59	0.36	0.36	0.34	0.34
Piglets (7.5 – 30 kg)	0.10	0.10	0.10	0.10	0.10	0.11	0.11	0.11	0.11
Slaughtering pigs (30 – 104 kg)	0.32	0.32	0.32	0.32	0.33	0.35	0.35	0.34	0.34
Poultry:									
Hens	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Pullet	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.004	0.004
Broilers	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
Turkeys, geeses and ducks	0.02	0.01	0.01	0.01	0.01	0.02	0.01	0.02	0.02

Table 3D.5 Changes in stable type 1990 – 2008.

Livestock categories	Stable type	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
											pct									
Horses		100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Cattle																				
Bull, 0-6 mth.	Deep litter (boxes)	100	100	100	100	100	100	100	100	100	100	100	91	86	82	77	95	95	97	97
	Deep litter, solid floor	0	0	0	0	0	0	0	0	0	0	0	9	14	18	23	5	5	3	3
Bull, 6 mth -440 kg	Tethered with liquid and solid manure	20	19	17	16	15	14	13	12	11	11	10	9	8	8	7	9	9	4	4
	Tethered with slurry	20	19	17	16	15	14	13	12	11	11	10	9	8	8	7	2	2	1	1
	Slatted floor-boxes	41	40	40	39	38	37	37	36	35	34	33	32	31	30	28	31	31	30	30
	Deep litter (all)	3	2	2	2	2	1	1	0	0	0	0	0	0	0	0	47	47	57	57
	Deep litter, solid floor	10	12	15	17	19	21	22	25	27	29	33	37	41	45	48	8	8	5	5
	Deep litter, slatted floor	4	5	6	7	8	8	9	10	11	10	9	8	7	5	6	1	1	1	1
	Deep litter, slatted floor, scrapes	1	1	1	1	1	2	2	2	2	2	2	2	2	1	1	0	0	1	1
	Deep litter, solid floor, scrapes	1	2	2	2	2	3	3	3	3	3	3	3	3	3	3	2	2	0	0
	Deep litter, long eating space, solid floor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
	Boxes with sloping bedded floor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0 (0.1)	0 (0.1)
Heifer, 0-6 mth.	Deep litter (boxes)	100	100	100	100	100	100	100	100	100	100	100	89	84	83	80	93	93	96	96
	Deep litter, solid floor	0	0	0	0	0	0	0	0	0	0	0	11	16	17	20	7	7	4	4
Heifer, 6 mth.-calving	Tethered with liquid and solid manure	19	18	17	16	14	13	12	11	10	10	9	8	7	7	5	14	14	7	7
	Tethered with slurry	19	18	17	16	14	13	12	11	10	10	9	8	7	7	5	5	5	2	2
	Slatted floor-boxes	40	39	38	37	36	35	34	33	33	32	32	31	30	30	29	23	23	38	38
	Loose-housing with beds, slatted floor	4	4	5	6	6	7	8	10	12	13	14	17	20	21	23	19	19	12	12
	Deep litter (all)	3	3	2	2	2	1	1	0	0	0	0	0	0	0	0	30	30	24	24
	Deep litter, solid floor	9	12	13	14	16	18	22	24	24	24	25	26	26	26	28	3	3	1	1
	Deep litter, slatted floor	4	4	5	6	7	7	7	7	6	6	6	5	5	5	5	3	3	2	2
	Deep litter, slatted floor, scrapes	1	1	1	1	1	1	1	1	2	2	2	2	2	1	2	2	2	2	2
	Deep litter, solid floor, scrapes	1	1	2	2	2	3	3	3	3	3	3	3	3	3	3	1	1	0	0
Livestock categories	Stable type	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
											pct									
Heifer, 6 mth.-calving	Loose-housing with beds, solid floor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	5
	Loose-housing with beds, slatted floor, scarpes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	5
	Deep litter, long eating space, solid floor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2

Continued	Boxes with sloping bedded floor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0 (0.1)	0 (0.1)
Dairy cows	Tethered with liquid and solid manure	35	35	34	33	32	31	30	30	30	30	18	15	12	8	6	12	12	7	7
	Tethered with slurry	44	43	43	43	43	42	42	36	30	30	28	25	23	18	16	14	14	10	10
	Loose-holding with beds, slatted floor	13	14	15	15	16	17	18	21	24	24	34	36	39	42	44	44	44	41	41
	Loose-holding with beds, slatted floor, scrapes	1	1	1	1	1	1	1	2	3	3	3	4	4	5	6	11	11	19	19
	Loose-holding with beds, solid floor	4	3	3	3	3	3	3	3	3	3	6	9	11	16	17	11	11	13	13
	Deep litter (all)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2
	Deep litter, slatted floor	3	3	3	4	4	5	5	6	8	8	7	7	7	7	7	4	4	3	3
	Deep litter, slatted floor, scrapes	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	2	2	2	2
	Deep litter, solid floor, scrapes	0	1	1	1	1	1	1	2	1	1	3	3	3	3	3	0	0	0	0
	Loose-holding with beds, drained floor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0(0.1)	0(0.1)
	Loose-holding with beds, solid floor with tilt	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
	Deep litter, long eating space, solid floor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2
Suckling cattle	Tethered with liquid and solid manure	10	10	10	10	10	10	10	10	10	10	9	8	7	4	5	30	30	18	18
	Deep litter (all)	73	69	66	62	59	55	52	48	45	45	45	44	43	44	43	35	35	65	65
	Deep litter, solid floor	17	21	24	28	31	35	38	42	45	45	46	48	50	52	52	35	35	2	2
	Tethered with slurry	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	9
	Deep litter, long eating space, solid floor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
	Deep litter, slatted floor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2

Livestock categories	Stable type	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
											pct									
Suckling cattle	Deep litter, slatted floor, scrapes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2
	Boxes with sloping bedded floor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Sheep and goats																				
Sheep	Deep litter (all)	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Goats	Deep litter (all)	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Swine																				
Sows	Full slatted floor	9	10	10	11	12	12	13	14	14	14	13	13	13	12	12	13	13	12	12
(incl. 22-25 pigs to 7.5 kg)	Partly slatted floor	56	57	57	57	57	57	57	57	57	57	56	55	54	53	51	70	70	73	73
	Solid floor	30	28	25	23	20	18	15	13	10	9	7	6	6	6	5	4	4	2	2

Continued	Deep litter	5	5	5	6	6	7	7	8	8	9	10	10	10	10	11	2	2	2	2
	Deep litter + slatted floor	0	0	1	1	2	2	3	3	4	4	6	7	8	9	10	8	8	8	8
	Deep litter + solid floor	0	0	1	1	2	2	3	3	4	4	5	6	7	8	9	1	1	1	1
	Outdoor sows	0	0	1	1	1	2	2	2	3	3	3	3	2	2	2	2	2	2	2
Piglets, 7.5-30 kg	Fully slatted floor	54	57	60	56	54	51	49	46	43	40	38	36	35	33	31	23	23	26	26
	Partly slatted floor	20	20	20	24	27	31	34	37	41	45	47	49	50	52	54	66	66	63	63
	Solid floor	21	18	15	14	13	11	9	8	7	5	5	5	5	5	5	3	3	1	1
	Deep litter (to-clima stables)	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	4	4	3	3
	Deep litter + slatted floor	0	0	0	1	1	2	3	4	4	5	5	5	5	5	5	4	4	0	0
	Partly slatted and drained floor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	7
Slaugther pigs, 30-105 kg	Fully slatted floor	51	56	60	60	60	60	60	60	60	60	58	57	56	55	53	49	49	53	53
	Partly slatted floor	23	21	20	21	23	24	25	26	28	29	31	33	34	35	38	38	38	34	34
	Solid floor	22	19	15	14	12	11	9	8	6	5	5	4	4	4	3	7	7	4	4
	Deep litter	4	4	5	4	4	3	3	2	2	1	1	1	1	1	1	5	5	4	4
	Partly slatted floor and partly deep litter	0	0	0	1	1	2	3	4	4	5	5	5	5	5	5	1	1	1	1
	Partly slatted and drained floor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	4

Livestock categories	Stable type	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
											pct									
Poultry																				
Outdoor hens		0	1	2	4	5	6	7	8	9	9	9	9	7	8	7	7	7	8	8
Ecological hens		0	1	2	4	5	6	7	10	12	15	15	15	15	16	16	16	16	19	19
Scrabe hens		11	11	12	12	12	13	14	15	17	18	18	18	19	18	20	20	20	19	19
Battery hens, manure house		54	52	49	46	44	42	39	36	32	29	26	26	23	23	20	20	20	7	36
Battery hens, manure tank		12	12	11	10	9	8	7	6	5	5	5	5	4	5	4	4	4	36	7
Battery hens, manure cellar		23	23	24	24	25	25	26	25	25	24	27	27	32	30	33	33	33	11	11
HPR-hens (egg for hatching)		100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Pullet, consumption, net		17	16	15	14	13	12	11	10	8	7	8	7	6	7	5	5	5	7	7
Pullet, consumption, floor		57	58	59	60	61	62	63	64	66	67	69	68	69	68	69	69	69	73	73
Pullet, egg for hatching		26	26	26	26	26	26	26	26	26	26	23	25	25	25	26	26	26	20	20
Broilers, (conv. 30 days)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Broilers, (conv. 32 days)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1

Continued																				
Broilers, (conv. 35 days)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	77	77
Broilers, (conv. 40 days)		100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	99	99	22	22
Broilers, (conv. 45 days)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Broilers, skrabe (56 days)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0
Ecological broilers (81 days)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Turkey, male		50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
Turkey, female		50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
Ducks		100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Geese		100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Fur farming																				
Mink	Slurry system	18	20	20	22	23	25	26	27	29	30	42	50	55	60	65	70	70	91	91
	Solid manure and black liquid	82	80	80	78	77	75	74	73	71	70	58	50	45	40	35	30	30	9	9
Foxes	Slurry system	0	0	0	0	0	0	0	0	0	0	2	5	10	15	30	0	0	0	0
	Solid manure and black liquid	100	100	100	100	100	100	100	100	100	100	98	95	90	85	70	100	100	100	100
Cattle																				
	Tethered in stables	79	78	77	75	74	73	72	66	60	60	46	40	35	26	22	26	26	17	17
	Loose-housing with beds	18	18	19	20	21	21	22	26	30	30	43	49	54	63	67	66	66	74	74
	Deep litter	3	4	4	5	5	6	6	8	10	10	11	11	11	11	11	8	8	9	9
Livestock categories	Stable type	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
											pct									
Swine																				
	Fully slatted floor	51	56	60	60	60	60	60	60	60	60	58	57	56	55	53	49	49	53	53
	Partly slatted floor	23	21	20	21	23	24	25	26	28	29	31	33	34	35	38	38	38	39	39
	Solid floor	22	19	15	14	12	11	9	8	6	5	5	4	4	4	3	7	7	4	4
	Deep litter	4	4	5	5	5	5	6	6	6	6	6	6	6	6	6	6	6	4	4

Reference: 1990 – 2004 = The Danish Agricultural Advisory Centre, 2005-2008 = The Danish Plant Directorate

Table 3D.6 Background data for estimation of N_2O emission from crop residue 2008.

	Stubble	Husks	Top	Leafs	Frequency of ploughing	Nitrogen content in crop residue	
Crop type	kg N pr ha	kg N pr ha	kg N pr ha	kg N pr ha	No. of year before ploughing	kg N pr ha pr yr	Gg N pr yr
Winter wheat	6.3	10.7	-	-	1	17.0	10.86
Spring wheat	6.3	7.4	-	-	1	13.7	0.15
Winter rye	6.3	10.7	-	-	1	17.0	0.53
Triticale	6.3	10.7	-	-	1	17.0	0.77
Winter barley	6.3	5.9	-	-	1	11.3	1.54
Spring barley	6.3	4.1	-	-	1	10.4	6.04
Oats	6.3	4.1	-	-	1	10.4	0.75
Winter rape	4.4	-	-	-	1	4.4	0.76
Spring rape	4.4	-	-	-	1	4.4	0.00
Potatoes (top), non-harvest	-	-	48.7	-	1	48.7	2.06
Beet (top), non-harvest	-	-	56.7[a]	-	1	56.7	2.35
Straw, non-harvest	-	-	-	-	1	5.3[a]	8.05
Pulse	11.3	-	-	-	1	11.3	0.06
Lucerne	32.3	-	-	-	3	10.8	0.04
Maize – for green fodder	6.3	-	-	-	1	6.3	1.00
Cereal – for green fodder	6.3	-	-	-	1	6.3	0.33
Peas for canning	11.3	-	-	-	1	11.3	0.04
Vegetable	11.3	-	-	-	1	11.3	0.08
Grass- and clover fiel in rotation	32.3		-	10.0	2	26.2	7.85
Grass- and clover field out of rotation	38.8		-	20.0	-	20.0	3.80
Aftermath	6.3	-	-	-	1	6.3	0.72
Seeds of grass crops	6.3	10.7	-	-	2	13.9	0.99
Set-a-side	38.8	-	-	15.0	10	18.9	1.33
Total N from crop residue - 2007							50.10

[a] express the yield for 2008 - varies from year to year. Based on yield data from Statistics Denmark and N-content from the feeding plan.
Reference: Djurhuus and Hansen 2003

Table 3D.7 Background data for reduction in CH_4 and N_2O from manure management by biogas plants.

	Joint biogas plant, TJ	Farm biogas plant, TJ	Total, TJ	Slurry (Est. amount), Mt	Slurry, Mt[a]	Slurry, Mt	VS Slurry, Mt	VS Slurry, Mt	Reduction in VS, Gg VS	Reduction in VS, Gg VS	CH_4 reduction, Gg	CH_4 reduction, Gg	CH_4 reduction, Gg	N_2O reduction, Gg	N_2O reduction, Gg	N_2O reduction, Gg	CO_2 eqv., Mt
				Total	Cattle	Swine	Cattle	Swine	Cattle	Swine	Cattle	Swine	Total	Cattle	Swine	Total	
1985	NO										NO	NO	NO	NO	NO	NO	NO
1986	NO										NO	NO	NO	NO	NO	NO	NO
1987	NO										NO	NO	NO	NO	NO	NO	NO
1988	NE										NO	NO	NO	NO	NO	NO	NO
1989	NE										NO	NO	NO	NO	NO	NO	NO
1990	211	19	230	0.19	0.09	0.10	0.0070	0.0051	2.1136	2.5498	0.03	0.08	0.111	0.0021	0.0028	0.0049	0.004
1991	369	19	388	0.32	0.14	0.18	0.0119	0.0086	3.5597	4.2944	0.06	0.13	0.187	0.0035	0.0048	0.0082	0.006
1992	449	24	473	0.39	0.18	0.21	0.0145	0.0105	4.3384	5.2338	0.07	0.16	0.228	0.0042	0.0058	0.0101	0.008
1993	529	27	556	0.46	0.21	0.25	0.0171	0.0123	5.1170	6.1732	0.08	0.19	0.268	0.0050	0.0068	0.0119	0.009
1994	632	26	658	0.54	0.24	0.30	0.0200	0.0145	6.0070	7.2468	0.10	0.22	0.315	0.0059	0.0080	0.0139	0.011
1995	745	27	772	0.64	0.29	0.35	0.0237	0.0172	7.1194	8.5888	0.11	0.26	0.373	0.0070	0.0095	0.0165	0.013
1996	803	27	830	0.69	0.31	0.38	0.0256	0.0185	7.6756	9.2598	0.12	0.28	0.403	0.0075	0.0103	0.0178	0.014
1997	973	32	1 005	0.83	0.37	0.46	0.0308	0.0223	9.2329	11.1386	0.15	0.34	0.484	0.0090	0.0123	0.0214	0.017
1998	1 166	56	1 222	1.01	0.45	0.56	0.0375	0.0271	11.2352	13.5542	0.18	0.41	0.589	0.0110	0.0150	0.0260	0.020
1999	1 183	70	1 253	1.04	0.47	0.57	0.0386	0.0279	11.5690	13.9568	0.19	0.42	0.607	0.0113	0.0155	0.0268	0.021
2000	1 279	129	1 408	1.16	0.52	0.64	0.0430	0.0311	12.9038	15.5672	0.21	0.47	0.677	0.0126	0.0173	0.0299	0.023
2001	1 345	179	1 524	1.26	0.57	0.69	0.0467	0.0338	14.0162	16.9092	0.23	0.51	0.735	0.0137	0.0187	0.0325	0.026
2002	1 403	344	1 747	1.44	0.65	0.79	0.0534	0.0386	16.0186	19.3248	0.26	0.58	0.840	0.0157	0.0214	0.0371	0.029
2003	1 508	625	2 133	1.76	0.79	0.97	0.0653	0.0472	19.5782	23.6192	0.31	0.71	1.027	0.0192	0.0262	0.0454	0.036
2004	1 531	745	2 276	1.9	0.85	1.03	0.0697	0.0505	20.9131	25.2296	0.34	0.76	1.097	0.0205	0.0280	0.0485	0.038
2005	1 593	745	2 338	1.9	0.87	1.06	0.0716	0.0518	21.4693	25.9006	0.35	0.78	1.126	0.0210	0.0287	0.0497	0.039
2006	1 678	907	2 585	2.1	0.96	1.18	0.0794	0.0574	23.8054	28.7188	0.38	0.87	1.249	0.0233	0.0318	0.0552	0.043
2007	1 699	904	2 603	2.2	0.97	1.18	0.0798	0.0578	23.9398	28.8810	0.38	0.87	1.256	0.0234	0.0320	0.0555	0.044
2008	1739	907	2646	2.2	0.98	1.20	0.0811	0.0587	24.3352	29.3581	0.39	0.89	1.276	0.0238	0.0325	0.0564	0.044

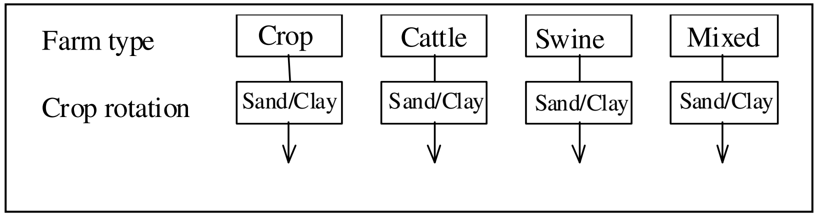
[a] Cattle slurry 45 % of estimated amount slurry, swine 55 %

Nitrogen leaching and Run-off

Calculations of nitrogen lost by leaching and run-off are based on two models described in Børgesen and Grant (2003) (in Danish). The model SKEP/DAISY is a dynamic model, N-LES is an empirical model and SKEP is an up scaling model. The SKEP/DAISY calculations were done for 10 scenarios (the years 1984, 1989 and 1995-2002) and the N-LES calculations were done for an 11 year period (1990-2000). Both calculations were up scaled nation wide. The key parameters for the models were land use, nitrogen from synthetic fertilizer and manure, application practice for manure and NH_3 evaporation at application of manure (SKEP/DAISY only). The calculations were normalised to an average climate. A schematic overview of the models is seen below.

Model calculation of nitrogen leaching nationwide by SKEP/DAISY and N-LES

Basic DAISY calculations of N-leaching



Each crop rotation calculates for:
6 climate regions
30 fertilizer plan
4 soil type (here 2 w/w.out water)

} 38.000 combinations

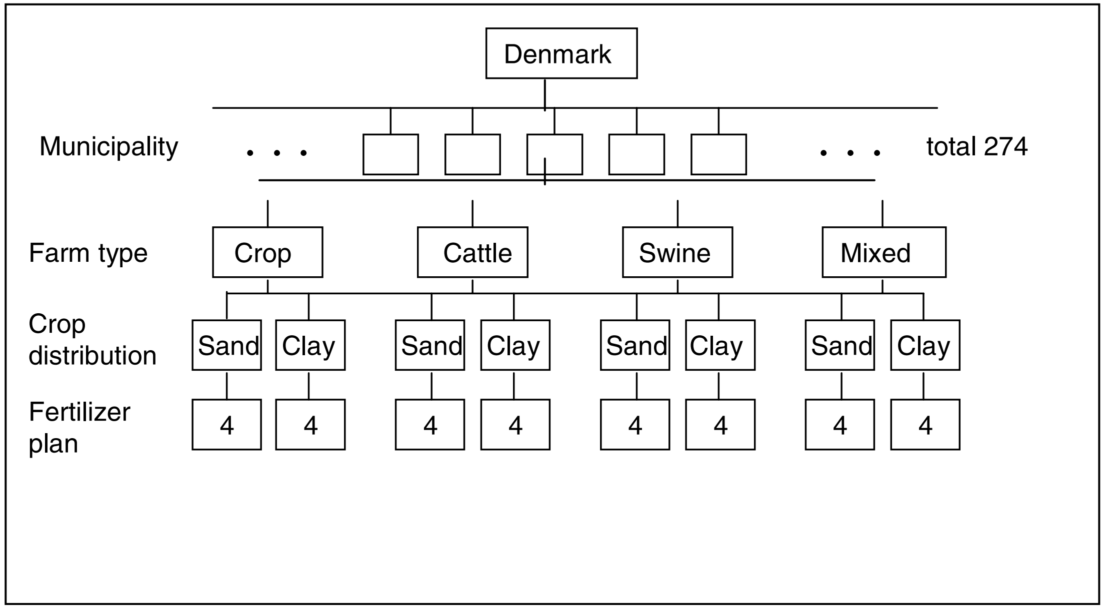
Data base
Calculation for all combinations for each of 4 climate year
Calculation for 12 combinations for each year in a 11 years period (1989-2001).

N-LES calculations

Model calculations for the crop rotations and fertilizer planes in SKEP plus appurtenant percolations from the DAISY calculations. Model calculations for each of the 11 years in the period 1989-2001, mean of the 11 years is up scaled nationwide by SKEP

Up scaling by the SKEP model

In the up scaling of DAISY calculations a climate normalisation and yield correction is made



Annex 3E LULUCF

This year all information is included in Chapter 7 and Chapter 11 of the NIR.

Annex 3F Waste

The starting year for the FOD model used is 1960 for historic data for waste amounts. The record of ISAG registration of waste amounts does not go back in time that far, but for the time-series 1990-2008 to be reported here this does not play a bigger role as regards time-series consistency.

In Table 3F.1 results from the calculations by the model for selected years 1970-1979 to illustrate how the model performs: The left two columns represent the time-series of potential emissions. The actual emissions are in the next column as total. In the "from year"columns are put the contribution of emissions from individual previous years to the actual years emission (the Total). The contribution from the deposited waste in 1970 with its potential emission in 1970 (= 110.0) to the actual emissions in 1970 is 0, since in this model formulation the emission starts the year after. In 1971 the contribution from the 1970 deposited waste is 5.31. In 1972 it is 5.06 and so on. Summing up the contribution from the potential of the year 1970 until 1984 equals 55 corresponding to a half-life time of 14 years; i.e. half of the potential emission of 110.0 in 1970 is emitted after 14 years. The reason for in this illustration to go back in time to from 1970 to 1984 is simply that this is a way in one illustration in a small table to illustrate the behaviours of the model.

Table 3F.1 Results from the FOD model 1970-1984.

	Emissioner [kt]																									
	Po ten tiel	Actual																								
			From year																							
Year		Total	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
1970	110.0	41.0	3.09	3.28	3.48	3.70	3.92	4.16	4.41	4.68	4.96	5.27														
1971	111.0	44.3	2.94	3.12	3.32	3.52	3.73	3.96	4.20	4.46	4.73	5.01	5.31													
1972	112.0	47.5	2.80	2.97	3.16	3.35	3.55	3.77	4.00	4.24	4.50	4.77	5.06	5.36												
1973	113.0	50.6	2.67	2.83	3.00	3.19	3.38	3.59	3.80	4.04	4.28	4.54	4.81	5.10	5.41											
1974	114.0	53.6	2.54	2.69	2.86	3.03	3.22	3.41	3.62	3.84	4.07	4.32	4.58	4.86	5.15	5.46										
1975	115.0	56.6	2.42	2.56	2.72	2.89	3.06	3.25	3.45	3.65	3.88	4.11	4.36	4.62	4.90	5.19	5.51									
1976	116.0	59.4	2.30	2.44	2.59	2.75	2.91	3.09	3.28	3.48	3.69	3.91	4.15	4.40	4.66	4.94	5.24	5.56								
1977	117.0	62.1	2.19	2.32	2.46	2.61	2.77	2.94	3.12	3.31	3.51	3.72	3.95	4.19	4.44	4.71	4.99	5.29	5.60							
1978	118.0	64.8	2.08	2.21	2.34	2.49	2.64	2.80	2.97	3.15	3.34	3.54	3.76	3.98	4.22	4.48	4.75	5.03	5.33	5.65						
1979	119.0	67.3	1.98	2.10	2.23	2.37	2.51	2.66	2.83	3.00	3.18	3.37	3.58	3.79	4.02	4.26	4.52	4.79	5.08	5.38	5.70					
1980	120.0	69.8	1.89	2.00	2.12	2.25	2.39	2.54	2.69	2.85	3.03	3.21	3.40	3.61	3.83	4.06	4.30	4.56	4.83	5.12	5.42	5.75				
1981	121.0	72.3	1.79	1.90	2.02	2.14	2.28	2.41	2.56	2.72	2.88	3.05	3.24	3.43	3.64	3.86	4.09	4.34	4.60	4.87	5.16	5.47	5.80			
1982	122.0	74.6	1.71	1.81	1.92	2.04	2.17	2.30	2.44	2.58	2.74	2.91	3.08	3.27	3.46	3.67	3.89	4.13	4.37	4.64	4.91	5.21	5.52	5.84		
1983	123.0	76.9	1.63	1.72	1.83	1.94	2.06	2.19	2.32	2.46	2.61	2.77	2.93	3.11	3.30	3.50	3.71	3.93	4.16	4.41	4.68	4.95	5.25	5.56	5.89	
1984	124.0	79.1	1.55	1.64	1.74	1.85	1.96	2.08	2.21	2.34	2.48	2.63	2.79	2.96	3.14	3.33	3.53	3.74	3.96	4.20	4.45	4.72	5.00	5.29	5.61	5.94
											total		55.0													

The result of summing this table horizontally in the "from years" columns is the total actual emission of that year.

Annex 3G Solvents

The National Atmospheric Inventory for Great Britain (http://www.naei.org.uk/) covers the following sectors and chemicals:

Total emission
Energy Production
Comm+ Residn Combusn.
Industrial Combustion
Production Processes
Extr & Distrib of Fossil Fuels
Solvent Use
Road Transport
Other Transp & Mach
Waste Treatment & Disp
Nature (Forests)

1 (1-methylethyl)cyclohexane
2 (1-methylpropyl)cyclohexane
3 (2-methyl-1-propyl)acetate
4 (2-methylbutyl)cyclohexane
5 (2-methylpropyl)cyclohexane
6 1-(2-butoxy-1-methyl-ethoxy)-2-propanol
7 1-(2-ethoxy-1-methyl-ethoxy)-2-propanol
8 1-(2-methoxy-1-methyl-ethoxy)2-propanol
9 1-(butoxyethoxy)-2-propanol
10 1,1,1-trichloroethane
11 1,1,1-trichlorotrifluoroethane
12 1,1,2,2-tetrachloroethane
13 1,1,2-trimethylcyclohexane
14 1,1,2-trimethylcyclopentane
15 1,1,3-trimethylcyclohexane
16 1,1,4,4-tetramethylcyclohexane
17 1,1-dichloroethane
18 1,1-dichloroethene
19 1,1-dichlorotetrafluoroethane
20 1,1-dimethylcyclohexane
21 1,1-dimethylcyclopentane
22 1,2,3,4-tetrahydronaphthalene
23 1,2,3,4-tetramethylbenzene
24 1,2,3,5-tetramethylbenzene
25 1,2,3,5-tetramethylcyclohexane
26 1,2,3-trichlorobenzene
27 1,2,3-trimethylbenzene
28 1,2,3-trimethylcyclohexane
29 1,2,3-trimethylcyclopentane
30 1,2,4,4-tetramethylcyclopentane
31 1,2,4,5-tetramethylbenzene
32 1,2,4-trichlorobenzene
33 1,2,4-trimethlycyclopentane
34 1,2,4-trimethylbenzene
35 1,2,4-trimethylcyclohexane
36 1,2,4-trimethylcyclopentane
37 1,2-diaminoethane
38 1,2-dibromoethane
39 1,2-dichlorobenzene

40 1,2-dichloroethane
41 1,2-dichloroethene
42 1,2-dichlorotetrafluoroethane
43 1,2-dimethyl-3-isopropylcyclopentane
44 1,2-dimethylcyclohexane
45 1,2-dimethylcyclopentane
46 1,2-ethanedioldiacetate
47 1,2-ethylmethylcyclopentane
48 1,2-propanediol
49 1,3,4,5,6-pentahydroxy-2-hexanone
50 1,3,5-trichlorobenzene
51 1,3,5-trimethylbenzene
52 1,3,5-trimethylcyclohexane
53 1,3-butadiene
54 1,3-dichlorobenzene
55 1,3-diethylbenzene
56 1,3-dimethyl-4-ethylbenzene
57 1,3-dimethyl-5-propylbenzene
58 1,3-dimethylcyclohexane
59 1,3-dimethylcyclopentane
60 1,3-dioxolane
61 1,3-ethylmethylcyclopentane
62 1,3-hexadiene
63 1,4-butyrolacetone
64 1,4-dichlorobenzene
65 1,4-diethylbenzene
66 1,4-dimethyl-2-isopropylbenzene
67 1,4-dimethylcyclohexane
68 1,4-dimethylpiperazine
69 1,4-dioxane
70 11-methyl-1-dodecanol
71 1-butanal
72 1-butanol
73 1-butene
74 1-butoxy-2-propanol
75 1-butyne
76 1-chloro-2,3-epoxypropane
77 1-chloro-4-nitrobenzene
78 1-chloropropane
79 1-decene
80 1-ethoxy-2-propanol
81 1-ethoxy-2-propyl acetate
82 1-ethyl-1,4-dimethylcyclohexane
83 1-ethyl-2,2,6-trimethylcyclohexane
84 1-ethyl-2,3-dimethylbenzene
85 1-ethyl-2,3-dimethylcyclohexane
86 1-ethyl-2-propylbenzene
87 1-ethyl-2-propylcyclohexane
88 1-ethyl-3,5-dimethylbenzene
89 1-ethyl-3-methylcyclohexane
90 1-ethyl-4-methylcyclohexane
91 1-ethylpropylbenzene
92 1-heptene
93 1-hexanal
94 1-hexene
95 1-hydrophenol

96 1-methoxy-2-ethanol
97 1-methoxy-2-propanol
98 1-methoxy-2-propyl acetate
99 1-methyl-1-phenylcyclopropane
100 1-methyl-1-propylcyclopentane
101 1-methyl-2-isopropylbenzene
102 1-methyl-2-propylbenzene
103 1-methyl-3-(isopropyl)benzene
104 1-methyl-3-isopropylcyclopentane
105 1-methyl-3-propylbenzene
106 1-methyl-4-isopropylbenzene
107 1-methyl-4-isopropylcyclohexane
108 1-methyl-4-tertbutylbenzene
109 1-methylbutylbenzene
110 1-methylindan
111 1-methylindene
112 1-nonene
113 1-octene
114 1-pentanal
115 1-pentanol
116 1-pentene
117 1-propanal
118 1-propanol
119 2-(2-aminoethylamino)ethanol
120 2-(2-butoxyethoxy)ethanol
121 2-(2-butoxyethoxy)ethyl acetate
122 2-(2-ethoxyethoxy)ethanol
123 2-(2-ethoxyethoxy)ethyl acetate
124 2-(2-hydroxy-ethoxy)ethanol
125 2-(2-hydroxy-propoxy)-1-propanol
126 2-(methoxyethoxy)ethanol
127 2,2,3,3-tetramethylhexane
128 2,2,4,6,6-pentamethylheptane
129 2,2,4-trimethyl-1,3-pentanediol
130 2,2,4-trimethylpentane
131 2,2,5-trimethylhexane
132 2,2-dimethylbutane
133 2,2-dimethylhexane
134 2,2-dimethylpentane
135 2,2-dimethylpropane
136 2,2′-iminodi(ethylamine)
137 2,2′-iminodiethanol
138 2,3,3,4-tetramethylpentane
139 2,3,3-trimethyl-1-butene
140 2,3,4-trimethylhexane
141 2,3,4-trimethylpentane
142 2,3,5-trimethylhexane
143 2,3-dimethylbutane
144 2,3-dimethylfuran
145 2,3-dimethylheptane
146 2,3-dimethylhexane
147 2,3-dimethylnonane
148 2,3-dimethyloctane
149 2,3-dimethylpentane
150 2,3-dimethylundecane
151 2,4,6-trichloro-1,3,5-triazine

152 2,4-difluoroaniline
153 2,4-dimethyl-1-(1-methylethyl)benzene
154 2,4-dimethylfuran
155 2,4-dimethylheptane
156 2,4-dimethylhexane
157 2,4-dimethylpentane
158 2,4-toluene diisocyanate
159 2,5-dimethyldecane
160 2,5-dimethylfuran
161 2,5-dimethylheptane
162 2,5-dimethylhexane
163 2,5-dimethyloctane
164 2,6-dimethyldecane
165 2,6-dimethylheptane
166 2,6-dimethyloctane
167 2,6-dimethylundecane
168 2,6-toluene diisocyanate
169 2,7-dimethyloctane
170 2-[2-(2-ethoxy-ethoxy)-ethoxy]ethanol
171 2-acetoxy-propyl acetate
172 2-aminoethanol
173 2-butanol
174 2-butanone
175 2-butanone oxime
176 2-butene
177 2-butoxyethanol
178 2-butoxyethyl acetate
179 2-chloroethanol
180 2-chloropropane
181 2-chlorotoluene
182 2-ethoxyethanol
183 2-ethoxyethyl acetate
184 2-ethoxypropanol
185 2-ethyl hexanol
186 2-ethyl-1,3-dimethylbenzene
187 2-ethyltoluene
188 2-hexoxyethanol
189 2-hydrophenol
190 2-isopropoxyethanol
191 2-methoxy-2-methylpropane
192 2-methoxyethanol
193 2-methoxyethyl acetate
194 2-methoxypropane
195 2-methyl benzaldehyde
196 2-methyl-1,3-dioxolane
197 2-methyl-1-butene
198 2-methyl-1-butylbenzene
199 2-methyl-1-pentene
200 2-methyl-1-propanol
201 2-methyl-2,4-pentanediol
202 2-methyl-2-butene
203 2-methyl-2-hexene
204 2-methyl-5-ethyloctane
205 2-methylbutanal
206 2-methylbutane
207 2-methyldecalin

208 2-methyldecane
209 2-methylfuran
210 2-methylheptane
211 2-methylhexane
212 2-methylnonane
213 2-methyloctane
214 2-methylpentane
215 2-methylpropanal
216 2-methylpropane
217 2-methylpropenal
218 2-methylpropene
219 2-methylpropyl acetate
220 2-methylpyridine
221 2-methylundecane
222 2-pentanone
223 2-pentene
224 2-phenoxy ethanol
225 2-phenylpropene
226 2-propanol
227 2-propen-1-ol
228 2-propyl acetate
229 3-(2-hydroxy-propoxy)-1-propanol
230 3,3,4-trimethylhexane
231 3,3,5-trimethylheptane
232 3,3-dimethylheptane
233 3,3-dimethyloctane
234 3,3-dimethylpentane
235 3,4-dimethylheptane
236 3,4-dimethylhexane
237 3,5-dimethyloctane
238 3,6-dimethyloctane
239 3,7-dimethylnonane
240 3A,4,7,7A-tetrahydro-4,7-methanoindene
241 3-chloro-4-fluoropicoline
242 3-chloropropene
243 3-chloropyridine
244 3-ethyl-2-methylheptane
245 3-ethyl-2-methylhexane
246 3-ethylheptane
247 3-ethylhexane
248 3-ethyloctane
249 3-ethylpentane
250 3-ethyltoluene
251 3-hydrophenol
252 3-methyl benzaldehyde
253 3-methyl-1-butene
254 3-methylbutanal
255 3-methylbutanol
256 3-methyldecane
257 3-methylfuran
258 3-methylheptane
259 3-methylhexane
260 3-methylnonane
261 3-methyloctane
262 3-methylpentane
263 3-methylundecane

264 3-pentanone
265 4,4-dimethylheptane
266 4,4′-methylenedianiline
267 4,5-dimethylnonane
268 4,6-dimethylindan
269 4,7-dimethylindan
270 4-4′-methylenediphenyl diisocyanate
271 4-bromophenyl acetate
272 4-chlorotoluene
273 4-ethyl morpholine
274 4-ethyl-1,2-dimethylbenzene
275 4-ethyloctane
276 4-ethyltoluene
277 4-methyl benzaldehyde
278 4-methyl-1,3-dioxol-2-one
279 4-methyl-1-pentene
280 4-methyl-2-pentanol
281 4-methyl-2-pentanone
282 4-methyl-4-hydroxy-2-pentanone
283 4-methyldecane
284 4-methylheptane
285 4-methylnonane
286 4-methyloctane
287 4-methylpentene
288 4-propylheptane
289 5-methyl-2-hexanone
290 5-methyldecane
291 5-methylnonane
292 5-methylundecane
293 6-ethyl-2-methyldecane
294 6-ethyl-2-methyloctane
295 6-methylundecane
296 8-methyl-1-nonanol
297 acenaphthene
298 acenaphthylene
299 acetaldehyde
300 acetic acid
301 acetic anhydride
302 acetone
303 acetonitrile
304 acetyl chloride
305 acetylene
306 acrolein
307 acrylamide
308 acrylic acid
309 acrylonitrile
310 aniline
311 anthanthrene
312 anthracene
313 atrazine
314 benzaldehyde
315 benzene
316 benzene-1,2,4-tricarboxylic acid 1,2-
317 benzo (a) anthracene
318 benzo (a) pyrene
319 benzo (b) fluoranthene

320 benzo (c) phenanthrene
321 benzo (e) pyrene
322 benzo (g,h,i) fluoranthene
323 benzo (g,h,i) perylene
324 benzo (k) fluoranthene
325 benzophenone
326 benzopyrenes
327 benzyl alcohol
328 benzyl chloride
329 biphenyl
330 bis(2-hydroxyethyl)ether
331 bis(chloromethyl)ether
332 bis(tributyltin) oxide
333 bromoethane
334 bromoethene
335 bromomethane
336 butane
337 butanethiols
338 butene
339 butoxyl
340 butyl acetate
341 butyl acrylate
342 butyl glycolate
343 butyl lactate
344 butylbenzene
345 butylcyclohexane
346 butyrolactone
347 C10 alkanes
348 C10 alkenes
349 C10 aromatic hydrocarbons
350 C10 cycloalkanes
351 C11 alkanes
352 C11 alkenes
353 C11 aromatic hydrocarbons
354 C11 cycloalkanes
355 C12 alkanes
356 C12 cycloalkanes
357 C13 alkanes
358 C13+ alkanes
359 C13+ aromatic hydrocarbons
360 C14 alkanes
361 C15 alkanes
362 C16 alkanes
363 C2-alkyl-anthracenes
364 C2-alkyl-benzanthracenes
365 C2-alkyl-benzophenanthrenes
366 C2-alkyl-chrysenes
367 C2-alkyl-phenanthrenes
368 C5 alkenes
369 C6 alkenes
370 C7 alkanes
371 C7 alkenes
372 C7 cycloalkanes
373 C8 alkanes
374 C8 alkenes
375 C8 cycloalkanes

376 C9 alkanes
377 C9 alkenes
378 C9 aromatic hydrocarbons
379 C9 cycloalkanes
380 camphor/fenchone
381 carbon disulphide
382 carbon tetrachloride
383 carbonyl sulphide
384 chlorobenzene
385 chlorobutane
386 chlorocyclohexane
387 chlorodifluoromethane
388 chloroethane
389 chloroethene
390 chloroethylene
391 chlorofluoromethane
392 chloromethane
393 chrysene
394 cis-1,3-dimethylcyclopentane
395 cis-2-butene
396 cis-2-hexene
397 cis-2-pentene
398 coronene
399 crotonaldehyde
400 cycloheptane
401 cyclohexanamine
402 cyclohexane
403 cyclohexanol
404 cyclohexanone
405 cyclopenta (c,d) pyrene
406 cyclopenta-anthracenes
407 cyclopentane
408 cyclopenta-phenanthrenes
409 cyclopentene
410 decalin
411 decane
412 diacetoneketogulonic acid
413 diazinon
414 dibenzanthracenes
415 dibenzo (a,h) anthracene
416 dibenzopyrenes
417 dichlorobutenes
418 dichlorodifluoromethane
419 dichlorofluoromethane
420 dichloromethane
421 dichlorvos
422 diethyl disulphide
423 diethyl ether
424 diethyl sulphate
425 diethylamine
426 diethylbenzene
427 difluoromethane
428 dihydroxyacetone
429 diisopropyl ether
430 diisopropylbenzene
431 dimethoxymethane

432 dimethyl disulphide
433 dimethyl esters
434 dimethyl ether
435 dimethyl sulphate
436 dimethyl sulphide
437 dimethylamine
438 dimethylbutene
439 dimethylcyclopentane
440 dimethylformamide
441 dimethylhexene
442 dimethylnonane
443 dimethylpentane
444 dipentene
445 dipropyl ether
446 dodecane
447 ethane
448 ethanethiol
449 ethanol
450 ethofumesate
451 ethyl acetate
452 ethyl acrylate
453 ethyl butanoate
454 ethyl chloroformate
455 ethyl hexanol
456 ethyl lactate
457 ethyl pentanoate
458 ethyl propionate
459 ethylamine
460 ethylbenzene
461 ethylcyclohexane
462 ethylcyclopentane
463 ethyldimethylbenzene
464 ethylene
465 ethylene glycol
466 ethylene oxide
467 ethylisopropylbenzene
468 fenitrothion
469 fluoranthene
470 fluorene
471 formaldehyde
472 formanilide
473 formic acid
474 fumaric acid
475 glycerol
476 glyoxal
477 heptadecane
478 heptane
479 hexachlorocyclohexane
480 hexachloroethane
481 hexadecane
482 hexafluoropropene
483 hexamethylcyclotrisiloxane
484 hexamethyldisilane
485 hexamethyldisiloxane
486 hexamethylenediamine
487 hexane

488 hexylcyclohexane
489 indan
490 indeno (1,2,3-c,d) pyrene
491 iodomethane
492 isobutylbenzene
493 isobutylcyclohexane
494 isopentylbenzene
495 isophorone
496 isoprene
497 isoprene + BVOC (1)
498 isopropylbenzene
499 isopropylcyclohexane
500 limonene
501 malathion
502 maleic anhydride
503 m-cresol
504 menthene
505 methacrylic acid
506 methanethiol
507 methanol
508 methyl acetate
509 methyl acrylate
510 methyl butanoate
511 methyl ethyl ether
512 methyl formate
513 methyl glyoxal
514 methyl methacrylate
515 methyl naphthalenes
516 methyl pentanoate
517 methyl styrene
518 methylamine
519 methyl-anthracenes
520 methyl-benzanthracenes
521 methyl-benzphenanthrenes
522 methylcyclodecane
523 methylcyclohexane
524 methylcyclopentane
525 methylethylbenzene
526 methyl-fluoranthenes
527 methylhexane
528 methylindane
529 methyl-phenanthrenes
530 methylpropene
531 methylpropylbenzene
532 methyltetralin
533 m-xylene
534 N-(hydroxymethyl) acrylamide
535 N,N-diethyl benzenamine
536 N,N-dimethyl benzenamine
537 naphthalene
538 naphthol
539 Nedocromil Sodium
540 nitrobenzene
541 nitromethane
542 nitropentane
543 nitropropane

544 N-methyl pyrrolidone
545 nonane
546 o-cresol
547 octahydroindan
548 octamethylcyclotetrasiloxane
549 octane
550 octylamine
551 o-xylene
552 palmitic acid
553 p-benzoquinone
554 p-cresol
555 pentadecane
556 pentafluoroethane
557 pentane
558 pentanethiols
559 pentylbenzene
560 pentylcyclohexane
561 permethrin
562 perylene
563 phenol
564 phenoxyacetic acid (phenoxy acid)
565 phenylacetic acid
566 phenylacetonitrile
567 phthalic anhydride
568 pine oil
569 polyethylene glycol
570 polyisobutene
571 polyvinyl chloride
572 potassium phenylacetate
573 propadiene
574 propane
575 propanetriol
576 propanoic acid
577 propionitrile
578 propyl acetate
579 propyl butanoate
580 propyl propionate
581 propylamine
582 propylbenzene
583 propylcyclohexane
584 propylcyclopentane
585 propylene
586 propylene oxide
587 propyne
588 p-xylene
589 pyrene
590 pyridine
591 salicylic acid
592 sec-butylbenzene
593 sec-butylcyclohexane
594 simazine
595 sodium 2-ethylhexanoate
596 sodium acetate
597 sodium phenylacetate
598 styrene
599 sulphanilamide

600 terpenes
601 tert-butylamine
602 tert-butylbenzene
603 tert-butylcyclohexane
604 tert-butylcyclopropane
605 tert-pentylbenzene
606 tetrachloroethene
607 tetradecane
608 tetrafluoroethene
609 tetrahydrofuran
611 tetramethylcyclohexane
612 toluene
613 toluene-2,3-diamine
614 toluene-2,4-diamine
615 toluene-2,4-diisocyanate
616 toluene-2,5-diamine
617 toluene-2,6-diamine
618 toluene-2,6-diisocyanate
619 toluene-3,4-diamine
620 toluene-3,5-diamine
621 trans-2-butene
622 trans-2-hexene
623 trans-2-pentene
624 trans-3-hexene
625 trialkyl phosphate
626 trichloroethene
627 trichlorofluoromethane
628 trichloromethane
629 tridecane
630 triethanolamine
631 triethylamine
632 trifluoroethene
633 trifluoromethane
634 trifluralin
635 trimethylamine
636 trimethylfluorosilane
637 tri-n-butyl phosphate
638 undecane
639 unspeciated alcohols
640 unspeciated aliphatic hydrocarbons
641 unspeciated alkanes
642 unspeciated alkenes
643 unspeciated amines
644 unspeciated aromatic hydrocarbons
645 unspeciated carboxylic acids
646 unspeciated cycloalkanes
647 unspeciated hydrocarbons
648 unspeciated ketones
649 urea
650 vinyl acetate
(1) BVOC- biogenic VOCs, such as alpha-pinene and other terpenes

Annex 4 CO_2 reference approach and comparison with sectoral approach, and relevant information on the national energy balance

Please refer to Chapter 3.4.

Annex 5 Assessment of completeness and (potential) sources and sinks of greenhouse gas emissions and removals excluded

GHG inventory

The Danish greenhouse gas emission inventories for 1990-2008 include all sources identified by the Revised 1996 IPCC Guidelines and the 2000 IPCC Good Practice Guidance except the following:

CO_2 emissions from iron foundries have not yet been estimated. Denmark is currently working on determining the technologies applied at Danish iron foundries. The emission estimates for CO_2 from iron foundries is still under development.

In the Solvent and other product use sector currently only N_2O emissions from anaesthesia are included in CRF category 3D, Denmark will try to obtain activity data for other uses of N_2O.

In the Agriculture sector methane emissions from enteric fermentation for poultry, fur farming, ostriches and pheasants is not estimated, because the methane conversion factor is not estimated. There is no default value recommended in IPCC GPG (Table A-4). However, these emissions are seen as non-significant compared with the total emission from enteric fermentation.

Methane and nitrous oxide emissions from manure management have not been estimated for ostriches and pheasants. There is no default factors provided in the revised 1996 IPCC Guidelines or IPCC GPG.

Direct and indirect CH_4 emissions from agricultural soils are not estimated. Direct and indirect soil emissions are considered of minor importance for CH_4. No methodology is recommended in IPCC-GPG.

In the LULUCF sector emissions/removals from many types of settlements are currently not estimated due to the lack of available data. This will be improved in the next submission. The lack of data availability is also an issue for other aspects of LULUCF, e.g. harvested wood products. For more detail please see chapter 7.

In the Waste sector CO_2 emissions from managed waste disposal on land are not estimated. According to the 1996 IPCC Guidelines: "Decomposition of organic material derived from biomass sources (e.g., crops, forests), which are regrown on an annual basis is the primary source of CO_2 released from waste. Hence, these CO_2 emissions are not treated as net emissions from waste in the IPCC Methodology."

KP-LULUCF inventory

The KP-LULUCF inventory is considered complete. The carbon pools not estimated has been documented as not being sources, please see chapter 11 for further documentation.

Annex 6: Additional information to be considered as part of the annual inventory submission and the supplementary information required under Article 7, paragraph 1, of the Kyoto Protocol or other useful reference information

SEF data allowed to be published according to Commission Regulation (EC) No 2216/2004 of 21 December 2004

Table A.6.1 Summary information on additions and subtractions.

	Additions						Subtractions					
	Unit type						Unit type					
Starting values	AAUs	ERUs	RMUs	CERs	tCERs	lCERs	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Issuance pursuant to Article 3.7 and 3.8	276 838 955											
Non-compliance cancellation							NO	NO	NO	NO		
Carry-over	NO	NO	NO	NO	NO							

Table A.6.2 Annual internal transactions.

	Additions			Subtractions			
	Unit type			Unit type			
Transaction type	AAUs	ERUs	RMUs	AAUs	ERUs	RMUs	CERs
Article 6 issuance and conversion							
Party-verified projects		NO					
Independently verified projects		NO					
Article 3.3 and 3.4 issuance or cancellation							
3.3 Afforestation and reforestation			NO	NO	NO	NO	NO
3.3 Deforestation			NO	NO	NO	NO	NO
3.4 Forest management			NO	NO	NO	NO	NO
3.4 Cropland management			NO	NO	NO	NO	NO
3.4 Grazing land management			NO	NO	NO	NO	NO
3.4 Revegetation			NO	NO	NO	NO	NO

Table A.6.3 Total quantities of Kyoto Protocol units by account type at end of reported year.

	Unit type			
Account type	AAUs	ERUs	RMUs	CERs
Other cancellation accounts	10 394	NO	NO	NO
Retirement account	26 171 207	NO	NO	375 230

DES Response Code	Average number of occurrences per transaction (x 100,000) for the reported year	Average number of occurrences per transaction (x 100,000) for the previous year	Explanation	Transaction Number	Proposal Date Time	Transaction Type Code	Final State	Serial Number	Unit Type	Quantity
4003	814	0	Issue with the message flow, the DK registry is trying to transfer freshly acquired units before the ITL completes the acquisition	DK386284	09/02/2009 14:44:38	3	Terminated	DE-1576275917-1576295916	1	20000
4003				DK386284	09/02/2009 14:44:38	3	Terminated	NL-3207294500-3207295202	1	703
4003				DK386284	09/02/2009 14:44:38	3	Terminated	NL-3207296319-3207296879	1	561
4003				DK386284	09/02/2009 14:44:38	3	Terminated	PT-2242644672-2242647001	1	2330
4003				DK386284	09/02/2009 14:44:38	3	Terminated	RO-2565159067-2565160066	1	1000
4003				DK386284	09/02/2009 14:44:38	3	Terminated	RO-2565172212-2565181211	1	9000
4003				DK386284	09/02/2009 14:44:38	3	Terminated	RO-2568285422-2568285566	1	145
4003				DK386284	09/02/2009 14:44:38	3	Terminated	RO-2568295058-2568295421	1	364
4003				DK386284	09/02/2009 14:44:38	3	Terminated	RO-2571902783-2571904782	1	2000
4003				DK386284	09/02/2009 14:44:38	3	Terminated	SK-450083010-450098009	1	15000
4003				DK386284	09/02/2009 14:44:38	3	Terminated	RO-2572622598-2572624315	1	1718
4003				DK386284	09/02/2009 14:44:38	3	Terminated	RO-2571904783-2571905700	1	918
4003				DK386284	09/02/2009 14:44:38	3	Terminated	RO-2568295422-2568300421	1	5000
4003				DK386284	09/02/2009 14:44:38	3	Terminated	RO-2568290422-2568295057	1	4636
4003				DK386284	09/02/2009 14:44:38	3	Terminated	RO-2568275079-2568275421	1	343
4003				DK386284	09/02/2009 14:44:38	3	Terminated	RO-2565160067-2565160723	1	657
4003				DK386284	09/02/2009 14:44:38	3	Terminated	RO-2565153067-2565159066	1	6000
4003				DK386284	09/02/2009 14:44:38	3	Terminated	RO-2565142785-2565144066	1	1282
4003				DK386284	09/02/2009 14:44:38	3	Terminated	RO-2565131724-2565135066	1	3343
4003				DK386286	09/02/2009 14:57:55	3	Terminated	DE-1576275917-1576295916	1	20000
4003				DK386286	09/02/2009 14:57:55	3	Terminated	RO-2565131724-2565135066	1	3343
4003				DK386286	09/02/2009 14:57:55	3	Terminated	RO-2565153067-2565159066	1	6000
4003				DK386286	09/02/2009 14:57:55	3	Terminated	RO-2565160067-2565160723	1	657
4003				DK386286	09/02/2009 14:57:55	3	Terminated	RO-2568275079-2568275421	1	343
4003				DK386286	09/02/2009 14:57:55	3	Terminated	RO-2568290422-2568295057	1	4636
4003				DK386286	09/02/2009 14:57:55	3	Terminated	SK-450083010-450098009	1	15000

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4003			DK386286	09/02/2009 14:57:55	3	Terminated	RO-2571904783-2571905700	1	918
4003			DK386286	09/02/2009 14:57:55	3	Terminated	RO-2571902783-2571904782	1	2000
4003			DK386286	09/02/2009 14:57:55	3	Terminated	RO-2568295422-2568300421	1	5000
4003			DK386286	09/02/2009 14:57:55	3	Terminated	RO-2568295058-2568295421	1	364
4003			DK386286	09/02/2009 14:57:55	3	Terminated	RO-2568285422-2568285566	1	145
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4003			DK386286	09/02/2009 14:57:55	3	Terminated	PT-2242644672-2242647001	1	2330
4003			DK386286	09/02/2009 14:57:55	3	Terminated	NL-3207294500-3207295202	1	703
4003			DK386286	09/02/2009 14:57:55	3	Terminated	NL-3207296319-3207296879	1	561
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4003	DK389987	19/02/2009 15:39:56	10	Terminated	DE-3441939720-3441943719	1	4000
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4003	DK389987	19/02/2009 15:39:56	10	Terminated	DE-1872661693-1872663105	1	1413
4003	DK389987	19/02/2009 15:39:56	10	Terminated	DE-1872651067-1872655043	1	3977
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4003				DK389987	19/02/2009 15:39:56	10	Terminated	DE-1782159762-1782160363	1	602
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4003				DK389989	19/02/2009 15:48:51	10	Terminated	DE-1782159364-1782159761	1	398
4003				DK389989	19/02/2009 15:48:51	10	Terminated	DE-1782159762-1782160363	1	602
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4003				DK389990	19/02/2009 15:59:02	3	Terminated	DE-1553753105-1553758104	1	5000
4003				DK389990	19/02/2009 15:59:02	3	Terminated	DE-1782159364-1782159761	1	398
4003				DK389990	19/02/2009 15:59:02	3	Terminated	DE-1782166254-1782167019	1	766
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4003				DK389990	19/02/2009 15:59:02	3	Terminated	FR-3363497613-3363498202	1	590

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4003	DK389990	19/02/2009 15:59:02	3	Terminated	FR-3363491578-3363491612	1	35
4003	DK389990	19/02/2009 15:59:02	3	Terminated	FR-3363490613-3363491577	1	965
4003	DK389990	19/02/2009 15:59:02	3	Terminated	FR-3342258298-3342258954	1	657
4003	DK389990	19/02/2009 15:59:02	3	Terminated	FR-3308280600-3308280629	1	30
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4003	DK389990	19/02/2009 15:59:02	3	Terminated	FR-3304586973-3304592972	1	6000
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4003	DK389990	19/02/2009 15:59:02	3	Terminated	ES-1689914550-1689915475	1	926
4003	DK389990	19/02/2009 15:59:02	3	Terminated	DE-1872651067-1872655043	1	3977
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4003	DK389990	19/02/2009 15:59:02	3	Terminated	DE-1546046352-1546058940	1	12589
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4003				DK532978	16/12/2009 13:20:21	10	Terminated	PL-3216826423-3216827422	1	1000
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4010				DK386284	09/02/2009 14:44:38	3	Terminated	RO-2568295058-2568295421	1	364
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4010				DK386284	09/02/2009 14:44:38	3	Terminated	RO-2565160067-2565160723	1	657
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4010				DK429095	12/05/2009 11:03:14	10	Terminated	CZ-1332482719-1332482918	1	200
4010				DK429096	12/05/2009 11:03:14	10	Terminated	CZ-1331639745-1331643732	1	3988
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4010				DK429399	12/05/2009 11:28:31	10	Terminated	CZ-1331639745-1331641671	1	1927
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4010				DK430786	13/05/2009 15:28:25	10	Terminated	DE-1698209491-1698215002	1	5512
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4010				DK432380	14/05/2009 13:42:08	10	Terminated	DE-1694095120-1694095770	1	651
4010				DK432381	14/05/2009 13:42:08	10	Terminated	DE-1694092435-1694092698	1	264
4010				DK432379	14/05/2009 13:42:08	10	Terminated	DE-3596226867-3596229130	1	2264
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4010				DK432388	14/05/2009 13:44:08	10	Terminated	CZ-1331659242-1331660080	1	839
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4010	DK433392	15/05/2009 11:40:04	10	Terminated	DE-1694095120-1694095770	1	651
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4010				DK433687	15/05/2009 12:02:51	10	Terminated	DE-1698209003-1698209285	1	283
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4010				DK433687	15/05/2009 12:02:51	10	Terminated	CZ-1331659242-1331660080	1	839
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4010				DK433687	15/05/2009 12:02:51	10	Terminated	DE-3596228126-3596229130	1	1005
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4010				DK433687	15/05/2009 12:02:51	10	Terminated	DE-1698209491-1698212034	1	2544
4010				DK433690	15/05/2009 12:05:23	10	Terminated	DE-1698209003-1698209285	1	283
4010				DK433696	15/05/2009 12:05:23	10	Terminated	DE-1694092169-1694092434	1	266
4010				DK433698	15/05/2009 12:05:23	10	Terminated	DE-3596225031-3596226866	1	1836
4010				DK433689	15/05/2009 12:05:23	10	Terminated	DE-1698212633-1698213057	1	425
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4010				DK433692	15/05/2009 12:05:23	10	Terminated	DE-3596226923-3596227125	1	203
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4010				DK433694	15/05/2009 12:05:23	10	Terminated	DE-1694092435-1694092698	1	264
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4010				DK433788	15/05/2009 12:22:20	10	Terminated	DE-1694095120-1694095770	1	651
4010				DK433785	15/05/2009 12:22:20	10	Terminated	DE-1698209003-1698209285	1	283
4010				DK433790	15/05/2009 12:22:20	10	Terminated	DE-3596228126-3596229130	1	1005
4010				DK433787	15/05/2009 12:22:20	10	Terminated	DE-3596226923-3596227125	1	203
4010				DK433784	15/05/2009 12:22:20	10	Terminated	DE-1698212633-1698212942	1	310
4010				DK433793	15/05/2009 12:22:20	10	Terminated	DE-3596225031-3596225952	1	922
4010				DK433786	15/05/2009 12:22:21	10	Terminated	DE-3596226867-3596226922	1	56
4010				DK433789	15/05/2009 12:23:05	10	Terminated	DE-1694092435-1694092698	1	264
4010				DK433791	15/05/2009 12:23:05	10	Terminated	DE-1694092169-1694092434	1	266
4010				DK433792	15/05/2009 12:23:05	10	Terminated	DE-1698209491-1698212034	1	2544
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4010				DK434182	15/05/2009 13:14:24	10	Terminated	DE-1698212633-1698212942	1	310
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4010				DK434298	15/05/2009 13:55:57	10	Terminated	CZ-1331658020-1331659241	1	1222
4010				DK434379	15/05/2009 13:55:57	10	Terminated	CZ-1332477919-1332478167	1	249
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4010				DK434380	15/05/2009 13:55:57	10	Terminated	CZ-1332478715-1332482718	1	4004
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4010				DK434485	15/05/2009 14:01:12	10	Terminated	DE-1698209003-1698209285	1	283
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4010				DK434679	15/05/2009 14:34:14	10	Terminated	DE-1698212633-1698212639	1	7
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4010				DK434683	15/05/2009 14:34:16	10	Terminated	DE-1698211460-1698212034	1	575
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4010				DK434782	15/05/2009 14:34:35	10	Terminated	DE-1698212035-1698212632	1	598
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4010	DK434882	15/05/2009 15:09:38	10	Terminated	DE-1698212035-1698212632	1	598
4010	DK434884	15/05/2009 15:09:38	10	Terminated	CZ-1331660081-1331660344	1	264
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4010	DK434786	15/05/2009 15:19:38	10	Terminated	DE-1698215151-1698216102	1	952
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4010				DK436594	19/05/2009 15:27:11	10	Terminated	PT-2215873696-2215874878	1	1183
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4010				DK438798	22/05/2009 13:03:18	3	Terminated	CZ-1303811592-1303812591	1	1000
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4010				DK438798	22/05/2009 13:03:18	3	Terminated	ES-1834337408-1834338162	1	755
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4010				DK532498	16/12/2009 12:31:17	10	Terminated	SK-407155214-407156213	1	1000
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4010				DK532498	16/12/2009 12:31:17	10	Terminated	SK-407144314-407145213	1	900
4010				DK532498	16/12/2009 12:31:17	10	Terminated	SK-407164214-407173313	1	9100
4010				DK532494	16/12/2009 12:41:30	10	Terminated	GB-3995328231-3995330344	1	2114
4010				DK532494	16/12/2009 12:41:30	10	Terminated	GB-3995941731-3995942537	1	807
4010				DK532494	16/12/2009 12:41:30	10	Terminated	IT-2730455890-2730456913	1	1024
4010				DK532494	16/12/2009 12:41:30	10	Terminated	IT-2880096857-2880096917	1	61
4010				DK532494	16/12/2009 12:41:30	10	Terminated	GB-3995321879-3995328230	1	6352
4010				DK532494	16/12/2009 12:41:30	10	Terminated	IT-2913948011-2913951489	1	3479
4010				DK532494	16/12/2009 12:41:30	10	Terminated	IT-2730460979-2730461414	1	436
4010				DK532494	16/12/2009 12:41:30	10	Terminated	GB-3995283330-3995286329	1	3000
4010				DK532494	16/12/2009 12:41:30	10	Terminated	GB-3995375529-3995377255	1	1727
4010				DK532782	16/12/2009 12:50:00	10	Terminated	PL-3216821423-3216829422	1	8000
4010				DK532782	16/12/2009 12:50:00	10	Terminated	PL-3216872423-3216878422	1	6000
4010				DK532789	16/12/2009 12:54:43	3	Terminated	IT-2929613614-2929614613	1	1000
4010				DK532790	16/12/2009 12:55:48	10	Terminated	SK-407141314-407142313	1	1000
4010				DK532790	16/12/2009 12:55:48	10	Terminated	SK-407164214-407173313	1	9100
4010				DK532790	16/12/2009 12:55:48	10	Terminated	SK-407143314-407144313	1	1000

4010	DK532790	16/12/2009 12:55:48	10	Terminated	SK-407142314-407142413	1	100
4010	DK532790	16/12/2009 12:55:48	10	Terminated	SK-407156214-407164213	1	8000
4010	DK532790	16/12/2009 12:55:48	10	Terminated	SK-407142414-407143313	1	900
4010	DK532790	16/12/2009 12:55:48	10	Terminated	SK-407155214-407156213	1	1000
4010	DK532790	16/12/2009 12:55:48	10	Terminated	SK-407145214-407154213	1	9000
4010	DK532790	16/12/2009 12:55:48	10	Terminated	SK-407144314-407145213	1	900
4010	DK532790	16/12/2009 12:55:48	10	Terminated	SK-407154214-407155213	1	1000
4010	DK532984	16/12/2009 13:42:17	10	Terminated	SK-407141314-407142313	1	1000
4010	DK532984	16/12/2009 13:42:17	10	Terminated	SK-407144314-407145213	1	900
4010	DK532984	16/12/2009 13:42:17	10	Terminated	SK-407145214-407154213	1	9000
4010	DK532984	16/12/2009 13:42:17	10	Terminated	SK-407155214-407156213	1	1000
4010	DK532984	16/12/2009 13:42:17	10	Terminated	SK-407142414-407143313	1	900
4010	DK532984	16/12/2009 13:42:17	10	Terminated	SK-407156214-407164213	1	8000
4010	DK532984	16/12/2009 13:42:17	10	Terminated	SK-407142314-407142413	1	100
4010	DK532984	16/12/2009 13:42:17	10	Terminated	SK-407143314-407144313	1	1000
4010	DK532984	16/12/2009 13:42:17	10	Terminated	SK-407154214-407155213	1	1000
4010	DK532984	16/12/2009 13:42:17	10	Terminated	SK-407164214-407173313	1	9100
4010	DK532986	16/12/2009 14:22:17	10	Terminated	GB-3702176325-3702178324	1	2000
4010	DK532987	16/12/2009 14:40:29	10	Terminated	GB-3702176325-3702178324	1	2000
4010	DK532989	16/12/2009 14:47:09	10	Terminated	GB-3702176325-3702178324	1	2000
4010	DK532990	16/12/2009 14:48:55	10	Terminated	GB-3702176325-3702178324	1	2000
4010	DK532992	16/12/2009 15:16:33	10	Terminated	GB-3702176325-3702178324	1	2000
4010	DK532996	16/12/2009 15:37:54	10	Terminated	GB-3702176325-3702178324	1	2000
4010	DK533081	16/12/2009 16:49:46	10	Terminated	SK-407141314-407142313	1	1000
4010	DK533081	16/12/2009 16:49:46	10	Terminated	SK-407144314-407145213	1	900
4010	DK533081	16/12/2009 16:49:46	10	Terminated	SK-407145214-407154213	1	9000
4010	DK533081	16/12/2009 16:49:46	10	Terminated	SK-407155214-407156213	1	1000
4010	DK533081	16/12/2009 16:49:46	10	Terminated	SK-407142414-407143313	1	900
4010	DK533081	16/12/2009 16:49:46	10	Terminated	SK-407156214-407164213	1	8000
4010	DK533081	16/12/2009 16:49:46	10	Terminated	SK-407142314-407142413	1	100
4010	DK533081	16/12/2009 16:49:46	10	Terminated	SK-407143314-407144313	1	1000
4010	DK533081	16/12/2009 16:49:46	10	Terminated	SK-407154214-407155213	1	1000
4010	DK533081	16/12/2009 16:49:46	10	Terminated	SK-407164214-407173313	1	9100
4010	DK533086	17/12/2009 00:06:41	3	Terminated	IT-2929613614-2929614613	1	1000
4010	DK534186	18/12/2009 14:36:34	10	Terminated	SE-420897692-420899691	1	2000
4010	DK534485	21/12/2009 13:19:21	10	Terminated	DE-1945201863-1945204862	1	3000
4010	DK534485	21/12/2009 13:19:21	10	Terminated	PL-3215593522-3215627521	1	34000

