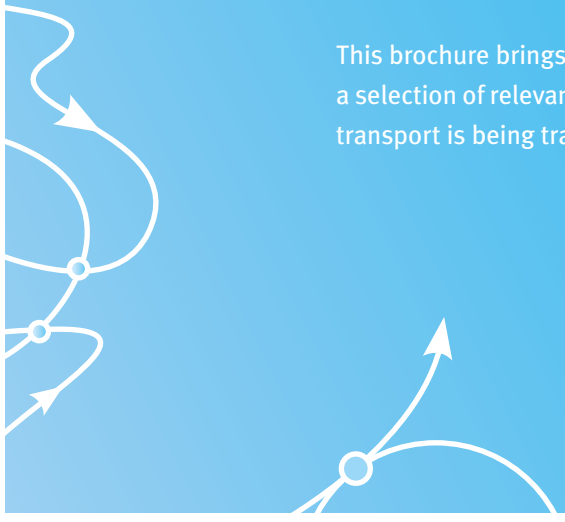
norden
Nordic Council of Ministers

Transport Transformed

SUSTAINABLE TRANSPORT SOLUTIONS FROM THE NORDIC REGION

CONTENTS

This brochure brings to light Nordic progress in sustainable transportation, using a selection of relevant companies and initiatives as examples. Read on to see how transport is being transformed in the Nordic region.



Nordic Strengths in Sustainable Transportation

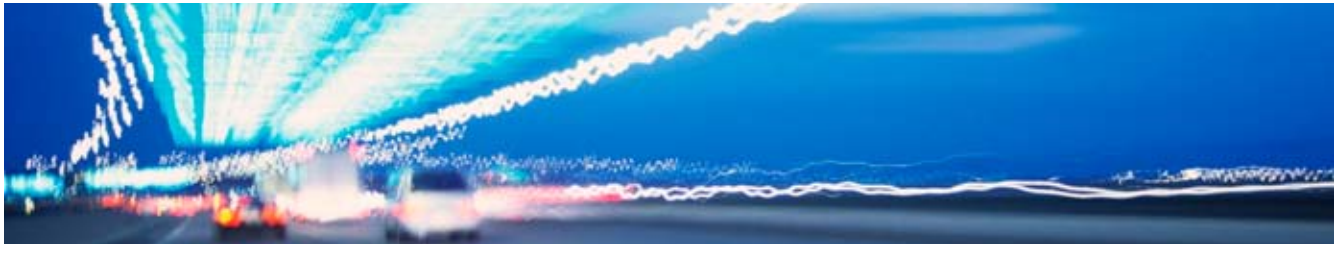
Transport accounts for almost a quarter of the world's energy related CO_2 emissions, and over half of the global consumption of oil. According to the International Energy Agency (IEA), energy use for transport purposes will more than double before 2050. Finding a way of making transport more sustainable will be crucial for attaining our goals in climate and energy. The large share of global oil consumption dedicated to transport also makes sustainable transportation a pressing concern from an energy security perspective.

In 2009 Iceland has the Chairmanship of the Nordic Council of Ministers, and during this year sustainable transportation is one of the top priorities on the Nordic energy policy agenda.

The Icelandic Chairmanship Project on Sustainable Transportation aims to tackle a number of issues in the transition to a more sustainable transport system in the Nordic region. A key element of the project is a report entitled "Foresight Analysis: Nordic Strategies for Renewable Transportation", which will depict a future Nordic transport system using 80% renewable energy. Emphasis is also placed on transport in sparsely populated areas in the West Nordic region, and on the planning needs associated with sustainable transportation.

The purpose of this brochure is to portray Nordic strengths in sustainable transportation. Through building on these strengths, and learning from the different competencies of the respective Nordic countries, the Nordic region could become a key global player in this increasingly important field. To make this possible, Nordic stakeholders from government, business and the general public must act and participate in the process to transform our transportation system. It is our hope that this brochure can be an inspiration in that direction.

