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Policies and Initiatives for Carbon Neutrality in Nordic Heating and Transport Systems

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Abstract: Policies and initiatives promoting carbon neutrality in the Nordic heating and transport systems are presented. The focus within heating systems is the promotion of HPs (heat pumps) while the focus within transport systems is initiatives regarding EVs (electric vehicles). It is found that the conversion to HPs in the Nordic region relies on both private economic and national economic incentives. Initiatives toward carbon neutrality in the transport system are mostly concentrated on research, development and demonstration for deployment of a large number of EVs. All Nordic countries have plans for the future heating and transport systems with the ambition of realizing carbon neutrality.

Key words: Policies and initiatives, carbon neutrality, heat pumps, electric vehicles.

1. Introduction

The Nordic countries have sufficient RES (renewable energy resources) to develop a carbon neutral electric power system even if electricity demand increases due to the electrification of the transport and heating sectors. However, investment lead times are very long and there is no common knowledge basis among Nordic countries how, and through what policies, carbon neutrality will be pursued. Furthermore, how the system develops and which challenges will emerge are dependent on the approach taken towards Europe.

Technical University of Denmark has entered collaboration with the independent research institute SINTEF (Stiftelsen for Industriell og Teknisk Forskning) and Stockholm Environment Institute on a Nordic Energy Research (Norden) financed project to investigate how a carbon neutral electric power system in the Nordic region can be achieved in 2050. The project is “Nordic Power Road Map 2050: Strategic Choices towards Carbon Neutrality (NORSTRAT)”.

The overall objective of the project is to build knowledge and understanding among politicians, decision makers and actors in the power industry about possible carbon neutral futures for an integrated Nordic power system in 2050. The knowledge and understanding is based on qualitative scenario analysis of impacts on the electricity, the transport and the heating system combined with the necessary governance aspects to enable the transformation.

This paper is to give an overview of the policies and initiatives in the Nordic region in order to achieve the goal of carbon neutrality in the heating and transport systems. The study covers the four Nordic countries of Denmark, Norway, Sweden and Finland. Since the power system in Iceland is not connected to the Nordic interconnected power system, Iceland is not included in the study.

In the remaining part of the paper, the development in Nordic heating and transport systems in recent years

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and the plans already in place for adapting these sectors towards carbon neutrality are presented. In Section 2, the development and plan in Nordic heating system are described. The development and plan on the electrification of the Nordic transport system are presented in Section 3. A brief conclusion on the electrification of the heating and transport systems in the Nordic region is drawn in the end.

2. Development and Plans of the Heating System in the Nordic Region

The heating systems in the Nordic region rely on a broad palette of energy carriers. Though composition of these carriers differs from one country to the others, the current approaches for stimulating development and market entry of low emission technology are to a great extent same in the Nordic countries. The overall tendency in the heating system is that oil stoves and electric space heaters are being substituted with more efficient technologies.

The oil and electricity consumed for heating dwellings and premises is presented in Figs. 1 and 2. The data are retrieved from the national statistics databases and the way of collecting the data differ from country to country. Therefore, the series should be used to understand the development in each country rather than compare actual consumption between countries.

The development and plans of the heating systems in the Nordic region are presented in Sections 2.1-2.4.

2.1 Heating in Denmark

The first law on heating supply in Denmark was enacted in 1979. This granted local governments the power to oblige entrepreneurs to connect new buildings to the district heating network. A few years later, installation of electric space heaters as main heating source in dwellings was made illegal if the dwelling had access to the district heating system.

