
Nordic Council
of Ministers
Check for updates
Nordic heating and cooling
Nordic approach to EU's Heating and Cooling Strategy

Nordic heating and cooling

Nordic approach to EU's Heating and Cooling Strategy

Jenni Patronen, Eeva Kaura and Cathrine Torvestad

TemaNord 2017:532

Nordic heating and cooling
Nordic approach to EU's Heating and Cooling Strategy
Jenni Patronen, Eeva Kaura and Cathrine Torvestad

ISBN 978-92-893-4991-8 (PRINT)
ISBN 978-92-893-4992-5 (PDF)
ISBN 978-92-893-4993-2 (EPUB)
http://dx.doi.org/10.6027/TN2017-532

TemaNord 2017:532
ISSN 0908-6692

Standard: PDF/UA-1
ISO 14289-1

Cover photo: unsplash.com

Print: Rosendahls
Printed in Denmark

5041 0457
Ecolabelled Printed Matter
Rosendahls

Although the Nordic Council of Ministers funded this publication, the contents do not necessarily reflect its views, policies or recommendations.

Nordic co-operation
Nordic co-operation is one of the world's most extensive forms of regional collaboration, involving Denmark, Finland, Iceland, Norway, Sweden, the Faroe Islands, Greenland, and Åland.

Nordic co-operation has firm traditions in politics, the economy, and culture. It plays an important role in European and international collaboration, and aims at creating a strong Nordic community in a strong Europe.

Nordic co-operation seeks to safeguard Nordic and regional interests and principles in the global community. Shared Nordic values help the region solidify its position as one of the world's most innovative and competitive.

Contents

Executive summary

Introduction

Heating and cooling in buildings and industry account for half of the EU's energy consumption. 75% of heating and cooling in the EU is still generated from fossil fuels while only 16% is generated from renewable energy. According to the EU commission, the heating and cooling sector must sharply reduce its energy consumption and cut its use of fossil fuels in order to meet the EU's climate and energy goals. (COM(2016) 51 final).

The EU's heating and cooling strategy (COM(2016) 51 final) was published in February 2016, and later on, on November 30th 2016, the European Commission came out with an extensive package of specific directive proposals referred to as EU Winter/Clean Energy Package. Several of these directives also have impact on the heating and cooling sectors.

In the Nordic countries, heating plays an important role in energy markets due to cold climate, and a lot of effort has already been put to make heat production and consumption energy efficient and to decrease the emissions. To disseminate these experiences and good practices wider in Europe, and to identify further needs for co-operation within the Nordic region, the Nordic Council of Ministers commissioned Pöyry Management Consulting to identify the common approaches of the Nordic countries towards the EU's Heating and Cooling Strategy and Winter Package regulation. This report describes the results of the work based on Pöyry's analysis of the current heating and cooling sector practices and regulation in the Nordic countries, and interviews of the regulators and energy industry representatives from each country. The report focuses especially on space heating markets in the Nordics, and on district heating due to its significant position in the Nordics. The views presented in this report are based on Pöyry's interpretations and do not necessarily reflect the views, policies or recommendations of the Nordic Council of Ministers.

Contact

- Pöyry Management Consulting Oy, Jaakonkatu 3, FI-01621 Vantaa
- Jenni Patronen, Tel +358 407544922, E-Mail Jenni.patronen@poyry.com

EU heating and cooling policy

The European Union is committed to a sustainable, competitive, secure and decarbonised energy system. The Energy Union and the Energy and Climate Policy Framework for 2030 establish ambitious Union commitments to reduce greenhouse gas emissions further (by at least 40% by 2030, as compared with 1990), to increase the proportion of renewable energy consumed (by at least 27%) and to make energy savings of 30% at the Union level by 2030.

To address the specific needs of the heating and cooling sector decarbonisation, the Commission proposed an EU Heating and Cooling Strategy in February 2016 (COM(2016) 51 final), as a first step in exploring the issues and challenges in this sector, and solving them with EU energy policies. On the 30th November 2016 the European Commission published several directive proposals related to the EU 2030 Climate and Energy Policy in a so called Winter Package.

The main regulation concerning heating and cooling sector are proposed in Renewable Energy Directive and Energy Efficiency Directive. Especially the proposal to endeavor to increase share of renewables in heating and cooling by 1 percentage point annually, and the district heating and cooling (DHC) related proposals of access of waste heat and renewable heat into DHC systems, disconnection rights for customers and information provision are important from the heating sector point of view. The renewables directive also sees the importance of integration of heating and cooling with electricity systems, and proposes that electricity distribution system operators (DSOs) and DHC system operators should assess biannually potential of DHC systems to provide balancing and other system services. In the energy efficiency directive, the proposal to require measuring of heat use on building unit level for buildings with a central source of heat or hot water is important especially for the district heating sector.

Heating markets in Nordic countries

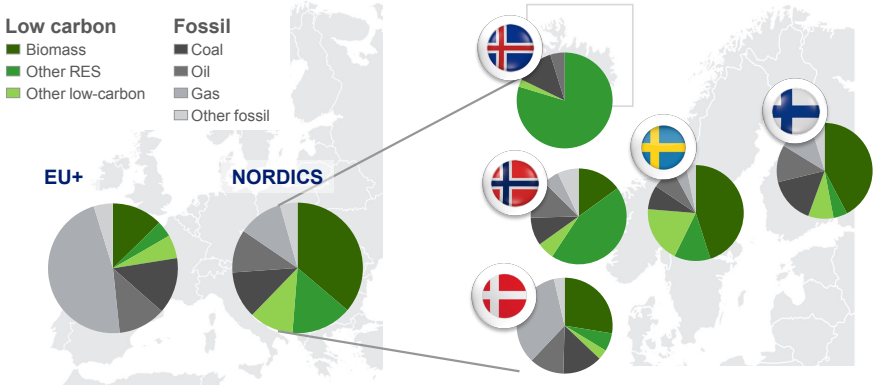
All the Nordic countries have developed their heating and cooling systems based on local needs and resources. As a result, for example Norway, with its vast hydro power resources, utilizes high share of electricity in heating, and Iceland bases the heating on geothermal sources. Finland and Sweden utilize biomass from forests, and Denmark also uses gas. However, the Nordic countries' heating and cooling markets have several common factors, such as:

- High share of renewable energy in the space heating and cooling.
- Rather high level of domestic energy resources used for heating and cooling, such as biomass, geothermal energy, heat pumps and waste-to-energy (in Norway also electricity based on renewable hydropower).
- Quite strong position of the consumer in choosing of heating and cooling systems and solutions – rather liberal and open markets.

- District heating plays an important role in all the Nordic countries except Norway. However, even in Norway the district heating market has grown rapidly due to new waste to energy plants.
- Ambitious national future targets for emission reductions and share of renewables in the energy mix.
- High level of taxation for fossil fuels used in heating as an existing key measure for cutting emissions in the sector.

The share of fuels used for heating and cooling sector in the Nordic countries and comparison to EU average is presented in Figure 1. In addition to residential and service sectors, the figure includes also industrial heating and cooling. The large share of renewable and other low carbon fuels presented in green color is noticeable in all Nordic countries compared to EU average.

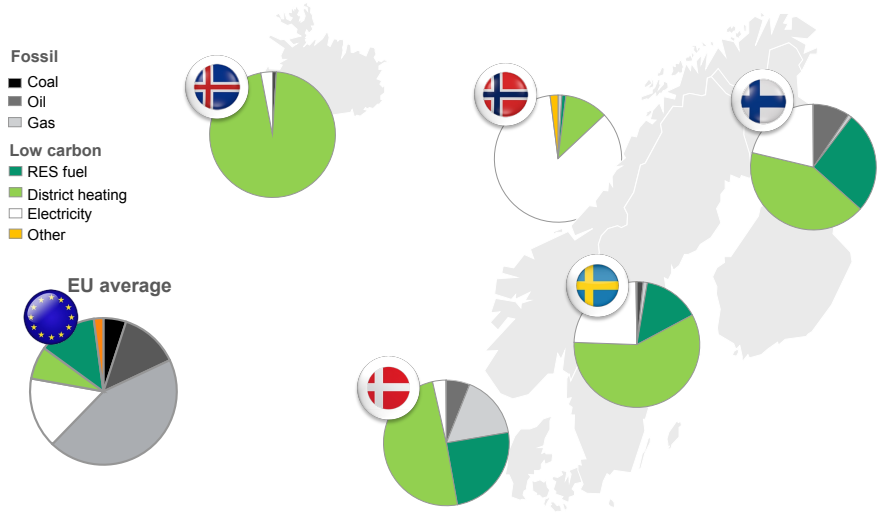
Figure 1: Final energy sources in heating and cooling (incl. industry) in EU and Nordic countries (2012)



Source: SWD 2016.

The Nordic countries also have a high share of district heating in the heat sector. The share of different heating sources for the residential and service sector is presented in Figure 2. Fossil fuel use directly in the buildings is very small in all Nordic countries compared to EU average.

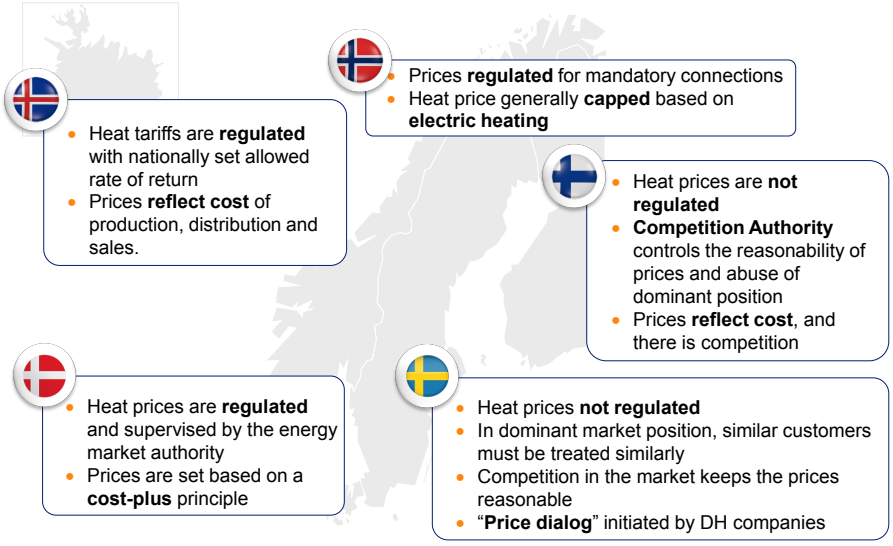
Figure 2: Energy sources used in residential and service sector heating (Nordic countries 2015, EU average 2012)



Source: National statistics, SWD 2016.

The open and liberal heat markets in the Nordic countries are reflected in the approaches to district heat connection and disconnection rights, and district heat pricing. The approaches to district heat pricing in the Nordic countries are presented in Figure 3. In Finland and Sweden, the heat prices are not regulated, and there is no obligation to connect and disconnection is allowed. In Denmark and Iceland, the connection can be mandatory, and disconnection is not always allowed. Also the prices are regulated. In Norway, there is in some cases obligation to connect with regulated prices, and in some cases no obligation and no price regulation. The role of cities and municipalities is however important in all countries, making the development of district heating and utilization of waste heat and local resources possible e.g. with town planning taking into account energy perspective.

Figure 3: Approaches to district heat pricing

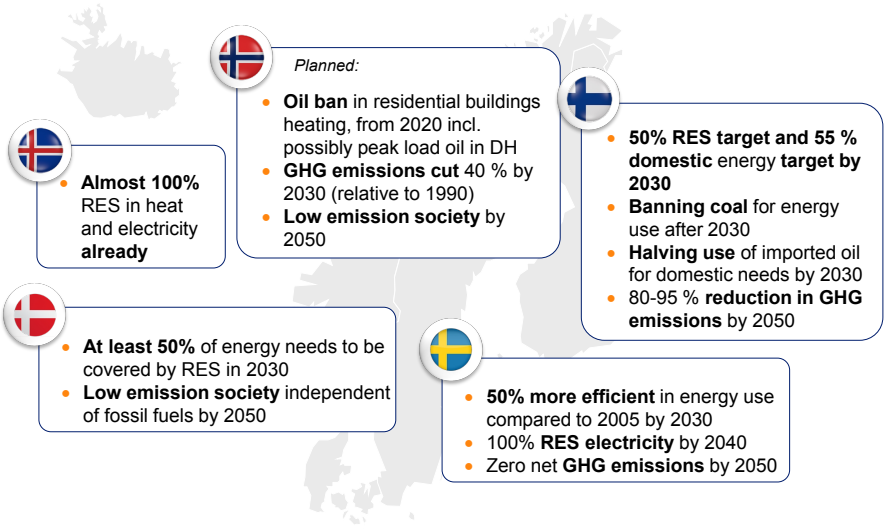


Source: Pöyry analysis.

Nordic view towards EU's heating and cooling policy

The Nordic countries all have very ambitious national policies to reduce emissions and energy use, and the importance of heating sector is recognized in the national strategies. These kinds of national strategies, taking into account the local resources and possible solutions can serve as important measures to promote the decarbonisation targets. Some of the main targets in each of the Nordic country related to heating and cooling sector are presented in Figure 4. The targets can be realized with national taxation decisions, support schemes or even restrictions to use some fossil fuels, like proposed in Finland and Norway.

Figure 4: National energy and climate targets in the Nordic countries



Source: Pöyry analysis, national policies.

Based on the interviews, many of the Nordic stakeholders would like to see EU emissions trading scheme (ETS) as the key measure to reduce emissions in district heating sector in the future. Building level heating based e.g. on fossil fuel boilers is not included in ETS, but in those sectors, the national targets to reduce emissions are strict and high fossil fuel taxation and some support measures attempt to address the emission reduction need.

District heating and CHP have been important sources of energy (heating, cooling and electricity) in the Nordic countries for a long time, and the benefits of district heating are realized from several viewpoints. The use of district heating instead of electricity for heating reduces the need for electricity but especially the peaks in demand, as the electricity demand is peaking at the coldest winter days. When district heat is produced with CHP, electricity can be produced especially during the peak demand. The district heat networks allow for heat storage, and heat can be stored also in separate heat storages with low cost compared to electricity storage. Therefore, district heating has an important role for the electricity system as well.

Taking into account the manifold advantages of district heating and CHP, it would be important to maintain district heating and CHP in the energy system also in the future. However, in many of the countries the view is that this should be done with market based approaches. As there are no restrictions to disconnect from district heating in some of the countries, it is important that there is a level playing field for all heating methods. Therefore, any regulation possibly increasing the cost of district heating should be analysed very carefully. Many of the interviewees brought up the concern that the proposed obligation to measure heat use on flat level, as well as the

third-party access of renewable energy to DHC systems can result in this kind of additional cost.

Concerning the regulated third party access to DHC systems, none of the interviewees found it beneficial in the proposed form. The respondents saw that it might not bring benefits especially in situations when district heating is already based on waste heat, waste incineration or renewables. In the current format of proposal, it would also require major regulatory changes, even unbundling of production, sales and transmission in district heating. This would increase the cost and decrease the competitiveness of district heat.

For the metering requirement proposal, the interviewees in the Nordic countries saw that it is important to measure the energy use more carefully on building level, but flat level measuring might not bring the benefits and can be even counterproductive. Energy efficiency is best promoted with building level investments and optimisation of energy use, and on the flat level, the residents can mainly save in hot water use.

Introduction

Heating and cooling in buildings and industry account for half of the EU's energy consumption. 75% of heating and cooling in the EU is still generated from fossil fuels while only 16% is generated from renewable energy. There is a lot of room for efficiency improvements to reduce the emissions and at the same time the cost for energy users. According to the EU commission, the heating and cooling sector must sharply reduce its energy consumption and cut its use of fossil fuels in order to meet the EU's climate and energy goals.

The EU's heating and cooling strategy was published in February 2016, and later on, on November 30th 2016, the European Commission came out with an extensive package of specific directive proposals referred to as EU Winter/Clean Energy Package. Several of these directives also have impact on the heating and cooling sectors. All the Nordic countries implement EU directives – even Norway and Iceland as non- EU member states through the European Economic Area (EEA) Agreement.

The Nordic Council of Ministers has commissioned Pöyry Management Consulting to analyse the current approached and views of each of the Nordic countries towards the proposed strategy and regulation, and to identify possible common interests of the Nordic countries. The work has been carried out based on publicly available information on the heating and cooling markets and regulation in each of the Nordic countries, as well as on interviews with energy regulators and energy industry representatives of the Nordic countries. The report focuses especially on space heating markets in the Nordics, and on district heating due to its generally significant position in the Nordics. The views presented in this report are based on Pöyry's interpretations and do not necessarily reflect the views, policies or recommendations of the Nordic Council of Ministers.

This study includes description of the specific conditions in the Nordic heating and cooling markets, and provides examples of success stories in the heating and cooling in the Nordic countries. There are several good examples of introducing new technological solutions in heating and cooling markets and energy efficiency achievements of the Nordics are significant both in the end-user side and production side. Combined production of electricity and heat (CHP) is very well utilized especially in Sweden and Finland. Energy efficiency of the buildings has been long developed taking into account the cold climate of Nordics.

1. EU heating and cooling policy

The European Union is committed to a sustainable, competitive, secure and decarbonised energy system. The Energy Union and the Energy and Climate Policy Framework for 2030 establish ambitious Union commitments to reduce greenhouse gas emissions further (by at least 40% by 2030, as compared with 1990), to increase the proportion of renewable energy consumed (by at least 27%) and to make energy savings of 30% at the Union level by 2030.

Heating and cooling consume some 50% of the EU's energy making it a very important energy use sector. Although the heating and cooling sector is taking steps towards clean low carbon energy, 75% of the fuels used for heating and cooling still come from fossil fuels.

The EU Commission proposed an EU heating and cooling strategy in February 2016 (COM(2016) 51 final). The EU heating and cooling strategy was a first step in exploring the issues and challenges in this sector, and solving them with EU energy policies. The key items of the strategy are summarized in Chapter 1.1.

On the 30th November 2016 the European Commission published several directive proposals related to the EU 2030 Climate and Energy Policy in a so called Winter Package. The main proposals of the Winter Package related to the heating and cooling sectors are described in Chapter 1.2.

1.1 EU Heating and Cooling Strategy

The core of the EU Heating and Cooling Strategy (COM(2016) 51 final) is decarbonisation and energy efficiency of heating and cooling sectors. Heating and cooling sector needs to contribute to EU's greenhouse gas emission reduction goal and meet its commitment under the climate agreement reached at the COP21 climate conference in Paris. Also, the energy imports and dependency should be reduced – security of supply remains a priority in the Heating and Cooling Strategy. This is especially important for the Member States that use gas for heating and rely on a single supplier. The strategy also highlights that the energy costs for households and businesses should be cut, and that there is possibility for new innovations in integrated energy systems, including heating and cooling.

