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Nordic Council of Ministers

Nordic Environmental Technology





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Nordic Environmental Co-operation

The Nordic Environmental Action Plan 2005-2008 forms the framework for the Nordic countries' environmental co-operation both within the Nordic region and in relation to the adjacent areas, the Arctic, the EU and other international forums. The programme aims to achieve results that will consolidate the position of the Nordic region as the leader in the environmental field. One of the overall goals is to create a healthier living environment for people in the Nordic region.

Nordic co-operation

Nordic co-operation, one of the oldest and most wide-ranging regional partnerships in the world, involves Denmark, Finland, Iceland, Norway, Sweden, the Faroe Islands, Greenland and Åland. Co-operation reinforces the sense of Nordic community while respecting national differences and similarities, makes it possible to assert Nordic interests in the world at large and promotes positive relations between neighbouring peoples.

Co-operation was formalised in 1952 when the Nordic Council was set up as a forum for parliamentarians and governments. The Helsinki Treaty of 1962 has formed the framework for Nordic partnership ever since. The Nordic Council of Ministers was set up in 1971 as the formal forum for co-operation between the governments of the Nordic countries and the political leadership of the autonomous areas, i.e. the Faroe Islands, Greenland and Åland.



Introduction

Using environmental technologies to ensure economic growth and protecting the environment at the same time – Nordic examples

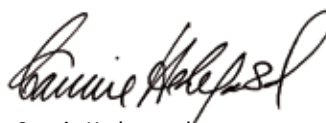
The Nordic Ministers for the Environment have identified environmental technologies as an important element in addressing the growing environmental challenges in the Environmental Action Plan 2005–2008.

This brochure contains a number of Nordic examples of innovative eco-friendly technologies developed by Nordic enterprises. The Nordic Ministers for the Environment have decided to single out a number of areas where we believe the Nordic countries are world pioneers regarding eco-innovation, although many more examples and themes could have been chosen. The areas chosen for this brochure are: Innovative shipping technology, energy-efficient and environmentally sound buildings and biologically based growth. Such technologies contribute to the Lisbon process, which aims to make the EU the most competitive and dynamic knowledge-driven economy by 2010, by decoupling economic growth from environmental degradation and damage to public health – an ambition which should be clear to all policy makers.

The aim of the brochure is twofold: to inspire policy makers and industries to implement environmental technologies and to illustrate the potential for economic growth while safeguarding the environment. It is obvious that there are benefits to be achieved for all, society, industry and the environment, from investing in eco-efficient technologies.

The Nordic examples can serve as a road map and guide for both national and international cooperation activities, and we hope that the Nordic examples will also serve as a source of inspiration in policy making and development in general.

On behalf of the Nordic Council of Ministers for the Environment.


Connie Hedegaard

Innovative shipping technology

With regard to the environment, marine transport is an environmentally efficient form of transport compared with most other. However, the potential for further reduction of pollution from marine vessels is considerable. And in this field, the Nordic countries play a leading role.

Ship engines fuelled by environmentally sound fuels and natural gas, new technologies that reduce fuel consumption and on-board energy management systems are some of the many technological innovations in shipping technology under way in the Nordic countries.

Marine transport plays a vital role in the global economy, and the Nordic countries are pivotal. Nordic shipping companies are amongst the largest in the world, and although a large proportion of the shipbuilding industry has moved to countries such as Japan, Korea and China, companies in the Nordic countries are still at the leading edge in knowledge on shipping technology. For example, most of the world's large ships are today powered by engines designed by companies based in the Nordic countries.

Environmental policies support best practices

The development of best practice technologies in shipping technology has been supported by:

- ***Environmental demands and standards set by the public authorities.***

For example: in Finland the preparatory process for the regulations (MARPOL Annex VI) concerning NOx emissions from ships supported innovations headed by the company Wärtsilä, which also participated in the policy making process.