Throughout the 1980s and 1990s, the tendency was to favor natural gas for district heating production as well as to convert the many decentralized heating

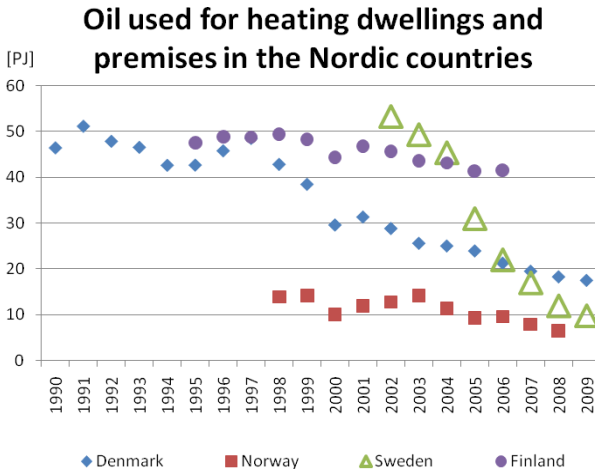

Fig. 1 Time series of oil consumption for heating premises and dwellings in Nordic countries by country (PJ/year).

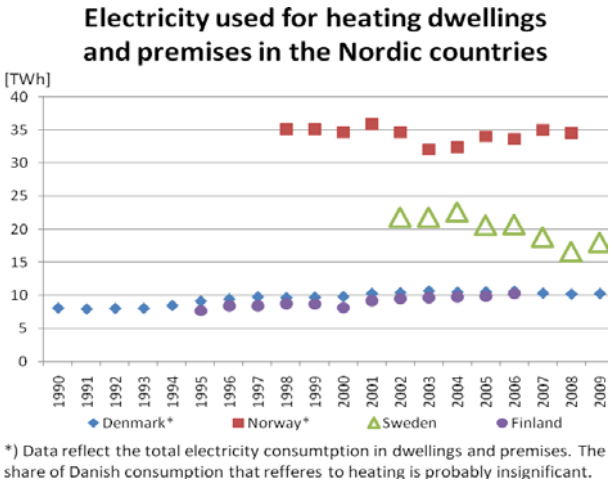

Fig. 2 Time series of electricity used for heating premises and dwellings in Nordic countries by country (TWh/year).

plants to production of CHP (combined heat and power). The CHP strategy led to incidents where heating demand exceeded the demand on electricity and caused export of electricity at a price that did not cover production costs. Since 2003 the small CHP plants have been relieved from the obligation of co-production of heat and power.

In 2009, 40% of the heat consumed in Danish dwellings was district heating. This corresponds to approximately two thirds of national consumption of district heating that year. Production of district heating and consumption of power and fuels in households were sources of 14% of Danish emissions of greenhouse gases in the same year [1].

In February 2008, the Danish parliament presented an agreement for the energy sector from 2008 to 2011. The objective was in brief to increase the share of renewable energy to 20% by 2011 and to reduce energy consumption 4% by 2020 [2]. In relation to this agreement, Danish Energy Agency initiated a campaign intended to raise public awareness and induce transparency in the heat pump market. The campaign included a limited option of subsidies to installation of heat pumps [3].

Danish Energy Agency estimates that 50 thousand heat pumps have been installed in individual dwellings while 5 thousand larger devices have been installed in building blocks, farms and industry. In the energy outlook for 2020, Danish Energy Agency suggests a tendency where heat pumps substitute the capacity of oil stoves that are gradually taken out of service [4].

2.2 Heating in Norway

Nearly all electricity production in Norway is based on hydro power [5]. Until recent years, the electricity price in Norway was considered amongst the lowest in Europe. Norwegian power market was deregulated in 1991 and the number of interconnections to neighboring countries has increased. From the year 2000 to present, the electricity price in Norway has risen to the same level as other European countries.

Conventional electric space heating is the most common heat source in Norwegian dwellings. Recent development shows however a clear tendency of conversion from electric heating and oil stoves to heat pumps [6].

Heating of buildings accounted for 4% of Norwegian greenhouse gas emissions in 2010 [7]. This small fraction may seem insignificant, but with the ambitions of increasing the share of renewable energy to 67.5% by 2020, the Norwegian government considers heating as one of the focus areas.

In 2001, the Norwegian government established a public enterprise named Enova SF with the objective of promoting environmentally friendly restructuring of the power system. Enova has a range of funding and public awareness programs targeting conversion from oil based heating in residents and industry. From 2001 to 2010, Enova's goal was 4 TWh of renewable energy in the heating system. From an evaluation in 2009, Enova stated that projects covering a total of 5 TWh renewable heating energy had been subsidized [8]. The National Statistics Bureau of Norway states that in 2009 18.5% of Norwegian dwellings had a heat pump installed and that the share of dwellings solely dependent on oil stoves for heating had decreased from 16% in 2006 to 5% in 2009 [6].