The priorities of the strategy include reducing energy imports and dependency, cutting costs for households and businesses and reducing greenhouse gas emissions. In the strategy, the Commission also sees the role of consumer important, and one of the targets of the strategy is to increase the consumer choice and possibilities.

According to the Strategy, to achieve the EU decarbonisation objectives, buildings must be decarbonized. This could be reached by renovating the existing building stock

and with intensified efforts in energy efficiency and renewable energy, supported by decarbonized electricity and district heating. According to the strategy, buildings can use automation and controls to serve their occupants better, and to provide flexibility for the electricity system through reducing and shifting demand, and thermal storage. In addition, the strategy highlights that industry should move in the same direction by taking advantage of the economic case for efficiency and new technical solutions to use more renewable energy. However, the strategy paper recognizes that some fossil fuel demand can be expected for very high temperature industrial processes. Industrial processes will continue to produce waste heat and cold, as will infrastructure. Much of it could be reused in buildings nearby according to the strategy.

1.2 EU Winter/Clean Energy Package

On 30th November 2016 the European Commission published several directive proposals related to the EU 2030 Climate and Energy Policy in a so called Winter Package or Clean Energy Package. The package includes goals and proposed measures for increasing renewable energy in heating and cooling sectors as well as proposals for improving energy efficiency in the heating and cooling.

The Winter Package's legislative proposals will go through the Ordinary Legislative Procedure before becoming binding Union legislation. The ongoing Maltese presidency of the Council of the EU is expected to prioritize the revision of the Energy Efficiency Directive and the Energy Performance of Buildings Directive. Discussions on the Renewable Energy Directive proposal will most probably be opened during the second part of the presidency (April–June 2017). (Linklaters, 2016).

1.2.1 Renewable energy in heating and cooling

The renewable energy directive proposal (COM (2016) 767 final) that was published as a part of the Winter Package includes two new articles directly addressing the heating market.

Increasing RES share in heating and cooling

In the article 23 the EC proposes that the share of renewable energy supplied for heating and cooling should increase by at least 1 percentage point annually in national share of final energy consumption. The increase may be implemented through one or more of the following options:

- Physical incorporation of renewable energy in the energy and energy fuel supplied for heating and cooling.
- Direct mitigation measures such as installation of highly efficient renewable heating and cooling systems in buildings or renewable energy use for industrial heating and cooling processes.

- Indirect mitigation measures covered by tradable certificates carried out by another economic operator such as an independent renewable technology installer or energy service company providing renewable installation services.

District Heating and Cooling

The article 24 on district heating and cooling includes several new district heating specific provisions on allowing third party access to the district heating networks, allowing customers to disconnect from the district heating network, requiring district heating companies to provide information on energy performance and share of RES, and finally requiring district heating companies to participate in mapping if district heating networks could be used in electricity balancing and other system services.

The proposal on the open access to the district heating system provides for producers of renewable heating and cooling and waste heat from industry to have an open access right to local district heating and cooling systems. This would enable direct supply of heating (or cooling) to customers connected to the district heating system by suppliers other than the operator of the district heating system. However, some possibilities for exemptions have been mentioned.[1]

When it comes to the right to disconnect from the district heating system, the proposal states that customers of district heating or cooling systems which are not "efficient district heating and cooling" should be allowed to disconnect from the system to produce heating or cooling from renewable energy sources themselves, or to switch to another supplier that produces heat or cold from renewable energy sources or provides waste heat or cold.

The article 24 also states that national electricity distribution system operations are required to assess at least biannually, with the operators of district heating or cooling systems, the potential of district heating or cooling systems to provide balancing and other system services. This includes demand response and storing of excess electricity produced from renewable sources.

Finally, the article 24 also proposes that the district heating and cooling suppliers should provide information to end-consumers on their energy performance and the share of renewable energy in their systems.

[1] An operator of a district heating or cooling system may refuse access to suppliers where the system lacks the necessary capacity due to other supplies of waste heat or cold, of heat or cold from renewable energy sources or of heat or cold produced by high-efficiency cogeneration. If such a refusal takes place the operator of the district heating or cooling system should provide information to the authority on measures that would reinforce the system. Also, new district heating or cooling systems may, upon request, be exempted from ensuring open access for a defined period of time.

1.2.2 *Energy Efficiency*

"Energy efficiency first" is a key element of the Energy Union. A way to improve energy efficiency is to tap the huge potential for efficiency gains in the building sector which is the largest single energy consumer in Europe, absorbing 40% of final energy. About 75% of buildings are energy inefficient and, depending on the Member State, only 0.4–1.2% of the stock is renovated each year. (COM (2016) 765 final). In the EU Winter/Clean Energy Package, the European Commission proposes a binding EU-wide target of 30% for energy efficiency by 2030 and launches new energy efficiency measures focusing on:

- Setting the framework for improving energy efficiency in general (Energy Efficiency Directive: COM(2016) 761 final).
- Improving energy efficiency in buildings (Energy performance of buildings directive: COM (2016) 765 final).
- Improving the energy performance of products (Ecodesign Working Plan for the 2016–2019) and informing consumers (Energy labelling).
- Financing for energy efficiency with the smart finance for smart buildings proposal (investment initiative called Smart Finance for Smart Buildings).

Energy Efficiency Directive

According to the proposal for Energy Efficiency Directive, each Member State shall set indicative national energy efficiency contributions towards the binding EU-wide target of 30% for energy efficiency by 2030. The energy efficiency target on EU level is set on fixed Mtoe-level for final energy and primary energy use in 2030, and the Member States have to set their targets so that this target will be reached. The Commission will lay down a process to ensure that the contributions add up to the Union's 2030 energy efficiency target in the legislative proposal on Energy Union Governance. The Commission also evaluates the energy efficiency progress towards the 2030 target and propose additional measures if the Union is not on track to reach the 2030 target.

The main policy measures in the proposal include setting a Member State level 1.5% annual energy savings target for 2021–2030 (Article 7). This policy measure is estimated to achieve half of the energy savings required under the whole Directive. Member States can achieve the required energy savings through an energy efficiency obligation scheme, alternative measures, or a combination of both approaches.Each member state should calculate the 1.5% annual energy savings target for 2021–2030 by multiplying 1.5% with the energy sales (to final customers by volume) average over the previous three years prior to 1 January 2019. The savings should have a cumulative effect with 1.5% saved in 2021, reaching 15% in year 2030 (1.5% times 10 years). In practice, member States have a flexibility to ensure the achievement of their energy savings over the whole period as long as the total amount is achieved by 2030. (Article 7).

The Energy Efficiency Directive also includes a proposition on improving metering and billing of energy consumption for consumers with centralized heating and cooling. Based on the proposed directive, multi-apartment and multi-purpose buildings with

heating and cooling or hot water supplied from a central source or from district heating and cooling network should install individual meters for each building unit if cost effective. In new buildings of or when a building undergoes major renovation, individual meters shall always be provided – the proposal does not in this case include a clear cost-effectiveness criteria. In other types of buildings the meters should be installed at heat exchanger or point of delivery. According to the proposal, new meters should be remotely readable by 2020. Existing meters and cost allocators should be adapted to be remotely readable by 2027.

The directive proposal also requires that new meters and cost allocators installed shall be remotely readable by 2020, and that existing meters and cost allocators should be adapted to be remotely readable by 2027.

Energy Performance of Buildings Directive and Ecodesign Working Plan

The European Commission is proposing a new directive for Energy Performance of Buildings (COM (2016) 765 final) as a part of the Winter Package. As a background, the existing EPBD already includes a target for all new buildings to deliver nearly zero-energy consumption by 2020. Furthermore, the existing EED requires member states to develop long-term renovation strategies to increase renovation rates.

As a result of the 2002 and 2010 EPBD Directives, all Member States have now energy efficiency requirements for existing and new buildings in their building codes (e.g. adoption of nearly zero energy requirements). The evaluation of current EPBD shows that national certification schemes for energy performance of buildings and independent control systems are still at early stages in several Member States and their usefulness could be improved.

In the new proposal the current Article 4 of the EED on long-term building renovation strategies is moved to EPBD for greater consistency, and will include additionally e.g. support for smart financing of building renovations and a vision for the decarbonisation of buildings by 2050, with specific milestones in 2030. The long-term building renovation strategies will become part of the integrated national energy and climate plans and will be notified by Member States to the Commission by 1 January 2019 for the period post 2020.Member States will retain the same flexibility as today, allowing adaptation to national circumstances and local conditions. To ensure that this proposal has maximum impact, the Smart Finance for Smart Buildings Initiative will contribute to mobilise and unlock private investments in a larger scale.

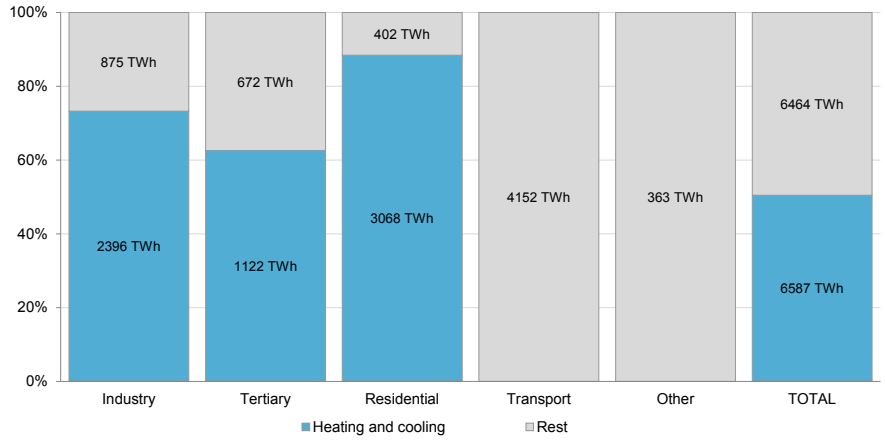
In the Winter Package, the Commission also published a new Ecodesign Working Plan for the 2016–2019. It includes a list of some new product groups, and sets minimum energy efficiency requirements for air heating and cooling products and standardisation requests in support of ecodesign measures for solid fuel boilers and local space heaters.

2. Heating markets in Nordic countries

The heating markets in each of the Nordic countries are presented in this chapter. The Nordic countries' heating and cooling markets have several common factors, such as:

- High share of renewable energy in the space heating and cooling.
- Rather high level of domestic energy resources used for heating and cooling, such as biomass, geothermal energy, heat pumps and waste-to-energy (in Norway also electricity based on renewable hydropower).
- Quite strong position of the consumer in choosing of heating and cooling systems and solutions – rather liberal and open markets.
- District heating plays an important role in all the Nordic countries except Norway. However, even in Norway the district heating market has grown rapidly due to new waste to energy –plants.
- Ambitious national future targets for emission reductions and share of renewables in the energy mix.
- High level of taxation for fossil fuels used in heating as an existing key measure for cutting emissions in the sector.
- Heating and cooling represents some 50% (Figure 5) of the EU total final energy consumption totaling 6,587 TWh in 2012 (including also Norway and Iceland). The heating and cooling market consists of space heating and cooling, hot water, process heating and cooling and cooking.

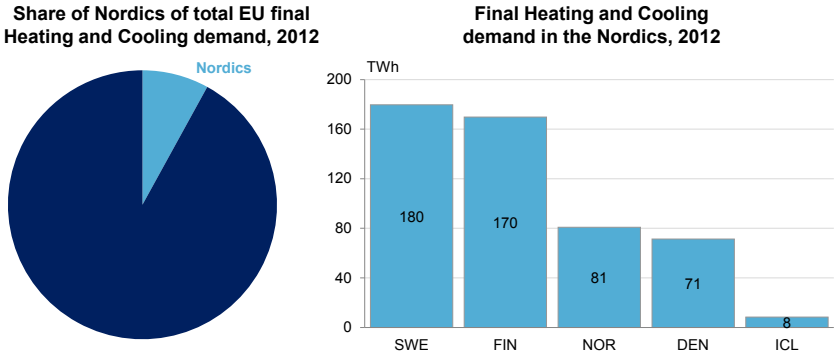
Figure 5: Share of heating and cooling in the EU (incl. NOR & ICL) final energy use, 2012



Source: SWD (2016) 24 final (2016).

Nordic countries' share of the EU's final energy use for heating and cooling was some 8% in 2012 (Figure 6). The size of heating and cooling demand in the Nordics vary considerably – the heating and cooling demand in Sweden and Finland is much larger than that of Norway and Denmark. Furthermore, the demand in Iceland is very small compared to all the other Nordic countries (Figure 6).

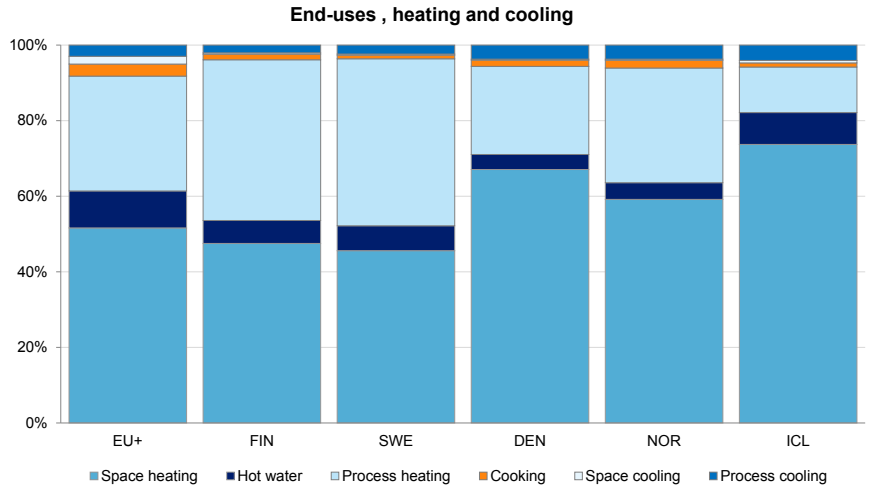
Figure 6: Role of the Nordics in the EU (incl. Iceland and Norway) final heating and cooling demand, 2012



Source: SWD (2016) 24 final (2016).

In the EU context, the space heating represents some 50% of the total final energy demand for heating and cooling and process heating some 30% (Figure 7). Hot water share of the total demand is some 10%, and the rest consists of cooking and cooling uses. The heating and cooling end-uses in the Nordic countries have considerable variation, with Sweden and Finland having a relatively large process heating consumption and the rest of the countries being mainly dominated by the space heating (Figure 7).

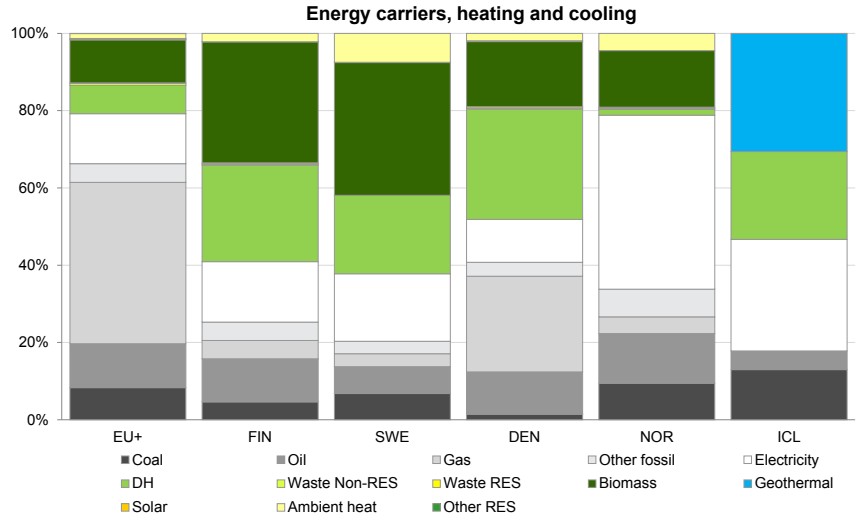
Figure 7: Heating and Cooling end-uses in the EU (incl. Norway and Iceland) and in the Nordics (final energy 2012)



Source: SWD (2016) 24 final (2016).

The Nordic countries can be characterized by relatively low share of fossil fuels directly used for heating and cooling compared to the EU (incl. Norway and Iceland) average (Figure 8). In the EU in average, the direct use of fossil fuels represented some 65% of the heating and cooling in 2012 whereas in the Nordics the share of direct use of fossil fuels for heating and cooling varied between 20% in Iceland and 40% in Denmark, where especially natural gas is used also for household heating. Also, the share of district heating of the total heating and cooling is generally clearly larger in the Nordics compared to the EU average (Figure 8). However, Norway is an exception with low share of district heating in the total mix. The Norwegian district heating sector has, however, grown in importance and size in the recent years due to the investments into waste-to-energy capacity.

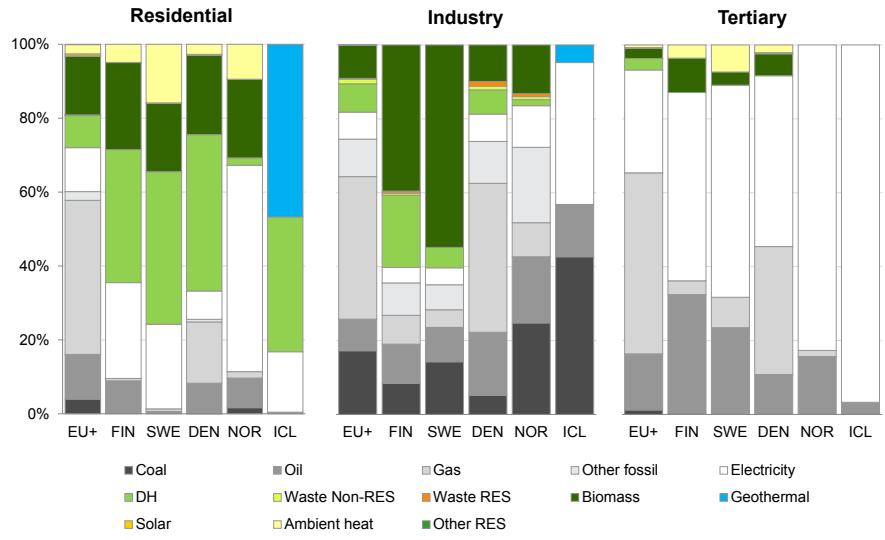
Figure 8: Heating and Cooling energy carriers in the EU (incl. Norway and Iceland) and in the Nordics (final energy 2012)



Source: SWD (2016) 24 final (2016).

