Environmental and Health Impact Assessment of Scenarios for Renewable Energy Systems with Hydrogen (HYSCENE)

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Objectives and background

The aim of the newly started project is to improve our understanding of the environmental impacts and related socio-cultural and welfare economic impacts of a renewable energy system where hydrogen is an important element.

The objective of the project is to enhance model development for the environmental and health impacts and related societal impacts of a hydrogen-based energy system.

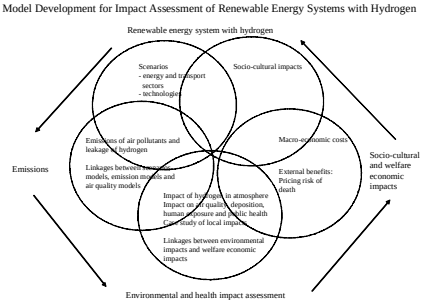
The vision of a renewable energy system with hydrogen as an important energy carrier requires a technological transformation of the present pre-dominantly fossil energy system.

It promises to reduce CO_2 emissions and hence reduces the green house effects. Furthermore, air quality problems in large cities and related public health problems will be solved due to reduction of fossil fuel emissions (Jacobsen et al., 2005). Ground level ozone will decrease and reduce related health problems and agricultural production losses. In addition, a reduction of environmental problems related to the deposition of air pollutants e.g. acidification and eutrofication will improve the natural environment for flora and fauna.

However, the production, distribution and use of hydrogen will increase the leakage of hydrogen to the atmosphere. Recent research indicates that hydrogen may be involved in processes leading to increased depletion of the ozone layer and an increase in the green house effect (Tromp et al. 2003). A pro-active environmental impact assessment of new technologies like hydrogen as an energy carrier is therefore very important.

Methodology

Main elements of the overall methodology of the project is outlined in the below figure.



A schematic outline of a model for impact assessment of an energy system with hydrogen

Scenarios

The main objective of the scenarios (reference and a realistic scenario) is to enable environmental assessments of hydrogen in a substantial role as energy carrier and to study the potentially positive and negative environmental impacts.

Since any penetration of hydrogen in the energy and transport system is likely to be slow, it is crucial to use a sufficiently long time frame to enable assessment of the full environmental impacts. Hence the time frame is 2005-2050, which will allow a full transition to a hydrogen-based energy system.

Both stationary and transport applications of hydrogen are included and key technologies for production, distribution and storage of hydrogen are covered. Calculations will be performed for every decade in the scenario time period.

Emissions of air pollutants and leakage of hydrogen

The aim of the emission estimates is to quantify the total emissions from energy production and transportation in the scenarios and hence assess the potential emission reductions.

Emissions will be estimated for both stationary and mobile sources. One important task will be to estimate the potential leakage of H_2 from the energy production and transportation system.

Environmental and health impact assessment

The environmental impacts will be conceptually described with focus on air quality, deposition, human exposure and public health. A few environmental and health indicators will be selected to demonstrate the model development.

For these selected impacts, the different scenarios will be studied in a few case studies that reflect different geographic scales, from regional to local scale. Key air quality indicators for health related air quality could be particles while for deposition it could be sulphur and nitrogen compounds.

The results will be related to WHO and EU air quality limit values, and to critical loads for various natural settings.

Impacts on the atmosphere due to H_2 leakages

Hydrogen leakage from an energy system with hydrogen as energy carrier will lead to an increase of H_2 in the atmosphere. At the same time NOx and NMHCs will be reduced due to the replacement of fossil fuels.

This will reduce the photochemical activity in the troposphere. As a consequence the lifetime of a series of greenhouse gases will be longer, thereby increasing their concentration in the atmosphere.

Increased concentrations of greenhouse gases will heat the surface layers of the troposphere and cool the stratosphere. Furthermore, hydrogen will lead to higher concentrations of water vapour in the stratosphere. Both these effects will increase the ozone depletion in the stratosphere.

One of the tasks of the present project will focus on analysing the impacts of more hydrogen on atmospheric chemistry in the lower part of the atmosphere, and study how this is affecting the physical and chemical processes that determine surface air quality. The project comprises process studies in the laboratory to understand how increased levels of H_2 influence atmospheric processes.

The results of the analysis will be used to improve regional air quality model.

External benefits: Pricing a change in the risk of death

The replacement of fossil fuel based technologies with hydrogen based technologies is expected to have a number of positive health effects.

In order to be able to make a complete welfare economic analysis of the shift of technology, it is important that the health effects are described as detailed as possible. But it is also important that the effects are valued in accordance with the pricing principles used in other parts of the analysis.

In this part of the project the aim is to investigate the possibilities for pricing the consequences of the technology shift for the risk of death.

Societal aspects of scenarios

An integrated part of the definition of scenarios will be a deeper analysis of societal and cultural aspects of development and implementation of a new energy system based on hydrogen and renewables. Any introduction of new energy technologies will necessarily take place in a societal context.

Barriers, potentials and socio-cultural aspects of the scenarios will be analysed through qualitative evaluation of indicators for critical developments, and through examination of previous work on energy scenarios.

Acknowledgement

The project has received a grant of DDK 2,000,000 for 2006-2008 from the Programme Commission on Energy and Environment under the Danish Strategic Research Council.

References

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