ANNUAL DANISH ATMOSPHERIC EMISSIONS INVENTORY

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Introduction

Since 1994 the National Environmental Research Institute (NERI) has carried out the Danish atmospheric emissions inventory within the frame of the European CORINAIR (CO-ordination of INformation on AIR emissions) air emission inventory system. The Danish CORINAIR-database makes the basis for official reports to international conventions such as the UNECE Convention on Long Range Transboundary Air Pollution (CLRTAP) and the UN Framework Convention on Climate Change (UNFCCC) under the Intergovernmental Panel on Climate Change (IPCC). The two international conventions deal with regional and global air pollution effects and this survey covers the pollutants reported to these conventions.

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The national inventory is mainly made according to the CORINAIR guidelines (Richardson (Ed) 1999) and the IPCC guidelines (Houghton et al., 1997). Parts of the inventories have been elaborated in order to reflect specific national conditions better. The emissions in this survey are categorised as prescribed in the UNECE reporting Guidelines. The emissions are not corrected for electricity trade or temperature variations during the year except for CO_2 where both actual and corrected emissions are shown. The National Inventory Report to UNFCCC in the IPCC format can be seen in Illerup et al. (2000) and is also available at NERI's homepage

www.dmu.dk.

Emission inventories are frequently updated and adjusted, as more or better information becomes available. As a consequence, the data in this report may be different from previously reported emissions.

Pollutants

Time series and distribution of emissions on main sectors for 1998 are shown for SO_2, NO_x, CO_2, CO, NMVOC, CH_4, N_2O and NH_3.

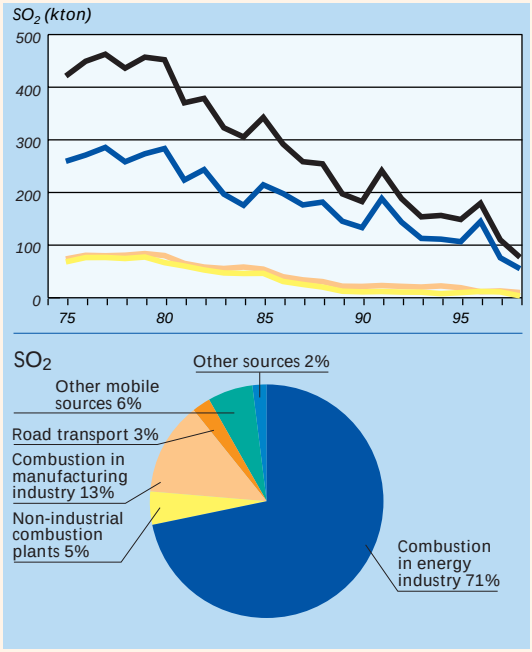
Total emissions are given for heavy metals (1990 and 1998) and for dioxin and PAH (1994 and 1998).

The pollutions reported to UNECE (1) and UNFCCC (2)

Pollutants	Formula, abbreviation		Pollutant	Formula, abbreviation	
Sulphur dioxide	SO_2	(1) (2)	Arsenic	As	(1)
Nitrogen oxides	NO_x	(1) (2)	Cadmium	Cd	(1)
Carbon dioxide	CO_2	(1) (2)	Chromium	Cr	(1)
Carbon monoxide	CO	(1) (2)	Copper	Cu	(1)
None-Methane Volatile Organic Compounds	NMVOC	(1) (2)	Mercury	Hg	(1)
Methane	CH_4	(1) (2)	Nickel	Ni	(1)
Nitrous oxide	N_2O	(2)	Lead	Pb	(1)
Ammonia	NH_3	(1)	Selenium	Se	(1)
Dioxins	Dioxins	(1)	Zinc	Zn	(1)
Polycyclic Aromatic Hydrocarbons	PAH	(1)	Hydrofluorocarbons	HFCs	(2)
			Perfluorocarbons	PFCs	(2)
			Sulphurhexafluoride	SF_6	(2)