The end-use sector specific final energy use for heating and cooling in both the EU and the Nordics is summarised in Figure 9.In the residential sector, heating is based on district heating, electricity (especially in Norway) and direct biomass use in buildings in the Nordic countries. Individual gas boilers are used in Denmark (appr. 17%), but in other Nordic countries the share is very low. Compared to the EU average of over 40%, this is a significant difference. In the industry, Sweden and Finland utilize biomass in large extent. Except for Denmark, the share of gas is minor compared to EU average.

Figure 9: Heating and Cooling energy carriers in the EU (incl. Norway and Iceland) and in the Nordics by end-use sector (final energy 2012)

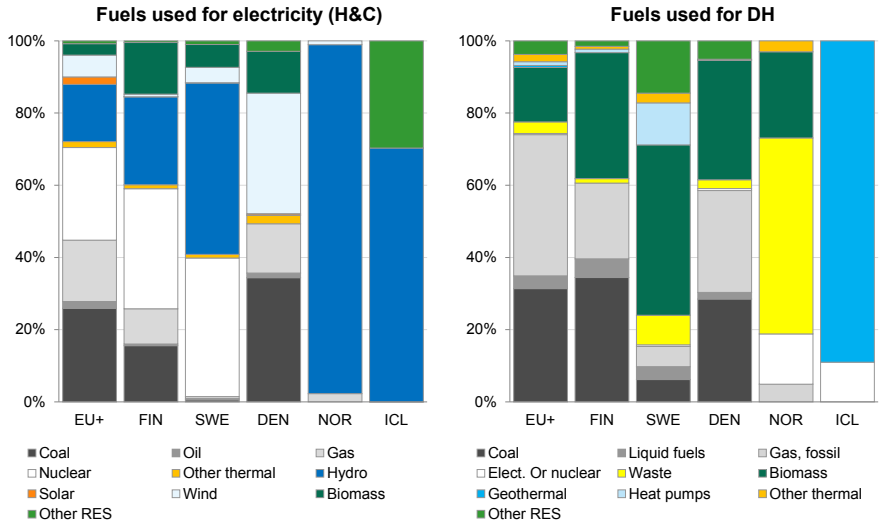


Source: SWD(2016) 24 final (2016).

Looking at the fuels used for district heating and the electricity used for heating and cooling, the Nordics again in general show high level of renewable energy use compared to the EU average (Figure 10). In the electricity sector, Norway is almost totally relying on hydro power, and Iceland utilizes totally hydro power and geothermal energy. Also Sweden and Finland have large shares of hydro power, but also nuclear power generation. Denmark has no hydro power resources, but the share of wind power was about a third of the total power generation in 2012. In the district heating production, biomass is largely used in all countries but Iceland, which has vast geothermal resources. In Norway, a large share of the district heating is based on waste incineration. Heat produced with heat pumps for the district heating is visible especially in Sweden and to smaller extent in Finland.

The figures presented in Figure 10 may differ from the national statistics due to a different statistical method utilized in the European wide analysis. The availability of data related to heating and cooling is not available similarly in all countries, which can make comparisons difficult sometimes.

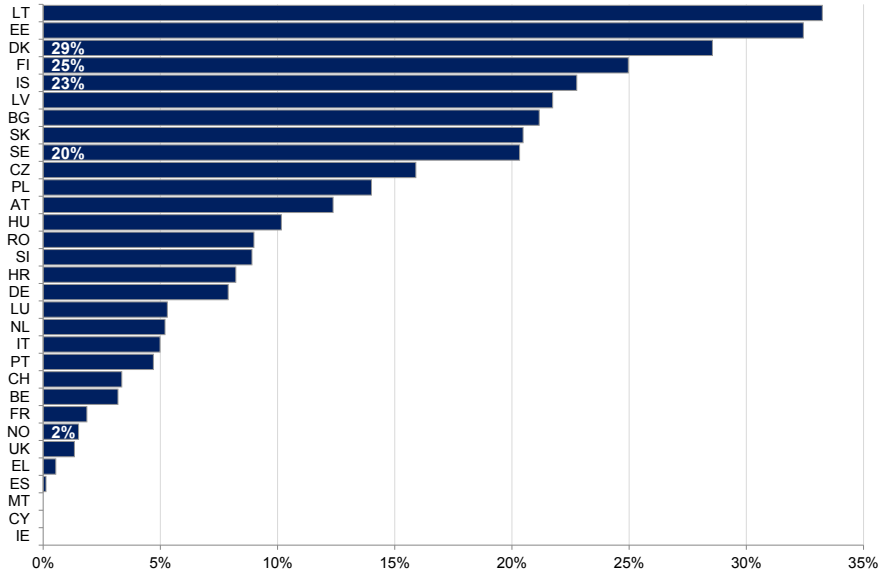
Figure 10: Heating and Cooling fuels in the electricity and district heating in the EU (incl. Norway and Iceland) and in the Nordics by end-use sector (final energy 2012



Source: SWD(2016) 24 final (2016).

District heating plays an important role of the entire heating and cooling market especially in the Nordic countries but also in the Baltics. Only in Norway the share is very low due to high share of electricity in the heating. The significant role of district heating in these regions is illustrated in Figure 11.

Figure 11: District heating role in the final heating and cooling energy demand in Europe,2012)



Source: SWD(2016) 24 final (2016).

3. Heating sector in Sweden

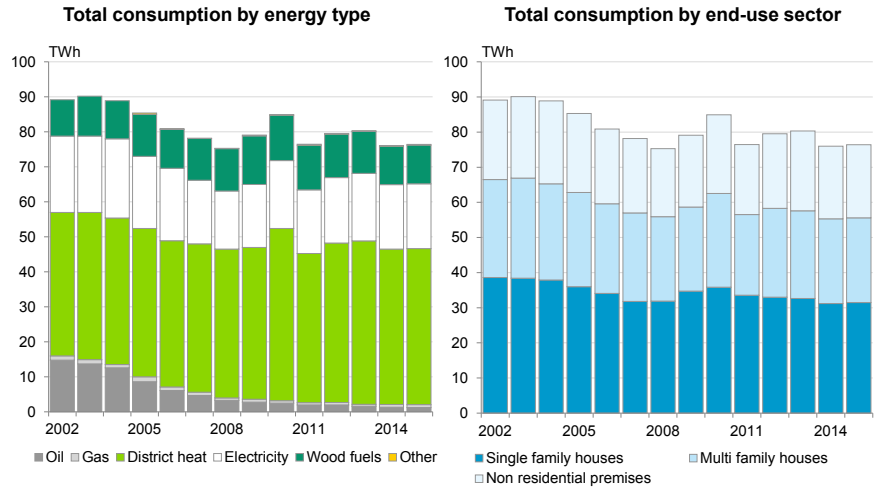
3.1 Heating sector development in Sweden

3.1.1 *Energy for heating and hot water in Swedish residential and service sectors*

The total energy demand for building heating in residential and service sectors in Sweden was 76 TWh in 2015 (Figure 12). Single family houses accounted for 41%, multi-family houses for 32% and non-residential buildings for 27% of the demand. District heating has been a dominant source of energy for heating and hot water in the residential and service sectors (Figure 12). In 2014, some 80% of the total 55 TWh district heat consumed in Sweden was used in the residential and service sectors (Figure 12).

The total energy consumption for heating and hot water in the residential and service sectors has decreased on average by -1% p.a. in 2002–2015 (Figure 12). The decrease in consumption can be explained partly by the increase in energy efficiency influenced by the high end-user energy prices in the 2000s, which have promoted many households to take measures to decrease their energy consumption e.g. by improving insulation or changing to energy efficient windows. In addition, the increased use of heat pumps has led to decreased energy use for heating and hot water as the heat pump energy is not shown in the statistics.

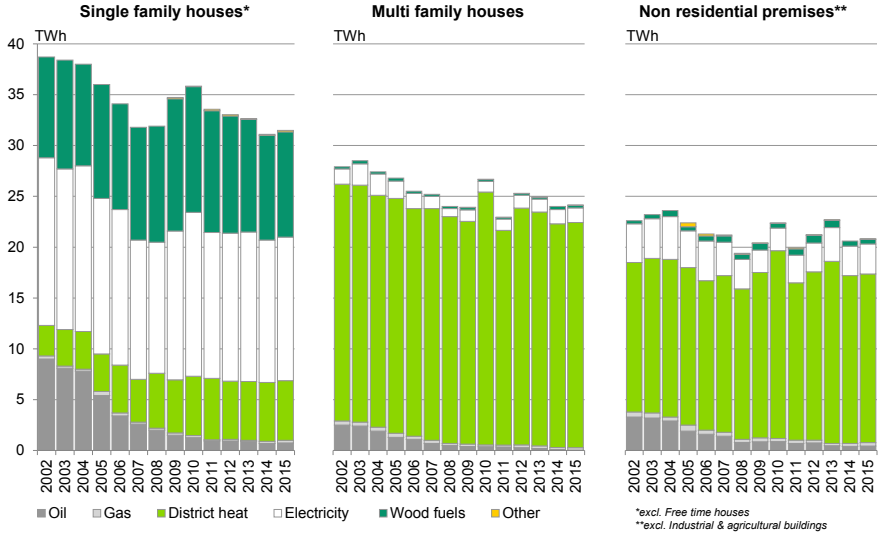
Figure 12: Energy consumption for heating and hot water in the Swedish residential and service sectors (2002–2015)



Source: Energimyndigheten (2016a).

The role of district heating is especially strong in multifamily and non-residential buildings, whereas biofuels and electricity are the dominant energy sources in single family houses (Figure 13). The use of oil for heating has rapidly decreased in all these building types between 2002 and 2015, especially in single family houses where the use of biofuels and district heating has increased. Oil use is heavily taxed while the use of biofuels is promoted, which has led oil boilers being mainly substituted by biofuel based alternatives or heat pumps.

Figure 13: Energy consumption for heating and hot water in the Swedish residential and service sectors (2002–2015) by building type

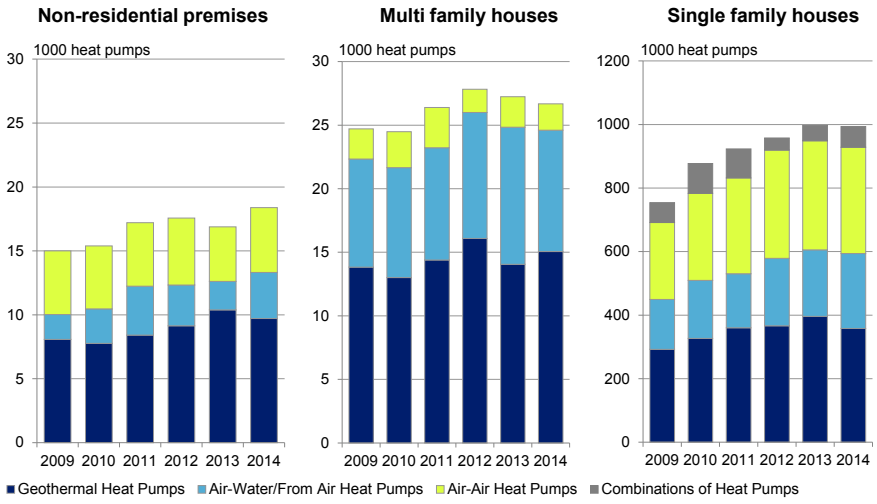


Source: Energimyndigheten (2016a).

Today, there are over 1 million heat pumps installed in Sweden, mainly in single-family houses. The heat pumps have primarily replaced direct electric heating, electric boilers and oil boilers, to some extent wood and pellets, and to very limited extent also district heating.

The growth in heat pump installations has been rapid in Sweden during the past years. In 2009–2014, the amount of installed heat pumps grew by average +6% p.a. in single family houses, by average +4% p.a. in non-residential buildings and by average +2% p.a. in multi-family houses (Figure 14).The growth in the amount of installed heat pumps has, however, slowed down during the recent years, as the potential has largely been exploited.

Figure 14: Amount of installed heat pumps by building type in Sweden (2009–2014)



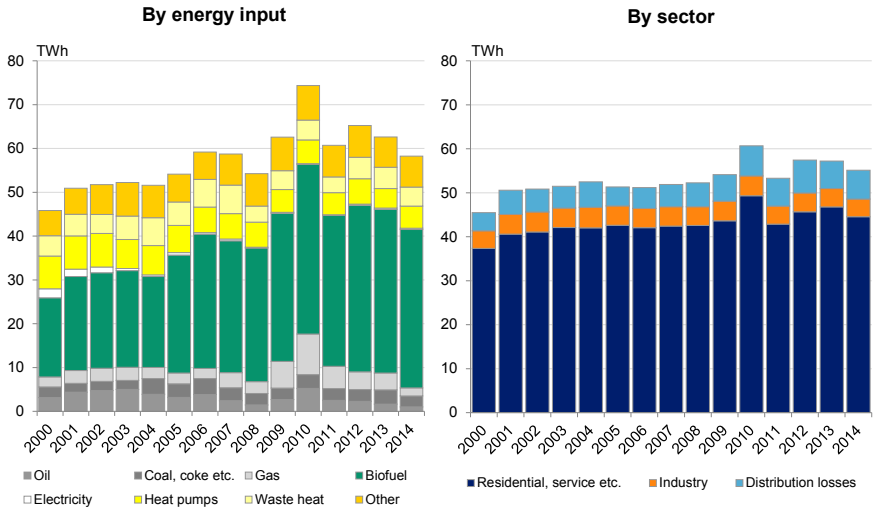
Source: Energimyndigheten (2015a, 2015b, 2015c).

3.1.2 *District heating market in Sweden*

In 2014, the district heating production totaled 55 TWh in Sweden. Over 90% of the district heating supplied was consumed by the residential and service sectors (Figure 15). Industry consumed only about 8% of total district heat used – this meaning the amount of district heat bought by the industry including e.g. steam, hot water and waste heat. However, industrial heat and steam users also produce heating in their own heat boilers and power plants. Distribution losses accounted for about 12% of total energy produced. Total consumption of district heat has grown by +2% p.a. since 1990 driven by the growth in the residential and service sectors (+2% p.a.). Consumption in the industrial sector has been stable during the same period.

Biofuels accounted for the major share (62%) of the total energy input used for district heat production in 2014, and the use of biofuels has increased rapidly between 1990 and 2014 (by +8% p.a.). At the same time, the use of fossil fuels has decreased by -4% p.a. (Figure 15). This development has been strongly supported by fuel taxation that supports the use of renewable energy sources over fossil fuels. In addition, the need to buy emission allowances, when using fossil fuels in energy plants belonging to the EU ETS, has had an impact on the fuel mix. In addition, the use of renewable fuels in the Swedish CHP plants has been supported by the renewable electricity certificate scheme.

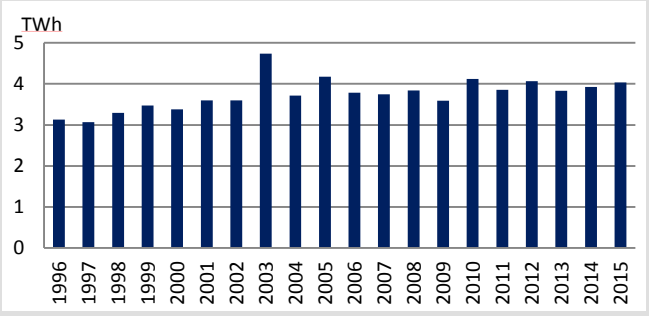
Figure 15: Energy input for district heating and consumption of district heating by sectors



Source: Energimyndigheten (2016c).

Best practice:
Utilisation of waste heat from industry in Sweden

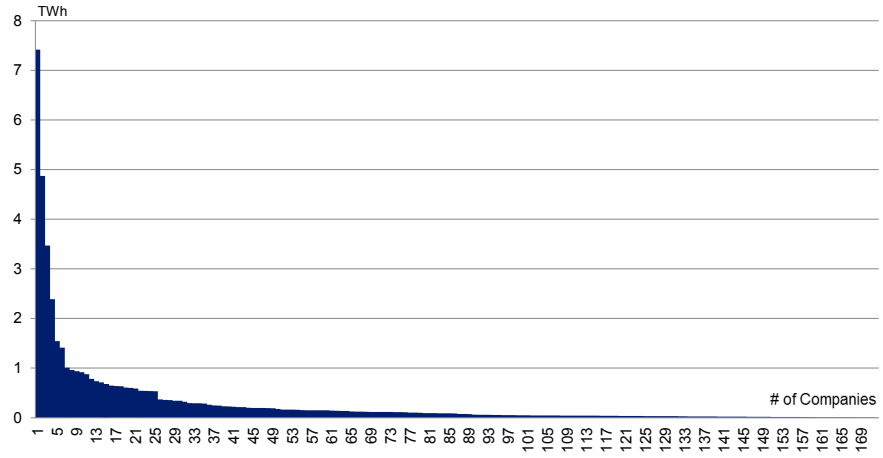
Industrial waste heat accounted for 7% (4 TWh) of the total district heat production in Sweden in 2015. (Swedish District Heating Association, 2016a) The amount has remained quite stable over the past two decades as illustrated in Figure below. Waste heat comes mainly from the pulp and paper, steel and chemical industries.



A good example of utilizing waste heat can be found in Gothenburg, where 30% of the district heat is waste heat from industry. The heat is acquired mainly from Shell's and Preem's refineries. (Göteborg Energi, 2016) The co-operation between Preem and the local energy utility Göteborg Energi started in 1996. Preem produces yearly about 475 GWh of waste heat. This heat is used for district heating within Gothenburg's district heating network. The key to success for this project has been openness in discussion between the two partners, the economics and the co-operation in operating the district heating network. The initial investment was split between Göteborg Energi and Preem and the pay-off was 3.5 years. The profits gained from selling the district heat to customers is also split between the two parties. (Swedish District Heating Association, 2004).

In 2015 some 170 district heating companies delivered district heating in Sweden (Figure 16). Most of these companies are municipally owned, operate only locally and deliver small volumes of district heat. However, there are also several companies with large scale district heating deliveries – in 2015 there were seven district heating players delivering over 1 TWh of district heating (Table 1). The Top 10 district heating companies include some players that deliver district heating in many locations (Vattenfall, E.ON, Värmevärden) but most of these larger district heating companies are active more locally (e.g. Fortum Värme in Stockholm region and Göteborg Energi in Göteborg).

Figure 16: District heating providers in Sweden in 2015 (delivered volume and the ranking order of the companies)



Note: The horizontal axis: Volume of heat provided. The vertical axel: Number of companies.

Source: Energimarknadsinspektionen (2016c).