- ***Investment and joint R & D efforts by industry and public institutions.***

One example is the Hercules project funded by the EU, see: www.ip-hercules.com

In Norway, the Norwegian Maritime Directorate and the company Det Norske Veritas have jointly developed an Environmental Information Portal for Maritime Industries. Read more: www.dnv.com

- ***Pilot installations of new technologies.***



Photo: Corbis

Norway:

Ferries fuelled by natural gas reduce emissions



Within the next few years, it is likely that a significant number of Norway's approximately 100 "fjord ferries" will be fuelled by environmentally friendly natural gas or other alternative technology.

One such ferry is already in use: the gas fuelled ferry, M/F "Glutra", constructed in 2000 and equipped with environmental technology. Five new ferries are under construction and are soon due in operation.

The main road ferry connections in Norway are financed by the public road administration. Through tenders or other contracts, Norwegian authorities have a unique opportunity to introduce best practice by demanding the use of fuel from natural gas or use of environmental technology.

The overall environmental benefits of the five new ferries will be substantial:

- Emissions of CO₂ will be reduced by 25%.
- Emissions of NO_x will be reduced by 83% – corresponding to the effect of 190.000 passenger cars, the equivalent to all the cars of the city of Oslo.
- Emissions of SO₂ will be eliminated.
- There will be no emissions of particles.

The new Norwegian ferries benefit from a range of technology innovations:

- LMG Marin has created an energy saving ship design resulting in reduced power consumption and thus reduced emissions.
- Fjord 1/LMG has developed new loading routines that reduces the need for the top speed operations and thus reduces emissions.
- Rolls Royce "Bergen Gas" main engine and system of propulsion result in substantial emission reductions compared to conventional technologies.

These technologies are ready for the market and, as they can be used in a range of other ship categories, including overseas ferries and freight transportation, they have significant potential both domestically and internationally.

Iceland:

Energy management reduces fuel consumption

An innovative system of energy management (Maren) which helps to minimize fuel consumption and harmful emissions on board marine vessels has been developed by the Icelandic company, Marorka. The underlying technologies included in Maren have been used in both fishing vessels and the commercial fleet e.g. container vessels.

Maren is an energy management system designed to maximize energy efficiency and thereby reduce operating costs through significant fuel savings. The Maren system is built on knowledge and experience gained from advanced research projects carried out during the last 10 years.

The energy management process on board a vessel starts with comprehensive planning by the management teams. Once the planning phase is complete, the energy systems are monitored and measurements and data are fed to a mathematical computer model that optimises the operational parameters.



Maren works continuously, maintaining peak efficiency by monitoring, optimising, analysing and making recommendations or taking actions when applicable. In other words, a detailed analysis of system performance is carried out to determine the appropriate course of action, which can be implemented automatically or reported to the ships officers.

The key environmental benefits from the onboard energy systems optimisation are:

- Energy conservation – significant reduction of fuel costs. Savings up to 12% have been reported by Marorka customers.
- Reductions in fuel consumption and harmful emissions.

Maren 2 won the best new product award at the Icelandic Fisheries Exhibition.



Denmark and Finland:

Developing environmentally friendly marine engines

Several efforts are being made in the Nordic countries to introduce more environmentally friendly engines in marine vessels.

In Denmark, the company MAN B&W has developed an optimised fuel injection system which reduces NOx emissions by 20 per cent. From 2000, all new marine engines manufactured by the company are based on this system. The system can also be mounted in existing marine engines in conjunction with renewal of fuel nozzles, which happens on average every 2½ years.

About half of the world's 31,000 vessels of more than 500 gross register tonnes are operated with marine engines constructed on the basis of a licence from MAN B&W. Thus, when MAN B&W introduces new environmentally efficient marine engines, they really make a difference.

An even more ambitious and expensive solution is to install a system of catalytic purification of exhaust from the vessels. This technology reduces NOx pollution from the vessels by 90%.

Another MAN B&W project is a full-scale test with a SAM (Saturated Air Moisturing) system, a technique that can lower NOx levels by 40-50%.

Finnish innovations reduce NOx emissions

In Finland, the company Wärtsilä has developed the Enviroengine, which by combining several innovative technologies makes it possible to reduce NOx emissions and obtain smokeless engines, as well as to reduce fuel consumption.