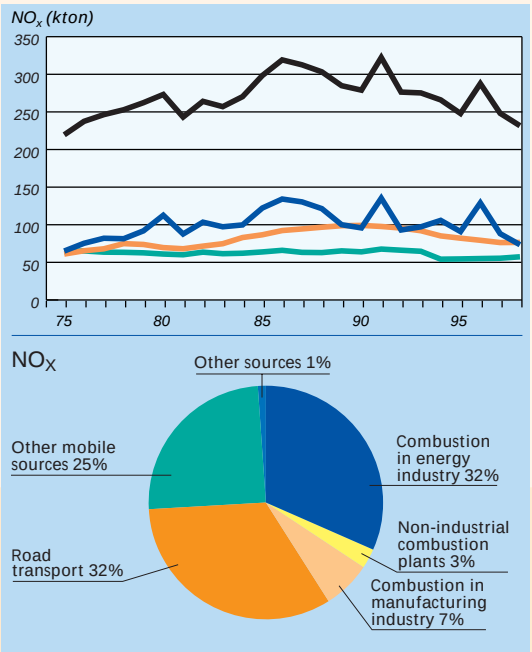
	SO_2 ton	NO_x ton	NMVOC ton	CH_4 ton	CO ton	CO_2 kton	N_2O ton	NH_3 ton
Combustion in energy and transformation industry	55180	73084	1681	19557	13440	31506	1009	0
Non-industrial combustion plants	3528	6316	9582	8195	158325	6130	194	0
Combustion in manufacturing industry	9923	15440	802	983	7714	5286	148	0
Production processes	1441	348	5061	45	0	1436	0	0
Extraction and distribution of fossil fuels and geotermel energy	0	0	5523	14053	31290	0	0	0
Solvent and other product use	0	0	38864	0	0	121	0	0
Road transport	1964	76492	52058	3102	305716	11204	1315	1824
Other mobile sources and machinery	4799	57393	13590	785	69740	3705	162	7
Waste treatment and disposal	70	2197	615	56540	1415	421	7	0
Agriculture	0	0	1222	183514	0	0	20755	102441
Other sources and sinks	0	0	14095	354238	0	-973	6867	0
Total	76904	231270	143094	641011	587639	58836	30458	104272

The distribution of emissions on main sectors are based on the emissions reported to UNECE for 1998.



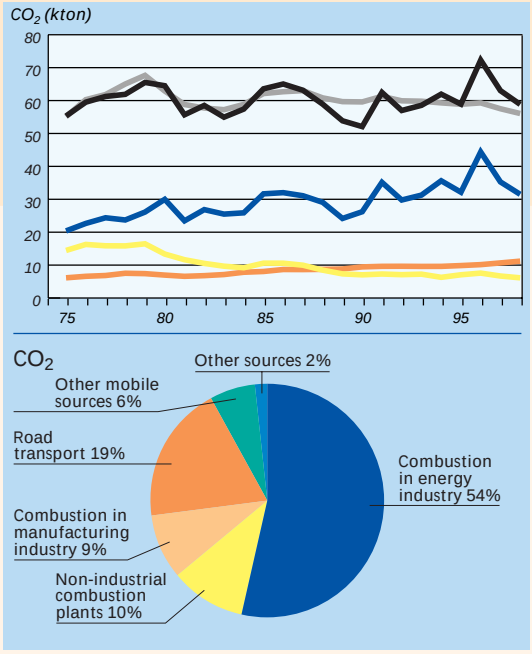
SO_2

The main part of the SO_2 emissions originates from the combustion of fossil fuels – mainly coal and oil – on public power plants and district heating plants. The emissions have decreased significantly from 1980 to 1998 due to increased use of low-sulphur fuels and installation of desulphurization plants. The relatively large fluctuations in the emissions are due to cross-country electricity trade. Thus the high emissions in 1991 and 1996 reflect a considerable electricity export.



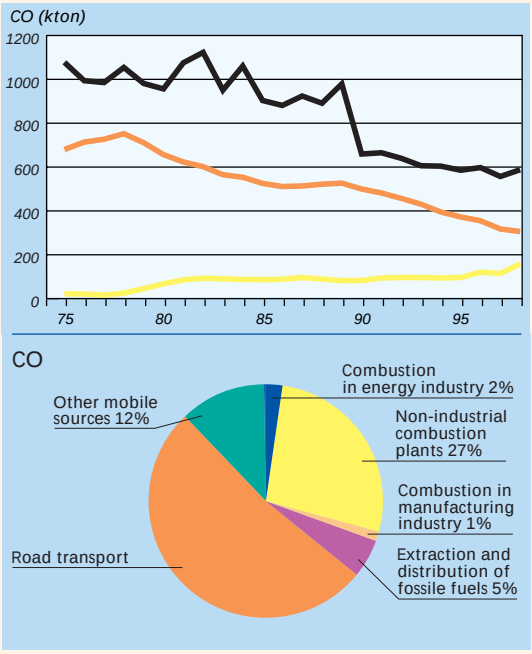
NO_x ($NO + NO_2$)

About half of the Danish emissions of NO_x stem from road transport and other mobile sources. Another large source is public power stations. In contrast to the SO_2 emission trend, the NO_x emissions have only shown a slight decrease. Despite of increasing road traffic the emission from this sector has decreased since 1990, as a result of the introduction of catalyst cars.