4010			DK534485	21/12/2009 13:19:21	10	Terminated	GB-3896386413-3896389358	1	2946
4010			DK534485	21/12/2009 13:19:21	10	Terminated	DE-2158108936-2158111591	1	2656
4010			DK534485	21/12/2009 13:19:21	10	Terminated	DE-2156784463-2156788860	1	4398
4010			DK534485	21/12/2009 13:19:21	10	Terminated	DE-2156783152-2156784462	1	1311
4010			DK534485	21/12/2009 13:19:21	10	Terminated	DE-2092263228-2092265592	1	2365
4010			DK534485	21/12/2009 13:19:21	10	Terminated	DE-2092265593-2092272534	1	6942
4010			DK534485	21/12/2009 13:19:21	10	Terminated	DE-2102511874-2102512469	1	596
4010			DK534485	21/12/2009 13:19:21	10	Terminated	DE-2105214637-2105215729	1	1093
4010			DK534485	21/12/2009 13:19:21	10	Terminated	DE-2102512470-2102512527	1	58
4010			DK534485	21/12/2009 13:19:21	10	Terminated	DE-1945205498-1945212497	1	7000
4010			DK534485	21/12/2009 13:19:21	10	Terminated	DE-1945204863-1945205497	1	635
4010			DK534487	21/12/2009 13:30:34	10	Terminated	DE-1945201863-1945204862	1	3000
4010			DK534487	21/12/2009 13:30:34	10	Terminated	DE-2102512470-2102512527	1	58
4010			DK534487	21/12/2009 13:30:34	10	Terminated	DE-2156783152-2156784462	1	1311
4010			DK534487	21/12/2009 13:30:34	10	Terminated	DE-2158108936-2158111591	1	2656
4010			DK534487	21/12/2009 13:30:34	10	Terminated	PL-3215593522-3215627521	1	34000
4010			DK534487	21/12/2009 13:30:34	10	Terminated	GB-3896386413-3896389358	1	2946
4010			DK534487	21/12/2009 13:30:34	10	Terminated	DE-2156784463-2156788860	1	4398
4010			DK534487	21/12/2009 13:30:34	10	Terminated	DE-2105214637-2105215729	1	1093
4010			DK534487	21/12/2009 13:30:34	10	Terminated	DE-2102511874-2102512469	1	596
4010			DK534487	21/12/2009 13:30:34	10	Terminated	DE-1945205498-1945212497	1	7000
4010			DK534487	21/12/2009 13:30:34	10	Terminated	DE-2092263228-2092265592	1	2365
4010			DK534487	21/12/2009 13:30:34	10	Terminated	DE-2092265593-2092272534	1	6942
4010			DK534487	21/12/2009 13:30:34	10	Terminated	DE-1945204863-1945205497	1	635
4010			DK534491	21/12/2009 13:39:23	10	Terminated	DE-1945201863-1945204862	1	3000
4010			DK534491	21/12/2009 13:39:23	10	Terminated	DE-2092263228-2092265592	1	2365
4010			DK534491	21/12/2009 13:39:23	10	Terminated	DE-2102511874-2102512469	1	596
4010			DK534491	21/12/2009 13:39:23	10	Terminated	DE-2105214637-2105215729	1	1093
4010			DK534491	21/12/2009 13:39:23	10	Terminated	DE-2156784463-2156788860	1	4398
4010			DK534491	21/12/2009 13:39:23	10	Terminated	GB-3896386413-3896389358	1	2946
4010			DK534491	21/12/2009 13:39:23	10	Terminated	PL-3215593522-3215627521	1	34000
4010			DK534491	21/12/2009 13:39:23	10	Terminated	DE-2158108936-2158111591	1	2656
4010			DK534491	21/12/2009 13:39:23	10	Terminated	DE-2156783152-2156784462	1	1311
4010			DK534491	21/12/2009 13:39:23	10	Terminated	DE-2102512470-2102512527	1	58
4010			DK534491	21/12/2009 13:39:23	10	Terminated	DE-2092265593-2092272534	1	6942
4010			DK534491	21/12/2009 13:39:23	10	Terminated	DE-1945204863-1945205497	1	635
4010			DK534491	21/12/2009 13:39:23	10	Terminated	DE-1945205498-1945212497	1	7000

4010		DK534493	21/12/2009 13:40:38	10	Terminated	DE-1945204863-1945205497	1	635
4010		DK534496	21/12/2009 13:40:38	10	Terminated	DE-2092265593-2092272534	1	6942
4010		DK534492	21/12/2009 13:40:38	10	Terminated	DE-1945201863-1945204862	1	3000
4010		DK534495	21/12/2009 13:40:38	10	Terminated	DE-2092263228-2092265592	1	2365
4010		DK534498	21/12/2009 13:40:40	10	Terminated	DE-2102512470-2102512527	1	58
4010		DK534497	21/12/2009 13:40:41	10	Terminated	DE-2102511874-2102512469	1	596
4010		DK534579	21/12/2009 13:40:41	10	Terminated	DE-2158108936-2158111591	1	2656
4010		DK534577	21/12/2009 13:40:42	10	Terminated	DE-2156783152-2156784462	1	1311
4010		DK534580	21/12/2009 13:40:43	10	Terminated	GB-3896386413-3896389358	1	2946
4010		DK534494	21/12/2009 13:40:44	10	Terminated	DE-1945205498-1945212497	1	7000
4010		DK534581	21/12/2009 13:40:44	10	Terminated	PL-3215593522-3215627521	1	34000
4010		DK534499	21/12/2009 13:40:45	10	Terminated	DE-2105214637-2105215729	1	1093
4010		DK534578	21/12/2009 13:40:45	10	Terminated	DE-2156784463-2156788860	1	4398
4010		DK534583	21/12/2009 13:42:47	10	Terminated	DE-1945201863-1945202862	1	1000
4010		DK534584	21/12/2009 13:42:47	10	Terminated	GB-3896386413-3896387412	1	1000
4010		DK534585	21/12/2009 13:42:47	10	Terminated	PL-3215593522-3215594521	1	1000
4010		DK534587	21/12/2009 13:49:18	10	Terminated	DE-1945202863-1945204862	1	2000
4010		DK534587	21/12/2009 13:49:18	10	Terminated	DE-1945205498-1945212497	1	7000
4010		DK534587	21/12/2009 13:49:18	10	Terminated	DE-2092265593-2092272534	1	6942
4010		DK534587	21/12/2009 13:49:18	10	Terminated	DE-2102511874-2102512469	1	596
4010		DK534587	21/12/2009 13:49:18	10	Terminated	DE-2092263228-2092265592	1	2365
4010		DK534587	21/12/2009 13:49:18	10	Terminated	DE-1945204863-1945205497	1	635
4010		DK534587	21/12/2009 13:49:18	10	Terminated	GB-3896387413-3896389358	1	1946
4010		DK534587	21/12/2009 13:49:18	10	Terminated	DE-1945201863-1945202862	1	1000
4010		DK534587	21/12/2009 13:49:18	10	Terminated	PL-3215594522-3215627521	1	33000
4010		DK534587	21/12/2009 13:49:18	10	Terminated	PL-3215593522-3215594521	1	1000
4010		DK534587	21/12/2009 13:49:18	10	Terminated	GB-3896386413-3896387412	1	1000
4010		DK534587	21/12/2009 13:49:18	10	Terminated	DE-2158108936-2158111591	1	2656
4010		DK534587	21/12/2009 13:49:18	10	Terminated	DE-2156784463-2156788860	1	4398
4010		DK534587	21/12/2009 13:49:18	10	Terminated	DE-2156783152-2156784462	1	1311
4010		DK534587	21/12/2009 13:49:18	10	Terminated	DE-2105214637-2105215729	1	1093
4010		DK534587	21/12/2009 13:49:18	10	Terminated	DE-2102512470-2102512527	1	58
4010		DK534588	21/12/2009 13:50:19	10	Terminated	PL-3215594522-3215599521	1	5000
4010		DK534589	21/12/2009 13:51:49	10	Terminated	DE-1945202863-1945203362	1	500
4010		DK534590	21/12/2009 13:51:49	10	Terminated	PL-3215594522-3215595021	1	500
4010		DK534879	21/12/2009 17:08:45	10	Terminated	BE-407251021-407252820	1	1800
4010		DK534879	21/12/2009 17:08:45	10	Terminated	FR-3211580787-3211595921	1	15135

4010				DK534879	21/12/2009 17:08:45	10	Terminated	FR-3335646126-3335649054	1	2929
4010				DK534879	21/12/2009 17:08:45	10	Terminated	FR-3335649055-3335653511	1	4457
4010				DK534879	21/12/2009 17:08:45	10	Terminated	GB-3563988306-3563995893	1	7588
4010				DK534879	21/12/2009 17:08:45	10	Terminated	GB-3563995894-3563998069	1	2176
4010				DK534879	21/12/2009 17:08:45	10	Terminated	GB-3563998070-3563998075	1	6
4010				DK534879	21/12/2009 17:08:45	10	Terminated	GB-3759396324-3759412232	1	15909

Annex 7 Tables 6.1 and 6.2 of the IPCC good practice guidance

IPCC Source category	Gas	Base year emission	Year t emission	Activity data uncer-tainty	Emission factor uncer-tainty	Combined uncer-tainty	Combined un-certainty as % of total national emissions in year t	Type A sensitiv-ity	Type B sensitiv-ity	Uncertainty i trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
		Input data Gg CO_2 eq	Input data Gg CO_2 eq	Input data %	Input data %	%	%	%	%	%	%	%
Stationary Combustion, Coal	CO_2	24077	16050	1	1	1.556	0.382	-0.102	0.235	-0.112	0.365	0.382
Stationary Combustion, BKB	CO_2	11	0	3	5	5.831	0.000	0.000	0.000	-0.001	0.000	0.001
Stationary Combustion, Coke	CO_2	138	112	2	5	5.385	0.009	0.000	0.002	-0.001	0.005	0.005
Stationary Combustion, Petroleum coke	CO_2	410	755	2	5	5.463	0.063	0.005	0.011	0.027	0.034	0.043
Stationary Combustion, Plastic waste	CO_2	394	1343	5	25	25.495	0.524	0.014	0.020	0.354	0.139	0.380
Stationary Combustion, Residual oil	CO_2	2505	1359	2	2	2.500	0.052	-0.015	0.020	-0.030	0.042	0.052
Stationary Combustion, Gas oil	CO_2	4547	1544	3	5	5.731	0.135	-0.041	0.023	-0.205	0.089	0.224
Stationary Combustion, Kerosene	CO_2	366	9	3	5	5.780	0.001	-0.005	0.000	-0.025	0.001	0.025
Stationary Combustion, Natural gas	CO_2	4320	9764	2	1	1.972	0.295	0.082	0.143	0.082	0.344	0.353
Stationary Combustion, LPG	CO_2	169	96	3	5	5.682	0.008	-0.001	0.001	-0.005	0.005	0.007
Stationary Combustion, Refinery gas	CO_2	806	841	1	5	5.099	0.066	0.001	0.012	0.005	0.017	0.018
1A1+1A2+1A4, Biomass	CH_4	83	187	16	100	101.256	0.289	0.002	0.003	0.157	0.061	0.169
Biogas fuelled engines, Biomass	CH_4	2	21	3	10	10.440	0.003	0.000	0.000	0.003	0.001	0.003
1A1+1A2+1A4, Natural gas	CH_4	8	15	2	100	100.014	0.023	0.000	0.000	0.010	0.001	0.010
Natural gas fuelled engines, Natural gas	CH_4	5	185	1	5	5.099	0.014	0.003	0.003	0.013	0.004	0.014
1A1+1A2+1A4, Liquid fuels	CH_4	7	4	2	100	100.018	0.007	0.000	0.000	-0.003	0.000	0.003
1A1+1A2+1A4, Municipal waste	CH_4	2	1	5	100	100.125	0.001	0.000	0.000	-0.001	0.000	0.001

Continued

IPCC Source category	Gas	Base year emission	Year t emission	Activity data uncer-tainty	Emission factor uncer-tainty	Combined uncer-tainty	Combined un-certainty as % of total national emissions in year t	Type A sensitiv-ity	Type B sensitiv-ity	Uncertainty i trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
		Input data Gg CO_2 eq	Input data Gg CO_2 eq	Input data %	Input data %	%	%	%	%	%	%	%
1A1+1A2+1A4, Solid fuels	CH_4	15	8	1	100	100.006	0.012	0.000	0.000	-0.009	0.000	0.009
1A1 + 1A2 + 1A4, Biomass	N_2O	39	81	16	400	400.316	0.497	0.001	0.001	0.259	0.027	0.260
1A1 + 1A2 + 1A4, Gaseous fuels	N_2O	28	61	2	300	300.005	0.282	0.001	0.001	0.153	0.002	0.153
1A1 + 1A2 + 1A4, Liquid fuels	N_2O	76	46	2	400	400.005	0.282	0.000	0.001	-0.154	0.002	0.154
1A1 + 1A2 + 1A4, Municipal waste	N_2O	18	19	5	200	200.062	0.060	0.000	0.000	0.006	0.002	0.006
1A1 + 1A2 + 1A4, Solid fuels	N_2O	80	49	2	1000	1000.002	0.751	0.000	0.001	-0.400	0.002	0.400
Transport, Road transport	CO_2	9275	12948	2	5	5.385	1.068	0.060	0.190	0.298	0.536	0.613
Transport, Military	CO_2	119	108	2	5	5.385	0.009	0.000	0.002	0.000	0.004	0.004
Transport, Railways	CO_2	297	237	2	5	5.385	0.020	-0.001	0.003	-0.003	0.010	0.010
Transport, Navigation (small boats)	CO_2	48	101	41	5	41.304	0.064	0.001	0.001	0.004	0.085	0.085
Transport, Navigation (large vessels)	CO_2	666	353	11	5	12.083	0.065	-0.004	0.005	-0.021	0.080	0.083
Transport, Fisheries	CO_2	591	449	2	5	5.385	0.037	-0.002	0.007	-0.008	0.019	0.020
Transport, Agriculture	CO_2	1272	1230	24	5	24.515	0.462	0.000	0.018	0.001	0.611	0.611
Transport, Forestry	CO_2	36	17	30	5	30.414	0.008	0.000	0.000	-0.001	0.011	0.011
Transport, Industry (mobile)	CO_2	842	1119	41	5	41.304	0.707	0.005	0.016	0.023	0.949	0.950
Transport, Residential	CO_2	113	239	35	5	35.355	0.129	0.002	0.003	0.010	0.173	0.173
Transport, Civil aviation	CO_2	243	164	10	5	11.180	0.028	-0.001	0.002	-0.005	0.034	0.034
Transport, Road transport	CH_4	55	22	2	40	40.050	0.013	0.000	0.000	-0.018	0.001	0.018
Transport, Military	CH_4	0	0	2	100	100.020	0.000	0.000	0.000	0.000	0.000	0.000
Transport, Railways	CH_4	0	0	2	100	100.020	0.000	0.000	0.000	0.000	0.000	0.000
Transport, Navigation (small boats)	CH_4	0	1	41	100	108.079	0.001	0.000	0.000	0.000	0.000	0.001

Continued

IPCC Source category	Gas	Base year emission	Year t emission	Activity data uncer-tainty	Emission factor uncer-tainty	Combined uncer-tainty	Combined un-certainty as % of total national emissions in year t	Type A sensitiv-ity	Type B sensitiv-ity	Uncertainty i trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
		Input data Gg CO_2 eq	Input data Gg CO_2 eq	Input data %	Input data %	%	%	%	%	%	%	%
Transport, Navigation (large vessels)	CH_4	0	0	11	100	100.603	0.000	0.000	0.000	0.000	0.000	0.000
Transport, Fisheries	CH_4	0	0	2	100	100.020	0.000	0.000	0.000	0.000	0.000	0.000
Transport, Agriculture	CH_4	2	2	24	100	102.840	0.003	0.000	0.000	-0.001	0.001	0.001
Transport, Forestry	CH_4	0	0	30	100	104.403	0.000	0.000	0.000	0.000	0.000	0.000
Transport, Industry (mobile)	CH_4	1	1	41	100	108.079	0.001	0.000	0.000	0.000	0.001	0.001
Transport, Residential	CH_4	3	5	35	100	105.948	0.008	0.000	0.000	0.003	0.004	0.005
Transport, Civil aviation	CH_4	0	0	10	100	100.499	0.000	0.000	0.000	0.000	0.000	0.000
Transport, Road transport	N_2O	97	126	2	50	50.040	0.096	0.000	0.002	0.024	0.005	0.025
Transport, Military	N_2O	1	1	2	1000	1000.002	0.017	0.000	0.000	0.000	0.000	0.000
Transport, Railways	N_2O	3	2	2	1000	1000.002	0.031	0.000	0.000	-0.006	0.000	0.006
Transport, Navigation (small boats)	N_2O	0	1	41	1000	1000.840	0.016	0.000	0.000	0.010	0.001	0.010
Transport, Navigation (large vessels)	N_2O	13	7	11	1000	1000.060	0.106	0.000	0.000	-0.081	0.002	0.081
Transport, Fisheries	N_2O	11	9	2	1000	1000.002	0.135	0.000	0.000	-0.032	0.000	0.032
Transport, Agriculture	N_2O	15	16	24	1000	1000.288	0.247	0.000	0.000	0.022	0.008	0.024
Transport, Forestry	N_2O	0	0	30	1000	1000.450	0.003	0.000	0.000	0.000	0.000	0.000
Transport, Industry (mobile)	N_2O	11	15	41	1000	1000.840	0.225	0.000	0.000	0.066	0.012	0.067
Transport, Residential	N_2O	1	1	35	1000	1000.612	0.018	0.000	0.000	0.009	0.001	0.010
Transport, Civil aviation	N_2O	3	3	10	1000	1000.050	0.041	0.000	0.000	-0.005	0.001	0.005
1.B.2. Flaring in refinery	CO_2	23	28	11	5	12.083	0.005	0.000	0.000	0.000	0.006	0.006
1.B.2. Flaring off-shore	CO_2	276	348	8	5	9.014	0.048	0.001	0.005	0.006	0.054	0.054
1.B.2. Flaring in refinery	CH_4	1	0	11	15	18.601	0.000	0.000	0.000	0.000	0.000	0.000
1.B.2. Flaring off-shore	CH_4	0	1	8	5	9.014	0.000	0.000	0.000	0.000	0.000	0.000
1.B.2. Refinery processes	CH_4	1	46	1	125	125.004	0.088	0.001	0.001	0.083	0.001	0.083
1.B.2. Land based activities	CH_4	17	37	2	40	40.050	0.022	0.000	0.001	0.012	0.002	0.012
1.B.2. Off-shore activities	CH_4	15	39	2	30	30.067	0.018	0.000	0.001	0.011	0.002	0.011

Continued

IPCC Source category	Gas	Base year emission	Year t emission	Activity data uncer-tainty	Emission factor uncer-tainty	Combined uncer-tainty	Combined uncertainty as % of total national emissions in year t	Type A sensitiv-ity	Type B sensitiv-ity	Uncertainty i trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
		Input data Gg CO_2 eq	Input data Gg CO_2 eq	Input data %	Input data %	%	%	%	%	%	%	%
1.B.2. Transmission of natural gas	CH_4	4	3	15	5	15.811	0.001	0.000	0.000	0.000	0.001	0.001
1.B.2. Distribution of natural gas	CH_4	5	4	25	10	26.926	0.002	0.000	0.000	0.000	0.002	0.002
1.B.2. Flaring in refinery	N_2O	0	0	11	500	500.121	0.001	0.000	0.000	0.000	0.000	0.000
1.B.2. Flaring off-shore	N_2O	1	1	8	500	500.056	0.006	0.000	0.000	0.001	0.000	0.001
2A1 Cement production	CO_2	882	1155	1	2	2.236	0.040	0.005	0.017	0.009	0.024	0.026
2A2 Lime production	CO_2	116	66	5	5	7.071	0.007	-0.001	0.001	-0.003	0.007	0.008
2A3 Limestone and dolomite use	CO_2	14	39	5	5	7.071	0.004	0.000	0.001	0.002	0.004	0.004
2A5 Asphalt roofing	CO_2	0	0	5	25	25.495	0.000	0.000	0.000	0.000	0.000	0.000
2A6 Road paving with asphalt	CO_2	2	2	5	25	25.495	0.001	0.000	0.000	0.000	0.000	0.000
2A7 Glass and Glass wool	CO_2	55	60	5	2	5.385	0.005	0.000	0.001	0.000	0.006	0.006
2B5 Catalysts/Fertilizers, Pesticides and Sulphuric acid	CO_2	1	2	5	5	7.071	0.000	0.000	0.000	0.000	0.000	0.000
2C1 Iron and steel production	CO_2	28	0	5	5	7.071	0.000	0.000	0.000	-0.002	0.000	0.002
2D2 Food and Drink	CO_2	4	3	5	5	7.071	0.000	0.000	0.000	0.000	0.000	0.000
2G Lubricants	CO_2	50	34	2	5	5.385	0.003	0.000	0.000	-0.001	0.001	0.002
2B2 Nitric acid production	N_2O	1043	0	2	25	25.080	0.000	-0.015	0.000	-0.365	0.000	0.365
2F Consumption of HFC	HFC	218	853	10	50	50.990	0.666	0.009	0.012	0.472	0.177	0.504
2F Consumption of PFC	PFC	1	13	10	50	50.990	0.010	0.000	0.000	0.009	0.003	0.009
2F Consumption of SF6	SF6	107	32	10	50	50.990	0.025	-0.001	0.000	-0.052	0.007	0.052
3A Paint application	CO_2	26	9	10	15	18.028	0.003	0.000	0.000	-0.003	0.002	0.004
3B Degreasing and dry cleaning	CO_2	0	0	10	15	18.028	0.000	0.000	0.000	0.000	0.000	0.000

Continued

IPCC Source category	Gas	Base year emission	Year t emission	Activity data uncer-tainty	Emission factor uncer-tainty	Combined uncer-tainty	Combined un-certainty as % of total national emissions in year t	Type A sensitiv-ity	Type B sensitiv-ity	Uncertainty i trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
		Input data Gg CO_2 eq	Input data Gg CO_2 eq	Input data %	Input data %	%	%	%	%	%	%	%
3C Chemical products, manufacturing and process-ing	CO_2	23	15	10	15	18.028	0.004	0.000	0.000	-0.002	0.003	0.003
3D5 Other	CO_2	86	41	10	20	22.361	0.014	-0.001	0.001	-0.012	0.008	0.015
3D1 Other - Use of N2O for Anaesthesia	N_2O	0	27	5	5	7.071	0.003	0.000	0.000	0.002	0.003	0.003
4A Enteric Fermentation	CH_4	3261	2819	10	8	12.806	0.553	-0.004	0.041	-0.035	0.584	0.585
4B Manure Management	CH_4	869	1050	10	100	100.499	1.615	0.003	0.015	0.320	0.217	0.387
4F Field burning af agricul-tural residues	CH_4	2	2	10	50	50.990	0.002	0.000	0.000	0.001	0.001	0.001
4.B Manure Management	N_2O	668	505	10	100	100.499	0.778	-0.002	0.007	-0.196	0.105	0.222
4.D1.1 Syntehetic Fertilizer	N_2O	2395	1318	3	50	50.090	1.011	-0.014	0.019	-0.711	0.082	0.715
4.D1.2 Animal waste ap-plied to soils	N_2O	1050	1124	10	50	50.990	0.877	0.002	0.016	0.087	0.233	0.248
4.D1.3 N-fixing crops	N_2O	269	213	20	50	53.852	0.175	-0.001	0.003	-0.033	0.088	0.094
4.D1.4 Crop Residue	N_2O	361	305	20	50	53.852	0.252	-0.001	0.004	-0.029	0.126	0.130
4.D1.5 Cultivation of histo-sols	N_2O	117	117	20	50	53.852	0.096	0.000	0.002	0.004	0.048	0.048
4.D.2 Grassing animals	N_2O	314	214	20	25	32.016	0.105	-0.001	0.003	-0.031	0.089	0.094
4.D3 Atmospheric deposi-tion	N_2O	441	286	10	50	50.990	0.223	-0.002	0.004	-0.099	0.059	0.116
4.D3 Leaching	N_2O	3334	1993	20	50	53.852	1.643	-0.017	0.029	-0.874	0.825	1.202
4.D1.6 Sewage sludge and Industrial waste used as fertiliser	N_2O	28	78	20	50	53.852	0.065	0.001	0.001	0.038	0.032	0.050
4.F Field Burning of Agricul-tural Residues	N_2O	1	1	10	50	50.990	0.001	0.000	0.000	0.000	0.000	0.000
5.A.1 Broadleaves	CO_2	-649	199	15	10	18.028	0.055	0.012	0.003	0.120	0.062	0.135
5.A.1 Conifers	CO_2	-254	239	15	10	18.028	0.066	0.007	0.003	0.071	0.074	0.102
5.A.2 Broadleaves	CO_2	3	-3	15	15	21.213	-0.001	0.000	0.000	-0.001	-0.001	0.002

Continued

IPCC Source category	Gas	Base year emission	Year t emission	Activity data uncer-tainty	Emission factor uncer-tainty	Combined uncertainty	Combined un-certainty as % of total national emissions in year t	Type A sensitivity	Type B sensitivity	Uncertainty i trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
		Input data Gg CO_2 eq	Input data Gg CO_2 eq	Input data %	Input data %	%	%	%	%	%	%	%
5.A.2 Conifers	CO_2	5	-5	15	15	21.213	-0.002	0.000	0.000	-0.002	-0.002	0.003
5A Drainage of soils	N_2O	16	12	30	75	80.777	0.015	0.000	0.000	-0.003	0.008	0.008
5.B Living biomass	CO_2	-53	48	10	20	22.361	0.017	0.001	0.001	0.029	0.010	0.031
5.B Mineral soils	CO_2	-2021	-511	10	20	22.361	-0.175	0.021	-0.007	0.416	-0.106	0.429
5.B Organic soils	CO_2	1056	1070	10	50	50.990	0.835	0.001	0.016	0.045	0.221	0.226
5.B Disturbance, Land con-verted to cropland	N_2O	3	0	50	75	90.139	0.001	0.000	0.000	-0.003	0.000	0.003
5.C Living biomass	CO_2	183	59	10	20	22.361	0.020	-0.002	0.001	-0.034	0.012	0.036
5.C Organic soils	CO_2	93	81	10	50	50.990	0.063	0.000	0.001	-0.006	0.017	0.018
5.D Reestablished wetlands	CO_2	0	-12	10	50	50.990	-0.009	0.000	0.000	-0.009	-0.002	0.009
5.D Land for peat extraction	CO_2	86	5	10	50	50.990	0.004	-0.001	0.000	-0.057	0.001	0.057
5.D Land for peat extraction	N_2O	0	0	10	100	100.499	0.000	0.000	0.000	0.000	0.000	0.000
5.E Living biomass	CO_2	80	52	10	50	50.990	0.040	0.000	0.001	-0.018	0.011	0.021
5 Liming	CO_2	565	229	5	50	50.249	0.176	-0.005	0.003	-0.228	0.024	0.229
6 A. Solid Waste Disposal on Land	CH_4	1111	1057	10	118	118.323	1.914	0.000	0.015	-0.009	0.219	0.219
6 B. Wastewater Handling	CH_4	30	47	44	78	89.554	0.065	0.000	0.001	0.021	0.043	0.048
5 B. Wastewater Handling - Direct	N_2O	24	70	37	98	104.752	0.112	0.001	0.001	0.067	0.054	0.086
6 B. Wastewater Handling - Indirect	N_2O	82	35	59	39	70.725	0.038	-0.001	0.001	-0.025	0.042	0.049
6.C Accidental fires, buil-dings	CO_2	15	18	10	500	500.100	0.134	0.000	0.000	0.026	0.004	0.026
6.C Accidental fires, vehicles	CO_2	6	11	10	500	500.100	0.084	0.000	0.000	0.036	0.002	0.036
6.C Incineration of corpses	CH_4	0	0	1	150	150.003	0.000	0.000	0.000	0.000	0.000	0.000
6.C Incineration of carcas-ses	CH_4	0	0	50	150	158.114	0.000	0.000	0.000	0.000	0.000	0.000
6.C Accidental fires, buil-dings	CH_4	2	3	10	500	500.100	0.022	0.000	0.000	0.004	0.001	0.004

Continued

IPCC Source category	Gas	Base year emission	Year t emission	Activity data uncer-tainty	Emission factor uncer-tainty	Combined uncertainty	Combined un-certainty as % of total national emissions in year t	Type A sensitivity	Type B sensitivity	Uncertainty i trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
		Input data Gg CO_2 eq	Input data Gg CO_2 eq	Input data %	Input data %	%	%	%	%	%	%	%
6.C Accidental fires, vehicles	CH_4	0	0	10	500	500,100	0,004	0,000	0,000	0,002	0,000	0,002
6.C Incineration of corpses	N_2O	0	0	1	150	150,003	0,000	0,000	0,000	0,000	0,000	0,000
6.C Incineration of carcas-ses	N_2O	0	0	50	150	158,114	0,000	0,000	0,000	0,000	0,000	0,000
6.C Accidental fires, buil-dings	N_2O	0	0	0	0	0,000	0,000	0,000	0,000	0,000	0,000	0,000
6.C Accidental fires, vehicles	N_2O	0	0	0	0	0,000	0,000	0,000	0,000	0,000	0,000	0,000
Total		68 318	65 309				16.748					5.883
Total uncertainties				Overall uncertainty i the year (%):			4.092				Trend uncertainty (%):	2.425

Annex 8 Annual emission inventories 1990-2008 CRF Table 10 for Denmark

Up until NIR 2004, NERI included the full CRF tables in the NIR report itself as well as the CRF submitted as spreadsheet files. Since NIR 2005 only the trend tables (CRF Table 10 sheet 1-5) have been included in the NIR as Tables A8.1-.5. These tables are copied from the CRF 2008 spreadsheet file, Tables 10.1-10.5. The full CRF tables 1990-2008 are submitted as spreadsheets separately, as well as the xml file generated by the CRF Reporter tool. Notice that this tool defines the base year regarding emissions in the sense of the Climate Change Convention (not as in the Kyoto protocol) which is the emissions in 1990.

Table A8.1.

TABLE 10 EMISSION TRENDS
CO_2
(Part 1 of 2)

Inventory 2008
Submission 2010 v1.3
DENMARK

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
1. Energy	**51.543**	**62.097**	**56.275**	**58.615**	**62.239**	**59.277**	**72.713**	**63.093**	**59.009**	**56.313**
A. Fuel Combustion (Sectoral Approach)	51.243	61.505	55.664	58.082	61.708	58.862	72.258	62.452	58.535	55.303
1. Energy Industries	26.215	35.159	30.206	31.801	35.533	32.204	44.674	35.465	31.766	28.643
2. Manufacturing Industries and Construction	5.424	5.944	5.769	5.609	5.769	5.892	6.081	6.124	6.154	6.222
3. Transport	10.528	10.904	11.102	11.226	11.712	11.852	12.109	12.303	12.275	12.271
4. Other Sectors	8.957	9.211	8.447	9.208	8.441	8.663	9.218	8.390	8.136	7.985
5. Other	119	287	141	237	252	252	176	171	204	182
B. Fugitive Emissions from Fuels	300	592	611	534	531	415	456	641	475	1.009
1. Solid Fuels	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
2. Oil and Natural Gas	300	592	611	534	531	415	456	641	475	1.009
2. Industrial Processes	**1.152**	**1.329**	**1.447**	**1.466**	**1.492**	**1.497**	**1.601**	**1.768**	**1.708**	**1.686**
A. Mineral Products	1.069	1.246	1.366	1.383	1.406	1.405	1.512	1.681	1.615	1.595
B. Chemical Industry	1	1	1	1	1	1	1	1	1	1
C. Metal Production	28	28	28	31	33	39	35	35	42	43
D. Other Production	4	4	4	4	4	4	4	4	5	5
E. Production of Halocarbons and SF_6										
F. Consumption of Halocarbons and SF_6										
G. Other	50	49	48	48	47	49	49	47	45	43
3. Solvent and Other Product Use	135	131	127	123	119	107	119	107	100	99
4. Agriculture										
A. Enteric Fermentation										
B. Manure Management										
C. Rice Cultivation										
D. Agricultural Soils										
E. Prescribed Burning of Savannas										
F. Field Burning of Agricultural Residues										
G. Other										
5. Land Use, Land-Use Change and Forestry(2)	**-1.658**	**185**	**4.226**	**-5.813**	**4.249**	**1.095**	**-2.560**	**2.597**	**-2.773**	**4.579**
A. Forest Land	-1.012	-918	-1.123	-972	-1.164	-1.118	-1.229	-1.231	-936	-1.075
B. Cropland	-706	1.157	5.309	-4.701	5.377	2.332	-1.243	3.983	-1.708	5.406
C. Grassland	133	18	106	-74	70	-76	-19	-61	-56	279
D. Wetlands	-85	-77	-76	-64	-41	-39	-70	-91	-70	-52
E. Settlements	13	4	11	-3	7	-3	1	-3	-3	22
F. Other Land	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
G. Other	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
6. Waste	**21**	**21**	**23**	**21**	**22**	**24**	**25**	**24**	**22**	**24**
A. Solid Waste Disposal on Land	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
B. Waste-water Handling										
C. Waste Incineration	21	21	23	21	22	24	25	24	22	24
D. Other	NO	NO	NO	NO	NA	NA	NA	NA	NA	NA
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Total CO_2 emissions including net CO_2 from LULUCF	**51.194**	**63.763**	**62.098**	**54.413**	**68.120**	**62.001**	**71.899**	**67.588**	**58.066**	**62.700**
Total CO_2 emissions excluding net CO_2 from LULUCF	**52.851**	**63.578**	**57.872**	**60.226**	**63.871**	**60.905**	**74.459**	**64.991**	**60.839**	**58.121**
Memo Items:										
International Bunkers	**4.823**	**4.394**	**4.580**	**5.958**	**6.647**	**6.928**	**6.774**	**6.414**	**6.573**	**6.445**
Aviation	1.736	1.632	1.693	1.659	1.818	1.867	1.971	2.010	2.159	2.290
Marine	3.087	2.762	2.887	4.300	4.829	5.061	4.803	4.403	4.414	4.155
Multilateral Operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
CO_2 Emissions from Biomass	4.596	4.984	5.190	5.390	5.340	5.582	5.924	6.144	6.096	6.423

Table A8.1 *continued.*

TABLE 10 EMISSION TRENDS
CO_2
(Part 2 of 2)

Inventory 2008
Submission 2010 v1.3
DENMARK

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	2008	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
1. Energy	**51.785**	**53.399**	**53.029**	**58.369**	**52.725**	**49.142**	**56.941**	**52.160**	**49.212**	**-5**
A. Fuel Combustion (Sectoral Approach)	51.122	52.691	52.433	57.753	52.041	48.644	56.463	51.742	48.836	-5
1. Energy Industries	25.572	26.880	27.080	31.904	25.929	22.662	30.423	25.696	23.553	-10
2. Manufacturing Industries and Construction	6.012	6.087	5.815	5.772	5.826	5.605	5.750	5.688	5.199	-4
3. Transport	12.061	12.059	12.161	12.623	12.934	13.052	13.417	14.028	13.802	31
4. Other Sectors	7.367	7.568	7.289	7.362	7.112	7.054	6.746	6.156	6.175	-31
5. Other	111	97	89	92	239	271	126	175	108	-10
B. Fugitive Emissions from Fuels	662	708	595	615	684	499	478	418	376	25
1. Solid Fuels	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0
2. Oil and Natural Gas	662	708	595	615	684	499	478	418	376	25
2. Industrial Processes	**1.701**	**1.703**	**1.701**	**1.569**	**1.688**	**1.604**	**1.649**	**1.647**	**1.360**	**18**
A. Mineral Products	1.616	1.612	1.656	1.527	1.644	1.544	1.607	1.606	1.320	24
B. Chemical Industry	1	1	1	1	3	3	2	2	2	200
C. Metal Production	41	47	NE,NO	NE,NO	NE,NO	16	NE,NO	NE,NO	NE,NO	-100
D. Other Production	4	5	4	4	4	4	2	2	3	-40
E. Production of Halocarbons and SF_6										
F. Consumption of Halocarbons and SF_6										
G. Other	40	38	40	37	38	38	37	38	34	-32
3. Solvent and Other Product Use	99	87	87	79	77	74	71	63	65	-52
4. Agriculture										
A. Enteric Fermentation										
B. Manure Management										
C. Rice Cultivation										
D. Agricultural Soils										
E. Prescribed Burning of Savannas										
F. Field Burning of Agricultural Residues										
G. Other										
5. Land Use, Land-Use Change and Forestry[(2)]	**-602**	**698**	**3.625**	**-519**	**-784**	**-2.834**	**6.454**	**-43**	**492**	**-130**
A. Forest Land	-1.041	-1.223	-1.240	-1.336	-1.541	-1.622	-1.161	-189	-217	-79
B. Cropland	340	1.846	4.987	814	796	-1.094	7.736	250	790	-212
C. Grassland	139	124	-50	62	29	-49	-57	-60	-57	-143
D. Wetlands	-51	-59	-70	-65	-71	-67	-70	-50	-30	-65
E. Settlements	12	11	-2	6	4	-1	6	6	6	-54
F. Other Land	NA	NA	NA	NA	NA	NA	NA	NA	NA	0
G. Other	NE	NE	NE	NE	NE	NE	NE	NE	NE	0
6. Waste	**23**	**23**	**23**	**24**	**22**	**23**	**25**	**26**	**29**	**36**
A. Solid Waste Disposal on Land	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0
B. Waste-water Handling										
C. Waste Incineration	23	23	23	24	22	23	25	26	29	36
D. Other	NA	NA	NA	NA	NA	NA	NO	NO	NO	0
7. Other ***(as specified in Summary 1.A)***	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**0**
Total CO_2 emissions including net CO_2 from LULUCF	**53.006**	**55.910**	**58.465**	**59.523**	**53.729**	**48.010**	**65.140**	**53.855**	**51.157**	**0**
Total CO_2 emissions excluding net CO_2 from LULUCF	**53.608**	**55.212**	**54.839**	**60.041**	**54.513**	**50.844**	**58.686**	**53.897**	**50.665**	**-4**
Memo Items:										
International Bunkers	**6.629**	**5.988**	**5.024**	**5.271**	**4.992**	**5.210**	**6.014**	**6.206**	**5.760**	**19**
Aviation	2.350	2.384	2.058	2.141	2.447	2.574	2.582	2.647	2.642	52
Marine	4.279	3.605	2.966	3.130	2.545	2.636	3.433	3.559	3.118	1
Multilateral Operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	0
CO_2 Emissions from Biomass	6.717	7.421	7.907	8.909	9.588	10.340	10.728	11.543	11.705	155

Table A8.2.

TABLE 10 EMISSION TRENDS
CH_4
(Part 1 of 2)

Inventory 2008
Submission 2010 v1.3
DENMARK

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
1. Energy	10,88	12,21	12,68	15,03	18,31	24,55	29,17	29,17	30,55	30,87
A. Fuel Combustion (Sectoral Approach)	8,81	9,65	10,23	12,35	15,51	21,34	26,08	25,85	27,24	27,08
1. Energy Industries	1,11	1,54	1,86	3,46	6,53	11,85	15,42	14,92	16,16	16,09
2. Manufacturing Industries and Construction	0,71	0,74	0,72	0,73	0,74	0,84	1,28	1,28	1,37	1,37
3. Transport	2,67	2,71	2,68	2,65	2,56	2,43	2,32	2,23	2,14	2,03
4. Other Sectors	4,31	4,63	4,96	5,50	5,67	6,21	7,05	7,40	7,55	7,57
5. Other	0,01	0,02	0,01	0,01	0,01	0,02	0,01	0,01	0,01	0,01
B. Fugitive Emissions from Fuels	2,07	2,57	2,46	2,68	2,80	3,21	3,09	3,32	3,32	3,79
1. Solid Fuels	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
2. Oil and Natural Gas	2,07	2,57	2,46	2,68	2,80	3,21	3,09	3,32	3,32	3,79
2. Industrial Processes	**IE,NA,NO**	**IE,NA,NO**	**IE,NA,NO**	**IE,NA,NO**	**IE,NA,NO**	**IE,NA,NO**	**IE,NA,NO**	**IE,NA,NO**	**IE,NA,NO**	**IE,NA,NO**
A. Mineral Products	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA
B. Chemical Industry	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
C. Metal Production	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
D. Other Production										
E. Production of Halocarbons and SF_6										
F. Consumption of Halocarbons and SF_6										
G. Other	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
3. Solvent and Other Product Use										
4. Agriculture	**196,77**	**197,50**	**196,49**	**199,63**	**194,66**	**193,82**	**193,69**	**188,75**	**189,77**	**182,79**
A. Enteric Fermentation	155,29	155,29	152,99	154,70	150,00	149,28	148,71	143,90	143,63	137,78
B. Manure Management	41,39	42,11	43,42	44,83	44,57	44,43	44,88	44,75	46,00	44,87
C. Rice Cultivation	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Agricultural Soils	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE
E. Prescribed Burning of Savannas	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
F. Field Burning of Agricultural Residues	0,09	0,09	0,09	0,09	0,09	0,10	0,10	0,11	0,14	0,13
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5. Land Use, Land-Use Change and Forestry	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**
A. Forest Land	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO
B. Cropland	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
C. Grassland	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
D. Wetlands	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE
E. Settlements	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO
F. Other Land	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
G. Other	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
6. Waste	**54,47**	**55,79**	**56,49**	**57,40**	**55,95**	**54,46**	**54,57**	**52,48**	**50,98**	**52,68**
A. Solid Waste Disposal on Land	52,90	54,21	54,90	55,78	54,20	52,56	52,55	50,33	48,71	50,45
B. Waste-water Handling	1,45	1,45	1,45	1,49	1,62	1,75	1,88	2,01	2,14	2,10
C. Waste Incineration	0,13	0,13	0,14	0,13	0,13	0,15	0,15	0,14	0,13	0,13
D. Other	NO	NO	NO	NO	0,00	0,00	0,00	0,00	0,00	0,00
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Total CH_4 emissions including CH_4 from LULUCF	**262,12**	**265,50**	**265,66**	**272,06**	**268,91**	**272,83**	**277,44**	**270,41**	**271,30**	**266,34**
Total CH_4 emissions excluding CH_4 from LULUCF	**262,12**	**265,50**	**265,66**	**272,06**	**268,91**	**272,83**	**277,44**	**270,41**	**271,30**	**266,34**
Memo Items:										
International Bunkers	0,10	0,09	0,09	0,12	0,14	0,15	0,14	0,13	0,14	0,13
Aviation	0,03	0,03	0,03	0,03	0,03	0,04	0,04	0,04	0,04	0,04
Marine	0,07	0,06	0,06	0,09	0,10	0,11	0,11	0,10	0,10	0,09
Multilateral Operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
CO_2 Emissions from Biomass										

Table A8.2 *continued.*

TABLE 10 EMISSION TRENDS
CH_4
(Part 2 of 2)

Inventory 2008
Submission 2010 v1.3
DENMARK

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	2008	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
1. Energy	30,62	31,95	31,49	31,38	31,63	30,38	30,94	29,04	27,62	153,94
A. Fuel Combustion (Sectoral Approach)	26,65	27,81	27,31	27,09	26,52	25,28	24,54	22,88	21,50	144,15
1. Energy Industries	15,28	16,16	15,74	15,11	14,40	12,80	11,78	9,64	8,69	680,68
2. Manufacturing Industries and Construction	1,57	1,61	1,45	1,43	1,43	1,26	1,18	0,98	1,02	44,01
3. Transport	1,91	1,79	1,69	1,63	1,53	1,44	1,35	1,24	1,09	-59,14
4. Other Sectors	7,88	8,24	8,43	8,92	9,15	9,77	10,23	11,00	10,70	148,22
5. Other	0,01	0,01	0,00	0,01	0,01	0,01	0,01	0,01	0,00	-8,07
B. Fugitive Emissions from Fuels	3,97	4,15	4,18	4,28	5,11	5,10	6,40	6,16	6,12	195,58
1. Solid Fuels	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
2. Oil and Natural Gas	3,97	4,15	4,18	4,28	5,11	5,10	6,40	6,16	6,12	195,58
2. Industrial Processes	**IE,NA,NO**	**IE,NA,NO**	**IE,NA,NO**	**IE,NA,NO**	**IE,NA,NO**	**IE,NA,NO**	**IE,NA,NO**	**IE,NA,NO**	**IE,NA,NO**	**0,00**
A. Mineral Products	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	0,00
B. Chemical Industry	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
C. Metal Production	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
D. Other Production										
E. Production of Halocarbons and SF_6										
F. Consumption of Halocarbons and SF_6										
G. Other	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
3. Solvent and Other Product Use										
4. Agriculture	**184,03**	**187,52**	**185,74**	**183,86**	**180,49**	**178,50**	**178,81**	**183,75**	**184,36**	**-6,30**
A. Enteric Fermentation	136,96	139,58	136,58	134,49	130,24	129,74	130,25	133,30	134,26	-13,55
B. Manure Management	46,94	47,80	49,04	49,23	50,11	48,62	48,41	50,32	49,99	20,78
C. Rice Cultivation	NO	NO	NO	NO	NO	NO	NO	NO	NO	0,00
D. Agricultural Soils	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	0,00
E. Prescribed Burning of Savannas	NA	NA	NA	NA	NA	NA	NA	NA	NA	0,00
F. Field Burning of Agricultural Residues	0,13	0,13	0,11	0,13	0,14	0,14	0,14	0,13	0,12	33,70
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	0,00
5. Land Use, Land-Use Change and Forestry	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**0,00**
A. Forest Land	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	0,00
B. Cropland	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
C. Grassland	NA	NA	NA	NA	NA	NA	NA	NA	NA	0,00
D. Wetlands	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	0,00
E. Settlements	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	0,00
F. Other Land	NA	NA	NA	NA	NA	NA	NA	NA	NA	0,00
G. Other	NE	NE	NE	NE	NE	NE	NE	NE	NE	0,00
6. Waste	**53,16**	**54,11**	**52,63**	**54,80**	**50,83**	**50,89**	**53,78**	**53,05**	**52,73**	**-3,20**
A. Solid Waste Disposal on Land	50,91	51,81	50,16	52,25	48,41	48,52	51,44	50,65	50,32	-4,88
B. Waste-water Handling	2,12	2,17	2,34	2,40	2,30	2,25	2,20	2,25	2,25	55,50
C. Waste Incineration	0,13	0,13	0,13	0,14	0,12	0,13	0,14	0,15	0,16	25,09
D. Other	0,00	0,00	0,00	0,00	0,00	0,00	NO	NO	NO	0,00
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**0,00**
Total CH_4 emissions including CH_4 from LULUCF	**267,81**	**273,58**	**269,86**	**270,03**	**262,95**	**259,78**	**263,53**	**265,84**	**264,71**	**0,99**
Total CH_4 emissions excluding CH_4 from LULUCF	**267,81**	**273,58**	**269,86**	**270,03**	**262,95**	**259,78**	**263,53**	**265,84**	**264,71**	**0,99**
Memo Items:										
International Bunkers	0,14	0,12	0,11	0,11	0,11	0,11	0,13	0,14	0,13	30,27
Aviation	0,04	0,04	0,04	0,04	0,05	0,05	0,05	0,05	0,05	62,34
Marine	0,10	0,08	0,07	0,07	0,06	0,06	0,08	0,09	0,08	14,99
Multilateral Operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	0,00
CO_2 Emissions from Biomass										

Table A8.3.

TABLE 10 EMISSION TRENDS
N_2O
(Part 1 of 2)

Inventory 2008
Submission 2010 v1.3
DENMARK

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	se year (199	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
1. Energy	**1,28**	**1,42**	**1,37**	**1,41**	**1,47**	**1,48**	**1,68**	**1,58**	**1,52**	**1,51**
A. Fuel Combustion (Sectoral Approach)	1,28	1,41	1,36	1,41	1,46	1,48	1,67	1,58	1,52	1,50
1. Energy Industries	0,38	0,47	0,43	0,44	0,49	0,48	0,64	0,55	0,52	0,50
2. Manufacturing Industries and Construction	0,18	0,19	0,18	0,18	0,18	0,18	0,19	0,19	0,19	0,19
3. Transport	0,37	0,40	0,42	0,43	0,46	0,48	0,50	0,51	0,51	0,50
4. Other Sectors	0,34	0,35	0,33	0,35	0,32	0,33	0,34	0,31	0,30	0,30
5. Other	0,00	0,01	0,00	0,01	0,01	0,01	0,01	0,01	0,01	0,01
B. Fugitive Emissions from Fuels	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,01
1. Solid Fuels	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
2. Oil and Natural Gas	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,01
2. Industrial Processes	**3,36**	**3,08**	**2,72**	**2,56**	**2,60**	**2,92**	**2,69**	**2,74**	**2,60**	**3,07**
A. Mineral Products	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA
B. Chemical Industry	3,36	3,08	2,72	2,56	2,60	2,92	2,69	2,74	2,60	3,07
C. Metal Production	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Other Production										
E. Production of Halocarbons and SF_6										
F. Consumption of Halocarbons and SF_6										
G. Other	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
3. Solvent and Other Product Use	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE
4. Agriculture	**28,96**	**28,46**	**27,48**	**26,82**	**26,15**	**25,50**	**24,78**	**24,16**	**24,00**	**22,94**
A. Enteric Fermentation										
B. Manure Management	2,15	2,14	2,15	2,14	2,08	2,01	2,01	2,02	2,04	1,98
C. Rice Cultivation										
D. Agricultural Soils	26,80	26,32	25,34	24,67	24,07	23,49	22,77	22,14	21,96	20,96
E. Prescribed Burning of Savannas	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
F. Field Burning of Agricultural Residues	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5. Land Use, Land-Use Change and Forestry	**0,05**	**0,04**	**0,04**	**0,03**	**0,04**	**0,03**	**0,04**	**0,03**	**0,03**	**0,05**
A. Forest Land	0,03	0,03	0,03	0,03	0,03	0,03	0,03	0,03	0,03	0,03
B. Cropland	0,01	0,01	0,01	0,00	0,01	0,00	0,00	0,00	0,00	0,02
C. Grassland	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
D. Wetlands	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
E. Settlements	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO
F. Other Land	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
G. Other	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
6. Waste	**0,34**	**0,33**	**0,30**	**0,35**	**0,39**	**0,36**	**0,30**	**0,28**	**0,29**	**0,28**
A. Solid Waste Disposal on Land										
B. Waste-water Handling	0,34	0,33	0,30	0,35	0,39	0,36	0,30	0,28	0,29	0,28
C. Waste Incineration	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
D. Other	NO	NO	NO	NO	0,00	0,00	0,00	0,00	0,00	0,00
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Total N_2O emissions including N_2O from LULUCF	**33,99**	**33,33**	**31,91**	**31,18**	**30,65**	**30,29**	**29,48**	**28,79**	**28,45**	**27,84**
Total N_2O emissions excluding N_2O from LULUCF	**33,94**	**33,29**	**31,87**	**31,14**	**30,61**	**30,26**	**29,45**	**28,76**	**28,41**	**27,78**
Memo Items:										
International Bunkers	**0,25**	**0,23**	**0,24**	**0,33**	**0,37**	**0,38**	**0,37**	**0,35**	**0,35**	**0,34**
Aviation	0,06	0,06	0,06	0,06	0,06	0,06	0,07	0,07	0,08	0,08
Marine	0,19	0,17	0,18	0,27	0,30	0,32	0,30	0,28	0,28	0,26
Multilateral Operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
CO_2 Emissions from Biomass										

Table A8.3 *continued*.

TABLE 10 EMISSION TRENDS

N_2O

(Part 2 of 2)

Inventory 2008

Submission 2010 v1.3

DENMARK

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	2008	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
1. Energy	**1,45**	**1,47**	**1,45**	**1,49**	**1,43**	**1,40**	**1,48**	**1,45**	**1,41**	**10,52**
A. Fuel Combustion (Sectoral Approach)	1,44	1,46	1,45	1,49	1,43	1,40	1,48	1,45	1,41	10,52
1. Energy Industries	0,47	0,48	0,49	0,52	0,46	0,42	0,50	0,44	0,43	11,85
2. Manufacturing Industries and Construction	0,19	0,19	0,18	0,18	0,19	0,18	0,19	0,19	0,19	5,35
3. Transport	0,49	0,47	0,46	0,47	0,46	0,45	0,45	0,46	0,45	19,09
4. Other Sectors	0,29	0,31	0,30	0,32	0,31	0,33	0,34	0,34	0,35	2,37
5. Other	0,00	0,00	0,00	0,00	0,01	0,01	0,00	0,01	0,00	-1,87
B. Fugitive Emissions from Fuels	0,00	0,01	0,00	0,00	0,01	0,00	0,00	0,00	0,00	10,41
1. Solid Fuels	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
2. Oil and Natural Gas	0,00	0,01	0,00	0,00	0,01	0,00	0,00	0,00	0,00	10,41
2. Industrial Processes	**3,24**	**2,86**	**2,50**	**2,89**	**1,71**	**IE,NA,NO**	**IE,NA,NO**	**IE,NA,NO**	**IE,NA,NO**	**-100,00**
A. Mineral Products	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	0,00
B. Chemical Industry	3,24	2,86	2,50	2,89	1,71	NA,NO	NA,NO	NA,NO	NA,NO	-100,00
C. Metal Production	NO	NO	NO	NO	NO	NO	NO	NO	NO	0,00
D. Other Production										
E. Production of Halocarbons and SF_6										
F. Consumption of Halocarbons and SF_6										
G. Other	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
3. Solvent and Other Product Use	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	0,05	0,12	0,12	0,09	100,00
4. Agriculture	**22,04**	**21,24**	**20,52**	**19,80**	**19,72**	**19,85**	**19,31**	**19,03**	**19,85**	**-31,45**
A. Enteric Fermentation										
B. Manure Management	1,88	1,88	1,83	1,76	1,79	1,83	1,75	1,63	1,63	-24,23
C. Rice Cultivation										
D. Agricultural Soils	20,16	19,36	18,68	18,03	17,93	18,02	17,56	17,40	18,22	-32,04
E. Prescribed Burning of Savannas	NA	NA	NA	NA	NA	NA	NA	NA	NA	0,00
F. Field Burning of Agricultural Residues	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	33,70
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	0,00
5. Land Use, Land-Use Change and Forestry	**0,05**	**0,04**	**0,03**	**0,04**	**0,03**	**0,03**	**0,03**	**0,03**	**0,03**	**-38,60**
A. Forest Land	0,03	0,03	0,03	0,03	0,03	0,03	0,03	0,03	0,03	-16,91
B. Cropland	0,02	0,01	0,00	0,01	0,01	0,00	0,00	0,00	0,00	-90,58
C. Grassland	NA	NA	NA	NA	NA	NA	NA	NA	NA	0,00
D. Wetlands	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	-17,33
E. Settlements	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	0,00
F. Other Land	NA	NA	NA	NA	NA	NA	NA	NA	NA	0,00
G. Other	NE	NE	NE	NE	NE	NE	NE	NE	NE	0,00
6. Waste	**0,30**	**0,28**	**0,32**	**0,26**	**0,25**	**0,28**	**0,24**	**0,26**	**0,34**	**-1,51**
A. Solid Waste Disposal on Land										
B. Waste-water Handling	0,30	0,28	0,32	0,26	0,25	0,28	0,24	0,26	0,34	-1,59
C. Waste Incineration	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	44,02
D. Other	0,00	0,00	0,00	0,00	0,00	0,00	NO	NO	NO	0,00
7. Other ***(as specified in Summary 1.A)***	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**0,00**
Total N_2O emissions including N_2O from LULUCF	**27,08**	**25,89**	**24,82**	**24,47**	**23,15**	**21,61**	**21,19**	**20,89**	**21,72**	**-36,11**
Total N_2O emissions excluding N_2O from LULUCF	**27,03**	**25,85**	**24,79**	**24,43**	**23,12**	**21,58**	**21,16**	**20,86**	**21,69**	**-36,10**
Memo Items:										
International Bunkers	**0,35**	**0,31**	**0,26**	**0,27**	**0,25**	**0,25**	**0,30**	**0,31**	**0,29**	**13,22**
Aviation	0,08	0,08	0,07	0,07	0,08	0,09	0,09	0,09	0,09	53,28
Marine	0,27	0,23	0,19	0,20	0,16	0,17	0,22	0,22	0,20	1,04
Multilateral Operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	0,00
CO_2 Emissions from Biomass										

Table A8.4.

TABLE 10 EMISSION TRENDS

HFCs, PFCs and SF_6

(Part 1 of 2)

Inventory 2008

Submission 2010 v1.3

DENMARK

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
Emissions of HFCs[3] - (Gg CO_2 equivalent)	**NA,NE,NO**	**NA,NE,NO**	**3,44**	**93,93**	**134,53**	**217,73**	**329,30**	**323,75**	**411,20**	**504,04**
HFC-23	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-32	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NO	NA,NO	0,00	0,00	0,00	0,00	0,00
HFC-41	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-43-10mee	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-125	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NO	0,00	0,00	0,01	0,02	0,02	0,03
HFC-134	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-134a	NA,NE,NO	NA,NE,NO	0,00	0,07	0,10	0,15	0,20	0,17	0,21	0,23
HFC-152a	NA,NE,NO	NA,NE,NO	0,00	0,03	0,05	0,04	0,03	0,02	0,01	0,04
HFC-143	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-143a	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NO	0,00	0,00	0,01	0,01	0,02	0,03
HFC-227ea	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-236fa	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-245ca	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
Unspecified mix of listed HFCs[4] - (Gg CO_2 equivalent)	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
Emissions of PFCs[3] - (Gg CO_2 equivalent)	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NO**	**0,05**	**0,50**	**1,66**	**4,12**	**9,10**	**12,48**
CF_4	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
C_2F_6	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
C_3F_8	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NO	0,00	0,00	0,00	0,00	0,00	0,00
C_4F_{10}	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
c-C_4F_8	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
C_5F_{12}	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
C_6F_{14}	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
Unspecified mix of listed PFCs[4] - (Gg CO_2 equivalent)	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
Emissions of SF6[3] - (Gg CO_2 equivalent)	**44,45**	**63,50**	**89,15**	**101,17**	**122,06**	**107,34**	**60,96**	**73,06**	**59,42**	**65,36**
SF_6	0,00	0,00	0,00	0,00	0,01	0,00	0,00	0,00	0,00	0,00

Table A8.4 *continued*.

TABLE 10 EMISSION TRENDS

HFCs, PFCs and SF_6

(Part 2 of 2)

Inventory 2008

Submission 2010 v1.3

DENMARK

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	2008	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
Emissions of HFCs[3] - (Gg CO_2 equivalent)	**606,74**	**650,46**	**676,24**	**700,70**	**755,23**	**802,31**	**823,26**	**849,90**	**852,72**	**100,00**
HFC-23	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00	0,00	0,00	100,00
HFC-32	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,02	0,02	100,00
HFC-41	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
HFC-43-10mee	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
HFC-125	0,04	0,05	0,05	0,05	0,06	0,07	0,07	0,07	0,08	100,00
HFC-134	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
HFC-134a	0,25	0,27	0,28	0,27	0,29	0,29	0,29	0,29	0,29	100,00
HFC-152a	0,02	0,01	0,01	0,00	0,01	0,00	0,00	0,00	0,00	100,00
HFC-143	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
HFC-143a	0,04	0,04	0,04	0,05	0,05	0,06	0,06	0,07	0,07	100,00
HFC-227ea	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
HFC-236fa	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
HFC-245ca	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
Unspecified mix of listed HFCs[4] - (Gg CO_2 equivalent)	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
Emissions of PFCs[3] - (Gg CO_2 equivalent)	**17,89**	**22,13**	**22,17**	**19,34**	**15,90**	**13,90**	**15,68**	**15,36**	**12,79**	**100,00**
CF_4	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00	0,00	0,00	100,00
C_2F_6	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
C_3F_8	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	100,00
C_4F_{10}	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
c-C_4F_8	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00	0,00	0,00	100,00
C_5F_{12}	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
C_6F_{14}	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
Unspecified mix of listed PFCs[4] - (Gg CO_2 equivalent)	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
Emissions of SF6[3] - (Gg CO_2 equivalent)	**59,23**	**30,40**	**25,01**	**31,37**	**33,15**	**21,75**	**35,99**	**30,35**	**31,60**	**-28,92**
SF_6	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	-28,92

Table A8.5

TABLE 10 EMISSION TRENDS
SUMMARY
(Part 1 of 2)

Inventory 2008
Submission 2010 v1.3
DENMARK

GREENHOUSE GAS EMISSIONS	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	CO_2 eqv. (Gg)	CO_2 eqv. (Gg)	CO_2 eqv. (Gg)	CO_2 eqv. (Gg)	CO_2 eqv. (Gg)	CO_2 eqv. (Gg)	CO_2 eqv. (Gg)	CO_2 eqv. (Gg)	CO_2 eqv. (Gg)	CO_2 eqv. (Gg)
CO_2 emissions including net CO_2 from LULUCF	51.193,69	63.762,83	62.098,23	54.412,75	68.119,65	62.000,80	71.898,81	67.587,95	58.066,29	62.700,17
CO_2 emissions excluding net CO_2 from LULUCF	52.851,27	63.578,19	57.872,18	60.225,80	63.870,67	60.905,48	74.458,65	64.991,13	60.839,24	58.121,20
CH_4 emissions including CH_4 from LULUCF	5.504,48	5.575,55	5.578,92	5.713,17	5.647,17	5.729,36	5.826,15	5.678,54	5.697,22	5.593,12
CH_4 emissions excluding CH_4 from LULUCF	5.504,48	5.575,55	5.578,92	5.713,17	5.647,17	5.729,36	5.826,15	5.678,54	5.697,22	5.593,12
N_2O emissions including N_2O from LULUCF	10.537,57	10.331,36	9.892,44	9.664,35	9.500,32	9.389,69	9.138,98	8.925,90	8.818,11	8.629,03
N_2O emissions excluding N_2O from LULUCF	10.522,74	10.319,05	9.878,59	9.654,18	9.487,57	9.379,72	9.128,11	8.916,11	8.808,41	8.613,31
HFCs	NA,NE,NO	NA,NE,NO	3,44	93,93	134,53	217,73	329,30	323,75	411,20	504,04
PFCs	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NO	0,05	0,50	1,66	4,12	9,10	12,48
SF_6	44,45	63,50	89,15	101,17	122,06	107,34	60,96	73,06	59,42	65,36
Total (including LULUCF)	**67.280,19**	**79.733,24**	**77.662,18**	**69.985,37**	**83.523,79**	**77.445,42**	**87.255,86**	**82.593,32**	**73.061,34**	**77.504,19**
Total (excluding LULUCF)	**68.922,94**	**79.536,29**	**73.422,28**	**75.788,25**	**79.262,05**	**76.340,12**	**89.804,83**	**79.986,71**	**75.824,59**	**72.909,51**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	CO_2 eqv. (Gg)	CO_2 eqv. (Gg)	CO_2 eqv. (Gg)	CO_2 eqv. (Gg)	CO_2 eqv. (Gg)	CO_2 eqv. (Gg)	CO_2 eqv. (Gg)	CO_2 eqv. (Gg)	CO_2 eqv. (Gg)	CO_2 eqv. (Gg)
1. Energy	52.167,89	62.793,00	56.965,28	59.368,29	63.078,15	60.252,68	73.845,68	64.195,27	60.122,37	57.427,78
2. Industrial Processes	2.239,52	2.347,09	2.383,27	2.456,45	2.554,84	2.726,56	2.827,30	3.017,46	2.994,07	3.218,15
3. Solvent and Other Product Use	135,10	130,97	126,84	122,71	118,57	107,06	119,32	106,62	99,84	98,76
4. Agriculture	13.109,10	12.968,76	12.645,92	12.504,81	12.194,15	11.975,17	11.748,93	11.454,43	11.426,23	10.948,69
5. Land Use, Land-Use Change and Forestry[(5)]	-1.642,76	196,95	4.239,90	-5.802,88	4.261,74	1.105,30	-2.548,97	2.606,61	-2.763,25	4.594,68
6. Waste	1.271,33	1.296,48	1.300,97	1.335,99	1.316,33	1.278,65	1.263,60	1.212,93	1.182,07	1.216,14
7. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total (including LULUCF)[(5)]	**67.280,19**	**79.733,24**	**77.662,18**	**69.985,37**	**83.523,79**	**77.445,42**	**87.255,86**	**82.593,32**	**73.061,34**	**77.504,19**

Table A8.5 *continued*.

TABLE 10 EMISSION TRENDS
SUMMARY
(Part 2 of 2)

Inventory 2008
Submission 2010 v1.3
DENMARK

GREENHOUSE GAS EMISSIONS	2000	2001	2002	2003	2004	2005	2006	2007	2008	Change from base to latest reported year
	CO_2 eqv. (Gg)	CO_2 eqv. (Gg)	CO_2 eqv. (Gg)	CO_2 eqv. (Gg)	CO_2 eqv. (Gg)	CO_2 eqv. (Gg)	CO_2 eqv. (Gg)	CO_2 eqv. (Gg)	CO_2 eqv. (Gg)	(%)
CO_2 emissions including net CO_2 from LULUCF	53.006,19	55.910,10	58.464,74	59.522,60	53.728,56	48.010,07	65.140,34	53.854,53	51.156,80	-0,07
CO_2 emissions excluding net CO_2 from LULUCF	53.608,07	55.212,02	54.839,30	60.041,27	54.512,52	50.844,29	58.686,06	53.897,10	50.665,16	-4,14
CH_4 emissions including CH_4 from LULUCF	5.623,91	5.745,22	5.667,07	5.670,72	5.521,89	5.455,35	5.534,03	5.582,57	5.558,96	0,99
CH_4 emissions excluding CH_4 from LULUCF	5.623,91	5.745,22	5.667,07	5.670,72	5.521,89	5.455,35	5.534,03	5.582,57	5.558,96	0,99
N_2O emissions including N_2O from LULUCF	8.395,38	8.024,76	7.694,15	7.584,93	7.176,94	6.698,29	6.568,34	6.477,07	6.732,90	-36,11
N_2O emissions excluding N_2O from LULUCF	8.378,93	8.012,04	7.684,63	7.573,52	7.166,27	6.688,92	6.559,05	6.467,88	6.723,79	-36,10
HFCs	606,74	650,46	676,24	700,70	755,23	802,31	823,26	849,90	852,72	100,00
PFCs	17,89	22,13	22,17	19,34	15,90	13,90	15,68	15,36	12,79	100,00
SF_6	59,23	30,40	25,01	31,37	33,15	21,75	35,99	30,35	31,60	-28,92
Total (including LULUCF)	**67.709,33**	**70.383,07**	**72.549,39**	**73.529,67**	**67.231,67**	**61.001,69**	**78.117,63**	**66.809,79**	**64.345,77**	**-4,36**
Total (excluding LULUCF)	**68.294,76**	**69.672,27**	**68.914,43**	**74.036,92**	**68.004,95**	**63.826,54**	**71.654,07**	**66.843,16**	**63.845,03**	**-7,37**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	2008	Change from base to latest reported year
	CO_2 eqv. (Gg)	CO_2 eqv. (Gg)	CO_2 eqv. (Gg)	CO_2 eqv. (Gg)	CO_2 eqv. (Gg)	CO_2 eqv. (Gg)	CO_2 eqv. (Gg)	CO_2 eqv. (Gg)	CO_2 eqv. (Gg)	(%)
1. Energy	52.876,81	54.524,89	54.140,11	59.489,69	53.832,84	50.215,66	58.050,26	53.219,50	50.230,50	-3,71
2. Industrial Processes	3.388,62	3.290,94	3.198,24	3.215,39	3.023,47	2.442,32	2.524,17	2.542,95	2.256,65	0,77
3. Solvent and Other Product Use	98,85	86,91	87,12	78,94	76,98	88,47	108,45	100,15	92,10	-31,83
4. Agriculture	10.697,80	10.523,37	10.260,84	9.998,09	9.904,08	9.901,10	9.741,72	9.758,70	10.025,15	-23,53
5. Land Use, Land-Use Change and Forestry[(5)]	-585,44	710,80	3.634,96	-507,26	-773,28	-2.824,85	6.463,56	-33,37	500,74	-130,48
6. Waste	1.232,68	1.246,15	1.228,13	1.254,82	1.167,59	1.179,00	1.229,47	1.221,86	1.240,63	-2,42
7. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	0,00
Total (including LULUCF)[(5)]	**67.709,33**	**70.383,07**	**72.549,39**	**73.529,67**	**67.231,67**	**61.001,69**	**78.117,63**	**66.809,79**	**64.345,77**	**-4,36**

Annex 9 Methodology applied for the Greenhouse Gas Inventory for Greenland

Contents

1 Introduction

The following sections contain a report of Greenland's part of the National Inventory Report (NIR) 2010. The structure of the report follows the UNFCCC guidelines on reporting and review (UNFCCC, 2002).