Table 1: Largest district heating companies in Sweden

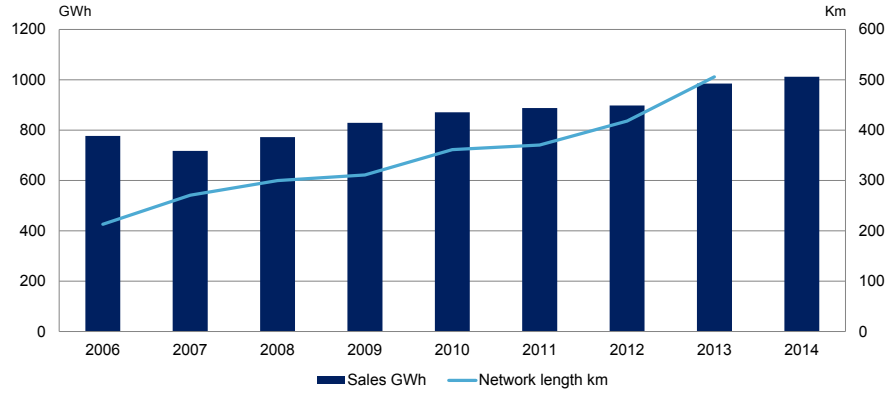
No	Company	Volume (GWh)	No. of networks
1	Fortum Värme	7,417	8
2	E.ON	4,872	32
3	Göteborg Energi	3,468	1
4	Vattenfall	2,389	10
5	Tekniska verken i Linköping	1,543	6
6	Mälarenergi	1,413	4
7	Öresundskraft	1,010	3
8	Värmevärden	961	15
9	Norrenergi	937	1
10	Södertörns Fjärrvärme AB	916	1

Source: Energimarknadsinspektionen (2016c).

Despite the cold climate, also the district cooling market has grown in the Nordic countries. High standards of living, and new very energy efficient buildings increase the demand for cooling in residential buildings. The demand has also increased by the

increasing amount of new buildings that are constructed in urban areas as district cooling is best suited for densely populated areas. The development of district cooling in Sweden is illustrated in Figure 17.

Figure 17: District cooling in Sweden, Sales and network length



Source: Swedish District Heating Association (2017).

Sweden is the leading country when it comes to district cooling in the EU. Total district cooling delivered reached 1 TWh in 2015 and is expected to rise in the future.

3.2 Heating market regulation in Sweden

3.2.1 Long term energy and climate goals

The objectives of the EU constitute the basis for the adopted energy and climate goals in Sweden. Sweden has ambitious climate targets compared to other EU Member States and there are several policy schemes in place to reach those. The Swedish Climate Roadmap 2050 (Naturvårdsverket, 2012) sets targets for zero net greenhouse gas emissions by 2050 and contains different scenarios and policy instrument proposals. In the "Integrated Climate and Energy policy (Swedish Government Bill 2008/2009:162) the Swedish Government sets objectives for 2020 and a vision for Sweden with a sustainable and resource effective energy supply:

- 50% renewable energy of total final energy consumption by 2020 (which was already achieved in 2012).
- 10% renewable energy in the transport sector by 2020.
- Vehicle fleet that is independent of fossil fuel by 2030.

- 20% more efficient use of energy by 2020 (compared to 2008). The goal that takes into all sectors means a decreased energy intensity of 20% between 2008 and 2020, thus the energy input per unit of GDP (in constant prices) should be cut by 20% between 2008–2020.
- 40% reduction of greenhouse gases by 2020 (compared to 1990) for activities that are not part of the EU Emission Trade System (ETS).

The Energy Framework Agreement and the Energy Commission

In a recent Energy Framework Agreement (Regeringskansliet, 2016a), the main Swedish political parties agreed on long-term energy policy goals and measures for Sweden. The framework agreement also specifically mentions that a competitive district heating sector and lower electricity consumption for heating are important preconditions in securing renewable electricity and heat supply also during the cold winter days.

In parallel to the Energy Framework Agreement, a Parliamentary Energy Commission has been analysing Sweden's long term energy agenda post-2025. The presented its recommendations on 9 January 2017.[2] The recommendations build further upon the targets developed in the Energy Framework Agreement and include e.g.:

- The goal by 2040 is 100% renewable electricity.
- Sweden will in 2030 be 50% more efficient in energy use compared to 2005. The target is expressed in terms of energy input in relation to gross domestic product (GDP).
- The electricity certificate system shall be extended and expanded by 18 TWh of new certificates by 2030.
- A special energy efficiency program for the Swedish electricity intensive industry, the corresponding PMUs, should be introduced given that a responsible financing could be found.
- An investigation should be appointed to investigate the wide potential barriers that may exist to enable service development in terms of active customers and efficiency. The study should examine the economic and other instruments, such as white certificates, which are effective for increasing the efficiency of both energy and power point.

The aim from the Commission, headed by the Minister for Energy, is to develop the proposals into propositions, assignments and investigations during the current mandate period, up until the general elections in 2018.

[2] SOU 2017:2 "Kraftsamling för framtidens energi" – Betänkande av Energikommissionen.

3.2.2 *Energy taxation in Sweden*

Fuel taxation in Sweden in general seeks to minimize the use of fossil fuels by imposing a heavier tax load on them. In Swedish fuel taxation, the energy consumers are divided into EU ETS participants and those excluded from it (Non-trading sector). Fuels used in electricity generation are tax free, but fuels used for heat generation are generally subject to taxation. The fuel taxation consists of energy tax, CO_2 tax, and sulphur tax. There is also a fee for nitrogen oxide emissions. (Swedish Government Bill 1994:1776) There is variation in the taxation depending on if the fuel is used in the residential sector, industry or energy industry. In general the Swedish energy tax levels are clearly higher than the EU's energy tax directive (Council Directive 2003/96/EC) proposes.

Energy tax is payable on most fuels and is based on energy content. CO2 tax is payable on every kilogram of carbon dioxide for all fuels other than biofuels and peat. However, there are reductions for tax on heating fuel in certain sectors.

Heat production at combined heat and power (CHP) plants covered by the European Union emissions trading scheme (EU ETS) has been completely exempt from CO2 tax since 2013. Furthermore, energy tax on heat production is 30% of the general energy tax rate. Since 2014, CO2 tax on district-heating plants exclusively producing heat under EU ETS was lowered from 94% to 80% of the general tax rate. On the other hand, the tax allowance for the manufacturing industry outside the EU emissions trading scheme, and for agriculture, forestry and aquaculture, was reduced in 2015. They now pay CO2 tax at 70%, compared to 30% previously. In accordance with the Swedish Government's proposals in the draft Budget for 2016, the Swedish Parliament has decided that CO2 tax on fuels for heating and for CHP plants outside the emissions trading scheme and those used in agriculture, forestry and aquaculture activities will be increased to the general rate of CO2 tax in 2018. (Swedish NREAP, 2015).

Sweden has not introduced any reductions to the electricity tax for district heating or cooling. The only exemption is heat produced for industry. For industry the electricity tax is generally very low. As a result, the electricity used for heat produced by electric boiler or large scale heat pumps in industry is taxed by 0.5 öre/kWh. The tax is same for all industrial manufacturing. (Skatteverket, 2017).

3.2.3 *Policy impacting heat consumption*

There are several policy instruments that impact the residential, service and industrial sectors' heat consumption and energy efficiency, and also may have an impact on the choice of heating method. Sweden sees that energy tax, carbon tax and EU ETS provide through price signals incentives for energy efficiency. However, in some sectors where energy expenditure accounts for a small proportion of total expenditure, these price signals are sometimes less effective and additional incentives for energy efficiency measures may be needed. (Swedish NEEAP, 2014).

The Swedish total primary energy use and end energy use fell in 2015 compared to the previous year. The same applies to energy use in households and services. Energy use in industry and transport was unchanged. However, in both sectors energy use has become more efficient. In 2015 Sweden took additional measures to fully implement

the Energy Efficiency Directive, including the adoption of the Act (2014:266) on energy surveys of large companies. An energy saving scheme aimed at small and medium-sized enterprises was launched in 2015 with support from the Regional Fund. A scheme for investment aid referred to as Klimatklivet was also introduced in 2015. The scheme contributes to sustained reductions in greenhouse gas emissions and covers, among other things, energy saving measures in transport and industry. Sweden has also earmarked funds for energy saving and renovation of apartment blocks and outdoor spaces. In order to boost energy saving efforts at local and regional level, Sweden has set aside funds for local and regional capacity-building in the field of climate and energy transition. (Regerignskansliet, 2016).

Since 2008, there has been an opportunity for private persons to receive a tax reduction ("ROT") of the costs of work to repair, maintain, convert or extend the property that one owns. Some of these measures contribute to more efficient energy consumption. Tax deduction also cover e.g. installing boilers, heat-pumps, pipes for district heating (only single-family houses), solar systems, etc. The ROT deduction was reduced from 50% to 30% from 2016. (Skatteverket, 2016).

3.2.4 Policy impacting district heating

The main regulatory bodies and energy industry organisations in Sweden are listed in Table 2 below. District heating is supervised by the Energy Markets Inspectorate and the Competition Authority. The energy industry organisations play a key role in taking part in the development of the regulations, acceptable pricing principles, etc.

Table 2: Swedish district heating related authorities and organisations

Actor	Role
Energimarknadsinspektionen (The Swedish Energy Markets Inspectorate)	The Energy Markets Inspectorate supervises the electricity, natural gas and district heating markets. It ensures that district heating companies comply with the *District Heating Act (SFS 2008:263).* The Energy Markets Inspectorate also analyses the development of the district heating market and suggest changes to the regulatory framework so that the market shall function better (however, does not supervise the price charged by the district heating companies as there is no price regulation).
Konkurrensverket (Swedish Competition Authority)	The Swedish Competition Authority may investigate suspected abuse of dominant position, as district heating companies are considered natural monopolies in their respective areas.
Energimyndigheten (Swedish Energy Agency)	Government agency for national energy policy issues.
The District Heating Board (Fjärrvärmenämnden)	The District Heating Board mediates negotiations between district heating companies and district heating customers about prices and other conditions. The District Heating Board cannot make any binding decision that the company or the customer must follow.
Energiföretagen Sverige	Energiföretagen Sverige (Energy Companies of Sweden) is an industry organisation formed by the previous organisations Svensk Energi (Swedish Energy) and Svensk Fjärrvärme (Swedish District Heating). It represents companies that produce, distribute, sell and store electricity, heat and cooling.

Source: Energimarknadsinspektionen (2016a), Konkurrensverket (2016): Energimyndigheten (2016b), Fjärrvärmenämnden (2016), Energiföretagen Sverige (2016).

The District Heating Act

District heating in Sweden is considered a natural monopoly and the market participants are regulated by the District Heating Act (SFS 2008:263).

A district heating companies need to ensure that information about the prices for district heating and for a connection to the district heating and for price determination are readily available to customers and the general public. The Energy Markets Inspectorate supervises this. Customers may complain to the District Heating Board where negotiations with the district heating company are facilitated.

There is an obligation to negotiate about third party access to network, if a producer wants to sell heat to the district heating company or use the network for distribution of heat. The obligation means that the district heating company has to attempt to reach an agreement but can refuse to give the access if it states reasons for the refusal, e.g. if it would harm its business.

Best practice:
Open district heating in Stockholm

The district heating network in Stockholm is an open district heating network. This means that the owner of the network, Fortum Värme, buys excess heat from different third party companies and sells it forward to the customers. The main sources for the excess heat are data centres and supermarkets. Fortum Värme pays for the heat and offers different types of contract for the heat producers, depending on the location in the network, availability of the capacity, and temperature level. The price varies even on hourly level based on the demand and available capacity.

The open network concept is also a pilot for investigating how a district heating network with distributed sources of heat can function. With this system the excess heat is put to use, rather than released into the outdoor air, and thus can be regarded as a renewable source of heat. Fortum is currently able to provide 1% of its heat demand with the excess heat from distributed sources. The potential of excess heat is estimated to be 1 TWh, accounting for 1/8 of the whole demand in Stockholm. (Fortum, 2017).

Typically district heating operations are part of larger energy company operations, such as electricity production and retail business. The district heating act requires the companies to keep separate financial accounts related to district heating operations, and producing an annual report to be submitted to the Energy Markets Inspectorate.

In addition, the customer is entitled to terminate the district heating agreement free of cost if the district if the district heating company changes the contract terms. The terms in the district heating contracts typically allow also customers to disconnect without cost even if changing the heating method in a case where district heating company does not change the contract terms.[3]

Even though the Swedish district heating companies are obligated by the District Heating Act to give information about district heating prices and price setting mechanisms, there is no price regulation for district heating companies. Instead, the

[3] There may however be some exceptions to this general rule when it comes to specific customers (e.g. industry player having contract with district heating company) but with private customers this free disconnection is allowed.

Competition Authority can initiate investigations if they suspect an abuse of pricing considering the dominant market position of district heating by charging unreasonably high prices.

Best practice:
Prisdialogen & REKO – absence of price regulation

The Swedish District Heating Association, the Swedish Association of Public Housing Companies (SABO) and Riksbyggen AB initiated a voluntary Price Dialogue ("Prisdialogen") between customers and district heating companies in 2013. The price dialogue aims to discuss the fair principles for district heating pricing and the envisaged price changes with the customers, thus increasing transparency and acceptance related to pricing towards customers. The dialogue led to a voluntary local price change model, where the price changes for the coming years and an outlook for the following two years are announced. In 2015, 54% of supplied district heat was included in the dialogue. The Price Dialogue was evaluated by the Energy Markets Inspectorate in March 2015, indicating that customers believe that the Price Dialogue has led to increased predictability of price development. Furthermore, neither the industry nor the customers thought it would be better with regulated prices. In May 2016, the Swedish Energy Markets Inspectorate further stated that there is currently no need to take further actions to strengthen the customers' position in the district heating market, meaning no need to introduce a district heating price regulation system in Sweden. (Energimarknadsinspektionen, 2016b)

Besides the Price Dialogue, there is also a system for quality assurance of the relationship between a district heating customer and a supplier that further increases the district heating market transparency. The system, REKO, is based on customer requirements and expectations. The district heating company issues a number of public promises that can be tested by an independent third party – the Quality Board. REKO heating means that the customer gets clearer and more accessible information. The customer gets better insight into the business including financial information and price changes and has the ability to easily compare the district heating company with competing alternatives. REKO is open to all district heating suppliers that are members of the Swedish District Heating Association. Participation in the REKO quality assurance system is voluntary. (Svensk Fjärrvärme, 2013).

Support for district heating producers

Many district heating producers are part of the EU ETS, and if using fossil fuels for the production, impacted by the CO_2 prices. However, according to the free-allocation provision, district heating companies receive free emission allowances based on benchmarks, allowing them to even receive income from selling the allowances. Sweden also has a system for the support of the green electricity called the green certificate system. RES electricity produced in the CHP plants is in many cases eligible for this support, thus indirectly the heat produced in the CHP plants gets supported. The certificate scheme is directed for new investments, and both biomass and peat use can receive the certificates.

4. Heating sector in Finland

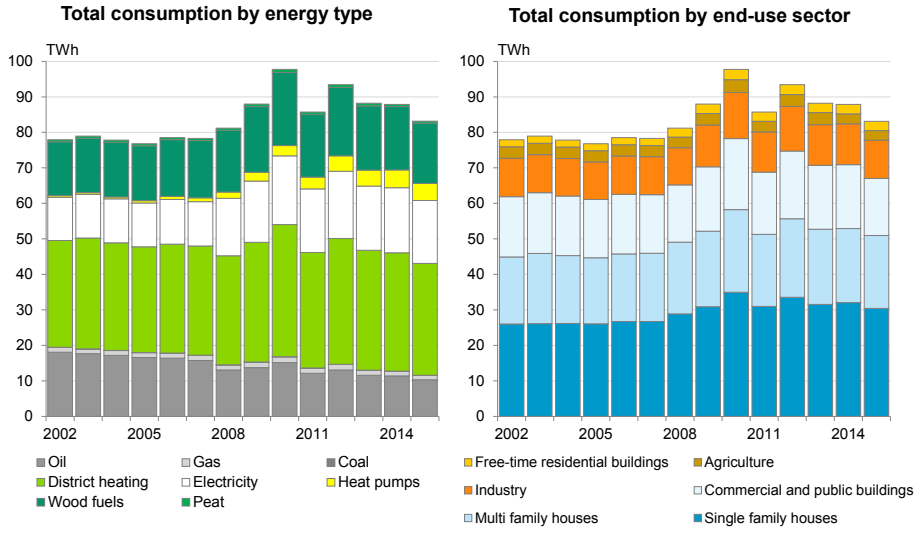
4.1 Heating sector development in Finland

4.1.1 *Energy for heating in Finnish residential and service sectors*

The total energy use for building heating and hot water in Finland was 83 TWh in 2015 (Figure 18) including heat and hot water used in single family houses, multi-family houses, commercial and public buildings, industrial buildings, agricultural buildings and free-time residential buildings. Single family houses accounted for 37%, multi-family houses for 25%, commercial and public buildings 19%, industrial buildings 13%, agricultural buildings 3% and free-time residential buildings 3% of the total energy for heating and hot water in the Finnish buildings in 2015 (Figure 18).

The total energy consumption for heating and hot water in Finnish buildings has increased on average by +0.5% p.a. in 2002–2015 (Figure 18). Especially the direct use of fossil fuels has decreased (by -4% p.a. in 2002–2015) rapidly whereas the use of renewable energy (wood fuels & heat pumps) has at the same time increased rather rapidly (by +3% p.a. in 2002–2015). The district heating consumption for heat and hot water has developed with a rather stable trend (+0.4% p.a. in 2002–2015).

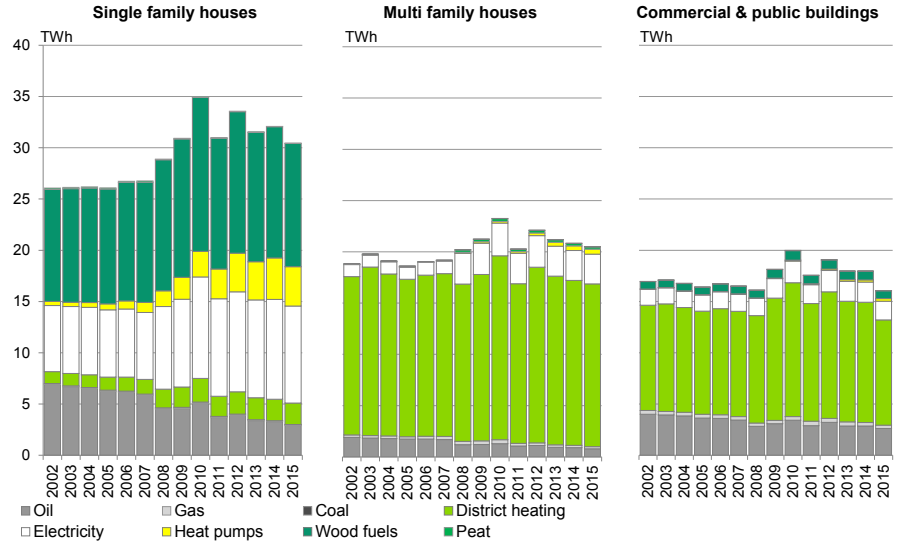
Figure 18: Energy sources for space heating and hot water by type of building and fuel



Source: Statistics Finland (2016).