Helga Barðadóttir, Icelandic Ministry of Industry
Chairman of the Nordic Comittee of Senior Officials for Energy



Fuelling Cars with Electrons

Small, silent and sensible new cars are becoming increasingly common on the streets of Nordic cities, offering a more sustainable flavour of motorised personal transport. While modal shifts from cars to public transportation and bicycles are necessary, cars are so popular that transportation simply cannot become sustainable without making cars more sustainable.

These more sustainable breeds of cars are making inroads into Nordic car markets, and one particular technology that is picking up speed is the battery electric vehicle. These cars store energy in a battery and use that energy with very high efficiency and without producing local emissions. With over 60% of the Nordic region's electricity coming from renewable sources, the emissions associated with electric cars are relatively low. However, even with fossil fuel-based electricity, the electric vehicle has greater overall 'well to wheel' efficiency than a petrol-burning car.[1]

Citizens of Oslo have become used to seeing the Buddy car about town, a small battery-powered three-seater with a limited range of up to 80 km. It is so small in fact that it is EU-approved as an electric four-wheel motorcycle and can legally park sideways in a regular parking space. The Buddy is therefore a radical departure from the average car, and is perfectly suited to the needs of the suburban commuter. For such drivers, the vast majority of trips do not test the maximum capacity, horsepower or range of the average-sized car.

However not everyone's needs will be satisfied with such limited range and size, which is the thought behind another small Norwegian electric vehicle – the Think City. The City offers four seats and a 210 km range, and is also prevalent on Norwegian streets. Both cars can be charged at any outlet whether at work or at home, and both will be available outside of Norway in the near future.

Due to political reasons the cost of owning and operating a car in the Nordic region is very high. Electric vehicles however are exempt from most vehicle taxes, inner city road tolls, and obviously don't pay the high Nordic petrol taxes. In addition, many places offer free use of public parking and bus lanes, and even free plug-in recharging stations. These perks, coupled with high personal incomes and environmental awareness, make the Nordic region highly conducive to a greater uptake of electric vehicles.

The Nordic region therefore has the potential to become an ideal test bed for the development of more sustainable motorised personal transportation. Testament to this is the fact that foreign electric vehicle manufacturers already have significant shares in the Nordic markets, and that many more manufacturers from Europe and Asia are looking to enter. In time it will not only be small cars for urban applications, but a spectrum of more sustainable cars covering a wide range of personal transport needs. As we move from powering our cars by oil to electricity however, we could be presented with significant infrastructural challenges.

Infrastructure for Electrification of the Transport System

Infrastructure poses a serious challenge to the electrification of transport. Electric cars are in use already, and most are charged at home directly after the driver returns from work. This simplistic charging method works with the low number of electric cars in use today, but might pose problems given a larger uptake in the future.

Estimates from the forthcoming report "Foresight Analysis: Nordic Strategies for Renewable Transportation" indicate that if 80% of Nordic transportation is to be drawn from renewable electricity and hydrogen, it would equal about half the electricity consumption by households today. Under a simplistic home-charging system this increase in demand will come in the early evening, when demand is already high in many countries. To avoid the sever price peaks and shortages this could lead to, we require a smarter vehicle charging infrastructure.

Ideally, cars would be charged when the electricity demand is low and capacity is abundant. In a system with a large amount of wind power, this is in the late night and early morning. A battery–swapping system could achieve this, in which consumers would not own batteries, but have their spent batteries automatically swapped for charged ones at swapping stations in a similar fashion to petrol stations today. The operator of the station would aim to recharge stored batteries at night when the demand, and therefore price, is lowest. Such a system would provide users with short "charging" times, but would require that all cars use compatible batteries.

Project BetterPlace is an international company now setting up a demonstration battery-swapping system in Denmark in cooperation with the Danish energy company DONG-energy. Another option is a network of high-voltage

fast charging stations. This would also be highly convenient for the user, and would likely move some of the demand for electricity away from the peak in demand in the early evening.