The report is to a far extent structured according to the recommended outline provided by the UNFCCC secretariat.

Previously the greenhouse gas (GHG) inventory and this annex were completed exclusively by The Danish National Environmental Research Institute, Aarhus University (NERI), with input from the Environmental and Nature Protection Agency (APA), Ministry of Domestic Affairs, Nature and Environment.

In 2008 an energy statistic was officially initiated at Statistics Greenland with the intention to "… create an important tool, which in regard to political and economical priorities, can contribute to the identification of efforts on energy matters…" and which "… in regard to environmental aspects will create a basis for assessing the development in regard to Greenland's meetings of the Kyoto protocol …". The first results on the new energy statistics, covering the period 2004-2007, were published in November 2008.

The GHG inventory submitted in April 2010 is completed by Statistics Greenland and The Greenland Climate and Infrastructure Agency with technical support from NERI. This report on methodology is written by Statistics Greenland with assistance from The Greenland Climate and Infrastructure Agency and documental support by NERI.

The annual emission inventories for Greenland for the years 1990-2008, are reported in the full CRF format.

The GHG's reported are:

- Carbon dioxide CO_2
- Methane CH_4
- Nitrous Oxide N_2O
- Hydrofluorocarbons HFCs
- Perfluorocarbons PFCs
- Sulphur hexafluoride SF_6

1.1 A description of the institutional arrangement for inventory preparation

The Greenland Climate and Infrastructure Agency is responsible for the annual preparation of the Greenlandic contribution to the National Inventory Report and the GHG inventories in the Common Reporting Format in accordance with the UNFCCC Guidelines. The Greenland Climate and Infrastructure Agency will provide the data to NERI. NERI is responsible for aggregating the Danish and Greenlandic CRF submissions and reporting the aggregated CRF and the National Inventory Report to the UNFCCC.

The inventory for KP-LULUCF is carried out by NERI and the documentation of the inventory (Chapter 11) is done by the Danish LULUCF experts.

The work concerning the annual GHG emission inventory is carried out in co-operation with other Greenlandic ministries, research institutes, organisations and companies:

Statistics Greenland (Ministry of Finance)
Annual energy statistics in a format suitable for the emission inventory work and fuel-use data for the large combustion plants. Statistical Yearbook. From 2009 annual survey on emissions of F-gases.

Agricultural Advisory Service (Ministry of Fisheries, Hunting and Agriculture)
Background data on cropland and grassland, and statistics on livestock (sheep and reindeer).

Agency of Environment and Nature (Ministry of Domestic Affairs, Nature and Environment)
Data on waste and emissions of F-gases. Annual Survey carried out by the Agency of Environment and Nature until 2008 and by Statistics Greenland from 2009 and onwards.

Ministry of Fisheries, Hunting and Agriculture and the Greenlandic Arboretum
Background data for forestry.

Greenland Airport Authority (Ministry of Housing, Infrastructure and Transport)
Statistics on domestic flights and foreign flights to and from Greenland.

Formerly, the provision of data was on a voluntary basis, but a more formal agreement is now in place for the 2009 GHG inventory report.

1.2 Brief description of the process of inventory preparation - data collection, data processing, data storage

The background data (activity data and emission factors) for estimation of the Greenlandic emission inventories is collected and stored in central databases at Statistics Greenland. The databases are in SAS format and handled with software from the SAS Institute Inc. The SAS programs are designed by Statistics Greenland. The methodologies and data sources used for the different sectors are described briefly in Chapter 1.4 and more in depth in Chapters 3 to 8 and Chapter 11.

The material is placed on servers at Statistics Greenland. The servers are subject to routine backup services. Material, which have been backed up is archived safely.

1.3 General description of methodologies and data sources used

The GHG inventory for Greenland includes the following sectors:

- Energy sector
- Industrial processes
- Solvent and other product use
- Agriculture
- Land Use, Land-use Change and Forestry
- Waste
- KP-LULUCF

The applied methodologies follow the IPCC Guidelines and IPCC Good Practice Guidance. In some cases the methodology is identical to the methodology applied in the Danish inventory, however, the availability of data – especially site specific data – do not allow the same methodology to be used for all the sectors. The brief methodological description is included below for the different sectors. More thorough descriptions are included in Chapter 3-8 and 11.

1.3.1 Energy sector

Fuel combustion

The Greenlandic emission inventory for fuel combustion has been performed according to the IPCC tier 1 methodology. The inventory is based on activity data from the Greenlandic energy statistics and on emission factors for different fuels, plants and sectors.

Total fuel combustion is based on data from Polaroil, Statoil and Malik Supply A/S. Polaroil imports fuel and distributes fuel in all parts of Greenland. Statoil imports and distributes fuel in Kangerlussuaq. Malik Supply A/S, a Danish company, re-distributes fuel bought from Polaroil to Greenlandic trawlers, ships etc. By using detailed data from Polaroil, Statoil and Malik Supply A/S it is possible to determine total import, total export, total international bunkers and total domestic fuel combustion.

Total domestic fuel combustion is then divided into sectors and private households by using data from a survey on energy consumption, company specific sales data from Polaroil and local fuel distributors, company tax accountings, municipality and the government of Greenland accountings, and by estimation.

Fuel combustion in private households is estimated using detailed information from a number of local fuel distributors. Fuel deliveries are registered by buildings. In Greenland each building has a unique number registered in the Greenlandic Area Register (NIN). By combining the NIN-register and the GER-register (see above) with statistics on housing and population each building is labelled *private household* or located to a sector describing the main activity in the building. This new building-sector register, completed annually, is used extensively to determine the buyer of fuel delivered by Polaroil or local fuel distributors.

Fuel combustion in road traffic is based on a model designed by Statistics Greenland. The model contains data on the vehicle stock obtained from the Greenland Police Department's register on engine data. The vehicles are divided into broad categories of type i.e. personal car, lorry, taxi, truck, ambulance, motorbike etc. Each category is assigned with ratios on fuel type and mileage. Input data on mileage is derived from a survey among businesses and private road traffic in 2008. Each vehicle is divided in business categories or labelled *private vehicle* according to the owner. For each group the emissions are estimated by combining vehicle and annual mileage numbers with standard emission factors according to the type of fuel. The model does not take cold start or hot engines into account.

For air traffic annual emissions are based on activity data from Air Greenland A/S and sales data from the Greenland Airport Authority. For navigation, ferries and freight, annual emissions are based on activity data from Royal Arctic Line A/S (freight), Royal Arctic Tankers A/S (freight), Royal Arctic Bygdeservice A/S (freight/passengers), and Arctic Umiaq Line A/S (passengers) and the liquidated Assartuivik A/S (passengers).

For further information please refer to Chapter 3.

Fugitive emission

Greenland has no coal mines, no off-shore activities, no oil refineries, no natural gas transmission or distribution. For that reason there are no fugitive emissions from such activities.

However, some fugitive emissions could possibly occur in the distribution of fuel e.g. when refuelling from ships to on-shore tanks, onshore loading of fuel to ships and offshore loading of ships. The fugitive emission from loading/unloading of ships is currently not estimated.

1.3.2 Industrial processes

Mineral products

CO_2 emissions occur from limestone and dolomite use, road paving with asphalt and asphalt roofing. Import statistics of asphalt and limestone are used as activity data for estimating the emissions.

Chemical industry

Greenland has no chemical industry.

Metal production

Greenland has no metal production.

Other production

There are several manufacturers of fish products and one tannery. Emissions of NMVOC are estimated, but there are no emissions of greenhouse gases occurring.

F-gases

Greenland has no production of halocarbons or SF_6. Data on consumption of F-gases (HFCs and SF_6) are obtained from the Agency of Environment and Nature. The Agency conducts an annual survey on consumption of halocarbons and SF_6. Information on emission of industrial gases is available from 1995 onwards. Greenland has no consumption of PFCs.

For further information on the methodology for calculating emissions from industrial processes please refer to Chapter 4.

1.3.3 Solvent and other product use

The emission estimates for solvent and other product use are prepared by using import statistics of pure chemicals that fits the criteria for being considered a NMVOC compound. Additionally import statistics are used for products containing NMVOC's. The NMVOC emission is then calculated in to a CO_2 emission by using a standard value for carbon content in the NMVOC's. For further information see Chapter 5.

1.3.4 Agriculture

Enteric Fermentation Manure Management

Agriculture is sparse in Greenland due to climatic conditions. However sheep and reindeer are considered to contribute to emission of greenhouse gases. Enteric fermentation and manure management is assumed to contribute to emission of CH_4, and nitrogen excretion is assumed to contribute to emission of N_2O.

The emissions are given in CRF: Table 4 Sectoral Report for Agriculture and Table 4.A, 4.B(a), 4.B(b) and 4.D Sectoral Background Data for Agriculture. The calculation of emissions from the agricultural sector is based on methods described in the IPCC Guidelines (IPCC, 1996) and the Good Practice Guidance (IPCC, 2000). Activity data for livestock is on a one year average basis from the agriculture statistics published by Statistics Greenland. Data concerning the land use and crop yield is obtained from the Agricultural Advisory Service.

Data concerning the feed consumption and nitrogen excretion from sheep is based on information from the Agricultural Advisory Service supplemented by data on imported feed. Data concerning the feed consumption and nitrogen excretion from reindeer is based on information from the Agricultural Advisory Service and information from an article on reindeer management in Greenland.

Emission of N_2O is closely related to the nitrogen balance. Thus, quite a lot of the activity data is related to the calculation of ammonia emission. National standards are used to estimate the amount of ammonia emission. When estimating the N_2O emission the IPCC standard value is used for all emission sources. The emission of CO_2 from Agricultural Soils is included in the LULUCF sector.

For a more thorough description of the methodology for the agricultural sector please refer to Chapter 6.

1.3.5 Land use, land-use change and forestry

Forest land

Greenland has four forests, which may qualify to the FAO criteria of forest definitions, e.g. larger than 0.5 ha, a width larger than 20 meters, a minimum height higher than 5 meters at maturity and a minimum crown cover of 10 % (except for the Qinngua Valley). It is assumed that no cuttings or wind felling have taken place in the period 1990 to 2008.

The four forests are:

A natural forest in the Qinngua valley of 45 ha consisting mainly of *Betula Pubescens ssp. czerepanovii* which in the period 1990 to 2008 has had an average height of six meters and app. 100 trees pr ha. It is thus assumed that it has had the same biomass for the whole period.

A planted forest in Qanassiassat of one ha (Larix sibirica andPicea Abies) which in 1990 had an average height of five meters increasing to 10 meters in 2008 with an average of 800 trees pr ha.

A planted forest in Kuussuaq of five ha (Picea sitchensis x glauca) which in 1990 had an average height of three meters increasing to nine meters in 2008 with app. 900 trees pr ha.

A planted forest in Orpiuteqarfia of three ha (Larix Sibirica) which in 1990 had an average height of four meters increasing to seven meters in 2008 with approx. 400 trees pr ha.

For the carbon stock and carbon stock changes calculations for forests are a combination of data from Greenland and default values on density, carbon content, BCEFs and shoot-root-ratio from IPCC Guidelines for National Green House Gas Inventories (IPPC, 2006) for living biomass for the boreal zone are used.

Cropland

In 1990 it was assumed that no annual crops were grown in Greenland. In 2008 five ha of cropland was used for annual crops. The primary production is potatoes. Potato fields are mainly managed by hand and primarily fens with a high content of organic matter which is used for this purpose. It is thus assumed that the IPCC standard emission factor for boreal/cold areas of five tonnes C pr ha can be used although it is probably an overestimation due to the cold climate and the current management practice.

Grassland

The total area with grassland has increased from 490 ha in 1990 to 973 ha in 2008. The grassland is improved grassland which occasionally is reseeded with grass to increase the yield. At the moment no information is available on how often the grass sward is broken. Approx. 25 % of the grassland is organics soils as well as 250 ha is assumed to be drained. For grassland on mineral/varying soils an emission of zero (steady state) is assumed although there has been an increase in the area since 1990. For the area on histosols it is assumed that the IPCC standard emission factor for boreal/cold areas of 0.25 tonnes C pr ha is applicable although it is probably an overestimation due to the cold climate. For the whole period it is assumed that 25 % of the grassland is on histosols leading to an increased emission from this source.

Wetlands

The area with water-reservoirs has been estimated, but due to lack of methodology for methane emissions under arctic conditions has no emission estimates has been made which is in accordance with the IPCC GPG 2003 guidelines.

Settlements

As settlements are mainly built on cliffs with very sparse vegetation is it assumed that no changes in C stock are occurring.

Other land

No emission estimates has been made since no data is available which is in accordance with IPCC GPG 2003 guidelines.

For a more thorough description of the methodology applied for LULUCF and KP-LULUCF please refer to Chapter 7 and 11.

1.3.6 Waste

Solid waste management

The solid waste management in Greenland can be divided in the following processes:

- Managed waste disposal combined with open burning
- Unmanaged waste disposal combined with open burning
- Wastewater handling
- Waste incineration with energy recovery
- Waste incineration without energy recovery

Waste incineration with energy recovery is according to IPCC Guidelines included under the energy sector.

Information on amount of waste produced pr year, amount of waste treated in the different processes, distribution between household and commercial waste, composition of the household waste and commercial waste, respectively, are provided by the Environmental and Nature Agency, Ministry of Infrastructure and Environment.

Wastewater handling

N_2O emission from human sewage is estimated. The calculation of the N_2O emission uses population data from Statistics Greenland and an estimate for average protein consumption combined with default values from the IPCC Guidelines. No emissions of CH_4 are assumed to occur.

For more information please refer to Chapter 8.

1.3.7 Memo Items

International Aviation Bunkers

Emissions from international aviation bunkers are considered to be of neglible importance. The Greenland Airport Authority has reported the annual amount of jet fuel loaded into foreign aircrafts including Danish aircrafts. However, it is not possible to distinguish between Danish aircrafts and other aircrafts. Since most foreign aircrafts by far are Danish the annual amount of jet fuel loaded into foreign aircrafts are therefore included as part of the IPCC category 1A3a Civil aviation.

International Marine Bunkers
Emissions from international marine bunkers are included from 2004 and onwards. Before 2004 international marine bunkers are considered to be of negligible importance.

1.3.8 KP-LULUCF

Regarding the possibility of including in the first commitment period emissions and removals associated with land use, land-use change and forestry activities under Article 3.4 of the Kyoto Protocol, Greenland as part of the Kingdom of Denmark has included emissions and removals from forest management (FM), cropland management (CM) and grazing land management (GM).

The national system has identified land areas associated with the activities under Article 3.4 of the Kyoto Protocol in accordance with definitions, modalities, rules and guidelines relating to land use, land-use change and forestry activities under the protocol. All land converted from other activities into Cropland and Grassland is accounted for. No land has been allowed to leave elected areas under art. 3.4.

Please see chapter 11 for further details.

1.4 Brief description of key categories

A key category analysis (KCA) for year 1990 and 2008 has been carried out in accordance with the IPCC Good Practice Guidance. This is the first KCA done for the Greenlandic inventory.

The categorisation used results in a total of 33 categories. In the level KCA for the inventory for 1990, 5 key categories were identified. For the KCA for 2008, 3 categories were identified as key categories due to both level and trend. Two further categories were key categories due to level while five other categories were key categories due to the trend.

Of the five key sources due to level four are in the energy sector, of which CO_2 from liquid fuels excluding transport in the analysis contributes most with 77.7 % of the national total (this contribution and the percentage contributions in the following are results from the level KCA based on the absolute values of the emissions; this contribution as percentages may differ somewhat from the percentage used in the sectoral chapters). The remaining level key categories in the energy sector are all CO_2 from the transport sector. Civil aviation, road transportation and domestic navigation comprise respectively, 7.3, 4.6 and 3.3 % of the national total. The last key category is N_2O from wastewater handling.

The trend assessment shows that consumption of HFCs, direct N_2O emissions from agricultural soils, enteric fermentation, CH_4 emission from waste incineration and indirect N_2O emissions from agricultural soils are key categories due to the trend.

The categorisation used, results, etc. are included in Annex 1.

1.5 Information on QA/QC plan including verification

A number of measures are in place to ensure the quality of the Greenlandic greenhouse gas inventory.

The general QC activities include:

- Check that data are correctly moved between data processing steps, e.g. it is ensured that the data are imported correctly from the emission spreadsheets/databases to the CRF Reporter.
- The time series are analysed. Any large fluctuations are investigated and explained/corrected.
- The recalculations are analysed and the consistency of the emission estimates are verified.
- The completeness of the inventory is checked utilising the completeness checker incorporated in the CRF Reporter as well as expert knowledge from the inventory compilers.
- All references are checked and it is ensured that the citations are correct.

These types of QC checks are recommended as tier 1 QC checks in the IPCC Good Practice Guidance (IPCC, 2000).

The Greenlandic emission inventory is reviewed by Danish emission experts, who provide input to the Greenlandic inventory compilers on necessary improvements etc. This is done as a QA procedure. When the emission estimates are transferred to NERI, the quality control system of the Danish emission inventory is applied to the Greenlandic data.

All information related to the Greenlandic emission estimates are documented and archived securely annually. This is done in order to ensure that any part of the inventory can be reproduced at a later stage if necessary.

In addition source specific QA/QC activities are carried out, please see the associated paragraphs in the sectoral chapters.

1.6 General uncertainty evaluation

The uncertainty estimates are based on the Tier 1 methodology in the IPCC Good Practice Guidance (GPG) (IPCC, 2000). Uncertainty estimates for the following sectors are included in the current year: fuel combustion, industrial processes, solid waste, wastewater treatment and waste incineration, solvents and other product use, agriculture and LULUCF.

The uncertainties for the activity rates and emission factors are shown in Table 1.4. The estimated uncertainties for total GHG and for CO_2, CH_4, N_2O and F-gases are shown in Table 1.3. The base year for F-gases is 1995 and for all other sources the base year is 1990. The total Greenlandic GHG emission is estimated with an uncertainty of ±5.8 % and the trend in GHG emission since 1990 has been estimated to be 10.6 % ± 3.2 %-age points. The GHG uncertainty estimates do not take into account the uncertainty of the GWP factors.

The uncertainty on CO_2 from liquid fuels in fuel combustion, N_2O emission waste water treatment and CH_4 emission from enteric fermentation are the largest sources of uncertainty for the Greenlandic GHG inventory. The result is skewed by the fact that more than 90% of the Greenlandic Greenhouse gas emission is from fuel combustion of liquid fuels.

Table 1.3 Uncertainties 1990-2008.

	Uncertainty [%]	Trend [%]	Uncertainty in trend [%-age points]
GHG	5.8	10.6	± 3.2
CO_2	5.3	9.7	± 3.1
CH_4	56	-5.6	± 9.0
N_2O	82	17	± 35
F-gases	51	+10 717	± 4 768

Table 1.4 Uncertainty rates for each emission source.

IPCC Source category	Gas	Base year emission	Year t emission	Activity data uncertainty	Emission factor uncertainty
		Gg CO_2 eq	Gg CO_2 eq	%	%
1A, Liquid fuels	CO_2	621	677	2	5
1A, Municipal waste	CO_2	1	6	2	25
1A, Liquid fuels	CH_4	1	1	2	100
1A, Municipal waste	CH_4	0	0	2	100
1A, Biomass	CH_4	0	0	2	100
1A, Liquid fuels	N_2O	2	2	2	500
1A, Municipal waste	N_2O	0	0	2	500
1A, Biomass	N_2O	0	0	2	200
2A3 Limestone and dolomite use	CO_2	0	0	5	5
2A5 Asphalt roofing	CO_2	0	0	5	25
2A6 Road paving with asphalt	CO_2	0	0	5	25
2F Consumption of HFC	HFC	0	7	10	50
2F Consumption of SF6	SF_6	0	0	10	50
3A Paint application	CO_2	0	0	10	15
3B Degreasing and dry cleaning	CO_2	0	0	10	15
3C Chemical products, manufacturing and processing	CO_2	0	0	10	15
3D5 Other	CO_2	0	0	10	20
4A Enteric Fermentation	CH_4	6	6	10	100
4B Manure Management	CH_4	0	0	10	100
4.B Manure Management	N_2O	0	0	10	100
4D1 Direct N2O emissions from agricultural soils	N_2O	0	2	20	50
4D2 Pasture range and paddock	N_2O	1	1	20	25
4D3 Indirect N2O emissions from agricultural soils	N_2O	1	2	20	50
5A Forest	CO_2	0	0	5	50
5B Cropland	CO_2	0	0	5	50
5.C Grassland	CO_2	0	0	5	50
6A Solid Waste Disposal on Land	CH_4	4	4	10	100
6B Wastewater Handling	N_2O	15	16	30	100
6C Waste incineration	CO_2	3	3	10	25
6C Waste incineration	CH_4	2	2	10	50
6C Waste incineration	N_2O	1	1	10	100

1.7 General assessment of completeness

The present Greenlandic greenhouse gas emission inventory includes all major sources identified by the Revised IPPC Guidelines.

1.8 References

Agency of Environment and Nature: Data on waste and ozone depleting substances and greenhouse gases HFCs, PFCs and SF_6.

Agricultural Advisory Service: Statistics on livestock (sheep and reindeer) and background data on land use (cropland and grassland).

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2 Trends in Greenhouse Gas Emissions

2.1 Description and interpretation of emission trends for aggregated greenhouse gas emission

The GHG emissions are estimated according to the IPCC guidelines and are aggregated into seven main sectors; Energy excl. Transport, Industrial Processes, Solvent and Other Product Use, Agriculture, LULUCF, and Waste. In Figure 2.3 and Figure 2.4 CO_2 emissions from fuel combustion in the Energy Sector is split into several sub-categories i.e. Energy Industries, Manufacturing Industries and Construction, Commercial and Institutional, Residential, Agriculture and Fishing.

The greenhouse gases include CO_2, CH_4, N_2O, HFCs, PFCs and SF_6. However, Greenland has no consumption of PFC. In 2008 total emission of greenhouse gases excluding LULUCF was 728.7 Gg CO_2-equivalent, and including LULUCF 728.2 Gg CO_2-equivalent.

Figure 2.1 shows total greenhouse gas emission in CO_2 equivalents from 1990 to 2008. The emissions are not corrected for temperature variations. CO_2 is the most important greenhouse gas. In 2008 CO_2 contributed to the total emission in CO_2 equivalent excluding LULUCF (Land Use and Land-Use Change and Forestry) with 94.1%, followed by N_2O with 3.3%, CH_4 1.7% and F-gases (HFCs and SF_6) with 0.9%. Since 1990 these percentages have been increasing for F-gases, almost constant for N_2O and falling for CO_2 and CH_4.

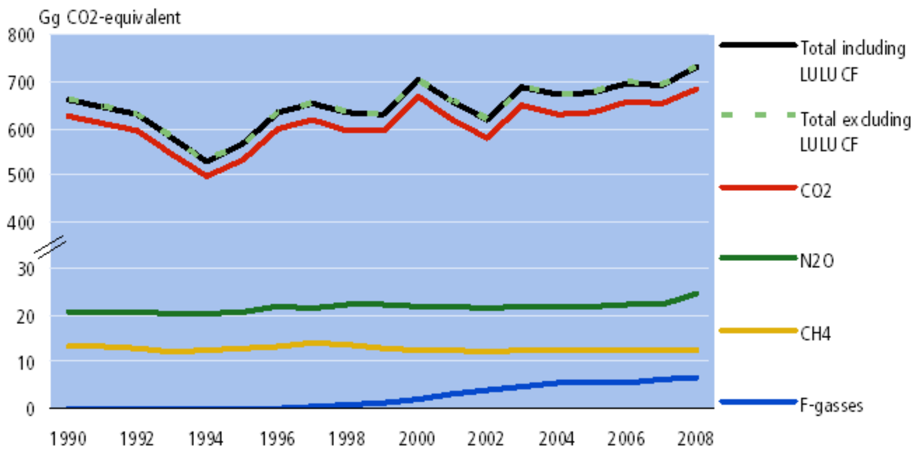

Figure 2.11 Greenhouse gas emission in CO_2 equivalents, time-series 1990-2008.

Stationary combustion plants and transport represent the largest categories. Energy excluding transport contributed to the total emission in CO_2 equivalents excluding LULUCF with 79 % in 2008, see Figure 2.2. Transport contributed with 15 %. Industrial processes, solvent and other products use, agriculture and waste contributed to the total emission in CO_2 equivalents with 4 %.

The net CO_2 removal by forestry is 0.08 % of the total emission in CO_2 equivalents in 2008. The total GHG emission in CO_2 equivalents excluding LULUCF has increased by 10.6% from 1990 to 2008 and increased 10.6% including LULUCF. Comments on the overall trends etc. seen in Figure 2.1 and Figure 2.2 are given in the sections below on the individual greenhouse gases.

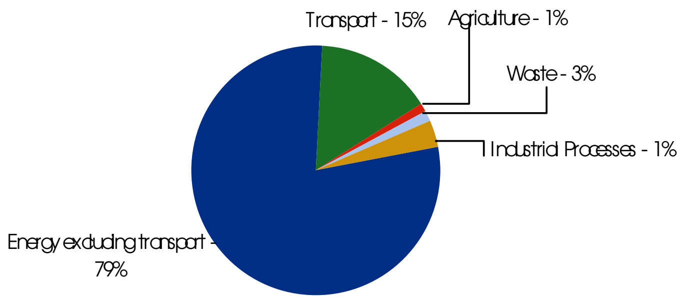

Figure 2.2 Greenhouse gas emission in CO_2 equivalents distributed on main sectors for 2008.

2.2 Description and interpretation of emission trends by gas

2.2.1 Carbon Dioxide

In Figure 2.3 CO_2 emissions from fuel combustion in the Energy Sector is split into several sub-categories i.e. Energy Industries, Manufacturing Industries and Construction, Commercial and Institutional, Residential, Agriculture and Fishing.

The largest source to the emission of CO_2 is the energy sector. This sector includes combustion of fossil fuels like gas oil, gasoline, jet kerosene etc. From this sector Energy Industries contributes with 25% of the total CO_2 emission followed by Agriculture and Fishing with 21% and Residential with 19% in 2008.

Transport contributes with 16% of the total CO_2 emission. Manufacturing Industries and Construction with 9%. Commercial and Institutions with 10%. The category *Other* contributes with 1% of the emissions.

The CO_2 emission excluding LULUCF increased by approximately 5.2% from 2007 to 2008. The main reason for this increase was a relatively warm 2007-spring and a following relative cold 2008-winter, which caused less fuel combustion in power plants in 2007 and more fuel combustion in power plants in 2008. In 2008, the actual CO_2 emission was 10.6% higher than the emission in 1990.

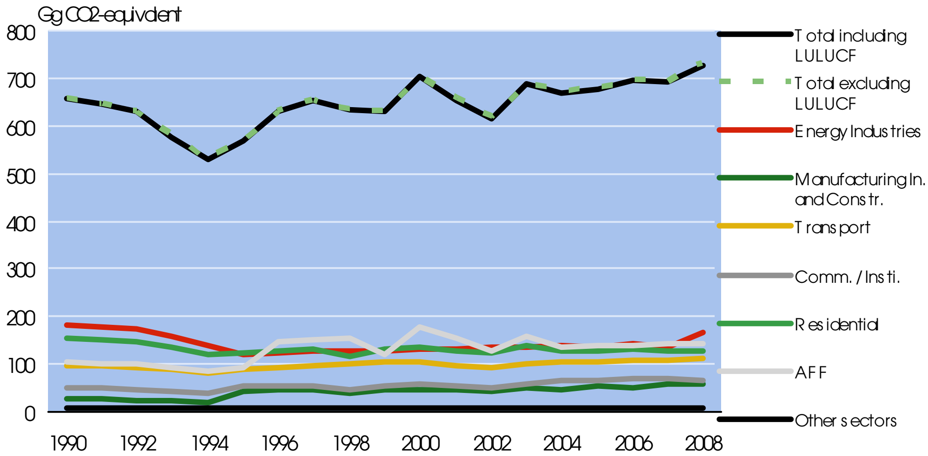

Figure 2.3 CO_2 emissions, time-series for 1990-2008.

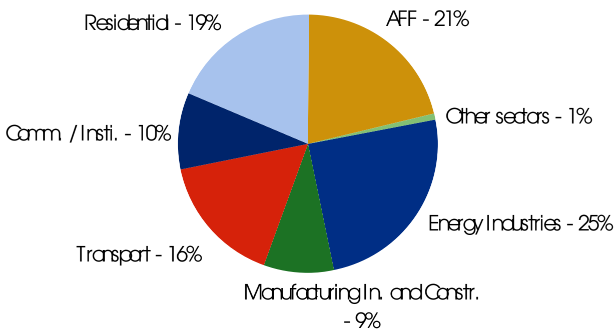

Figure 2.4 CO_2 emissions, distribution according to the main sectors for 2008.

2.2.2 Nitrous oxide

Waste, particularly waste water handling is the most important N_2O emission source in 2008 contributing 70 % to the total N_2O emissions, see Figure 2.6. Emission of N_2O from agricultural contributed 21 % to the total N_2O emissions in 2008. Fuel combustion including transport contributed 9 %. Since 1990 total emission of N_2O has increased by 17.3 %.

The N_2O emission from agriculture decreased during the early nineties due to a decrease in reindeer livestock from 1990 to 1994. Since 1995 the emission of N_2O has increased and decreased for shorter periods depending on changes in the livestock and the use of fertiliser. Since 2002 the N_2O emission has increased. In 2008, the actual N_2O emission was double than the emission in 1990, see Figure 2.5. The cause of this was a significant increase in the use of fertilisers in 2008.

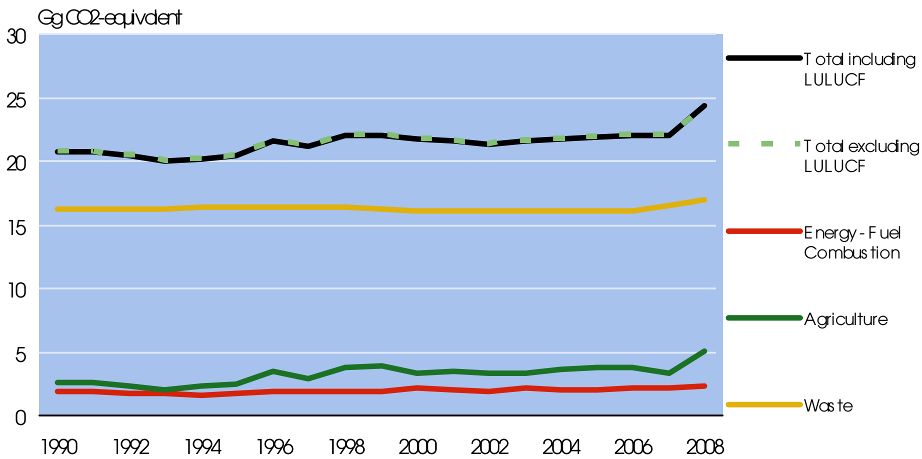

Figure 2.5 N_2O emissions, time-series for 1990-2008.

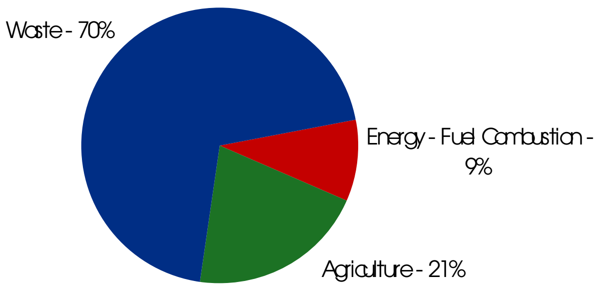

Figure 2.6 N_2O emissions, distribution according to the main sectors in 2008.

2.2.3 Methane

The largest sources of anthropogenic CH_4 emissions are agricultural activities and waste handling, each contributing in 2008 with 45 % of total CH_4 emissions, see Figure 2.8. The energy sector contributes with 10 %. The emission from agriculture derives from enteric fermentation (98 %) and management of animal manure (2 %).

Since 1990 the overall number of sheep has increased, while the overall number of reindeer has decreased. From 1990 to 2008 the emission of CH_4 from agricultural activities has decreased by 8.6 %.

The emission of CH_4 from waste derives from solid waste disposal (72 %) and waste incineration (28 %). From 1990 to 2008 the emission of CH_4 from solid waste disposal has increased by 9 %, while emissions from waste incineration have decreased by 31%. Overall emission of CH_4 from waste handling has decreased by 6 % from 1990 to 2008.

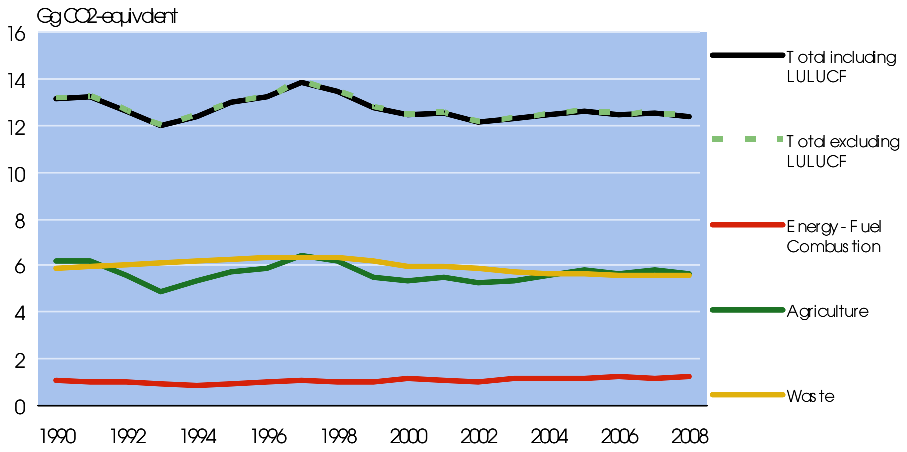

Figure 2.7 CH_4 emissions, time-series for 1990-2008.

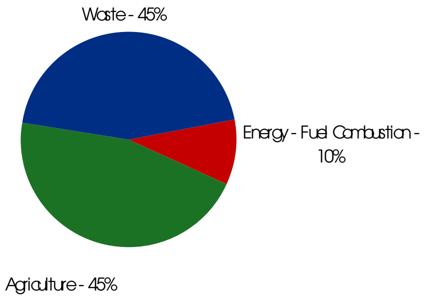

Figure 2.8 CH_4 emissions, distribution according to the main sectors in 2008.

2.2.4 HFCs, PFCs and SF_6

This part of the Greenland inventory only comprises a full data set for HFCs and SF_6 from 1995. Greenland has no consumption that leads to emission of PFCs. From 1995 to 2008 there has been a continuous and substantial increase in the contribution from F-gases calculated as the sum of emissions in CO_2 equivalents, see figure 2.9. This increase is caused by and simultaneous with an increase in the emission of HFCs. For the time-series 2004-2008 the increase is lower than for the years 1995 to 2004. The increase from 1995 to 2004 is 8,892%. From 2004 to 2007 total emission increased by 20%. SF_6 contributed to the F-gas sum in 1995 with 59%. Environmental awareness and regulation of this gas under Danish law has reduced its use considerably since 1995. In 2008 the contribution from SF_6 to the emission of F-gases was only 0.05%.

The use of HFCs has increased to a great extent. Today HFCs are by far the dominant F-gas, comprising 41% in 1995, but 99.95 % in 2008. HFCs are mainly used as a refrigerant.

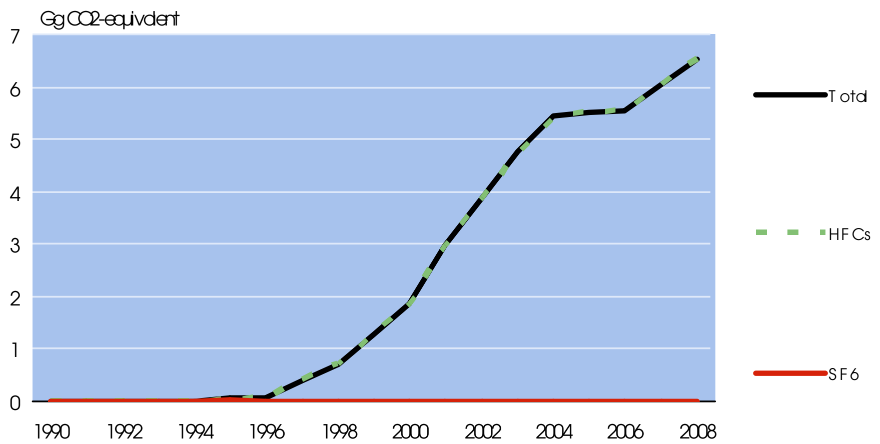

Figure 2.9 F-gas emissions, time-series for 1990-2008.

2.3 Description and interpretation of emission trends by category

2.3.1 Energy

The emission of CO_2 from fuel combustion has increased by 9.7% from 1990 to 2008. Combustion of fuel was decreasing from 1990 until 1994 due to the implementation of the first hydro power plant. However, since 1994 combustion of fuel has increased continuously. The reason for this increase is primarily higher demand for transportation and heating. Combustion of fuel may decrease certain years due to milder temperatures.

Emission of CH_4 has increased by 15% from 1990 to 2008 primarily due to an increase in the use of fuel for transportation. The CH_4 emission from the transport sector has increased by 52% from 1990 to 2008, mainly due to increasing domestic aviation.

Emission of N_2O has increased by 21% from 1990 to 2008.

2.3.2 Industrial processes

Emissions from industrial processes (consumption of halocarbons and SF_6) other than fuel combustion amount to 0.9% of the total emission in CO_2 equivalents excluding LULUCF in 2008. The main source is consumptions of HFCs. Emission of F-gases have increased considerable since 1990.

2.3.3 Agriculture

The agricultural sector contributes with 1.5% of the total greenhouse gas emissions in 2008, 45% of the total CH_4 emission and 21% of the total N_2O emission. The total emission from the sector has increased by 22.5% from 1990 to 2008. This increase is due to an increase in the use of fertilisers in 2008. The number of reindeer has decreased from 6,000 heads in 1990 to 2,500 heads in 2008. The number of sheep has increased from 19,929 heads in 1990 to 21,080 heads in 2008. The N_2O emission has increased by 97% from 1990 to 2008 due to a significantly increased in the use of fertilisers in 2008, while the CH_4 emission decreased by 8.6% during the same period.

2.3.4 LULUCF

Emissions from the LULUCF sector amount to just 0.08 % of the total emission in CO_2 equivalents in 2008. Forests are assumed to be a sink for the whole period increasing from approximately zero in 1990 to 46.3 tonnes CO_2 in 2008. The emission removal from cropland is assumed to be zero in 1990 and a net source in 2008 of 22.9 tonnes CO_2 pr year. The emission removal from grassland has been estimated to 471.1 tonnes CO_2 in 1990 increasing to 483.9 tonnes CO_2 in 2008.

2.3.5 Waste

The waste sector contributes with 3.5 % of the total greenhouse gas emissions in 2008, 45 % of the total CH_4 emission and 70% of the total N_2O emission. The total emission from the sector has increased by 3 % from 1990 to 2008. This increase is caused by an increase in the CH_4 emission from solid waste disposal sites by 9 %, an increase in N_2O emission from waste water handling by 7 %. Total GHG emission from waste incineration without energy recovery has decreased by 11% from 1990 to 2008 due to an increasing amount of waste incineration with energy recovery. Emission from incinerated waste used for heat production is included in the 1A1 IPCC category Energy Industries.

2.4 Description and interpretation of emission trends for indirect greenhouse gases and SO_2

NO_X

The largest sources to emission of NOx are AFF (agriculture, forestry and fisheries) followed by transport and combustion in energy industries (public power and district heating plants). The AFF-sector is the most contributing the most to the emission of NO_X. In 2008, 52 % of the Greenlandic emission of NO_X came from AFF-related activities.

The emission of NO_X from AFF varies from year to year. In recent years emission of NO_X from AFF has been relatively stabile with a slightly increasing tendency.

The emissions from transport obtain 24 % of total emissions in 2008. From 1990 to 2008 emission of NO_X from transport has decreased by 9 %. In the same period total emission of NO_X has increased by 19 %.

The emissions from energy industries obtain 10 % of total emission in 2008. The emission from energy industries have decreased by 8 % from 1990 to 2008. The reduction is due to the increasing use of renewable energy primarily hydro power, which has caused a reduction in the use of fossil fuel in power and district heating plants.

Emission of NO_X from waste handling obtains 1 % of total emission, see Figure 2.10.

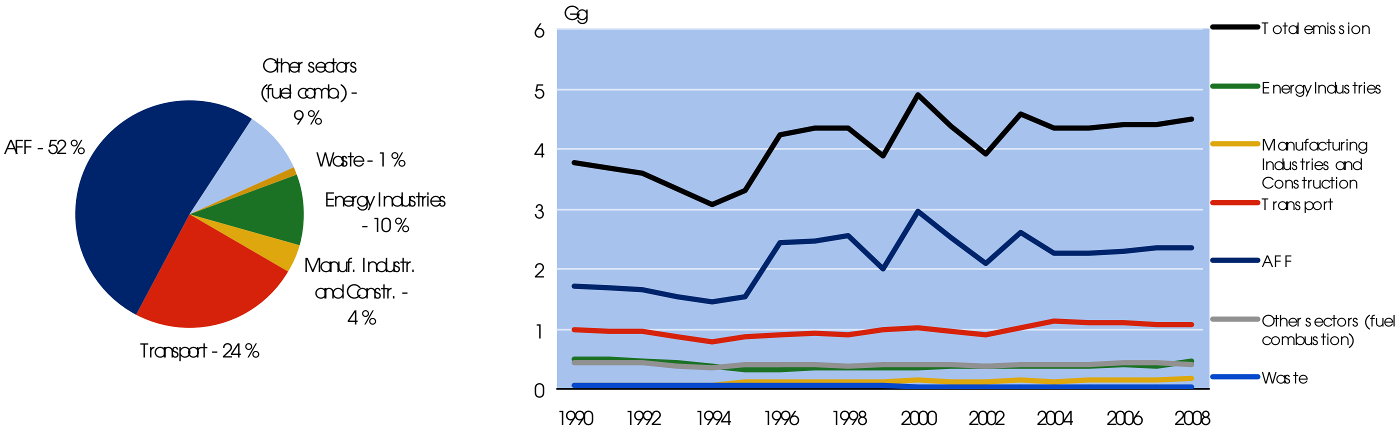

Figure 2.10 NO_X emissions. Distribution according to the main sectors (2008), and time-series (1990-2008).

CO

Mobile sources like transport and AFF (agriculture, forestry and fisheries) contribute significantly to the total emission of this pollutant. Transport is the largest contributor to the total CO emission, see Figure 2.11.

Total CO emission has increased by 44 % from 1990 to 2008, largely due to increasing emissions from road transportation and civil aviation. Emissions from transport have nearly doubled from 1990 to 2008.

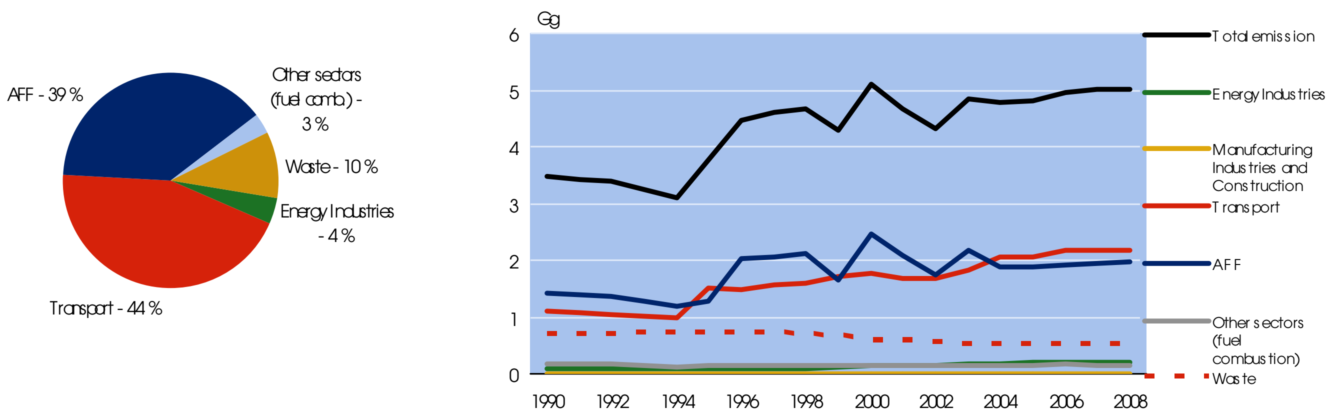

Figure 2.11 CO emissions. Distribution according to the main sectors (2008), and time-series (1990-2008).

NMVOC

The emissions of NMVOC originate from many different sources and can be divided into two main groups: incomplete combustion and evaporation. Road vehicles and other mobile sources such as national navigation vessels fishing vessels and off-road machinery are the main sources of NMVOC emissions from incomplete combustion processes. Road transportation and fishing vessels are the main contributors to this pollutant. Road transportation is included under transportation, which obtain 38 % of the total NMVOC emission in 2008. Fishing vessels are included under AFF (agriculture, forestry and fisheries), which obtain 33 % of total NMVOC emission in 2008, see Figure 2.12.

The evaporative emissions mainly originate from the use of solvents and the extraction, handling and storage of oil. Emissions from solvents and other product use have decreased by 17 % from 1990 to 2008.

The total anthropogenic emissions have increased by 26 % from 1990 to 2008, largely due to the increase in road transportation and AFF activities.

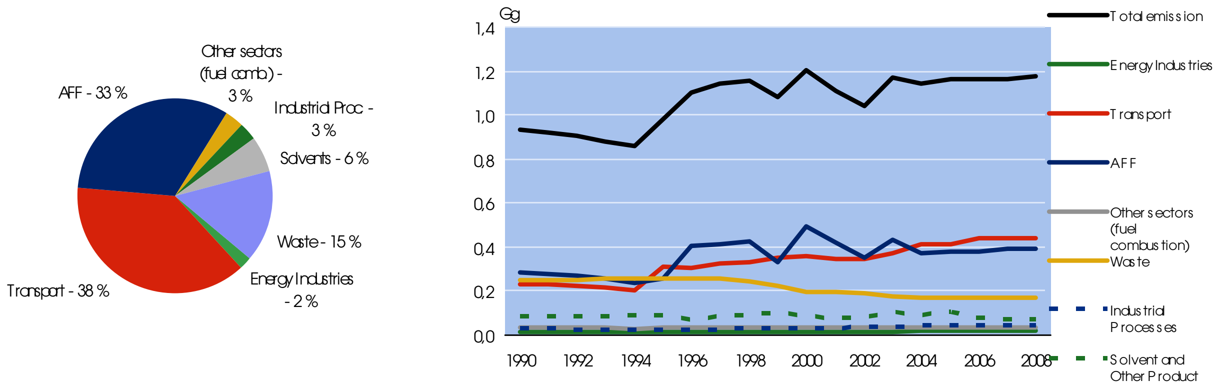

Figure 2.12 NMVOC emissions. Distribution according to the main sectors (2008), and time-series (1990-2008).

SO_2

The main part of the SO_2 emission originates from the combustion of fossil fuels mainly gas oil in public power and district heating plants. From 1990 to 2008, total emission of SO_2 increased by 4 %.

Emissions from energy industries obtain 27 % of total SO_2 emission in 2008. Also emissions from other industrial combustion plants, non-industrial combustion plants and mobile sources are important. AFF (agriculture, forestry and fisheries) contributes with 22 % of total SO2 emission in 2008.

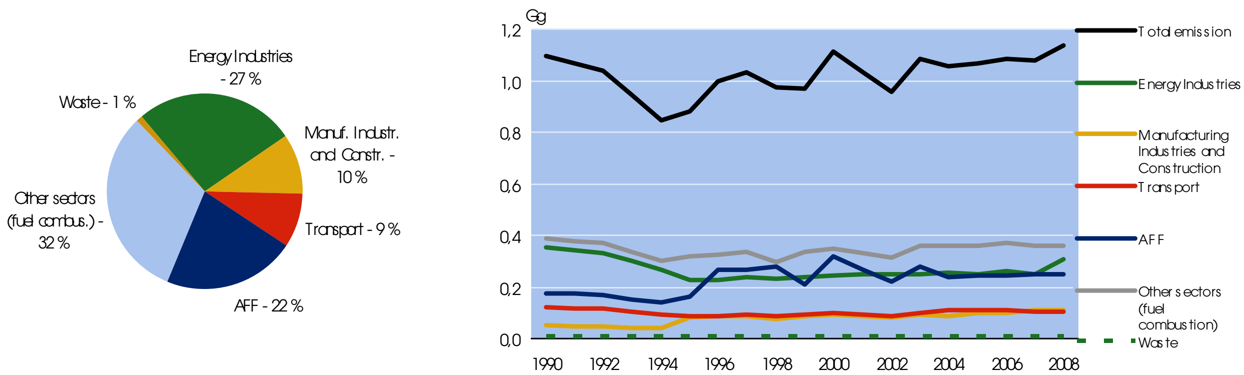

Figure 2.13 SO_2 emissions. Distribution according to the main sectors (2008), and time-series (1990-2008).

3 Energy (CRF sector 1)

3.1 Overview of sector

The emission of greenhouse gases from energy activities includes CO_2, CH_4 and N_2O emission from fuel combustion. The emissions are reported in CRF Tables 1.A(a), 1.A(b), 1.A(c), 1.A(d) and 1.B. Furthermore, the emission of non-methane volatile organic compounds (NMVOC), NO_X, CO and SO_2 from fuel combustion is given in CRF Table 1.

Summary tables for the energy sector are shown below.

Table 3.1 CO_2 emission from the energy sector.

Greenhouse gas source and sink categories	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
					Gg					
1. Energy	622.2	607.4	593.3	543.2	492.9	530.9	593.8	614.4	592.9	590.8
A. Fuel Combustion (Sectoral Approach)	622.2	607.4	593.3	543.2	492.9	530.9	593.8	614.4	592.9	590.8
1. Energy Industries	182.5	177.3	173.2	156.7	140.1	120.8	121.8	128.8	126.7	128.7
2. Manufacturing Industries and Construction	26.4	25.6	25.0	22.5	20.1	43.8	44.5	46.2	40.0	45.9
3. Transport	95.9	95.4	93.4	87.0	80.6	88.4	92.3	96.3	100.6	104.0
4. Other Sectors	309.1	301.1	293.9	269.8	245.7	270.5	327.9	335.9	318.4	304.9
5. Other	8.2	8.0	7.8	7.0	6.3	7.3	7.3	7.3	7.3	7.3
B. Fugitive Emissions from Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
1. Energy	664.3	614.8	576.3	646.5	627.9	632.2	654.0	648.9	682.4	
A. Fuel Combustion (Sectoral Approach)	664.3	614.8	576.3	646.5	627.9	632.2	654.0	648.9	682.4	
1. Energy Industries	132.1	133.2	133.8	134.3	137.9	136.5	143.3	135.8	167.5	
2. Manufacturing Industries and Construction	48.2	45.8	43.3	49.9	47.4	52.7	51.6	57.8	58.6	
3. Transport	105.4	95.7	92.0	100.9	104.8	105.5	110.1	109.0	111.7	
4. Other Sectors	371.3	332.9	299.9	354.1	330.6	329.8	340.8	338.8	337.9	
5. Other	7.3	7.3	7.3	7.3	7.1	7.7	8.2	7.5	6.6	
B. Fugitive Emissions from Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	

Table 3.2 CH_4 emission from the energy sector.

Greenhouse gas source and sink categories	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
					Gg					
1. Energy	0.05	0.05	0.05	0.04	0.04	0.04	0.05	0.05	0.05	0.05
A. Fuel Combustion (Sectoral Approach)	0.05	0.05	0.05	0.04	0.04	0.04	0.05	0.05	0.05	0.05
1. Energy Industries	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
2. Manufacturing Industries and Construction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3. Transport	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01
4. Other Sectors	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.04	0.03	0.03
5. Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B. Fugitive Emissions from Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
1. Energy	0.06	0.05	0.05	0.06	0.06	0.05	0.06	0.06	0.06	
A. Fuel Combustion (Sectoral Approach)	0.06	0.05	0.05	0.06	0.06	0.05	0.06	0.06	0.06	
1. Energy Industries	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	
2. Manufacturing Industries and Construction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
3. Transport	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	
4. Other Sectors	0.04	0.04	0.03	0.04	0.04	0.04	0.04	0.04	0.04	
5. Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
B. Fugitive Emissions from Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	

Table 3.3 N_2O emission from the energy sector.

Greenhouse gas source and sink categories	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
					Gg					
1. Energy	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.01
A. Fuel Combustion (Sectoral Approach)	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.01
1. Energy Industries	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2. Manufacturing Industries and Construction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3. Transport	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4. Other Sectors	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5. Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B. Fugitive Emissions from Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
1. Energy	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	
A. Fuel Combustion (Sectoral Approach)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	
1. Energy Industries	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
2. Manufacturing Industries and Construction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
3. Transport	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
4. Other Sectors	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
5. Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
B. Fugitive Emissions from Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	

3.2 Source category description

In the section emission source categories, fuel consumption data and emission data are presented.

Activity data on fuel consumption is based on annual statistics on energy published by Statistics Greenland, and information on waste incineration with energy recovery. The annual statistics on energy is divided into sectors according to the Greenlandic Business Register (GB2000). The register comprises 577 business categories. The official statistics on energy is published by aggregation into 34 categories.

In the Greenlandic emission database, all activity rates and emissions are based on the official statistics on energy. However, in order to fit the CRF format fuel consumption from the official statistics on energy is further aggregated into 15 sectors.

3.2.1 Fuel combustion

In 2008, total fuel combustion was 9.473 TJ of which 9.372 TJ was fossil fuels.

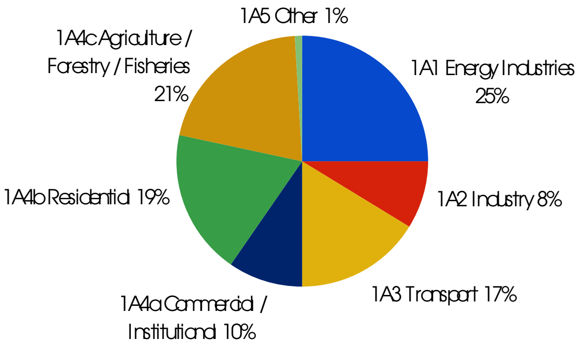

Figure 3.1 Fuel combustion rate, fossil fuels 2008 (Statistics Greenland).

In Greenland gas oil, kerosene and gasoline are used in fuel combustion. Gas oil and kerosene are the most utilised fuels. Gas oil is used in power plants to produce electricity and heat, as well as in district heating, private households, industries and for transportation.

Kerosene is primarily used in aviation, but also for heating in smaller settlements.

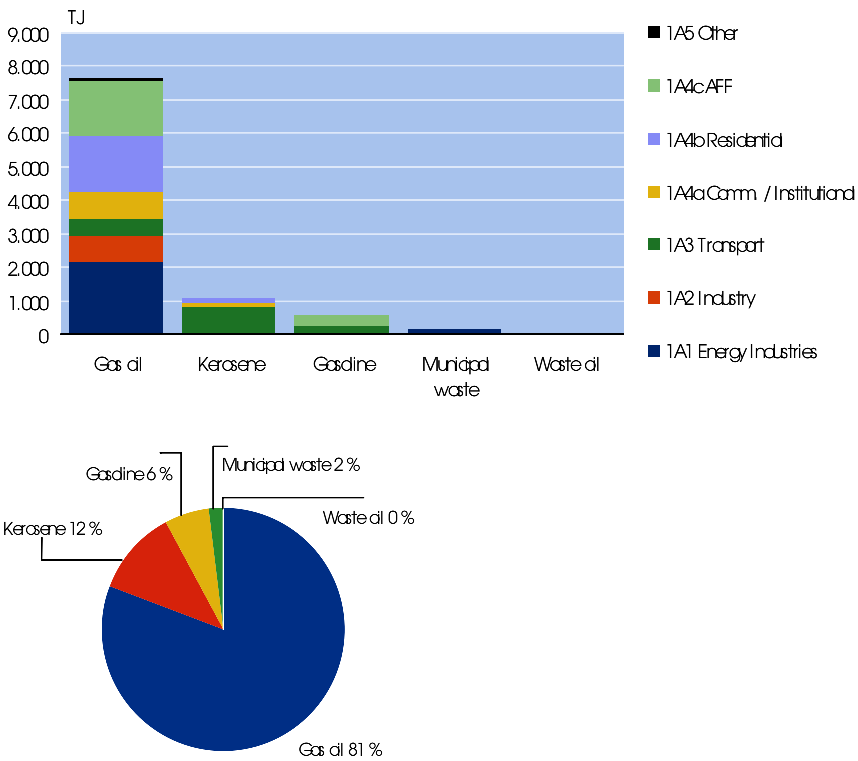

Figure 3.2 Fuel combustion, 2008 (Statistics Greenland).

Time-series on fuel consumption are presented in Figure 3.3. Total fuel consumption has increased by 10.7 % from 1990 to 2008. Fossil fuel consumption has increased by 9.3 %. Consumption of renewable energy has increased since 1990.

Fuel consumption is dominated by liquid fuels e.g. gas oil, kerosene and gasoline. In 2008 total fuel consumption consists of 98% liquid fuels, 1 % solid fuels and 1% biomass.

In 2008 Energy Industries accounted for 25 % of total fuel consumption. From 1990 to 1995 fuel consumption in Energy Industries decreased significantly due to the introduction of the first hydro power plant in 1993, and the introduction of burning waste to produce heat for district heating networks in 1989. Dependence on gas oil conversion decreased immediately. Nevertheless, from 1995 an onwards consumption of gas oil once again increased due to the general development of the country. In 2007 fuel consumption in Energy Industries decreased due to a relatively warm winter. Contrary to this, the winter in 2008 was relatively colder, which increased fuel consumption to produce heat.

Fuel consumption in Agriculture, Forestry and Fisheries accounted for 21 % of total fuel consumption in 2008. Fuel consumption in this sector has been relative stabile since 2004. Before 2004 annual fuel combustion in this sector varied a great deal primarily due to fluctuations in fishing activities from year to year. However, some uncertainty is expected in the 1990-2003 time-series on fuel consumption in Agriculture, Forestry and Fisheries.

Residential fuel consumption accounted for 19 % of total fuel consumption in 2008. Fluctuations in fuel consumption are largely a result of variation in outdoor temperatures from year to year, which also causes fluctuations in fuel consumption in Energy Industries.

For 2004-2008 Statistics Greenland has conducted statistics on energy including detailed information on fuel consumption divided into 33 business categories and private households, see Section 3.3.1. Compared to the new statistics on energy the historic construction of time-series on fuel consumption in 1990-2003 was based on a much simpler method. Some uncertainty is therefore to be expected in the 1990-2003 time-series on sector-divided fuel consumption.

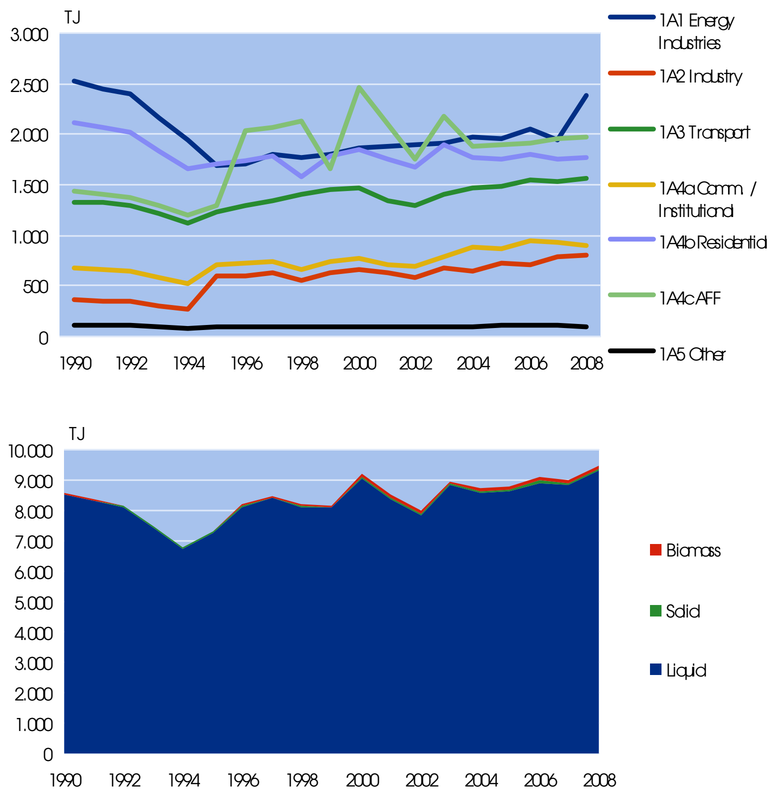

Figure 3.3 Fuel consumption time-series 1990-2008 (Statistics Greenland).

3.2.2 Fugitive emissions from fuels

Greenland has no coal mines, no off-shore activities, no oil refineries, no natural gas transmission or distribution. For that reason there are no fugitive emissions from such activities.

However, some fugitive emission occurs in the distribution of fuel e.g. when refuelling from ships to on-shore tanks, onshore loading of fuel to ships and offshore loading of ships. The emission would only be in the form of NMVOC. The fugitive emission from loading/unloading of ships is currently not estimated.

3.2.3 International bunker fuels

International Aviation Bunkers

Emissions from international aviation bunkers are considered to be of neglible importance. The Greenland Airport Authority has reported the annual amount of jet fuel loaded into foreign aircrafts including Danish aircrafts. However, it is not possible to distinguish between Danish aircrafts and other aircrafts. Since most foreign aircrafts by far are Danish the annual amount of jet fuel loaded into foreign aircrafts are therefore included as part of the IPCC category 1A3a Civil aviation.

International Marine Bunkers

Emission from international marine bunkers are included from 2004 and onwards. Before 2004 international marine bunkers are considered to be of neglible importance.

3.2.4 Feedstocks and non-energy use of fuels

At the moment Greenland has no production or use of feedstocks. Emissions from non-energy use of fuels (e.g. bitumen and solvents) are included in other sectors of the Greenlandic inventory (Industrial Processes (CRF sector 2) and Solvent and Other Product Use (CRF sector 3)).

3.3 Methodological issues

3.3.1 Activity data

The Greenlandic emission inventory for fuel combustion has been performed according to the IPCC tier 1 methodology. The inventory is based on activity data from the Greenlandic energy statistics and on emission factors for different fuels, plants and sectors.

Total fuel combustion is based on data from Polaroil, Statoil and Malik Supply A/S. Polaroil imports and distributes fuel in all parts of Greenland. Statoil imports and distributes fuel in Kangerlussuaq. Malik Supply A/S, a Danish company, re-distributes fuel bought from Polaroil to Greenlandic trawlers, ships etc. By using detailed data from Polaroil, Statoil and Malik Supply A/S it is possible to determine total import, total export, total international bunkers and total domestic fuel combustion.

Total domestic fuel combustion is then divided into sectors and private households by using data from a survey on energy consumption, company specific sales data from Polaroil and local fuel distributors, company tax accountings, municipal accountings and Greenland Government accountings, and by estimation.

In 2008 and 2009 Statistics Greenland conducted a survey among the greater companies. By completing a questionnaire each company returned detailed information on the consumption of specific types of fuel in 2004-2008. The survey covered 54.1 % of total GHG emission from energy combustion in 2008, see Table 3.4.

By using detailed information on sales from Polaroil and local fuel distributors it is possible to determine fuel combustion in private companies and public offices with an automatic deal on supply. The sales data covers 11.9 % of total GHG emission from energy combustion in 2008, see Table 3.4.

Tax accountings in DKK are used to determine annual consumption of fuel in private companies, in municipalities, and within the Greenland Government. At the moment tax accountings are primarily used for determining fuel combustion in municipalities and public offices in settlements. Accountings cover 13.2 % of total GHG emission from energy combustion in 2008, see Table 3.4.

The remaining amount of total inland fuel combustion is divided into sectors and private households by estimation. This work is carried out by involving statistical material on population, housing, public finances, fisheries and hunting, and national accountings. The Greenlandic Business Register (GER) is used to divide remaining companies into sectors.

Information on employees, operating units, vehicles etc. is used to determine the activity in each company.

Fuel combustion in private households is estimated using detailed information from a number of local fuel distributors. Fuel deliveries are registered by buildings. In Greenland each building has a unique number registered in the Greenlandic Area Register (NIN). By combining the NIN-register and the GER-register (see above) with statistics on housing and population each building is labelled *private household* or located to a sector describing the main activity in the building. This new building-sector register, completed annually, is used extensively to determine the buyer of fuel delivered by Polaroil or local fuel distributors.

Fuel combustion in road traffic is based on a model designed by Statistics Greenland. The model contains data on the vehicle stock obtained from the Greenland Police Department's register on engine data. The vehicles are divided into broad categories of type i.e. personal car, lorry, taxi, truck, ambulance, motorbike etc. Each category is assigned with ratios on fuel type and mileage. Input data on mileage is derived from a survey among businesses and private road traffic in 2008. Each vehicle is divided in business categories or labelled *private vehicle* according to the owner. For each group the emissions are estimated by combining vehicle and annual mileage numbers with standard emission factors according to the type of fuel. The model does not take cold start or hot engines into account.

For air traffic annual emissions are based on activity data from Air Greenland A/S and sales data from the Greenland Airport Authority. For navigation, ferries and freight, annual emissions are based on activity data from Royal Arctic Line A/S (freight), Royal Arctic Tankers A/S (freight), Royal Arctic Bygdeservice A/S (freight/passengers), and Arctic Umiaq Line A/S (passengers) and the liquidated Assartuivik A/S (passengers).

Table 3.4 shows the part of total CO_2 emission divided into sources - survey, specific sales data, tax accountings, and estimation.

Table 3.4 CO_2 emission from fuel combustion by sources to sectoral division (2004-2008).

	2004	2005	2006	2007	2008
			pct.		
Total	100.0	100.0	100.0	100.0	100.0
Survey	49,1	48,9	48,6	50,0	54,1
Sales data from Polaroil	2,4	3,1	3,3	3,7	5,3
Sales data from local fuel distributors	0,0	0,0	3,3	5,2	6,7
Accountings	14,2	14,0	14,2	14,0	13,2
Estimation	34,3	34,0	30,6	27,1	20,7

The procedure described above is used to divide total fuel combustion into sectors and private households during the period 2004-2008. Formerly, the period 1990-2003, activity data on sectors and private households were estimated using aggregated statistics on population, housing, companies, data on sales from Polaroil, and data on energy consumption in larger companies.

An increasing part of municipal waste incineration is utilised for heat and power production. Thus, incineration with energy-recovery is included in the Energy sector.

Table 3.5 shows the activity data on fuel combustion for the period 1990-2008.

Table 3.5 Activity data on fuel combustion (SINK categories).