The tendency is that heat pumps substitute the oil stoves and electric space heaters that are being abandoned.

2.3 Heating in Sweden

The number of heat pumps installed in Swedish dwellings in 2008 was close to 700,000 [9]. The amount of electricity used for heating including driving energy to heat pumps was 18 TWh in 2009 [10]. This makes electricity the second largest energy carrier in the Swedish heating system. The largest is district heating. The share of greenhouse gas emissions that referred to electricity and district heat production and from fuel consumption in households was 20% in 2009 [11].

Sweden aims for a heating system independent on fossil fuels by 2020. Government plans include investments in district heating and combined heat and power. The goal is to reduce national emissions of greenhouse gases 40% by 2020 and expand the share of renewable energy to 50% [12].

The Swedish government has experiences with subsidizing homeowners' conversion from oil based and electric space heating. The Ministry of Enterprise, Energy and Communication initiated in 2006 a campaign for subsidizing homeowners in conversion from electric space heating to more efficient or carbon neutral heating systems [13]. By April 2007, 6

thousand cases were granted subsidies within the campaign. Among these cases, the heating systems installed to substitute the space heaters were distributed on district heating (69%), heat pumps (24%), and systems based on bio fuels (7%) [14]. A similar campaign targeting conversion from oil based heating systems was also initiated in 2006. By 2007, the entire budget of the campaign had been met as a result of high popularity of the subsidies. Nearly 37 thousand cases were granted subsidies for converting to district heating (20%), heat pumps (43%), and systems based on bio fuels (37%) [15].

The Swedish Energy Agency expects a decrease in electricity used for heating of 1.6 TWh towards 2020 [16].

2.4 Heating in Finland

The market shares on the Finnish heating market were in 2009 distributed on district heating (49%), electric heating (18%), firewood (14%), heat pumps (12%), heating oil and natural gas (7%) [17]. The share of greenhouse gas emissions that referred to heating buildings in 2009 was 10% of national emissions [18].

In 2008, the Finnish parliament agreed on a long term climate and energy strategy. The strategy has two scenarios: a base scenario that is a mere expansion of the current development without further stimuli and a goal scenario that combines national and European goals for renewable energy along means of obtaining these [19]. The base scenario states that heat pumps will cover 3 TWh of heating demand in 2020 while the goal scenario suggests a possibility of 5 TWh coverage which is an increase of approximately 100% according to 2006 level. Subsidies to conversion of heating system are included in the strategy. Subsidies are granted to companies and communities but homeowners with low income and social housing communities are also targeted in the funding program. Other homeowners are addressed through public awareness programs [20]. A government affiliated agency named Motiva Oy runs several public awareness programs on energy efficiency that are related to the climate and energy strategy.

In a press release from June 6, 2011, Senior Advisor Heikki Väisänen of the Ministry of Employment and the Economy stated that the effect of the initiatives is likely to exceeded initial expectations [21].

3. Development and Plans of EVs (Electric Vehicles) in the Nordic Region

The transport system is a large contributor to greenhouse gas emission worldwide. Mobility in the Nordic region is high and hence transport is a big source of greenhouse gas emissions in this region. Reducing mobility is not considered an option when it comes to reduction of emissions from the transport system. Therefore, the countries strive to promote energy efficiency and renewable energy in the transport system.

The passenger car fleet in the Nordic countries has been gradually growing for the last century. Applying a linear fit to the tendency over the last few decades can provide a rough estimate of the development towards 2050 shown in Fig. 3.

The IEA (International Energy Agency) has developed a series of roadmaps for technologies targeting a 50% reduction of global CO_2 emissions by 2050. One roadmap released in 2009 suggests that the annual passenger car sales by 2050 can be distributed nearly equal on hybrid electric, battery electric and fuel cell vehicles if the right stimuli are applied to market entry and development of the technologies. IEA emphasizes the importance of research, development and demonstration collaborations between governments and industry, the strategic deployment of charging infrastructure and strong policy support on making the technologies cost competitive to conventional technology [22].