The role of district heating is especially strong in multifamily and commercial and public sector buildings; in single family houses other energy sources such as wood fuels and electricity dominate the demand (Figure 19).

Figure 19: Energy sources for space heating by type of building



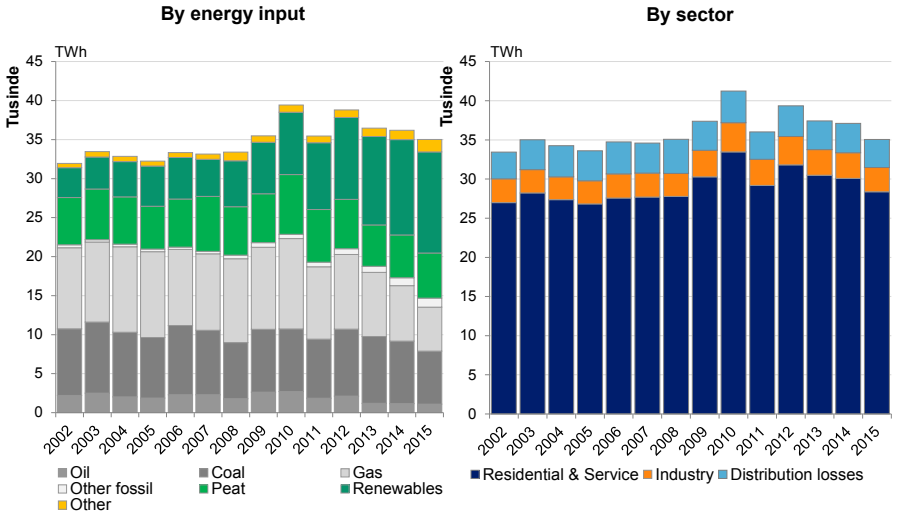
Source: Statistics Finland (2016).

4.1.2 *District heating in Finland*

The total district heat supply was 36 TWh in Finland in 2015. 90% of the district heat was consumed by the residential and service sectors in 2015, while industry consumed only 10% of total district heat supply (Figure 20). However, this does not take into account the production of heat on industrial sites. Distribution losses accounted for 10% of the total district heat production. Total consumption of district heat has grown on average by +0.4% p.a. since 2002 mainly driven by demand development in residential and service sectors.

Renewable energy accounted for 37% of the total energy input used for district heat production in 2015 (Figure 20), and the use of renewable energy in district heating production has increased rapidly between 2002 and 2015 (by +10% p.a. on average). Fossil fuels, mainly coal and gas, still represent some 42% of the total energy input used for district heat production in 2015, however, their use has decreased by some -3% p.a. on average between 2002–2015. This development has been supported mainly by the fuel taxation that adds the cost of using fossil fuels for heat generation in both heat-only and CHP plants, as well as by the carbon costs from the EU ETS and the feed-in-tariff for electricity production with wood chips supporting the use of renewable fuels in the CHP plants.

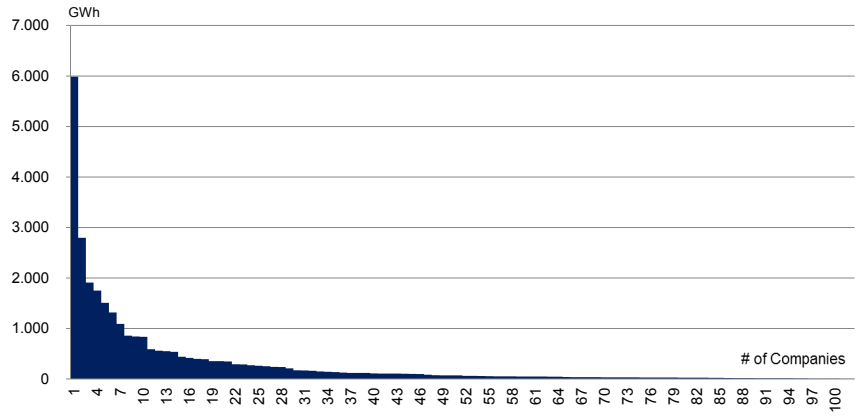
Figure 20: Energy input for district heating and consumption of district heating by sectors



Source: Statistics Finland & Finnish Energy Industries (2016), Statistics Finland & Finnish Energy Industries & Association of Finnish Local and Regional Authorities (2016).

In 2015 some 102 district heating companies delivered district heating in Finland (Figure 21). Most of these companies are municipally owned, operate only locally and deliver small volumes of district heat. However, there are also several companies with large scale district heating deliveries – in 2015 there were seven district heating players delivering over 1 TWh of district heating (Table 3). The top 10 district heating companies include some players that deliver district heating in many locations or network areas (Fortum Power & Heat, Elenia Lämpö) but most of the companies operate only in one city or the larger city area and the municipalities around it. However, the amount of district heating network is clearly larger than the number of companies, and there are about 400 district heating networks in Finland. In addition to district heating, there is also district cooling networks in Finland. The total length of the networks is presented in Figure 21.

Figure 21: District heating providers in Finland in 2015 (delivered volume and ranking order of the companies)



Source: Finnish Energy Industries (2016a).

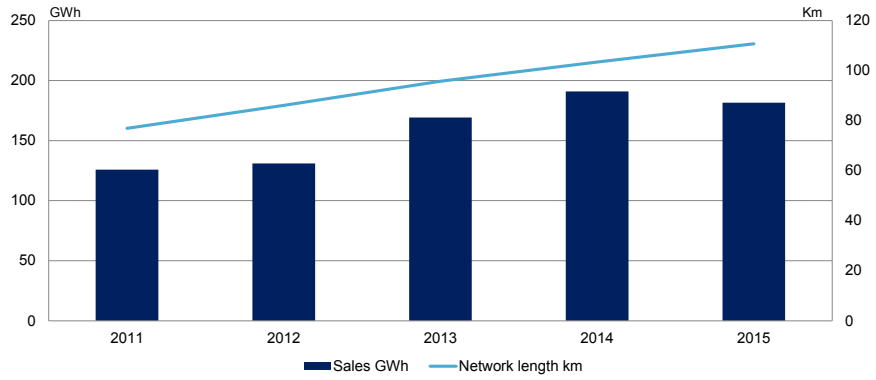
Table 3: Largest district heating companies in Finland, 2015

no	Company	Volume (GWh)	No of network
1	Helen Oy	5,985	1
2	Fortum Power and Heat Oy	2,797	6
3	Tampereen Sähkölaitos	1,911	4
4	Turku Energia Oy Ab	1,751	4
5	Vantaan Energia Oy	1,510	1
6	Oulun Energia Oy	1,320	1
7	Lahti Energia Oy	1,091	4
8	Jyväskylän Energia Oy	857	1
9	Elenia Lämpö Oy	843	8
10	Kuopion Energia Oy	837	1

Source: Finnish Energy Industries (2016a).

There is also some district cooling networks in Finland. The total sales of district cooling was some 180 GWh in 2015, and the network length is over 100 km. District cooling is available in the largest cities and typically utilized by service sector and e.g. data centers, but the users are increasingly also coming from the residential building sector.

Figure 22: District cooling in Finland, sales and network length



Source: Finnish Energy (2016b).

Best practice:
Trigeneration of electricity, district heating and cooling and utilisation of waste heat

In Helsinki, the local energy company Helen produces efficiently both heating and cooling based on CHP-production, and combined district heating and cooling (CHC). The latter one utilises the energy flows from district cooling back to the district heating system. The core of the system is a large heat pump station with a capacity of 90 MW for heating and 60 MW for cooling. This heat pump utilises the wastewater heat and also heat from returning district cooling water. (Helen, 2017a) As the district cooling water returns to the heat pump station the heat acquired from the customer is transferred to the district heating network by using the heat pump. This combined with the waste heat from sewage water is used for district heating. Helen has made an investment for a second heat pump station to be built in the centre of Helsinki with a total cooling capacity of 15 MW in 2018. Heat pump station is combination of heat pumps and 35,000 m³ cooling energy storage. Maximum discharge power capacity for this new heat pump – cooling energy storage application for afternoon peak hours is 50 MW. (Helen, 2016).

Helen provides district cooling to some 300 buildings in Helsinki. The connected capacity is currently about 200 MW, and the business is growing. Other sources for district cooling in Helsinki include an absorption cooler with capacity of 35 MW and free cooling from sea water with a capacity of 70 MW. (Finnish Energy, 2016b) District cooling is offered currently only in the inner city of Helsinki, but expands to new areas. Cooling is used by commercial and public buildings, data centres and residential buildings.

Helen is also taking part in the demand response capacity for the national grid with one of the heat pump stations with a capacity of 12 MW. As heat pumps can quickly be shut down they are a good way of taking part in the demand response. (Helen, 2017b).

Best practice:
Utilising waste heat from data center in Mäntsälä, Finland

There are several locations, where waste heat from data centers or similar sources are utilised in district heating in Finland and Sweden. The following example is from a smaller city in Finland.

In the city of Mäntsälä in Finland, a local energy company Nivos Oy has made an agreement to utilise the waste heat from a data center of Yandex. The excess heat from cooling the data center is utilised in the district heating network of Mäntsälä. The heat recovery unit produces 20 GWh of district heat annually, which covers about half of the district heat use in city area of Mäntsälä. This decreases the emissions from district heating and Nivos has also been able to decrease the price of district heating.

4.2 Heating market regulation in Finland

4.2.1 Long term energy and climate goals

Finland's long-term goal is a carbon-neutral society. Also security of energy supply, the functioning of the energy market and the promotion of renewable energy sources and energy efficiency are in the core of the energy policy in Finland.

A long-term energy and climate roadmap until 2050 was published in 2014 to analyse the options to reduce emissions, increase energy efficiency and maintain the competitiveness of the society (VTT, 2014). The government programme sets the concrete current targets for the energy sector. The main focus in the government program is to increase the use of renewable energy, especially bioenergy and biofuels for transport, and energy self-sufficiency in 2020s. The specific targets set in the government program are:

- The use of emission-free, renewable energy will be increased in a sustainable way so that its share will rise to more than 50% by the end of 2020s and the self-sufficiency to more than 55% (including peat).
- Coal will no longer be used in energy production and the use of imported oil for the domestic needs will be cut by half by the end of 2020s.
- The share of renewable transport fuels will be raised to 40% by 2030.
- Finland will create new support scheme for renewable energy. Support will be based on technology neutrality and ranking of economic priorities.
- To achieve 80–95% reduction in greenhouse gas emissions by 2050.
- Halve the imported oil for domestic demand by 2030 (Prime minister's office 2015).

In November 2016, the Finnish government published the new Energy and Climate Strategy to reach the targets of the government program, and the EU's climate and energy union targets until 2030. (Minister of Economic Affairs and Employment, 2016) For the heating sector, especially the decision to abandon coal use by 2030 has a

significant impact. In the heating sector, coal is used by some larger cities in CHP plants and heat boilers to produce district heating, accounting for 25% of the total heat produced. (Finnish Energy, 2015a) .These district heating companies should find new fuels or technologies to replace coal. Also, the target to halve the use of imported oil can have an effect on heating companies as oil is used for peak boilers.

4.2.2 *Energy taxation in Finland and support for wood fuels*

Fossil fuels (coal, natural gas, oil) used in heat production are taxed in Finland based on their energy content and CO_2-content. The level of energy taxation is clearly higher than the minimum tax levels set by the EU. Fuels used for CHP production have a 50% tax reduction of the CO_2-tax component to avoid extra burden for installations already included in EU ETS. Peat is not taxed based on the same principles but has only a fiscal, clearly lower tax, and renewable fuels like wood fuels are not taxed at all. Fuels used for electricity production are not taxed, but instead electricity consumption is taxed. Energy intensive industry in Finland enjoys tax relief up to 85% (Vero, 2017).

Forest chips used in electricity production are supported with a so-called feed-in-system. The system is actually a premium for electricity produced with forest chips (Finlex, 2010). As the electricity production takes practically only place in CHP plants, this also impacts the fuel choice for district heat production. The support system has been designed to make forest chips competitive with peat in CHP plants, and it has increased the use of biomass for CHP use.

In the electricity use, the level of taxes depend on the user. For the international competition reasons, industry generally has a lower electricity tax whereas the households and other businesses pay a higher tax on electricity use. The use of electricity for heat production by energy companies is taxed based on the higher general electricity tax, currently 2,253 cent/kWh (Vero, 2017).

4.2.3 *Policy impacting heat demand*

Energy Authority is the authority responsible for promoting energy efficiency improvements. The measures include voluntary energy efficiency agreements, energy audits, energy information for consumers and ecolabelling and ecodesign of products. A separate state owned energy information company, Motiva was established in 1993. It offers services to the public administration, businesses, communities, and consumers (www.motiva.fi).

In Finland, energy efficiency has been improved through voluntary agreements since the 1990s. The voluntary approach has been chosen by the government and participating sectors to avoid the need to introduce new legislation to achieve the national energy efficiency targets.

In the building sector, energy efficiency is improved with building codes, which are based on the EU directives. The legislation on building codes was introduced in 2013. (Ministry of Environment, 2017) The greatest energy savings can be achieved in the building sector, where the most important measures are related to building regulations

and the choice of heating. The replacement of direct electrical heating with for example heat pumps or district heating provides a great way to enhance the energy efficiency. (Finnish NEEAP, 2014).

Best practice:
Voluntary energy efficiency agreements for promoting energy efficiency

Finland has chosen to use voluntary energy efficiency agreements as a primary tool to increase energy efficiency. The choice has been made in cooperation by the government, industrial associations and municipalities to avoid the need for legislation and other coercive measures.

The agreements are made for a fixed period with quantified targets for each of the participant. Hundreds of Finnish companies and municipalities had joined the energy efficiency agreements for the previous period 2008–2016. The participants report annually on their energy efficiency improvement measures. As a result of the implemented energy efficiency measures, the annual energy consumption was reduced by 14 TWh in the beginning of 2016. Due to the good results, Finland in continuing with the voluntary approach and the new agreement period covers years 2017–2025.

The sectors covered include industry, the energy and service sectors, the real estate sector, the municipal sector and in oil-heated properties (distribution of heating oils). The agreement covers both production of energy and end use. As a result, the energy companies also advise their customers in energy use. The development of new energy efficiency services is seen as an important part of the efficiency agreement. (Energy Efficiency agreements, 2017).

4.2.4 Policy impacting district heating

There is no separate district heating act in Finland. The Competition Authority has interpreted that district heating operators have been in dominant market position among their current district heating customers. The abuse of a dominant market position is prohibited, which sets certain requirements for the district heating operators. The conditions are typically related to prohibitive prices and terms, and price discrimination. District heating prices are not regulated, but the dominant market position requires pricing to be on equal terms for all customers. The Competition Authority can initiate investigations if they suspect an abuse of pricing considering the dominant market position of district heating by charging unreasonably high prices (Finnish Competition and Consumer Authority 2017).

There is in general no obligation to connect to a district heating network. In some special cases this could be required locally in certain areas. The current district heating customers also have the right to disconnect without any extra fees. As the district heating networks are owned by the energy companies, there is no third party access guaranteed by law. If a third party wishes to conduct business on the network it needs to negotiate with the owner.

Table 4 lists the main regulatory bodies and energy industry organisations in Finland related to district heating.

Table 4: Finnish district heating related authorities and organisations

Actor	Role
Ministry of Economic Affairs and Employment	The Ministry's principal tasks in energy policy are to develop the energy markets and the security of supply, promote renewable energy and energy efficiency, and regulate nuclear energy. The Ministry's responsibilities also include implementing emissions trading and coordinating the national preparation and implementation of climate policy. There is no separate heating and cooling policy, but especially district heating is a crucial part of the energy policy.
Ministry of the Environment	The Ministry of the Environment is responsible for coordinating the preparation of the medium-term plan for climate change policy in accordance with the Climate Change Act. Heating of buildings is one of the main areas of the climate plan. The Ministry is responsible for Finland's emission reduction target in non-ETS sectors, including heating by individual boilers (especially oil-based heating).
Finnish Competition and Consumer Authority	The Finnish Competition and Consumer Authority may investigate suspected abuse of the dominant position that district heating companies have.
Finnish Energy Agency	Government agency which regulates electricity and natural gas markets, promotes energy efficiency and the use of renewable energy. Also implements tasks related to energy politics, emission trading scheme and energy efficiency.
Finnish Energy	Finnish Energy represents companies that produce, acquire, transmit and sell electricity, district heat and district cooling and offer related services.

Source: TEM (2017b), Finnish Competition and Consumer Authority (2017), Finlex (2013), Finnish Energy (2017).

The use of fossil fuels in individual boilers is regulated through fuel taxation and in some cases investments in renewable heat sources can be supported with investment support. Energy aid can be granted e.g. to new small heating plants utilising renewable energy, when invested by companies, municipalities and other organisations. (Ministry of economy and employment, 2017).

5. Heating sector in Denmark

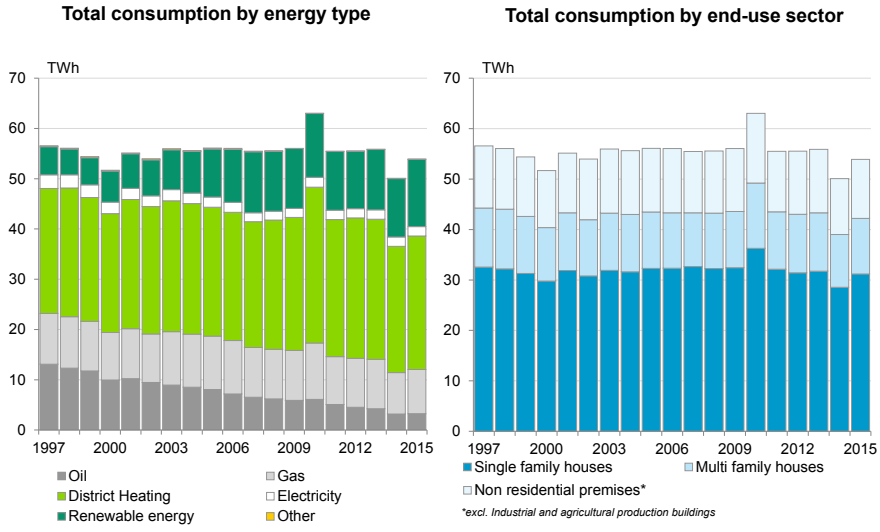
5.1 Heating sector development in Denmark

5.1.1 *Energy for heating in Danish residential and service sectors*

The total energy consumption for building heating in residential and service sectors in Denmark was 54 TWh in 2015 (Figure 23). Single family houses accounted for 58%, multi-family houses for 20% and non-residential buildings for 22% of the demand. District heating represented almost 50% of the total energy for heating and hot water in the Danish residential and service sectors in 2015 (Figure 23).