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
					TJ					
Total	8 559	8 358	8 166	7 484	6 801	7 331	8 190	8 475	8 189	8 172
Energy industries	2 519	2 447	2 393	2 169	1 944	1 685	1 698	1 794	1 766	1 805
Manufacturing and construction	360	349	340	307	274	598	607	630	546	626
Domestic aviation	541	556	547	524	500	581	636	660	775	748
Road transport	501	488	476	437	397	370	369	387	361	401
National navigation	288	280	273	249	224	285	285	299	276	308
Commercial/Institutional	682	662	645	583	520	715	724	748	658	744
Residential	2 120	2 062	2 014	1 832	1 651	1 710	1 731	1 787	1 576	1 777
AFF	1 436	1 405	1 372	1 288	1 205	1 287	2 039	2 070	2 134	1 663
Other	112	109	106	96	86	99	99	99	99	99
continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
Total	9 192	8 514	7 995	8 964	8 713	8 775	9 080	9 012	9 473	
Energy industries	1 868	1 885	1 900	1 915	1 971	1 953	2 047	1 947	2 381	
Manufacturing and construction	658	624	590	680	647	719	705	788	800	
Domestic aviation	738	632	603	646	604	637	695	704	756	
Road transport	417	399	388	433	443	455	484	483	476	
National navigation	321	308	298	334	419	385	364	341	335	
Commercial/Institutional	774	716	690	787	884	872	950	937	900	
Residential	1 851	1 748	1 670	1 895	1 767	1 748	1 807	1 747	1 762	
AFF	2 465	2 101	1 755	2 174	1 882	1 901	1 917	1 963	1 972	
Other	99	99	99	99	98	105	112	103	91	

Sources: Statistics Greenland. Notes: Data on fuel combustion in 1993 are interpolated from 1992 and 1994, since no data is available for 1993.

3.3.2 Emission factors

For each fuel and source category a set of general area source emission factors has been determined. The emission factors are either nationally referenced or based on the IPCC Reference Manual (IPCC 1997).

CO_2

The CO_2 emission factors applied for 2008 are presented in Table 3.6. For municipal waste, time-series has been estimated according to the Danish emission factors. For all other fuels the same emission factor is applied for 1990-2008.

In reporting to the Climate Convention, the CO_2 emission is aggregated to three fuel types: Liquid fuel, Biomass and Other fuel.

The CO_2 emission from incineration of municipal waste with energy-recovery (79.6 + 32.5 kg pr GJ) is divided into two parts: the emission from combustion of the plastic content of waste (which is included in the Greenlandic total) and the emission from combustion of the rest of the waste – the biomass part (which is reported as a memo item). In the IPCC reporting, the fossil part of the waste and the associated emissions from fuel combustion of the plastic content of the waste is reported in the fuel category, *Other fuels*.

Table 3.6 CO_2 emission factors 2008.

Fuel	Emission factor	Unit	Reference type	IPCC fuel Category
Gas oil	73.326	kg pr GJ	IPCC reference manual	Liquid
Kerosene	71.148	kg pr GJ	IPCC reference manual	Liquid
Jet-Kerosene	70.785	kg pr GJ	IPCC reference manual	Liquid
Gasoline	68.607	kg pr GJ	IPCC reference manual	Liquid
Waste oil	76.593	kg pr GJ	IPCC reference manual	Liquid
Municipal waste – biomass	79.600	kg pr GJ	Country specific	Biomass
Municipal waste – fossil fuel	32.500	kg pr GJ	Country specific	Other fuels

The CO_2 emission has been calculated by using the same methodology as described in the IPCC Guidelines (IPCC, 1997). This methodology implies use of C content pr fuel type (default) and fraction of carbon oxidised (default); see the equation below.

$$E_{CO_2} = \sum Act_a \times EF_{C,a} \times Ox \times 44/12$$

where:

Act_{fuel} = activity; consumption of fuel a

$EF_{C,fuel}$ = C emission factor for fuel a

Ox = oxidation factor

The emissions of CH_4, N_2O, NO_X, CO and NMVOC have been calculated at sector/fuel level by using IPCC default emission factors combined with measured/Danish EF waste incineration (with energy recovery), se Table 3.7 – Table 3.9 below.

The equation applied for each pollutant is:

$$E = \sum (EF_{ab} \times Act_{ab})$$

where:

EF = emission factor

Act = activity; fuel input

a = fuel type

b = sector activity

CH_4

The CH_4 emission factors applied for 2008 are presented in Table 3.7. For municipal waste, time-series has been estimated according to the Danish emission factors. For all other fuels the same emission factor is applied for 1990-2008.

Emission factors for municipal waste refer to emission measurements carried out in Danish plants (Nielsen et al., 2009). Other emission factors refer to the IPCC Guidelines (IPCC, 1997).

Table 3.7 CH_4 emission factors 2008.

Fuel group	Fuel	CRF sector		Emission factor g pr GJ	Reference
Liquid	Gas oil	1A1	Energy Industries	3	IPCC, 1997
		1A2	Manufacturing Industries and Constructions	2	IPCC, 1997
		1A3a	Transport – Civil aviation	0.5	IPCC, 1997
		1A3b	Transport – Road transportation	5	IPCC, 1997
		1A3d	Transport – Navigation	5	IPCC, 1997
		1A4a	Other sectors – Commercial / Institutional	10	IPCC, 1997
		1A4b	Other sectors – Residential	10	IPCC, 1997
		1A4c	Other sectors – AFF stationary	10	IPCC, 1997
		1A4c	Other sectors – AFF mobile	5	IPCC, 1997
		1A5b	Other – Military mobile	5	IPCC, 1997
	Kerosene	1A1	Energy Industries	3	IPCC, 1997
		1A2	Manufacturing Industries and Constructions	2	IPCC, 1997
		1A3a	Transport – Civil aviation	0.5	IPCC, 1997
		1A3b	Transport – Road transportation	20	IPCC, 1997
		1A3d	Transport – Navigation	5	IPCC, 1997
		1A4a	Other sectors – Commercial / Institutional	10	IPCC, 1997
		1A4b	Other sectors – Residential	10	IPCC, 1997
		1A4c	Other sectors – AFF stationary	10	IPCC, 1997
		1A4c	Other sectors – AFF mobile	5	IPCC, 1997
		1A5b	Other – Military mobile	5	IPCC, 1997
	Gasoline	1A1	Energy Industries	3	IPCC, 1997
		1A2	Manufacturing Industries and Constructions	2	IPCC, 1997
		1A3a	Transport – Civil aviation	0.5	IPCC, 1997
		1A3b	Transport – Road transportation	20	IPCC, 1997
		1A3d	Transport – Navigation	5	IPCC, 1997
		1A4a	Other sectors – Commercial / Institutional	10	IPCC, 1997
		1A4b	Other sectors – Residential	10	IPCC, 1997
		1A4c	Other sectors – AFF stationary	10	IPCC, 1997
		1A4c	Other sectors – AFF mobile	5	IPCC, 1997
		1A5b	Other – Military mobile	5	IPCC, 1997
	Waste oil	1A1	Energy Industries	3	IPCC, 1997
Biomass	Municipal waste	1A1	Energy Industries	30	Nielsen et al., 2009
Other fuel	Municipal waste	1A1	Energy Industries	30	Nielsen et al., 2009

N_2O

The N_2O emission factors applied for the 2008 inventory are listed in Table 3.8. The same emission factors have been applied in the period 1990-2008.

Emission factors for municipal waste refer to emission measurements carried out in Danish plants (Nielsen et al. 2009). Other emission factors refer to the IPCC Guidelines (IPCC, 1997)

Table 3.8 N_2O emission factors 2008.

Fuel group	Fuel	CRF sector		Emission factor g pr GJ	Reference
Liquid	Gas oil	1A1	Energy Industries	0.6	IPCC, 1997
		1A2	Manufacturing Industries and Constructions	0.6	IPCC, 1997
		1A3a	Transport – Civil aviation	2	IPCC, 1997
		1A3b	Transport – Road transportation	0.6	IPCC, 1997
		1A3d	Transport – Navigation	0.6	IPCC, 1997
		1A4	Other sectors	0.6	IPCC, 1997
		1A5b	Other – Military mobile	0.6	IPCC, 1997
	Kerosene	1A1	Energy Industries	0.6	IPCC, 1997
		1A2	Manufacturing Industries and Constructions	0.6	IPCC, 1997
		1A3a	Transport – Civil aviation	2	IPCC, 1997
		1A3b	Transport – Road transportation	0.6	IPCC, 1997
		1A3d	Transport – Navigation	0.6	IPCC, 1997
		1A4	Other sectors	0.6	IPCC, 1997
		1A5b	Other – Military mobile	0.6	IPCC, 1997
	Gasoline	1A1	Energy Industries	0.6	IPCC, 1997
		1A2	Manufacturing Industries and Constructions	0.6	IPCC, 1997
		1A3a	Transport – Civil aviation	2	IPCC, 1997
		1A3b	Transport – Road transportation	0.6	IPCC, 1997
		1A3d	Transport – Navigation	0.6	IPCC, 1997
		1A4	Other sectors	0.6	IPCC, 1997
		1A5b	Other – Military mobile	0.6	IPCC, 1997
	Waste oil	1A1	Energy Industries	0.6	IPCC, 1997
Biomass	Municipal waste	1A1	Energy Industries	4	Nielsen et al., 2009
Other fuel	Municipal waste	1A1	Energy Industries	4	Nielsen et al., 2009

SO_2, NO_X, NMVOC and CO

Emission factors for SO_2, NO_X, NMVOC and CO are listed in Table 3.9. The same emission factors have been applied in the period 1990-2008.

Table 3.9 SO_2, NO_X, NMVOC and CO emission factors 2008 (g pr GJ).

Fuel group	Fuel	CRF sector		NO_X	CO	NMVOC	SO_2	Reference
Liquid	Gas oil	1A1	Energy Industries	200	15	5	141	1
		1A2	Manufacturing Industries and Constructions	200	10	5	141	1
		1A3a	Transport – Civil aviation	300	100	50	141	1
		1A3b	Transport – Road transportation	800	1 000	200	141	1
		1A3d	Transport – Navigation	1 500	1 000	200	141	1
		1A4a,b	Other sectors	100	20	5	141	1
		1A4c	Other sectors – AFF stationary	100	20	5	141	1
		1A4c	Other sectors – AFF mobile	1 200	1 000	200	141	1
		1A5b	Other – Military mobile	1 500	1 000	200	141	1
	Kerosene	1A1	Energy Industries	200	15	5	23	1
		1A2	Manufacturing Industries and Constructions	200	10	5	23	1
		1A3a	Transport – Civil aviation	300	100	50	23	1
		1A3b	Transport – Road transportation	600	8 000	1 500	23	1
		1A3d	Transport – Navigation	1 500	1 000	200	23	1
		1A4a,b	Other sectors	100	20	5	23	1
		1A4c	Other sectors – AFF stationary	100	20	5	23	1
		1A4c	Other sectors – AFF mobile	1 200	1 000	200	23	1
		1A5b	Other – Military mobile	1 500	1 000	200	23	1
	Gasoline	1A1	Energy Industries	200	15	5	46	1
		1A2	Manufacturing Industries and Constructions	200	10	5	46	1
		1A3a	Transport – Civil aviation	300	100	50	46	1
		1A3b	Transport – Road transportation	600	8 000	1 500	46	1
		1A3d	Transport – Navigation	1 500	1 000	200	46	1
		1A4a,b	Other sectors	100	20	5	46	1
		1A4c	Other sectors – AFF stationary	100	20	5	46	1
		1A4c	Other sectors – AFF mobile	1 200	1 000	200	46	1
		1A5b	Other – Military mobile	1 500	1 000	200	46	1
	Waste oil	1A1	Energy Industries	200	15	5	477	1
Biomass	Municipal waste	1A1	Energy Industries	100	1 000	50	6	2
Other fuel	Municipal waste	1A1	Energy Industries	100	1 000	50	6	2

Sources: 1) IPCC Guidelines (IPCC, 1997). 2) Nielsen et al., 2009.

3.3.3 Emissions

The Greenhouse gas (GHG) emissions are listed in Table 3.10. The total emission of greenhouse gases from fuel combustion (Sectoral Approach) accounts for 94.2 % of total Greenlandic GHG emission.

The CO_2 emission from fuel combustion (Sectoral Approach) accounts for 99.5 % of the Greenlandic CO_2 emission (excluding net CO_2 emission from Land Use, Land Use Change and Forestry (LULUCF). The CH_4 emission from fuel combustion (Sectoral Approach) accounts for 9.8 % of the Greenlandic emission and the N_2O emission from fuel combustion accounts for 9.3 % of the Greenlandic N_2O emission.

Table 3.10 Greenhouse gas emission for the year 2008

		CO_2	CH_4	N_2O
		Gg CO_2-equivalent		
1A1	Fuel consumption, Energy Industries	167.5	0.2	0.6
1A2	Fuel consumption, Manufacturing Industries and Construction	58.6	0.0	0.1
1A3	Fuel consumption, Transport	111.7	0.2	0.6
1A4	Fuel consumption, Other sectors	344.5	0.8	0.9
Total emission from fuel consumption (Sectoral Approach)		682.4	1.2	2.3
Greenlandic emission (excluding net emission from LULUCF)		685.5	12.4	24.3
			%	
Emission share for fuel consumption (Sectoral Approach)		99.5	9.8	9.3

CO_2 is the most important GHG pollutant and accounts for 99.5 % of the GHG emission in CO_2 equivalents from fuel combustion (Sectoral Approach), see Figure 3.4.

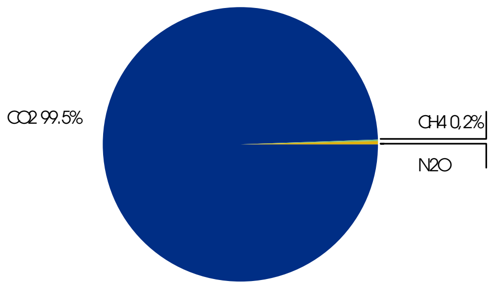

Figure 3.4 GHG emissions (CO_2 equivalent) from stationary combustion plants.

Figure 3.5 depicts the time-series of GHG emission in CO_2 equivalents from fuel combustion (Sectoral Approach). As shown by the blue curve the development in total GHG emission follows the CO_2 emission development very closely. Both CO_2 and total GHG emission are 9.7 % higher in 2008 compared to 1990.

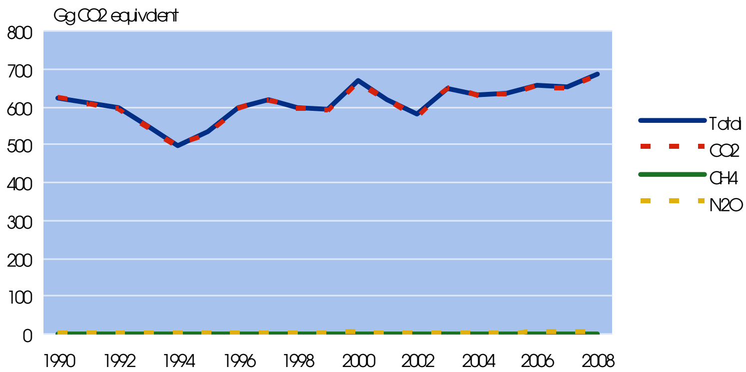

Figure 3.5 GHG emission time-series for fuel combustion (Sectoral Approach).

From 1990 to 1994 total GHG emission was reduced by 21%. This was primarily due to the introduction of the first hydropower plant in 1993 but also to the introduction of burning waste to produce heat for district heating network in 1989. Dependence on gas oil conversion decreased immediately. Nevertheless, from 1995 an onwards consumption of gas oil once again increased due to the general development of the country.

In 2001-2002 total GHG emission decreased due to a minor recession in the economy. However since 1994 GHG emissions have increased in general with some fluctuations from year to year. The fluctuations are largely a result of outdoor temperature variations from year to year i.e. in 2008 the winter was relatively colder than in 2007. As a result fuel consumption increased in 2008 increasing GHG emission from fuel combustion.

CO_2

Stationary combustion plants are the most important GHG emission sources to CO_2 emission from fuel combustion. In 2008 CO_2 emission from stationary combustion plants accounted for 24.2% of the Greenlandic CO_2 emission from fuel combustion, see Table 3.11.

Table 3.11 lists CO_2 emission for fuel combustion in 2008 as well as the relative percentage for each SINK category under the sectoral approach. The table reveals that *Electricity and Heat Production* – the only active category under Energy Industries – accounts for 24.5% of the CO_2 emission from fuel combustion. Other large CO_2 emission sources are transportation, residential plants and activities regarding agriculture, forestry and fisheries. These are sectors, which also account for a considerable share of fuel consumption.

Table 3.11 CO_2 emission from fuel combustion 2008.

		2008	
		Gg	%
1A1	Energy Industries (Electricity and Heat Production)	167.5	24.5
1A2	Industry	58.6	8.6
1A3	Transport	111.7	16.4
1A4a	Commercial / Institutional	65.8	9.6
1A4b	Residential	128.9	18.9
1A4c	Agriculture / Forestry / Fisheries	143.2	21.0
1A5	Other	6.6	1.0
Total		682.4	100.0

The CO_2 emission from combustion of biomass fuels is not included in the total CO_2 emission data, since biomass fuels are considered CO_2 neutral. The CO_2 emission from biomass combustion is reported as a memo item in the Climate Convention reporting. In 2008, the CO_2 emission from biomass combustion was 13.7 Gg.

Time-series for CO_2 emissions are provided in Figure 3.6. Fluctuations in CO_2 emission from agriculture, forestry and fisheries primarily regard fluctuations in fishing activities from year to year. Fluctuations in CO_2 emission from residential plants are largely a result of outdoor temperature variations from year to year. This also causes fluctuations in CO_2 emission from energy industries which cover electricity and heat production.

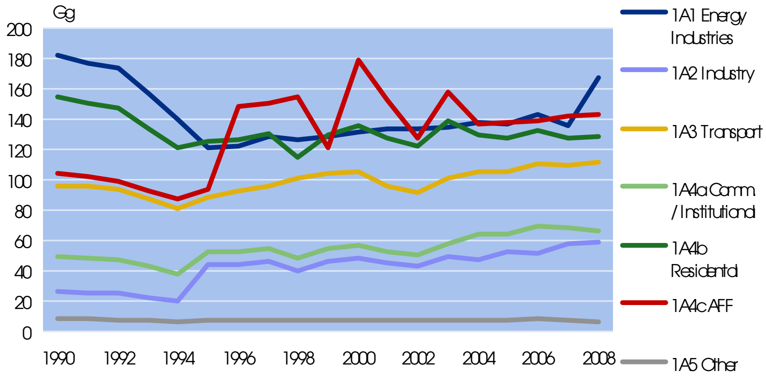

Figure 3.6 CO_2 emission time-series for fuel combustion (Sectoral Approach).

Detailed trend discussion on CRF category level is available in Section 2.

CH_4

CH_4 emission from fuel combustion accounts for 1.4 % of the Greenlandic CH_4 emission. Table 3.12 lists the CH_4 emission inventory for fuel combustion in 2008. The table reveals that Energy Industries – *Electricity and Heat Production* – accounts for 20.5 % of the CH_4 emission from fuel combustion, which is somewhat less than the fuel combustion share. Residential plants accounts for 30.6 % of the emission.

Table 3.12 CH_4 emission from fuel combustion 2008.

		2008	
		Mg	%
1A1	Energy Industries (Electricity and Heat Production)	11.8	20.5
1A2	Industry	1.6	2.8
1A3	Transport	7.2	12.5
1A4a	Commercial / Institutional	9.0	15.6
1A4b	Residential	17.6	30.6
1A4c	Agriculture / Forestry / Fisheries	9.9	17.2
1A5	Other	0.5	0.8
Total		57.6	100

The CH_4 emission from fuel combustion has increased by 15 % since 1990. Time-series for CH_4 emissions are provided in Figure 3.7. Fluctuations in CH_4 emission from agriculture, forestry and fisheries primarily regard fluctuations in fishing activities from year to year. Fluctuations in CH_4 emission from residential plants are largely a result of outdoor temperature variations from year to year. This also causes fluctuations in CH_4 emission from energy industries, which cover electricity and heat production.

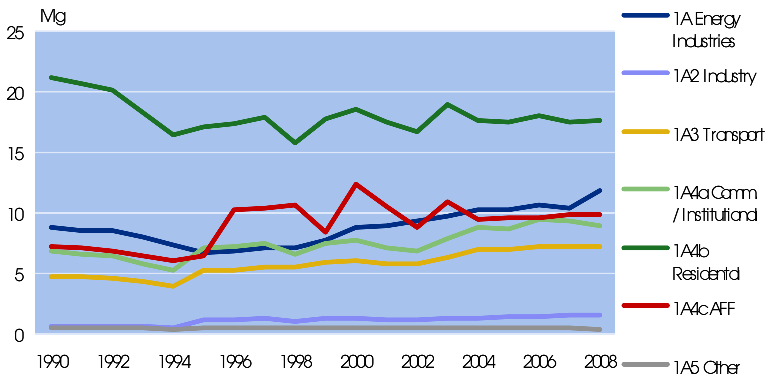

Figure 3.7 CH_4 emission time-series for fuel combustion (Sectoral Approach).

Detailed trend discussion on CRF category level is available in Section 2.

N_2O

The N_2O emission from fuel combustion accounts for 9.1 % of the Greenlandic N_2O emission. Table 3.13 lists the N_2O emission inventory for fuel combustion in 2008. The table reveals that Energy Industries – *Electricity and Heat Production* – accounts for 27.5% of the N_2O emission from fuel combustion. This is higher than the fuel consumption share. Transport accounts for 27.3 % of the emission.

Table 3.13 N_2O emission from fuel combustion 2008.

		2008	
		Mg	%
1A1	Energy Industries (Electricity and Heat Production)	2.0	27.5
1A2	Industry	0.5	6.6
1A3	Transport	2.0	27.3
1A4a	Commercial / Institutional	0.5	7.4
1A4b	Residential	1.1	14.4
1A4c	Agriculture / Forestry / Fisheries	1.2	16.1
1A5	Other	0.1	0.7
Total		7.3	100

Figure 3.8 shows the time-series for the N_2O emission from fuel combustion. The N_2O emission has increased by 21 % from 1990 to 2008. Once again fluctuations are primarily caused by variations in outdoor temperature from year to year.

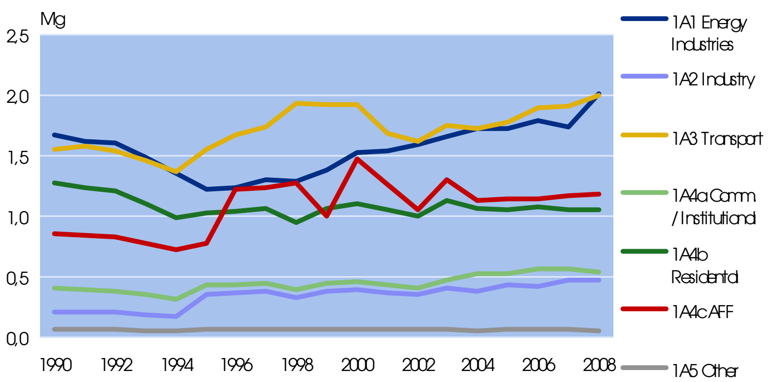

Figure 3.8 N_2O emission time-series for fuel combustion (Sectoral Approach).

Detailed trend discussion on CRF category level is available in Section 2.

SO_2, NO_X, NMVOC and CO

The emissions of SO_2, NO_X, NMVOC and CO from Greenlandic fuel combustion in 2008 are presented in Table 3.14. SO_2 from fuel combustion accounts for 99.5% of the Greenlandic SO_2 emission. NO_X, CO and NMVOC account for 99.2, 89.8% and 75.8% respectively, of the Greenlandic emissions for these substances.

Table 3.14 SO_2, NO_X, NMVOC and CO emission from fuel combustion 2008.

	NO_X	CO	NMVOC	SO_2
	Gg	Gg	Gg	Gg
1A1 Fuel consumption, Energy Industries	0.5	0.2	0.0	0.3
1A2 Fuel consumption, Manuf. Industries and Constr.	0.2	0.0	0.0	0.1
1A3 Fuel consumption, Transport	1.1	2.2	0.4	0.1
1A4 Fuel consumption, Other sectors	2.8	2.1	0.4	0.6
Total emission from fuel consumption	4.4	4.5	0.9	1.1
Greenlandic emission	4.5	5.5	1.3	1.1
		%		
Emission share for fuel consumption	99.2	89.8	75.8	99.5

3.4 Uncertainties

A tier 1 uncertainty assessment has been carried out in accordance with the IPCC GPG (IPCC, 2000). The uncertainty has been estimated for all sources included in the reporting for the energy sector. The uncertainties for the activity data and emission factors are shown in Table 3.15.

Table 3.15 Uncertainties for activity data and emission factors for the energy sector.

Subsector	Pollutant	Activity data uncertainty	Emission factor uncertainty
1A, Liquid fuels	CO_2	2	5
1A, Municipal waste	CO_2	2	25
1A, Liquid fuels	CH_4	2	100
1A, Municipal waste	CH_4	2	100
1A, Biomass	CH_4	2	100
1A, Liquid fuels	N_2O	2	500
1A, Municipal waste	N_2O	2	500
1A, Biomass	N_2O	2	200

The activity data comes from the official Greenlandic energy statistics, which is considered to be of high quality, therefore the uncertainty of the activity data has been set to 2 %.

Regarding the emission factor uncertainty, the CO_2 emission factors are considered the most certain, and for liquid fuels an emission factor uncertainty of 5 % has been assumed. To account for the more inhomogeneous nature of municipal waste the emission factor uncertainty has been set to 25 %. For CH_4 the emission factor uncertainty has been set to 100 % in accordance with the IPCC GPG (IPCC, 2000). For N_2O the emission factor uncertainties have been estimated to between 200 % and 500 %. This is based on a first estimate and can be improved upon in the future.

The resulting uncertainties for the individual greenhouse gases and the total uncertainty on the greenhouse gas emission are shown in Table 3.16.

Table 3.16 Uncertainties for the emission estimates.

	Uncertainty %	Trend 1990-2008 %	Trend uncertainty %
GHG	5.5	9.7	±3.1
CO_2	5.3	9.7	±3.1
CH_4	91	15.0	±9.2
N_2O	454	21.2	±43

3.5 Source specific QA/QC

The elaboration of a formal QA/QC plan is to be completed.

However, the official Greenland energy statistics has gone through a great deal of quality work with regard to accuracy, comparability and completeness. Statistics Greenland is responsible for the official Greenlandic energy statistics, and as such responsible for the completeness of data. The uncertainties connected with estimating fuel consumption do not influence the accordance between the energy statistics and the datasets used in the emission inventory submission. For the remainder of the datasets, it is assumed that the level of uncertainty is relatively small. See chapter regarding uncertainties for further comments.

Statistics on fuel consumption statistics is reported by Statistics Greenland in form of a spreadsheet. Annual consumption of gas oil, kerosene and gasoline are divided into business categories and private households. To ensure consistency data are compared with those from previous years and large discrepancies are checked.

All external data used for the emission inventory submission are archived in spreadsheets. Data are archived annually in order to ensure that the basic data for a given report are always available in their original form.

Safely stored and quality checked activity data are then processes by using a methodological approach consistent with international guidelines.

Calculated emission factors are compared with guideline emission factors to ensure that they are reasonable. The calculations follow the principle in international guidelines.

During data processing, it is checked that calculations are being carried out correctly. However, a documentation plan for this needs to be elaborated.

Time-series for activity data, emission factors and calculated emissions are used to identify possible errors in the calculation procedure. In fact, during the calculation, numerous controls take place to ensure correctness. Sums are checked of the various stages in the calculation procedure. Implied emission factors are compared to emission factors.

Every single time-series imported to the CRF Reporter is checked for fuel rate, units for fuel rate, emission factor and plant-specific emissions. Additional checks are performed on the database. The database encloses every single activity data, emission factors, emission, notation key and comment imported to the CRF Reporter. In other words, no information is typed manually into the CRF Reporter. Instead, all information is imported to the CRF Reporter through XML-files to ensure maximum accuracy and completeness.

3.5.1 Reference approach

In addition to the sector-specific CO_2 emission inventories (the Greenlandic approach), the CO_2 emission is also estimated using the reference approach described in the IPCC Reference manual (IPCC, 1997). The reference approach is based on data for fuel production, import, export and stock change. The CO_2 emission inventory based on the reference approach is reported to the Climate Convention and used for verification of the official data in the Greenlandic approach.

Data for import, export and stock change used in the reference approach originate from the annual "basic data" table prepared by Statistics Greenland. The fraction of carbon oxidised has been assumed to be 1.00. The carbon emission factors are default factors originating from the IPCC Reference Manual (IPCC, 1997). The country-specific emission factors are not used in the reference approach, the approach being for the purposes of verification.

The Climate Convention reporting tables include a comparison of the Greenlandic approach and the reference approach estimates. To make results comparable, the CO_2 emission from incineration of the plastic content of municipal waste is added in the reference approach while the fuel consumption is subtracted.

In 2008 the fuel consumption rates in the two approaches differ by -0.1 % and the CO_2 emission differs by 0.9 % in the period 1990-2008 both the fuel consumption and the CO_2 emission differ by less than 1.2 %. The differences in energy consumption are below 1 % for all years. The difference in CO_2 emission is above 1 % from 1990 to 2005, and below 1 % since 2006. According to IPCC Good Practice Guidance (IPCC, 2000) the difference should be within 2 %. A comparison of the Greenlandic approach and the reference approach is illustrated in Figure 3.9.

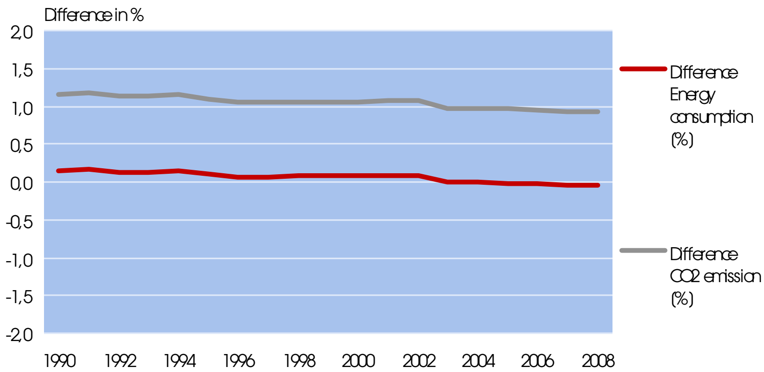

Figure 3.9 Comparison of the reference approach and the national approach.

3.6 Source specific recalculations and improvements

Improvements and recalculations since the 2009 emission inventory submission include:

- Update of fuel rates according to the latest energy statistics. The update include the years 2004-2007.

- Adjustments of applied plant specific emission factors for CH_4 and N_2O. The adjustments include the years 1990-2007.

- Adjustment of the applied CO_2 emission factor for municipal waste with energy recovery according to a study by the Danish National Environmental Research Institute in 2009.

Table 3.17 shows recalculations in the energy sector compared with the 2009 submission.

Table 3.17 Changes in GHG emission in the energy sector compared with the 2009 submission.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Previous inventory, Gg CO_2 eqv.	627.4	612.5	598.1	547.4	496.7	534.9	597.8	618.7	580.1	594.8
Recalculated, Gg CO_2 eqv.	625.2	610.3	596.1	545.8	495.3	533.5	596.6	617.4	595.9	593.8
Change in Gg CO_2 eqv.	-2.3	-2.2	-1.9	-1.6	-1.4	-1.4	-1.2	-1.3	15.8	-1.0
Change in pct.	-0.4	-0.4	-0.3	-0.3	-0.3	-0.3	-0.2	-0.2	2.7	-0.2
continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
Previous inventory, Gg CO_2 eqv.	668.3	618.4	579.5	649.6	637.2	636.0	659.6	651.7	-	
Recalculated, Gg CO_2 eqv.	667.6	617.9	579.2	649.8	631.1	635.5	657.4	652.2	685.9	
Change in Gg CO_2 eqv.	-0.6	-0.5	-0.3	0.2	-6.1	-0.5	-2.3	0.5	-	
Change in pct.	-0.1	-0.1	-0.1	0.0	-1.0	-0.1	-0.3	0.1	-	

3.7 Source specific planned improvements

Some planned improvements to the emission inventories are discussed below.

1) Improved documentation for emission factors
The reporting of, and references for, the applied emission factors have been improved in the current year and will be further developed in future inventories. This will happen on the advice from the Danish National Environmental Research Institute.

2) Improvements in plant specific fuel combustion
Plant specific fuel combustion will be further improved according to the developments made by Statistics Greenland in the energy statistics.

3) Uncertainty estimates
Uncertainty estimates are largely based on the default uncertainty levels for activity rates and emission factors. More country-specific uncertainty estimates will be incorporated in future inventories.

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4 Industrial processes (CRF sector 2)

4.1 Overview of sector

In this chapter industrial emissions of greenhouse gases, not related to generation of energy, are presented. An overview of the sources identified is presented in Table 4.1 with an indication of the contribution to the industrial part of the emission of greenhouse gases in 2008. The emissions are extracted from the CRF tables.

The emission of greenhouse gases from industrial processes includes CO_2, HFCs and SF_6. The emissions are reported in CRF Tables 2(I), 2(I).A, 2(II), 2(II).C, 2(II).E and 2(II).F. Furthermore, the emission of non-methane volatile organic compounds (NMVOC) and CO from industrial processes related to asphalt roofing, road paving with asphalt and production of food and drink are given in CRF Table 2(I).

Summary tables for the industrial processes are shown in Table 4.1.

Table 4.1 Overview of greenhouse gas sources (2008).

Process	IPCC Code	Substance	Emission ktonnes CO_2 eqv.	%
Mineral Products				
Limestone and Dolomite Use	2A		2.96	0.05
Asphalt Roofing	2A		0.08	0.00
Road Paving with Asphalt	2A		0.20	0.00
Consumption of Halocarbons and SF6				
Refrigeration and Air Conditioning Equipment	2F	HFCs	6,527	99.90
Electrical Equipment	2F	SF6	3.02	0.05
Total emission			6,533	100

The subsectors *Mineral Products* (2A) constitutes 0.05 % and *Consumption of Halocarbons and SF_6* (2F) constitutes 99.95% of the industrial emission of greenhouse gases. The total emission of greenhouse gases (excl. LULUCF) in Greenland is estimated to 728.75 Gg CO_2-equivalent, of which industrial processes contribute with 6.53 Gg CO_2-equivalent (0.9 %). The emission of greenhouse gases from industrial processes from 1990-2008 are presented in Figure 4.1.

Greenland has no chemical industry, metal production or production of halocarbons or SF_6. Greenland has no consumption of PFCs.

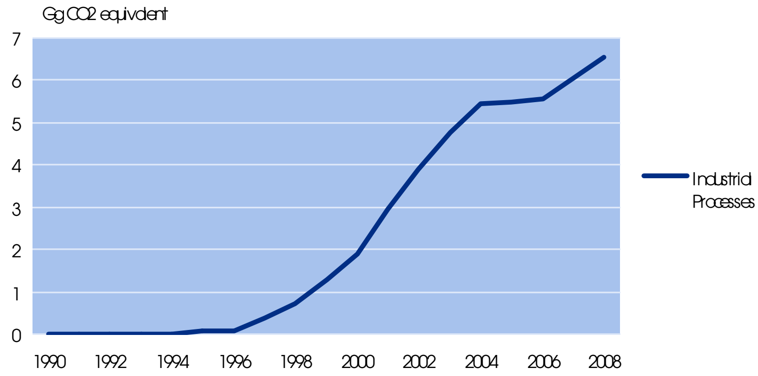

Figure 4.1 Emission of greenhouse gases from industrial processes from 1990-2008.

The key categories in the industrial sector *Mineral Products* and *Consumption of Halocarbons and SF_6* constitute 0.0004% and 0.9% of the total emission of greenhouse gases. The trends in greenhouse gases from the industrial sector/subsectors are presented in Table 4.2. The emissions are extracted from the CRF tables.

Table 4.2 Emission of greenhouse gases from industrial processes in different subsectors from 1990-2008.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
CO_2 (tonnes CO_2)										
A. Mineral Products	0.11	0.11	0.11	0.11	0.10	0.11	0.10	0.13	0.12	0.13
CH_4	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
N_2O	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFCs (tonnes CO_2 eqv.)										
F. Consumption of Halocarbons and SF_6	NE	NE	NE	NE	16	25	77	390	713	1 279
PFCs (tonnes CO_2 eqv.)										
F. Consumption of Halocarbons and SF_6	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
SF_6 (tonnes CO_2 eqv.)										
F. Consumption of Halocarbons and SF_6	NE	NE	NE	NE	NE	35.9	3.4	3.4	3.3	3.3
continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
CO_2 (tonnes CO_2)										
A. Mineral Products	4.09	2.94	1.46	3.05	2.06	0.52	0.20	1.70	3.24	
CH_4	NO	NO	NO	NO	NO	NO	NO	NO	NO	
N_2O	NO	NO	NO	NO	NO	NO	NO	NO	NO	
HFCs (tonnes CO_2 eqv.)										
F. Consumption of Halocarbons and SF_6	1 871	2 964	3 898	4 750	5 425	5 499	5 558	6 065	6 527	
PFCs (tonnes CO_2 eqv.)										
F. Consumption of Halocarbons and SF_6	NO	NO	NO	NO	NO	NO	NO	NO	NO	
SF_6 (tonnes CO_2 eqv.)										
F. Consumption of Halocarbons and SF_6	3.3	3.2	3.2	3.2	3.1	3.1	3.1	3.0	3.0	

Greenland has no production of halocarbons or SF_6. Data on consumption of F-gases (HFCs and SF_6) are obtained from the Statistics Greenland (imports) and by an annual survey on consumption halocarbons and SF_6. Information on consumption of F-gases is available from 1995 onwards. Greenland has no consumption of PFCs.

One single plant in Greenland has reported use of SF_6 in 1995. The emission of SF_6 was 35.9 tonnes CO_2-eqv. in 1995. The annual emission from 1996 and onwards is assumed to be 0.5 % of the amount filled into the plant in 1995. This causes a relative high emission of SF_6 in 1995 and a much lower emission in the period 1996-2008.

Energy consumption associated with industrial processes and emissions thereof are included in the Energy sector of the inventory.

4.2 Source category description

4.2.1 Mineral Products

The subsector *Mineral products* (2A) cover the following processes:

- Limestone and dolomite use
- Roof covering with asphalt materials
- Road paving with asphalt

The time-series for the emission of CO_2 from Mineral products (2A) are presented in Table 4.3. The emissions are extracted from the CRF tables and the values are rounded.

Table 4.3 Time-series for emission of CO_2 (tonnes) from Mineral products (2A).

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
3. Limestone and dolomite use	-	-	-	-	-	-	-	-	-	-
5. Asphalt roofing	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.00
6. Road paving	0.10	0.10	0.10	0.10	0.10	0.10	0.09	0.11	0.11	0.13
Total	0.11	0.11	0.11	0.11	0.10	0.11	0.10	0.13	0.12	0.13
continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
3. Limestone and dolomite use	3.96	2.77	1.32	2.64	1.80	0.11	0.03	1.51	2.96	
5. Asphalt roofing	0.01	0.00	0.02	0.04	0.07	0.03	0.05	0.04	0.08	
6. Road paving	0.12	0.17	0.12	0.37	0.19	0.38	0.12	0.15	0.20	
Total	4.09	2.94	1.46	3.05	2.06	0.52	0.20	1.70	3.24	

The use of limestone and dolomite started in 2000. Hence there is no emission from limestone and dolomite use before 2000. The increase in CO_2 emission is most significant for the use of asphalt roofing. From 1990 to 2008, the CO_2 emission increased from 0.01 to 0.08 tonnes CO_2; an increase of 779%. The increase in CO_2 from asphalt roofing has primarily taken place from 2002 and onwards. Since 2002 annual building activities have increased by an average of 5.5% for dwellings alone compared to 1990.

The most significant CO_2 emission comes from the use of limestone and dolomite, which constitutes 91.1% of the total CO_2 emission from mineral products in 2008. The maximum emission occurred in 2000 and constituted 3.96 tonnes CO_2.

The CO_2 emission from subsectors under mineral products fluctuates a great deal from year to year. This is caused by fluctuations in building activities and road paving. However fluctuations in CO_2 are also caused by the fact that activity data for mineral products are based on import data, which do not allow distinction of imported amount into consumption and stockpiling.

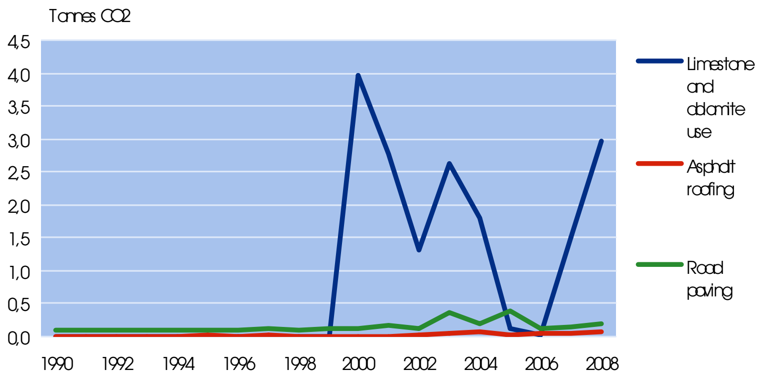

Figure 4.2 Emission of CO_2 from mineral products.

4.2.2 Consumption of Halocarbons and SF_6

The subsector *Consumption of Halocarbons and SF6* (2F) includes the following source categories and the following F-gases of relevance for Greenlandic emissions:

- 2F1: Refrigeration: HFC32, 125, 134a, 143a, unspecified HFCs
- 2F8: Electrical equipment: SF_6

A quantitative overview is given below for each of these source categories and each F-gas, showing their emissions in tonnes through the time-series. The data is extracted from the CRF tables that form part of this submission and the data presented is rounded values. It must be noticed that the inventories for the years 1990-1993 (1994) might not cover emissions of these gases in full. The choice of base-year for these gases is 1995 for Greenland.

Table 4.4 Emission of HFCs from refrigeration (t).

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
HFC32	NE	NE	NE	NE	NE	NA	0.00	0.00	0.00	0.00
HFC125	NE	NE	NE	NE	NE	NA	0.01	0.04	0.08	0.15
HFC134a	NE	NE	NE	NE	0.01	0.02	0.03	0.06	0.10	0.17
HFC143a	NE	NE	NE	NE	NE	NA	0.01	0.05	0.09	0.16
Unspecified HFCs	NE	NE	NE	NE	NE	NA	0.00	0.00	0.00	0.00
continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
HFC32	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	
HFC125	0.22	0.35	0.46	0.56	0.64	0.64	0.65	0.71	0.76	
HFC134a	0.24	0.35	0.45	0.55	0.63	0.65	0.65	0.68	0.67	
HFC143a	0.24	0.39	0.51	0.63	0.71	0.72	0.72	0.79	0.86	
Unspecified HFCs	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	

Table 4.5 Emission of SF_6 from electrical equipment (kg).

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
SF_6	NE	NE	NE	NE	NE	1.50	0.14	0.14	0.14	0.14
continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
SF_6	0.14	0.14	0.13	0.13	0.13	0.13	0.13	0.13	0.13	

The emission of SF_6 was highest in 1995, when one single plant in Greenland reported use of SF_6. The emission of SF_6 was 1.5 kg in 1995. Since 1995 the annual emission is assumed to be 0.5 % of the amount filled into the plant in 1995. This causes a relative high emission of SF_6 in

1995 and a much lower emission in the following years. In 2008 the emission of SF_6 was 0.13 kg.

HFCs are used in various types of refrigeration in industry, retail, buildings and onboard ships. In 1994 and 1995 consumption of HFC134a was the only reported HFC used for refrigeration. Since 1996 consumption of HFC32, 125, 134A, 143A has been reported continuously. The emission of HFCs has increased rapidly since 1995.

Table 4.6 and Figure 4.3 and Figure 4.4 quantify an overview of the emissions of the gases in CO_2-eqv. The reference is the trend table as included in the CRF table for year 2008.

Table 4.6 Time-series for emission of HFCs and SF_6 (tonnes CO_2-eqv.).

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
HFCs	NE	NE	NE	NE	16	25	77	390	713	1 279
SF_6	NE	NE	NE	NE	NE	35,9	3,4	3,4	3,3	3,3
continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
HFCs	1 871	2 964	3 898	4 750	5 425	5 499	5 558	6 065	6 527	
SF_6	3,3	3,2	3,2	3,2	3,1	3,1	3,1	3,0	3,0	

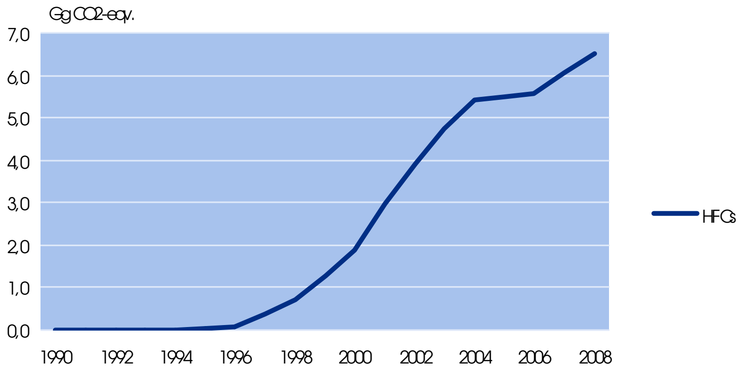

Figure 4.3 Emission of HFCs (from refrigeration).

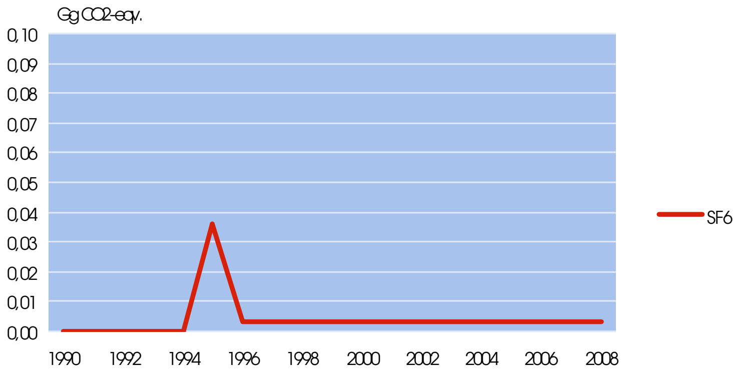

Figure 4.4 Emission of SF_6 (from electrical equipment).

HFCs is by far the most dominant group. HFCs constitute a key category both with regard to the key category level and the trend analysis.

4.3 Methodological issues

4.3.1 General

The CO_2 emission from the use of limestone and dolomite, asphalt materials used for roof covering and road paving has been estimated from the annual import of these products to Greenland.

The emissions of HFCs and SF_6 have been estimated from data on consumption of F-gases. Activity data includes annual imports and data on consumption of halocarbons and SF_6 obtained from an annual survey among importers and consumers of F-gases.

The following sections contain a description of activity data and emission factors used for the subsectors under industrial processes. The section is concluded by a description of the emissions of greenhouse gases from industrial processes.

4.3.2 Activity data

Activity data for subsectors *Mineral Products* (2A) and *Other Production* (2D) are presented in Table 4.7. Activity data under subsector *Other Production* (2D) are used for calculation of emission of non-methane volatile organic compounds (NMVOC).

The activity data are rounded. Notice that production of beer is given in hectolitre (hl). All other activity data are given in tonnes (t).

Statistics on imports are used to estimate annual consumption of mineral products. Statistics on imports of whole coffee beans and yeast for baking are used to estimate annual production of coffee and bread. Statistics on landings of fish and seafood to domestic plants are used to determine domestic processing of fish and seafood. Statistics on imports are produced by Statistics Greenland (2009b).

Production of beer including a fermentation process has taken place at the brewery "Godthåb Bryghus" since 2005 (Godthåb Bryghus, 2010). The brewery has reported annual production in rounded hectolitre. The much larger brewery "Nuuk Imeq" has no production of beer including a fermentation process. The activity at the brewery "Nuuk Imeq" only includes diluting of the concentrated quantities imported to Greenland and afterwards bottling of the beer.

Table 4.7 Time-series for activity data for Mineral Products and Other Production (Godthåb Bryghus, 2010, Statistics Greenland, 2009b).

		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Mineral Products											
2A3	Limestone and dolomite use (t)	-	-	-	-	-	-	-	-	-	-
2A5	Asphalt materials used for roofing (t)	37	35	39	39	13	56	29	59	39	7
2A6	Asphalt used for road paving (t)	591	581	595	604	597	577	532	664	649	752
Other Production											
2D2	Food and Drink - Beans roasted to produce coffee (t)	0	0	0	0	-	0	-	-	0	0
2D2	Food and Drink - Production of bread (t)	356	346	339	358	501	244	415	500	847	689
2D2	Food and Drink - Landings of fish and seafood (t)	81 768	72 395	65 553	59 423	64 479	67 786	60 662	62 244	67 247	63 750
2D2	Food and Drink - Production of beer (hl)	-	-	-	-	-	-	-	-	-	-
continued		2000	2001	2002	2003	2004	2005	2006	2007	2008	Source
Mineral Products											
2A3	Limestone and dolomite use (t)	9	6	3	6	4	0	0	3	7	1
2A5	Asphalt materials used for roofing (t)	26	11	81	149	263	114	193	148	321	1
2A6	Asphalt used for road paving (t)	694	988	705	2 218	1 127	2 258	698	910	1 206	1
Other Production											
2D2	Food and Drink - Beans roasted to produce coffee (t)	0	1	-	0	0	0	0	1	0	2
2D2	Food and Drink - Production of bread (t)	687	566	1,020	1,048	1,338	1,014	1,134	622	931	2
2D2	Food and Drink - Landings of fish and seafood (t)	74 105	66 929	85 970	80 667	102 570	103 979	109 564	108 751	109 771	3
2D2	Food and Drink - Production of beer (hl)	-	-	-	-	-	1 000	2 000	2 000	2 000	4

Sources:

1) Statistics on imports are used to estimate annual consumption of mineral products.

2) Statistics on imports of whole coffee beans and yeast for baking are used to estimate annual production of coffee and bread.

3) Statistics on landings of fish and seafood to domestic plants are used to determine domestic processing of fish and seafood.

4) Data from the brewery "Godthåb Bryghus" are used to determine annual production of beer.

The data for emission of HFCs and SF_6 has been obtained in continuation on the work on inventories for previous years. The determination includes the quantification and determination of any import and export of HFCs and SF_6 contained products and substances in stock form. This is in accordance with IPCC guidelines (IPCC (1997), vol. 3, p. 2.43ff), as well as the relevant decision trees from the IPCC Good Practice Guidance (IPCC (2000) p. 3.53ff).

The following sources of information have been used (Statistics Greenland, 2009a):

- Importers, wholesaler and suppliers
- Statistics Greenland
- Consuming enterprises

Importers and suppliers provide consumption data of F-gases. Emission factors are defaults from the GPG. Import/export data for sub-source categories where import/export is relevant are quantified on estimates from import/export statistics of products + default values of the amount of gas in the product.

The determination of emissions of F-gases is based on a calculation of the actual emission. The actual emission is the emission in the evaluation year, accounting for the time lapse between consumption and emission. The actual emission includes Greenlandic emissions from production and from products during their lifetimes. Consumption and emissions of F-gases are, whenever possible for individual substances, even though the consumption of certain HFCs has been limited. This has been varied out to ensure transparency of evaluation in the determination of GWP values. However, the continued use for Other HFCs has been necessary since not all importers and suppliers have specified records of sales for individual substances.

Only the actual emission has been calculated. Thus, the potential emission is assumed to be the same as the actual emission in the CRF tables.

Table 4.8 Content (w/w%) of "pure" HFC in HFC-mixtures, used as trade names.

HFC mixtures	HFC32	HFC125	HFC134a	HFC143a	Unspecified HFCs
	%	%	%	%	%
HFC-134, total			100		
HFC-404, total		44	4	52	
HFC-407c, total	23	25	52		
HFC-507a, total		50		50	
Unspecified HFCs					100

The substances have been accounted for in the survey according to their trade names, which are mixtures of HFCs used in the CRF. In the transfer to the "pure" substances used in the CRF reporting schemes, the ratios shown in Table 4.8 have been used.

Activity data for the consumption of F-gases is shown in Table 4.9. The activity data are rounded and given in kg.

Table 4.9 Time-series for activity data for the consumption of F-gases by trade-names (Statistics Greenland, 2009a).

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
					Kg					
HFC-134										
Domestic	NE	NE	NE	264	139	91	187	134	453	319
Commercial and Industry	NE	NE	NE	0	0	0	123	123	247	247
Transport	NE	NE	NE	0	0	0	64	64	128	128
HFC-404a										
Commercial and Industry	NE	NE	NE	0	0	0	488	488	976	976
Transport	NE	NE	NE	0	0	0	82	82	164	164
HFC-407c										
Commercial and Industry	NE	NE	NE	0	0	0	34	34	68	68
HFC-507a										
Transport	NE	NE	NE	0	0	0	113	113	225	225
Unspecified HFCs										
Commercial and Industry	NE	NE	NE	0	0	0	45	45	90	90
SF6										
Electrical Equipment	NE	NE	NE	0	0	30	0	0	0	0

Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008
HFC-134									
Domestic	289	492	774	635	635	0	0	0	0
Commercial and Industry	493	493	493	493	260	208	680	329	312
Transport	256	256	256	256	120	120	30	30	0
HFC-404a									
Commercial and Industry	1 952	1 952	1 952	1 952	1 324	1 041	2 033	2 069	1 950
Transport	328	328	328	328	154	222	369	413	384
HFC-407c									
Commercial and Industry	135	135	135	135	68	83	31	4	112
HFC-507a									
Transport	450	450	450	450	0	0	120	180	0
Unspecified HFCs									
Commercial and Industry	180	180	180	180	326	314	556	698	309
SF6									
Electrical Equipment	0	0	0	0	0	0	0	0	0

4.3.3 Emission factors

The CO_2 emission factors applied for mineral products in 2008 are presented in Table 4.10. The same emission factor has been applied for 1990-2008.

Table 4.10 CO_2 emission factors 2008.

Product	Emission factor	Unit	Reference	IPCC Category
Limestone and dolomite use	440	kg pr ton	IPCC, 1997	2A3
Asphalt materials used for roofing	0.25	kg pr ton	Nielsen et al., 2009	2A5
Asphalt used for road paving	0.168	kg pr ton	Nielsen et al., 2009	2A6

The CO emission factors applied for the consumption of asphalt products under mineral products in 2008 are presented in Table 4.11. The same emission factor has been applied for 1990-2008.

Table 4.11 CO emission factors 2008.

Product	Emission factor	Unit	Reference	IPCC Category
Asphalt materials used for roofing	0.01	kg pr tonnes	Nielsen et al., 2009	2A5
Asphalt used for road paving	0.075	kg pr tonnes	Nielsen et al., 2009	2A6

The NMVOC emission factors applied for the consumption of asphalt products under mineral products and products used in the production of food and drink in 2008 are presented in Table 4.12. The same emission factor has been applied for 1990-2008.

Table 4.12 NMVOC emission factors 2008.

Product	Emission factor	Unit	Reference	IPCC Category
Asphalt materials used for roofing	0.08	kg pr tonnes	Nielsen et al., 2009	2A5
Asphalt used for road paving	0.015	kg pr tonnes	Nielsen et al., 2009	2A6
Food and Drink - Beans roasted to produce coffee	0.55	kg pr tonnes	IPCC, 1997	2D2
Food and Drink - Production of bread	8	kg pr tonnes	IPCC, 1997	2D2
Food and Drink - Landings of fish and seafood	0.3	kg pr tonnes	IPCC, 1997	2D2
Food and Drink - Production of beer	0.0625	kg pr hl	Nielsen et al., 2009	2D2

4.3.4 Emissions

The Greenhouse gas (GHG) emissions are listed in Table 4.13. The emission from industrial processes accounts for 0.9 % of the Greenlandic GHG emission.

The CO_2 emission from industrial processes accounts for just 0.0005% of the Greenlandic CO_2 emission (excluding net CO_2 emission from Land Use, Land Use Change and Forestry (LULUCF). The HFC emission from accounts for 100 % of the Greenlandic emission and the SF_6 emission accounts for 100% of the Greenlandic SF_6 emission.

Table 4.13 Greenhouse gas emission for the year 2008

		CO_2	HFC	SF_6
		Tonnes CO_2-equivalent		
2A3	Limestone and Dolomite Use	3.0	NA	NA
2A5	Asphalt Roofing	0.1	NA	NA
2A6	Road Paving with Asphalt	0.2	NA	NA
2F1	Refrigeration	NA	6 527	NA
2F8	Electrical Equipment	NA	NA	3.0
Total emission from industrial processes		3.2	6 527	3.0
		Gg CO_2-equivelent		
Greenlandic emission (excluding net emission from LULUCF)		685.5	6.527	0.003
		%		
Emission share for industrial processes		0.0005	100	100

HFC is the most important GHG pollutant and accounts for 99.9 % of the GHG emission in CO_2 equivalents from industrial processes. Illustration of the percentage of share in a figure is omitted due to the large share of HFC, which completely dominates as the most significant GHG pollutant from industrial processes.

CO_2

Figure 4.5 depicts the time-series of CO_2 emission from industrial processes. As shown by the blue curve total CO_2 emission follows the CO_2 emission from use of limestone and dolomite closely. Limestone and dolomite first was imported in 2000. Thus emission of CO_2 from the use of mineral products increased significantly in 2000. The emission of CO_2 has increased by a factor 30 from 1990 to 2008 primarily due to the introduction of limestone and dolomite import in 2000.

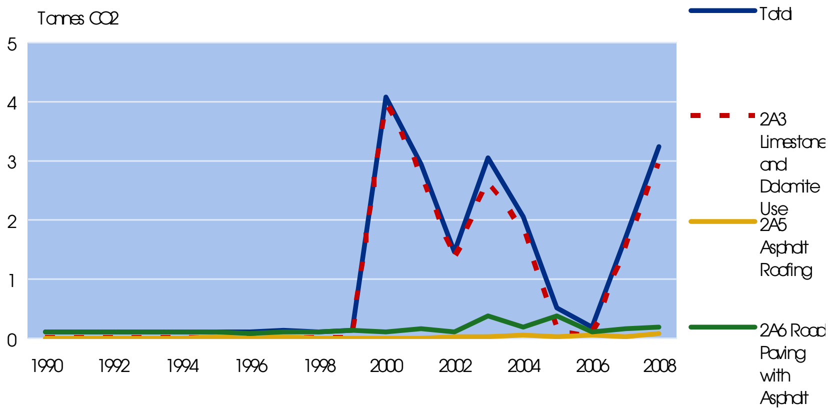

Figure 4.5 Emission of CO_2 from industrial processes.

Emission of HFCs and SF_6 are illustrated in Figure 4.3 and Figure 4.4.

NMVOC and CO

The emissions of NMVOC and CO from industrial processes in 2008 are presented in Table 4.14. NMVOC and CO account for 3.5 % and 0.002 % respectively, of the Greenlandic emissions for these substances.

Table 4.14 NMVOC and CO emission from industrial processes 2008.

		NMVOC	CO
		Tonnes	
2A5	Asphalt Roofing	0.03	0.00
2A6	Road Paving with Asphalt	0.02	0.09
2D2	Food and Drink	40.51	NA
Total emission from industrial processes		40.55	0.09
Greenlandic emission		1 173.6	5 018.4
		%	
Emission share for industrial processes		3.46	0.002

4.4 Uncertainties

A tier 1 uncertainty assessment has been carried out in accordance with the IPCC GPG (IPCC, 2000). The uncertainty has been estimated for all sources included in the reporting for industrial processes. The uncertainties for the activity data and emission factors are shown in Table 4.15.

Table 4.15 Uncertainties for activity data and emission factors for industrial processes.

Subsector	Pollutant	Activity data uncertainty	Emission factor uncertainty
2A3 Limestone and dolomite use	CO_2	5	5
2A5 Asphalt roofing	CO_2	5	25
2A6 Road paving with asphalt	CO_2	10	50
2F Consumption of HFC	HFC	10	50
2F Consumption of SF_6	SF_6	10	50

The activity data comes from the import statistics, which is considered to be of high quality, therefore the uncertainty of the activity data has been set to 5 % for limestone and dolomite use and asphalt roofing, while it is assumed to be 10 % for road paving and consumption of HFCs and SF_6.

Regarding the emission factor uncertainty, the CO_2 emission factor for limestone and dolomite use is considered very certain since it is derived from stoichiometric calculations, therefore an emission factor of 5 % has been assumed. The uncertainty levels for ashphalt roofing and road paving are expert judgements. The emission of F-gases is dominated by emissions from refrigeration equipment and, therefore, the uncertainties assumed for this sector will be used for all the F-gases. The IPCC propose an uncertainty at 30-40 % for regional estimates. However, Greenlandic statistics have been developed over a number of years and, therefore the uncertainty on activity data is assumed to be 10 %. The uncertainty on the emission factor is, on the other hand, assumed to be 50 %. The base year for F-gases for Greenland is 1995.

The resulting uncertainties for the individual greenhouse gases and the total uncertainty on the greenhouse gas emission are shown in Table 4.16.

Table 4.16 Uncertainties for the emission estimates.

	Uncertainty %	Trend 1990-2008[1] %	Trend uncertainty %
GHG	36	15 284	±4 249
CO_2	6.7	2 891	±676
HFC	51	26 523	±3 765
SF_6	51	-92	±1.9

[1] For f-gases the base year of 1995 is used

4.5 Source specific QA/QC

The elaboration of a formal QA/QC plan is to be completed.

However, the official Greenland import statistics has gone through a great deal of quality work with regard to accuracy, comparability and completeness. Statistics Greenland is responsible for the official Greenlandic import statistics, and as such responsible for the completeness of data.

Statistics on imports is reported by Statistics Greenland in form of a spreadsheet. Annual import of limestone and dolomite, asphalt materials used for roof covering and road paving, whole coffee beans and yeast for baking are compared with imports in previous years and large discrepancies are checked. The same procedure is used to ensure accuracy in annual use of F-gases and statistics on landings of fish and seafood to domestic plants.

All external data used for the emission inventory submission are archived in spreadsheets. Data are archived annually in order to ensure that the basic data for a given report are always available in their original form.

Safely stored and quality checked activity data are then processes by using a methodological approach consistent with international guidelines.

Calculated emission factors are compared with guideline emission factors to ensure that they are reasonable. The calculations follow the principle in international guidelines.

During data processing, it is checked that calculations are being carried out correctly. However, a documentation plan for this needs to be elaborated.

Time-series for activity data, emission factors and calculated emissions are used to identify possible errors in the calculation procedure. In fact, during the calculation, numerous controls take place to ensure correctness. Sums are checked in the various stages in the calculation procedure. Implied emission factors are compared to emission factors.

Every single time-series imported to the CRF Reporter is checked for annual activity, units for activity, emission factor and emissions. Additional checks are performed on the database. The database encloses every single activity data, emission factors, emission, notation key and comment imported to the CRF Reporter. In other words, no information is typed manually into the CRF Reporter. Instead, all information is imported to the CRF Reporter through XML-files to ensure maximum accuracy and completeness.

4.6 Source specific recalculations and improvements

The sectors *Mineral Products* (2A) and *Other Production* (2D) are included in the inventory for the first time. Improvements and recalculations since the 2009 emission inventory submission include:

- Introduction of new activity data on non-energy use of limestone and dolomite, products containing bitumen used for asphalt roofing, and road paving with asphalt. The new introductions include the years 1990-2007.
- Introduction of new activity data on consumption of products used in the production of food and drink i.e. raw coffee beans, yeast used for baking, landings of fish, shellfish, seals and whales, and production of beer. Use of these products caused no CO_2 emission only non-methane volatile organic compounds (NMVOC).
- Improved data on use of F-gases. Activity data on F-gases are now divided into domestic, commercial and industry, transport, and electrical equipment. Further more the substances, which are accounted according to their trade names, are now transferred into "pure" substances.

Table 4.17 shows recalculations relating to industrial processes compared with the 2009 submission.

Table 4.17 Changes in GHG emission in the industrial processes sector compared with the 2009 submission.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Previous inventory, Gg CO_2 eqv.	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.4	0.7	1.3
Recalculated, Gg CO_2 eqv.	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.4	0.7	1.3
Change in Gg CO_2 eqv.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Change in pct.	-	-	-	-	-	0.2	0.3	1.0	1.1	1.1
continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
Previous inventory, Gg CO_2 eqv.	1.9	2.9	3.9	4.7	5.4	5.4	5.5	6.0	-	
Recalculated, Gg CO_2 eqv.	1.9	3.0	3.9	4.8	5.4	5.5	5.6	6.1	6.5	
Change in Gg CO_2 eqv.	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	-	
Change in pct.	1.3	1.3	1.2	1.3	1.3	1.1	1.0	0.9	-	

4.7 Source specific planned improvements

Some planned improvements to the emission inventories are discussed below.

1) Distribution of unspecified mix of HFCs into single HFCs

An unspecified mix of HFCs is used in commercials and industries. In future inventories attempts will be made in order to distribute the unspecified mix of HFCs into single substances.

4.8 References

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http://www.stat.gl/Statistik/Udenrigshandel/tabid/101/language/da-DK/Default.aspx as "Grønlands udenrigshandel 2008 (foreløbige tal)" (24-07-2009). Data more detailed than the published version of the foreign trade statistics are used in order to access imports at the most detailed level.

5 Solvent and other product use (CRF sector 3)

5.1 Overview of sector

This section presents the methodology used for calculating CO_2 and NMVOC emissions from use of solvents in industrial processes and households that are related to the source categories Paint application (CRF sector 3A), Degreasing and dry cleaning (CRF sector 3B), Chemical products, manufacture and processing (CRF sector 3C) and Other (CRF sector 3D).

Solvents are chemical compounds that are used on a global scale in industrial processes and as constituents in final products to dissolve e.g. paint, cosmetics, adhesives, ink, rubber, plastic, pesticides, aerosols or are used for cleaning purposes, i.e. degreasing. NMVOCs are main components in solvents - and solvent use in industries and households is typically the dominant source of anthropogenic NMVOC emissions. In industrial processes where solvents are produced or used NMVOC emissions to air and as liquid can be recaptured and either used or destroyed. Solvent containing products are used indoor and outdoor and the majority of solvent sooner or later evaporate. A small fraction of the solvent ends up in waste or as emissions to water and may finally also contribute to air pollution by evaporation from these compartments.

In this section the methodology for the Greenland NMVOC emission inventory for solvent use is presented and the results for the period 1990 – 2008 are summarised. The method is based on the detailed approach described in EMEP/CORINAIR (2004) and emissions are calculated for the CRF sectors mentioned above.

5.2 Source category description

Table 5.1 and Figure 5.1 show the emissions of chemicals from 1990 to 2008, where the used amounts of single chemicals have been assigned to specific products and CRF categories.

Table 5.2 shows the used amounts of chemicals for the same period. Table 5.1 is derived from Table 5.2 by applying emission factors relevant to individual chemicals and production or use activities. Table 5.3 shows the used amounts of products from 1990 to 2008.

The default NMVOC-CO_2 conversion factor of 0.85 * 3.667 = 3.11 is used.

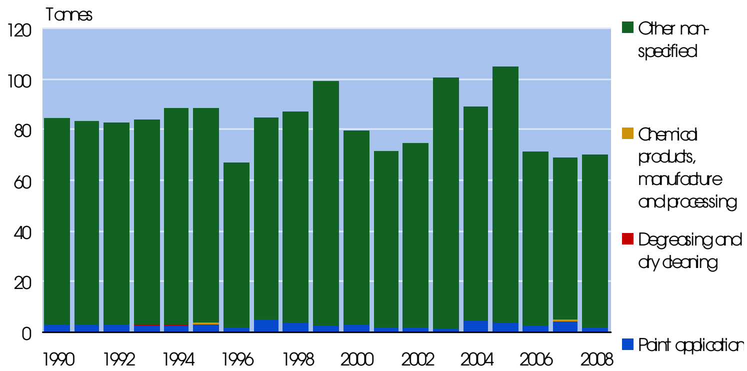

Figure 5.1 Emission of NMVOC from solvent and other product use. The methodological approach for finding emissions is described in the text. Figures can be seen in Table 5.1.