Wärtsilä has introduced dual fuel (DF) engines, which run on liquefied natural gas and 1% marine diesel oil. This dual fuel technology reduces NOx emissions by 90% and CO₂ emissions by up to 20%. Emissions of SO₂ and particles are eliminated. Wärtsilä also has developed a smokeless engine which thanks to its flexibility in fuel injection, reduces emissions and ensures steady and secure operation of the vessel without smoke.

The use of steam is an effective way to limit the formation of NOx emissions in the combustion process. In the applications

developed by Wärtsilä the steam can be added into the process at several alternative stages. The maximum reduction of NOx emissions is as high as 60%, depending on the quantity of steam added to the combustion air.

Also, Wärtsilä has succeeded – in cooperation with a range of mainly Nordic partners – in developing a new type of waste heat recovery plant for ships. This is the only commercially

available technology today that reduces both fuel consumption and exhaust emissions at the same time.

A range of Finnish companies in the maritime industry have jointly engaged in a project aiming at the implementation and further development of technology of Aker Kvaerner Power already in use on land for use on board ships. Scrubbers have proven to be an interesting alternative to low sulphur fuel operation in many ways, including financially. SOx-emission abatement on board the ship using scrubbers also results in significantly lower CO₂-emissions compared to the energy intensive process of desulphurisation of residual fuel in refineries.





Environmental policies support best practices

The development of best practice technologies in energy efficient buildings has been supported by:

- *National environmental quality objectives including targets concerning, for example, noise, waste, energy consumption in buildings and a good indoor air.*

Here are some examples:

- *The new Danish Energy strategy 2025 includes a long list of initiatives to enhance the energy efficiency of buildings, see www.ens.dk*
- *In Norway, to achieve national objectives, the Norwegian Parliament has set up an Energy Fund with up to 650 M Euro over a ten-year period. See www.enova.no*
- *In Sweden, national environmental targets have been developed concerning the consumption of energy. For more information on the Swedish case, see www.miljomal.nu*
- *Organisations providing expertise and projects service. One example is Motiva Corporation in Finland, see www.motiva.fi*
- *Systems for Eco labelling and classification of buildings. One example is PromisE in Finland, for further information see www.environment.fi*
- *Investment and joint R & D efforts by industry. For Swedish examples, see www.formas.se or www.kretsloppsradet.com*
- *Voluntary environmental agreements between the government and companies with the building and property sector. For Swedish examples see www.byggobodialogen.se and www.gardstensbostader.se*
- *A joint UK-Swedish initiative on sustainable construction: www.constructingexcellence.org.uk/uksweden*

Photo: P.Schussler/PhotoLink



Energy-efficient and environmentally friendly buildings

The building and property sector is responsible for a high proportion of the world's environmental impact. It accounts for 40-50% of total energy use, around 40% of the use of materials, and a considerable share of waste and greenhouse gases are generated (i.e. CO₂). Environmental improvements within this sector therefore have a major impact on the environment.

In the Nordic countries many schemes for sustainable buildings are in progress focussing on energy-efficiency, efficient use of resources and materials and – in the long run – reduction of greenhouse gases. Some examples are presented below.

A range of innovative technologies such as solar energy, heat-recycling systems, new insulation technologies and environmentally friendly building materials have been developed and applied in Nordic buildings in recent years. A set of criteria for the eco-labelling of houses has also recently been introduced.

Home buyers in the Nordic countries are displaying a great demand for new environmentally sound houses with a good indoor climate. Also, the Nordic countries all contain a large stock of existing buildings that need maintenance and modernization in order to reduce energy consumption while retaining the buildings' other qualities. A range of technologies has been developed for making older buildings more energy-efficient.

All Nordic countries:

The house of the future will be Swan eco-labelled



In all the Nordic countries efforts are being made to develop environmentally friendly housing. One way to reach this goal is by labelling houses that fulfil certain standards of sustainability. The Nordic eco-label “the Swan” has recently adopted the first version of criteria for Swan-labelled houses.

The joint Nordic criteria allow eco-labelling of small standard houses, for instance single-family houses and terraced houses. The Swan eco-label lays down strict requirements for heat loss and consumption of energy during “the operation” of the house. To meet the heat loss requirements the house must be very well insulated, and thermal bridges must be minimised. Moreover, to meet the criteria, the house must have an energy saving system, such as heat recycling and/or use energy from solar cells or panels.