The total energy consumption for heating and hot water in the residential and service sectors has decreased by -0.3% p.a. in 1997–2015 (Figure 23). Especially the direct use of oil has decreased (by -7% p.a. in 1997–2015) rapidly whereas the use of renewable energy has at the same time increased rather rapidly (by +5% p.a. in 1997–2015). The district heating consumption in the residential and service sectors has been rather stable.

Figure 23: Energy consumption for heating and hot water in the Danish residential and service sectors (1997–2015)

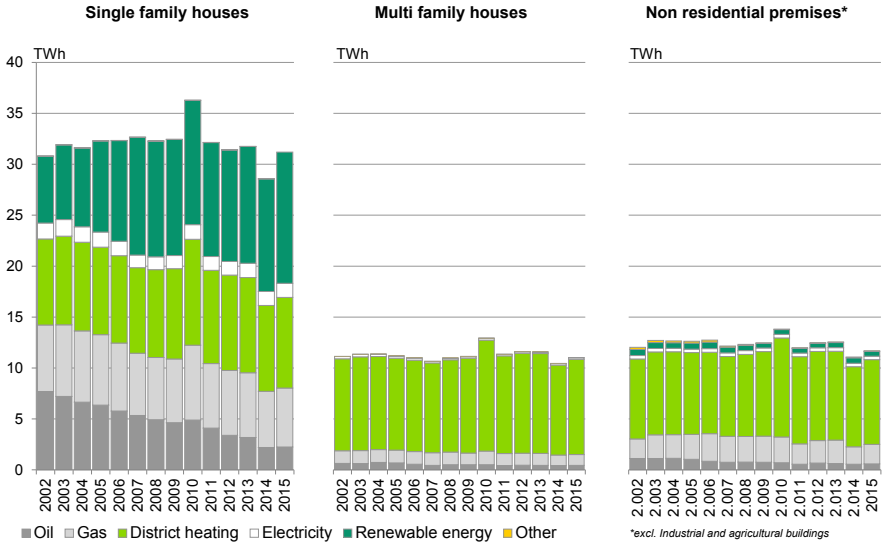


Source: Danish Energy Agency (2016).

The role of district heating is especially strong in multifamily and non-residential buildings. District heating is also used in the single family houses but there biofuels have even stronger role (Figure 24). Oil has been used especially in single family houses, but

the use has decreased rapidly during last decades. Oil has been replaced especially with direct use of renewable energy in the buildings.

Figure 24: Energy consumption for heating and hot water in Danish residential and service sectors by building type



Source: Danish Energy Agency (2016).

5.1.2 District heating in Denmark

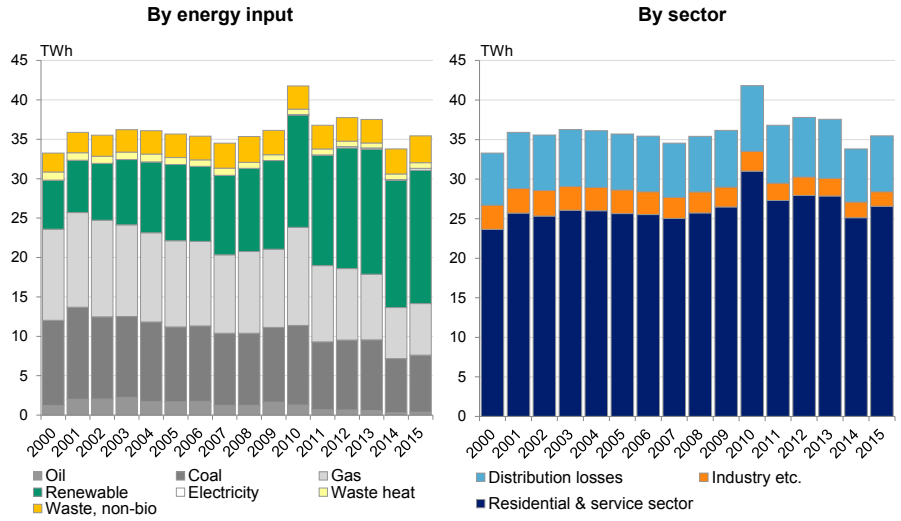
Over 90% of the total 36 TWh of district heat supply in Denmark was consumed by the residential and service sectors in 2015 (Figure 25), and industry consumed less than 10%. Total consumption of district heat has grown on average by +0.4% p.a. since 2000; the demand in residential and service sectors has grown by +1% p.a. but industry demand has at the same time decreased by some -3% p.a. between 2000–2015.

Renewable energy accounted for almost half (48%) of the total energy input used for district heat production in 2015 (Figure 25), and the use of renewable energy in district heating production has increased rapidly between 2000 and 2015 (by +7% p.a. on average). Fossil fuels, mainly coal and gas, still represent some 40% of the total energy input used for district heat production in 2015.

Renewable energy used in the district heating production is largely based on biomass. The main biomass resources utilised in Denmark (aside from waste) are wood pellets, wood chips, and straw. Unlike Sweden and Finland, a large share of biomass is imported to Denmark. In 2012, 35% of the total biomass consumed in Denmark was imported. Two thirds of the imported biomass was based on wood pellets (State of Green, 2015). Biomass is primarily combusted and used for heat and power generation, and since the 1990s, Denmark has been increasing the deployment of large-scale biomass CHP plants. Older large-scale coal fired CHP plants are also being converted to biomass as part of the strategy to reduce CO_2 emissions. Also waste is an important energy resource for the production of district heating. In Denmark, almost all waste, if

not recycled, is used for energy production, and only a minor fraction of the waste is deposited in landfill. Consequently, waste-to-energy is an important part of the Danish waste management system. (Danish Energy Agency, 2015). Denmark is also among the world leading countries within the field of integrating large-scale solar heating into district heating systems.

Figure 25: Energy input for district heating and consumption of district heating by sectors



Source: Danish Energy Agency (2016).

Best practice:
CHP utilization and heat storages

With the increase in variable renewable electricity generation, especially wind power in the Nordic markets, the demand for energy storage increases significantly. CHP generation with large heat storages offer a low-cost opportunity for energy storage. Also large heat pumps and electric boilers can be used to accommodate to variable electricity generation and utilise the excess power production.

Danish district heating networks are equipped with short-term heat storages meaning that the CHP plants can optimise their cogeneration according to the electricity demand without compromising the heating supply. Both large and smaller district heating systems utilise short term heat storages. Heating storage allows CHP plants to decrease their production when it is e.g. very windy and excess supply of electricity. CHP plants can also increase their electricity production when there is a higher electricity demand. When the heat production is higher than the excess heat demand, the heating is stored. Typically, short-term heat storage has a capacity corresponding to approx. 12 hours of full load heat production at the heating plant. (Danish Energy Agency, 2015).

Cooling demand has also fluctuations. To deal with these cooling storages are used. In Helsinki, underground cooling storage with total storage water capacity of 46,500 m^3 has been built to optimize cooling demand fluctuation. (Helen, 2013) Also in many other Nordic cities there are heat storages ranging from day-to-day storages to even seasonal storages. (State of green, 2016).

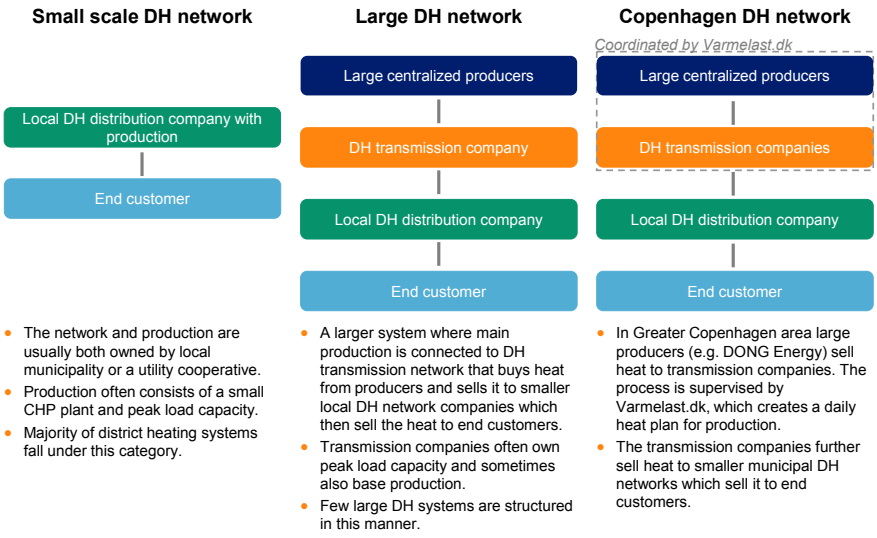
Best practice:
Large-scale solar panels in district heating

Denmark is among the world leading countries in integrating large-scale solar heating into the DH systems. The number of solar heating plants larger than 1000 m2 has increased significantly during the recent years. In 2015, the estimated total surface area of large-scale solar facilities (>1,000 m2) was more than 750,000 m2, the largest facilities being 70,000 m2. Since the main solar heat production occurs in the summer, and heating demand being highest in the winter, many large solar DH systems often utilise seasonal thermal storage. The main drivers for the development have been the solar heating technology becoming less expensive and therefore more viable alternative to natural gas during summertime. Furthermore, solar thermal heating is also supported by making it exempt from fuel tax. (Danish Energy Agency, 2015).

Denmark has six large central district heating areas with a total heating supply of 19 TWh in 2014, 56% of the national district heating supply. There are also around 400 small- and medium-sized district heating areas with an annual heating supply of about 15 TWh in total. In 2014, 69% of all district heating was produced in cogeneration with electricity (CHP). One characteristic of the Danish district heating networks is short-term heat storage meaning that the CHP plants can optimise their cogeneration according to the electricity demand without compromising the heating supply. Both large and smaller district heating systems utilise short term heat storages. Heating storage allows CHP plants to decrease their production e.g. when it is very windy and there is excess supply of electricity. CHP plants can also increase their production when there is a higher electricity demand. When the heat production is higher than the heat demand, the heat is stored. Typically, short-term heat storage has a capacity corresponding to approx. 12 hours of full load heat production at the heating plant. (Danish Energy Agency, 2015).

The Danish district heating sector is split into several actors: Large centralized producers, district h eating transmission companies, small local district heating distributors and a heat planning company, Varmelast.dk, which is responsible for coordinating the heat production in Copenhagen district heating system. Some typical district heating market structures in Denmark are illustrated in Figure 26.

Figure 26: Examples of the most common type of district heating system structures in Denmark



Source: Danish Energy Agency (2015), Varmelast.dk webpage, Danish Energy Agency & State of Green & DBdistrict heating (2015).

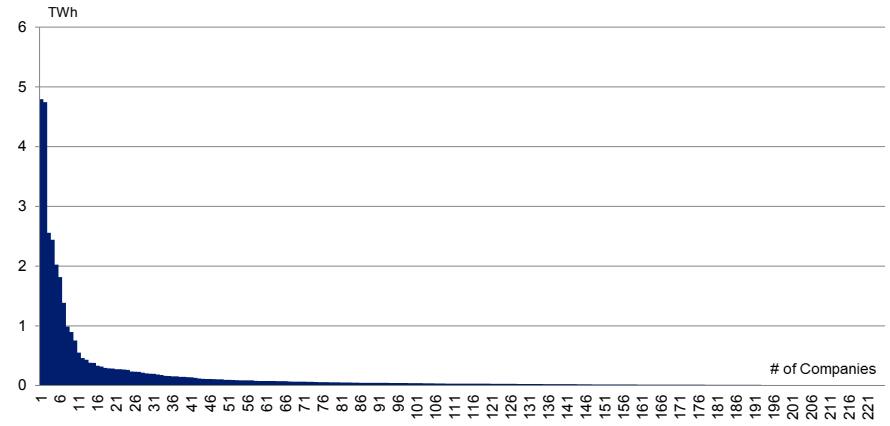
Examples of large centralized producers of district heating (illustrated in Figure 27) include companies like DONG Energy and Vattenfall that typically own CHP and waste incineration plants which are connected to separately owned district heating transmission networks. Neither DONG Energy or Vattenfall own district heating networks, and sell heat to the transmission companies.

Danish district heating transmission companies include e.g. CTR and VEKS. The transmission companies transmit heat to local district heating distribution networks. Some transmission companies also have their own CHP plants whilst others only have peak load capacity of their own. Transmission companies are typically owned by consortium of surrounding municipalities.

Local distribution companies are responsible for delivering heat to and billing the end customers. Distribution companies are typically owned by municipalities or cooperatives.

Top 10 Danish district heating network companies (Table 5) delivered some 60% of the total district heating delivery volume in 2015 – this structure of deliveries is further illustrated in Figure 27. In 2015 there were 261 network companies in total (Dansk Fjernvarme, 2016) of which, however, some had now reported heat deliveries in 2015.

Figure 27: District heating deliveries to network by network companies in Denmark in 2015 and the ranking order of the companies



Source: Dansk Fjernvarme (2016a).

Table 5: Largest network companies delivering district heating to network in Denmark, 2015

no	Company	Volume (GWh)
1	HOFOR	4,794
2	CTR I/S	4,745
3	VEKS I/S	2,557
4	AFFALDVARME AARHUS	2,440
5	FJERNVARME FYN A/S	2,024
6	AALBORG VARME A/S	1,817
7	TVIS	1,384
8	ESBJERG VARME A/S	987
9	TREFOR VARME A/S	896
10	FREDERIKSBERG FJERNVARME A/S	755

Source: Dansk Fjernvarme (2016a).

The largest network company by delivered volume (Table 5), HOFOR, is a utility company owned by and operating in Copenhagen municipality. It has both district heating distribution and production. The second largest network company by delivered volume, CTR, is one of the two interconnected district heating transmission companies in Greater Copenhagen area. It sells heat to local district heating distribution companies, HOFOR and VEKS. CTR production capacity is limited to some peak load units. The third largest network company by delivered volume, VEKS, is a non-profit company that is owned by municipalities operating in and near Greater Copenhagen area. It is mainly a transmission company but owns also CHP plant and distribution network.

5.2 Heating market regulation in Denmark

5.2.1 Long term energy and climate goals

The energy resources in Denmark are somewhat different compared to other Nordic countries. Unlike Finland and Sweden, Denmark has own natural gas production, but the hydro power and wood-based biomass resources are scarce. Denmark also has clearly longer experience with wind power generation and the role of wind power is large in the electricity generation.

In 2012 a major political agreement about Danish energy policy for the period 2012–2020 was reached containing a wide range of policy initiatives on energy efficiency, renewable energy and the energy system. This Danish Energy Agreement from 2012 (EFKM, 2012) contains targets for 2020 including:

- About 50% of electricity consumption supplied by wind power.
- Over 35% of final energy consumption supplied from renewable energy sources (vs. the binding target of 30% allocated to Denmark as a part of EU 2020 policy).
- Reduction of gross energy consumption by 7.6% in 2020 relative to 2010.

In the government platform for energy, utilities and climate (STM, 2016) the following targets have been set:

- A target of at least 50% of the Danish energy needs covered by renewable energy sources in 2030.
- A willingness to accept an ambitious non-ETS reduction target from the EU for 2030.
- A long-term target of Denmark becoming a low emission society independent of fossil fuels in 2050.

The sitting government will present a new climate plan in 2017.

5.2.2 Main current support systems for heat (and electricity) producers

Feed-in premiums for electricity generation based on renewable energy

Support is provided for electricity generation based on renewable energy and for the use of biogas for upgrading. The support is provided in the form of feed-in premiums for:

- Wind turbines
- Biogas, etc.
- Biomass
- Other renewable plants.

Most of the decentralised CHP plants receive an electricity production subsidy that is a fixed annual amount, which is available until the end of 2018. After 2018, only power and CHP plants using renewable energy sources will receive an add-on to the market price of electricity. (Danish Energy Agency, 2015).

In Denmark, sustainability criteria have been introduced for the use of wood pellets and wood chips for electricity and district heating in a voluntary industry-level agreement. The agreement has been drawn up by Dansk Energi (the Danish Energy Association) and Dansk Fjernvarme (the Danish District Heating Association) and has the backing of the Danish Government. (Danish NREAP, 2015).

Demonstration programme and heat pump task force

Grants are provided to promote the use of large electric heat pumps for district heating generation. The demonstration and advisory support that attempts to initiate the spread of heat pumps. Support for both, advisory services to install large electric heat pumps as well as for the installation costs. (Danish NREAP, 2015).

Support for conversion to renewable energy or district heating in processing industries

Industrial energy consumption is still largely based on the use of fossil fuels. One reason is the lower energy taxes on fossil fuels for process energy. With the Energy Policy Agreement (EFKM, 2012), it was decided to establish an investment grant scheme for undertakings using process energy that convert from the use of fossil fuels to renewable energy or district heating. It is estimated that it will be possible to achieve conversions to renewable energy and district heating totaling 4.4 TWh/year with the funds in the pool, the expectation being that the main emphasis of the scheme will be on conversion to biomass. (Danish NREAP, 2015).

5.2.3 Energy taxation in Denmark

The Danish energy taxation is generally divided to fuel taxation and electricity taxation. Fossil fuels used for heat production are taxed with energy tax and CO_2 tax, and in most cases also with sulphur tax and NOX-tax. In some cases, there is also a methane tax. Fuels consumed for process use are generally exempt from CO_2 taxation. Renewable fuels are generally exempt from fuel taxes. However, biomass use has sulphur and NOX-taxation, and biogas use NOX tax in larger plants. (Ea Energianalyse, 2015).

All taxes are indexed to consumer price index from the beginning of 2016. By indexation, Denmark seeks to keep the real value of taxation stable. (Skatteministeriet, 2016) In addition, the EU ETS sets a market price for CO_2 emissions in larger energy plants indirectly supporting CO_2-free renewable energy.