Grid infrastructure is being continually upgraded, and with new technologies allowing greater communication within the grid, we open the door to ”smart charging”. Smart charging means that the car communicates with the grid to determine the optimal time for charging, taking into account demand, price and the specific needs of the car owner. Under this system, a car plugged in after work might not begin charging until demand drops later at night, thereby avoiding price peaks and shortages.

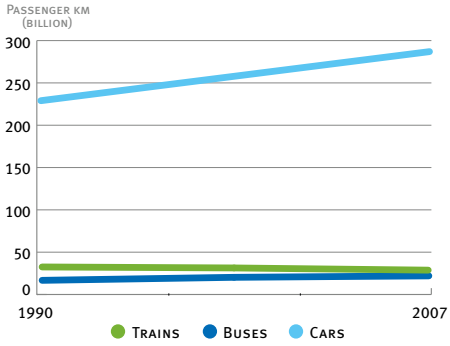
With increasing amounts of electricity coming from intermittent renewable energy sources such as wind power, the challenges of balancing supply and demand in the grid increase. In systems such as Denmark’s, with significant wind power and no hydropower that can rapidly be turned off and on, electric vehicles can potentially assist in balancing the grid. Batteries connected to the grid through “smart” infrastructure, whether at home or in battery swapping stations, may be charged in times with excess electricity generation and possibly provide short-term bursts of power into the grid at times with a shortage of electricity production.

The Danish Energy Association and, the Danish Transmission System Operator, Energinet.dk together with other partners have recently launched a large demonstration project called EDISON (Electric vehicles in a Distributed and Integrated market using Sustainable energy and Open Networks) on the island of Bornholm in Denmark. EDISON’s purpose is to explore the infrastructural and regulatory possibilities of a large electric vehicle fleet in an energy system with a considerable share of wind power and a large short-term balancing need.

Infrastructure for electric vehicles is strongly linked to the development of more efficient and intelligent electricity grids, known as Smart Grids. Several Nordic countries are part of the SmartGrids ERA-Net - a European Research Area Network for research financing actors in smart grids. The concurrent development of both smart grids and electric vehicle infrastructure is an integral step in putting more electric vehicles on our roads.

The Story in Statistics

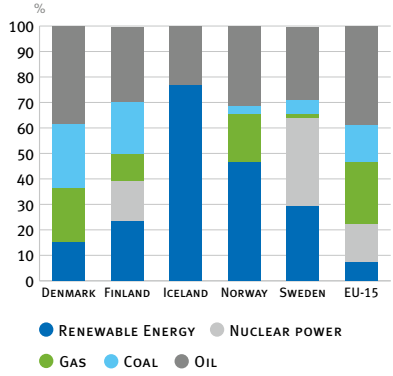
NORDIC PASSENGER TRANSPORT TRENDS, 1990 – 2007



Source: International Transport Forum

Cars are the primary means of passenger transport in the Nordic region, and their use is growing rapidly. This highlights the need for both cars that are more sustainable, and modal shifts from cars to more sustainable forms of transportation.

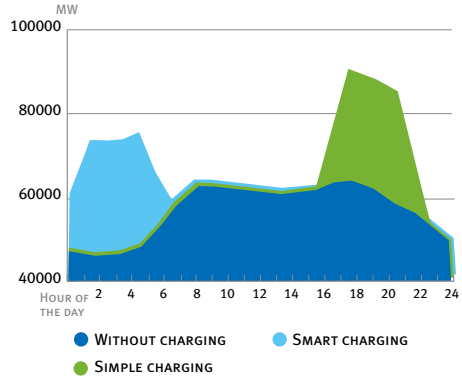
NORDIC ENERGY SUPPLY BY SOURCE, 2006



Source: Eurostat

The Nordic region has a high share of renewable energy sources and nuclear power, leading to very low CO_2 emissions in electricity generation. While oil remains the dominant energy supply in the transport sector, various initiatives work to displace it through the electrification of transport and alternative fuels.