The Swan criteria applied to houses also mean that a large number of known environmentally hazardous and harmful substances are not allowed in building products for these houses.

Denmark:

Environmentally friendly housing for everybody

In Denmark, the Municipality of Køge and The Centre for Sustainable Environment “The Green House” of the city of Køge, have initiated a project known as “The single-family house of the future”, which aims at making low-energy housing available to all.

A total of 55 completed single-family houses, 5 two family houses, and 24 terraced houses, all different and built by different building companies, have been built and exhibited. In the future, the houses will be part of the companies’ catalogue, and will offer a unique opportunity for launching the Swan label for houses.

All the houses must meet the requirements of the Swan eco-label by using less than 75% of the energy allowed for new houses built in Denmark today.



Photo: Studio Force 4

Norway:

Solar energy used for heating in houses

In Norway a flexible solar heat system has been developed, which can provide up to half of the energy consumed in an average house.

In collaboration with General Electric Plastics, the Norwegian company SOLARNOR A/S has developed a flexible technology of heat producing solar collectors crafted in plastic materials.

The SOLARNOR collector is a standard building element that can replace other types of roof or facade coverings. When used in houses, the solar heat collector is a standard building element, which can substitute for usual roof or facade cover materials. Thanks to their great flexibility, the solar collectors can be used on different scales, from single and multi-family homes, to institutions, hotels, swimming pools and sport centres.

The solar heating system can supply free solar energy for up to half of the annual energy need of an average house. In properly designed solar heating systems each square meter of collector area delivers between 250-700 kWh per year, depending on the solar fraction. In Norway combined systems are optimally designed with a solar fraction of 30-50%. Further south in Europe the solar fraction will be higher for a similar system.

The SOLARNOR collector is the world's first high-temperature polymer collector which heats pure water that flows through a collector manifold into a heat store. SOLARNOR A/S has completed several projects in the Nordic and other European countries, and the commercial potential of the heating systems is significant.



Photo: Creatas

Sweden and Finland:

Energy saving and sustainable housing

Both in Sweden and Finland, a number of projects have been initiated for converting existing buildings into more sustainable ones, including requirements regarding energy efficiency.

Sweden: New and older sustainable housing

In the southern part of Sweden 35 apartments were constructed during 2003-2004 by the municipal housing company, AB Landskronahem. Thanks to insulation thickness and triple glazed windows the energy savings are 30-50%. The apartments have no conventional heating i.e. radiators or under floor heating. The apartments are built with high quality air tightness and moisture prevention. There are other examples of similar technical solutions in Gothenburg, Lund, Malmö and Stockholm.

A number of existing apartment buildings in Sweden have been renovated and turned into sustainable housing. In western Sweden ten multifamily houses from the 1970s comprising 255 flats have been renovated and made into low-energy flats in the project "Solar Buildings". After the renovation, consumption of district heating has been reduced by 40% and electricity consumption has decreased by approximately 30%.

All buildings have been insulated (façade, roofs) and windows have been replaced by a low energy type. A system for individual measurement of electricity, heat, hot and cold water for each flat provide greater energy awareness and results in lower consumption.

Furthermore solar technology has been used both to heat water for the flats and for "air based solar heating", which heats up an air gap in thick the concrete walls of the building.

Finland: Full scale sustainable housing

In Finland 1800 residents now live in ecologically sustainable houses as part of the Viikki environmental housing project, established as a full scale test of sustainable solutions. The project, which consists of a mix of housing types, was built between 1999 and 2004 outside Helsinki.

The city of Helsinki set 17 exceptionally strict criteria related to five main issues: emissions, the use of natural resources, health factors, biodiversity, and food production. All the approved construction projects surpassed the minimum environmental standards set for Eco-Viikki, which were much stricter than those usually applied to new buildings.

Architectural competitions were organised for housing blocks, emphasising the role of ecological innovation and practical environmentally sound construction design. These competitions attracted a great deal of interest from major Finnish construction companies.