Best practice:
Electric boilers and heat pumps in the district heating system in Denmark

With the variable electricity production mainly due to the high wind power capacity, a new taxation scheme was formed in Denmark in 2005 for electrical boilers and heat pumps called "elpatronordning". This tax scheme provides decreased electricity tax when electricity is used in electrical boilers or in heat pumps for producing district heating. (Skat, 2017) This regulation encourages utilization of excess electricity, mainly due to peaks from wind production, and helps balance the grid. The system works best when connected to heat storage as then the cheaply produced heat can be sold when the demand is high. The investment cost is relatively low, thus electric boilers work best as a regulating power and "shaving" wind peaks. (Energy Analyses, 2015).

Heat pumps on the other hand are expected to play a bigger role in the Danish heat market. Denmark founded a heat pump task force in 2015 which helped district heating plants in implementing heat pump solutions. This task force gave advice on how to implement heat pump solutions for district heating. (Danish NREAP, 2015) A grant has also been founded for incentivizing investment in heat pumps for district heating. This grant awarded a total of 26,7 million kr in 2015 for 10 projects. (Energistyrelsen, 2016) Heat pumps use waste heat streams or for example ambient heat from ground or water and transfers them to the district heat network. Heat pumps work better for base or intermediate load rather than peak as the electric boilers. This is because of the higher investment cost and technological restrictions. The heat produced is carbon free depending on the source of electricity. (Energy Analyses, 2015).

5.2.4 Policy impacting heat consumption

In the Danish energy agreement from 2012, emphasis is put on, among other things, energy renovation of existing buildings and energy saving by energy companies as two of the primary national instruments to drive energy efficiency forward in Denmark. (Danish NEEAP, 2014).

A key measure to improve energy efficiency is the energy efficiency obligation scheme with tradable certificates. In this respective, the approach in Denmark is clearly different from other Nordic countries.

In new buildings, heating has to be based on renewable energy – this applies to all new buildings except those built in areas designated for supply by district heating or which were designated for natural gas supply before 2013. In these buildings, the heating may be based on renewable energy or on either district heating or natural gas. In other buildings, the building heating must be based on renewable energy such as wind power, solar energy, heat pumps, biomass, landfill gas, gas from wastewater treatment plants, biogas and bio-oil. (Danish NREAP, 2015).

The Building Regulations set the requirement to reduce the energy demand in new buildings, and defines voluntary energy classes for existing buildings. There is a strategy for building renovation, with a target of 35% reduction in net energy consumption for heating and hot water in the existing building stock by 2050. One of the assumptions of the strategy is that the best way to finance energy renovations is through the Danish mortgage system, which is considered to be stable and robust. However, according to the strategy there may be a need to investigate alternative financing schemes, including financing via energy prices. (Danish NEEAP, 2014).

To disseminate information in the private sector, an Energy Savings Secretariat was founded in 2014 to support the identification of energy efficiency measures in the private sector. For large industrial companies, energy audits are mandatory (every fourth year).

Under the Meter Order, meters for measuring heat consumption must be installed in individual residential units or commercial units in both existing buildings and new buildings. However, buildings may be exempt from this requirement on the grounds of, for example, special technical circumstances. This is not a requirement for the district heat company however, but the flat level measuring is carried out by building owners. Around half of all the district heating customers currently have smart meters. A majority of the meters installed on the market today enable consumers to read their consumption in both volume (m3) and MWh. In 2014, Denmark planned further amendments to the Meter Order that the Danish Energy Agency is considering making as part of the implementation of Article 9 of the Energy Efficiency Directive.

A lot of effort has also been put on different consumer information programmes and training. Municipalities are offered loans for energy saving efforts. Denmark also has energy labelling and ecodesing requirements. In addition to household appliances, they will also cover building components (e.g. windows) and products for enterprises in the future.

In Denmark district heating supplier delivers and measures heat at building level. The building owner is obligated to install sub-metering at unit level and allocates the cost of heat between the units, but the district heating companies typically invoice only on building level. Based on the interviews, possible requirement for the district heating companies to measure the heat demand on building unit level and bill the inhabitants directly is not seen a viable option. This would require significant changes to the system, but most likely would not bring much benefits compared to the current system of measuring heat on building unit level. About half of the meters at building level are remotely readable.

Best practice:
Energy efficiency obligations scheme in Denmark

To achieve energy efficiency targets, Denmark has set up an energy efficiency obligation scheme for energy transmission and distribution companies. The system was set up based on voluntary agreements to join the system. The obligation scheme relies on tradable energy efficiency certificates, which make it possible to achieve the energy efficiency improvements in the most cost-efficient way. The scheme covers electricity, natural gas and district heating distributors. Investments with verified energy efficiency improvements receive certificates, which can be used to comply with the energy efficiency targets of each company, and therefore have a value. As a result, energy efficiency investments are more profitable as the certificates provide additional income in addition to the decrease in the energy cost for the end user. It also encourages energy service companies to look for the most profitable energy efficiency investments and offer services to realise these projects. The energy efficiency obligation scheme requires also district heating companies to achieve a certain level of energy efficiency improvements annually. They can achieve this by energy efficiency investments not only within district heat users, but also for natural gas users or electricity users. The obligation scheme also makes it possible to realise the investments in other network areas, as the benefits can be transferred in the form of certificates to the company.

The scheme provides for some 50% of all energy savings per year in Denmark. Also energy efficiency improvements in industry are included in the scheme. The system has resulted in significant energy savings in industry. Other important sources of energy savings are private and public buildings, business and transmission. (Bundgaard *et al.*, 2013) The distribution companies pass the implementation task on to third party companies e.g. energy service providers, energy service companies, private companies such as installers, craftsmen, engineering companies, lighting companies etc. This has created the market for energy services in Denmark, and further increases energy efficiency improvements.

5.2.5 *Policy impacting district heating*

Both district heating production and network companies are considered as monopolies and regulated as non-profit undertakings. District heating is regulated by Heat Supply Act that regulates public heating supply installations with heating output over 250 kW and CHP installations with heating output up to 25 MW. Large CHP plants are regulated with Electricity Law, but heating supply of large CHP plants is regulated with Heat Supply Act. Local authorities approve new projects ensuring that the heating projects with highest socioeconomic benefits are chosen. In addition, according to the Heat Supply Act, if possible, heat must be produced with CHP.

Rules regulate also which fuels can be used when establishing or extending district heating supply. In the case of CHP, more or less all fuel types can be chosen. For the heat only production, if the district heating facility is in an area with natural gas supply, only natural gas can be used. In areas without natural gas supply, the fuels can be either biomass, waste, biogas, landfill gas and other gasified biomass. However, in 2013 and 2015 a number of district heating companies with very high heating prices located in public gas supply areas were permitted to establish a 1 MW heat only boilers based on biomass. As biomass is exempt from tax, these district heating companies were able to lower their heating price for consumers. (Danish Energy Agency, 2015).

According to the Heat Supply Act, the heat price paid by the consumer should cover all necessary costs related to heat supply. However, the heat supply company is not permitted to make a profit. The non-profit principle ensures the consumers are protected against abuse of the natural district heating monopoly, because the district heating price is based on cost based pricing. Consumer protection from inefficient management and operation is however not ensured by the non-profit principle. To help ensure efficiency, district heating companies are voluntarily benchmarked against each other on an annual basis. (Danish Energy Agency, 2015).

In some areas, the city council can impose buildings to connect to district heating. This can apply to both new and existing buildings. This means that the consumers are obligated to pay a connection fee and/or a fixed annual fee to the heating supply company, whether or not they use heating. In some cases, there might also be an obligation to actually purchase heating. The city council can also impose buildings to remain connected to district heating. (Danish Energy Agency, 2015) Currently there is no regulation for a third-party access to heat networks.

With the Danish Energy Agreement in 2012 it was decided, that no oil and natural gas boilers can be installed in new buildings in Denmark starting from 2013. Furthermore, it was decided that from 2016 new oil boilers cannot be installed in existing buildings, which are placed in areas with district heating or natural gas supply. To support the switching from oil and natural gas to renewable energy a fund on 5.6 million euro was earmarked to the advancement of alternatives to oil and natural gas boilers in existing buildings in the years 2013–2015.

District heating operations in Denmark are supervised by the Danish Energy Regulatory Authority (Energitilsynet). The energy industry organisations play a key role in taking part in the development of the regulations, such as acceptable pricing principles. Energy Sector Board of Appeal and Energy Supplies Complaints Board are the main bodies when it comes to the district heating related dispute solving. The main regulatory bodies and energy industry organisations in Denmark are listed in Table 6 below.

Table 6: Danish district heating related authorities and organisations

Actor	Role
Danish Energy Regulatory Authority (Energitilsynet)	Supervises and regulates district heating prices and terms and conditions for customer, as well as district heating companies to ensure that they only include necessary costs in their prices.
Energy Sector Board of Appeal (Energiklagenævnet)	Independent appeal board under The Ministry of Climate, Energy and Building. Deals with private consumers' complaints regarding energy companies' purchase and delivery of heat. From 2017 onwards the Energiklagenævnet will be moved to be under the Erhvervsministeriet (Ministry of Business) Energiklagenævnet is the final administrative appeal body for decisions by public authorities under various laws governing the energy sector. The decisions that are subject to appeal will in most cases have been handed down by the Danish Energy Regulatory Authority (Energitilsynet), the Danish Energy Authority (Energistyrelsen) or one of Denmark's 98 municipalities.
Energy Supplies Complaints Board (Ankenævnet på Energiområdet)	The board handles complaints regarding the purchase and delivery of energy services from energy companies to consumers. Electricity, district heating, natural gas and gas for cooking, are all within the Energy Supplies Complaints Board's area of competence. The energy supplies complaint board is a private complaints board founded by the energy sector and the Danish Consumer Council. As a consumer you can choose to file a complaint here instead of going direct to the court system.
Danish Board of District Heating (DBdistrict heating)	Promotes district heating and represent the leading actors of the district energy sector
Two district heating associations: Danish District Heating (Dansk Fjernvarme) & Association for CHP plants (Foreningen Danske Kraftvarmeværker)	Danish District Heating Association has >400 members of which 55 are municipally owned district heating companies delivering around 2/3 of all Danish district heating, others members are consumer owned cooperatives. Association for CHP plants represents CHP producers (active in district heating market).

Source: Energitilsynet (2016), Energiklagenævnet (2016), Energiankenævnet (2016), DBdistrict heating (2016), Dansk Fjernvarme (2016b), Foreningen Danske Kraftvarmeværker(2016).

The current district heating regulatory regime is going through a thorough modernization – focused on increasing the productivity of sector. Furthermore it has just recently been proposed to further liberalize the sector by deregulating investments within the sector as well as current possibilities to bind consumers to district heating.

6. Heating sector in Norway

6.1 Heating sector development in Norway

6.1.1 Energy for heating and hot water in Norwegian residential and service sectors

Electricity is the dominant source of energy for heating and hot water in the residential and services sectors, and data collection from ENOVA estimated that 85% of space heating was based on electricity in 2015, and in 2012 SSB estimated that over 90% of residential housing have access to heating from electrical ovens and heating cables. There is however no data available in Norway showing the total actual energy use for heating in the residential and service sector for all buildings, and the data from e.g. ENOVA is based on a sample of 3,415 buildings and on self-reported numbers. The data represents about 8.4 TWh of energy use in space heating.

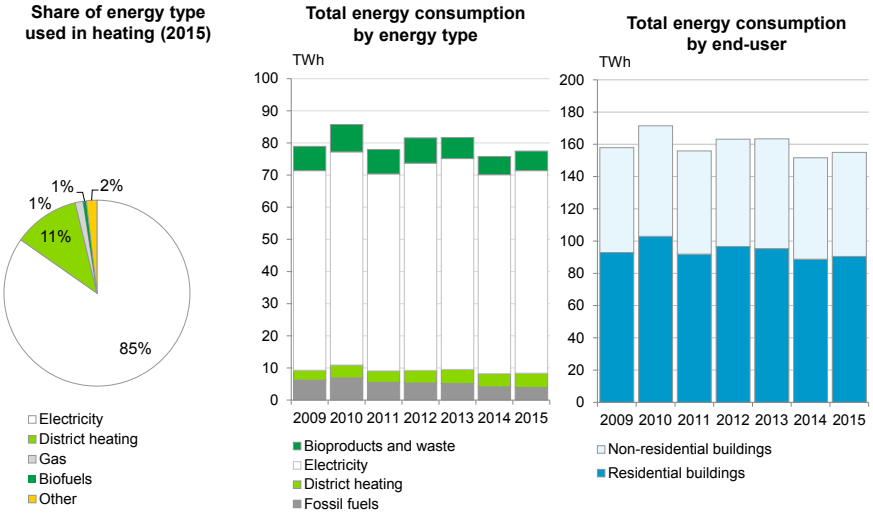
Figure 28 shows the total energy use for the residential and service sector from 2009 to 2015. The data includes all energy use and is not limited to heating and hot water. The 2015 numbers reported from ENOVA are also presented in Figure 28 and show the distribution between energy carriers in residential and service buildings based on their data collection from 2015. It should be noted that small single-family houses are underrepresented in the data reported to ENOVA, and the data is therefore most likely not representative of buildings in Norway as a whole.

Heat demand depends on the type of building (e.g. single and multi-family housing), but it also greatly depends on the buildings construction year and building standards. In the data collected by ENOVA 61% of energy demand is temperature dependent and heating dependent for buildings build before 1950,[4] whereas the average temperature dependent demand for buildings with TEK10 building standards (2012–2014) is only 30%.[5]

[4] Arithmetic average for all building types; minimum: 45%, maximum: 75%.

[5] Minimum: 20%, maximum 40%.

Figure 28: Total energy consumption in the Norwegian residential and service sectors (2009–2015)



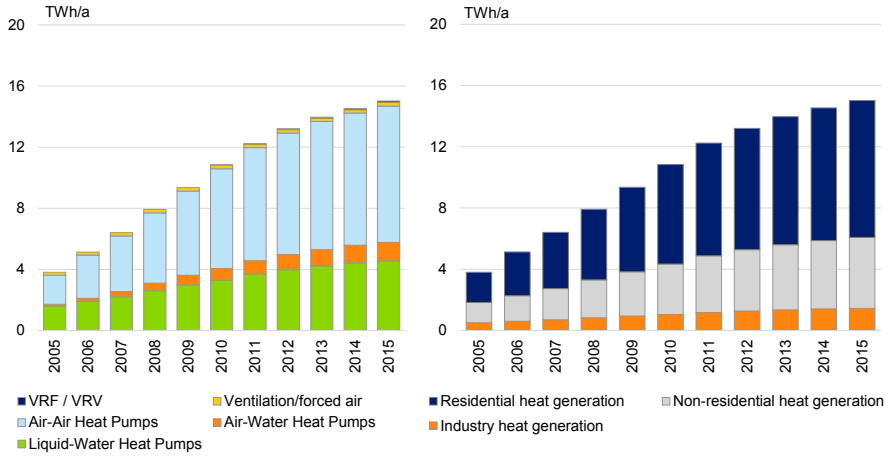
Source: SSB, Enova: Byggstatistikk 2015.

There are currently about 750,000 installed heat pumps in Norway, corresponding to about 15 TWh of heat delivery in 2015.[6] The heat pump market has seen a strong growth in the last 10 years, and historically installation and sale of heat pumps correlates with cold winters and high electricity costs for end-users. Air-sourced heat pumps were subsidized in 2003, which helped stimulating growth in the market, but the investment support for air-sourced pumps has been removed. End-user investments for air-to-water- and liquid-to-water heat pumps are still subsidised. It is expected that future demand will mainly come from replacing old pumps with new and better technology. The current energy labelling system promotes the use of heat pumps in buildings. Figure 29 shows calculated estimates[7] of heat generation from heat pumps in Norway, the calculation include electricity used by the heat pumps.

[6]NOVAP and NVE: Varmepumper i energigystemet, 2016.

[7] Calculation is made by NVE, and is based on NOVAPs sales statistics.

Figure 29: Amount of installed heat pumps by building and type in Norway (2005–2015)



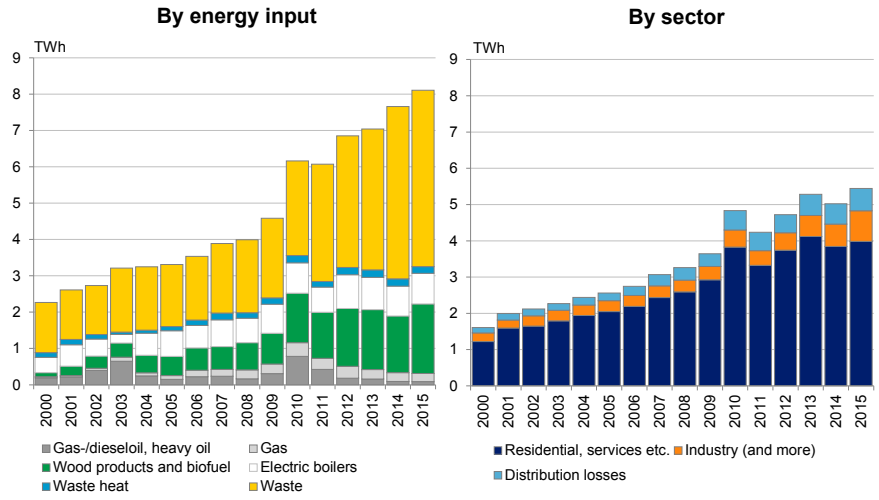
Source: NOVAP, NVE.

6.1.2 *District heating market in Norway*

The district heating market in Norway is very small compared to other Nordic countries. The historical background for this limited market size is related to the access to relatively cheap electricity and alternative sources of heating. With increasing electricity prices in the late 1990's district heating regulations and investment subsidies were introduced to promote the build-up of district heating, and investments and infrastructure capacity have grown significantly since the early 2000's.

The service industry is by far the largest consumer of district heating (over 62% in 2015) in Norway. 82% of the total 4.8 TWh of district heat delivered to end users in Norway was consumed by the residential and service sectors in 2015 (Figure 30), and. On average over the period 2000–2015 the residential and service sectors have accounted for 87% of total district heat consumption. Distribution losses accounted for 11% of the net production of district heat. Total consumption of district heat has grown on average by almost 9% since 2000.

Figure 30: Energy input for district heating and consumption of district heating by sectors, 2000–2015



Source: SBB.