Below is a brief presentation on the initiatives currently in action in the Nordic countries that is thought to impact the development of the electric vehicle technology.

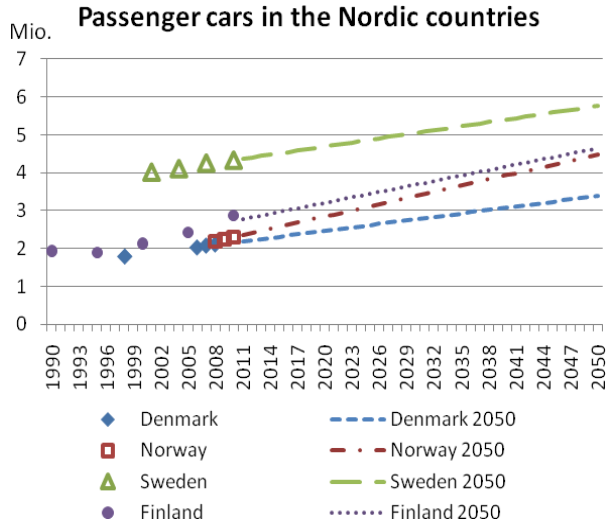

Fig. 3 Passenger cars in the Nordic countries historical and expected development towards 2050.

3.1 Transport in Denmark

In 2009, the Danish parliament agreed on a common policy for a greener transport system. Some of the focus areas of the policy are to bring down greenhouse gas emissions from transport and to have public transport facilitate the expected growth in transport. Further it is intended to turn Denmark into a green technology laboratory of transport [23].

Car owners in Denmark pay a registration tax that is a onetime expense when a car is purchased and an annual tax which is based on fuel economy. The registration tax in Denmark is more than 100% of the sales value of the car. It has been discussed to reform the registration tax in a way that promotes energy efficient technology but no agreement has yet been achieved on this matter. Electric battery cars are however relived from registration tax until 2015 [24].

Danish Transport Authority has been assigned to administrate a fund for research activities and demonstration projects on energy efficient transport. Currently, the fund has subsidized 10 projects of which two concerned electric vehicles [25]. The largest single grant has been given to the project “Test-an-EV” where 300 electric battery cars are tested for daily use by 2400 families in turn. The test is expected to revile information on driving and charging patterns and user experiences with the vehicles.

Another large scale project named EDISON (Electric vehicles in a Distributed and Integrated market using Sustainable energy and Open Networks) uses the small Danish island of Bornholm to investigate system perspectives of electric vehicle technology [26]. System perspectives include market solutions, electric network configurations and interaction between energy technologies. Along the EDISON project, the citizens of Bornholm participate in the smart grid project “EcoGrid EU” and results are exchanged between these two projects [27].

Several companies are pursuing a position on the electric vehicle market in Denmark. A trade organization has been formed for service and coordination of business aspects. The trade organization is called Danish Electric Vehicle Alliance.

3.2 Transport in Norway

Consumption of fossil fuels for road transport and aviation in Norway has been regulated by a carbon emission tax since 1991 [28]. The registration tax in Norway was reformed in 2007 to promote vehicles with low greenhouse gas emissions. In addition electric battery cars and hydrogen fuel cell cars are relived from both registration tax and annual taxes. Electric battery cars are further relived from parking fees at public parking lots, road pricing and are allowed driving in bus lanes that are otherwise reserved for public transport [29].

The Public Roads Administration of Norway administers a trial funding program for reduction of greenhouse gas emissions in the transport system. Transnova as the program is called financed deployment of electric vehicle charging stations in 2009. Many other projects on electric vehicles have been subsidized within the program. Transnova is to be evaluated in 2012 for a possible extension of the program [30].