Many other environmental projects are being run at Eco-Viikki, including schemes using solar energy to provide heat and electricity for homes and electricity collected by solar energy panels. Furthermore, flexible timber construction techniques have been innovatively applied at Eco-Viikki, and the residents benefit from a low energy housing design.

The Valkoapila housing scheme, part of Eco-Viikki, employs the entire range of energy efficient solutions and has succeeded in reducing the consumption of purchased energy by 50%. The housing is equipped with a mechanical supply/extract ventilation system with heat recovery and solar energy used for under floor heating in bathrooms and lavatories and for producing hot water.

Biologically based growth

Agriculture and forestry and associated industries have traditionally played a central role in the Nordic countries. Therefore the Nordic countries have developed considerable knowledge and competences in the field of biologically based processes and materials with the associated techniques. In recent years competences has also developed in contemporary biotechnology.

The Nordic countries have developed biologically based production, which makes a direct contribution to the overall environmental efforts in society:

- By producing energy based on renewable resources, including bio ethanol and biogas,
- By rethinking the use of wood fibres, a traditional base for Finnish and Swedish economies,
- By achieving biologically based environmental optimisation of agricultural production, including use of enzymes to reduce the amount of phosphorus excreted by livestock.

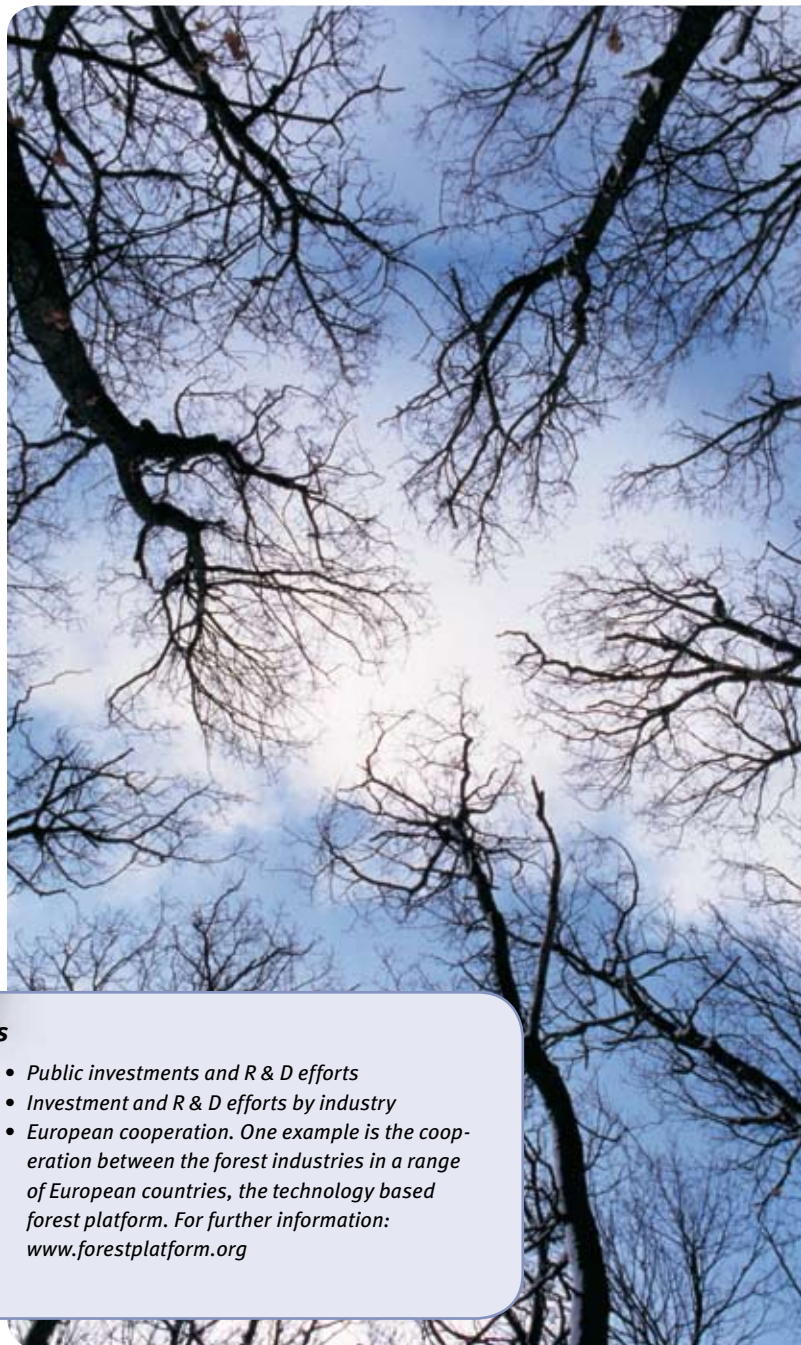
Today, technological development has limited the environmental problems facing the traditional industries based on biological growth. In addition there are areas where exports of technologies by Nordic enterprises can contribute significantly to global environmental efforts.