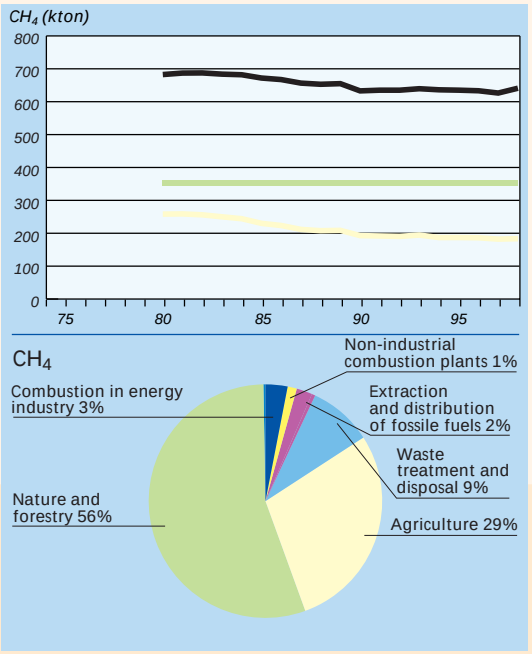
CO_2

The large sources for emission of CO_2 are combustion of coal, oil and natural gas in power plants, residential and industrial plants. In general the actual CO_2 emission shows an increasing trend while the emission corrected for electricity trade and temperature variations shows a decreasing trend in the recent years.



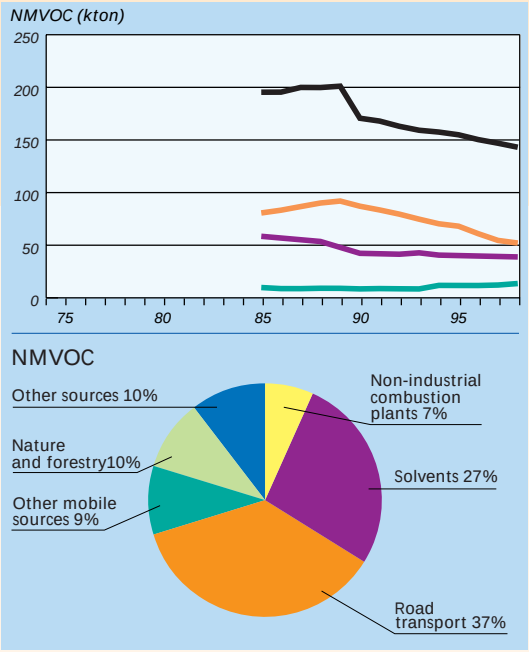
CO

Even though catalyst cars were introduced in 1990, road transport still has the dominant share of the total CO emission. Also other mobile sources and non-industrial combustion plants contribute significantly to the total emissions of this specie.



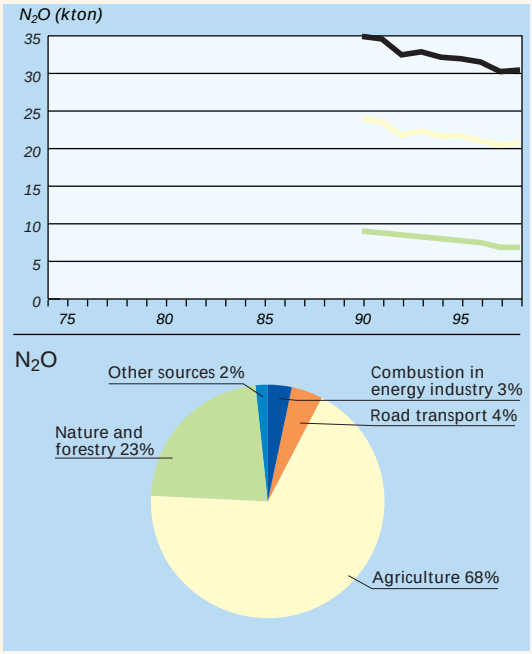
CH_4

There are two main sources to CH_4 emissions: nature and agriculture. Natural sources contribute with more than half of the emissions and originate mainly from anaerobic processes in wetlands. The emission from agriculture derives from enteric fermentation and management of animal manure.