Every fourth year the Ministry of Transport and Communication releases a 10 year plan for developments in the transport system. The latest plan

spanning from 2010 to 2019 emphasizes the environmental impact of the transport system and sets up goals for reducing emissions by 2.5-4.0 Mio tones of CO_2 equivalents in 2020 referred to a continuation of the current development in emissions from the sector. Among means of obtaining this goal are mentioned increase in funding of research and development, reform of the tax on fuel and stimulation of market entry of low emission technology [31].

3.3 Transport in Sweden

A goal for the Swedish transport system is a 10% reduction of greenhouse gas emissions by 2020 [16].

Currently, Sweden has no legislation that favors electric vehicles over other energy efficient or low emission technologies. A vehicle class in the Swedish tax system called eco cars has been introduced for promotion of more energy efficient transport. Eco cars can be cars driven by diesel or gasoline with CO_2 emissions less than 120 g/km or cars driven by alternative fuels with fuel consumption per 100 km equivalent to 9.2 L of gasoline, 9.2 m^3 of gas or 37 kWh electricity [32]. Purchase of an eco car gives some tax benefits. From January 2008 to September 2011, the number of eco cars registered has grown from 111,453 to 465,743 [33].

In propositions for the national budget of 2012, the Swedish government suggests introduction of a new vehicle class called Super eco cars. Super eco cars will include electric battery cars and hybrid cars with CO_2 emissions less than 50 g/km [34].

The Swedish state and the automotive industry of Sweden have formed a research collaboration named Strategic Vehicle Research and Innovation (FFI). FFI funds research projects related to many aspects of transport and vehicles including electric vehicles and alternative fuels. The Swedish government also subsidizes demonstration projects with electric vehicles.

3.4 Transport in Finland

The Ministry of Transport and Communication of Finland has been planning the transport system with regard to its environmental impact since the beginning of the 1990s [35]. According to the Finnish climate and energy strategy energy efficiency in the transport system should have increased 9% by 2020 [36].

The registration tax in Finland is based on carbon dioxide emissions. A base tariff in the annual tax on cars was reformed in 2010 and is now also dependent on CO_2 emissions [37].

In 2009 the Ministry of Employment and the Economy had a working group appointed for examining the business opportunities of electric vehicle technology in a Finnish perspective. The working group concluded that significant export opportunities exist within the field and handed over a report with recommendations on actions for targeting net sales of 1-2 billion Euros in 2020 [38].

The fraction of Technical Research Centre of Finland (VTT) that deals with fuel technology has its main focus on fuel cells, bio fuels and hybrid technologies for heavy duty vehicles. VTT has no projects directly on battery electric vehicles but participate in the collaborative program TransEco. TransEco is intended to run from 2009 to 2013 while providing tools for adapting the transport system to goals in the climate strategy in a cost effective way [39].

Development Center for Technology and Innovation (TEKES) governed by the Ministry of Employment and the Economy is an institution servicing innovating businesses in Finland by financing research and development projects. TEKES informs that a lithium deposit has been discovered in Finland, that a battery factory is starting production of batteries for electric vehicles and that series production of electric vehicles are starting up at the Velmet Automtive car manufactory [40]. TEKES has initiated an electric vehicle systems program for business development in Finnish companies within the field with objectives of increasing net sales from the 200 Mio Euros of today to 2 billion by 2020 [41].

4. Conclusions

Measures for carbon neutrality in the Nordic heating sector appear on both private economic level and national economic level. The private economic move is to increase prices on electricity and fossil fuels used for heating. The private economic measure is most common in Norway and Sweden due to significant reliance on conventional electric space heating. National economic measures are present in all countries in the Nordic region and the tendency is to act on this by means of legislation, subsidies and public awareness programs in favor of carbon neutrality in the heating sector.

There are many initiatives towards carbon neutrality in the transport sector, most of them concentrating on research, development and demonstration. Along possibilities of reducing greenhouse gas emissions, the electric vehicle technology is expected to contribute with export potential in the Nordic region. Collaborations among research institutes, state authorities, industry and innovating businesses have been established. Vehicle tax systems either have been or are subjected to changes that promote carbon neutrality and energy efficiency.

All Nordic countries have plans for the future heating and transport systems in order to achieve carbon neutrality.

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