Table 5.1 Emission of chemicals in tonnes per year.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Paint application (3A)	3.1	3.0	2.9	2.8	2.5	3.4	2.1	5.2	3.8	2.5
Degreasing and dry cleaning (3B)	0.1	0.1	0.1	0.1	0.4	NO	NO	0.1	0.2	NO
Chemical products, manufacturing and processing (3C)	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.1
Other (3D)	81.2	80.1	79.4	81.2	85.4	85.2	64.9	79.2	82.8	96.8
Total NMVOC	84.4	83.3	82.5	84.1	88.3	88.7	67.1	84.4	86.9	99.4
Total CO_2	263.4	259.7	257.4	262.5	275.6	276.7	209.3	263.4	271.0	310.1
continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
Paint application (3A)	3.1	1.9	2.1	1.3	4.4	3.9	2.2	4.7	1.8	
Degreasing and dry cleaning (3B)	NO	NO	NO	NO	NO	NO	NO	NO	0.0	
Chemical products, manufacturing and processing (3C)	0.0	0.0	0.1	0.0	0.2	0.1	0.1	0.1	0.0	
Other (3D)	76.4	69.8	72.7	99.4	84.3	100.5	69.2	63.9	68.2	
Total NMVOC	79.5	71.7	74.8	100.7	88.9	104.5	71.5	68.7	70.0	
Total CO_2	247.9	223.6	233.5	314.0	277.5	326.1	223.0	214.3	218.3	

Table 5.2 Used amounts of chemicals in tonnes per year.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Paint application (3A)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Degreasing and dry cleaning (3B)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Chemical products, manufacturing and processing (3C)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Other (3D)	37.0	36.6	35.1	34.8	59.6	43.5	45.4	32.8	27.1	36.5
Total NMVOC	37.0	36.6	35.1	34.8	59.6	43.5	45.4	32.8	27.1	36.5
continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
Paint application (3A)	NO	NO	NO	NO	NO	NO	NO	NO	NO	
Degreasing and dry cleaning (3B)	NO	NO	NO	NO	NO	NO	NO	NO	NO	
Chemical products, manufacturing and processing (3C)	NO	NO	NO	NO	NO	NO	NO	NO	NO	
Other (3D)	18.6	33.0	20.0	31.9	27.5	27.4	30.4	24.1	26.2	
Total NMVOC	18.6	33.0	20.0	31.9	27.5	27.4	30.4	24.1	26.2	

Table 5.3 Used amounts of products in tonnes per year.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Paint application (3A)	3.9	3.8	3.7	3.5	3.1	4.3	2.7	6.5	4.8	3.1
Degreasing and dry cleaning (3B)	0.2	0.2	0.1	0.1	0.8	NO	NO	0.1	0.4	0.0
Chemical products, manufacturing and processing (3C)	0.3	0.2	0.2	0.2	0.5	0.1	0.1	0.1	0.1	0.8
Other (3D)	84.6	83.5	83.5	85.8	84.9	84.5	61.8	81.8	90.9	105.7
Total products	89.0	87.7	87.5	89.7	89.4	89.0	64.6	88.6	96.1	109.5
continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
Paint application (3A)	3.8	2.4	2.6	1.6	5.5	4.8	2.8	5.8	2.3	
Degreasing and dry cleaning (3B)	NO	NO	NO	NO	NO	NO	NO	NO	0.0	
Chemical products, manufacturing and processing (3C)	0.0	0.1	0.4	0.2	0.5	0.3	0.4	2.0	0.2	
Other (3D)	83.8	72.2	83.3	109.5	96.2	107.2	74.3	67.6	71.5	
Total products	87.6	74.6	86.2	111.4	102.2	112.3	77.5	75.4	73.9	

5.3 Methodological issues

Emission modelling of solvents can basically be done in two ways: 1) By estimating the amount of (pure) solvents consumed, or 2) By estimating the amount of solvent containing products consumed, taking account of their solvent content (EMEP/CORINAIR, 2004).

In 1) all relevant solvents must be estimated, or at least those together representing more than 90 % of the total NMVOC emission, and in 2) all relevant source categories must be inventoried or at least those together contributing more than 90 % of the total NMVOC emission. A simple approach is to use a pr capita emission for each category, whereas a detailed approach is to get all relevant consumption data (EMEP/CORINAIR, 2004).

The detailed method 1) is used in the emission inventory for solvent use, thus representing a chemicals approach, where each chemical (NMVOC) and chemical containing product (group) is estimated separately. The sum of emissions of all estimated NMVOCs used as solvents equals the NMVOC emission from solvent use.

5.3.1 Activity data

The definitions of solvents and VOC that are used are as defined in the solvent directive (Directive 1999/13/EC) of the EU legislation: "Organic solvent shall mean any VOC which is used alone or in combination with other agents, and without undergoing a chemical change, to dissolve raw materials, products or waste materials, or is used as a cleaning agent to dissolve contaminants, or as a dissolver, or as a dispersion medium, or as a viscosity adjuster, or as a surface tension adjuster, or a plasticiser, or as a preservative". VOCs are defined as follows: "Volatile organic compound shall mean any organic compound having at 293.15 K a vapour pressure of 0.01 kPa or more, or having a corresponding volatility under the particular condition of use".

Import figures of chemicals and chemical containing products are obtained from Statistics Greenland. There is no production or export of chemicals and chemical containing products, therefore the import amount is assumed to be equivalent to the used amount.

5.3.2 Emission factors

For some chemicals the emission factors are precise but for others they are rough estimates. In the Danish inventory emission factors are divided into four categories: 1) chemical industry (lowest EF), 2) other industry, 3) non-industrial activities, 4) domestic and other diffuse use (highest EF). This implies that high emission factors are applicable for use of solvent containing products and lower emission factors are applicable for use in industrial processes

The emission factors used in the Greenlandic inventory are the same as developed for the Danish inventory please refer to chapter 5. For the chemicals assumed to be used for industrial purposes the mean value of category 1 and 2 above is used.

5.3.3 Emissions

Table 5.1 and Figure 5.1 show the emissions of chemicals from 1994 to 2008, where the used amounts of single chemicals have been assigned to specific products and CRF categories. Table 5.2 shows the used amounts of chemicals for the same period. Table 5.1 is derived from Table 5.2 by applying emission factors relevant to individual chemicals and production or use activities. Table 5.3 showing the used amount of products is derived from Table 5.2, by assessing the amount of chemicals that is comprised within products belonging to each of the four source categories. The default NMVOC-CO_2 conversion factor of 0.85 * 3.667 = 3.11 is used.

5.4 Uncertainties

A tier 1 uncertainty assessment has been carried out in accordance with the IPCC GPG (IPCC, 2000). The uncertainty has been estimated for all sources included in the reporting for solvent and other product use. The uncertainties for the activity data and emission factors are shown in Table 5.4.

Table 5.4 Uncertainties for activity data and emission factors for solvents.

Subsector	Pollutant	Activity data uncertainty	Emission factor uncertainty
3A Paint application	CO_2	10	15
3B Degreasing and dry cleaning	CO2	10	15
3C Chemical products, manufacturing and processing	CO_2	10	15
3D5 Other	CO_2	10	20

The activity data comes from the import statistics, which is considered to be of high quality, therefore the uncertainty of the activity data has been set to 10 %.

Regarding the emission factor uncertainties, the uncertainty comprises of both the uncertainty of the NMVOC emission factor, and the uncertainty of the conversion factor of NMVOC to CO_2.

The resulting uncertainty for CO_2 is shown in Table 5.5.

Table 5.5 Uncertainties for the emission estimates.

	Uncertainty %	Trend 1990-2008 %	Trend uncertainty %
CO_2	21.8	-17.1	±11.4

5.5 Source specific QA/QC

Time series of activity data and emissions are analysed large inter annual variations is investigated further to ensure the accuracy of the estimates.

5.6 Source specific recalculations and improvements

This is the first year where emissions from solvent and other product use have been included in the Greenlandic emission inventory.

5.7 Source specific planned improvements

It will be investigated whether use of N_2O is occurring in Greenland.

5.8 References

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Directive 1999/13/EC of 11 March 1999 on the limitation of emissions of volatile organic compounds due to the use of organic solvents in certain activities and installations, Brüssel, 1999.

6 Agriculture (CRF sector 4)

The emission of greenhouse gases from agricultural activities includes CH_4 emission from enteric fermentation, CH_4 and N_2O emission from manure management and N_2O emission from agricultural soils. The emissions are reported in CRF Tables 4.A, 4.B and 4.D.

Emission from rice production, burning of agricultural crop residue and burning of savannas does not occur in Greenland and the CRF Tables 4.F, 4.C and 4.E have, consequently, not been completed.

Emission of non-methane volatile organic compounds (NMVOC) from agricultural activities has not been estimated.

6.1 Overview of sector

In CO_2 equivalents, the agricultural sector (without LULUCF) contributes with 2 % of the overall greenhouse gas emission (GHG) in 2008. From 1990 to 2008, the emissions increased from 8.7 Gg CO_2 equivalents to 10.7 Gg CO_2 equivalents, which correspond to an increase of 22 % (Table 6.1). This emission increase has mainly taken place from 2007 to 2008 due to a significant rise in use of synthetic fertiliser.

Table 6.1 Emission of GHG in the agricultural sector 1990-2008

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
					Gg CO_2-eqv.					
CH_4	6.16	6.21	5.58	4.89	5.33	5.72	5.89	6.42	6.16	5.52
N_2O	2.57	2.59	2.34	2.09	2.27	2.40	3.41	2.92	3.82	3.87
Total	8.73	8.80	7.92	6.97	7.60	8.13	9.30	9.34	9.98	9.39
continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
CH_4	5.36	5.46	5.26	5.33	5.60	5.82	5.64	5.77	5.63	
N_2O	3.40	3.52	3.33	3.38	3.61	3.78	3.80	3.29	5.06	
Total	8.76	8.98	8.59	8.72	9.21	9.61	9.44	9.06	10.69	

As showed in Figure 6.1, CH_4 emission contributed with 53 % of the total GHG emission from the agricultural sector in 2008 and N_2O contributed with the remaining 47 % given in CO_2 equivalents. The major part of the emission is related to livestock production, which in Greenland particularly means the production of sheep. A smaller part is related to the reindeer production. Concerning the emission from agricultural soils, the main sources are, use of synthetic fertiliser, nitrogen leaching from leaching and run-off and emission from grassing animals.

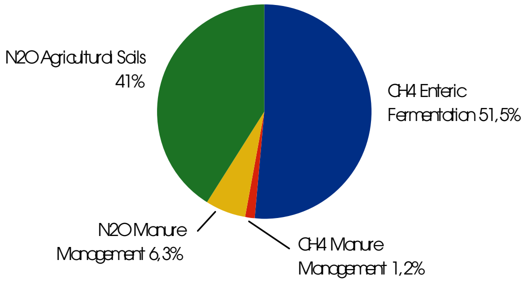

Figure 6.1 Emission of greenhouse gases from agriculture in 2008.

6.2 Source category description

The calculations of the emissions are based on methods described in the IPCC Reference Manual (IPCC, 1997) and the Good Practice Guidance (IPCC, 2000).

Statistic Greenland is responsible for collecting of data, preparation of emission inventory and reporting. Inputs of data are basically obtained from Statistic Greenland and the Greenlandic Agricultural Consulting Services. Data on climate are supplied by the Danish Meteorological Institute (DMI) and Greenland Survey (ASIAQ), and published by Statistics Greenland.

Table 6.2 List of institutes involved in the emission inventory for the agricultural sector.

References	Link	Abbreviation	Data/information
Statistics Greenland	*www.stat.gl*	GST	- reporting
			- data collecting
			- no. of animal
			- feed import
			- use of synthetic fertiliser
			- spring temperature
The Agricultural Consulting Services	*http://nunalerineq.org/*	ACS	- N-excretion
			- milk yield
			- feed consumption and composition
			- stable- and grassing situation
			- animal growth and weight
			- land use
			- crop production
The Danish Plant Directorate	*www.pdir.dk*	PD	- N content in different fertiliser types
The Danish Agricultural Advisory Centre, Aarhus University	*www.lr.dk*	DAAC	- N content in crop residue

6.3 CH_4 emission from Enteric Fermentation (CRF sector 4A)

6.3.1 Description

The major part of the agricultural CH_4 emission originates from digestive processes. In 2008, this source accounts for 51 % of the total GHG emission from agricultural activities. The emission is primarily related to ruminants, which in Greenland means sheep. In 2008 sheep contributed with 90 % and the remaining 10% from reindeer.

6.3.2 Methodological issues

The implied emission factors for all animal categories are based on the Tier 2/Country Specific (CS) approach. Feed consumption and composition for sheep and reindeer is based on data from Statistic Greenland and the Agricultural Consulting Services (ACS), which has information concerning the agricultural conditions in practice. Default values for the methane conversion rate (Y_m) for sheep given by the IPCC are used, as an average of mature sheep and lambs, which mean an Y_m value of 6%.

Gross energy intake (GE)

The gross energy intake for sheep and reindeer is based on feeding plans for sheep from the Agricultural Advisory Service supplemented by data on imported feed. For reindeer information on gross energy intake is based on an article on reindeer management in Greenland.

Table 6.3 Parameters for calculation of emission from enteric fermentation.

Animal Category	Gross Energy (GE)	Methane conversion factor (Y_m)	Emission factor
	MJ pr head pr day		Kg CH_4 pr head pr yr
Sheep	28.4	0.06	11.2
Reindeer	27.5	0.06	10.7

The default CH_4 emission factor for sheep Tier 1 methodology is estimated to 8 kg CH_4 per animal per year. The default GE is given as 20 MJ/head/yr, which is lower than the calculated GE for Greenland, and can explain the lower emission factor. Another reason could be the fact that the national value for feed intake includes lambs. After lambing ewes and lambs are put out to pasture. Thus lambs only feed through their mother and grass. Lambs are not fed separately before slaughter.

There is no default GE for reindeer. However, Norway, Sweden and Finland have estimated gross energy intake for reindeer to 29.6 – 31.6 MJ/head/day. Based on an article on reindeer management in southern Greenland by H.E. Rasmussen in 1992, the Greenlandic gross energy intake for reindeer has been estimated to 27.5 MJ pr head pr day, which is lower than Norway, Sweden and Finland. However, holding in mind that food conditions for reindeer is more scarcely in Greenland compared to conditions in Norway, Sweden and Finland, which have more forest, and that reindeer in Greenland are not fed separately, the estimated of gross energy intake for reindeer in Greenland seems acceptable.

Activity data

Table 6.4 shows the development in livestock from the Statistic Greenland. The number of sheep is varying slightly. The number of reindeer has decreased considerably since 1990. The reindeer livestock decreased significantly in 1999, when one of two reindeer stations closed. Since 1999 there has been only one reindeer station in Greenland.

Table 6.4 Number of animals from 1990-2008.

CRF Table 4.A. 4.B (a) and 4.B (b)	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Sheep	19 929	20 134	17 900	16 256	17 818	19 464	20 163	23 134	19 929	21 007
Reindeer	6 000	6 000	5 600	4 300	4 600	4 600	4 600	3 800	6 000	2 106
continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
Sheep	20 444	20 394	18 967	19 259	20 383	21 317	21 289	21 704	21 080	
Reindeer	2 000	2 480	3 100	3 100	3 100	3 100	2 318	2 441	2 500	

Implied emission factor

The implied emission factor (IEF) could vary across years for sheep and reindeer due to changes in feed consumption. However, no existing data can document a change in feed intake. Therefore the same IEF is used for all years.

6.3.3 Time-series consistency

The emission from enteric fermentation is given in Table 6.5. From 1990 to 2008, the emission has decreased by 9% due to a fall in number of reindeer.

Table 6.5 Emission of CH_4 from Enteric Fermentation 1990 – 2008, tonnes CH_4.

CRF 4.A	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Sheep	222	225	200	181	199	217	225	258	222	234
Reindeer	64	64	60	46	49	49	49	41	64	23
Total, tonnes CH_4	287	289	260	227	248	266	274	299	287	257
Total, tonnes CO_2 eqv.	6 018	6 066	5 452	4 775	5 208	5 594	5 758	6 275	6 018	5 396
continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
Sheep	228	228	212	215	227	238	238	242	235	
Reindeer	21	27	33	33	33	33	25	26	27	
Total, tonnes CH_4	250	254	245	248	261	271	262	268	262	
Total, tonnes CO_2 eqv.	5 240	5 336	5 141	5 209	5 473	5 692	5 510	5 635	5 502	

6.4 CH_4 and N_2O emission from Manure Management (CRF sector 4B)

6.4.1 Description

The emissions of CH_4 and N_2O from manure management are given in CRF Table 4.B (a) and 4.B (b). This source contributes with 7% of the total emission from the agricultural sector in 2008. The major part of the emission originates from the production of sheep.

6.4.2 Methodological issues

CH_4 emission

The IPCC Tier 2/CS methodology has been used for the estimation of the CH_4 emission from manure management. Calculation of volatile solids, VS is based on national value of gross energy intake (GE). Default values is used for the maximum methane producing capacity (B_0), digestibility (DE), the ash content and the methane conversion factor (MCF).

For reindeer no default values exists. Thus DE, ASH and B_o estimates for sheep are used. Sheep and reindeer are similar creatures, both ruminant. Greenlandic reindeer weigh an average of 70 kg. Greenlandic sheep weight approximately 50 kg. However, while sheep are fed relative more intensively, reindeer only feed on what they find in nature all year around. On these arguments the best estimate is to use DE, ASH and B_o estimates for sheep on reindeer as well.

Table 6.6 CH_4 – Manure management – use of national parameters and IPCC default values.

Parameter	Unit	Sheep	Reindeer	Default or national value
Gross energy intake (GE)	MJ pr head pr day	28.4	27.2	National
Digestibility (DE)	Percent	60	60	IPCC default
Ash content (ASH)	Percent	8	8	IPCC default
Volatile solids (VS)	Kg VS pr head pr day	0.57	0.54	National
Max. methane producing capacity (B_0)	M^3 per kg VS	0.19	0.19	IPCC default
CH_4 conversion factor (MCF), solid storage and pasture	Percent	1	1	IPCC default
Emission factor	Kg CH_4 pr head pr yr	0.26	0.25	Tier 2

There are no changes in stable conditions or feed intake during the years 1990 to 2008. The implied emission factor is therefore the same for all years.

The default emission factor for sheep is 0.19 kg CH_4 pr head pr yr. The higher national value is due to a higher estimate for gross energy intake.

Table 6.7 shows a decrease in the CH_4 emission from manure management from 1990 to 2008 by 9 %, which chiefly is related to the fall in the production of reindeer.

Table 6.7 Emission of CH_4 from Manure Management 1990-2008, tonnes CH_4.

CRF 4.A	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Sheep	5.2	5.2	4.7	4.2	4.6	5.1	5.2	6.0	5.2	5.5
Reindeer	1.5	1.5	1.4	1.1	1.2	1.2	1.2	1.0	1.5	0.5
Total, tonnes CH_4	6.7	6.7	6.1	5.3	5.8	6.2	6.4	7.0	6.7	6.0
continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
Sheep	5.3	5.3	4.9	5.0	5.3	5.5	5.5	5.6	5.5	
Reindeer	0.5	0.6	0.8	0.8	0.8	0.8	0.6	0.6	0.6	
Total, tonnes CH_4	5.8	5.9	5.7	5.8	6.1	6.3	6.1	6.3	6.1	

N_2O emission

Based on information from the Agricultural Advisory Service it is estimated that for sheep 55% of the N-excretion is taken place in stable and all manure is handling as solid manure. The IPCC default emission value is applied, which mean 2.0 % of the N-excretion for solid manure.

Reindeer is grassing all year. The emission from manure deposits on grass is included in "Animal Production" (Section 6.4.2.2).

The total nitrogen excretion for sheep has increased by 5% from 1990 to 2008 (Table 6.8) due to a small growth of sheep production.

Table 6.8 Total nitrogen excretion for sheep, 1990 – 2008, tonnes N.

CRF table 4.B(b)	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Livestock category										
N-excreted, tonnes in total	120	121	107	98	107	117	121	139	120	126
N-excretion, tonnes in stable	66	66	59	54	59	64	67	76	66	69
continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
Livestock category										
N-excreted, tonnes in total	123	122	114	116	122	128	128	130	126	
N-excretion, tonnes in stable	67	67	63	64	67	70	70	72	70	

6.4.3 Time-series consistency

As shown in Table 6.9 total emission from manure management from 1990 to 2008 in CO_2 equivalents has increased by 3 % due to increase in number of sheep.

Table 6.9 Emissions of N_2O and CH_4 from Manure Management 1990-2008.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
N_2O emission, tonnes CO_2 eqv.	641	647	576	523	573	626	648	744	641	675
CH_4 emission, tonnes CO_2 eqv.	140	141	127	111	121	130	134	146	140	126
Total, tonnes CO_2 eqv.	781	789	703	634	694	756	783	890	781	801
continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
N_2O emission, tonnes CO_2 eqv.	657	656	610	619	655	685	684	698	678	
CH_4 emission, tonnes CO_2 eqv.	122	124	120	121	128	133	128	131	128	
Total, tonnes CO_2 eqv.	779	780	730	741	783	818	813	829	806	

6.5 N_2O emission from Agricultural Soils (CRF sector 4D)

6.5.1 Description

The N_2O emissions from agricultural soils CRF Table 4.D contribute in 2008 with 41% of the national emission from the agricultural sector. Figure 6.2 shows the overall development from 1990 to 2008 and the distribution on different sources. The total emission has more than doubled from 1990 to 2008, which is a result of an increasing use of synthetic fertiliser.

Emission from synthetic fertiliser and nitrogen leaching is an essential part of the total emission from agricultural soils and contributes totally with 73%. Of the remaining sources the greatest part of the emission, by 15%, origins from animal on pasture. Emissions from all sources have increased from 1990 to 2008 except from grassing animal where a fall in number of reindeer has taken place.

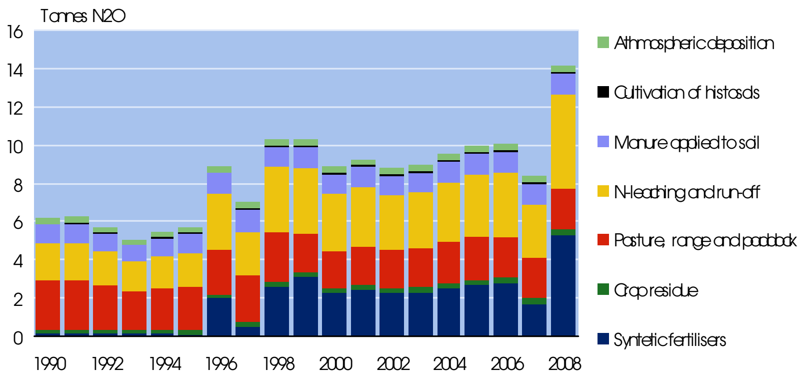

Figure 6.2 N_2O emissions from agricultural soils 1990-2008.

6.5.2 Methodological issues

To calculate the N_2O emission a combination of IPCC Tier 1a and Tier 1b is used. Tier 1b is use in calculation of emission from crops residue. Emissions of N_2O are closely related to the nitrogen balance. Data concerning the N-excretion, evaporation of ammonia from synthetic fertiliser and grassing animal are based on national values.

The NH_3 and N_2O emission factor survey is presented in Table 6.10 and shows that except from histosols all N_2O emission factor is based on IPCC default values. The estimated emissions from the different subsources are described in the text which follows.

Table 6.10 Emissions factor - N_2O emission from the Agricultural Soils 1990 – 2008.

Agricultural soils – emission sources CRF Table 4.D	Ammonia emission factor	N_2O emission factor (country specific value)	N_2O emission factor (IPCC default value)
	Kg NH_3-N pr kg N	kg N_2O-N pr ha	kg N_2O -N pr kg N
1. Direct Soil Emissions			
Synthetic Fertiliser Applied to Soils	0.01 (CS)		0.0125
Animal Wastes Applied to Soils	0.20 (IPCC default)		0.0125
N-fixing Crops			0.0125
Crop Residue			0.0125
Cultivation of Histosols		0.2	
2. Animal Production	0.07 (CS)		0.02
3. Indirect Soil Emissions			
Atmospheric Deposition			0.01
Nitrogen Leaching and Runoff			0.025

CS = country specific value

Direct emissions

Synthetic fertiliser

The calculation of nitrogen (N) applied to soil from use of synthetic fertiliser is based on data on imports from the Statistic Greenland. No data is available before 1994. The consumption for 1990 to 1993 is assumed to be on the same level as 1994. The nitrogen content for each fertiliser type is estimated based on expert judgement from the Danish Plant Directorate (Troels Knudsen, pers. comm.).

Table 6.11 shows the consumption of each type of fertiliser. Furthermore, the ammonia emission factor for each fertiliser is given, based on the values given in EMEP/EEA emission inventory guide book 2009 (Table 3-2). The emission factors are depending on the mean spring temperature estimated to 7 degrees in Greenland. The spring temperature has to reflect the time where the fertilisers are applied, which in Greenland normally takes place in June.

Table 6.11 Synthetic fertiliser consumption 2008 and the NH_3 emission factors.

Synthetic fertiliser year 2008	Calculation of ammonia emission factor (ts=mean spring temperature=7 degree)[1]	NH_3 Emission factor[1] kg NH_3-N pr kg N	Consumption[2] t N
Fertiliser type			
Ammonium sulphate	=0.0107+0.0006*ts	1.49	NO
Ammonium nitrate	=0.008+0.0001*ts	0.87	153
Calcium ammonium nitrate	=0.008+0.0001*ts	0.87	0
Anhydrous ammonia	=0.0127+0.0012*ts	2.11	NO
Urea	=0.1067+0.0035*ts	13.12	0
Nitrogen solutions	=0.0481+0.0025*ts	6.56	NO
Ammonium phosphates	=0.0107+0.0006*ts	1.49	NO
Other NK and NPK	=0.008+0.0001*ts	0.87	120
Total consumption of N in synthetic fertiliser			273
National emission of NH_3-N, tonnes	2.4		
Average NH_3-N emission (FracGASF)	0.01		

[1]) EMEP/EEA (2009).

[2]) Statistics Greenland and the Danish Plant Directorate

The Greenlandic value for the FracGASF is estimated to less than 0.01 in 2008, which is considerably lower than the recommended default value in IPCC, i.e. 0.10. The major part of the fertiliser types used in Greenland is related to ammonia nitrate and NPK fertiliser where the emission factor is quite low, i.e. 0.0087 kg NH_3-N pr kg N. Before 1995 urea accounted for a higher fraction. The value of FracGASF for these years is estimated to 0.10-0.13.

Table 6.12 FracGASF, 1990-2008.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
FracGASM	0.13	0.13	0.13	0.13	0.13	0.10	0.02	0.03	0.01	0.01
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
FracGASM	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01	

Table 6.13 shows an over time increase in use of fertiliser and a particularly high increase in 2008. Due to a relatively small number of farms the individual handling of one farmer has a high effect on the total consumptions. With consumption of fertilisers being based on imports of fertilisers it is not possible to account for fertilisers bought for stockpiling. Thus it is possible that the relative high increase in use of fertilisers in 2008 is due to stockpiling. Another explanation could be that both 2007 and 2008 were relative dry years leading to a considerable decrease in amount of hey harvested. Hence, it is possible that farmers have tended to increase the use of fertilisers in 2008 to produce more feed.

Table 6.13 Nitrogen applied as fertiliser to agricultural soils 1990-2008.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
N content in synthetic fertiliser, tonnes N	9	9	9	9	9	6	102	28	135	158
NH_3-N emission, tonnes	1	1	1	1	1	1	2	1	1	1
N in fertiliser applied on soil, tonnes N	8	8	8	8	8	6	100	27	134	157
N_2O emission, tonnes	0.16	0.16	0.16	0.16	0.16	0.11	1.97	0.53	2.63	3.08
continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
N content in synthetic fertiliser, tonnes N	117	126	114	117	128	136	144	86	273	
NH_3-N emission, tonnes	1	1	1	1	1	1	1	1	2	
N in fertiliser applied on soil, tonnes N	116	125	113	116	127	135	142	85	271	
N_2O emission, tonnes	2.28	2.45	2.22	2.27	2.49	2.65	2.80	1.67	5.32	

Manure applied to soil

The amount of nitrogen applied to soil from sheep on stables is estimated as the N-excretion in stables minus the ammonia emission, which occur in stables, under storage and in relation to the application of manure. There are no measurements of ammonia emission from stables in Greenland. Thus IPCC default is used. However, the FracGASM default at 0.20 (IPCC 1997. Table 4-19) match the Danish emission ammonia from sheep, which are estimated to 24% in 1990 reduced to 19% in 2008. A lower ammonia emission in Greenland is expected due to the cold climate, but on the other hand no ammonia reducing measures are implemented as in Denmark. The FracGASM at 0.20 are therefore considered as reliable.

Table 6.14 shows the development in nitrogen excretion in stables, the estimated amount of N applied on soil and the N_2O emission.

Table 6.14 Nitrogen applied as manure to agricultural soils 1990-2008.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
N-excretion in stable, tonnes N	66	66	59	54	59	64	67	76	66	69
NH_3-N emission, tonnes N	13	13	12	11	12	13	13	15	13	14
N in manure applied on soil, tonnes N	53	53	47	43	47	51	53	61	53	55
N_2O emission, tonnes N_2O	1.03	1.04	0.93	0.84	0.92	1.01	1.05	1.20	1.03	1.09
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
N-excretion in stable, tonnes N	67	67	63	64	67	70	70	72	70	
NH_3-N emission, tonnes N	13	13	13	13	13	14	14	14	14	
N in manure applied on soil, tonnes N	54	54	50	51	54	56	56	57	56	
N_2O emission, tonnes N_2O	1.06	1.06	0.98	1.00	1.06	1.11	1.10	1.13	1.09	

Crop residue

The cultivated area is approximately 1.000 ha with the main part as grass fields, only 5 ha from 2001 are used for potato production. To estimate the emission from crop residue, IPCC Tier 1b has been applied. N_2O emissions from crop residues are calculated based on the total above-ground N-content in crop residue returned to soil, which in Greenland includes residue of leafs from grass fields and the top from potatoes.

National values for nitrogen content are used provided by the Faculty of Agricultural Sciences, Aarhus University (Djurhuus and Hansen, 2003).

It is calculated based on relatively few observations related to Danish conditions, but is at present the best available data.

Table 6.15 N-content in crops residue.

	Stubble	Husks	Top	Leafs	Frequency of ploughing	Nitrogen content in crop residue	
Crop type	kg N pr ha	kg N pr ha	kg N pr ha	kg N pr ha	No. of year before ploughing	kg N pr ha pr yr	kg N pr yr
Potatoes (top), non-harvest	-	-	48.7	-	1	48.7	16 378
Grass- and clover field in rotation	32.3		-	10.0	5	16.5	244
Total N from crop residue – 2008, kg							16 622

Reference: Djurhuus and Hansen 2003

To calculate the N_2O emission the IPCC standard emission factor 1.25% is used. The national emission from crop residues has more than doubled from 1990 to 2008 (Table 6.16) as a result of increasing agricultural area.

Table 6.16 Emissions from crop residue 1990-2008.

Crop residue	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Grass stub/leaves, kg N	8 071	8 498	8 925	9 352	9 778	10 205	10 632	11 059	11 486	11 912
Potato tops, kg N	0	0	0	0	0	0	0	0	0	0
Crop residue total, kg N	8 071	8 498	8 925	9 352	9 778	10 205	10 632	11 059	11 486	11 912
N_2O emission, kg	159	167	175	184	192	200	209	217	226	234
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
Grass stub/leaves, kg N	12 339	12 766	14 005	14 384	14 614	15 176	15 823	16 018	16 378	
Potato tops, kg N	0	244	244	244	244	244	244	244	244	
Crop residue total, kg N	12 339	13 010	14 249	14 628	14 857	15 420	16 066	16 262	16 621	
N_2O emission, kg	242	256	280	287	292	303	316	319	326	

Frac vaules

There is no cultivation of nitrogen fixing crops, why the Fraction value $Frac_{NCRBF}$ is not relevant. Until national data is available, the default value of $Frac_{NCRO}$ by 0.015 is used. The default value of $Frac_R$ is not current for the Greenlandic conditions, where the main part of the above-ground biomass is harvest and used for ensilage. Until national data is available, the $Frac_R$ is registered as "Not Estimated".

Cultivation of histosols

N_2O emissions from histosols are based on the area with organic soils multiplied by the emission factor for C. the C:N relationship for the organic matter in the histosols and an emission factor of 1.25 of the total amount of released N. See chapter 7 on LULUCF for further description on cultivation of histosols.

Table 6.17 shows an increase in the N_2O emission from 1990 to 2008 due to extend of the agricultural area.

Table 6.17 Activity data and emission from cultivation of histosols.

CRF – Table 4.D	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Cultivated histosols, ha	123	129	136	142	149	155	161	168	174	181
N_2O emission, kg	40	42	44	46	49	51	53	55	57	59
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
Cultivated histosols, ha	187	195	214	220	223	232	242	245	250	
N_2O emission, kg	61	72	78	80	81	84	87	88	90	

Pasture, Range and Paddock

The amount of nitrogen deposited on grass includes grassing from reindeer 365 days a year and from sheep 164 days a year. An ammonia emission factor of 7 % is used for all animal categories based on investigations from the Netherlands and the United Kingdom (Jarvis et al., 1989a. Jarvis et al., 1989b; Bussink, 1994). EMEP/EEA emission inventory guidebook 2009 use a similar emission factor at 6 % for grassing dairy cattle (calculated from 4B, Appendix B).

Table 6.18 shows the estimated values of N-excretion from grassing animals, ammonia emission, the N_2O emission and the FracGRAZ value. As a consequence of all in number of reindeer, both the N_2O emission and the FracGRAZ value have decreased from 1990 to 2008.

Table 6.18 Emission from grassing animals 1990-2008.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
N-excretion on grass, tonnes N	88	89	81	69	75	79	81	84	88	69
NH_3-N emission, tonnes	6	6	6	5	5	6	6	6	6	5
N deposited on grass, tonnes N	82	83	75	64	69	73	75	78	82	64
N_2O emission, tonnes	2.58	2.60	2.35	2.01	2.18	2.31	2.36	2.46	2.58	2.01
FracGRAZ	0.57	0.57	0.58	0.56	0.56	0.55	0.55	0.52	0.57	0.50
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
N-excretion on grass, tonnes N	67	69	69	70	73	75	71	73	71	
NH_3-N emission, tonnes	5	5	5	5	5	5	5	5	5	
N deposited on grass, tonnes N	62	64	64	65	68	70	66	68	66	
N_2O emission, tonnes	1.95	2.03	2.02	2.04	2.13	2.20	2.07	2.12	2.08	
FracGRAZ	0.50	0.51	0.52	0.52	0.52	0.52	0.50	0.50	0.51	

Indirect emissions

Atmospheric deposition

Atmospheric deposition includes ammonia emission from manure management, use of synthetic fertiliser and from grassing animals

The N_2O emission from atmospheric deposition is nearly unaltered from 1990 to 2008. The fall in the reindeer production compensate for increase in number of sheep and a rise in use of synthetic fertiliser.

Table 6.19 Emission from atmospheric deposition 1990-2008.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
NH_3-N manure management, tonnes	13	13	12	11	12	13	13	15	13	14
NH_3-N synthetic fertliser, tonnes	1	1	1	1	1	1	2	1	1	1
NH_3-N pasture, tonnes	6	6	6	5	5	6	6	6	6	5
NH_3-N total, tonnes	21	21	19	17	18	19	21	22	21	20
N_2O emission, tonnes	0.32	0.33	0.29	0.26	0.29	0.30	0.33	0.34	0.32	0.32
continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
NH_3-N manure management, tonnes	13	13	13	13	13	14	14	14	14	
NH_3-N synthetic fertliser, tonnes	1	1	1	1	1	1	1	1	2	
NH_3-N pasture, tonnes	5	5	5	5	5	5	5	5	5	
NH_3-N total, tonnes	19	19	18	19	20	21	20	21	21	
N_2O emission, tonnes	0.30	0.30	0.29	0.29	0.31	0.32	0.32	0.33	0.33	

Nitrogen leaching and Run-off

The amount of nitrogen lost by leaching and run-off is calculated by using the IPCC default FracLEACH at 0.3 (IPCC 1997, Table 4-24).

The emission from 1990 to 2008 has more than doubled. The total nitrogen content in manure has decreased due to a fall in the reindeer production. The increasing is due to a significant rise in use of synthetic fertiliser.

Table 6.20 Emission from N-leaching and runoff 1990-2008.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
N-excretion total, tonnes N	154	155	140	122	133	143	147	161	154	138
N in synthetic fertiliser, tonnes	9	9	9	9	9	6	102	28	135	158
N_2O emission, tonnes	1.92	1.94	1.75	1.55	1.68	1.76	2.94	2.22	3.41	3.50
continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
N-excretion total, tonnes N	134	137	132	133	140	146	141	144	141	
N in synthetic fertiliser, tonnes	117	126	114	117	128	136	144	86	273	
N_2O emission, tonnes	2.96	3.09	2.89	2.95	3.16	3.32	3.36	2.72	4.88	

6.5.3 Activity data

Table 6.21 provides an overview on activity data from 1990 to 2008 used to the estimation of N_2O emission from agricultural soils. For all emission sources the unit tonnes of nitrogen is used except from cultivation of histosols, where the unit are given as hectare.

Table 6.21 Activity data - agricultural soils 1990-2008, tonnes N (cultivation of histosols = ha)

CRF – Table 4.D	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1. Direct Emissions										
Synthetic Fertiliser	8	8	8	8	8	6	100	27	134	157
Animal Manure Applied to Soils	53	53	47	43	47	51	53	61	53	55
Crop Residue	8	8	9	9	10	10	11	11	11	12
Cultivation of histosols	123	129	136	142	149	155	161	168	174	181
2. Pasture, Range and Paddock Manure	82	83	75	64	69	73	75	78	82	64
3. Indirect Emissions										
Atmospheric Deposition	21	21	19	17	18	19	21	22	21	20
Nitrogen Leaching and Run-off	49	49	45	39	43	45	75	56	87	89
continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
1. Direct Emissions										
Synthetic Fertiliser	116	125	113	116	127	135	142	85	271	
Animal Manure Applied to Soils	54	54	50	51	54	56	56	57	56	
Crop Residue	12	13	14	15	15	15	16	16	17	
Cultivation of histosols	187	195	214	220	223	232	242	245	250	
2. Pasture, Range and Paddock Manure	62	64	64	65	68	70	66	68	66	
3. Indirect Emissions										
Atmospheric Deposition	19	19	18	19	20	21	20	21	21	
Nitrogen Leaching and Run-off	75	79	74	75	80	85	85	69	124	

6.5.4 Time-series consistency

The N_2O emissions from agricultural soils have increased from 6.2 tonnes N_2O in 1990 to 14.1 tonnes N_2O in 2008. The more than doubled emission is a consequence of a significant increase in use of nitrogen in synthetic fertiliser.

Table 6.22 Emissions of N_2O from Agricultural Soils 1990 – 2008, tonnes N_2O.

CRF – Table 4.D	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Total N_2O emission	6.22	6.27	5.71	5.05	5.47	5.74	8.91	7.03	10.26	10.29
1. Direct Emissions										
Synthetic Fertiliser	0.16	0.16	0.16	0.16	0.16	0.11	1.97	0.53	2.63	3.08
Animal Manure Applied on Soil	1.03	1.04	0.93	0.84	0.92	1.01	1.05	1.20	1.03	1.09
Crop Residue	0.16	0.17	0.18	0.18	0.19	0.20	0.21	0.22	0.23	0.23
Cultivation of Histosols	0.04	0.04	0.04	0.05	0.05	0.05	0.05	0.05	0.06	0.06
2. Pasture, Range and Paddock Manure	2.58	2.60	2.35	2.01	2.18	2.31	2.36	2.46	2.58	2.01
3. Indirect Emissions										
Atmospheric Deposition	0.32	0.33	0.29	0.26	0.29	0.30	0.33	0.34	0.32	0.32
Nitrogen Leaching and Run-off	1.92	1.94	1.75	1.55	1.68	1.76	2.94	2.22	3.41	3.50
continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
Total N_2O emission	8.85	9.25	8.76	8.92	9.52	9.99	10.05	8.37	14.13	
1. Direct Emissions										
Synthetic Fertiliser	2.28	2.45	2.22	2.27	2.49	2.65	2.80	1.67	5.32	
Animal Manure Applied on Soil	1.06	1.06	0.98	1.00	1.06	1.11	1.10	1.13	1.09	
Crop Residue	0.24	0.26	0.28	0.29	0.29	0.30	0.32	0.32	0.33	
Cultivation of Histosols	0.06	0.07	0.08	0.08	0.08	0.08	0.09	0.09	0.09	
2. Pasture, Range and Paddock Manure	1.95	2.03	2.02	2.04	2.13	2.20	2.07	2.12	2.08	
3. Indirect Emissions										
Atmospheric Deposition	0.30	0.30	0.29	0.29	0.31	0.32	0.32	0.33	0.33	
Nitrogen Leaching and Run-off	2.96	3.09	2.89	2.95	3.16	3.32	3.36	2.72	4.88	

6.6 Uncertainties

A tier 1 uncertainty assessment has been carried out in accordance with the IPCC GPG (IPCC, 2000). The uncertainty has been estimated for all sources included in the reporting for agricultural sector. The uncertainties for the activity data and emission factors are shown in Table 6.23.

Table 6.23 Uncertainties for activity data and emission factors for agriculture.

Subsector	Pollutant	Activity data uncertainty	Emission factor uncertainty
4A Enteric Fermentation	CH_4	10	100
4B Manure Management	CH_4	10	100
4B Manure Management	N_2O	10	100
4D1 Direct N2O emissions from agriculturalsoils	N_2O	20	50
4D2 Pasture range and paddock	N_2O	20	25
4D3 Indirect N2O emissions from agricultural soils	N_2O	20	50

The resulting uncertainties for the individual greenhouse gases and the total uncertainty on the greenhouse gas emission are shown in Table 6.24.

Table 6.24 Uncertainties for the emission estimates.

	Uncertainty %	Trend 1990-2008 %	Trend uncertainty %
GHG	54	22.5	±27
CH_4	98	-8.6	±13
N_2O	32	96.9	±46

6.7 Source specific QA/QC

The elaboration of a formal QA/QC plan is to be completed.

However, data on livestock, land-use categories, synthetic fertilisers and cultivation of histosols has gone through a great deal of quality work with regard to accuracy, comparability and completeness.

All external data used for the emission inventory submission are archived in spreadsheets. Data are archived annually in order to ensure that the basic data for a given report are always available in their original form.

Annual data on livestock, land-use categories, synthetic fertilisers and cultivation of histosols are compared with previous years and large discrepancies are checked.

Safely stored and quality checked activity data are then processes by using a methodological approach consistent with international guidelines.

Calculated emission factors are compared with guideline emission factors to ensure that they are reasonable. The calculations follow the principle in international guidelines.

During data processing, it is checked that calculations are being carried out correctly. However, a documentation plan for this needs to be elaborated.

Time-series for activity data, emission factors and calculated emissions are used to identify possible errors in the calculation procedure. In fact, during the calculation, numerous controls take place to ensure correctness. Sums are checked of the various stages in the calculation procedure. Implied emission factors are compared to emission factors.

Every single time-series imported to the CRF Reporter is checked for annual activity, units for activity, emission factor and emissions. Additional checks are performed on the database. The database encloses every single activity data, emission factors, emission, notation key and comment imported to the CRF Reporter. In other words, no information is typed manually into the CRF Reporter. Instead, all information is imported to the CRF Reporter through XML-files to ensure maximum accuracy and completeness.

6.8 Source specific recalculations and improvements

The sector *Agricultural Soils* (4D) includes, for the first time, emission from use of synthetic fertilisers and cultivation of histosols.

Since the 2009 emission inventory submission, an adjustment of the applied emission factors for enteric fermentation and manure management for sheep and reindeer has been provided. Previously default IPCC factors were used. According to a survey on the feeding of sheep and reindeer energy intake a set of country specific emission factors have been calculated. The adjustments include the years 1990-2007.

Table 6.25 shows recalculations in the agricultural sector compared with the 2009 submission. The improvements and recalculations have decreased the agricultural emission by 20-30 %, which is primarily due to the change from default factors to country specific factors on CH4 emission from fermentation, manure management, and nitrogen excretion, see sections 6.3.2 and 6.4.2.

Table 6.25 Changes in GHG emission in the agricultural sector compared with the 2009 submission.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Previous inventory, Gg CO_2 eqv.	12.4	12.5	11.2	9.9	10.8	11.7	12.1	13.4	12.4	11.8
Recalculated, Gg CO_2 eqv.	8.7	8.8	7.9	7.0	7.6	8.1	9.3	9.3	10.0	9.4
Change in Gg CO_2 eqv.	-3.7	-3.7	-3.3	-2.9	-3.2	-3.6	-2.8	-4.1	-2.4	-2.4
Change in pct.	-29.5	-29.5	-29.1	-29.7	-29.9	-30.6	-23.0	-30.4	-19.4	-20.4
continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
Previous inventory, Gg CO_2 eqv.	11.5	11.6	11.0	11.2	11.8	12.2	12.0	12.3	-	
Recalculated, Gg CO_2 eqv.	8.8	9.0	8.6	8.7	9.2	9.6	9.4	9.1	10.7	
Change in Gg CO_2 eqv.	-2.7	-2.6	-2.4	-2.4	-2.5	-2.6	-2.6	-3.2	-	
Change in pct.	-23.5	-22.4	-22.0	-21.9	-21.7	-21.6	-21.4	-26.1	-	

6.9 Source specific planned improvements

The Greenlandic emission inventory for the agricultural sector largely meets the request as set down in the IPCC Good Practice Guidance. Thus for the moment improvements especially concern the QA/QC practice.

6.10 References

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7 LULUCF (CRF sector 5)

7.1 Overview of LULUCF

This LULUCF chapter covers only the territory of Greenland. Greenland is part of the Kingdom of Denmark.

Figure 7.1 Municipalities and major cities in Greenland.

Greenland is the world's largest non-continental island on the northern American continent between the Arctic Ocean and the North Atlantic Ocean, northeast of Canada. The northernmost point of Greenland, Cape Morris Jesup, is only 740 km from then North Pole. The southernmost point is Cape Farewell, which lies at about the same latitude as Oslo in Norway. Geographical coordinates are 72 00 N, 40 00 W.

Greenland is covering app. 2,166,086 km^2. It has been estimated that 81 % is covered permanently with ice leaving only 410,449 km^2 ice free. The distance from the South to the North is 2,670 km, and from East to West 1,050 km.

The Terrain is flat to gradually sloping ice cap which covers all but a narrow, mountainous, barren, rocky coast. The ice cap is up to 3 km thick, and contains 10 percent of the world's resources of freshwater.

The climate is Arctic to sub arctic with cool winters and cold summers in which the mean temperature does not exceed 10° C.

The mean temperature in January is for Nuuk, -8.6°, Kangerlussuaq, -17.0° and Ilulissat -9.6° (2007) and for July: Nuuk 7.7°, Kangerlussuaq 11.5° and Ilulissat 9.6° (2007).

Greenland is normally defined as having three different climatic zones. For the purpose of reporting is used the definition "Polar and Moist" according to IPCC GPG 2006 although some areas may qualify as artic deserts.

The sparse population is confined to small settlements along the coast, but close to one-quarter of the population lives in the capital, Nuuk. The total population in January 2009 were 56,194 inhabitants.

Due to the cold climate and the small constant population there is almost no land use change occurring. The total area with Forests has been estimated to 218.5 hectares and 5 hectares with Cropland. Grassland is divided into improved Grassland covering 995 hectares and unimproved Grassland covering 241,000 hectares. Wetlands consist of man made water reservoirs – in total 1,076 hectares. Settlements cover 5,105 hectares. Land classified as "Other Land" is then 99.9 % of the total area.

In the following text the abbreviations is used in accordance with definitions in the IPCC guidelines:

A:	Afforestation, areas with forest established after 1990 under article 3.3
R:	Reforestation, areas which have temporarily been unstocked for less than 10 years - included under article 3.4
D:	Deforestation, areas where forests are permanently removed to allow for other land use, included under article 3.3
FF:	Forest remaining Forest, areas remaining forest after 1990
FL:	Forest Land meeting the definition of forests
CL:	Cropland
GL:	Grassland
SE:	Settlements
OL:	Other land, unclassified land
FM:	Forest Management, areas managed under article 3.4
CM:	Cropland Management, areas managed under article 3.4
GM:	Grazing land Management, areas managed under article 3.4

The LULUCF sector differs from the other sectors in that it contains both sources and sinks of carbon dioxide. LULUCF are reported in the new CRF format. Removals are given as negative figures and emissions are reported as positive figures according to the guidelines.

In total the LULUCF sector has been estimated as a net sink of -0.06 Gg CO_2-eqv. in 2008 or less than 0.01 % of the total Greenlandic emission.

The overall land use change from 1990 to 2008 is very small. Afforestation has been made on 14 hectares. No deforestation has occurred and the Cropland area has increased from none to 5 hectares.

The emission data are reported in the new CRF format under IPCC categories 5A (Forestry), 5B (Cropland), 5C (Grassland), 5D (Wetlands) and 5E (Settlements) and 5F (Other Land).

Fertilisation of forests and other land is negligible and all fertiliser consumption is therefore reported in the agricultural sector. No drainage of forest soils is made. All liming is reported under Grassland because liming is not occurring in the forests and the very small area with Cropland. Field burning of wooden biomass is not occurring. Wildfires may occur sporadic in the mountains which are reported as “Other land”. Hence wildfires is reported as NO.

Table 7.1 gives an overview of the emission from the LULUCF sector in Greenland. The Forests are a net sink. Cropland is ranging from being zero in 1990 (no Cropland were occurring in 1990) to be a net source in 2008. GL has been estimated to be a net sink due to the increased area with living biomass.

Table 7.1 Overall emission (Gg CO_2) from the LULUCF sector in Greenland, 1990-2008.

Greenhouse gas source and sink categories	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
5. Land Use, Land-Use Change and Forestry, CO_2	**-0.47**	**-0.44**	**-0.44**	**-0.45**	**-0.46**	**-0.47**	**-0.47**	**-0.48**	**-0.49**	**-0.50**
A. Forest Land	NA	-0.01	-0.01	-0.01	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
B. Cropland	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO
C. Grassland	-0.47	-0.42	-0.43	-0.44	-0.44	-0.45	-0.45	-0.46	-0.47	-0.47
D. Wetlands	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
E. Settlements	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
F. Other Land	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5. Land Use, Land-Use Change and Forestry, N_2O	0.05	0.04	0.04	0.03	0.04	0.03	0.04	0.03	0.03	0.05
A. Forest Land	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**
B. Cropland	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C. Grassland	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
D. Wetlands	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
E. Settlements	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE
F. Other Land	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5. Land Use, Land-Use Change and Forestry, CO_2-eqv. CO_2 and N_2O	-0.47	-0.44	-0.44	-0.45	-0.46	-0.47	-0.47	-0.48	-0.49	-0.50

Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008
5. Land Use, Land-Use Change and Forestry, CO_2	**-0.50**	**-0.55**	**-1.15**	**-0.53**	**-0.42**	**-0.68**	**-0.75**	**-0.42**	**-0.55**
A. Forest Land	-0.03	-0.03	-0.03	-0.03	-0.04	-0.04	-0.04	-0.04	-0.05
B. Cropland	IE,NA,NO	-0.07	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
C. Grassland	-0.48	-0.45	-1.10	-0.47	-0.36	-0.62	-0.69	-0.36	-0.48
D. Wetlands	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
E. Settlements	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
F. Other Land	NA	NA	NA	NA	NA	NA	NA	NA	NA
5. Land Use, Land-Use Change and Forestry, N_2O	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**
A. Forest Land	NA	NA	NA	NA	NA	NA	NA	NA	NA
B. Cropland	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
C. Grassland	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
D. Wetlands	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE
E. Settlements	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
F. Other Land	NA	NA	NA	NA	NA	NA	NA	NA	NA
G. Other	NE	NE	NE	NE	NE	NE	NE	NE	NE
5. Land Use, Land-Use Change and Forestry, CO_2-eqv. CO_2 and N_2O	-0.50	-0.55	-1.15	-0.53	-0.42	-0.68	-0.75	-0.42	-0.55

7.2 Forest remaining forest (5.A.1)

7.2.1 Forests and forest management

Greenland is virtually free from forests and therefore there exist no official forest statistics. All forests are situated in the most southern part of Greenland. In an attempt to introduce trees to Greenland research were carried out to find species adaptable for the Greenlandic climate. This resulted in establishment of the Greenlandic Arboretum which covers 150 hectares out of the total area of 218.5 hectares, Figure 7.2 and Table 7.2. Information about the Greenlandic Arboret can be found at http://www.sl.life.ku.dk/Faciliteter/GroenlandsArboretet.aspx?forside=false&expath=&type=

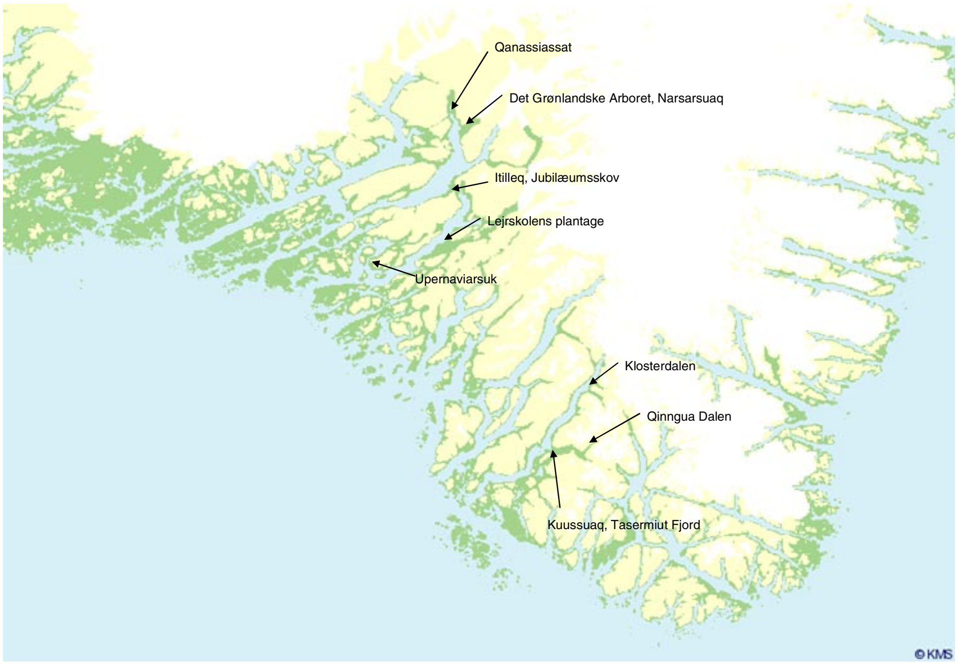

Figure 7.2 The position of the Greenlandic forests (Courtesy to Rasmus Enoksen Christensen).

Table 7.2 Forests in Greenland 1990 and 2008.

Location	Established	Dominant tree	Area	1990 average tree height (m)	2008 average tree height	Density 1990 (trees/ha)	Density 2008
Qinngua Valley	Natural	Birch and mountain ash	45 hectares	n.a	6	100	100
Qanassiassat Forest	1953-63	Conifer	1	5	10	1500	1000
Kuussuaq Forest	1962-64 -1982	Conifer	5	3	9	1300	900
Kuussuaq Forest	2008	Conifer	3	***	< 1	***	3500
Greenland Arboretum	(1976-1980)	Conifer	3	4	7	300	300
Greenland Arboretum	1980 -	Conifer	150	2	3	1500	1700
Itilleq	2004-2005	Conifer	6	***	< 1	***	3500
Upernaviarsuk	1954	Conifer	0,5	1,5	3	200	200
Lejrskolen	1999-2005	Conifer	4	***	1	***	2500
Klosterdalen	2000	Conifer	1	***	1	***	2000
Total			218,5				

Forest definition

The forest definition adopted in Greenland is almost identical to the FAO definition (TBFRA, 2000). It includes "wooded areas larger than 0.5 ha, that are able to form a forest with a height of at least 5 m and crown cover of at least 10 %. The minimum width is 20 m." Temporarily non wooded areas, fire breaks, and other small open areas, that are an integrated part of the forest, are also included. However, due to extreme slow growing rates are many of the forests below 5 meters height at the moment.

Figure 7.3 shows a picture of the best developed forest in Greenland.

Figure 7.3 The forest in Kuusuaq. Photo: Rasmus E. Christensen, 2005

Of special interest is the forest in Qinngua Valley. The Qinngua Valley is situated in a remote area. It consists of natural birch (*Betula pubescens spp. czerepanovii* and *B. glandulosa.)* which develops to forest like trees (Figure 7.3) probably due to an introgressiv hybridisation (Rasmus Enoksen Christensen). This forest will probably not follow the FAO forest definition but are included in the inventory as a sub-division under forests. In the FAO forest statistics are the Qinngua-valley not included.

Figure 7.4 The forest in Qinngua-valley. Photo: Christian Lejon, 2008.

Methodological issues for forests

Estimation of volume, biomass and carbon pools

Due to lack of precise data and slow growth rates, simple functions are used which only include the height of the trees and the number per hectare.

The height of the trees has been estimated by Rasmus Enoksen Christensen based on data from the Aboretum. It is assumed that the trees are conical and the stem diameter at ground level is based on the general formula for even-aged forests (Vanclay, 2009).

$D = \beta(H - 1.3)/\ln(N)$ (eq.1)

Where:

D = diameter at breast height, cm

ß = slope, species dependent

H = Height of the trees (meters)

N = Number of trees per hectare

Eq. 1 has been simplified by omitting the breast height (1.3 meters) to

$D = \beta(H)/\ln(N)$ (eq.2)

so that D is representing the diameter at ground level. The ß-value used is given in table 7.2

Table 7.2   ß-values for estimating the diameter of trees (from Vanclay, 2009).

	Betula, spp	Conifers
ß-values	6.54	7.51

In order to estimate the C stock and C stock change is used the average default values from the IPCC 2006 guidelines for BCEF, density, C-content and Root-Shoot ratio for Boreal stands with a growing stock level of 21-50 m^3, IPCC table 4.5, pp 4.50. The values are given in Table 7.3.

Table 7.3   Biomass expansion factors used for Greenland.

		Qinngua Walley (Betula, spp.) Birch	Conifers	Orpiuteqarfia (Larix sibirica) Sibirian Larch)
BCEF	Dimensionless	0.7	0.66	0.78
Density	kg dry matter per litre	0.51	0.4	0.46
C-content	kg C per kg dry matter	0.48	0.51	0.51
Root-shoot-ratio	Dimensionless	0.39	0.39	0.39
Dead Organic Matter	kg per kg aboveground biomass	0.1	0.2	0.1

Source: IPCC 2006 guidelines.

Dead wood volume, biomass and carbon

The volume of dead organic matter (DOM) is estimated as a fraction of the aboveground biomass (Table 7.3). It is assumed that litter is included in DOM.

Forest soils: forest floors and mineral soil

Following the cold climate and the slow growing rate it is assumed that no changes takes place in C-stock in the soil and hereby following the IPCC 2006 guidelines at Tier 1 level.

Uncertainties and time-series consistency

The uncertainty in estimation of the C stock changes in the Greenlandic forests is very high. As there is very limited resources to visit and monitor the remote areas there is very few data available. The current inventory is therefore based on the best knowledge available. It should also be taken into consideration that the importance of the forest sector in Greenland is marginal as only very little thinning is taking place as well as no deforestation and that the effect on the inventory is almost not measurable.

In the overall uncertainty section for the LULUCF is made a Tier 1 uncertainty analysis.

QA/QC and verification

Focus on the measurements of carbon pools in forest in Greenland will contribute to QA/QC and verification, but at the moment there are no plans to a further monitoring of the Greenlandic forests.

Recalculations and changes made in response to the review process
This is the first time Greenland submit a full inventory. A more thoroughly review of the current available forest data has been made since the last submission and therefore the performed recalculation.

Planned improvements
No improvements are planned.

7.2.2 Land converted to forests

Forest area
See section 1.2.1.1 Information on approaches used for representing land areas and on land-use databases used for the inventory preparation

Forest definition
See section 1.2.1.2 Land-use definitions and the classification systems used and their correspondence to the LULUCF categories (e.g. land use and land-use change matrix)

Methodological issues for land converted to forest
See also section 1.2.1.3

Since 1990 there has been a slightly increase in the forest area of 14 hectares. This has taken place on land converted from “OL”.

Uncertainties and time-series consistency
See section 1.2.1.4 and 1.2.2.6 for recalculation since 1990. For uncertainties, please se chapter 7.13.

QA/QC and verification
No QA/QC plan has been made yet. The afforestated area is known.

Recalculations, including changes made in response to the review process
See section 1.2.1.

Recalculation for 1990 - 2009

As this is the first time a full inventory for Greenland is submitted there is no recalculation.

Planned improvements
No improvements are planned.

7.3 Cropland – 5B

7.3.1 Cropland and cropland management – 5B1

In 1990 there were no cropland occurring in Greenland. Due to the global warming it is now possible to have a few crops which may mature. In 2001 were established the first five hectares with annual crops. These are reported under 5.B.2 (section 1.3.2). A more intensive description of the agriculture in Greenland can be found at
http://nunalerineq.gl/english/landbrug/jord/index-jord.htm

7.3.2 Land converted to cropland – 5B2

In 2001 the first annual crops were grown in Greenland. Approximately five hectares with garden crops were grown. Of this is it assumed that 25 % of the area is on organic soils (pers. comm. with Kenneth Høeg, former chief agricultural advisor in Greenland). The area converted to cropland was improved grassland.

Figure 7.5 Cropland and Grassland in Greenland. Photos from: http://nunalerineq.gl/english/landbrug/landbrug/index-landbrug.htm

The region is generally characterized by a slightly podsol type of soil with a low pH and small amounts of accessible plant nutrients. Larger concentrations of clay occur rarely, but considerable quantities of silt are often observable on the surface. There also occurs a certain amount of brown earth in inland areas.

Methodological issues

Change in carbon stock in living biomass

For land converted to cropland is used a standard default value of 5,000 kg DM (dry matter) per hectare in above- and below-ground (IPCC, 2006).

Change in carbon stock in dead organic matter

No organic matter is reported under CL.

Change in carbon stock in soils

No C stock changes in mineral soils are assumed. The emission in the 25 % organic soils is estimated by using the IPCC 2006 default value for cropland, Table 5.6 pp 5.19 of 5000 kg C per ha per yr.

Uncertainties and time-series consistency

The time-series are complete. For uncertainties, please se chapter 7.13.

Category-specific QA/QC and verification

The number of hectares is provided by the Greenlandic Agricultural Consulting Services. As the agriculture is subsidised in Greenland the figures are very accurate.

Category-specific recalculation

No recalculation has been made.

Category-specific planned improvements

No improvements are planned.

7.4 Grassland – 5C

7.4.1 Grassland remaining grassland – 5C1

Grassland in Greenland is dominated by unimproved grassland where the sheep is grazing. The total area with GL has been estimated to 242,000 hectares. Of these only approximately 1,000 hectare is improved where stones have been removed combined with sowing of more high yielding species, see Figure 7.5.

Since 1990 has the area with improved grassland been extended from 460 hectares to 995 hectares.

Methodological issues for grassland

Grassland is divided into improved and unmanaged Grassland.

Change in carbon stock in living biomass

As more GL becomes improved the amount of living biomass at peak is increased. To estimate the amount of living biomass in improved GL is using the same default value as for Cropland, e.g. 5000 kg DM per hectare, IPCC 2006 default value for cropland, Table 5.9 pp 5.28. For unmanaged Grassland is used a default value of 1700 kg DM per hectare according to IPCC 2006 default, Table 6.4 pp 6.27. No estimates for below-ground biomass are given. For conversion from DM to C is used a default value of 0.5 kg C per kg DM.

Change in carbon stock in dead organic matter

No changes in dead organic matter are estimated as this is not occurring for this category.

Change in carbon stock in soils

No changes in the carbon stock in mineral soils are assumed. For organic soils on improved grassland is used a default EF of 250 kg C per ha per year (IPCC, 2006) default value for grassland, Table 6.3 pp 6.17. For unmanaged grassland is no carbon stock change expected.

Uncertainties and time-series consistency

The time series is complete. For uncertainties, please se chapter 7.13.

Category-specific QA/QC and verification

The number of hectares is provided by the Greenlandic Agricultural Consulting Services. As the agriculture is subsidised in Greenland the figures are very accurate.

Recalculations

No recalculation has been made.

Planned improvements

No improvements are planned.

7.5 Wetlands – 5D

Wetland in Greenland includes only human made water reservoirs and not naturally occurring wetlands. In total is reported 1,076 hectares with ponds and water reservoirs distributed on 48 locations.

No emission estimates from these reservoirs has been made yet.

Uncertainties and time-series consistency
Not estimated.

QA/QC and verification
Not applicable.

Recalculation
Not applicable.

Category-specific planned improvements
No improvements are planned.

7.6 Settlements – 5E

In total there are approximately 56,000 inhabitants in Greenland with about one quarter of the population in the capital, Nuuk.

Table 7.4 Inhabitants and the area occupied with houses, hectares.

	1990	2000	2008
Cities, inhabitants	44,427	45,734	47,139
Small villages, inhabitants	11,131	10,373	9,323
City area, ha	2,964	3,051	3,245
Villages, ha	1,825	1,825	1,825
Settlements, total, ha	4,789	4,876	5,070

The cities are build on the rocky coastline where almost none vegetation occurs. As a consequence estimates for C stock in living biomass and in soil have been made.

The small increase in the area with Settlements since 1990 has taken place on "Other land".

Currently, no official data or measurements of the area of villages and settlements is available. Alternatively, land utilized for villages and settlements have been measured by the use of NunaGIS, which is a digital internet atlas displaying maps over villages and settlements in Greenland available at www.nunagis.gl.

7.7 Other land

The far major part of Greenland is covered with snow or rocks. OL consists therefore of 99.9 % of the total area.

No emission estimates have been made for this area.

The global warming can be seen in Greenland with longer and warmer summers which again increase the amount of living biomass. Especially since the early 1990's there has been changes observed in the environment, e.g. as given in the area with Cropland and Grassland has increased. However, no methodology exists currently to estimate a proper estimate of the amount of living biomass in the large area classified as "Other land".

7.8 Direct N_2O emissions from N fertilization of Forest Land and Other land use – 5(I)

Not occurring.

7.9 Non-CO_2 emissions from drainage of forest soils and wetlands – 5(II)

Not occurring.

7.10 N_2O emissions from disturbance associated with land-use conversion to cropland – 5(III)

Not occurring.

7.11 CO_2 emissions from agricultural lime application – 5(IV)

As part of the agricultural practice liming is taking place on acidic agricultural soils (Kenneth Høeg, personal communation). Currently it is not possible to get a proper estimate of the lime consumption. Therefore a consumption of 10 ton lime and 10 ton dolomite are reported for all years until further information on this item has been obtained.

The amount of C is calculated according to the guidelines with a 90 % purity of lime and 95 % purity for dolomite. It is assumed that all C disappear as CO_2 the same year as the lime is applied.

Planned Improvements

Actual consumption data for lime will probably be available for the next submission.

7.12 Biomass burning – 5(V)

No biomass burning takes place in Greenland, as well as wildfires do not occur due to moist climate.