CONCEPTUAL DAILY ELECTRICITY USE WITH LARGE SCALE UPTAKE OF ELECTRIC CARS



Source: COWI

The dark blue area shows the typical demand for electricity throughout the day. With simplistic home charging most electric cars are likely to be charged in the evening when it is most convenient (Green area). This will increase demand at a point of already high demand, causing distribution problems and price increases. Using smart charging, cars will be charged when demand is lowest, regardless of when the cars are plugged in (light Blue area). This will result in a more even demand for electricity.

Lowering Emissions on the High Seas

The Nordic region is home to leading marine technology providers, ship builders, and shipping companies, and is becoming a strong force in making the industry more sustainable.

While ships can be the most efficient way to transport goods, the sheer volume of goods transported puts the sector at a significant 3.5% of global CO_2 emissions.[2] Freight shipping increases as international trade grows, which is unlikely to slow significantly in the long-term. Therefore it is crucial to minimise the impact of ships and make them as sustainable as possible.

Encouragingly, the sector has considerable potential for emission reductions. These are found through greater efficiency (in engines, hull shapes and surfaces, smarter logistics and speed reductions) and through new fuels.
When it comes to freight shipping, bigger is better – the larger the ship, the lower the emissions per tonne of cargo. Launched in 2006, Emma Mærsk is the world's largest container ship and according to its manufacturers produces 30% less emissions per tonne of cargo than a mid-sized vessel. The ship was built by Odense Steel Shipyard in Denmark, and is owned by the world's leading container ship operator, Danish A.P. Møller-Mærsk. Technologies from Finnish Wärtsilä led to more than 10% in fuel savings thanks to advanced waste heat recovery systems and a highly efficient engine, which – quite suitably – is the world's largest.

But not all ships can be four football pitches in length like Emma Mærsk. Fishing and other smaller vessels are responsible for a significant share of emissions, and represent an important part of the economy, especially in

economies dependant on fisheries such as Iceland, Greenland and the Faroe Islands. Marorka is an Icelandic company, developing software to optimise maritime energy management for a range of different ships. This software increases efficiency and led to the company winning the 2008 Nordic Council Nature and Environment Prize.

Another route to greater sustainability in shipping is in alternative fuels. Heavy fuel oil is the standard fuel of the shipping industry, the dirtiest and lowest grade of oil-based fuel and the reason why shipping is a significant source of both NO_x and SOx emissions. A significant barrier to any potential replacement fuel for freight shipping is the necessity for near global availability. Despite this, Eidesvik of Norway has developed vessels powered by liquefied natural gas, which according to the company cuts nitrous oxide emissions by almost 90% and CO_2 emissions by 20%. The company is also developing fuel cell applications for shipping alongside Wärtsilä and other companies in the Fellowship programme. The potential for biofuels in shipping is great but due to high costs the technology has not yet seen commercial application.

Odense Steel Shipyard, A.P. Møller-Mærsk and another Danish firm – Aalborg Industries, have recently joined with MAN Diesel in the Green Ship of the Future initiative. From 2009 it will look to reduce emissions through developments in the engine, hull, paint, operation, port facilities, and logistics. Such partnerships have been the story of Nordic leadership in making the shipping sector more sustainable.

Alternatives to Fossil Fuels

Fossil fuel is the predominant form of mobile energy and one of the main causes of CO_2 emissions. We must look to alternatives in order to achieve a more sustainable transport system. Energy stored in batteries has the potential to provide clean and efficient mobile energy, but an uptake of batteries requires the replacement of existing vehicles and extensive investments in infrastructure. Liquid biofuels however, such as bioethanol and biodiesel, can be used instead of oil with minimal changes in engine technology, distribution infrastructure and user behaviour, offering a shortcut to more sustainable transportation. Gaseous alternative fuels such as biogas and hydrogen also offer sustainable alternatives to oil.

Biofuels are produced from plants that absorb CO_2 when grown and release it again when burned. So-called “first generation” biofuels are those in commercial use today and are produced directly from crops such as soy beans, corn and rape seed. Production of first generation liquid biofuels such as bioethanol from crops and biodiesel takes place throughout the Nordic region on a small scale, as well as in larger facilities such as those of Lantmännen and Perstorp in Sweden. Biodiesel can also be produced from waste vegetable oil from the food industry, as Neste Oil of Finland does in producing its NExBTL Renewable Diesel.