Environmental policies support best practices

The development of best practice technologies in biologically based growth has been supported by:

- *Environmental demands and standards set by public authorities. For example: the Danish "Action Plan for the Aquatic Environment III" focuses on ecologically efficient solutions to problems related to emissions of phosphorus. See: www.vmp3.dk*

- *Public investments and R & D efforts*
- *Investment and R & D efforts by industry*
- *European cooperation. One example is the cooperation between the forest industries in a range of European countries, the technology based forest platform. For further information: www.forestplatform.org*



Denmark:

Enzymes reduce phosphorus pollution from agriculture

The Danish company, Novozymes, has developed an enzyme that can significantly reduce the amount of phosphorus excreted by livestock. This enzyme, Phytase, contributes to solving an environmental problem, namely the release of phosphorus to the aquatic environment.

The feed enzyme, called Phytase, improves livestock uptake of phosphorus. Phosphorus is an essential nutrient for building strong bones. Plants store a major part of the naturally occurring phosphorus in cereals and seeds as phytate or phytic acid, which animals such as poultry and pigs cannot break down. They simply lack the enzyme needed to break it down, and the phosphorus passes straight through their digestive system and is excreted.

Studies have shown that by adding Phytase to pig feed, release of phosphorus can be reduced by up to 30%. The phosphorus tax introduced in connection with the Danish Action Plan for the Aquatic Environment III supports the use of Phytase. Research is now being carried out to develop enzymes that improve the uptake of nitrate by animals.

The production of these types of enzyme is based on genetically modified microorganisms. Danish research groups are focusing on modifying crops so that they produce the enzymes themselves.



Photo: Corbis

Finland:

Paper industry introducing cleaner technology

Technological innovation and development in the Finnish paper industry has lead to increased production capacity and simultaneously reduced the pollutant load significantly.

In Finland, the pulp and paper industry plays a highly significant role in the economy. At the same time, the environmental impacts of the sector have been great, due to extensive use of energy and timber as well as emissions to air and water.

During the past two decades several important technological innovations have been introduced, e.g. chlorine-free bleaching and biological wastewater treatment. Significant advances have been made to improve the resource efficiency and water consumption of the production processes, the latter developing towards closed water systems within a plant. For example, the per unit water consumption of pulp production has been reduced from 600 m³ per ton, in the 1950s, to close to 10 m³ per ton in the early 21st century

In 2002, over 40% of the electricity consumption of the Finnish forest industry was obtained from its own electricity production and 75% of the energy used by the forest industry is bio-energy. For heat energy, the industry is completely self-sufficient.

A Nordic Initiative for a sustainable European effort

At the initiative of the Finnish and Swedish forest industries, a Forest-based Sector Technology Platform (FTP) has been established at European level. Its main aims are to meet the multifunctional demands on forest resources and their sustainable management, to promote sustainability and to carry out more efficient R&D.

Technology Platforms are characterised by a shared vision, long-term perspective (2030) and major challenges. The



technology platform aims to boost European competitiveness by efficient stakeholder co-operation.

Among the strategic objectives of the FTP are:

- Meeting the multifunctional demands on forest resources and their sustainable management.
- Enhancing availability and use of forest biomass for products and energy.
- Development of intelligent and efficient manufacturing processes, including reduced energy consumption.
- Development of innovative products for changing markets and customer needs.