7.13 Uncertainties

A tier 1 uncertainty assessment has been carried out in accordance with the IPCC GPG (IPCC, 2000). The uncertainty has been estimated for all sources included in the reporting for LULUCF. The uncertainties for the activity data and emission factors are shown in Table 7.4.

Table 7.4 Uncertainties for activity data and emission factors for LULUCF.

Subsector	Pollutant	Activity data uncertainty	Emission factor uncertainty
5A Forest	CO_2	5	50
5B Cropland	CO_2	5	50
5C Grassland	CO_2	5	50

The assumed uncertainties represent expert judgement.

The resulting uncertainties for the individual greenhouse gases and the total uncertainty on the greenhouse gas emission are shown in Table 7.5.

Table 7.5 Uncertainties for the emission estimates.

	Uncertainty %	Trend 1990-2008 %	Trend uncertainty %
CO_2	56	-77	±12.9

References

Vanclay, J.K. 2009: Tree diameter, height and stocking in even-aged forests, Ann. For. Sci. 66. 702 Available online at: EDP Sciences, 2009 www.afs-journal.org DOI: 10.1051/forest/2009063.

Christensen, R.E. 2010: Information on Greenlandic forests. Not published.

8 Waste (CRF sector 6)

8.1 Overview of sector

The waste sector consists of the CRF source category 6.A. Solid Waste Disposal on Land, 6.B. Wastewater Handling, 6.C. Waste Incineration and 6.D. Other.

In 2008 the waste sector accounted for 3.5 % of the total greenhouse gas emissions in Greenland. This corresponded to an emission of 25.4 Gg CO_2 equivalents.

The Greenlandic inventory includes CH_4 emissions from solid waste disposal on land, CH_4 and N_2O from wastewater handling and CO_2, CH_4, N_2O, NO_x, CO, NMVOC and SO_2 from waste incineration. Only emissions from waste incineration without energy recovery are included in the waste sector. Emissions from waste incineration with energy recovery are included in the energy sector. Table 8.1 shows the greenhouse gas emissions from the waste sector.

In Table 8.1, an overview of all the emissions is presented. The emissions are taken from the CRF tables and are presented as rounded figures.

Table 8.1 Emissions for the waste sector, Gg CO_2 equivalents.

		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
6 A. Solid Waste Disposal on Land	CH_4	3.6	3.7	3.8	3.8	3.9	3.9	4.0	4.1	4.1	4.1
6 B. Wastewater Handling	N_2O	15.2	15.2	15.2	15.2	15.2	15.2	15.2	15.2	15.2	15.2
6 C. Waste incineration	CO_2	2.6	2.6	2.6	2.6	2.7	2.7	2.9	3.0	3.4	3.3
6 C. Waste incineration	CH_4	2.3	2.3	2.3	2.3	2.3	2.4	2.3	2.3	2.2	2.1
6 C. Waste incineration	N_2O	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.0
6. Waste	Total	24.7	24.8	24.9	25.0	25.2	25.4	25.6	25.7	26.0	25.7
Continued		2000	2001	2002	2003	2004	2005	2006	2007	2008	
6 A. Solid Waste Disposal on Land	CH_4	4.2	4.1	4.1	4.1	4.1	4.1	4.0	4.0	4.0	
6 B. Wastewater Handling	N_2O	15.2	15.2	15.2	15.2	15.3	15.2	15.3	15.7	16.2	
6 C. Waste incineration	CO_2	3.1	3.1	3.1	3.0	2.9	2.9	2.9	2.9	2.9	
6 C. Waste incineration	CH_4	1.8	1.8	1.7	1.6	1.6	1.6	1.6	1.6	1.6	
6 C. Waste incineration	N_2O	0.9	0.9	0.9	0.8	0.8	0.8	0.8	0.8	0.8	
6. Waste	Total	25.1	25.2	25.1	24.8	24.6	24.6	24.7	25.0	25.4	

The largest source of greenhouse gas emission in 2008 from the waste sector is N_2O emission from wastewater handling (64 %), more specifically from industrial effluents. The other larger sources are CH_4 from solid waste disposal on land (16 %) and CO_2 from waste incineration (11 %).

The total greenhouse gas emission from the waste sector has increased by 2.9 % from 1990 to 2008. Emissions of N_2O from wastewater handling, CH_4 from solid waste disposal on land and CO_2 from waste incineration have been slightly increasing since 1990, while emissions of CH_4 and

N_2O from waste incineration have been deceasing due to a reduction in open burning.

8.2 Solid waste management

Activity data for waste amounts for solid waste management are shown in Table 8.2.

Table 8.2 Waste amounts for solid waste management, tonnes.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
6 A1. Managed Waste Disposal	6 057	6 125	6 168	6 232	6 333	6 428	6 410	6 416	6 148	5 702
6 A2. Unmanaged Waste Disposal	1 361	1 359	1 358	1 360	1 341	1 289	1 217	1 160	1 061	988
6 C. Waste incin., energy recovery	5 519	5 578	5 618	5 733	5 918	6 072	6 178	6 275	6 402	8 205
6 C. Waste incin., without energy rec.	16 567	16 713	16 808	16 955	17 195	17 459	17 828	18 163	18 767	17 842
6. Waste total	29 504	29 775	29 951	30 280	30 787	31 249	31 633	32 014	32 378	32 737
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
6 A1. Managed Waste Disposal	4 879	4 944	4 749	4 455	4 217	4 248	4 267	4 295	4 321	
6 A2. Unmanaged Waste Disposal	908	867	841	831	826	825	816	790	758	
6 C. Waste incin., energy recovery	11 280	11 525	12 657	14 084	15 312	15 572	15 786	16 055	16 360	
6 C. Waste incin., without energy rec.	16 073	16 287	15 877	15 224	14 703	14 792	14 839	14 827	14 789	
6. Waste total	33 140	33 624	34 124	34 594	35 057	35 437	35 708	35 966	36 228	

The waste amounts are based on municipal data on waste and waste incineration with energy recovery on local incinerator plants in 2004, and a survey by Consulting Company Carl Bro in 1996 and 2001, where waste amounts pr person pr year was identified as 650 kg and 455 kg for Greenlandic towns and villages, respectively. For the time-series these amounts were regulated by 1 % per year upwards for years after 2004 and by 1 % per year downwards for years before 2004. Further, to construct the time-series statistical data from Statistics Greenland on population in towns and villages were used. Other results of the survey used for the time-series are that it was estimated that (1) 70 % of waste amounts is incinerated and 30 % deposited and (2) 80 % of combustible waste amounts deposited is burned in open burning.

8.2.1 Solid waste disposal

Source Category Description

The category consists of managed and unmanaged disposal of waste on land.

Methodological issues, activity data, emission factors and emissions

In Table 8.3 the composition of the waste according to the survey mentioned is shown.

Table 8.3 Composition of household and Commercial waste before and after open burning.

Fraction	Household waste[2]	Commercial waste[2]	Household / Commercial Weighted	After open burning	Weighted (after open burning)
			%		
Paper/cardboard, dry	8.00[1]	20.00	11.84	2.37	7.66
Paper/cardboard, wet	10.00[1]	7.00	9.04	1.81	5.85
Plastics	7.00[1]	9.00	7.64	1.53	4.94
Organic waste	44.00[1]	34.00	40.80	8.16	26.40
Other combustible	17.50[1]	16.00	17.02	3.40	11.00
Glass	7.50[1]	3.00[1]	6.06	6.06	19.60
Metal	3.50[1]	3.00[1]	3.34	3.34	10.80
Other, non combustible	1.00[1]	5.00	2.28	2.28	7.37
Hazardous waste	1.50[1]	3.00[1]	1.98	1.98	6.40
Total	100.00	100.00	100.00	30.93	100.00
Pct (%)	68[3]	32[3]		80[4]	

Notes:

[1] Measured values.

[2] Source: Environmental and Nature Agency, Ministry of Infrastructure and Environment.

[3] Distribution of household and commercial waste.

[4] Share of combustible waste burned at waste disposal sites.

A Tier 2 approach with a first order decay model is introduced for estimation of emissions of CH_4 from the solid waste disposals. For this purpose the activity data in Table 8.2 are estimated back to 1960 (not shown) based on the methodology described in connection to Table 8.2. Combining these activity data and the composition data in Table 8.3 time-series for 1960-2008 with amounts of waste in waste fractions are calculated.

For these time-series the waste fractions are associated to (1) DOC values according to Section 8.2 of this NIR and (2) emission factors based on DOC values and values of methane correction factors, fraction of DOC dissimilated and fraction of CH_4 in gas emitted according to the IPCC GL and GPG for managed disposals, Table 8.4 and unmanaged disposal, Table 8.5.

Table 8.4 DOC values and emission factors for CH_4 for managed disposals.

	Paper / cardboard, dry	Paper / cardboard, wet	Plastics	Organic waste	Other combustible	Glass	Metal	Other, non combustible	Hazardous waste
DOC weighted (after open burning) fraction	0.40	0.20	0.00	0.20	0.20	0.00	0.00	0.00	0.00
Emission factor kg CH_4/ton[1]	133.3	66.7	0.0	66.7	66.7	0.0	0.0	0.0	0.0

[1]) based on:

Methane correction factor	1
Fraction of DOC dissimilated and emitted	0.5
Fraction of CH_4 in gas emitted	0.5

Table 8.5 DOC values and emission factors for CH_4 for unmanaged disposals.

	Paper / cardboard dry	Paper / cardboard wet	Plastics	Organic waste	Other combustible	Glass	Metal	Other, non combustible	Hazardous waste
DOC weighted (after open burning) fraction	0.40	0.20	0.00	0.20	0.20	0.00	0.00	0.00	0.00
Emission factor kg CH_4/ton[1]	53.3	26.7	0.0	26.7	26.7	0.0	0.0	0.0	0.0

[1]) based on:

Methane correction factor	0.4
Fraction of DOC dissimilated and emitted	0.5
Fraction of CH_4 in gas emitted	0.5

For managed and unmanaged disposals the default half life time of 14 years and a time lag of 0.5 years are used. For the oxidation factor and according to the GPG for managed disposal 0.1 and for unmanaged 0.0 are used.

In Tables 8.6 and 8.7 are shown selected data and results for 1990-2008 for managed and unmanaged disposal, respectively. The data in the tables are as follows. The AD for the FOD model as amounts of waste in fractions, the potential emission of CH_4 calculated with emission factors on waste amounts in fractions, the annual generated emission of CH_4 calculated with the FOD model using the potential emissions, the oxidized CH_4 and the actual annual CH_4 emission calculated as the annual generated emission minus the CH_4 oxidized. Calculations are performed since 1960 and are not shown.

Table 8.6 Managed disposal. AD for the FOD model (amounts of waste in fractions), the potential emission of CH_4, the oxidized CH_4 and the annual CH_4 emission for 1990-2008.

	Paper /cardboard	Paper /cardboard	Plastics	Organic waste	Other combustible	Glass	Metal	Other, non combustible	Hazardous waste	Waste	Potential	Annual generated	Annual oxidized	Annual
	dry	wet								total	emission	emission	emission	emission
Unit	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes CH_4	Tonnes CH_4	Tonnes CH_4	Tonnes CH_4
1990	464	354	299	1 598	667	1 187	654	447	388	6 057	232.4	174.9	17.5	157.4
1991	469	358	303	1 616	674	1 200	661	452	392	6 125	236.4	177.8	17.8	160.1
1992	472	361	305	1 627	679	1 209	666	455	395	6 168	239.1	180.8	18.1	162.7
1993	477	364	308	1 644	686	1 221	673	459	399	6 232	240.8	183.7	18.4	165.3
1994	485	370	313	1 671	697	1 241	684	467	405	6 333	243.2	186.6	18.7	167.9
1995	492	376	318	1 696	707	1 259	694	474	411	6 428	247.2	189.5	18.9	170.5
1996	491	375	317	1 691	705	1 256	692	473	410	6 410	250.9	192.5	19.2	173.2
1997	491	375	317	1 693	706	1 257	693	473	411	6 416	250.2	195.2	19.5	175.7
1998	471	359	304	1 622	677	1 205	664	453	394	6 148	250.4	197.9	19.8	178.1
1999	437	333	282	1 504	628	1 117	616	420	365	5 702	240.0	199.9	20.0	180.0
2000	374	285	241	1 287	537	956	527	360	312	4 879	222.6	201.0	20.1	180.9
2001	379	289	244	1 305	544	969	534	365	317	4 944	190.4	200.5	20.1	180.5
2002	364	278	235	1 253	523	931	513	350	304	4 749	193.0	200.2	20.0	180.1
2003	341	260	220	1 175	490	873	481	328	285	4 455	185.4	199.4	19.9	179.5
2004	323	247	208	1 113	464	826	455	311	270	4 217	173.9	198.2	19.8	178.4
2005	325	248	210	1 121	468	832	459	313	272	4 248	164.6	196.6	19.7	176.9
2006	327	249	211	1 126	470	836	461	315	273	4 267	165.8	195.1	19.5	175.6
2007	329	251	212	1 133	473	842	464	317	275	4 295	166.5	193.7	19.4	174.4
2008	331	253	213	1 140	476	847	467	319	277	4 321	167.7	192.5	19.2	173.2

Table 8.7 Unmanaged disposal. AD for the FOD model (amounts of waste in fractions), the potential emission of CH_4, the oxidized CH_4 and the annual CH_4 emission for 1990-2008.

	Paper /cardboard dry	Paper /cardboard wet	Plastics	Organic waste	Other com-bustible	Glass	Metal	Other, non combustible	Hazardous waste	Waste total	Potential emission	Annual generated emission	Annual oxidized emission	Annual emission
Unit	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes CH_4	Tonnes CH_4	Tonnes CH_4	Tonnes CH_4
1990	104	80	67	359	150	267	147	100	87	1 361	21.2	15.8	0.0	15.8
1991	104	79	67	359	150	266	147	100	87	1 359	21.3	16.1	0.0	16.1
1992	104	79	67	358	149	266	147	100	87	1 358	21.2	16.3	0.0	16.3
1993	104	80	67	359	150	267	147	100	87	1 360	21.2	16.5	0.0	16.5
1994	103	78	66	354	148	263	145	99	86	1 341	21.2	16.8	0.0	16.8
1995	99	75	64	340	142	253	139	95	83	1 289	20.9	17.0	0.0	17.0
1996	93	71	60	321	134	238	131	90	78	1 217	20.1	17.1	0.0	17.1
1997	89	68	57	306	128	227	125	86	74	1 160	19.0	17.2	0.0	17.2
1998	81	62	52	280	117	208	115	78	68	1 061	18.1	17.3	0.0	17.3
1999	76	58	49	261	109	194	107	73	63	988	16.6	17.2	0.0	17.2
2000	70	53	45	240	100	178	98	67	58	908	15.4	17.1	0.0	17.1
2001	66	51	43	229	95	170	94	64	56	867	14.2	17.0	0.0	17.0
2002	64	49	42	222	93	165	91	62	54	841	13.5	16.8	0.0	16.8
2003	64	49	41	219	91	163	90	61	53	831	13.1	16.7	0.0	16.7
2004	63	48	41	218	91	162	89	61	53	826	13.0	16.5	0.0	16.5
2005	63	48	41	218	91	162	89	61	53	825	12.9	16.3	0.0	16.3
2006	62	48	40	215	90	160	88	60	52	816	12.9	16.1	0.0	16.1
2007	60	46	39	208	87	155	85	58	51	790	12.7	16.0	0.0	16.0
2008	58	44	37	200	83	148	82	56	49	758	12.3	15.8	0.0	15.8

8.3 Wastewater handling

8.3.1 Source category description

In Greenland no wastewater treatment occurs; although it should be mentioned some filtering of solid residues from industry may occur and likewise there are ongoing projects focussing on septic tanks at household levels. N_2O emission from human sewage is estimated. It is assumed that no methane emission occurs.

8.3.2 Methodological issues

According to the IPCC Guidelines (IPCC, 1997) the important factors for CH_4 production from handling of wastewater are: wastewater characteristics, handling systems, temperature and BOD vs. COD.

Regarding temperature the Guidelines state that production of CH_4 generally requires temperatures above 15˚C, and at temperatures below this the lagoon is principally a sedimentation tank. (IPCC, 1997) It is very rare that the temperature in Greenland exceeds 15˚C, and the monthly average temperature has not been higher than 12˚C during the period 1993-2008. Therefore CH_4 is reported as Not Applicable in the CRF.

N_2O emission from wastewater handling

The IPCC default methodology only includes N_2O emissions from human sewage based on annual per capita protein intake. The methodology account for nitrogen intake ("outcome"), i.e. faeces and urine, only and neither the industrial nitrogen input nor non-consumption protein from kitchen, bath and laundry discharges are included.

The formula used for calculation of the emission from effluent WWTP discharges is:

$$E_{effluents} = P \cdot F_N \cdot N_{pop} \cdot F_{nc} \cdot F \cdot EF \cdot effluent \cdot \frac{M_{N_2O}}{M_{N_2}}$$

where *P* is the annual protein per capita consumption per person per year set constant to 171.5 g/day (see below text)

FN is the fraction of nitrogen in protein, i.e. 0.16 (IPCC, 1997)

Npop is the Greenlandic population (Source: Statistics Greenland*)*

Fnc is the fraction of the population not connected to the municipal sewer system, i.e. set to 1 as no wastewater treatment plants exists in Greenland at this point

F is the fraction of non-consumption protein in domestic wastewater. i.e. 1.1 (IPCC, 2006)

$EFN_2O.WWTP.effluent$ is the IPCC GL default emission factor of 0.01 kg N_2O-N/kg sewage-N produced (IPCC, 1996)[1]

MN_2O and *MN_2* are the mass ratio. i.e. 44/28 to convert the discharged units in mass of total N to emissions in mass N_2O.

For households

A large part of the diet originates from seafood, fish or sea animals, but imported fabricated foods are expected to continue to take over an increasing part of their energy consumption. Due to weather conditions most of fresh food comes from wild animals or fish. Greenland has a production of lamb and a limited supply of vegetables; still most of the produced foods are imported from outside (Mulvad et al., 2007).

In Greenland, the traditional diet based on meat and fish has undergone diversification towards more carbohydrates with the development of a monetary economy; in 1855 the protein content of a mean diet was 377 g protein, whereas 80 years later, in 1935 – 43, the protein content of a mean diet was 257 g protein (Périssé and François, 1981). Today, the majority of young urbanised Greenlandic Inuit have Western dietary habits and consume less meat from marine mammals, terrestrial mammals and birds than Inuit from the hunting districts; Dietary profiles of Canadian Baffin Island Inuit with a high consumption of traditional foods have shown a mean daily protein intake of 199-144 g/day in 41- to 61-year-old (Laursen et al., 2001).

As no data on the protein intake are available a protein intake of 172 g/day, i.e. the average of the Canadian Inuit were adopted, as it is assumed that the protein intake has declined even more since 1935 due to increased number of urbanised Greenlandic Inuit. For comparison the Danish yearly protein consumption according to FAOSTAT has increased from 98 g/day in 1990 to 112 g/day in 2005. Using this number, the yearly protein intakes may be derived by multiplying with the population number and days in a year. Based on the above it was decided to set the protein intake to the average value of the Canadian Inuit data, 171.5 g/day. The N-content in effluent wastewater in Greenland was calculated the equation shown above.

From industries

The production of residue products from the fish industry in Greenland amounts to around 14.000 tons per year (Nielsen et al, 2005). Overall the waste amount from the Greenland halibut production is around 40 %, while the waste amount from codfish production is 50 %; this governs only the fish production including pre-processing.

According to IPCC, the fraction of nitrogen in protein is 0.16 (IPCC, 1996). The IPCC reports a range of 0.3 to 3.1 kg total N/ton fish referring to effluent loads form cod filleting; i.e. 0.0031. The report also presents values of the total N content of untreated wastewater from the fish industry in the range of 400-1000 mg/l corresponding to a fraction of corresponding. However, as it was not possible to find data for all fish groups, and as it was not possible to determine that fraction of fish,

[1] The IPCC (2006) gives a default value for the N_2O emissions from domestic wastewater nitrogen effluent of 0.005 (0.0005 - 0.25) kg N_2O-N/kg N. However, the IPCC EF from the 1996 guidelines has been used.

which was pre-processed and how big a fraction that was sold without pre-processing, the below approach was adopted.

From the EC BAT note (EC, 2003) the total N-content of untreated wastewater from the fishing industry was reported to be between 400 and 1000 mg/L with an average value of 700 mg/L. The number was multiplied by the water used within the fishing industry reported for 2004 to 2008 by Statistics Greenland. The effluent N-content for 1990 to 2003 was set equal to the estimated value for 2003.

8.3.3 Emissions

Emission of N_2O from wastewater handling is shown in Table 8.8.

Table 8.8 N_2O emissions from households and industries 1990-2008.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
N_2O emission, effluents households, Gg	0.0096	0.0096	0.0096	0.0096	0.0096	0.0096	0.0097	0.0097	0.0097	0.0097
N_2O emission, effluents industries, Gg	0.0394	0.0394	0.0394	0.0394	0.0394	0.0394	0.0394	0.0394	0.0394	0.0394
N_2O emission, effluents sum, Gg	0.0490	0.0490	0.0490	0.0489	0.0490	0.0490	0.0490	0.0491	0.0491	0.0491
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
N_2O emission, effluents households, Gg	0.0097	0.0097	0.0098	0.0098	0.0098	0.0099	0.0099	0.0098	0.0098	
N_2O emission, effluents industries, Gg	0.0394	0.0394	0.0394	0.0394	0.0394	0.0393	0.0396	0.0410	0.0425	
N_2O emission, effluents sum, Gg	0.0491	0.0491	0.0492	0.0492	0.0492	0.0492	0.0494	0.0508	0.0522	

Total emission of N_2O has increased in later years due to an increase in the emission from industrial effluents.

8.4 Waste incineration

8.4.1 Source category description

In Greenland waste incineration is carried out both with and without energy recovery. According to IPCC Guidelines the emissions associated with waste incineration for energy production is included in the energy sector more specifically in the source category 1.A1a Public Electricity and Heat Production. The emissions from waste incineration without energy recovery is reported in source category 6.C. Waste Incineration. Additionally in Greenland open burning of waste occurs at landfill sites. Emissions associated with this are also reported under sector 6.C. Waste Incineration.

8.4.2 Methodological issues

The methodology used follows the IPCC Guidelines. For waste incineration the Danish emission factors are used, as it is believed that they are also a good representation of Greenlandic conditions.

Neither the revised 1996 IPCC Guidelines (IPCC, 1997) nor the Good Practice Guidance (IPCC, 2000) contains a methodology for estimating emissions from open burning, therefore the methodology provided in the 2006 IPCC Guidelines (IPCC, 2006) is used.

The emission factors used for both waste incineration and open burning are included in chapter 8.4.4.

8.4.3 Activity data

The amount of waste incinerated without energy recovery is presented in Table 8.9. The activity data is provided by the method described in Section 8.2.

Table 8.9 Activity data for waste incineration without energy recovery, Mg.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Waste incinerated without energy recovery, Mg	NO	NO	NO	NO	56	225	795	1 242	2 667	2 901
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
Waste incinerated without energy recovery, Mg	3 150	3 308	3 392	3 418	3 440	3 463	3 487	3 470	3 446	

The open burning of waste is assumed to be 80 % of the waste deposited to landfills (Survey on waste by Carl Bro, 1996 and 2001). The activity data for open burning is presented in Table 8.10. The activity data for open burning is provided by the method described in Section 8.2.

Table 8.10 Activity data for open burning of waste, Mg.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Open burning of waste, Mg	16 567	16 713	16 808	16 955	17 139	17 235	17 033	16 921	16 100	14 941
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
Open burning of waste, Mg	12 924	12 979	12 484	11 806	11 262	11 329	11 352	11 356	11 343	

8.4.4 Emission factors

Waste incineration

For waste incineration without energy recovery the same emission factors have been assumed as for waste incineration with energy recovery. The emission factors refer to the Danish emission factors (Nielsen et al., 2009). The greenhouse gas emission factors are shown in Table 8.11.

Table 8.11 Emission factors for greenhouse gases from waste incineration.

	Emission factor	Unit
CO_2	32.5	kg/GJ
CH_4	30	g/GJ
N_2O	4	g/GJ

The emission factors used for the indirect greenhouse gases are shown in table 8.12.

Table 8.12 Emission factors for indirect greenhouse gases from waste incineration.

	NO_x	SO_2	NMVOC	CO
Waste incineration, g/GJ	100	6	50	1000

Open burning

For open burning emissions are calculated using the methodology, standard parameters and emission factors provided by the 2006 IPCC Guidelines.

The CH_4 emission factor used recommended and default is 6500 g/t MSW wet weight. This factor refers to US EPA (2001).

For N_2O a default emission factor of 150 g/t MSW dry weight is recommended (IPCC, 2006) this is corrected for the dry matter content to acquire an N_2O emission factor of 214 g/ton MSW wet weight.

For calculating the CO_2 emission the dry matter content, carbon content and the fossil carbon content of the waste fractions are used. The parameters are included in Table 8.13.

Table 8.13 Parameter used in calculating CO2 emissions from open burning.

	Dry matter content	Total carbon content, %	Fossil carbon content as percent of total carbon
Paper	0,9	46	1
Cardboard	0,9	46	1
Plastics	1,0	75	100
Organic waste	0,4	38	0
Other	0,9	3	100

Source: 2006 IPCC Guidelines, Volume 5, chapter 2, table 2.4.

An oxidation factor of 58 % is assumed for open burning (IPCC, 2006).

The emission factors for NO_x, SO_2, NMVOC and CO are presented in Table 8.14. The emission factors are from the US EPA (1992).

Table 8.14 Emission factors for indirect greenhouse gases from open burning of waste.

	NO_x	SO_2	NMVOC	CO
Open burning of municipal refuse, kg pr Mg	3	0.5	15	42

8.4.5 Emissions

Total emission of greenhouse gases from sector 6.C. Waste Incineration is shown in Table 8.15. Figure 8.2 shows total emission of greenhouse gases from sector 6.C. Waste incineration is shown in Figure 8.1.

Table 8.15 Greenhouse gas emissions from waste incineration.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
CO_2, Gg	2.6	2.6	2.6	2.6	2.7	2.7	2.9	3.0	3.4	3.3
CH_4, Mg	107.7	108.6	109.2	110.2	111.4	112.1	111.0	110.4	105.5	98.0
N_2O, Mg	3.5	3.6	3.6	3.6	3.7	3.7	3.7	3.7	3.6	3.3
CO_2 eqv., Gg	5.9	6.0	6.0	6.0	6.1	6.2	6.4	6.5	6.7	6.4
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
CO_2, Gg	3.1	3.1	3.1	3.0	2.9	2.9	2.9	2.9	2.9	
CH_4, Mg	85.0	85.4	82.2	77.8	74.3	74.7	74.9	74.9	74.8	
N_2O, Mg	2.9	2.9	2.8	2.7	2.6	2.6	2.6	2.6	2.6	
CO_2 eqv., Gg	5.7	5.8	5.7	5.4	5.3	5.3	5.3	5.3	5.3	

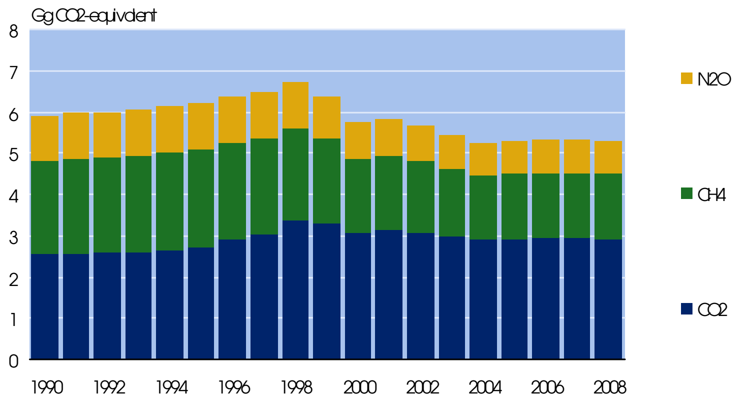

Figure 8.1 Emission of greenhouse gases from waste incineration.

The emissions of indirect greenhouse gases from waste incineration are shown in Table 8.16.

Table 8.16 Emissions of indirect greenhouse gases from waste incineration, Mg.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
NO_x	49.7	50.1	50.4	50.9	51.5	51.9	51.9	52.1	51.1	47.9
SO_2	8.3	8.4	8.4	8.5	8.6	8.6	8.6	8.5	8.2	7.6
NMVOC	248.5	250.7	252.1	254.3	257.1	258.6	255.9	254.5	242.9	225.6
CO	695.8	702.0	705.9	712.1	720.4	726.1	723.7	723.7	704.2	658.0
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
NO_x	42.1	42.4	41.0	39.0	37.4	37.6	37.7	37.7	37.6	
SO_2	6.7	6.7	6.4	6.1	5.8	5.9	5.9	5.9	5.9	
NMVOC	195.5	196.4	189.0	178.9	170.7	171.7	172.1	172.2	172.0	
CO	575.9	579.9	560.0	531.7	509.1	512.2	513.4	513.4	512.6	

8.5 Uncertainties

A tier 1 uncertainty assessment has been carried out in accordance with the IPCC GPG (IPCC, 2000). The uncertainty has been estimated for all sources included in the reporting for the waste sector. The uncertainties for the activity data and emission factors are shown in Table 8.17.

Table 8.17 Uncertainties for activity data and emission factors for the waste sector.

Subsector	Pollutant	Activity data uncertainty	Emission factor uncertainty
6C Waste incineration	CO_2	10	25
6A Solid Waste Disposal on Land	CH_4	10	100
6C Waste incineration	CH_4	10	50
6B Wastewater Handling	N_2O	30	100
6C Waste incineration	N_2O	10	100

The amount of waste incinerated and burned is relatively well known and the uncertainty is set to 10 %. The same is the case for the waste deposited to landfills. For waste water handling an uncertainty of 30 % on the activity data has been assumed.

Regarding the emission factor uncertainty, a value of 100 % has been used for CH_4 from solid waste disposal, N_2O from wastewater treatment and N_2O from waste incineration. This is in the same range as recommended by the IPCC GPG. For CO_2 and CH_4 from waste incineration emission factor uncertainties of 25 % and 50 % respectively have been chosen.

The resulting uncertainties for the individual greenhouse gases and the total uncertainty on the greenhouse gas emission are shown in Table 8.18.

Table 8.18 Uncertainties for the emission estimates.

	Uncertainty %	Trend 1990-2008 %	Trend uncertainty %
GHG	68	2,9	±28,1
CO_2	27	14,6	±16,2
CH_4	73	-6,1	±14,6
N_2O	100	4,3	±42,3

8.6 Source specific QA/QC

The elaboration of a formal QA/QC plan is to be completed.

However, data on solid waste disposal, waste water handling and waste incineration has gone through a great deal of quality work with regard to accuracy, comparability and completeness.

All external data used for the emission inventory submission are archived in spreadsheets. Data are archived annually in order to ensure that the basic data for a given report are always available in their original form.

Annual data on solid waste disposal, waste water handling and waste incineration are compared with previous years and large discrepancies are checked.

Safely stored and quality checked activity data are then processed by using a methodological approach consistent with international guidelines.

Calculated emission factors are compared with guideline emission factors to ensure that they are reasonable. The calculations follow the principle in international guidelines.

During data processing, it is checked that calculations are being carried out correctly.

Time-series for activity data, emission factors and calculated emissions are used to identify possible errors in the calculation procedure. In fact, during the calculation, numerous controls take place to ensure correctness. Sums are checked in the various stages in the calculation procedure. Implied emission factors are compared to emission factors.

Every single time-series imported to the CRF Reporter is checked for annual activity, units for activity, emission factor and emissions. Additional checks are performed on the database. The database encloses every single activity data, emission factors, emission, notation key and comment imported to the CRF Reporter. In other words, no information is typed manually into the CRF Reporter. Instead, all information is imported to the CRF Reporter through XML-files to ensure maximum accuracy and completeness.

8.7 Source specific recalculations and improvements

The sector *Waste Water Handling* (6B) is included in the inventory for the first time. Improvements and recalculations since the 2009 emission inventory submission include:

- Implementation of a Tier 2 approach with a first order decay model for estimation of emission of CH_4 from solid waste disposals. The update includes the years 1990-2007. Yearly emission of CH_4 is reduced due to the introduction of the decay model. Previously CH_4 emission from waste produced in one year was assumed to be emitted 100 % in that year.
- Introduction of activity data on waste water handling for households and fishing industries.
- Adjustment of the applied CO_2 emission factor for municipal waste incineration according to a study by the Danish National Environmental Research Institute in 2009.

Table 8.19 shows recalculations in the energy sector compared with the 2009 submission.

Table 8.19 Changes in GHG emission in the waste sector compared with the 2009 submission.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Previous inventory, Gg CO_2 eqv.	11.5	11.7	11.8	11.8	11.9	12.1	12.1	12.1	11.8	10.9
Recalculated, Gg CO_2 eqv.	24.7	24.8	24.9	25.0	25.2	25.4	25.6	25.7	26.0	25.7
Change in Gg CO_2 eqv.	13.2	13.2	13.2	13.2	13.3	13.3	13.5	13.7	14.2	14.8
Change in pct.	115.1	112.7	112.1	111.8	111.0	109.9	112.1	113.2	120.9	135.4
continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
Previous inventory, Gg CO_2 eqv.	9.4	9.4	9.0	9.5	9.1	9.1	9.1	9.1	-	
Recalculated, Gg CO_2 eqv.	25.1	25.2	25.1	24.8	24.6	24.6	24.7	25.0	25.4	
Change in Gg CO_2 eqv.	15.7	15.8	16.0	15.3	15.5	15.5	15.6	16.0	-	
Change in pct.	167.5	167.0	177.0	160.3	170.9	170.7	171.3	175.7	-	

8.8 Source specific planned improvements

Some planned improvements to the emission inventories are discussed below.

1) Improved data on solid waste disposals
In future inventories attempts will be made in order to improve data on solid waste disposals in general.

2) Improved data on waste water handling
In future inventories attempts will be made in order to improve data on waste water handling in general.

8.9 References

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9 Other

In CRF Sector 7, there are no activities and emissions or removals for the inventory of Greenland.

10 Recalculations and improvements

The 2010 submission is the first where Greenland on the request of the ERT has submitted a full CRF. Therefore Table 8(a) in the CRF does not contain any useful information, from the 2011 submission this will be corrected.

10.1 Explanations and justifications for recalculations

10.1.1 GHG inventory

10.1.2 KP-LULUCF inventory

The 2010 submission is the first year of reporting KP-LULUCF, therefore no recalculations have been carried out.

10.2 Implications for emission levels

10.2.1 GHG inventory

10.2.2 KP-LULUCF inventory

The 2010 submission is the first year of reporting KP-LULUCF, therefore no recalculations have been carried out.

10.3 Implications for emission trends, including time-series consistency

10.3.1 GHG inventory

10.3.2 KP-LULUCF inventory

The 2010 submission is the first year of reporting KP-LULUCF, therefore no recalculations have been carried out.

10.4 Recalculations, including those in response to the review process, and planned improvements to the inventory

10.4.1 GHG inventory

10.4.2 KP-LULUCF inventory

The 2010 submission is the first year of reporting KP-LULUCF, therefore no recalculations have been carried out.

11 KP-LULUCF

11.1 General information

In the following text, the abbreviations used are in accordance with definitions in the IPCC guidelines:

A:	Afforestation
R:	Reforestation
D:	Deforestation
FF:	Forest remaining Forest, areas remaining forest after 1990
FL:	Forest Land meeting the Danish definition of forests
CL:	Cropland
GL:	Grassland
SE:	Settlements
OL:	Other land, unclassified land
FM:	Forest Management, areas managed under article 3.4
CM:	Cropland Management, areas managed under article 3.4
GM:	Grazing land Management, areas managed under article 3.4

11.1.1 Definition of forest and any other criteria

For the estimation of anthropogenic emissions by sources and removals by sinks associated with afforestation (A), reforestation (R) and deforestation (D) since 1990 under Article 3.3 and forest management (FM) under Article 3.4 of the Kyoto Protocol, the following forest definition will be applied:

- Minimum values for tree crown cover: 10 per cent tree crown cover for forests.
- Minimum values for land area: 0.5 ha.
- Minimum value for tree height: trees must be able to reach a minimum height of 5 m in the site.

In addition, the forest area includes temporarily unstocked areas, smaller open areas in the forest needed for management purposes and fire breaks. Forests in national parks, reserves, or areas under special protection are included. Windbreaks and groves covering more than 0.5 ha and with a minimum width of 20 m are also considered as forests.

Woody biomass does not exist out side the forest and hence not reported under Cropland and Grassland.

11.1.2 Elected activities under Article 3, paragraph 4, of the Kyoto Protocol

As regards the possibility of including in the first commitment period emissions and removals associated with land use, land-use change and forestry activities under Article 3.4 of the Kyoto Protocol, it has been decided to include emissions and removals from forest management (FM), cropland management (CM) and grazing land management (GM).

The national system has identified land areas associated with the activities under Article 3.4 of the Kyoto Protocol in accordance with definitions, modalities, rules and guidelines relating to land use, land-use change and forestry activities under the protocol by satellite monitoring, use of EU Land Parcel Information System (LPIS), detailed crop information data on field level, soil mapping and sample plots from the national forest inventory (NFI).

Inventories of emissions and removals under Article 3.3 and Article 3.4 are prepared for 2009, and reported annually in 2010 together with the other greenhouse gas inventory information.

11.1.3 Description of how the definitions of each activity under Article 3.3 and each elected activity under Article 3.4 have been implemented and applied consistently over time

The definition of afforestation, reforestation and deforestation is in accordance with the GPG (IPSS 2003).

Afforestation or reforestation is identified when areas have wooded tree-cover and fulfils the forest definition given above. The time of the AF is given by the time of action, i.e. planting of trees. No deforestation and reforestation is reported for Greenland as this is not occurring. All types of establishment of forest (AF or RF) are considered human induced.

As for the forest management (Article 3.4), the forest areas fulfilling the definition given above are included under this activity. All forest areas are considered managed except for the remote Qinngua-valley.

For Cropland and Grassland the area accounted for under Art. 3.4 has been estimated with the best knowledge from the Greenlandic Agricultural Consulting Services. As the agriculture in Greenland is subsidized the area is estimated with a high accuracy. Only areas which are reported as CL and GL are included in the accounted area.

11.1.4 Description of precedence conditions and/or hierarchy among article 3.4 activities and how they have been consistently applied in determining how land was classified

All Forest activities have precedence, after this Cropland activities and then Grassland activities.

Afforestation has precedence. All land converted to forest are included as afforested area. Deforestated areas are not reported as this is not occurring. The following categories in the Convention reporting are included under afforestation:

- 5A25 OL to A

FM activities are only related to:

- 5A1 Forest remaining Forest

CM activities are related to:

- 5B22 GL to CL

GM activities area related to:

- 5C1 GL remaining GL

No elected land has left land which is not accounted for. Land conversion between elected activities (FM, CM and GM) has been allowed but is currently not occurring. No land elected under 3.4 activities has been converted to Other Land. Other land converted to elected activities is included in the respective category. As a consequence has there been a steady increase in the land which is accounted for under Art. 3.3 and Art. 3.4 with 14 hectares from 1990 to 2008.

The Land Use matrix developed for the purpose of reporting Art. 3.3 and 3.4 activities for 2008 are shown in Table 11.1.

Table 11.1 Land Use matrix for art. 3.3 and 3.4 activities in 2008.

To current inventory year / From previous inventory year		Article 3.3 activities		Article 3.4 activities				Other (5)
		Afforestation and Reforestation	Deforestation	Forest Management (if elected)	Cropland Management (if elected)	Grazing Land Management (if elected)	Revegetation (if elected)	
		(kha)						
Article 3.3 activities	Afforestation and Reforestation	NO	NO					
	Deforestation		NO					
Article 3.4 activities	Forest Management (if elected)		NO	0.21				
	Cropland Management(4) (if elected)	NO	NO		0.01	NO	NA	
	Grazing Land Management(4) (if elected)	NO	NO		NO	242.00	NA	
	Revegetation(4) (if elected)	NA			NA	NA	NA	
Other (5)		0.01	NO	NO	0.00	NO	NO	216,366.38
Total area at the end of the current inventory year		0.01	NO	0.21	0.01	242.00	NA,NO	216,366.38

11.2 Spatial assessment unit used for determining the areas of the units of land under Article 3.3

Afforestation and reforestation are identified as areas which not were covered by forest in 1990. The increase in the forest area is planted.

11.2.1 Methodology used to develop the land transition matrix

The land use matrix is based on the best available data. No vector maps exist of the individual forests, cropland and grassland.

11.2.2 Maps and/or database to identify the geographical locations, and the system of identification codes for the geographical locations

The forests have been given individual names. For the Cropland and Grassland area no identification has been made.

11.3 Afforestation, Reforestation & Deforestation (ARD)

11.3.1 Methods for carbon stock change and GHG emission and removal estimates

For afforestation the carbon stock change in the period 1990 - 2008 is based both on the area of afforestation and the information on species composition.

In the afforestation a steady increase in carbon stock is found.

11.3.2 Description of the methodologies and the underlying assumptions used

See Chapter 7.

11.3.3 Justification when omitting any carbon pool or GHG emissions/removals from ARD

C stock changes in the soil is not expected to occur and hence following the guidelines for a Tier 1 approach. As the afforestation is made by hand planting no damages of the existing soil C is expected to take place.

11.3.4 Information on whether or not indirect and natural GHG emissions and removals have been factored out

No factoring out has been performed in the emission and removal estimates.

11.3.5 Changes in data and methods since the previous submission (recalculations)

No recalculation has been performed.

11.3.6 Uncertainty estimates

Not available - included in later version.

11.3.7 Information on other methodological issues

See Chapter 7.

11.3.8 The year of the onset of an activity, if after 2008

Not applicable.

11.4 Forest Management (FM)

11.4.1 Methods for carbon stock change and GHG emission and removal estimates

See Chapter 7 in LULUCF on "Forest remaining forest (5.A.1)".

11.4.2 Methodologies and the underlying assumptions

See Chapter 7 in LULUCF on "Forest remaining forest (5.A.1)".

11.4.3 Omission of pools from FM

C changes in forest soils are omitted and hereby following GPG 2003 guidelines at a Tier 1 level.

11.4.4 Factoring out

No factoring out has been performed.

11.4.5 Recalculations

No recalculation has been performed.

11.4.6 Uncertainty estimates

Not available.

11.4.7 Information on other methodological issues

See Chapter 7 in LULUCF on "Forest remaining forest (5.A.1)".

11.4.8 The year of the onset of an activity, if after 2008

Not applicable.

11.5 Cropland Management (CM)

11.5.1 Methods for carbon stock change and GHG emission and removal estimates

11.5.2 Methodologies and the underlying assumptions used

The area with agricultural CL is reported as the area given in Statistics Greenland.

The same methodology as used in the Convention reporting is used in the KP reporting.

11.5.3 Omission of pool from CM

Aboveground and belowground living biomass, litter and dead organic are only reported for perennial woody crops in accordance with IPCC GPG 2003. No litter and dead organic matter are reported under CL as these are not occurring.

Under cropland are therefore only reported aboveground living biomasses. Below-ground biomass is included in above-ground biomass.

11.5.4 Factoring out

No factoring out has been made.

11.5.5 Recalculations

No recalculation has been performed.

11.5.6 Uncertainty estimates

No uncertainty analysis has been performed.

11.5.7 Information on other methodological issues

None

11.5.8 The year of the onset of an activity, if after 2008

Not applicable.

11.6 Grazing land management (GM)

11.6.1 Methods for carbon stock change and GHG emission and removal estimates

Grazing land is defined as land improved grassland and unmanaged grassland.

11.6.2 Description of the methodologies and the underlying assumptions used

The far major part of the grassland is unmanaged (241,000 hectare). Only 995 hectares is improved grassland with occasional reseeding and fertiliser application. The methodology used is the default Tier 1. This is in accordance with IPCC GPG 2003 (3.4.1.2.1.2) as the total emission from LULUCF consists of less than 0.05 % of the total emission from Greenland.

11.6.3 Omission of pools from GM

Aboveground and belowground living biomass, litter and dead organic are only reported for perennial woody crops in accordance with IPCC GPG 2003. No litter and dead organic matter are reported under CL as these are not occurring.

Under cropland are therefore only reported aboveground living biomasses. Below-ground biomass is included in above-ground biomass.

11.6.4 Factoring out

No factoring out has been made.

11.6.5 Recalculations

No recalculation has been performed.

11.6.6 Uncertainty estimates

No uncertainty analysis has been performed.

11.6.7 Information on other methodological issues

None.

11.6.8 The year of the onset of an activity, if after 2008

Not applicable.

11.7 Article 3.3

11.7.1 Information that demonstrates that activities under Article 3.3 began on or after 1 January 1990 and before 31 December 2012 and are direct human-induced

All forests in Greenland are planted except for the Qinngua-valley which is in a remote area. Forests are not a naturally occurring in Greenland.

11.7.2 Information on how harvesting or forest disturbance that is followed by the re-establishment of forest is distinguished from deforestation

No deforestation is occurring and therefore not applicable.

11.7.3 Information on the size and geographical location of forest areas that have lost forest cover but which are not yet classified as deforested

Not applicable.

11.8 Article 3.4

11.8.1 Information that demonstrates that activities under Article 3.4 have occurred since 1 January 1990 and are human-induced

Forest Management

In FM all forest area is under management and changes in carbon stock are hence seen as human induced.

Cropland Management

Due to the cold climate in Greenland and the recent increase in temperature it has only very recently been possible to grow agricultural crops in Greenland with the first fields established around 2001. Today it is estimated that five hectares are regularly ploughed.

Grassland Management

Due to the cold climate in Greenland and the recent increase in temperature it has only recently been valuable to introduce management activities in the grassland to increase the crop yield. This is well documented in the Greenlandic subsidiary system to the farmers.

11.8.2 Information relating to Cropland Management, Grazing Land Management and Revegetation, if elected, for the base year

No further information is available.

11.8.3 Information relating to Forest Management

No further information is available.

11.9 Other information

11.9.1 Key category analysis for Article 3.3 activities and any elected activities under Article 3.4

According to the IPCC Good Practice Guidance for LULUCF a category that is identified as key in the UNFCCC inventory should also be considered key under the Kyoto Protocol (IPCC, 2003).

No LULUCF categories are reported as a key source. The total emission from the LULUCF sector is only 0.05 % of the total emission from Greenland.

11.10 Information relating to Article 6

There are no Article 6 projects (Joint Implementation) on the Greenlandic territory.

Annex 1 Key categories

A Key Category Analysis (KCA) for year 1990 and 2008 for Greenland has been carried out in accordance with the IPCC Good Practice Guidance. For 1990 a level KCA has been carried out.

The base year in the analysis is the year 1990 for the greenhouse gases CO_2, CH_4, N_2O and 1995 for the greenhouse F-gases HFC, PFC and SF_6. The KCA approach is a Tier 1 quantitative analysis.

The level assessment of the Tier 1 KCA is a ranking of the source categories in accordance to their relative contribution to the national total of greenhouse gases calculated in CO_2 equivalents. The level key categories are found from the list of source categories ranked according to their contribution in descending order. Level key categories are those from the top of the list and of which the sum constitutes 95 % of the national total.

The trend assessment of the Tier 1 KCA is a ranking of the source categories according to their contribution to the trend of the national total of greenhouse gases, calculated in CO_2 equivalents, from the base year to the year under consideration. The trend of the source category is calculated relative to that of the national totals and the trend is then weighted with the contribution, according to the level assessment. The ranking is in descending order. As for the level assessment, the cut-off point for the sum of contribution to the trend is 95 % and the source categories from the top of the list to the cut-off line are trend key categories.

The result of the Key Category Analysis for Greenland for the year 1990 and 2008

The entries in the results of KCA in Tables 1.1 to 1.3 for the years 1990 and 2008 are composed from CRFs for those years in this report. Note that base-year estimates are not used in the level assessment analysis for year 2008, but are only included in Table 1.2 to make it more uniform with Tables 1.1 and 1.3.

The result of the Tier 1 KCA level assessment for Greenland for 1990 is shown in Table 1.1. For the assessment, 4 categories were identified as key categories and marked as shaded, refer Table 1.1.

The result of the Tier 1 KCA level assessment for Greenland for 2008 is shown in Table 1.2. For the assessment, 4 categories were identified as key categories, refer Table 1.3.

The result of the Tier 1 KCA trend assessment for Greenland for 1990/1995-2008 is shown in Table 1.3. For the assessment, 8 categories were identified as key categories, refer Table 1.3. Note that according to the GPG, the analysis implies that contributions to the trend are all calculated as mathematically positive to be able to perform the ranking. The LULUCF activities are in the table included with there sign, i.e. emissions: +, removals: -.

In Table 1.4 is given a summary of Key Category Analysis for Greenland for level assessment for year 1990/95 and 2008 and for trend for years 1990-2008. All the categories are listed by sector and key sources are shown with their ranking.

Table 1.1 Key Category Analysis base year 1990/1995, level assessment, Tier 1.

Table 7.A1 (of Good Practice Guidance)

Tier 1 Analysis - Level Assessment GRL – inventory

A			B	C	D	E
IPCC Source Categories (LULUCF excluded)			**Direct GHG**	**Base Year Estimate Ex,o Gg CO_2-eqv.**	**Base Year Level Assessment Lx,o**	**Base Year Cumulative total of Col. D**
Energy	Combustion excluding transport	Liquid fuels	CO_2	525.1306	0.7966	0.7966
Energy	Civil aviation		CO_2	38.3214	0.0581	0.8548
Energy	Road transportation		CO_2	36.5641	0.0555	0.9102
Energy	Domestic navigation		CO_2	21.0639	0.0320	0.9422
Waste	Wastewater handling		N_2O	15.1868	0.0230	0.9652
Agriculture	Enteric fermentation		CH_4	6.0175	0.0091	0.9744
Waste	Solid waste disposal on land		CH_4	3.6366	0.0055	0.9799
Waste	Waste incineration		CO_2	2.5507	0.0039	0.9837
Waste	Waste incineration		CH_4	2.2614	0.0034	0.9872
Energy	Combustion excluding transport		N_2O	1.3922	0.0021	0.9893
Agriculture	Direct emissions from agricultural soils		N_2O	1.2311	0.0019	0.9912
Energy	Combustion excluding transport	Other fuels	CO_2	1.1494	0.0017	0.9929
Waste	Waste incineration		N_2O	1.0991	0.0017	0.9946
Energy	Combustion excluding transport		CH_4	0.9511	0.0014	0.9960
Agriculture	Indirect emissions from agricultural soils		N_2O	0.6968	0.0011	0.9971
Agriculture	Manure management		N_2O	0.6407	0.0010	0.9980
Energy	Civil aviation		N_2O	0.3357	0.0005	0.9986
Solvents and other product use	Solvents		CO_2	0.2634	0.0004	0.9990
LULUCF	Grassland remaining grassland		CO_2	-0.2464	0.0004	0.9993
Agriculture	Manure management		CH_4	0.1403	0.0002	0.9995
Energy	Road transportation		N_2O	0.0932	0.0001	0.9997
Energy	Road transportation		CH_4	0.0641	0.0001	0.9998
Energy	Domestic navigation		N_2O	0.0536	0.0001	0.9999
Industry	Consumption of SF6		SF_6	0.0329	0.0000	0.9999
Energy	Domestic navigation		CH_4	0.0302	0.0000	1.0000
Industry	Consumption of HFC's		HFCs	0.0245	0.0000	1.0000
Energy	Civil aviation		CH_4	0.0057	0.0000	1.0000
Industry	Road Paving with asphalt		CO_2	0.0001	0.0000	1.0000
Industry	Asphalt roofing		CO_2	0.0000	0.0000	1.0000
Industry	Limestone and dolomite use		CO_2	0.0000	0.0000	1.0000
LULUCF	Forest land remaining forest		CO_2	0.0000	0.0000	1.0000
LULUCF	Conversion to forest land		CO_2	0.0000	0.0000	1.0000
LULUCF	Conversion to cropland		CO_2	0.0000	0.0000	1.0000
Total				**658.69**	**1.0000**	

Table 1.2 Key Category Analysis year 2008, level assessment, Tier 1.

Table 7.A1 (of Good Practice Guidance) Tier 1 Analysis - Level Assessment GRL – inventory							
A			B	C	D	E	F
IPCC Source Categories (LULUCF excluded)			Direct GHG	Base Year Estimate Ex,o Gg CO_2-eqv.	Year 2008 Estimate Ex,t Gg CO_2-eqv.	Year 2008 Level Assessment Lx,t	Year 2008 Cumulative total of Col. E
Energy	Combustion excluding transport	Liquid fuels	CO_2	525.1306	565.0616	0.7753	0.7753
Energy	Civil aviation		CO_2	38.3214	53.5036	0.0734	0.8487
Energy	Road transportation		CO_2	36.5641	34.1163	0.0468	0.8955
Energy	Domestic navigation		CO_2	21.0639	24.1153	0.0331	0.9286
Waste	Wastewater handling		N_2O	15.1868	16.1896	0.0222	0.9508
Industry	Consumption of HFC's		HFCs	0.0245	6.5266	0.0090	0.9598
Energy	Combustion excluding transport	Other fuels	CO_2	1.1494	5.5827	0.0077	0.9674
Agriculture	Enteric fermentation		CH_4	6.0175	5.5015	0.0075	0.9750
Waste	Solid waste disposal on land		CH_4	3.6366	3.9693	0.0054	0.9804
Waste	Waste incineration		CO_2	2.5507	2.9224	0.0040	0.9844
Agriculture	Direct emissions from agricultural soils		N_2O	1.2311	2.7627	0.0038	0.9882
Energy	Combustion excluding transport		N_2O	1.3922	1.6515	0.0023	0.9905
Agriculture	Indirect emissions from agricultural soils		N_2O	0.6968	1.6163	0.0022	0.9927
Waste	Waste incineration		CH_4	2.2614	1.5711	0.0022	0.9948
Energy	Combustion excluding transport		CH_4	0.9511	1.0576	0.0015	0.9963
Waste	Waste incineration		N_2O	1.0991	0.7974	0.0011	0.9974
Agriculture	Manure management		N_2O	0.6407	0.6778	0.0009	0.9983
Energy	Civil aviation		N_2O	0.3357	0.4687	0.0006	0.9990
Solvents and other product use	Solvents		CO_2	0.2634	0.2183	0.0003	0.9993
Agriculture	Manure management		CH_4	0.1403	0.1282	0.0002	0.9994
Energy	Road transportation		CH_4	0.0641	0.1085	0.0001	0.9996
Energy	Road transportation		N_2O	0.0932	0.0886	0.0001	0.9997
Energy	Domestic navigation		N_2O	0.0536	0.0623	0.0001	0.9998
LULUCF	Forest land remaining forest		CO_2	0.0000	-0.0513	0.0001	0.9999
Energy	Domestic navigation		CH_4	0.0302	0.0352	0.0000	0.9999
LULUCF	Grassland remaining grassland		CO_2	-0.2464	-0.0279	0.0000	0.9999
LULUCF	Conversion to cropland		CO_2	0.0000	0.0229	0.0000	1.0000
Energy	Civil aviation		CH_4	0.0057	0.0079	0.0000	1.0000
Industry	Limestone and dolomite use		CO_2	0.0000	0.0030	0.0000	1.0000
Industry	Consumption of SF6		SF_6	0.0329	0.0028	0.0000	1.0000
Industry	Road Paving with asphalt		CO_2	0.0001	0.0002	0.0000	1.0000
Industry	Asphalt roofing		CO_2	0.0000	0.0001	0.0000	1.0000
LULUCF	Conversion to forest land		CO_2	0.0000	0.0000	0.0000	1.0000
Total				**658.69**	**728.69**	**1.0000**	

Table 1.3 Key Category Analysis years 1990/1995-2008, trend assessment, Tier 1.

Table 7.A1 (of Good Practice Guidance)

Tier 1 Analysis - Trend Assessment GRL – inventory

A			B	C	D	E	F	G
IPCC Source Categories (LULUCF excluded)			**Direct GHG**	**Base Year Estimate Ex,o Gg CO_2-eqv.**	**Year 2008 Estimate Ex,t Gg CO_2-eqv.**	**Trend Assess-ment Tx,t**	**Contri bution to Trend**	**Cumul. total of col. F**
Energy	Combustion excluding transport	Liquid fuels	CO_2	525.1306	565.0616	0.0197	0.3100	0.3100
Energy	Civil aviation		CO_2	38.3214	53.5036	0.0138	0.2169	0.5269
Industry	Consumption of HFC's		HFCs	0.0245	6.5266	0.0081	0.1269	0.6538
Energy	Road transportation		CO_2	36.5641	34.1163	0.0079	0.1237	0.7774
Energy	Combustion excluding transport	Other fuels	CO_2	1.1494	5.5827	0.0053	0.0842	0.8616
Agriculture	Direct emissions from agricultural soils		N_2O	1.2311	2.7627	0.0017	0.0273	0.8889
Agriculture	Enteric fermentation		CH_4	6.0175	5.5015	0.0014	0.0226	0.9115
Waste	Waste incineration		CH_4	2.2614	1.5711	0.0012	0.0182	0.9297
Agriculture	Indirect emissions from agricultural soils		N_2O	0.6968	1.6163	0.0010	0.0165	0.9462
Energy	Domestic navigation		CO_2	21.0639	24.1153	0.0010	0.0159	0.9621
Waste	Wastewater handling		N_2O	15.1868	16.1896	0.0008	0.0119	0.9740
Waste	Waste incineration		N_2O	1.0991	0.7974	0.0005	0.0082	0.9822
LULUCF	Grassland remaining grassland		CO_2	-0.2464	-0.0279	0.0003	0.0048	0.9869
Energy	Combustion excluding transport		N_2O	1.3922	1.6515	0.0001	0.0022	0.9891
Waste	Waste incineration		CO_2	2.5507	2.9224	0.0001	0.0020	0.9911
Energy	Civil aviation		N_2O	0.3357	0.4687	0.0001	0.0019	0.9930
Solvents and other product use	Solvents		CO_2	0.2634	0.2183	0.0001	0.0014	0.9944
Waste	Solid waste disposal on land		CH_4	3.6366	3.9693	0.0001	0.0011	0.9955
LULUCF	Forest land remaining forest		CO_2	0.0000	-0.0513	0.0001	0.0010	0.9965
Energy	Road transportation		CH_4	0.0641	0.1085	0.0000	0.0007	0.9972
Industry	Consumption of SF6		SF_6	0.0329	0.0028	0.0000	0.0007	0.9978
Agriculture	Manure management		N_2O	0.6407	0.6778	0.0000	0.0006	0.9984
Agriculture	Manure management		CH_4	0.1403	0.1282	0.0000	0.0005	0.9990
LULUCF	Conversion to cropland		CO_2	0.0000	0.0229	0.0000	0.0004	0.9994
Energy	Road transportation		N_2O	0.0932	0.0886	0.0000	0.0003	0.9997
Energy	Combustion excluding transport		CH_4	0.9511	1.0576	0.0000	0.0001	0.9998
Energy	Domestic navigation		N_2O	0.0536	0.0623	0.0000	0.0001	0.9999
Industry	Limestone and dolomite use		CO_2	0.0000	0.0030	0.0000	0.0001	0.9999
Energy	Domestic navigation		CH_4	0.0302	0.0352	0.0000	0.0000	1.0000
Energy	Civil aviation		CH_4	0.0057	0.0079	0.0000	0.0000	1.0000
Industry	Road Paving with asphalt		CO_2	0.0001	0.0002	0.0000	0.0000	1.0000
Industry	Asphalt roofing		CO_2	0.0000	0.0001	0.0000	0.0000	1.0000
LULUCF	Conversion to forest land		CO_2	0.0000	0.0000	0.0000	0.0000	1.0000
Total				**658.69**	**728.69**		**1.0000**	

Table 1.4 Summary of Key Category Analysis for Greenland for level assessment for year 1990/95 and 2008 and for trend for years 1990-2008.

Summary of Key Category analysis for Greenland IPCC Source Categories (LULUCF excluded)				Key categories with number according to ranking in analysis Identification criteria		
			GHG	Level Tier1 1990	Level Tier1 2008	Trend Tier1 1990-2008
Energy	Combustion excluding transport	Liquid fuels	CO_2	1	1	1
Energy	Combustion excluding transport	Other fuels	CO_2			5
Energy	Combustion excluding transport		CH_4			
Energy	Combustion excluding transport		N_2O			
Energy	Road transportation		CO_2	3	3	4
Energy	Road transportation		CH_4			
Energy	Road transportation		N_2O			
Energy	Civil aviation		CO_2	2	2	2
Energy	Civil aviation		CH_4			
Energy	Civil aviation		N_2O			
Energy	Domestic navigation		CO_2	4	4	
Energy	Domestic navigation		CH_4			
Energy	Domestic navigation		N_2O			
Industry	Limestone and dolomite use		CO_2			
Industry	Asphalt roofing		CO_2			
Industry	Road Paving with asphalt		CO_2			
Industry	Consumption of HFC's		HFCs			3
Industry	Consumption of SF6		SF_6			
Solvents and other product use	Solvents		CO_2			
Agriculture	Enteric fermentation		CH_4			7
Agriculture	Manure management		CH_4			
Agriculture	Manure management		N_2O			
Agriculture	Direct emissions from agricultural soils		N_2O			6
Agriculture	Indirect emissions from agricultural soils		N_2O			9
Waste	Solid waste disposal on land		CH_4			
Waste	Wastewater handling		N_2O	5	5	
Waste	Waste incineration		CO_2			
Waste	Waste incineration		CH_4			8
Waste	Waste incineration		N_2O			
LULUCF	Forest land remaining forest		CO_2			
LULUCF	Conversion to forest land		CO_2			
LULUCF	Conversion to cropland		CO_2			
LULUCF	Grassland remaining grassland		CO_2			

Annex 2 Detailed discussion of methodology and data for estimating CO_2 emission from fossil fuel combustion

Detailed information regarding the methodology and input data used to calculate CO_2 emissions from fossil fuel combustion is included in Chapter 3.

Annex 3 Other detailed methodological descriptions for individual source or sink categories

All methodological descriptions are included in Chapter 3-8 and Chapter 11.

Annex 4 CO_2 reference approach and comparison with sectoral approach, and relevant information on the national energy balance

See Chapter 3.5.1 of this annex for the results of the comparison between the sectoral and reference approach.

Annex 5 Assessment of completeness and (potential) sources and sinks of greenhouse gas emissions and removals excluded

GHG inventory

The Greenlandic greenhouse gas emission inventories for 1990-2008 include all sources identified by the Revised 1996 IPCC Guidelines and the 2000 IPCC Good Practice Guidance except the following:

In the Solvent and other product use sector currently no N_2O emissions are included in CRF category 3D, Greenland will try to obtain activity data if they exist for uses of N_2O.

Direct and indirect CH_4 emissions from agricultural soils are not estimated. Direct and indirect soil emissions are considered of minor importance for CH_4. No methodology is recommended in IPCC-GPG.

In the LULUCF sector emissions/removals from wetlands, settlements and other land are currently not estimated due to the lack of available data. The lack of data availability is also an issue for other aspects of LULUCF, e.g. harvested wood products. For more detail please see chapter 7.

In the Waste sector CO_2 emissions from managed waste disposal on land are not estimated. According to the 1996 IPCC Guidelines: "Decomposition of organic material derived from biomass sources (e.g., crops, forests), which are regrown on an annual basis is the primary source of CO_2 released from waste. Hence, these CO_2 emissions are not treated as net emissions from waste in the IPCC Methodology."

KP-LULUCF inventory

The KP-LULUCF inventory is considered complete. The carbon pools not estimated has been documented as not being sources, please see chapter 11 for further documentation.

Annex 6 Additional information to be considered as part of the annual inventory submission and the supplementary information required under Article 7, paragraph 1, of the Kyoto Protocol or other useful reference information

No additional information for Greenland is deemed relevant.

Annex 7 Tables 6.1 and 6.2 of the IPCC good practice guidance

IPCC Source category	Gas	Base year emission	Year t emission	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in year t	Type A sensitivity	Type B sensitivity	Uncertainty i trend in national emissions introduced by emission factor uncertarinty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
		Input data	Input data	Input data	Input data							
		Gg CO2 eq	Gg CO2 eq	%	%	%	%	%	%	%	%	%
1A Liquid fuels	CO2	621	677	2	5	5,385	5,002	-0,015	1,027	-0,077	2,906	2,907
1A Municipal waste	CO2	1	6	2	25	25,080	0,192	0,007	0,008	0,164	0,024	0,165
1A Liquid fuels	CH4	1	1	2	100	100,020	0,151	0,000	0,002	-0,005	0,005	0,007
1A Municipal waste	CH4	0	0	2	100	100,020	0,006	0,000	0,000	0,005	0,000	0,005
1A Biomass	CH4	0	0	2	100	100,020	0,009	0,000	0,000	0,006	0,000	0,006
1A Liquid fuels	N2O	2	2	2	500	500,004	1,412	0,000	0,003	0,035	0,009	0,036
1A Municipal waste	N2O	0	0	2	500	500,004	0,060	0,000	0,000	0,051	0,000	0,051
1A Biomass	N2O	0	0	2	200	200,010	0,034	0,000	0,000	0,025	0,001	0,025
2A3 Limestone and dolomite use	CO2	0	0	5	5	7,071	0,000	0,000	0,000	0,000	0,000	0,000
2A5 Asphalt roofing	CO2	0	0	5	25	25,495	0,000	0,000	0,000	0,000	0,000	0,000
2A6 Road paving with asphalt	CO2	0	0	5	25	25,495	0,000	0,000	0,000	0,000	0,000	0,000
2F Consumption of HFC	HFC	0	7	10	50	50,990	0,457	0,010	0,010	0,493	0,140	0,513
2F Consumption of SF6	SF6	0	0	10	50	50,990	0,000	0,000	0,000	-0,003	0,000	0,003
3A Paint application	CO2	0	0	10	15	18,028	0,000	0,000	0,000	0,000	0,000	0,000
3B Degreasing and dry cleaning	CO2	0	0	10	15	18,028	0,000	0,000	0,000	0,000	0,000	0,000
3C Chemical products, manufacturing and processing	CO2	0	0	10	15	18,028	0,000	0,000	0,000	0,000	0,000	0,000
3D5 Other	CO2	0	0	10	20	22,361	0,007	0,000	0,000	-0,002	0,005	0,005
4A Enteric Fermentation	CH4	6	6	10	100	100,499	0,759	-0,002	0,008	-0,175	0,118	0,211
4B Manure Management	CH4	0	0	10	100	100,499	0,018	0,000	0,000	-0,004	0,003	0,005
4B Manure Management	N2O	1	1	10	100	100,499	0,093	0,000	0,001	-0,005	0,015	0,015
4D1 Direct N2O emissions from agricultural soils	N2O	0	2	20	50	53,852	0,156	0,002	0,003	0,124	0,091	0,154

Continued												
4D2 Pasture range and paddock	N2O	1	1	20	25	32,016	0,028	0,000	0,001	-0,009	0,028	0,029
4D3 Indirect N2O emissions from agri-cultural	N2O	1	2	20	50	53,852	0,119	0,001	0,002	0,064	0,069	0,095
5A Forest	CO2	0	0	5	50	50,249	-0,004	0,000	0,000	-0,004	-0,001	0,004
5B Cropland	CO2	0	0	5	50	50,249	0,002	0,000	0,000	0,002	0,000	0,002
5C Grassland	CO2	0	0	5	50	50,249	-0,002	0,000	0,000	0,019	0,000	0,019
6A Solid Waste Disposal on Land	CH4	4	4	10	100	100,499	0,547	0,000	0,006	-0,008	0,085	0,086
6B Wastewater Handling	N2O	15	16	30	100	104,403	2,320	-0,001	0,025	-0,093	1,043	1,047
6C Waste incineration	CO2	3	3	10	25	26,926	0,108	0,000	0,004	0,004	0,063	0,063
6C Waste incineration	CH4	2	2	10	50	50,990	0,110	-0,001	0,002	-0,071	0,034	0,078
6C Waste incineration	N2O	1	1	10	100	100,499	0,110	-0,001	0,001	-0,064	0,017	0,066
Total		659	729				33,625					9,943
Total uncertainties				Overall uncertainty i the year (%):			5.799		Trend uncertainty (%):			3.153

Annex 10 Information regarding the aggregated submission for Denmark and Greenland

This annex contains information on the aggregated submission for Denmark and Greenland. This annex contains a trend discussion, a tier 1 uncertainty analysis, information on the aggregated reference approach and information relating to key categories. Sector specific information is included for Denmark in Chapter 3-11 and for Greenland in Annex 9.