“Second generation” biofuels are produced from forest and agricultural residues and therefore do not compete directly with food production like most first generation biofuels do. These fuels, such as bioethanol from cellulose, biomethanol and synthetic biodiesel, are not yet on the market but offer significant potential. Various Nordic companies are already producing second

generation biofuels in pilot plants. Swedish SEKAB for example utilises wood chips from pine trees plant in Örnsköldsvik, while BioGasol of Denmark uses agricultural residues from crop farming as a feedstock.[3] Other Nordic companies, such as the Danish Novozymes and Danisco, are world-leading suppliers of enzymes, a key element in second generation ethanol production.

Ongoing collaborative research between Nordic countries aims at speeding up the commercialisation of second generation biofuels. These range from specific projects such as "New, innovative pre-treatment of Nordic wood for cost-effective fuel-ethanol production", to large projects such as the Sustainable Biofuels programme within the Nordic Top Level Research Initiative. This collaboration extends beyond the Nordic countries in projects such as Bioenergy Promotion, which focuses on the Baltic Sea Region.

While liquid alternative fuels offer a direct transition from oil, gaseous alternative fuels such as biogas and hydrogen provide mobile energy with high efficiency and have great potential. Biogas can be produced from the gasification of biomass or through digestion or fermentation of biomass and organic waste. It can then be burned in a modified internal combustion engine. Hydrogen can be produced in a number of ways, and stores the energy used in its production until it is fed through a fuel cell in a vehicle to produce electricity for an electric motor. Both fuels have significant potential, but an uptake of compatible vehicles is dependent on infrastructure, which itself is dependent on an uptake of compatible vehicles.

To address this deadlock, various projects have attempted to tackle both vehicles and infrastructure concurrently. Biogas Väst is a Swedish project which has helped create a system in Western Sweden with 36 filling stations, 7000 vehicles and eight biogas production facilities.[3] Similarly, the Scandinavian Hydrogen Highway Partnership aims to create a network of hydrogen filling stations and a fleet of fuel cell electric vehicles across the Nordic region. Nordic countries have also been highly involved in larger European initiatives such as the Hydrogen and Fuel Cell Co-ordination (HYCO) ERA-NET programme.

Another important aspect in bringing alternative fuels to the market in the Nordic region has been bold regulatory decisions. In Sweden all major petrol stations have been required to offer a alternative fuel. This has drastically increased the availability of fuels such as bioethanol, which will be available at over 60% of all filling stations in the country by the end of 2009.[4]

Community-based Projects

A number of Nordic municipalities have been active in promoting both shifts to cleaner modes of transport, and technology to make public transportation cleaner. Such community-based projects serve as important test-beds for larger regional projects.

Cars are the primary means of transportation in the Nordic countries, as in other developed economies. Modal shifts to more sustainable forms of transport, such as public transportation and bicycles, are of high priority in the Nordic region. Stockholm offers a successful example of such a modal shift with their inner-city road toll. The toll led to a drop in inner city traffic of over 20% and a marked increase in people taking public transportation into the city.[5]

When it comes to promoting inner-city cycling, Copenhagen leads by example. The city offers raised cycling lanes on most inner-city streets, has 36% of its population biking to work every day and is known as being among the best cities in the world for cyclists.[6] Direct measures such as improving and extending cycling tracks, as well as indirect measures such as limiting car parking space and high car taxes have both played a role in building the city's strong bike culture. Following Copenhagen's lead, a number of other Nordic cities have also been successful in increasing bike traffic. Bike-sharing schemes are a useful instrument for getting more people on bikes, and have been successfully implemented in a number of Nordic cities, including the capitals of Sweden, Denmark and Norway.