The Forest-based Sector Technology Platform is an industry-driven process, embedded in industry reality, and supporting the sector's strategy. The FTP is organized as a high level group, an advisory committee, a scientific council and management persons. The FTP also has established national support groups in a range of European countries.



Sweden:

Biofuels in transport

Sweden has high ambitions for the introduction of biofuels for transport. As from 2005, these fuels should make up at least 3% of total petrol and diesel consumption for transport operations, calculated on the basis of energy content.

The use of biofuels for transport in Sweden has increased rapidly in the last couple of years. In the year 2000, biofuels made up 0.4% of the total petrol and diesel consumption for transport operations calculated on the basis of energy content. By 2004 biofuels had reached 2.3%.

Several policies have contributed to this development:

- Target for environmentally sound vehicles used by authorities: the equivalent of 25% of all vehicles purchased in 2005 by authorities must be environmentally friendly. This target has been increased to 35% for 2006.
- According to the Swedish tax strategy for alternative fuels, carbon dioxide neutral fuels are exempt from energy and carbon dioxide taxes, making fuels like biogas, ethanol and RME commercially viable.
- Tax reductions are given to certain types of environmentally friendly company cars. Cars powered wholly or partly by electricity, alcohol or biogas may qualify for a reduction from 60 to 80% in tax in comparison to conventional cars.

Strong focus on research and development

Long-established R&D and demonstration efforts are the prerequisites of the successful introduction of biofuels in Swedish transportation.

Sweden supports research, development and demonstration measures for developing more energy-efficient and more cost-effective processes for the production of biofuels. The Swedish Energy Agency funds R&D measures as part of several different programmes for developing production processes for motor fuels, where ethanol, dimethylether (DME), FT diesel, biogas and hydrogen are seen as the most interesting alternatives.

A pilot plant for studying ethanol production from forest raw materials was inaugurated in 2004. This is a research and development unit designed to verify and optimise the chosen technology and to provide the basis for a processing technology for the production of ethanol and lignin, which is commercially viable for a demonstration plant. The pilot plant has a capacity to process 2 tonnes of biomass per day, corresponding to a maximum production of 500 litres of ethanol per day.

The results from the pilot plant have been encouraging. This has resulted in the formation of the regional industrial consortium Bio fuel Industries, which is currently planning for investments in three ethanol production plants.

Two pilot plants have also been established for the production of FT diesel, DME and hydrogen: A pilot plant has been opened in northern Sweden producing a gas mixture from black liquor, which can be used to make fuel and electricity and can improve the efficiency of the pulp and paper industries.

And a biomass-fuelled pilot plant facility is being used for studying the processes of gasification of biomass. The aim of the project is to demonstrate the production of a clean hydrogen-rich synthesis gas from biomass.





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Further information

Nordic best practice in environmental technologies:

Denmark

Eco-innovation: www.ecoinnovation.dk
Energy efficiency in buildings: www.ens.dk
Ministry for the Environment: www.mim.dk
Reduction in emissions of phosphorus: www.vmp3.dk

Finland

Ministry of the environment: www.environment.fi
Ministry of Trade and Industry: www.ktm.fi
National Technological Agency of Finland: www.tekes.fi
Motiva Corporation: www.motiva.fi
Forest Platform: www.forestplatform.org

Norway

Innovative shipping technology: www.ip-hercules.com
Environmental Information Portal for Maritime Industries:
www.dnv.com
Norwegian Parliaments Energy Fund: www.enova.no
Ministry for the Environment: www.dep.no/md

Sweden

Ministry of sustainable development:
www.sweden.gov.se/sb/d/2066
National environmental targets on housing:
www.miljomal.nu
Investment and joint R & D efforts by industry:
www.formas.se or www.kretsloppsradet.com
Voluntary environmental agreements:
www.byggobodialogen.se and www.gardstensbostader.se
UK-Swedish initiative on sustainable construction:
www.constructingexcellence.org.uk/uksweden/

Iceland

Ministry for the environment: www.umhverfisraduneyti.is/

Greenland

Government homepage: www.nanoq.gl

Faroe Islands

Government homepage: www.imr.fo/

Åland

Government homepage: <http://www.lagtinget.aland.fi>