The institutional arrangements and the overall QA/QC plan are described in Chapter 1, this description covers all the Danish submissions to the European Union, the UNFCCC and the Kyoto Protocol, therefore information regarding the national system is not presented in this annex.

Trends in emissions

Due to the small emission originating from Greenland the trends for Denmark and Greenland are practically identical to the trends for Denmark presented in Chapter 2.

Greenhouse Gas Emissions

The greenhouse gas emissions are estimated according to the IPCC guidelines and are aggregated into seven main sectors. The greenhouse gases include CO_2, CH_4, N_2O, HFCs, PFCs and SF_6. Figure 1 shows the estimated total greenhouse gas emissions in CO_2 equivalents from 1990 to 2008. The emissions are not corrected for electricity trade or temperature variations. CO_2 is the most important greenhouse gas contributing in 2008 to the national total in CO_2 equivalents excluding LULUCF (Land Use and Land Use Change and Forestry) with 79.5 % followed by N_2O with 10.5 %, CH_4 8.6 % and F-gases (HFCs, PFCs and SF_6) with 1.4 %. Seen over the time-series from 1990 to 2008 these percentages have been increasing for F-gases, almost constant for CO_2 and CH_4 and falling for N_2O. Stationary combustion plants, transport and agriculture represent the largest categories, followed by industrial processes, waste and solvents, see Figure 1. The net CO_2 emission by LULUCF in 2008 is 2.2 % of the total emission in CO_2 equivalents excl. LULUCF. The national total greenhouse gas emission in CO_2 equivalents excluding LULUCF has decreased by 7.2 % from 1990 to 2008 and increased 3.9 % including LULUCF. Comments on the overall trends etc seen in Figure 1 are given in he sections below on the individual greenhouse gases.

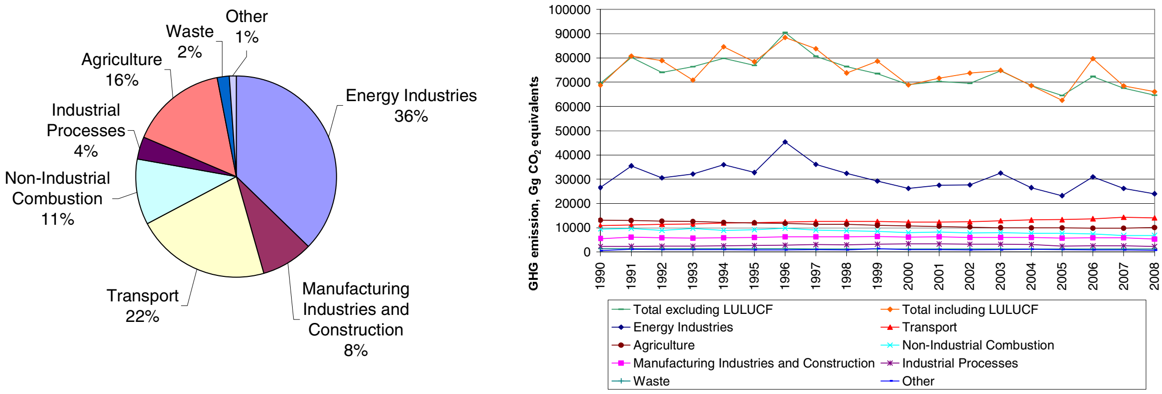

Figure 1 Greenhouse gas emissions in CO_2 equivalents distributed on main sectors for 2008 (excluding LULUCF) and time-series for 1990 to 2008 (including LULUCF).

Carbon dioxide

The largest source to the emission of CO_2 is the energy sector, which includes combustion of fossil fuels like oil, coal and natural gas (Figure 2.2). Energy Industries contribute with 46 % of the emissions (excl. LULUCF). About 27 % come from the transport sector. The main reason for the fluctuations during the time series is the variations in electricity import/export. The CO_2 emission (excl. LULUCF) decreased by 6 % from 2007 to 2008. The main reason for this decrease was a change from export of electricity in 2007 to import in 2008. In 2008, the CO_2 emission (excl. LULUCF) was 4 % lower than the emission in 1990.

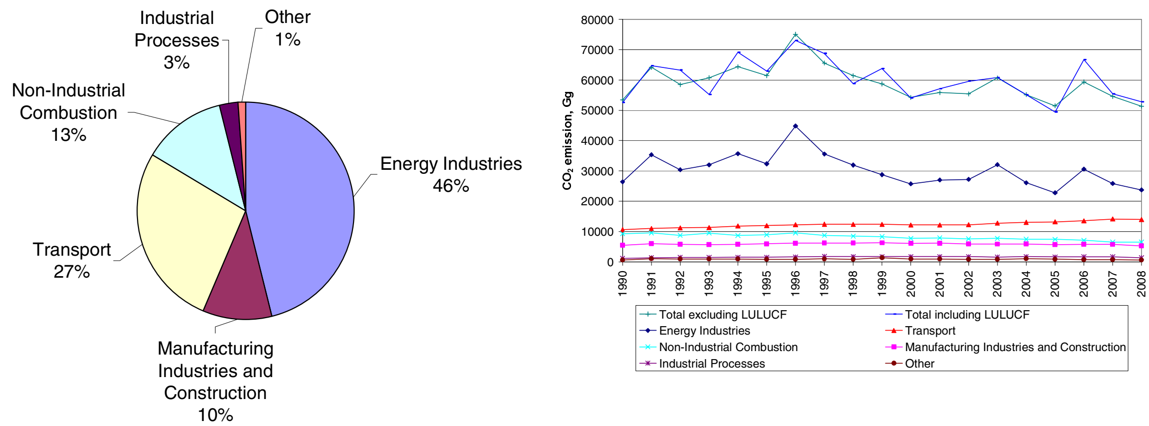

Figure 2 CO_2 emissions. Distribution according to the main sectors (2008) and time-series for 1990 to 2008.

Nitrous oxide

Agriculture is the most important N_2O emission source in 2008 contributing 91 % (Figure 3) of which N_2O from agricultural soils accounts for 84 %. N_2O is emitted as a result of microbial processes in the soil. Substantial emissions also come from drainage water and coastal waters where nitrogen is converted to N_2O through bacterial processes. However, the nitrogen converted in these processes originates mainly from the agricultural use of manure and nitrogen fertilisers. The main reason for the drop in the emissions of N_2O in the agricultural sector of 33 % from 1990 to 2008 is legislation to improve the utilisation of nitrogen in manure. The legislation has resulted in less nitrogen excreted pr unit of livestock produced and a considerable reduction in the use of nitrogen fertilisers. The basis for the N_2O emission is then reduced. Combustion of fossil fuels in the energy sector, both stationary and mobile sources, contributes 6.5 %. The N_2O emission from transport contributes by 2.1 % in 2008. This emission has increased during the nineties because of the increase in the use of catalyst cars. Production of nitric acid stopped in 2004 and the emissions from industrial processes is therefore not occurring from 2005 onwards. The sector Solvent and Other Product Use covers N_2O from e.g. anaesthesia.

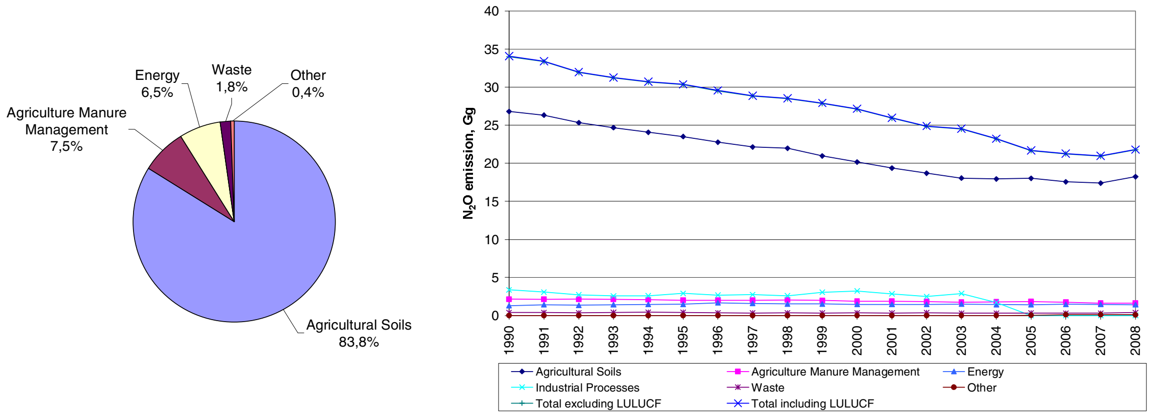

Figure 3 N_2O emissions. Distribution according to the main sectors (2008) and time-series for 1990 to 2008.

Methane

The largest sources of anthropogenic CH_4 emissions are agricultural activities contributing in 2008 with 69.5 %, waste (20.0 %), public power and district heating plants (3.3 %), see Figure 4. The emission from agriculture derives from enteric fermentation and management of animal manure contributing with 50.7 % and 18.8 % of the national CH_4 emission in 2008. The CH_4 emission from public power and district heating plants increased in the nineties, mainly 1992-1996, due to the increasing use of gas engines in the decentralised cogeneration plant sector. Up to 3 % of the natural gas in the gas engines is not combusted. The deregulation of the electricity market has made production of electricity in gas engines less favourable, therefore the fuel consumption has decreased and hence the CH_4 emission has decreased. Over the time-series from 1990 to 2008, the emission of CH_4 from enteric fermentation has decreased 13.5 % due to the decrease in the number of cattle. However, the emission from manure management has in the same period increased 20.8 % due to a change in traditional stable systems towards an increase in slurry-based stable systems. Altogether, the emission of CH_4 from the agriculture sector has decreased by 6.3 % from 1990 to 2008. The emission of CH_4 from waste has decreased 3.2 % since 1990 due to an increase in the incineration of waste.

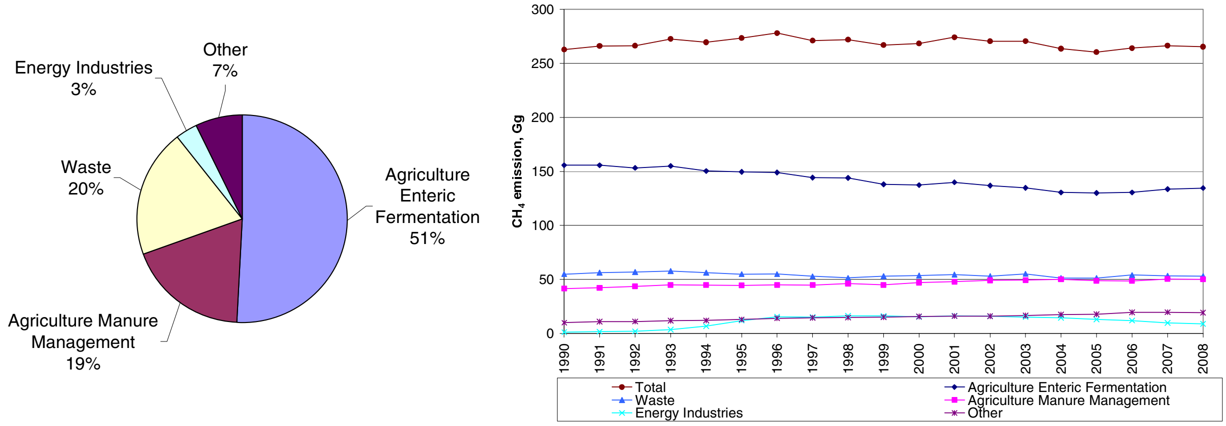

Figure 4 CH_4 emissions. Distribution according to the main sectors (2008) and time-series for 1990 to 2008.

HFCs, PFCs and SF_6

This part of the Danish KP inventory only comprises a full data set for all substances from 1995. From 1995 to 2000, there has been a continuous and substantial increase in the contribution from the range of F-gases as a whole, calculated as the sum of emissions in CO_2 equivalents, see Figure 5. This increase is simultaneous with the increase in the emission of HFCs. For the time-series 2000-2008, the increase is lower than for the years 1995 to 2000. The increase from 1995 to 2008 for the total F-gas emission is 178 %. SF_6 contributed considerably to the F-gas sum in earlier years, with 33 % in 1995. Environmental awareness and regulation of this gas under Danish law has reduced its use in industry, see Figure 5. A further result is that the contribution of SF_6 to F-gases in 2008 was only 3.5 %. The use of HFCs has increased several folds. HFCs have, therefore, become the even more dominant F-gases, comprising 66.9 % in 1995, but 95.1 % in 2008. HFCs are mainly used as a refrigerant. Danish legislation regulates the use of F-gases, e.g. since January 1, 2007 new HFC-based refrigerant stationary systems are forbidden. Refill of old systems are still allowed. The use of air conditioning in mobile systems and the amount of HFC for this purpose increases.

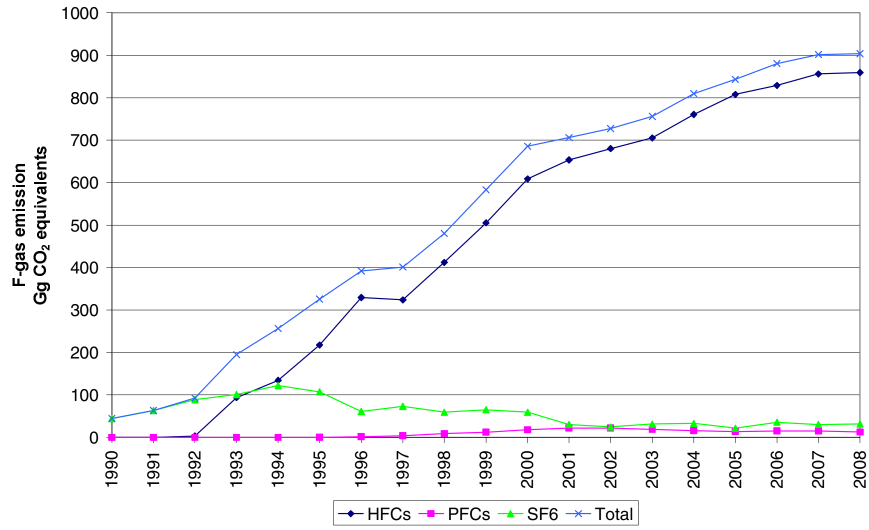

Figure 5 F-gas emissions. Time-series for 1990 to 2008.

The reference approach

In addition to the sector-specific CO_2 emission inventories (the national approach), the CO_2 emission is also estimated using the reference approach described in the IPCC Reference Manual (IPCC, 1997). The reference approach is based on data for fuel production, import, export and stock change. The CO_2 emission inventory based on the reference approach is reported to the Climate Convention and used for verification of the official data in the national approach.

The reference approach for Denmark and Greenland is an aggregation of the individual reference approaches for the two. The reference approach for Denmark is described in Chapter 3.4 and the reference approach for Greenland is included in Annex 9.

In 2008 the fuel consumption rates in the two approaches differ by -0.79 % and the CO_2 emission differs by -0.49%. In the period 1990-2008 both the fuel consumption and the CO_2 emission differ by less than 1.6%. The differences are below 1 % for all years except 1998 and 2006. This is almost identical to the reference approach for Denmark, due to the very small emission from Greenland compared to Denmark. According to IPCC Good Practice Guidance (IPCC 2000) the difference should be within 2 %. A comparison of the national approach and the reference approach is illustrated in Figure 6.

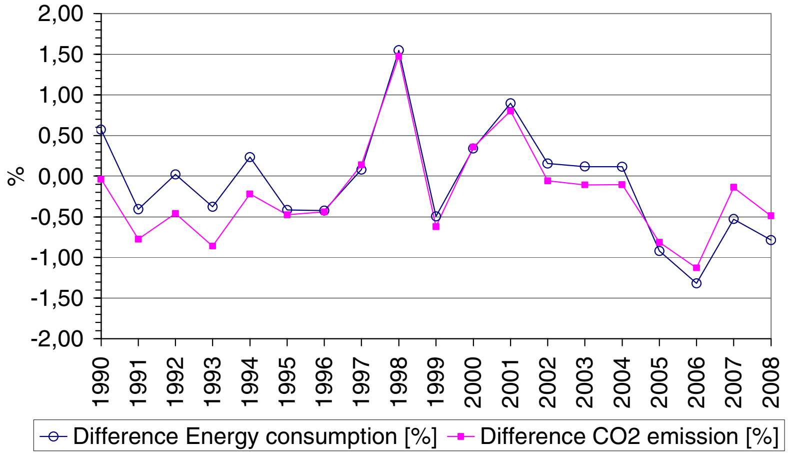

Figure 6 Comparison of the reference approach and the national approach.

Uncertainties

An uncertainty estimate has been calculated for Denmark and Greenland. The uncertainty estimate for Denmark is included in Chapter 1.7 and for Greenland in Annex 9.

The uncertainty estimates are based on the Tier 1 methodology in the IPCC Good Practice Guidance (GPG) (IPCC, 2000). Uncertainty estimates for the following sectors are included in the current year: stationary combustion plants, mobile combustion, fugitive emissions from fuels, industry, solid waste and wastewater treatment, CO_2 from solvents, agriculture and LULUCF. The sources included in the uncertainty estimate cover 100 % of the total net greenhouse gas emissions and removals. The emissions from Greenland has been treated separately due to the uncertainties being different than the uncertainties in the Danish inventory. The uncertainty of the Greenlandic emissions have almost no effect on the overall uncertainty estimate, due to the low emissions originating from Greenland.

The uncertainties for the activity rates and emission factors are shown in Table 2.

The estimated uncertainties for total GHG and for CO_2, CH_4, N_2O and F-gases are shown in Table 1. The base year for F-gases is 1995 and for all other sources the base year is 1990. The total Danish net GHG emission is estimated with an uncertainty of ±4.0 % and the trend in net GHG emission since 1990/1995 has been estimated to be -4.3 % ± 2.4 %-age points. The GHG uncertainty estimates do not take into account the uncertainty of the GWP factors.

The uncertainty on CH_4 emission from solid waste disposal, N_2O emission from leaching and run-off and CH_4 emission from manure management are the largest sources of uncertainty for the aggregated greenhouse gas inventory for Greenland and Denmark.

Table 1 Uncertainties 1990-2008.

	Uncertainty [%]	Trend [%]	Uncertainty in trend [%-age points]
GHG	4.0	-4.3	± 2.4
CO_2	2.2	0.4	± 2.1
CH_4	30	1.0	± 9.2
N_2O	24	-36	± 7
F-gases	48	+178	± 67

Table 2 Uncertainties 2008 for activity rates and emission factors.

	IPCC Source category	Gas	Base year emission	Year t emission	Activity data uncertainty	Emission factor uncertainty
			Gg CO_2 eq	Gg CO_2 eq	%	%
Denmark	Stationary Combustion, Coal	CO_2	24 077	16 050	1	1
Denmark	Stationary Combustion, BKB	CO_2	11	0	3	5
Denmark	Stationary Combustion, Coke	CO_2	138	112	2	5
Denmark	Stationary Combustion, Petroleum coke	CO_2	410	755	2	5
Denmark	Stationary Combustion, Plastic waste	CO_2	394	1343	5	25
Denmark	Stationary Combustion, Residual oil	CO_2	2505	1359	2	2
Denmark	Stationary Combustion, Gas oil	CO_2	4547	1544	3	5
Denmark	Stationary Combustion, Kerosene	CO_2	366	9	3	5
Denmark	Stationary Combustion, Natural gas	CO_2	4320	9764	2	1
Denmark	Stationary Combustion, LPG	CO_2	169	96	3	5
Denmark	Stationary Combustion, Refinery gas	CO_2	806	841	1	5
Denmark	1A1+1A2+1A4, Biomass	CH_4	83	187	16	100
Denmark	Biogas fuelled engines, Biomass	CH_4	2	21	3	10
Denmark	1A1+1A2+1A4, Natural gas	CH_4	8	15	2	100
Denmark	Natural gas fuelled engines, Natural gas	CH_4	5	185	1	5
Denmark	1A1+1A2+1A4, Liquid fuels	CH_4	7	4	2	100
Denmark	1A1+1A2+1A4, Municipal waste	CH_4	2	1	5	100
Denmark	1A1+1A2+1A4, Solid fuels	CH_4	15	8	1	100
Denmark	1A1 + 1A2 + 1A4, Biomass	N_2O	39	81	16	400
Denmark	1A1 + 1A2 + 1A4, Gaseous fuels	N_2O	28	61	2	300
Denmark	1A1 + 1A2 + 1A4, Liquid fuels	N_2O	76	46	2	400
Denmark	1A1 + 1A2 + 1A4, Municipal waste	N_2O	18	19	5	200
Denmark	1A1 + 1A2 + 1A4, Solid fuels	N_2O	80	49	2	1000
Denmark	Transport, Road transport	CO_2	9275	12948	2	5
Denmark	Transport, Military	CO_2	119	108	2	5
Denmark	Transport, Railways	CO_2	297	237	2	5
Denmark	Transport, Navigation (small boats)	CO_2	48	101	41	5
Denmark	Transport, Navigation (large vessels)	CO_2	666	353	11	5
Denmark	Transport, Fisheries	CO_2	591	449	2	5
Denmark	Transport, Agriculture	CO_2	1272	1230	24	5
Denmark	Transport, Forestry	CO_2	36	17	30	5
Denmark	Transport, Industry (mobile)	CO_2	842	1119	41	5
Denmark	Transport, Residential	CO_2	113	239	35	5
Denmark	Transport, Civil aviation	CO_2	243	164	10	5
Denmark	Transport, Road transport	CH_4	55	22	2	40
Denmark	Transport, Military	CH_4	0	0	2	100
Denmark	Transport, Railways	CH_4	0	0	2	100
Denmark	Transport, Navigation (small boats)	CH_4	0	1	41	100
Denmark	Transport, Navigation (large vessels)	CH_4	0	0	11	100
Denmark	Transport, Fisheries	CH_4	0	0	2	100
Denmark	Transport, Agriculture	CH_4	2	2	24	100
Denmark	Transport, Forestry	CH_4	0	0	30	100
Denmark	Transport, Industry (mobile)	CH_4	1	1	41	100
Denmark	Transport, Residential	CH_4	3	5	35	100
Denmark	Transport, Civil aviation	CH_4	0	0	10	100
Denmark	Transport, Road transport	N_2O	97	126	2	50
Denmark	Transport, Military	N_2O	1	1	2	1000
Denmark	Transport, Railways	N_2O	3	2	2	1000
Denmark	Transport, Navigation (small boats)	N_2O	0	1	41	1000
Denmark	Transport, Navigation (large vessels)	N_2O	13	7	11	1000
Denmark	Transport, Fisheries	N_2O	11	9	2	1000

Continued	IPCC Source category	Gas	Base year emission Gg CO_2 eq	Year t emission Gg CO_2 eq	Activity data uncertainty %	Emission factor uncertainty %
Denmark	Transport, Agriculture	N_2O	15	16	24	1000
Denmark	Transport, Forestry	N_2O	0	0	30	1000
Denmark	Transport, Industry (mobile)	N_2O	11	15	41	1000
Denmark	Transport, Residential	N_2O	1	1	35	1000
Denmark	Transport, Civil aviation	N_2O	3	3	10	1000
Denmark	1.B.2. Flaring in refinery	CO_2	23	28	11	5
Denmark	1.B.2. Flaring off-shore	CO_2	276	348	8	5
Denmark	1.B.2. Flaring in refinery	CH_4	1	0	11	15
Denmark	1.B.2. Flaring off-shore	CH_4	0	1	8	5
Denmark	1.B.2. Refinery processes	CH_4	1	46	1	125
Denmark	1.B.2. Land based activities	CH_4	17	37	2	40
Denmark	1.B.2. Off-shore activities	CH_4	15	39	2	30
Denmark	1.B.2. Transmission of natural gas	CH_4	4	3	15	5
Denmark	1.B.2. Distribution of natural gas	CH_4	5	4	25	10
Denmark	1.B.2. Flaring in refinery	N_2O	0	0	11	500
Denmark	1.B.2. Flaring off-shore	N_2O	1	1	8	500
Denmark	2A1 Cement production	CO_2	882	1155	1	2
Denmark	2A2 Lime production	CO_2	116	66	5	5
Denmark	2A3 Limestone and dolomite use	CO_2	14	39	5	5
Denmark	2A5 Asphalt roofing	CO_2	0	0	5	25
Denmark	2A6 Road paving with asphalt	CO_2	2	2	5	25
Denmark	2A7 Glass and Glass wool	CO_2	55	60	5	2
Denmark	2B5 Catalysts/Fertilizers, Pesticides	CO_2	1	2	5	5
Denmark	2C1 Iron and steel production	CO_2	28	0	5	5
Denmark	2D2 Food and Drink	CO_2	4	3	5	5
Denmark	2G Lubricants	CO_2	50	34	2	5
Denmark	2B2 Nitric acid production	N_2O	1043	0	2	25
Denmark	2F Consumption of HFC	HFC	218	853	10	50
Denmark	2F Consumption of PFC	PFC	1	13	10	50
Denmark	2F Consumption of SF6	SF6	107	32	10	50
Denmark	3A Paint application	CO_2	26	9	10	15
Denmark	3B Degreasing and dry cleaning	CO_2	0	0	10	15
Denmark	3C Chemical products	CO_2	23	15	10	15
Denmark	3D5 Other	CO_2	86	41	10	20
Denmark	3D1 Other - Use of N2O for Anaesthesia	N_2O	0	27	5	5
Denmark	4A Enteric Fermentation	CH_4	3261	2819	10	8
Denmark	4B Manure Management	CH_4	869	1050	10	100
Denmark	4F Field burning af agricultural residues	CH_4	2	2	10	50
Denmark	4.B Manure Management	N_2O	668	505	10	100
Denmark	4.D1.1 Syntehetic Fertilizer	N_2O	2395	1318	3	50
Denmark	4.D1.2 Animal waste applied to soils	N_2O	1050	1124	10	50
Denmark	4.D1.3 N-fixing crops	N_2O	269	213	20	50
Denmark	4.D1.4 Crop Residue	N_2O	361	305	20	50
Denmark	4.D1.5 Cultivation of histosols	N_2O	117	117	20	50
Denmark	4.D.2 Grassing animals	N_2O	314	214	20	25
Denmark	4.D3 Atmospheric deposition	N_2O	441	286	10	50
Denmark	4.D3 Leaching	N_2O	3334	1993	20	50
Denmark	4.D1.6 Sewage sludge used as fertiliser	N_2O	28	78	20	50
Denmark	4.F Field Burning of Agricultural Residues	N_2O	1	1	10	50
Denmark	5.A.1 Broadleaves	CO_2	-649	199	15	10
Denmark	5.A.1 Conifers	CO_2	-254	239	15	10
Denmark	5.A.2 Broadleaves	CO_2	3	-3	15	15
Denmark	5.A.2 Conifers	CO_2	5	-5	15	15

Continued						
Denmark	5A Drainage of soils	N_2O	16	12	30	75
Denmark	5.B Living biomass	CO_2	-53	48	10	20
Denmark	5.B Mineral soils	CO_2	-2021	-511	10	20
Denmark	5.B Organic soils	CO_2	1056	1070	10	50
Denmark	5.B Disturbance, Land converted to cropland	N_2O	3	0	50	75
Denmark	5.C Living biomass	CO_2	183	59	10	20
Denmark	5.C Organic soils	CO_2	93	81	10	50
Denmark	5.D Re-established wetlands	CO_2	0	-12	10	50
Denmark	5.D Land for peat extraction	CO_2	86	5	10	50
Denmark	5.D Land for peat extraction	N_2O	0	0	10	100
Denmark	5.E Living biomass	CO_2	80	52	10	50
Denmark	5 Liming	CO_2	565	229	5	50
Denmark	6 A. Solid Waste Disposal on Land	CH_4	1111	1057	10	118
Denmark	6 B. Wastewater Handling	CH_4	30	47	44	78
Denmark	5 B. Wastewater Handling - Direct	N_2O	24	70	37	98
Denmark	6 B. Wastewater Handling - Indirect	N_2O	82	35	59	39
Denmark	6.C Accidental fires, buildings	CO_2	15	18	10	500
Denmark	6.C Accidental fires, vehicles	CO_2	6	11	10	500
Denmark	6.C Incineration of corpses	CH_4	0	0	1	300
Denmark	6.C Incineration of carcasses	CH_4	0	0	50	300
Denmark	6.C Accidental fires, buildings	CH_4	2	3	10	500
Denmark	6.C Accidental fires, vehicles	CH_4	0	0	10	500
Denmark	6.C Incineration of corpses	N_2O	0	0	1	1000
Denmark	6.C Incineration of carcasses	N_2O	0	0	50	1000
Greenland	1A, Liquid fuels	CO2	621	677	2	5
Greenland	1A, Municipal waste	CO2	1	6	2	25
Greenland	1A, Liquid fuels	CH4	1	1	2	100
Greenland	1A, Municipal waste	CH4	0	0	2	100
Greenland	1A, Biomass	CH4	0	0	2	100
Greenland	1A, Liquid fuels	N2O	2	2	2	500
Greenland	1A, Municipal waste	N2O	0	0	2	500
Greenland	1A, Biomass	N2O	0	0	2	200
Greenland	2A3 Limestone and dolomite use	CO2	0	0	5	5
Greenland	2A5 Asphalt roofing	CO2	0	0	5	25
Greenland	2A6 Road paving with asphalt	CO2	0	0	5	25
Greenland	2F Consumption of HFC	HFC	0	7	10	50
Greenland	2F Consumption of SF6	SF6	0	0	10	50
Greenland	3A Paint application	CO2	0	0	10	15
Greenland	3B Degreasing and dry cleaning	CO2	0	0	10	15
Greenland	3C Chemical products	CO2	0	0	10	15
Greenland	3D5 Other	CO2	0	0	10	20
Greenland	4A Enteric Fermentation	CH4	6	6	10	100
Greenland	4B Manure Management	CH4	0	0	10	100
Greenland	4.B Manure Management	N2O	1	1	10	100
Greenland	4D1 Direct N2O emissions, agricultural soils	N2O	0	2	20	50
Greenland	4D2 Pasture range and paddock	N2O	1	1	20	25
Greenland	4D3 Indirect N2O emissions, agricultural soils	N2O	1	2	20	50
Greenland	5A Forest	CO2	0	0	5	50
Greenland	5B Cropland	CO2	0	0	5	50
Greenland	5.C Grassland	CO2	0	0	5	50
Greenland	6A Solid Waste Disposal on Land	CH4	4	4	10	100
Greenland	6B Wastewater Handling	N2O	15	16	30	100
Greenland	6C Waste incineration	CO2	3	3	10	25
Greenland	6C Waste incineration	CH4	2	2	10	50
Greenland	6C Waste incineration	N2O	1	1	10	100

Key category analysis

A tier 1 key category analysis has been carried out on emissions from Denmark and Greenland. The key category analysis has been carried out at CRF level, which is slightly more aggregated than the key category analysis carried out for Denmark. The key category analysis for Denmark is included in Chapter 1.5 and Annex 1, and the key category analysis for Greenland is included in Annex 9.

The key category analysis (KCA) for year 1990 and 2008 has been carried out in accordance with the IPCC Good Practice Guidance and including and excluding the LULUCF sector. The categorisation used results in a total of 101 and 81 categories including and excluding LULUCF, respectively.

In the level KCA for the inventory for 1990 and for 2008, 21 and 16 key categories were identified including and excluding LULUCF, respectively, refer to Tables 3-6. In the trend KCA for 1990-2008 were identified 23 and 16 key categories including and excluding LULUCF, respectively, refer Tables 7 and 8. In Table 9 an overview is given for all KCA categories and with a ranking of the key sources.

Tables 7.A1 – 7.A3 of the Good Practice Guidance

Table 3 Key Category Analysis for Denmark and Greenland, base year 1990/1995 incl LULUCF, level assessment, tier 1.

Table 7.A1 (of Good Practice Guidance) Tier 1 Analysis - Level Assessment DK+GRL - inventory

A			B	C	D	E
IPCC Source Categories (LULUCF included)			Direct GHG	Base year Estimate Ex,o Mt CO_2-eq	Base year Level Assessment Lx,o	Base year Cumulative total of Col. D
Energy	Combustion excluding transport	Solid Fuels	CO2	24.2259	0.3231	0.3231
Energy	Combustion excluding transport	Liquid Fuels	CO2	12.3012	0.1641	0.4872
Energy	Road transportation		CO2	9.3118	0.1242	0.6114
Energy	Combustion excluding transport	Gaseous Fuels	CO2	4.3195	0.0576	0.6690
Agriculture	Agriculture soils, indirect	Nitrogen Leaching and Run-off	N2O	3.3345	0.0445	0.7135
Agriculture	Enteric Fermentation		CH4	3.2672	0.0436	0.7571
Agriculture	Agriculture soils, direct emissions	Synthetic Fertilizers	N2O	2.3946	0.0319	0.7890
LULUCF	Cropland	5B Cropland rem. Cr. Mineral soils	CO2	-2.0207	0.0270	0.8160
Waste	Solid Waste Disposal Sites		CH4	1.1145	0.0149	0.8309
LULUCF	Cropland	5B Cropland rem. Cr. Organic soils	CO2	1.0555	0.0141	0.8449
Agriculture	Agriculture soils, direct emissions	Animal Manure Appl. to Soils	N2O	1.0505	0.0140	0.8590
Industrial processes	Nitric acid production		N2O	1.0429	0.0139	0.8729
Industrial processes	Cement production		CO2	0.8824	0.0118	0.8846
Agriculture	Manure Management		CH4	0.8693	0.0116	0.8962
Energy	Domestic navigation		CO2	0.7346	0.0098	0.9060
Agriculture	Manure management		N2O	0.6675	0.0089	0.9149
LULUCF	Forest Land remaining Forest L.	5A1 Broadleaves	CO2	-0.6487	0.0087	0.9236
LULUCF	Agricultural lime application	5IV Cropland Limestone	CO2	0.5652	0.0075	0.9311
Agriculture	Agriculture soils, indirect	Atmospheric Deposition	N2O	0.4415	0.0059	0.9370
Energy	Combustion excluding transport	Other Fuels	CO2	0.3948	0.0053	0.9423
Agriculture	Agriculture soils, direct emissions	Crop Residue	N2O	0.3613	0.0048	0.9471
Agriculture	Agriculture soils, pasture, range and paddock		N2O	0.3149	0.0042	0.9513
Energy	Railways		CO2	0.2967	0.0040	0.9553
Energy	Civil aviation		CO2	0.2810	0.0037	0.9590
Energy	Fugitive emissions	1B2c2ii, Flaring gas	CO2	0.2762	0.0037	0.9627
Agriculture	Agriculture soils, direct emissions	N-fixing Crops	N2O	0.2695	0.0036	0.9663
LULUCF	Forest Land remaining Forest L.	5A1 Conifers	CO2	-0.2543	0.0034	0.9697
Industrial processes	Foam Blowing		HFC	0.1826	0.0024	0.9721
LULUCF	Grassland	5C Land converted to Grassland, Living biomass	CO2	0.1783	0.0024	0.9745
Agriculture	Agriculture soils, direct emissions	Cultivation of Histosols	N2O	0.1165	0.0016	0.9761

Continued						
Energy	Combustion excluding transport	Liquid Fuels	N2O	0.1163	0.0016	0.9776
Industrial processes	Lime production		CO2	0.1155	0.0015	0.9791
Energy	Road transportation		N2O	0.0971	0.0013	0.9804
LULUCF	Grassland	5C Grassland rem. Grasland. Organic soils	CO2	0.0930	0.0012	0.9817
Energy	Combustion excluding transport	Biomass	CH4	0.0861	0.0011	0.9828
LULUCF	Wetlands	5D Wetlands remaining Wetlands (peat)	CO2	0.0861	0.0011	0.9840
Solvents and other product use	Other solvent		CO2	0.0860	0.0011	0.9851
Waste	N_2O indirect from human sewage		N2O	0.0852	0.0011	0.9863
Energy	Combustion excluding transport	Solid Fuels	N2O	0.0798	0.0011	0.9873
LULUCF	Settlements	5E Total settlements. Living bio-mass	CO2	0.0796	0.0011	0.9884
LULUCF	Cropland	5B Cropland remaining Cr. Living biomass	CO2	-0.0691	0.0009	0.9893
Industrial processes	Other emissions of SF_6 i.e. from double glaze windows and laboratories		SF6	0.0676	0.0009	0.9902
Energy	Road transportation		CH4	0.0551	0.0007	0.9909
Energy	Combustion excluding transport	Biomass	N2O	0.0510	0.0007	0.9916
Solvents and other product use	Other, lubricants		CO2	0.0497	0.0007	0.9923
Industrial processes	Refrigeration and AC Equipment		HFC and PFC	0.0442	0.0006	0.9929
Waste	N_2O direct, Domestic and Commercial Wastewater		N2O	0.0362	0.0005	0.9934
Industrial processes	Magnesium Production		SF6	0.0359	0.0005	0.9938
Energy	Fugitive emissions	1B2aiv, Oil refining and storage	CH4	0.0328	0.0004	0.9943
Waste	Waste Water Handling		CH4	0.0304	0.0004	0.9947
Industrial processes	Iron and steel production		CO2	0.0284	0.0004	0.9951
Agriculture	Agriculture soils, direct emissions	Sludge	N2O	0.0279	0.0004	0.9954
Energy	Combustion excluding transport	Gaseous Fuels	N2O	0.0278	0.0004	0.9958
Solvents and other product use	Paint application		CO2	0.0263	0.0004	0.9962
Waste	Waste incineration		CO2	0.0236	0.0003	0.9965
Energy	Fugitive emissions	1B2c2i, Flaring oil	CO2	0.0234	0.0003	0.9968
Solvents and other product use	Chemical Products, Manufacture and Processing		CO2	0.0231	0.0003	0.9971
Industrial processes	Bricks		CO2	0.0230	0.0003	0.9974
Industrial processes	Glass production		CO2	0.0174	0.0002	0.9976
LULUCF	Cropland	5B Land converted to Cropland. Living biomass	CO2	0.0160	0.0002	0.9978
LULUCF	Non-CO_2 drainage of soils and wetlands	5IID Forest Land.	N2O	0.0157	0.0002	0.9981
Energy	Combustion excluding transport	Liquid Fuels	CH4	0.0151	0.0002	0.9983
Energy	Combustion excluding transport	Solid Fuels	CH4	0.0149	0.0002	0.9985

Continued						
Industrial processes	Expanded clay		CO2	0.0149	0.0002	0.9987
Industrial processes	Limestone and dolomite use		CO2	0.0137	0.0002	0.9988
Energy	Domestic navigation		N2O	0.0134	0.0002	0.9990
Energy	Combustion excluding transport	Gaseous Fuels	CH4	0.0130	0.0002	0.9992
Energy	Combustion excluding transport	Other Fuels	N2O	0.0059	0.0001	0.9993
Energy	Fugitive emissions	1B2biv, Gas distribution	CH4	0.0053	0.0001	0.9993
LULUCF	Land converted to Forest L.	5A2 Conifers	CO2	0.0051	0.0001	0.9994
Waste	Waste incineration		CH4	0.0049	0.0001	0.9995
Industrial processes	Food and drink		CO2	0.0045	0.0001	0.9995
LULUCF	Grassland	5C Grassland rem. Grasland. Living biomass	CO2	0.0039	0.0001	0.9996
Industrial processes	Electrical equipment		SF6	0.0039	0.0001	0.9996
Energy	Fugitive emissions	1B2biii, Gas transmission	CH4	0.0036	< 0.0001	0.9997
Energy	Civil aviation		N2O	0.0035	< 0.0001	0.9997
LULUCF	Land converted to Forest L.	5A2 Broadleaves	CO2	0.0033	< 0.0001	0.9998
LULUCF	N_2O Disturbance, Land converted to cropland	5III Cropland	N2O	0.0032	< 0.0001	0.9998
Energy	Railways		N2O	0.0025	< 0.0001	0.9999
Agriculture	Field Burning of Agricultural Residues		CH4	0.0018	< 0.0001	0.9999
Industrial processes	Road Paving with asphalt		CO2	0.0018	< 0.0001	0.9999
Energy	Fugitive emissions	1B2c2i, Flaring oil	CH4	0.0013	< 0.0001	0.9999
Waste	Waste incineration		N2O	0.0013	< 0.0001	0.9999
Industrial processes	Catalysts/Fertilizers, Pesticides and Sulphuric acid		CO2	0.0008	< 0.0001	0.9999
Agriculture	Field Burning of Agricultural Residues		N2O	0.0007	< 0.0001	1.0000
Energy	Domestic navigation		CH4	0.0007	< 0.0001	1.0000
Energy	Fugitive emissions	1B2c2ii, Flaring gas	N2O	0.0006	< 0.0001	1.0000
Energy	Combustion excluding transport	Other Fuels	CH4	0.0006	< 0.0001	1.0000
Energy	Fugitive emissions	1B2c2ii, Flaring gas	CH4	0.0004	< 0.0001	1.0000
LULUCF	Wetlands	5D Land converted to wetlands	CO2	0.0004	< 0.0001	1.0000
Energy	Railways		CH4	0.0003	< 0.0001	1.0000
Energy	Civil aviation		CH4	0.0002	< 0.0001	1.0000
LULUCF	Non-CO_2 drainage of soils and wetlands	5IID Wetlands. Peatland	N2O	0.0001	< 0.0001	1.0000
Energy	Fugitive emissions	1B2c2i, Flaring oil	N2O	0.0001	< 0.0001	1.0000
Industrial processes	Asphalt roofing		CO2	0.0000	< 0.0001	1.0000
LULUCF	Cropland	5B Land converted to Cropland. Mineral soils	CO2	0.0000	< 0.0001	1.0000
Solvents and other product use	Degreasing and Dry Cleaning		CO2	0.0000	< 0.0001	1.0000
Industrial processes	Aerosols		HFC	0.0000	< 0.0001	1.0000

Continued						
Industrial processes	Other i.e Fibre Optics		HFC and PFC	0.0000	< 0.0001	1.0000
Solvents and other product use	Other solvent		N2O	0.0000	< 0.0001	1.0000
LULUCF	Cropland	5B Land converted to Cropland. Organic soils	CO2	0.0000	< 0.0001	1.0000
Total				**64.5738**	**1.00**	

Table 4 Key Category Analysis for Denmark and Greenland, base year 1990/1995 excl LULUCF, level assessment, tier 1.

Table 7.A1 (of Good Practice Guidance) Tier 1 Analysis - Level Assessment DK+GRL - inventory

A			B	C	D	E
IPCC Source Categories (LULUCF excluded)			Direct GHG	Base year Estimate Ex,o Mt CO_2-eq	Base year Level Assessment Lx,o	Base year Cumulative total of Col. D
Energy	Combustion excluding transport	Solid Fuels	CO2	24.2259	0.3467	0.3467
Energy	Combustion excluding transport	Liquid Fuels	CO2	12.3012	0.1761	0.5228
Energy	Road transportation		CO2	9.3118	0.1333	0.6560
Energy	Combustion excluding transport	Gaseous Fuels	CO2	4.3195	0.0618	0.7179
Agriculture	Agriculture soils, indirect	Nitrogen Leaching and Run-off	N2O	3.3345	0.0477	0.7656
Agriculture	Enteric Fermentation		CH4	3.2672	0.0468	0.8124
Agriculture	Agriculture soils, direct emissions	Synthetic Fertilizers	N2O	2.3946	0.0343	0.8466
Waste	Solid Waste Disposal Sites		CH4	1.1145	0.0160	0.8626
Agriculture	Agriculture soils, direct emissions	Animal Manure Appl. to Soils	N2O	1.0505	0.0150	0.8776
Industrial processes	Nitric acid production		N2O	1.0429	0.0149	0.8925
Industrial processes	Cement production		CO2	0.8824	0.0126	0.9052
Agriculture	Manure Management		CH4	0.8693	0.0124	0.9176
Energy	Domestic navigation		CO2	0.7346	0.0105	0.9281
Agriculture	Manure management		N2O	0.6675	0.0096	0.9377
Agriculture	Agriculture soils, indirect	Atmospheric Deposition	N2O	0.4415	0.0063	0.9440
Energy	Combustion excluding transport	Other Fuels	CO2	0.3948	0.0057	0.9496
Agriculture	Agriculture soils, direct emissions	Crop Residue	N2O	0.3613	0.0052	0.9548
Agriculture	Agriculture soils, pasture, range and paddock		N2O	0.3149	0.0045	0.9593
Energy	Railways		CO2	0.2967	0.0042	0.9636
Energy	Civil aviation		CO2	0.2810	0.0040	0.9676
Energy	Fugitive emissions	1B2c2ii, Flaring gas	CO2	0.2762	0.0040	0.9715
Agriculture	Agriculture soils, direct emissions	N-fixing Crops	N2O	0.2695	0.0039	0.9754
Industrial processes	Foam Blowing		HFC	0.1826	0.0026	0.9780
Agriculture	Agriculture soils, direct emissions	Cultivation of Histosols	N2O	0.1165	0.0017	0.9797
Energy	Combustion excluding transport	Liquid Fuels	N2O	0.1163	0.0017	0.9813
Industrial processes	Lime production		CO2	0.1155	0.0017	0.9830
Energy	Road transportation		N2O	0.0971	0.0014	0.9844
Energy	Combustion excluding transport	Biomass	CH4	0.0861	0.0012	0.9856
Solvents and other product use	Other solvent		CO2	0.0860	0.0012	0.9868
Waste	N_2O indirect from human sewage		N2O	0.0852	0.0012	0.9881

Continued						
Energy	Combustion excluding transport	Solid Fuels	N2O	0.0798	0.0011	0.9892
Industrial processes	Other emissions of SF6 i.e. from double glaze windows and laboratories		SF6	0.0676	0.0010	0.9902
Energy	Road transportation		CH4	0.0551	0.0008	0.9910
Energy	Combustion excluding transport	Biomass	N2O	0.0510	0.0007	0.9917
Solvents and other product use	Other, lubricants		CO2	0.0497	0.0007	0.9924
Industrial processes	Refrigeration and AC Equipment		HFC and PFC	0.0442	0.0006	0.9930
Waste	N_2O direct, Domestic and Commercial Wastewater		N2O	0.0362	0.0005	0.9936
Industrial processes	Magnesium Production		SF6	0.0359	0.0005	0.9941
Energy	Fugitive emissions	1B2aiv, Oil refining and storage	CH4	0.0328	0.0005	0.9945
Waste	Waste Water Handling		CH4	0.0304	0.0004	0.9950
Industrial processes	Iron and steel production		CO2	0.0284	0.0004	0.9954
Agriculture	Agriculture soils, direct emissions	Sludge	N2O	0.0279	0.0004	0.9958
Energy	Combustion excluding transport	Gaseous Fuels	N2O	0.0278	0.0004	0.9962
Solvents and other product use	Paint application		CO2	0.0263	0.0004	0.9966
Waste	Waste incineration		CO2	0.0236	0.0003	0.9969
Energy	Fugitive emissions	1B2c2i, Flaring oil	CO2	0.0234	0.0003	0.9972
Solvents and other product use	Chemical Products, Manufacture and Processing		CO2	0.0231	0.0003	0.9976
Industrial processes	Bricks		CO2	0.0230	0.0003	0.9979
Industrial processes	Glass production		CO2	0.0174	0.0002	0.9981
Energy	Combustion excluding transport	Liquid Fuels	CH4	0.0151	0.0002	0.9984
Energy	Combustion excluding transport	Solid Fuels	CH4	0.0149	0.0002	0.9986
Industrial processes	Expanded clay		CO2	0.0149	0.0002	0.9988
Industrial processes	Limestone and dolomite use		CO2	0.0137	0.0002	0.9990
Energy	Domestic navigation		N2O	0.0134	0.0002	0.9992
Energy	Combustion excluding transport	Gaseous Fuels	CH4	0.0130	0.0002	0.9994
Energy	Combustion excluding transport	Other Fuels	N2O	0.0059	0.0001	0.9994
Energy	Fugitive emissions	1B2biv, Gas distribution	CH4	0.0053	0.0001	0.9995
Waste	Waste incineration		CH4	0.0049	0.0001	0.9996
Industrial processes	Food and drink		CO2	0.0045	0.0001	0.9997
Industrial processes	Electrical equipment		SF6	0.0039	0.0001	0.9997
Energy	Fugitive emissions	1B2biii, Gas transmission	CH4	0.0036	0.0001	0.9998
Energy	Civil aviation		N2O	0.0035	0.0001	0.9998
Energy	Railways		N2O	0.0025	< 0.0001	0.9998
Agriculture	Field Burning of Agricultural Residues		CH4	0.0018	< 0.0001	0.9999
Industrial processes	Road Paving with asphalt		CO2	0.0018	< 0.0001	0.9999

Continued						
Energy	Fugitive emissions	1B2c2i, Flaring oil	CH4	0.0013	< 0.0001	0.9999
Waste	Waste incineration		N2O	0.0013	< 0.0001	0.9999
Industrial processes	Catalysts/Fertilizers, Pesticides and Sulphuric acid		CO2	0.0008	< 0.0001	0.9999
Agriculture	Field Burning of Agricultural Residues		N2O	0.0007	< 0.0001	1.0000
Energy	Domestic navigation		CH4	0.0007	< 0.0001	1.0000
Energy	Fugitive emissions	1B2c2ii, Flaring gas	N2O	0.0006	< 0.0001	1.0000
Energy	Combustion excluding transport	Other Fuels	CH4	0.0006	< 0.0001	1.0000
Energy	Fugitive emissions	1B2c2ii, Flaring gas	CH4	0.0004	< 0.0001	1.0000
Energy	Railways		CH4	0.0003	< 0.0001	1.0000
Energy	Civil aviation		CH4	0.0002	< 0.0001	1.0000
Energy	Fugitive emissions	1B2c2i, Flaring oil	N2O	0.0001	< 0.0001	1.0000
Industrial processes	Asphalt roofing		CO2	0.0000	< 0.0001	1.0000
Solvents and other product use	Degreasing and Dry Cleaning		CO2	0.0000	< 0.0001	1.0000
Industrial processes	Aerosols		HFC	0.0000	< 0.0001	1.0000
Industrial processes	Other i.e Fibre Optics		HFC and PFC	0.0000	< 0.0001	1.0000
Solvents and other product use	Other solvent		N2O	0.0000	< 0.0001	1.0000
Total				**69.8715**	**1.00**	

Table 5 Key Category Analysis for Denmark and Greenland, year 2008 incl LULUCF, level assessment, tier 1.

Table 7.A1 (of Good Practice Guidance) Tier 1 Analysis - Level Assessment DNK+GRL - inventory

A			B	C	D	E
IPCC Source Categories (LULUCF included)			Direct GHG	2008 Estimate Ex,o Mt CO_2-eq	2008 Level Assessment Lx,o	2008 Cumulative total of Col. D
Energy	Combustion excluding transport	Solid Fuels	CO2	16.1616	0.2406	0.2406
Energy	Road transportation		CO2	12.9826	0.1933	0.4340
Energy	Combustion excluding transport	Gaseous Fuels	CO2	9.7644	0.1454	0.5794
Energy	Combustion excluding transport	Liquid Fuels	CO2	8.3307	0.1240	0.7034
Agriculture	Enteric Fermentation		CH4	2.8249	0.0421	0.7455
Agriculture	Agriculture soils, indirect	Nitrogen Leaching and Run-off	N2O	1.9942	0.0297	0.7752
Energy	Combustion excluding transport	Other Fuels	CO2	1.3482	0.0201	0.7952
Agriculture	Agriculture soils, direct emissions	Synthetic Fertilizers	N2O	1.3194	0.0196	0.8149
Industrial processes	Cement production		CO2	1.1547	0.0172	0.8321
Agriculture	Agriculture soils, direct emissions	Animal Manure Appl. to Soils	N2O	1.1238	0.0167	0.8488
LULUCF	Cropland	5B Cropland rem. Cr. Organic soils	CO2	1.0700	0.0159	0.8647
Waste	Solid Waste Disposal Sites		CH4	1.0607	0.0158	0.8805
Agriculture	Manure Management		CH4	1.0499	0.0156	0.8962
Industrial processes	Refrigeration and AC Equipment		HFC and PFC	0.7457	0.0111	0.9073
LULUCF	Cropland	5B Cropland rem. Cr. Mineral soils	CO2	-0.5107	0.0076	0.9149
Agriculture	Manure management		N2O	0.5060	0.0075	0.9224
Energy	Domestic navigation		CO2	0.4773	0.0071	0.9295
Energy	Fugitive emissions	1B2c2ii, Flaring gas	CO2	0.3478	0.0052	0.9347
Agriculture	Agriculture soils, direct emissions	Crop Residue	N2O	0.3052	0.0045	0.9392
Agriculture	Agriculture soils, indirect	Atmospheric Deposition	N2O	0.2863	0.0043	0.9435
LULUCF	Forest Land remaining Forest L.	5A1 Conifers	CO2	0.2387	0.0036	0.9471
Energy	Railways		CO2	0.2367	0.0035	0.9506
LULUCF	Agricultural lime application	5IV Cropland Limestone	CO2	0.2288	0.0034	0.9540
Energy	Civil aviation		CO2	0.2173	0.0032	0.9572
Agriculture	Agriculture soils, pasture, range and paddock		N2O	0.2149	0.0032	0.9604
Agriculture	Agriculture soils, direct emissions	N-fixing Crops	N2O	0.2127	0.0032	0.9636
Energy	Combustion excluding transport	Biomass	CH4	0.2081	0.0031	0.9667
Energy	Combustion excluding transport	Gaseous Fuels	CH4	0.2000	0.0030	0.9697
LULUCF	Forest Land remaining Forest L.	5A1 Broadleaves	CO2	0.1992	0.0030	0.9726

Continued						
Energy	Road transportation		N2O	0.1257	0.0019	0.9745
Energy	Fugitive emissions	1B2aiv, Oil refining and storage	CH4	0.1211	0.0018	0.9763
Agriculture	Agriculture soils, direct emissions	Cultivation of Histosols	N2O	0.1168	0.0017	0.9780
Industrial processes	Foam Blowing		HFC	0.1026	0.0015	0.9796
Energy	Combustion excluding transport	Biomass	N2O	0.0926	0.0014	0.9809
Energy	Combustion excluding transport	Liquid Fuels	N2O	0.0896	0.0013	0.9823
Waste	N_2O direct, Domestic and Commercial Wastewater		N2O	0.0830	0.0012	0.9835
LULUCF	Grassland	5C Grassland rem. Grasland. Organic soils	CO2	0.0815	0.0012	0.9847
Agriculture	Agriculture soils, direct emissions	Sludge	N2O	0.0783	0.0012	0.9859
Industrial processes	Lime production		CO2	0.0656	0.0010	0.9869
Energy	Combustion excluding transport	Gaseous Fuels	N2O	0.0613	0.0009	0.9878
LULUCF	Grassland	5C Land converted to Grassland, Living biomass	CO2	0.0550	0.0008	0.9886
LULUCF	Settlements	5E Total settlements. Living bio-mass	CO2	0.0518	0.0008	0.9894
LULUCF	Cropland	5B Cropland remaining Cr. Living biomass	CO2	0.0497	0.0007	0.9901
Energy	Combustion excluding transport	Solid Fuels	N2O	0.0490	0.0007	0.9908
Waste	Waste Water Handling		CH4	0.0473	0.0007	0.9916
Solvents and other product use	Other solvent		CO2	0.0411	0.0006	0.9922
LULUCF	Wetlands	5D Land converted to wetlands	CO2	-0.0404	0.0006	0.9928
Industrial processes	Limestone and dolomite use		CO2	0.0387	0.0006	0.9933
Waste	N_2O indirect from human sewage		N2O	0.0377	0.0006	0.9939
Solvents and other product use	Other, lubricants		CO2	0.0340	0.0005	0.9944
LULUCF	Wetlands	5D Wetlands remaining Wetlands (peat)	CO2	0.0331	0.0005	0.9949
Waste	Waste incineration		CO2	0.0314	0.0005	0.9954
Industrial processes	Bricks		CO2	0.0284	0.0004	0.9958
Energy	Fugitive emissions	1B2c2i, Flaring oil	CO2	0.0282	0.0004	0.9962
Solvents and other product use	Other solvent		N2O	0.0273	0.0004	0.9966
Energy	Road transportation		CH4	0.0221	0.0003	0.9969
Industrial processes	Aerosols		HFC	0.0186	0.0003	0.9972
Industrial processes	Electrical equipment		SF6	0.0162	0.0002	0.9975
Industrial processes	Expanded clay		CO2	0.0161	0.0002	0.9977
Industrial processes	Other emissions of SF6 i.e. from double glaze windows and laboratories		SF6	0.0154	0.0002	0.9979
Industrial processes	Glass production		CO2	0.0151	0.0002	0.9982
Solvents and other product use	Chemical Products, Manufacture and Processing		CO2	0.0146	0.0002	0.9984
Energy	Combustion excluding transport	Liquid Fuels	CH4	0.0132	0.0002	0.9986

Continued						
LULUCF	Non-CO_2 drainage of soils and wetlands	5IID Forest Land.	N2O	0.0122	0.0002	0.9988
Solvents and other product use	Paint application		CO2	0.0092	0.0001	0.9989
Energy	Combustion excluding transport	Other Fuels	N2O	0.0081	0.0001	0.9990
Energy	Combustion excluding transport	Solid Fuels	CH4	0.0081	0.0001	0.9991
Energy	Domestic navigation		N2O	0.0080	0.0001	0.9993
Industrial processes	Other i.e Fibre Optics		HFC and PFC	0.0052	0.0001	0.9993
Waste	Waste incineration		CH4	0.0049	0.0001	0.9994
LULUCF	Land converted to Forest L.	5A2 Conifers	CO2	-0.0048	0.0001	0.9995
LULUCF	Grassland	5C Grassland rem. Grasland. Living biomass	CO2	0.0040	0.0001	0.9995
Energy	Fugitive emissions	1B2biv, Gas distribution	CH4	0.0037	0.0001	0.9996
Energy	Civil aviation		N2O	0.0032	< 0.0001	0.9996
LULUCF	Land converted to Forest L.	5A2 Broadleaves	CO2	-0.0031	< 0.0001	0.9997
Energy	Fugitive emissions	1B2biii, Gas transmission	CH4	0.0027	< 0.0001	0.9997
Industrial processes	Food and drink		CO2	0.0027	< 0.0001	0.9998
Agriculture	Field Burning of Agricultural Residues		CH4	0.0024	< 0.0001	0.9998
Industrial processes	Catalysts/Fertilizers, Pesticides and Sulphuric acid		CO2	0.0024	< 0.0001	0.9998
Energy	Railways		N2O	0.0020	< 0.0001	0.9999
Industrial processes	Road Paving with asphalt		CO2	0.0019	< 0.0001	0.9999
LULUCF	Cropland	5B Land converted to Cropland. Living biomass	CO2	-0.0013	< 0.0001	0.9999
Waste	Waste incineration		N2O	0.0011	< 0.0001	0.9999
Agriculture	Field Burning of Agricultural Residues		N2O	0.0009	< 0.0001	0.9999
Energy	Fugitive emissions	1B2c2ii, Flaring gas	CH4	0.0008	< 0.0001	1.0000
Energy	Fugitive emissions	1B2c2ii, Flaring gas	N2O	0.0008	< 0.0001	1.0000
Energy	Domestic navigation		CH4	0.0007	< 0.0001	1.0000
LULUCF	N_2O Disturbance, Land converted to cropland	5III Cropland	N2O	0.0004	< 0.0001	1.0000
Energy	Combustion excluding transport	Other Fuels	CH4	0.0004	< 0.0001	1.0000
Energy	Fugitive emissions	1B2c2i, Flaring oil	CH4	0.0002	< 0.0001	1.0000
Energy	Railways		CH4	0.0002	< 0.0001	1.0000
Energy	Civil aviation		CH4	0.0001	< 0.0001	1.0000
LULUCF	Non-CO_2 drainage of soils and wetlands	5IID Wetlands. Peatland	N2O	0.0001	< 0.0001	1.0000
Energy	Fugitive emissions	1B2c2i, Flaring oil	N2O	0.0001	< 0.0001	1.0000
Industrial processes	Asphalt roofing		CO2	0.0000	< 0.0001	1.0000
LULUCF	Cropland	5B Land converted to Cropland. Organic soils	CO2	0.0000	< 0.0001	1.0000
LULUCF	Cropland	5B Land converted to Cropland. Mineral soils	CO2	0.0000	< 0.0001	1.0000

Continued					
Solvents and other product use	Degreasing and Dry Cleaning	CO2	0.0000	< 0.0001	1.0000
Industrial processes	Nitric acid production	N2O	0.0000	< 0.0001	1.0000
Industrial processes	Iron and steel production	CO2	0.0000	< 0.0001	1.0000
Industrial processes	Magnesium Production	SF6	0.0000	< 0.0001	1.0000
Total			**66.0379**	**1.00**	

Table 6 Key Category Analysis for Denmark and Greenland, year 2008 excl LULUCF, level assessment, tier 1.

Table 7.A1 (of Good Practice Guidance) Tier 1 Analysis - Level Assessment DK+GRL - inventory

A			B	C	D	E
IPCC Source Categories (LULUCF excluded)			Direct GHG	2008 Estimate Ex,o Mt CO2-eq	2008 Level Asses-sment Lx,o	2008 Cumulative total of Col. D
Energy	Combustion excluding transport	Solid Fuels	CO2	16.1616	0.2503	0.2503
Energy	Road transportation		CO2	12.9826	0.2011	0.4513
Energy	Combustion excluding transport	Gaseous Fuels	CO2	9.7644	0.1512	0.6025
Energy	Combustion excluding transport	Liquid Fuels	CO2	8.3307	0.1290	0.7316
Agriculture	Enteric Fermentation		CH4	2.8249	0.0437	0.7753
Agriculture	Agriculture soils, indirect	Nitrogen Leaching and Run-off	N2O	1.9942	0.0309	0.8062
Energy	Combustion excluding transport	Other Fuels	CO2	1.3482	0.0209	0.8271
Agriculture	Agriculture soils, direct emissions	Synthetic Fertilizers	N2O	1.3194	0.0204	0.8475
Industrial processes	Cement production		CO2	1.1547	0.0179	0.8654
Agriculture	Agriculture soils, direct emissions	Animal Manure Appl. to Soils	N2O	1.1238	0.0174	0.8828
Waste	Solid Waste Disposal Sites		CH4	1.0607	0.0164	0.8992
Agriculture	Manure Management		CH4	1.0499	0.0163	0.9155
Industrial processes	Refrigeration and AC Equipment		HFC and PFC	0.7457	0.0115	0.9270
Agriculture	Manure management		N2O	0.5060	0.0078	0.9348
Energy	Domestic navigation		CO2	0.4773	0.0074	0.9422
Energy	Fugitive emissions	1B2c2ii, Flaring gas	CO2	0.3478	0.0054	0.9476
Agriculture	Agriculture soils, direct emissions	Crop Residue	N2O	0.3052	0.0047	0.9524
Agriculture	Agriculture soils, indirect	Atmospheric Deposition	N2O	0.2863	0.0044	0.9568
Energy	Railways		CO2	0.2367	0.0037	0.9605
Energy	Civil aviation		CO2	0.2173	0.0034	0.9638
Agriculture	Agriculture soils, pasture, range and paddock		N2O	0.2149	0.0033	0.9671
Agriculture	Agriculture soils, direct emissions	N-fixing Crops	N2O	0.2127	0.0033	0.9704
Energy	Combustion excluding transport	Biomass	CH4	0.2081	0.0032	0.9737
Energy	Combustion excluding transport	Gaseous Fuels	CH4	0.2000	0.0031	0.9768
Energy	Road transportation		N2O	0.1257	0.0019	0.9787
Energy	Fugitive emissions	1B2aiv, Oil refining and storage	CH4	0.1211	0.0019	0.9806
Agriculture	Agriculture soils, direct emissions	Cultivation of Histosols	N2O	0.1168	0.0018	0.9824
Industrial processes	Foam Blowing		HFC	0.1026	0.0016	0.9840
Energy	Combustion excluding transport	Biomass	N2O	0.0926	0.0014	0.9854

Continued						
Energy	Combustion excluding transport	Liquid Fuels	N2O	0.0896	0.0014	0.9868
Waste	N_2O direct, Domestic and Commercial Wastewater		N2O	0.0830	0.0013	0.9881
Agriculture	Agriculture soils, direct emissions	Sludge	N2O	0.0783	0.0012	0.9893
Industrial processes	Lime production		CO2	0.0656	0.0010	0.9903
Energy	Combustion excluding transport	Gaseous Fuels	N2O	0.0613	0.0009	0.9913
Energy	Combustion excluding transport	Solid Fuels	N2O	0.0490	0.0008	0.9920
Waste	Waste Water Handling		CH4	0.0473	0.0007	0.9928
Solvents and other product use	Other solvent		CO2	0.0411	0.0006	0.9934
Industrial processes	Limestone and dolomite use		CO2	0.0387	0.0006	0.9940
Waste	N_2O indirect from human sewage		N2O	0.0377	0.0006	0.9946
Solvents and other product use	Other, lubricants		CO2	0.0340	0.0005	0.9951
Waste	Waste incineration		CO2	0.0314	0.0005	0.9956
Industrial processes	Bricks		CO2	0.0284	0.0004	0.9960
Energy	Fugitive emissions	1B2c2i, Flaring oil	CO2	0.0282	0.0004	0.9965
Solvents and other product use	Other solvent		N2O	0.0273	0.0004	0.9969
Energy	Road transportation		CH4	0.0221	0.0003	0.9972
Industrial processes	Aerosols		HFC	0.0186	0.0003	0.9975
Industrial processes	Electrical equipment		SF6	0.0162	0.0003	0.9978
Industrial processes	Expanded clay		CO2	0.0161	0.0002	0.9980
Industrial processes	Other emissions of SF6 i.e. from double glaze windows and laboratories		SF6	0.0154	0.0002	0.9983
Industrial processes	Glass production		CO2	0.0151	0.0002	0.9985
Solvents and other product use	Chemical Products, Manufacture and Processing		CO2	0.0146	0.0002	0.9987
Energy	Combustion excluding transport	Liquid Fuels	CH4	0.0132	0.0002	0.9989
Solvents and other product use	Paint application		CO2	0.0092	0.0001	0.9991
Energy	Combustion excluding transport	Other Fuels	N2O	0.0081	0.0001	0.9992
Energy	Combustion excluding transport	Solid Fuels	CH4	0.0081	0.0001	0.9993
Energy	Domestic navigation		N2O	0.0080	0.0001	0.9994
Industrial processes	Other i.e Fibre Optics		HFC and PFC	0.0052	0.0001	0.9995
Waste	Waste incineration		CH4	0.0049	0.0001	0.9996
Energy	Fugitive emissions	1B2biv, Gas distribution	CH4	0.0037	0.0001	0.9997
Energy	Civil aviation		N2O	0.0032	< 0.0001	0.9997
Energy	Fugitive emissions	1B2biii, Gas transmission	CH4	0.0027	< 0.0001	0.9997
Industrial processes	Food and drink		CO2	0.0027	< 0.0001	0.9998
Agriculture	Field Burning of Agricultural Residues		CH4	0.0024	< 0.0001	0.9998
Industrial processes	Catalysts/Fertilizers, Pesticides and Sulphuric acid		CO2	0.0024	< 0.0001	0.9999

Continued						
Energy	Railways		N2O	0.0020	< 0.0001	0.9999
Industrial processes	Road Paving with asphalt		CO2	0.0019	< 0.0001	0.9999
Waste	Waste incineration		N2O	0.0011	< 0.0001	0.9999
Agriculture	Field Burning of Agricultural Residues		N2O	0.0009	< 0.0001	0.9999
Energy	Fugitive emissions	1B2c2ii, Flaring gas	CH4	0.0008	< 0.0001	1.0000
Energy	Fugitive emissions	1B2c2ii, Flaring gas	N2O	0.0008	< 0.0001	1.0000
Energy	Domestic navigation		CH4	0.0007	< 0.0001	1.0000
Energy	Combustion excluding transport	Other Fuels	CH4	0.0004	< 0.0001	1.0000
Energy	Fugitive emissions	1B2c2i, Flaring oil	CH4	0.0002	< 0.0001	1.0000
Energy	Railways		CH4	0.0002	< 0.0001	1.0000
Energy	Civil aviation		CH4	0.0001	< 0.0001	1.0000
Energy	Fugitive emissions	1B2c2i, Flaring oil	N2O	0.0001	< 0.0001	1.0000
Industrial processes	Asphalt roofing		CO2	0.0000	< 0.0001	1.0000
Solvents and other product use	Degreasing and Dry Cleaning		CO2	0.0000	< 0.0001	1.0000
Industrial processes	Nitric acid production		N2O	0.0000	< 0.0001	1.0000
Industrial processes	Iron and steel production		CO2	0.0000	< 0.0001	1.0000
Industrial processes	Magnesium Production		SF6	0.0000	< 0.0001	1.0000
Total				**64.5738**	**1.00**	

Table 7 Key Category Analysis for Denmark and Greenland, year 1990-2008 incl LULUCF, trend assessment, tier 1.