Skånetrafiken, the regional rail company in Skåne, Sweden, has attempted to bring environmentally-aware passengers to its electric trains through an emission calculator displayed on the company's website when planning trips. Electric trains offer one of the cleanest forms of transport, and all of Skånetrafiken's electric trains carry the stringent eco-label of the Swedish Society for Nature Conservation.

In addition to promoting modal shifts, numerous municipalities in the Nordic region have seen cleaner technologies implemented in their public transportation networks. Examples include the past project with hydrogen-powered buses in Reykjavik, bioethanol-powered buses in Oslo and biogas-powered buses in Norrköping, Sweden. Programmes such as the Ethanol Bus & Truck Initiative in Sweden help to promote and assist the uptake of cleaner forms of public transport.

Community-based initiatives have even promoted the purchase of cleaner private vehicles. The Bioethanol for Sustainable Transport (BEST) project aims to contribute to a market breakthrough for flexible-fuel vehicles that can burn both petrol and bioethanol. Stockholm is the coordinating city of this international project, and has also come furthest in Europe in introducing clean vehicles and fuels. In 2008 clean vehicles, meaning ethanol (FFV) or electric hybrid cars accounted for 32% of new car sales in Stockholm. Sweden has one of the largest fleets of such vehicles in Europe, as well as widespread availability of bioethanol (see page 10).[7]

The Nordic Test bed

Reducing greenhouse gas emissions, energy dependency and creating new competitive markets is at the very top of the Nordic political agenda. Making transportation more sustainable is an important step towards solving all three of these crucial issues. The transport sector is already responsible for a significant share of greenhouse gas emissions and global oil trade, and demand for transportation is projected to grow.

The Nordic region has already developed competencies in sustainable transportation. Examples range from small enterprises such as Marorka, to large-scale demonstration projects such as the EDISON project. The well-functioning Nordic electricity market and the relatively low carbon footprint of the Nordic energy mix means that electric transportation in the Nordic region has very low greenhouse gas intensity and great potential for further development. Through both smaller community-based initiatives, and larger Nordic and European projects, the region has also built significant competencies in biofuels, hydrogen, and in promoting modal shifts to more sustainable modes of transport.

These competencies, combined with a strong renewable energy sector, high personal incomes and an environmentally aware public, make the Nordic region an ideal candidate to become a test bed for sustainable transportation.

By building on the positive experiences presented here, the region is well poised to take a lead in the emerging market for sustainable transportation – especially with all eyes on the region at the COP15 Climate Summit in Copenhagen in December 2009.

Together with the other elements of the Nordic Council of Ministers Chairmanship project on sustainable transportation, this brochure has aimed to portray examples of the Nordic competencies in sustainable transportation.

To further develop its potential the Nordic region needs to create a regulatory framework that fosters business development in sustainable transportation, including market incentives that increase the profitability of clean transport technologies. Further research, development and demonstration into a range of technologies will also play a significant role in bringing clean technologies to market. Finally, the development and implementation of “intelligent” electricity infrastructure will be pivotal in the large-scale electrification of transport. By coordinating national efforts into developing regulatory frameworks, increasing research, and implementing intelligent energy infrastructure, the added value will increase, moving the Nordic region one step closer to a transformed transport system.

”The Region should act as a test market for green transport and build the green Nordic brand in the global energy sector”.

Anders Fogh Rasmussen, then Danish Prime Minster (Globalisation Forum, Reykjavik 22 February 2009) .

Other parts of the Project

FORESIGHT ANALYSIS

The analysis is performed by COWI, and will focus on the Nordic transport sector in 2050, providing a basis for Nordic strategies to increase renewable energy in transportation

FORTHCOMING WHITEPAPERS

- Sustainable transportation in sparsely populated areas
- Spatial Planning and its contribution to climate friendly and sustainable transport solutions

CONFERENCE

The international conference "Driving Sustainability" in Reykjavik 14-15 September 2009. The Nordic perspectives will be presented to an audience of Nordic and global stakeholders. The conference also features presentations by a range of international experts. For more information visit the conference website: www.driving.is

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