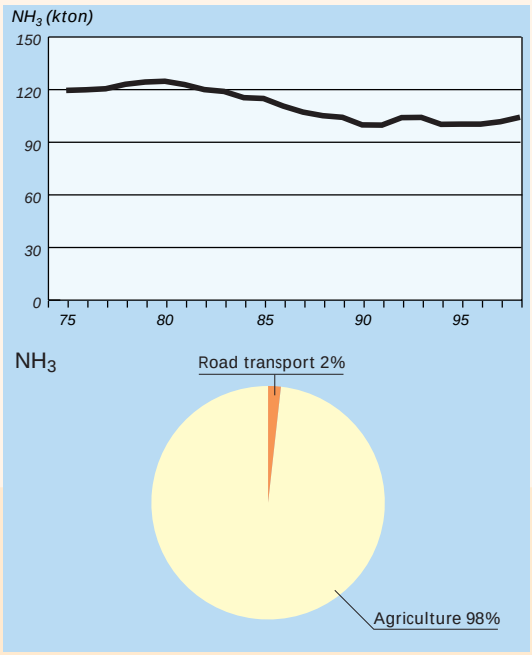
NMVOC

The emissions of NMVOC originate from many different sources – both anthropogenic and natural – and can be divided into two main types: Incomplete combustion and evaporation. The main sources to NMVOC emissions from incomplete combustion processes are road vehicles and other mobile sources such as sea vessels and off-road machinery. Road transportation vehicles are still main contributors even though the emissions have declined since the introduction of catalyst cars in 1990. The evaporative emissions mainly originate from forestry and use of solvent.



N_2O

Agriculture is the most important N_2O emission source. N_2O is emitted from agricultural crops and formed in soil from nitrogen in manure and fertilisers. 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 fertilisers.



NH_3

Almost all atmospheric emissions of NH_3 result from agricultural activities. The main part is emitted from manure management while a minor part comes from the use of fertilisers. By the end of 2000 the NH_3 inventory will be adjusted according to new scientific work at NERI (Andersen, et al., 1999).

Heavy metals

In general the most important sources of heavy metal emissions are combustion of fossil fuels and waste. Despite the increased consumption of these fuels from 1990 to 1998, the heavy metal emissions have decreased substantially. The reductions are between 3% and 94% for Cu and Pb, respectively.

The reason for the reduced emissions is mainly the increased use of gas cleaning devices at power and district heating plants (including waste incineration plants). The large reduction in the Pb emission is due to gradual shift towards unleaded gasoline being essential for catalyst cars.

Total emissions for 1990 og 1998:

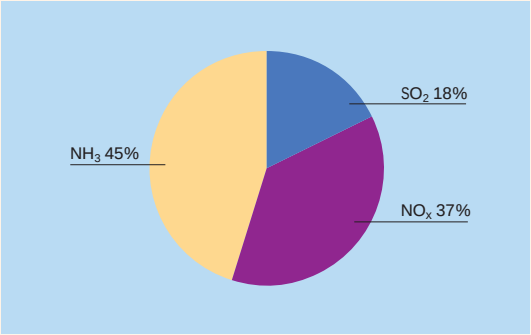
(kg)	As	Cd	Cr	Cu	Hg	Ni	Pb	Se	Zn
1990	1447	1123	6200	9670	3171	26479	124234	4233	34353
1998	846	775	2696	9384	1948	18910	7832	2830	22953
% red.	42	31	57	3	39	29	94	33	33

Dioxins and PAHs

Both the dioxin and the PAH emission figures are uncertain compared to the estimated emissions for the other pollutants. Ongoing work at the Danish Environmental Protection Agency may improve future dioxin emission inventories.

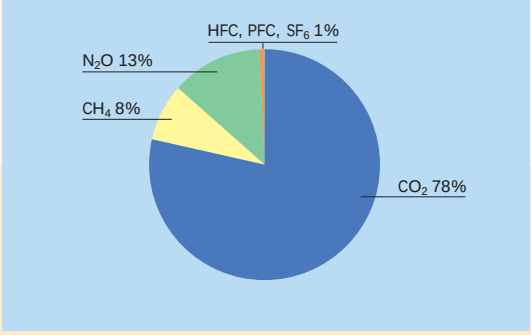
Total emissions for 1994 and 1998:

	Dioxins and Furans (g toxic eq.)	PAHs (kg)
1994	15	9848
1998	20	10490



Acidifying gases

Emission of Danish acidifying gases in 1998 in terms of acid equivalents. The most important acidification factor in Denmark today is ammonia nitrogen.



Greenhouse gases

Danish greenhouse gas emissions in 1998 apportioned by type of total antropogenic emissions in CO_2-equivalents. CO_2 is the most important greenhouse gas followed by CH_4 and N_2O in relative importance. The share from HFCs, PFCs and SF_6 is less than 1%.