Table 7.A2 (of Good Practice Guidance) Tier 1 Analysis - Trend Assessment DK+GRL-inventory

A			B	C	D	E	F	G
IPCC Source Categories (LULUCF included)			Direct GHG	Base Year Estimate Ex,o Mt CO_2-eq	Year 2008 Estimate Ex,t Mt CO_2-eq	Trend Assess-ment Tx,t	Contri bution to Trend	Cumul. total of col. F
Energy	Combustion excluding transport	Solid Fuels	CO2	24.2259	16.1616	0.1093	0.2231	0.2231
Energy	Combustion excluding transport	Gaseous Fuels	CO2	4.3195	9.7644	0.0876	0.1786	0.4017
Energy	Road transportation		CO2	9.3118	12.9826	0.0633	0.1291	0.5308
Energy	Combustion excluding transport	Liquid Fuels	CO2	12.3012	8.3307	0.0536	0.1093	0.6401
LULUCF	Cropland	5B Cropland rem. Cr. Mineral soils	CO2	-2.0207	-0.5107	0.0221	0.0452	0.6853
Agriculture	Agriculture soils, indirect	Nitrogen Leaching and Run-off	N2O	3.3345	1.9942	0.0186	0.0380	0.7233
Industrial processes	Nitric acid production		N2O	1.0429	0.0000	0.0155	0.0317	0.7550
Agriculture	Agriculture soils, direct emissions	Synthetic Fertilizers	N2O	2.3946	1.3194	0.0151	0.0309	0.7858
Energy	Combustion excluding transport	Other Fuels	CO2	0.3948	1.3482	0.0151	0.0308	0.8166
LULUCF	Forest Land remaining Forest L.	5A1 Broadleaves	CO2	-0.6487	0.1992	0.0128	0.0260	0.8426
Industrial processes	Refrigeration and AC Equipment		HFC and PFC	0.0442	0.7457	0.0109	0.0223	0.8650
LULUCF	Forest Land remaining Forest L.	5A1 Conifers	CO2	-0.2543	0.2387	0.0075	0.0153	0.8803
LULUCF	Agricultural lime application	5IV Cropland Limestone	CO2	0.5652	0.2288	0.0049	0.0099	0.8902
Industrial processes	Cement production		CO2	0.8824	1.1547	0.0048	0.0098	0.9000
Agriculture	Enteric Fermentation		CH4	3.2672	2.8249	0.0047	0.0096	0.9096
Energy	Domestic navigation		CO2	0.7346	0.4773	0.0035	0.0072	0.9168
Agriculture	Manure Management		CH4	0.8693	1.0499	0.0034	0.0069	0.9237
Energy	Combustion excluding transport	Gaseous Fuels	CH4	0.0130	0.2000	0.0029	0.0060	0.9296
Agriculture	Agriculture soils, indirect	Atmospheric Deposition	N2O	0.4415	0.2863	0.0021	0.0043	0.9340
Agriculture	Manure management		N2O	0.6675	0.5060	0.0021	0.0042	0.9382
Energy	Combustion excluding transport	Biomass	CH4	0.0861	0.2081	0.0020	0.0040	0.9422
Agriculture	Agriculture soils, direct emissions	Animal Manure Appl. to Soils	N2O	1.0505	1.1238	0.0018	0.0038	0.9459
LULUCF	Cropland	5B Cropland remaining Cr. Living biomass	CO2	-0.0691	0.0497	0.0018	0.0037	0.9496
LULUCF	Grassland	5C Land converted to Grassland, Living biomass	CO2	0.1783	0.0550	0.0018	0.0037	0.9533
Energy	Fugitive emissions	1B2aiv, Oil refining and storage	CH4	0.0328	0.1211	0.0014	0.0028	0.9561
Agriculture	Agriculture soils, pasture, range and paddock		N2O	0.3149	0.2149	0.0013	0.0027	0.9589
Energy	Fugitive emissions	1B2c2ii, Flaring gas	CO2	0.2762	0.3478	0.0013	0.0026	0.9615
Industrial processes	Foam Blowing		HFC	0.1826	0.1026	0.0011	0.0023	0.9638
LULUCF	Cropland	5B Cropland rem. Cr. Organic soils	CO2	1.0555	1.0700	0.0009	0.0019	0.9657

Continued								
Energy	Civil aviation		CO2	0.2810	0.2173	0.0008	0.0016	0.9673
Agriculture	Agriculture soils, direct emissions	Sludge	N2O	0.0279	0.0783	0.0008	0.0016	0.9690
LULUCF	Wetlands	5D Wetlands remaining Wetlands (peat)	CO2	0.0861	0.0331	0.0008	0.0016	0.9705
Industrial processes	Other emissions of SF6 i.e. from double glaze windows and laboratories		SF6	0.0676	0.0154	0.0008	0.0016	0.9721
Waste	N_2O direct, Domestic and Commercial Wastewater		N2O	0.0362	0.0830	0.0008	0.0015	0.9736
Energy	Railways		CO2	0.2967	0.2367	0.0007	0.0015	0.9751
Agriculture	Agriculture soils, direct emissions	N-fixing Crops	N2O	0.2695	0.2127	0.0007	0.0014	0.9766
Industrial processes	Lime production		CO2	0.1155	0.0656	0.0007	0.0014	0.9780
Waste	N_2O indirect from human sewage		N2O	0.0852	0.0377	0.0007	0.0014	0.9794
Energy	Combustion excluding transport	Biomass	N2O	0.0510	0.0926	0.0007	0.0014	0.9808
Solvents and other product use	Other solvent		CO2	0.0860	0.0411	0.0006	0.0013	0.9821
LULUCF	Wetlands	5D Land converted to wetlands	CO2	0.0004	-0.0404	0.0006	0.0013	0.9834
Agriculture	Agriculture soils, direct emissions	Crop Residue	N2O	0.3613	0.3052	0.0006	0.0013	0.9847
Energy	Combustion excluding transport	Gaseous Fuels	N2O	0.0278	0.0613	0.0005	0.0011	0.9858
Industrial processes	Magnesium Production		SF6	0.0359	0.0000	0.0005	0.0011	0.9869
Energy	Road transportation		N2O	0.0971	0.1257	0.0005	0.0010	0.9879
Energy	Road transportation		CH4	0.0551	0.0221	0.0005	0.0010	0.9889
Energy	Combustion excluding transport	Solid Fuels	N2O	0.0798	0.0490	0.0004	0.0009	0.9897
Solvents and other product use	Other solvent		N2O	0.0000	0.0273	0.0004	0.0009	0.9906
Industrial processes	Iron and steel production		CO2	0.0284	0.0000	0.0004	0.0009	0.9915
Industrial processes	Limestone and dolomite use		CO2	0.0137	0.0387	0.0004	0.0008	0.9923
LULUCF	Settlements	5E Total settlements. Living bio-mass	CO2	0.0796	0.0518	0.0004	0.0008	0.9930
Energy	Combustion excluding transport	Liquid Fuels	N2O	0.1163	0.0896	0.0003	0.0007	0.9937
Industrial processes	Aerosols		HFC	0.0000	0.0186	0.0003	0.0006	0.9943
Waste	Waste Water Handling		CH4	0.0304	0.0473	0.0003	0.0006	0.9949
LULUCF	Cropland	5B Land converted to Cropland. Living biomass	CO2	0.0160	-0.0013	0.0003	0.0005	0.9954
Solvents and other product use	Paint application		CO2	0.0263	0.0092	0.0002	0.0005	0.9959
Solvents and other product use	Other, lubricants		CO2	0.0497	0.0340	0.0002	0.0004	0.9964
Industrial processes	Electrical equipment		SF6	0.0039	0.0162	0.0002	0.0004	0.9968
LULUCF	Land converted to Forest L.	5A2 Conifers	CO2	0.0051	-0.0048	0.0002	0.0003	0.9971
Waste	Waste incineration		CO2	0.0236	0.0314	0.0001	0.0003	0.9974
LULUCF	Grassland	5C Grassland rem. Grasland. Organic soils	CO2	0.0930	0.0815	0.0001	0.0002	0.9976
Solvents and other product use	Chemical Products, Manufacture and Processing		CO2	0.0231	0.0146	0.0001	0.0002	0.9978
Industrial processes	Bricks		CO2	0.0230	0.0284	0.0001	0.0002	0.9980

Continued								
LULUCF	Land converted to Forest L.	5A2 Broadleaves	CO2	0.0033	-0.0031	0.0001	0.0002	0.9982
Energy	Combustion excluding transport	Solid Fuels	CH4	0.0149	0.0081	0.0001	0.0002	0.9984
Waste	Solid Waste Disposal Sites		CH4	1.1145	1.0607	0.0001	0.0002	0.9986
Energy	Fugitive emissions	1B2c2i, Flaring oil	CO2	0.0234	0.0282	0.0001	0.0002	0.9988
Agriculture	Agriculture soils, direct emissions	Cultivation of Histosols	N2O	0.1165	0.1168	0.0001	0.0002	0.9990
Industrial processes	Other i.e Fibre Optics		HFC and PFC	0.0000	0.0052	0.0001	0.0002	0.9991
Energy	Domestic navigation		N2O	0.0134	0.0080	0.0001	0.0002	0.9993
LULUCF	Non-CO_2 drainage of soils and wetlands	5IID Forest Land.	N2O	0.0157	0.0122	< 0.0001	0.0001	0.9994
LULUCF	N_2O Disturbance, Land converted to cropland	5III Cropland	N2O	0.0032	0.0004	< 0.0001	0.0001	0.9995
Energy	Combustion excluding transport	Other Fuels	N2O	0.0059	0.0081	< 0.0001	0.0001	0.9995
Industrial processes	Expanded clay		CO2	0.0149	0.0161	< 0.0001	0.0001	0.9996
Industrial processes	Catalysts/Fertilizers, Pesticides and Sulphuric acid		CO2	0.0008	0.0024	< 0.0001	0.0001	0.9996
Industrial processes	Food and drink		CO2	0.0045	0.0027	< 0.0001	0.0001	0.9997
Industrial processes	Glass production		CO2	0.0174	0.0151	< 0.0001	0.0001	0.9998
Energy	Fugitive emissions	1B2biv, Gas distribution	CH4	0.0053	0.0037	< 0.0001	< 0.0001	0.9998
Energy	Combustion excluding transport	Liquid Fuels	CH4	0.0151	0.0132	< 0.0001	< 0.0001	0.9998
Energy	Fugitive emissions	1B2c2i, Flaring oil	CH4	0.0013	0.0002	< 0.0001	< 0.0001	0.9999
Agriculture	Field Burning of Agricultural Residues		CH4	0.0018	0.0024	< 0.0001	< 0.0001	0.9999
Energy	Fugitive emissions	1B2biii, Gas transmission	CH4	0.0036	0.0027	< 0.0001	< 0.0001	0.9999
Energy	Railways		N2O	0.0025	0.0020	< 0.0001	< 0.0001	0.9999
Energy	Fugitive emissions	1B2c2ii, Flaring gas	CH4	0.0004	0.0008	< 0.0001	< 0.0001	0.9999
Agriculture	Field Burning of Agricultural Residues		N2O	0.0007	0.0009	< 0.0001	< 0.0001	0.9999
LULUCF	Grassland	5C Grassland rem. Grasland. Living biomass	CO2	0.0039	0.0040	< 0.0001	< 0.0001	1.0000
Industrial processes	Road Paving with asphalt		CO2	0.0018	0.0019	< 0.0001	< 0.0001	1.0000
Energy	Civil aviation		N2O	0.0035	0.0032	< 0.0001	< 0.0001	1.0000
Waste	Waste incineration		CH4	0.0049	0.0049	< 0.0001	< 0.0001	1.0000
Energy	Combustion excluding transport	Other Fuels	CH4	0.0006	0.0004	< 0.0001	< 0.0001	1.0000
Energy	Fugitive emissions	1B2c2ii, Flaring gas	N2O	0.0006	0.0008	< 0.0001	< 0.0001	1.0000
Waste	Waste incineration		N2O	0.0013	0.0011	< 0.0001	< 0.0001	1.0000
Energy	Railways		CH4	0.0003	0.0002	< 0.0001	< 0.0001	1.0000
Energy	Domestic navigation		CH4	0.0007	0.0007	< 0.0001	< 0.0001	1.0000
Energy	Fugitive emissions	1B2c2i, Flaring oil	N2O	0.0001	0.0001	< 0.0001	< 0.0001	1.0000
LULUCF	Cropland	5B Land converted to Cropland. Organic soils	CO2	0.0000	0.0000	< 0.0001	< 0.0001	1.0000
Energy	Civil aviation		CH4	0.0002	0.0001	< 0.0001	< 0.0001	1.0000
Industrial processes	Asphalt roofing		CO2	0.0000	0.0000	< 0.0001	< 0.0001	1.0000

Continued								
LULUCF	Cropland	5B Land converted to Cropland. Mineral soils	CO2	0.0000	0.0000	< 0.0001	< 0.0001	1.0000
LULUCF	Non-CO_2 drainage of soils and wetlands	5IID Wetlands. Peatland	N2O	0.0001	0.0001	< 0.0001	< 0.0001	1.0000
Solvents and other product use	Degreasing and Dry Cleaning		CO2	0.0000	0.0000	< 0.0001	< 0.0001	1.0000
Total (incl Lulucf)				**68.9842**	**66.0379**		**1.0000**	

Table 8 Key Category Analysis for Denmark and Greenland, year 1990-2008 excl LULUCF, trend assessment, tier 1.

Table 7.A2 (of Good Practice Guidance) Tier 1 Analysis - Trend Assessment DK+GRL-inventory								
A			B	C	D	E	F	G
IPCC Source Categories (LULUCF excluded)			Direct Greenh. Gas	Base Year Estimate Ex,o Mt CO2-eq	Year 2008 Estimate Ex,t Mt CO2-eq	Trend Assess-ment Tx,t	Contri bution to Trend	Cumul. total of col. F
Energy	Combustion excluding transport	Gaseous Fuels	CO2	4.3195	9.7644	0.1018	0.2452	0.2452
Energy	Road transportation		CO2	9.3118	12.9826	0.0843	0.2030	0.4482
Energy	Combustion excluding transport	Solid Fuels	CO2	24.2259	16.1616	0.0759	0.1828	0.6311
Energy	Combustion excluding transport	Liquid Fuels	CO2	12.3012	8.3307	0.0365	0.0878	0.7189
Energy	Combustion excluding transport	Other Fuels	CO2	0.3948	1.3482	0.0169	0.0408	0.7597
Industrial processes	Nitric acid production		N2O	1.0429	0.0000	0.0149	0.0360	0.7957
Agriculture	Agriculture soils, indirect	Nitrogen Leaching and Run-off	N2O	3.3345	1.9942	0.0143	0.0345	0.8301
Agriculture	Agriculture soils, direct emissions	Synthetic Fertilizers	N2O	2.3946	1.3194	0.0122	0.0293	0.8594
Industrial processes	Refrigeration and AC Equipment		HFC and PFC	0.0442	0.7457	0.0119	0.0286	0.8880
Industrial processes	Cement production		CO2	0.8824	1.1547	0.0067	0.0162	0.9042
Agriculture	Manure Management		CH4	0.8693	1.0499	0.0052	0.0124	0.9166
Agriculture	Agriculture soils, direct emissions	Animal Manure Appl. to Soils	N2O	1.0505	1.1238	0.0038	0.0091	0.9257
Energy	Combustion excluding transport	Gaseous Fuels	CH4	0.0130	0.2000	0.0032	0.0076	0.9334
Energy	Domestic navigation		CO2	0.7346	0.4773	0.0025	0.0061	0.9394
Energy	Combustion excluding transport	Biomass	CH4	0.0861	0.2081	0.0023	0.0054	0.9449
Energy	Fugitive emissions	1B2c2ii, Flaring gas	CO2	0.2762	0.3478	0.0019	0.0045	0.9494
Waste	Solid Waste Disposal Sites		CH4	1.1145	1.0607	0.0018	0.0044	0.9538
Energy	Fugitive emissions	1B2aiv, Oil refining and storage	CH4	0.0328	0.1211	0.0016	0.0038	0.9575
Agriculture	Agriculture soils, indirect	Atmospheric Deposition	N2O	0.4415	0.2863	0.0015	0.0037	0.9612
Agriculture	Manure management		N2O	0.6675	0.5060	0.0011	0.0026	0.9638
Agriculture	Agriculture soils, direct emissions	Sludge	N2O	0.0279	0.0783	0.0009	0.0022	0.9660
Agriculture	Agriculture soils, pasture, range and paddock		N2O	0.3149	0.2149	0.0009	0.0022	0.9682
Industrial processes	Foam Blowing		HFC	0.1826	0.1026	0.0009	0.0022	0.9703
Waste	N_2O direct, Domestic and Commercial Wastewater		N2O	0.0362	0.0830	0.0009	0.0021	0.9724
Energy	Combustion excluding transport	Biomass	N2O	0.0510	0.0926	0.0008	0.0020	0.9744
Energy	Road transportation		N2O	0.0971	0.1257	0.0007	0.0017	0.9761
Industrial processes	Other emissions of SF6 i.e. from double glaze windows and laboratories		SF6	0.0676	0.0154	0.0007	0.0017	0.9778
Energy	Combustion excluding transport	Gaseous Fuels	N2O	0.0278	0.0613	0.0006	0.0015	0.9793
Waste	N_2O indirect from human sewage		N2O	0.0852	0.0377	0.0006	0.0014	0.9808

Continued								
Agriculture	Enteric Fermentation		CH4	3.2672	2.8249	0.0006	0.0014	0.9821
Industrial processes	Lime production		CO2	0.1155	0.0656	0.0006	0.0013	0.9835
Solvents and other product use	Other solvent		CO2	0.0860	0.0411	0.0005	0.0013	0.9848
Industrial processes	Magnesium Production		SF6	0.0359	0.0000	0.0005	0.0012	0.9860
Solvents and other product use	Other solvent		N2O	0.0000	0.0273	0.0005	0.0011	0.9871
Industrial processes	Limestone and dolomite use		CO2	0.0137	0.0387	0.0005	0.0011	0.9882
Energy	Road transportation		CH4	0.0551	0.0221	0.0004	0.0010	0.9892
Industrial processes	Iron and steel production		CO2	0.0284	0.0000	0.0004	0.0010	0.9902
Energy	Civil aviation		CO2	0.2810	0.2173	0.0004	0.0009	0.9911
Waste	Waste Water Handling		CH4	0.0304	0.0473	0.0004	0.0009	0.9920
Energy	Combustion excluding transport	Solid Fuels	N2O	0.0798	0.0490	0.0003	0.0008	0.9927
Industrial processes	Aerosols		HFC	0.0000	0.0186	0.0003	0.0007	0.9935
Agriculture	Agriculture soils, direct emissions	N-fixing Crops	N2O	0.2695	0.2127	0.0003	0.0007	0.9942
Agriculture	Agriculture soils, direct emissions	Cultivation of Histosols	N2O	0.1165	0.1168	0.0003	0.0007	0.9949
Energy	Railways		CO2	0.2967	0.2367	0.0003	0.0007	0.9956
Solvents and other product use	Paint application		CO2	0.0263	0.0092	0.0002	0.0005	0.9961
Industrial processes	Electrical equipment		SF6	0.0039	0.0162	0.0002	0.0005	0.9966
Waste	Waste incineration		CO2	0.0236	0.0314	0.0002	0.0005	0.9971
Energy	Combustion excluding transport	Liquid Fuels	N2O	0.1163	0.0896	0.0002	0.0004	0.9975
Industrial processes	Bricks		CO2	0.0230	0.0284	0.0001	0.0004	0.9978
Solvents and other product use	Other, lubricants		CO2	0.0497	0.0340	0.0001	0.0003	0.9982
Energy	Fugitive emissions	1B2c2i, Flaring oil	CO2	0.0234	0.0282	0.0001	0.0003	0.9985
Industrial processes	Other i.e Fibre Optics		HFC and PFC	0.0000	0.0052	0.0001	0.0002	0.9987
Solvents and other product use	Chemical Products, Manufacture and Processing		CO2	0.0231	0.0146	0.0001	0.0002	0.9989
Energy	Combustion excluding transport	Solid Fuels	CH4	0.0149	0.0081	0.0001	0.0002	0.9991
Energy	Domestic navigation		N2O	0.0134	0.0080	0.0001	0.0001	0.9992
Agriculture	Agriculture soils, direct emissions	Crop Residue	N2O	0.3613	0.3052	0.0001	0.0001	0.9994
Industrial processes	Expanded clay		CO2	0.0149	0.0161	0.0001	0.0001	0.9995
Energy	Combustion excluding transport	Other Fuels	N2O	0.0059	0.0081	0.0001	0.0001	0.9996
Industrial processes	Catalysts/Fertilizers, Pesticides and Sulphuric acid		CO2	0.0008	0.0024	< 0.0001	0.0001	0.9997
Industrial processes	Food and drink		CO2	0.0045	0.0027	< 0.0001	< 0.0001	0.9997
Energy	Fugitive emissions	1B2c2i, Flaring oil	CH4	0.0013	0.0002	< 0.0001	< 0.0001	0.9998
Energy	Fugitive emissions	1B2biv, Gas distribution	CH4	0.0053	0.0037	< 0.0001	< 0.0001	0.9998
Agriculture	Field Burning of Agricultural Residues		CH4	0.0018	0.0024	< 0.0001	< 0.0001	0.9999
Waste	Waste incineration		CH4	0.0049	0.0049	< 0.0001	< 0.0001	0.9999
Energy	Fugitive emissions	1B2c2ii, Flaring gas	CH4	0.0004	0.0008	< 0.0001	< 0.0001	0.9999

Continued								
Industrial processes	Road Paving with asphalt		CO2	0.0018	0.0019	< 0.0001	< 0.0001	0.9999
Agriculture	Field Burning of Agricultural Residues		N2O	0.0007	0.0009	< 0.0001	< 0.0001	0.9999
Energy	Fugitive emissions	1B2biii, Gas transmission	CH4	0.0036	0.0027	< 0.0001	< 0.0001	0.9999
Energy	Combustion excluding transport	Liquid Fuels	CH4	0.0151	0.0132	< 0.0001	< 0.0001	1.0000
Energy	Fugitive emissions	1B2c2ii, Flaring gas	N2O	0.0006	0.0008	< 0.0001	< 0.0001	1.0000
Industrial processes	Glass production		CO2	0.0174	0.0151	< 0.0001	< 0.0001	1.0000
Energy	Railways		N2O	0.0025	0.0020	< 0.0001	< 0.0001	1.0000
Energy	Civil aviation		N2O	0.0035	0.0032	< 0.0001	< 0.0001	1.0000
Energy	Domestic navigation		CH4	0.0007	0.0007	< 0.0001	< 0.0001	1.0000
Energy	Combustion excluding transport	Other Fuels	CH4	0.0006	0.0004	< 0.0001	< 0.0001	1.0000
Energy	Railways		CH4	0.0003	0.0002	< 0.0001	< 0.0001	1.0000
Energy	Fugitive emissions	1B2c2i, Flaring oil	N2O	0.0001	0.0001	< 0.0001	< 0.0001	1.0000
Waste	Waste incineration		N2O	0.0013	0.0011	< 0.0001	< 0.0001	1.0000
Industrial processes	Asphalt roofing		CO2	0.0000	0.0000	< 0.0001	< 0.0001	1.0000
Energy	Civil aviation		CH4	0.0002	0.0001	< 0.0001	< 0.0001	1.0000
Solvents and other product use	Degreasing and Dry Cleaning		CO2	0.0000	0.0000	< 0.0001	< 0.0001	1.0000
Energy	Fugitive emissions	1B2biii, Gas transmission	CH4	0.0036	0.0027	< 0.0001	< 0.0001	0.9999
Energy	Railways		N2O	0.0025	0.0020	< 0.0001	< 0.0001	0.9999
Energy	Fugitive emissions	1B2c2ii, Flaring gas	CH4	0.0004	0.0008	< 0.0001	< 0.0001	0.9999
Agriculture	Field Burning of Agricultural Residues		N2O	0.0007	0.0009	< 0.0001	< 0.0001	0.9999
LULUCF	Grassland	5C Grassland rem. Grasland. Living biomass	CO2	0.0039	0.0040	< 0.0001	< 0.0001	1.0000
Industrial processes	Road Paving with asphalt		CO2	0.0018	0.0019	< 0.0001	< 0.0001	1.0000
Energy	Civil aviation		N2O	0.0035	0.0032	< 0.0001	< 0.0001	1.0000
Waste	Waste incineration		CH4	0.0049	0.0049	< 0.0001	< 0.0001	1.0000
Energy	Combustion excluding transport	Other Fuels	CH4	0.0006	0.0004	< 0.0001	< 0.0001	1.0000
Energy	Fugitive emissions	1B2c2ii, Flaring gas	N2O	0.0006	0.0008	< 0.0001	< 0.0001	1.0000
Waste	Waste incineration		N2O	0.0013	0.0011	< 0.0001	< 0.0001	1.0000
Energy	Railways		CH4	0.0003	0.0002	< 0.0001	< 0.0001	1.0000
Energy	Domestic navigation		CH4	0.0007	0.0007	< 0.0001	< 0.0001	1.0000
Energy	Fugitive emissions	1B2c2i, Flaring oil	N2O	0.0001	0.0001	< 0.0001	< 0.0001	1.0000
LULUCF	Cropland	5B Land converted to Cropland. Organic soils	CO2	0.0000	0.0000	< 0.0001	< 0.0001	1.0000
Energy	Civil aviation		CH4	0.0002	0.0001	< 0.0001	< 0.0001	1.0000
Industrial processes	Asphalt roofing		CO2	0.0000	0.0000	< 0.0001	< 0.0001	1.0000
LULUCF	Cropland	5B Land converted to Cropland. Mineral soils	CO2	0.0000	0.0000	< 0.0001	< 0.0001	1.0000
LULUCF	Non-CO_2 drainage of soils and wetlands	5IID Wetlands. Peatland	N2O	0.0001	0.0001	< 0.0001	< 0.0001	1.0000

Continued								
Solvents and other product use	Degreasing and Dry Cleaning		CO2	0.0000	0.0000	< 0.0001	< 0.0001	1.0000
Total (incl Lulucf)				**68.9842**	**66.0379**		**1.0000**	

Table 9 Summary of Key Category Analysis for Denmark and Greenland, tier 1, for level assessment for year 2008 and for trend for years 1990-2008, incl and excl. LULUCF.

Table 7.A3 (modified from Good Practice Guidence) Summary of Key Category Analysis for Denmark and Greenland Inventory

IPCC Source Categories (LULUCF included)			GHG	Key categories with number according to ranking in analysis. Identification criteria: Level Tier1 incl LULUCF 1990/95	Level Tier1 incl LULUCF 2008	Trend Tier1 incl LULUCF 1990-2008	Level Tier1 excl LULUCF 1990/95	Level Tier1 excl LULUCF 2008	Trend Tier1 excl LULUCF 1990-2008
Energy	Combustion excluding transport	Liquid Fuels	CO2	2	4	4	2	4	4
Energy	Combustion excluding transport	Solid Fuels	CO2	1	1	1	1	1	3
Energy	Combustion excluding transport	Gaseous Fuels	CO2	4	3	2	4	3	1
Energy	Combustion excluding transport	Other Fuels	CO2	20	7	9	16	7	5
Energy	Combustion excluding transport	Liquid Fuels	CH4						
Energy	Combustion excluding transport	Solid Fuels	CH4						
Energy	Combustion excluding transport	Gaseous Fuels	CH4			18			13
Energy	Combustion excluding transport	Biomass	CH4			21			15
Energy	Combustion excluding transport	Other Fuels	CH4						
Energy	Combustion excluding transport	Liquid Fuels	N2O						
Energy	Combustion excluding transport	Solid Fuels	N2O						
Energy	Combustion excluding transport	Gaseous Fuels	N2O						
Energy	Combustion excluding transport	Biomass	N2O						
Energy	Combustion excluding transport	Other Fuels	N2O						
Energy	Road transportation		CO2	3	2	3	3	2	2
Energy	Road transportation		CH4						
Energy	Road transportation		N2O						
Energy	Civil aviation		CO2						
Energy	Civil aviation		CH4						
Energy	Civil aviation		N2O						
Energy	Domestic navigation		CO2	15	17	16	13	15	14
Energy	Domestic navigation		CH4						
Energy	Domestic navigation		N2O						
Energy	Railways		CO2						
Energy	Railways		CH4						
Energy	Railways		N2O						
Energy	Fugitive emissions	1B2aiv, Oil refining and storage	CH4						
Energy	Fugitive emissions	1B2biii, Gas transmission	CH4						
Energy	Fugitive emissions	1B2biv, Gas distribution	CH4						

Continued

Energy	Fugitive emissions	1B2c2ii, Flaring gas	CO_2		18			16	16
Energy	Fugitive emissions	1B2c2ii, Flaring gas	CH_4						
Energy	Fugitive emissions	1B2c2ii, Flaring gas	N_2O						
Energy	Fugitive emissions	1B2c2i, Flaring oil	CO_2						
Energy	Fugitive emissions	1B2c2i, Flaring oil	CH_4						
Energy	Fugitive emissions	1B2c2i, Flaring oil	N_2O						
Industrial processes	Cement production		CO_2	13	9	14	11	9	10
Industrial processes	Lime production		CO_2						
Industrial processes	Limestone and dolomite use		CO_2						
Industrial processes	Asphalt roofing		CO_2						
Industrial processes	Road Paving with asphalt		CO_2						
Industrial processes	Glass production		CO_2						
Industrial processes	Bricks		CO_2						
Industrial processes	Expanded clay		CO_2						
Industrial processes	Nitric acid production		N_2O	12		7	10		6
Industrial processes	Catalysts/Fertilizers, Pesticides and Sulphuric acid		CO_2						
Industrial processes	Iron and steel production		CO_2						
Industrial processes	Food and drink		CO_2						
Industrial processes	Refrigeration and AC Equipment		HFC and PFC		14	11		13	9
Industrial processes	Foam Blowing		HFC						
Industrial processes	Aerosols		HFC						
Industrial processes	Electrical equipment		SF_6						
Industrial processes	Other emissions of SF_6 i.e. from double glaze windows and laboratories		SF_6						
Industrial processes	Other i.e Fibre Optics		HFC and PFC						
Industrial processes	Magnesium Production		SF_6						
Solvents and other product use	Other, lubricants		CO_2						
Solvents and other product use	Paint application		CO_2						
Solvents and other product use	Degreasing and Dry Cleaning		CO_2						
Solvents and other product use	Chemical Products, Manufacture and Processing		CO_2						
Solvents and other product use	Other solvent		CO_2						
Solvents and other product use	Other solvent		N_2O						
Agriculture	Enteric Fermentation		CH_4	6	5	15	6	5	
Agriculture	Manure Management		CH_4	14	13	17	12	12	11
Agriculture	Manure management		N_2O	16	16	20	14	14	
Agriculture	Agriculture soils, direct emissions	Synthetic Fertilizers	N_2O	7	8	8	7	8	8
Agriculture	Agriculture soils, direct emissions	Animal Manure Appl. to Soils	N_2O	11	10	22	9	10	12

Continued

Agriculture	Agriculture soils, direct emissions	N-fixing Crops	N2O						
Agriculture	Agriculture soils, direct emissions	Crop Residue	N2O	21	19				
Agriculture	Agriculture soils, direct emissions	Cultivation of Histosols	N2O						
Agriculture	Agriculture soils, direct emissions	Sludge	N2O						
Agriculture	Agriculture soils, pasture, range and paddock		N2O						
Agriculture	Agriculture soils, indirect	Atmospheric Deposition	N2O	19	20	19	15		
Agriculture	Agriculture soils, indirect	Nitrogen Leaching and Run-off	N2O	5	6	6	5	6	7
Agriculture	Field Burning of Agricultural Residues		CH4						
Agriculture	Field Burning of Agricultural Residues		N2O						
Waste	Solid Waste Disposal Sites		CH4	9	12		8	11	
Waste	N_2O direct, Domestic and Commercial Wastewater		N2O						
Waste	N_2O indirect from human sewage		N2O						
Waste	Waste Water Handling		CH4						
Waste	Waste incineration		CO2						
Waste	Waste incineration		CH4						
Waste	Waste incineration		N2O						
LULUCF	Forest Land remaining Forest L.	5A1 Broadleaves	CO2	17		10			
LULUCF	Forest Land remaining Forest L.	5A1 Conifers	CO2		21	12			
LULUCF	Land converted to Forest L.	5A2 Broadleaves	CO2						
LULUCF	Land converted to Forest L.	5A2 Conifers	CO2						
LULUCF	Cropland	5B Cropland rem. Cr. Organic soils	CO2	10	11				
LULUCF	Cropland	5B Cropland rem. Cr. Mineral soils	CO2	8	15	5			
LULUCF	Cropland	5B Cropland remaining Cr. Living biomass	CO2			23			
LULUCF	Cropland	5B Land converted to Cropland. Organic soils	CO2						
LULUCF	Cropland	5B Land converted to Cropland. Mineral soils	CO2						
LULUCF	Cropland	5B Land converted to Cropland. Living biomass	CO2						
LULUCF	Grassland	5C Grassland rem. Grasland. Organic soils	CO2						
LULUCF	Grassland	5C Grassland rem. Grasland. Living biomass	CO2						
LULUCF	Grassland	5C Land converted to Grassland, Living biomass	CO2						
LULUCF	Wetlands	5D Wetlands remaining Wetlands (peat)	CO2						
LULUCF	Wetlands	5D Land converted to wetlands	CO2						
LULUCF	Settlements	5E Total settlements. Living biomass	CO2						

Continued

LULUCF	Non-CO_2 drainage of soils and wetlands	5IID Forest Land.	N2O			
LULUCF	Non-CO_2 drainage of soils and wetlands	5IID Wetlands. Peatland	N2O			
LULUCF	N_2O Disturbance, Land converted to cropland	5III Cropland	N2O			
LULUCF	Agricultural lime application	5IV Cropland Limestone	CO2	18	13	

Annex 11 Methodology applied for the GHG inventory for Faroe Islands

GHG inventory for Faroe Islands

The GHG inventory for the Faroe Islands includes the following sectors:

- Energy sector (Including waste incineration)
- Industrial processes (consumption of F-gasses)
- Agriculture (sheep and cows)

Short description of recalculations and improvements compared to the 2009 inventory submission.

For the first time activity data and emissions are reported in the full CRF format for the years 1990-2008 using CRF Reporter. This improvement has meant higher data security and limited the potential for errors in the reporting. The emission inventory is both reported in the form of an xml file and as CRF excel tables.

Energy

The inventory includes all oil bunkered in Faroese territory excluding oil bunkered at open sea by international companies. (From foreign supplier to foreign customer)

In previous inventories bunkering of airplanes in the Faroe Islands was excluded by mistake. This has been corrected. In this inventory the fuel consumption for Atlantic Airways has been split into international and civil aviation. This has not been possible for fuel sold to other airlines (500-1000 t per year). Therefore this consumption has been included under civil aviation.

Waste incineration has been included under sector 1A1a.

Planned improvements

- Fuel sale to other airlines than Atlantic Airways should be divided into international aviation and civil aviation.
- Emissions from the use of lubricants should be completed.

Industrial processes

In order to use the CRF Reporter all emissions of HFC's needed to be calculated in units of mass, previously the HFC's were reported directly in CO_2 equivalents.

The HFC emissions are reported with the following assumptions:

- Domestic refrigeration is use in freezers and refrigerators.
- Commercial refrigeration is use in land based units.
- Industrial refrigeration is use in ships.
- Mobile air condition is use in cars, buses and trucks.

Agriculture

There are no significant changes to the emission inventory submission in 2009.

Planned improvements

- Include emissions from other animal categories than cattle and sheep.

Waste

There are two waste incineration plants in the Faroe Islands. Both plants are with energy recovery and therefore the emissions have been allocated to the energy sector in accordance with the IPCC Guidelines. The calculation of emissions has been changed to account for the fact that the waste contains both a biogenic and fossil part.

Emission trends

The trend tables 1990-2008 for CO_2, CH_4, N_2O, f-gases and CO_2 equivalents (CRF: Table10) are presented below.

Table A11.1

TABLE 10 EMISSION TRENDS

CO_2

(Part 1 of 2)

Inventory 2008

Submission 2010 v1.2

Faroe Islands

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
1. Energy	**665,48**	**646,30**	**636,41**	**526,65**	**531,58**	**537,90**	**558,16**	**553,72**	**596,98**	**638,65**
A. Fuel Combustion (Sectoral Approach)	665,48	646,30	636,41	526,65	531,58	537,90	558,16	553,72	596,98	638,65
1. Energy Industries	94,41	90,90	90,80	84,31	80,26	77,68	92,41	86,34	96,81	98,77
2. Manufacturing Industries and Construction	62,16	73,47	43,49	39,46	38,53	32,03	38,08	37,85	54,22	52,74
3. Transport	105,12	103,34	114,48	99,53	90,86	97,89	93,15	102,43	95,69	110,34
4. Other Sectors	403,79	378,59	387,64	303,35	321,93	330,30	334,52	327,09	350,26	376,80
5. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
B. Fugitive Emissions from Fuels	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO
1. Solid Fuels	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO
2. Oil and Natural Gas	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO
2. Industrial Processes	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**
A. Mineral Products	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO
B. Chemical Industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Metal Production	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
D. Other Production	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
E. Production of Halocarbons and SF_6										
F. Consumption of Halocarbons and SF_6										
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3. Solvent and Other Product Use	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE
4. Agriculture										
A. Enteric Fermentation										
B. Manure Management										
C. Rice Cultivation										
D. Agricultural Soils										
E. Prescribed Burning of Savannas										
F. Field Burning of Agricultural Residues										
G. Other										
5. Land Use, Land-Use Change and Forestry(2)	**NA,NE**	**NA,NE**	**NA,NE**	**NA,NE**	**NA,NE**	**NA,NE**	**NA,NE**	**NA,NE**	**NA,NE**	**NA,NE**
A. Forest Land	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
B. Cropland	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
C. Grassland	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
D. Wetlands	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
E. Settlements	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
F. Other Land	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
6. Waste	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**
A. Solid Waste Disposal on Land	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO
B. Waste-water Handling										
C. Waste Incineration	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
D. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
7. Other ***(as specified in Summary 1.A)***	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Total CO_2 emissions including net CO_2 from LULUCF	**665,48**	**646,30**	**636,41**	**526,65**	**531,58**	**537,90**	**558,16**	**553,72**	**596,98**	**638,65**
Total CO_2 emissions excluding net CO_2 from LULUCF	**665,48**	**646,30**	**636,41**	**526,65**	**531,58**	**537,90**	**558,16**	**553,72**	**596,98**	**638,65**
Memo Items:										
International Bunkers	**NA,NE,NO**	**0,13**	**105,34**	**142,73**	**140,14**	**131,72**	**142,31**	**138,26**	**112,50**	**121,93**
Aviation	NO	0,13	0,13	0,13	0,13	0,13	0,29	0,29	0,44	0,59
Marine	NA,NE,NO	NA,NE,NO	105,21	142,60	140,01	131,59	142,02	137,96	112,06	121,34
Multilateral Operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
CO_2 Emissions from Biomass	15,90	15,92	17,18	16,41	15,83	16,65	18,46	21,21	25,71	27,56

Table A11.1 *continued.*

TABLE 10 EMISSION TRENDS
CO_2
(Part 2 of 2)

Inventory 2008
Submission 2010 v1.2
Faroe Islands

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	2008	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
1. Energy	**662,49**	**735,81**	**725,83**	**735,93**	**741,73**	**724,44**	**726,29**	**742,64**	**695,90**	**4,57**
A. Fuel Combustion (Sectoral Approach)	662,49	735,81	725,83	735,93	741,73	724,44	726,29	742,64	695,90	4,57
1. Energy Industries	117,19	161,10	124,61	131,32	120,88	110,38	120,20	126,67	134,64	42,61
2. Manufacturing Industries and Construction	59,53	66,93	67,85	78,40	73,68	65,58	59,97	60,91	55,98	-9,94
3. Transport	99,17	108,60	115,76	112,90	117,88	120,82	120,74	133,85	141,32	34,43
4. Other Sectors	386,60	399,18	417,61	413,30	429,28	427,67	425,37	421,21	363,96	-9,86
5. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	0,00
B. Fugitive Emissions from Fuels	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	0,00
1. Solid Fuels	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	0,00
2. Oil and Natural Gas	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	0,00
2. Industrial Processes	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**0,00**
A. Mineral Products	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	0,00
B. Chemical Industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	0,00
C. Metal Production	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
D. Other Production	NA	NA	NA	NA	NA	NA	NA	NA	NA	0,00
E. Production of Halocarbons and SF_6										
F. Consumption of Halocarbons and SF_6										
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	0,00
3. Solvent and Other Product Use	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	0,00
4. Agriculture										
A. Enteric Fermentation										
B. Manure Management										
C. Rice Cultivation										
D. Agricultural Soils										
E. Prescribed Burning of Savannas										
F. Field Burning of Agricultural Residues										
G. Other										
5. Land Use, Land-Use Change and Forestry(2)	**NA,NE**	**NA,NE**	**NA,NE**	**NA,NE**	**NA,NE**	**NA,NE**	**NA,NE**	**NA,NE**	**NA,NE**	**0,00**
A. Forest Land	NE	NE	NE	NE	NE	NE	NE	NE	NE	0,00
B. Cropland	NE	NE	NE	NE	NE	NE	NE	NE	NE	0,00
C. Grassland	NE	NE	NE	NE	NE	NE	NE	NE	NE	0,00
D. Wetlands	NE	NE	NE	NE	NE	NE	NE	NE	NE	0,00
E. Settlements	NE	NE	NE	NE	NE	NE	NE	NE	NE	0,00
F. Other Land	NE	NE	NE	NE	NE	NE	NE	NE	NE	0,00
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	0,00
6. Waste	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**0,00**
A. Solid Waste Disposal on Land	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	0,00
B. Waste-water Handling										
C. Waste Incineration	NA	NA	NA	NA	NA	NA	NA	NA	NA	0,00
D. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	0,00
7. Other ***(as specified in Summary 1.A)***	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**0,00**
Total CO_2 emissions including net CO_2 from LULUCF	**662,49**	**735,81**	**725,83**	**735,93**	**741,73**	**724,44**	**726,29**	**742,64**	**695,90**	**4,57**
Total CO_2 emissions excluding net CO_2 from LULUCF	**662,49**	**735,81**	**725,83**	**735,93**	**741,73**	**724,44**	**726,29**	**742,64**	**695,90**	**4,57**
Memo Items:										
International Bunkers	**136,46**	**177,77**	**75,05**	**65,89**	**75,84**	**66,24**	**25,78**	**25,54**	**19,67**	**100,00**
Aviation	0,88	1,48	1,15	1,25	1,15	1,21	1,29	1,05	1,00	100,00
Marine	135,59	176,29	73,90	64,64	74,68	65,04	24,50	24,50	18,67	100,00
Multilateral Operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	0,00
CO_2 Emissions from Biomass	28,18	28,99	29,53	27,24	25,48	24,88	24,86	28,86	27,51	72,98

Table A11.2

TABLE 10 EMISSION TRENDS
CH_4
(Part 1 of 2)

Inventory 2008
Submission 2010 v1.2
Faroe Islands

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
1. Energy	0,05	0,05	0,05	0,05	0,05	0,05	0,06	0,06	0,06	0,14
A. Fuel Combustion (Sectoral Approach)	0,05	0,05	0,05	0,05	0,05	0,05	0,06	0,06	0,06	0,14
1. Energy Industries	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,01	0,01
2. Manufacturing Industries and Construction	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
3. Transport	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,05	0,05	0,13
4. Other Sectors	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01
5. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
B. Fugitive Emissions from Fuels	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO
1. Solid Fuels	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO
2. Oil and Natural Gas	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO
2. Industrial Processes	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**
A. Mineral Products	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
B. Chemical Industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Metal Production	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
D. Other Production										
E. Production of Halocarbons and SF_6										
F. Consumption of Halocarbons and SF_6										
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3. Solvent and Other Product Use										
4. Agriculture	**0,82**	**0,79**	**0,80**	**0,80**	**0,84**	**0,84**	**0,84**	**0,84**	**0,83**	**0,83**
A. Enteric Fermentation	0,78	0,76	0,76	0,77	0,81	0,81	0,80	0,80	0,79	0,79
B. Manure Management	0,04	0,03	0,03	0,03	0,04	0,04	0,04	0,04	0,04	0,04
C. Rice Cultivation	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
D. Agricultural Soils	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE
E. Prescribed Burning of Savannas	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
F. Field Burning of Agricultural Residues	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5. Land Use, Land-Use Change and Forestry	**NA,NE**	**NA,NE**	**NA,NE**	**NA,NE**	**NA,NE**	**NA,NE**	**NA,NE**	**NA,NE**	**NA,NE**	**NA,NE**
A. Forest Land	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
B. Cropland	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
C. Grassland	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
D. Wetlands	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
E. Settlements	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE
F. Other Land	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
6. Waste	**,NA,NE,NO**	**,NA,NE,NO**	**,NA,NE,NO**	**,NA,NE,NO**	**,NA,NE,NO**	**,NA,NE,NO**	**,NA,NE,NO**	**,NA,NE,NO**	**,NA,NE,NO**	**,NA,NE,NO**
A. Solid Waste Disposal on Land	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO
B. Waste-water Handling	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE
C. Waste Incineration	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA
D. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
7. Other ***(as specified in Summary 1.A)***	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Total CH_4 emissions including CH_4 from LULUCF	**0,88**	**0,84**	**0,85**	**0,85**	**0,89**	**0,90**	**0,89**	**0,89**	**0,89**	**0,97**
Total CH_4 emissions excluding CH_4 from LULUCF	**0,88**	**0,84**	**0,85**	**0,85**	**0,89**	**0,90**	**0,89**	**0,89**	**0,89**	**0,97**
Memo Items:										
International Bunkers	NA,NE,NO	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,01	0,01
Aviation	NO	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Marine	NA,NE,NO	NA,NE,NO	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Multilateral Operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
CO_2 Emissions from Biomass										

Table A11.2 *continued.*

TABLE 10 EMISSION TRENDS
CH_4
(Part 2 of 2)

Inventory 2008
Submission 2010 v1.2
Faroe Islands

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	2008	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
1. Energy	0,06	0,07	0,08	0,07	0,09	0,14	0,13	0,12	0,12	124,28
A. Fuel Combustion (Sectoral Approach)	0,06	0,07	0,08	0,07	0,09	0,14	0,13	0,12	0,12	124,28
1. Energy Industries	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	60,30
2. Manufacturing Industries and Construction	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	-14,41
3. Transport	0,05	0,05	0,06	0,05	0,07	0,12	0,11	0,11	0,11	166,63
4. Other Sectors	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	-15,61
5. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	0,00
B. Fugitive Emissions from Fuels	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	0,00
1. Solid Fuels	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	0,00
2. Oil and Natural Gas	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	0,00
2. Industrial Processes	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**0,00**
A. Mineral Products	NO	NO	NO	NO	NO	NO	NO	NO	NO	0,00
B. Chemical Industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	0,00
C. Metal Production	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
D. Other Production										
E. Production of Halocarbons and SF_6										
F. Consumption of Halocarbons and SF_6										
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	0,00
3. Solvent and Other Product Use										
4. Agriculture	**0,84**	**0,84**	**0,85**	**0,85**	**0,84**	**0,82**	**0,81**	**0,82**	**0,81**	**-1,65**
A. Enteric Fermentation	0,80	0,81	0,81	0,81	0,80	0,79	0,78	0,78	0,77	-1,50
B. Manure Management	0,04	0,04	0,04	0,04	0,04	0,04	0,03	0,04	0,03	-4,74
C. Rice Cultivation	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
D. Agricultural Soils	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	0,00
E. Prescribed Burning of Savannas	NA	NA	NA	NA	NA	NA	NA	NA	NA	0,00
F. Field Burning of Agricultural Residues	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	0,00
5. Land Use, Land-Use Change and Forestry	**NA,NE**	**NA,NE**	**NA,NE**	**NA,NE**	**NA,NE**	**NA,NE**	**NA,NE**	**NA,NE**	**NA,NE**	**0,00**
A. Forest Land	NE	NE	NE	NE	NE	NE	NE	NE	NE	0,00
B. Cropland	NE	NE	NE	NE	NE	NE	NE	NE	NE	0,00
C. Grassland	NE	NE	NE	NE	NE	NE	NE	NE	NE	0,00
D. Wetlands	NE	NE	NE	NE	NE	NE	NE	NE	NE	0,00
E. Settlements	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	0,00
F. Other Land	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	0,00
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	0,00
6. Waste	**,NA,NE,NO**	**,NA,NE,NO**	**,NA,NE,NO**	**,NA,NE,NO**	**,NA,NE,NO**	**,NA,NE,NO**	**,NA,NE,NO**	**,NA,NE,NO**	**,NA,NE,NO**	**0,00**
A. Solid Waste Disposal on Land	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	0,00
B. Waste-water Handling	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	0,00
C. Waste Incineration	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	0,00
D. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	0,00
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**0,00**
Total CH_4 emissions including CH_4 from LULUCF	**0,90**	**0,91**	**0,92**	**0,92**	**0,93**	**0,96**	**0,95**	**0,94**	**0,93**	**6,23**
Total CH_4 emissions excluding CH_4 from LULUCF	**0,90**	**0,91**	**0,92**	**0,92**	**0,93**	**0,96**	**0,95**	**0,94**	**0,93**	**6,23**
Memo Items:										
International Bunkers	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	100,00
Aviation	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	100,00
Marine	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	100,00
Multilateral Operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	0,00
CO_2 Emissions from Biomass										

Table A11.3

TABLE 10 EMISSION TRENDS
N_2O
(Part 1 of 2)

Inventory 2008
Submission 2010 v1.2
Faroe Islands

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
1. Energy	**0,03**	**0,03**	**0,03**	**0,02**	**0,02**	**0,02**	**0,02**	**0,02**	**0,03**	**0,03**
A. Fuel Combustion (Sectoral Approach)	0,03	0,03	0,03	0,02	0,02	0,02	0,02	0,02	0,03	0,03
1. Energy Industries	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
2. Manufacturing Industries and Construction	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
3. Transport	0,00	0,00	0,01	0,00	0,00	0,00	0,00	0,01	0,00	0,00
4. Other Sectors	0,02	0,02	0,02	0,01	0,01	0,02	0,02	0,02	0,02	0,02
5. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
B. Fugitive Emissions from Fuels	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
1. Solid Fuels	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
2. Oil and Natural Gas	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
2. Industrial Processes	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**
A. Mineral Products	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
B. Chemical Industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Metal Production	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
D. Other Production										
E. Production of Halocarbons and SF_6										
F. Consumption of Halocarbons and SF_6										
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3. Solvent and Other Product Use	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE
4. Agriculture	**0,05**	**0,05**	**0,05**	**0,05**	**0,05**	**0,05**	**0,05**	**0,05**	**0,05**	**0,05**
A. Enteric Fermentation										
B. Manure Management	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
C. Rice Cultivation										
D. Agricultural Soils	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04
E. Prescribed Burning of Savannas	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
F. Field Burning of Agricultural Residues	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5. Land Use, Land-Use Change and Forestry	**NA,NE**	**NA,NE**	**NA,NE**	**NA,NE**	**NA,NE**	**NA,NE**	**NA,NE**	**NA,NE**	**NA,NE**	**NA,NE**
A. Forest Land	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
B. Cropland	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
C. Grassland	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
D. Wetlands	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
E. Settlements	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE
F. Other Land	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
6. Waste	**IE,NA,NE**	**IE,NA,NE**	**IE,NA,NE**	**IE,NA,NE**	**IE,NA,NE**	**IE,NA,NE**	**IE,NA,NE**	**IE,NA,NE**	**IE,NA,NE**	**IE,NA,NE**
A. Solid Waste Disposal on Land										
B. Waste-water Handling	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE
C. Waste Incineration	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA
D. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
7. Other ***(as specified in Summary 1.A)***	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Total N_2O emissions including N_2O from LULUCF	**0,08**	**0,07**	**0,08**	**0,07**	**0,07**	**0,07**	**0,07**	**0,07**	**0,07**	**0,08**
Total N_2O emissions excluding N_2O from LULUCF	**0,08**	**0,07**	**0,08**	**0,07**	**0,07**	**0,07**	**0,07**	**0,07**	**0,07**	**0,08**
Memo Items:										
International Bunkers	**NA,NE,NO**	**0,00**	**0,01**	**0,01**	**0,01**	**0,01**	**0,01**	**0,01**	**0,01**	**0,01**
Aviation	NO	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Marine	NA,NE,NO	NA,NE,NO	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01
Multilateral Operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
CO_2 Emissions from Biomass										

Table A11.3 *continued.*

TABLE 10 EMISSION TRENDS
N_2O
(Part 2 of 2)

Inventory 2008
Submission 2010 v1.2
Faroe Islands

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	2008	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
1. Energy	**0,03**	**0,03**	**0,03**	**0,03**	**0,03**	**0,03**	**0,03**	**0,03**	**0,03**	**-3,39**
A. Fuel Combustion (Sectoral Approach)	0,03	0,03	0,03	0,03	0,03	0,03	0,03	0,03	0,03	-3,39
1. Energy Industries	0,00	0,01	0,01	0,00	0,01	0,01	0,00	0,00	0,00	49,26
2. Manufacturing Industries and Construction	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	-9,53
3. Transport	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,01	0,01	13,62
4. Other Sectors	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	-15,88
5. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	0,00
B. Fugitive Emissions from Fuels	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
1. Solid Fuels	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
2. Oil and Natural Gas	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
2. Industrial Processes	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**0,00**
A. Mineral Products	NO	NO	NO	NO	NO	NO	NO	NO	NO	0,00
B. Chemical Industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	0,00
C. Metal Production	NA	NA	NA	NA	NA	NA	NA	NA	NA	0,00
D. Other Production										
E. Production of Halocarbons and SF_6										
F. Consumption of Halocarbons and SF_6										
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	0,00
3. Solvent and Other Product Use	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	0,00
4. Agriculture	**0,05**	**0,05**	**0,05**	**0,05**	**0,05**	**0,05**	**0,05**	**0,05**	**0,05**	**-0,28**
A. Enteric Fermentation										
B. Manure Management	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	-3,88
C. Rice Cultivation										
D. Agricultural Soils	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,01
E. Prescribed Burning of Savannas	NA	NA	NA	NA	NA	NA	NA	NA	NA	0,00
F. Field Burning of Agricultural Residues	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	0,00
5. Land Use, Land-Use Change and Forestry	**NA,NE**	**NA,NE**	**NA,NE**	**NA,NE**	**NA,NE**	**NA,NE**	**NA,NE**	**NA,NE**	**NA,NE**	**0,00**
A. Forest Land	NE	NE	NE	NE	NE	NE	NE	NE	NE	0,00
B. Cropland	NE	NE	NE	NE	NE	NE	NE	NE	NE	0,00
C. Grassland	NE	NE	NE	NE	NE	NE	NE	NE	NE	0,00
D. Wetlands	NE	NE	NE	NE	NE	NE	NE	NE	NE	0,00
E. Settlements	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	0,00
F. Other Land	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	0,00
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	0,00
6. Waste	**IE,NA,NE**	**IE,NA,NE**	**IE,NA,NE**	**IE,NA,NE**	**IE,NA,NE**	**IE,NA,NE**	**IE,NA,NE**	**IE,NA,NE**	**IE,NA,NE**	**0,00**
A. Solid Waste Disposal on Land										
B. Waste-water Handling	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	0,00
C. Waste Incineration	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	0,00
D. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	0,00
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**0,00**
Total N_2O emissions including N_2O from LULUCF	**0,08**	**0,08**	**0,08**	**0,08**	**0,08**	**0,08**	**0,08**	**0,08**	**0,08**	**-1,44**
Total N_2O emissions excluding N_2O from LULUCF	**0,08**	**0,08**	**0,08**	**0,08**	**0,08**	**0,08**	**0,08**	**0,08**	**0,08**	**-1,44**
Memo Items:										
International Bunkers	**0,01**	**0,01**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**100,00**
Aviation	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	100,00
Marine	0,01	0,01	0,00	0,00	0,00	0,00	0,00	0,00	0,00	100,00
Multilateral Operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	0,00
CO_2 Emissions from Biomass										

Table A11.4

TABLE 10 EMISSION TRENDS
HFCs, PFCs and SF_6
(Part 1 of 2)

Inventory 2008
Submission 2010 v1.2
Faroe Islands

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
Emissions of HFCs(3) - (Gg CO_2 equivalent)	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**0,02**	**0,02**	**0,06**	**0,66**	**1,22**	**3,29**
HFC-23	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO
HFC-32	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	0,00	0,00	0,00	0,00
HFC-41	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO
HFC-43-10mee	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO
HFC-125	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	0,00	0,00	0,00	0,00
HFC-134	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO
HFC-134a	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	0,00	0,00	0,00	0,00	0,00	0,00
HFC-152a	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO
HFC-143	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO
HFC-143a	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	0,00	0,00	0,00	0,00
HFC-227ea	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO
HFC-236fa	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO
HFC-245ca	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO
Unspecified mix of listed HFCs(4) - (Gg CO_2 equivalent)	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO
Emissions of PFCs(3) - (Gg CO_2 equivalent)	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**
CF_4	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO
C_2F_6	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO
C_3F_8	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO
C_4F_{10}	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO
$c\text{-}C_4F_8$	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO
C_5F_{12}	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO
C_6F_{14}	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO
Unspecified mix of listed PFCs(4) - (Gg CO_2 equivalent)	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO
Emissions of SF6(3) - (Gg CO_2 equivalent)	**NA,NE,NO**	**NA,NE,NO**	**0,12**	**0,13**	**0,14**	**0,15**	**0,17**	**0,18**	**0,19**	**0,09**
SF_6	NA,NE,NO	NA,NE,NO	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Table A11.4 *continued.*

TABLE 10 EMISSION TRENDS
HFCs, PFCs and SF_6
(Part 2 of 2)

Inventory 2008
Submission 2010 v1.2
Faroe Islands

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	2008	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
Emissions of HFCs(3) - (Gg CO_2 equivalent)	**4,35**	**6,93**	**8,69**	**10,21**	**11,40**	**11,20**	**11,66**	**12,09**	**12,40**	**100,00**
HFC-23	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	0,00
HFC-32	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	100,00
HFC-41	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	0,00
HFC-43-10mee	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	0,00
HFC-125	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	100,00
HFC-134	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	0,00
HFC-134a	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	100,00
HFC-152a	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	0,00
HFC-143	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	0,00
HFC-143a	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	100,00
HFC-227ea	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	0,00
HFC-236fa	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	0,00
HFC-245ca	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	0,00
Unspecified mix of listed HFCs(4) - (Gg CO_2 equivalent)	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	0,00
Emissions of PFCs(3) - (Gg CO_2 equivalent)	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**0,00**
CF_4	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	0,00
C_2F_6	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	0,00
C_3F_8	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	0,00
C_4F_{10}	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	0,00
$c\text{-}C_4F_8$	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	0,00
C_5F_{12}	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	0,00
C_6F_{14}	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	0,00
Unspecified mix of listed PFCs(4) - (Gg CO_2 equivalent)	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	0,00
Emissions of SF6(3) - (Gg CO_2 equivalent)	**0,08**	**0,08**	**0,09**	**0,08**	**0,19**	**0,15**	**0,14**	**0,13**	**0,16**	**100,00**
SF_6	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	100,00

Table A11.5

TABLE 10 EMISSION TRENDS
SUMMARY
(Part 1 of 2)

Inventory 2008
Submission 2010 v1.2
Faroe Islands

GREENHOUSE GAS EMISSIONS	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	CO_2 eqv. (Gg)	CO_2 eqv. (Gg)	CO_2 eqv. (Gg)	CO_2 eqv. (Gg)	CO_2 eqv. (Gg)	CO_2 eqv. (Gg)	CO_2 eqv. (Gg)	CO_2 eqv. (Gg)	CO_2 eqv. (Gg)	CO_2 eqv. (Gg)
CO_2 emissions including net CO_2 from LULUCF	665,48	646,30	636,41	526,65	531,58	537,90	558,16	553,72	596,98	638,65
CO_2 emissions excluding net CO_2 from LULUCF	665,48	646,30	636,41	526,65	531,58	537,90	558,16	553,72	596,98	638,65
CH_4 emissions including CH_4 from LULUCF	18,38	17,64	17,78	17,85	18,75	18,85	18,77	18,79	18,67	20,44
CH_4 emissions excluding CH_4 from LULUCF	18,38	17,64	17,78	17,85	18,75	18,85	18,77	18,79	18,67	20,44
N_2O emissions including N_2O from LULUCF	23,65	23,09	23,35	21,71	22,06	22,29	22,41	22,44	22,90	23,40
N_2O emissions excluding N_2O from LULUCF	23,65	23,09	23,35	21,71	22,06	22,29	22,41	22,44	22,90	23,40
HFCs	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	0,02	0,02	0,06	0,66	1,22	3,29
PFCs	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO
SF_6	NA,NE,NO	NA,NE,NO	0,12	0,13	0,14	0,15	0,17	0,18	0,19	0,09
Total (including LULUCF)	**707,51**	**687,04**	**677,67**	**566,34**	**572,55**	**579,21**	**599,56**	**595,78**	**639,96**	**685,87**
Total (excluding LULUCF)	**707,51**	**687,04**	**677,67**	**566,34**	**572,55**	**579,21**	**599,56**	**595,78**	**639,96**	**685,87**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	CO_2 eqv. (Gg)	CO_2 eqv. (Gg)	CO_2 eqv. (Gg)	CO_2 eqv. (Gg)	CO_2 eqv. (Gg)	CO_2 eqv. (Gg)	CO_2 eqv. (Gg)	CO_2 eqv. (Gg)	CO_2 eqv. (Gg)	CO_2 eqv. (Gg)
1. Energy	675,48	655,87	646,18	534,70	539,78	546,41	566,89	562,50	606,33	650,21
2. Industrial Processes	NA,NE,NO	NA,NE,NO	0,12	0,13	0,16	0,18	0,22	0,83	1,41	3,38
3. Solvent and Other Product Use	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE
4. Agriculture	32,04	31,16	31,36	31,51	32,61	32,62	32,45	32,44	32,22	32,28
5. Land Use, Land-Use Change and Forestry[(5)]	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE
6. Waste	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO
7. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total (including LULUCF)[(5)]	**707,51**	**687,04**	**677,67**	**566,34**	**572,55**	**579,21**	**599,56**	**595,78**	**639,96**	**685,87**

Table A11.5 *continued.*

TABLE 10 EMISSION TRENDS
SUMMARY
(Part 2 of 2)

Inventory 2008
Submission 2010 v1.2
Faroe Islands

GREENHOUSE GAS EMISSIONS	2000	2001	2002	2003	2004	2005	2006	2007	2008	Change from base to latest reported year
	CO_2 eqv. (Gg)	CO_2 eqv. (Gg)	CO_2 eqv. (Gg)	CO_2 eqv. (Gg)	CO_2 eqv. (Gg)	CO_2 eqv. (Gg)	CO_2 eqv. (Gg)	CO_2 eqv. (Gg)	CO_2 eqv. (Gg)	(%)
CO_2 emissions including net CO_2 from LULUCF	662,49	735,81	725,83	735,93	741,73	724,44	726,29	742,64	695,90	4,57
CO_2 emissions excluding net CO_2 from LULUCF	662,49	735,81	725,83	735,93	741,73	724,44	726,29	742,64	695,90	4,57
CH_4 emissions including CH_4 from LULUCF	18,89	19,19	19,36	19,25	19,47	20,23	19,86	19,78	19,53	6,23
CH_4 emissions excluding CH_4 from LULUCF	18,89	19,19	19,36	19,25	19,47	20,23	19,86	19,78	19,53	6,23
N_2O emissions including N_2O from LULUCF	23,69	24,47	25,16	24,63	25,33	24,97	24,36	24,49	23,31	-1,44
N_2O emissions excluding N_2O from LULUCF	23,69	24,47	25,16	24,63	25,33	24,97	24,36	24,49	23,31	-1,44
HFCs	4,35	6,93	8,69	10,21	11,40	11,20	11,66	12,09	12,40	100,00
PFCs	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	0,00
SF_6	0,08	0,08	0,09	0,08	0,19	0,15	0,14	0,13	0,16	100,00
Total (including LULUCF)	**709,50**	**786,48**	**779,13**	**790,10**	**798,12**	**781,00**	**782,32**	**799,13**	**751,30**	**6,19**
Total (excluding LULUCF)	**709,50**	**786,48**	**779,13**	**790,10**	**798,12**	**781,00**	**782,32**	**799,13**	**751,30**	**6,19**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	2008	Change from base to latest
	CO_2 eqv. (Gg)	CO_2 eqv. (Gg)	CO_2 eqv. (Gg)	CO_2 eqv. (Gg)	CO_2 eqv. (Gg)	CO_2 eqv. (Gg)	CO_2 eqv. (Gg)	CO_2 eqv. (Gg)	CO_2 eqv. (Gg)	(%)
1. Energy	672,62	746,83	737,67	747,15	754,00	737,50	738,62	754,94	707,02	4,67
2. Industrial Processes	4,43	7,01	8,78	10,29	11,59	11,36	11,80	12,22	12,56	100,00
3. Solvent and Other Product Use	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	0,00
4. Agriculture	32,45	32,64	32,68	32,66	32,53	32,14	31,90	31,96	31,71	-1,02
5. Land Use, Land-Use Change and Forestry[(5)]	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	0,00
6. Waste	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	0,00
7. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	0,00
Total (including LULUCF)[(5)]	**709,50**	**786,48**	**779,13**	**790,10**	**798,12**	**781,00**	**782,32**	**799,13**	**751,30**	**6,19**

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Emission Inventories 1990-2008
– Submitted under the United Nations Framework Convention on Climate Change and the Kyoto Protocol

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