Progress towards targets

In the sulphur protocol under the UNECE-CLRTAP Denmark is obligated to reduce the SO_2 emission with 80 % from 1980 to 2000. This target is likely to be met since the reduction was 85 % in 1998.

The general target in the NOx protocol is a stabilation of the NOx emission at 1987 level in 1994. In this period Denmark achieved a reduction of 15 %. In addition, Denmark agreed together with ten other countries - on a voluntary basis - to reduce the NOx emissions from 1986 to 1998 by 30 % and this target was almost reached. Also the target in the VOC-protocol seems to be fulfilled.

If the target in the Kyoto protocol is to be archived, new actions in order to reduce the greenhouse gases in Denmark are needed.

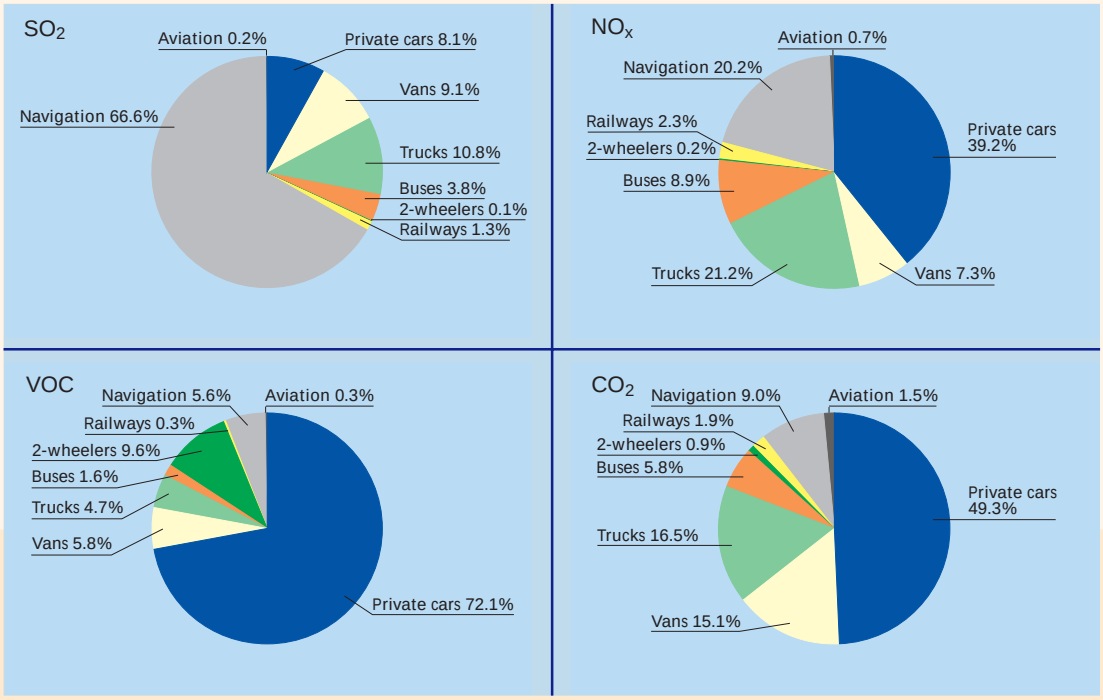
The reduction of the emission of pollutants according to existing protocols.

	Pollutants	Base year	Target year	Target Reduction (%)	Reduction in 1998 (%)	Projected reduction in target year (Fenhann, 1999)
UNECE-CLRTAP sulphur protocol	SO_2	1980	2000	80	85	-
UNECE-CLRTAP NO_x protocol	NO_x	1987	1994	0	15 (1994)	-
UNECE-CLRTAP NO_x protocol – voluntary agreement	NO_x	1986	1998	30	28	-
UNECE-CLRTAP VOC protocol	VOC	1985	1999	30	31	-
UNFCCC Kyoto-protocol (not yet ratified)	CO_2, N_2O, CH_4, HFC's, PFC's SF_6	1990: CO_2, N_2O, CH_4 1995: HFC's, PFC's, SF_6	2008-2012	21*)	5	17

**) Based on CO_2 emissions adjusted for import of electricity in 1990.*

Emissions from the transport sector

Distribution of the emissions of SO_2, NO_x, CO_2 and VOC from the transport sector on different categories.



With emission shares of 88, 77 and 94% respectively, road transportation vehicles are major contributors to the emissions of CO_2, NO_x and VOC from the transport sector. Private cars alone contribute with 49, 39 and 72% of this overall emission total.

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The emission data used for presentation in this survey can be found at the internet address:
http://www.dmu.dk

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