Waste accounts for the major share (60%) of the total energy input used for district heat production in 2015, and it has been the major energy input since the mid-1980s. The waste landfill ban was introduced in Norway in 2009, and this has been an important driver for waste incineration plant investments, and the use of waste in district heat production. Due to low electricity market prices it has been considered more cost efficient and profitable to use waste for heat production rather that electricity generation. However, due to the lack of district heating systems and off-takers of heat, some of the waste incineration plants have limited possibility to fully utilise the energy produced, and there has been a full stop in investments of new incineration plants. The industry still use a large share of oil, gas and electricity for heating in their production processes, but it is expected that conversion to renewables will continue within this sector.[8]

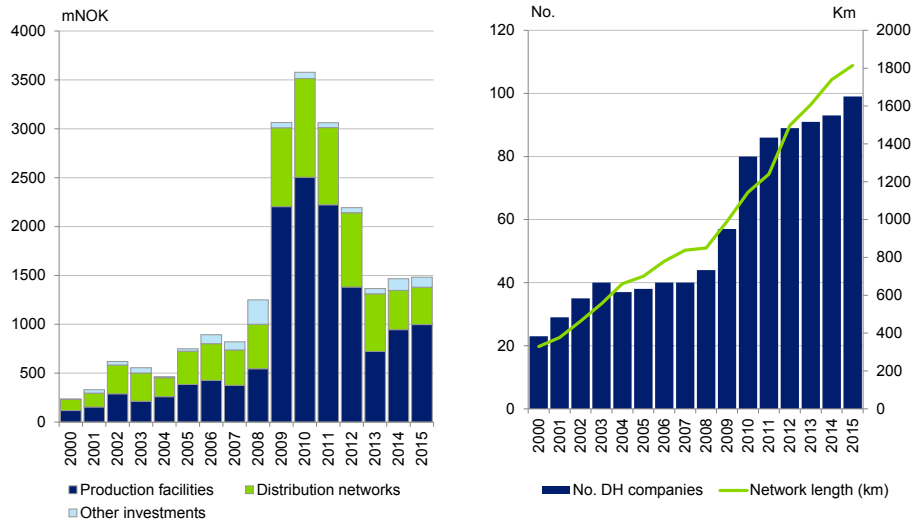
In 2015, there were 100 district heating companies in Norway delivering district heating to the market. The number of companies has increased rapidly, as in early 2000's there were only about 20 companies operating in this market. A large number of companies entered the market in 2009 and 2010, and this is also reflected in the sharp increase in production and infrastructure investments in this period as shown in Figure 31. Large investments growth in this sector has mainly been the result of political ambitions and public funding of production and network facilities through ENOVA, and mandatory network connections to new buildings in areas with district heating network concession.

District heating facilities are mainly located in city areas, and district heating is established in majority of all cities. The potential for new facilities in densely populated areas is limited, and this explains the sharp decline in new production investment in the period 2013–2015. There is however still a need to expand existing district heating

[8] ENOVA: Markedsutviklingen 2016.

infrastructure capacity in cities with existing district heating as energy use per m² of land area is on the rise in the larger cities. District heating capacity could also be established in new areas in the future, as smaller cities are experiencing densification of buildings areas as people from surrounding areas move in to the cities. District heating companies are mainly publically or municipality owned, and a list of the 10 largest companies is presented in Table 7.

Figure 31: District heating investments, no. of companies and network length, 2000–2015



Source: SBB.

Table 7: Largest district heating companies in Norway

No	Company	Volume (GWh)	No. of network concessions
1	Hafslund Varme	1,600	1 (1089MW)[9]
2	Statkraft Varme	794	7 (528MW)
3	Eidsiva Bioenergi	380	10 (447MW)
4	BKK Varme	266	1 (240MW)
5	Oslofjord Varme	207	2 (54 MW)
6	Lyse Neo	151	2 (167MW)
7	Akershus Energi Varme	144	5 (204MW)
8	Agder Energi Varme	139	3 (225MW)
9	Tafjord Kraftvarme	103	1 (72MW)
10	Drammen Fjernvarme	91	1 (99MW)

Source: Fjernkontrollen.no, NVE.

[9] Oslo municipality.

6.2 Heating market regulation in Norway

6.2.1 Long term energy and climate goals

EUs climate and energy ambitions for 2020 and 2030 is EEA relevant, and therefor impacts Norwegian climate and energy policies directly. Norway is part of EUs ETS scheme, the internal European market and EUs climate framework, and about 50% of Norway's emissions are incorporated in the EU emission trading scheme.

Norway's climate policies have been anchored through two parliamentary climate settlements in 2008[10] and 2012.[11] As part of the Paris agreement the Norwegian parliament has also agreed to accelerate the national target for climate neutrality from 2050 to 2030.[12] The overall targets for the Norwegian climate policies include the following:

- Overachievement of its Kyoto obligations by 10% in the first commitment period.
- 30% reduction in national emissions by year 2020 relative to 1990 levels.
- Carbon neutrality by year 2030 (at the latest) given a global and ambitious climate agreement.
- Strengthen technical building standards to passive house standard by 2015, and close to zero energy level in 2020.

The government has also proposed the following measures which are currently on a public hearing:

- Ban on the use of fossil oil heating in residential buildings and from year 2020 (with the exceptions of peak load demand).
- Establish by law that Norway will cut 40% of emissions by 2030 (relative to 1990 levels) and low emission society by 2050.

Relevant EU directives for Norway's climate and energy policy include the Renewable Energy Directive, whereas the Energy Efficiency Directive (EED), the Energy Performance of Buildings Directive (EPBD), the Industrial Emissions Directive (IED) is currently under EEA assessment and has not been incorporated into Norwegian laws and regulations. As Norway is not an EU member the process of assessing the EEA relevance and incorporating EU regulation into national laws is usually a slower process compared to that of EU member countries.

[10] St.mld. nr. 24 (2006-2007).
[11] St.mld. nr. 21 (2011-2012).
[12] Innst. 407 S (2015-2016).

6.2.2 Policy impacting heat sector

ENOVA (public body) offers investment support for investments in production and distribution of district heating from renewable energy sources.

There are several policy instruments that impact the residential, service and industrial sectors' heat consumption, and also may have an impact on the choice of heating method. For promoting energy efficiency in the buildings in Norway, the main measures are the building regulation and energy labelling. Also, the smart metering of electricity and energy taxation promote energy efficiency at building level.

Smart meters will be installed for all end-users of electricity by 1 january 2019. Installation of smart meters is a preliminary to ensure more optimal energy use in buildings, and could impact heat and electricity demand. Electricity taxation (elavgift) and tariffs have an impact on the end-user cost of electricity, and also affect the price level cap of district heating. Higher taxes on electricity could indirectly promote the use of district heating. Energy use in buildings is regulated under the Building Technology Regulation (TEK10) and the Energy Labelling system. The regulation of TEK10 was revised in January 2016. Since 2010 it has been mandatory for all buildings to be energy labelled. The purpose of energy labelling is to promote energy efficiency and information on energy use in buildings. The rating and grading is based on net energy demand, and the system therefore promotes self-production of energy. The use of district heating will therefore have a negative impact on the building's net energy demand and energy labelling. The grading system has therefore been criticized for promoting sub-optimal investment decisions. ENOVA is currently evaluating the labelling system.

6.2.3 Policy and regulation impacting district heating

District heating is supervised by the Norwegian Water and Energy Directorate, and there has been little change in district heating regulation since the 1980's. The overall framework for construction and operation of district heating facilities is regulated by the Energy Act and attached regulation, and mandatory connection of district heating supply to end-users is regulated by the Planning and Building Act. The main regulatory bodies and energy industry organisations in Norway are listed in Table 8 below.

Table 8: Norwegian district heating related authorities and organisations

Actor	Role
Directorate of Building Quality	Administrative authority regarding building regulations and technical building specifications (TEK), and a subordinate agency to the Ministry of Local Government and Administration. The authority is also central in the administration of parts of the the Planning- and Building Act.
ENOVA	Public agency responsible for promoting environmentally friendly and efficient energy use, energy production and the development of renewable technologies. The agency is a subordinate of Ministry of Oil and Energy.
Ministry of Climate and Environment	The ministry is not responsible for laws or regulations directly related to district heating market, however the ministry is responsible for the overall climate policies and emission targets affecting market players.
Ministry of Local Government and Modernisation	The ministry is the legal and responsible authority regarding regulations on mandatory district heating connection for end-users. The ministry can make changes to regulation if seen necessary, but this has not been carried our (so far).
Ministry of Petroleum and Energy	The ministry is the legal and responsible authority regarding The Energy Act and overall energy policy.
Norwegian Environment Agency	Subordinate agency to the Ministry of Climate and Environment. Important agency with regards to energy recovery and emission regulations.
Norwegian Water and Energy Directorate (NVE)	Responsible for handling and granting of district heating concessions, and is the supervising authority for the district heating market. The directorate is also responsible for dealing with complaints regarding mandatory district heating connections. NVE is a subordinate agency to the Ministry of Oil and Energy.
Norsk Fjernvarme	Interest organisation for market players in the district heating sector, currently representing 47 companies covering 80% of district heating production. The main purpose is to ensure a good political and regulatory framework for its members and to promote and provide information on the district heating sector.
Norwegian Home Builders' Association	Interest organisation building owners and developers. The organisation lobbies for good political and regulatory framework regarding building policies and building regulations and technical standards.

The Energy Act requires district heating operators to apply for concession in order to build and operate a district heating network. A concession gives the owner the right and a duty to build district heating network within its concession area. After a district heating facility has been granted concession the municipality within the concession area can decide on a mandatory connection for new buildings. In concession areas with mandatory connection, all new buildings have to be connected to the district heating network.

The purpose of mandatory connection is to ensure better utilisation of constructed district heating facilities, and to ensure profitability for district heating operators/owners. However, building owners with mandatory connection are not obliged to use district heating as heating source even if they are connected to the district heating network. As building owners are still required to take the investment cost to ensure that they meet the technical requirements in order to connect and receive heat from the district heating network, the cost burden of mandatory connection makes district heating use economic for most building owners.

Due to the partly mandatory connections, there are two types of agreements: voluntary and mandatory. The Energy Act regulates pricing and pricing structure for mandatory agreements. District heating cannot be priced higher that the alternative cost of other heating sources in the respective concession areas. The district heating price is therefore capped by electricity prices, including grid tariffs and electricity taxes.

Metering of district heating is most commonly carried out when the hot water reaches the building – and the cost of district heating is then divided by floor area to the individual flats. Currently there is thus very limited amount of individual meters on flat level.

Regarding external heat delivery in district heating concession areas, a district heating concession does not grant the concession owner a monopoly on heat delivery within the concession areas. Thus an end-user can enter into heat delivery contracts with other suppliers. Other suppliers however will not be allowed to construct district heating facilities with installed capacity ≥ 10MW unless they have a concession, and only one concession is granted for each area.

The need to use heat pumps and electric boilers has been identified in Norway as well. The electricity tax for electricity used in energy production and in district heating/cooling production is reduced from the original 16.32 øre per kWh to 0.48 øre per kWh in 2017. (Skatteetaten, 2017) There is also a tax deduction on the local grid tariff, decided by the energy authority if larger enterprises or a district heating company have a possibility for flexible loads in the energy production. This applies for example for heat pumps or electric boilers which can work as flexible production. (Thema, 2014).

7. Heating sector in Iceland

7.1 Heating sector development in Iceland

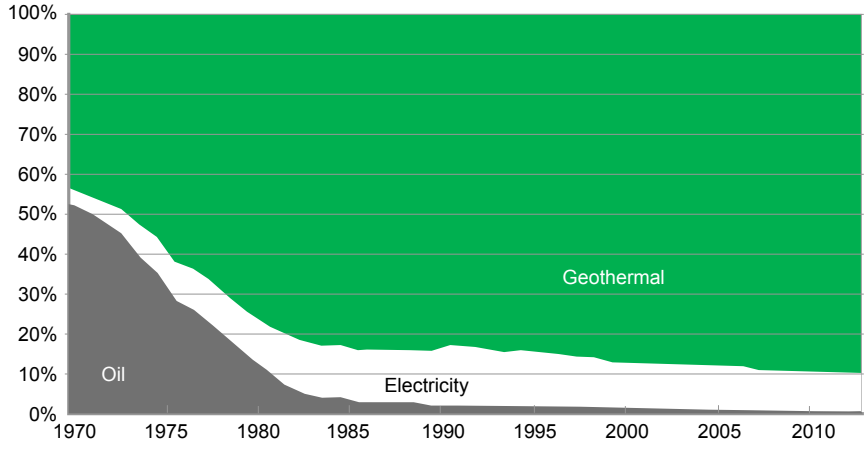
7.1.1 *Energy for heating and hot water in Icelandic residential and service sectors*

A large share of Iceland's energy consumption comes from renewable resources, and 99% of houses in Iceland are heated with renewable energy. Nine out of ten are heated directly with geothermal heat, through district heating systems, and the remaining 10% with renewable electricity (in areas where there are no geothermal resources). (Icelandic Ministry of Industry and Commerce, 2016).

Electricity generation is based on hydro power (71% in 2014) and geothermal energy (29% in 2014). In the 1970's more than 50% of Iceland's space heating was based on oil, but following the oil crisis in 1973 the share of oil rapidly declined towards the 1990's and was replaced by an increased share of geothermal heating and electricity.

Figure 32 shows the shares of oil, electricity and geothermal energy used for space heating in Iceland from 1970 onwards. Geothermal energy is utilized beside district space heating and electricity production e.g. for to heat swimming pools all year round, for various industrial purposes, greenhouses, agriculture, geothermal resource parks and snow melting (Orkustofnun, 2016a).

Figure 32: – Energy sources for space heating in Iceland 1970–2014



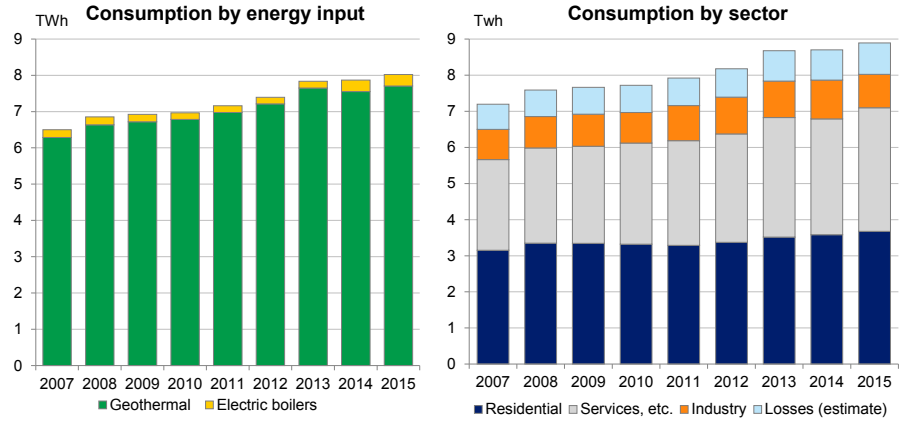
Source: Orkustofnun (2017a).

Heat pumps are not utilised to significant amount in Iceland as the geothermal water for space heating has been commonly available and inexpensive. Subsidies of electrical and oil heating have also caused reluctance to invest in heat pumps. However, a recent legislation allows users of subsidized electrical heating to get a contribution to improve or convert their heating system. It is likely that heat pumps will become competitive in areas where water with temperature above 50°C is not found. In those areas heat pumps can be used to replace or reduce the use of direct electrical heating. (Orkustofnun, 2017b).

7.1.2 District heating market in Iceland

There is no official data available for energy input and conversion factors for district heating in Iceland, but the consumption data gives an estimate of the share of geothermal and electricity used for the production of district heating. Figure 33 shows district heating consumption for residential, services and industry sectors in Iceland. Consumption amounted to 8 TWh in 2015, and 96% of district heating comes from geothermal energy. The residential sector is the largest consumer of geothermal heat and more that 90% of Iceland's homes are connected to the geothermal district heating systems (Orkustofnun, 2015b).The industry only account for about 11% of district heat consumption.

Figure 33: Energy input for district heating and consumption of district heating by sectors, 2000–2015



Source: Orkustofnun (2016).

In 2015 there were 25 companies delivering district heating in Iceland, and Table 9 shows the 10 largest district heating companies in Iceland ranged by volume. The largest provider of district heating is Veitur, which accounts for more than 50% of the district heating market. Veitur's primary market area is he Reykjavík area, but is also provides heat in many parts of the south and west of the country. Besides district heating, it is also an electricity distribution and water supply and sewage water company. Most utilities are owned and operated by municipalities.

Table 9: Largest District heating companies in Iceland

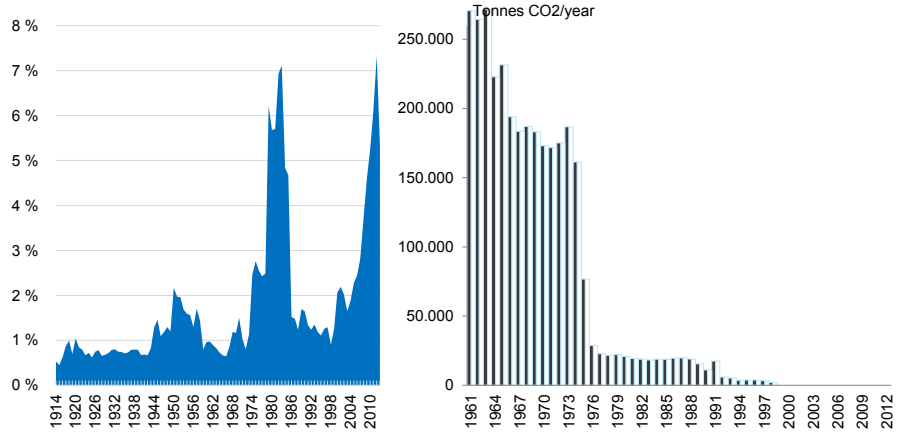
no	Company	Volume (TWh)
1	Veitur	4.30
2	HS Veitur	0.48
3	Norðurorka	0.42
4	HS Orka	0.42
5	Hitaveita Mosfellsbæjar	0.22
6	Selfossveitur	0.18
7	Skagafjarðarveitur	0.16
8	RARIK	0.13
9	Orkubú Vestfjarða	0.12
10	Hitaveita Seltjarnarness	0.11

Source: Orkustofnun (2016).

Best practice:
Geothermal district heating in Iceland

Due to its geological location, Iceland has vast energy resources in geothermal energy. Geothermal energy is used both in electricity generation and heat generation. Replacing fossil oil with geothermal heating has resulted in significant reductions in emissions and economic benefits at the same time. Figure 34 describes the savings, defined as the difference in value between price of heating by oil and price of heating by geothermal district heating. It also illustrates reduction in CO_2 emissions in Reykjavík due to geothermal space heating.

Figure 34: Economic Benefits of Geothermal District Heating (left) & Reduction in CO_2 emissions in Reykjavík due to geothermal space heating



Source: Icelandic Ministry of Industry and Commerce (2016).

7.2 Heating market regulation in Iceland

7.2.1 Long term energy and climate goals

Iceland is a part of the EEA framework and not an EU member state. It has adapted and incorporated the Renewable Energy Directive, and has already achieved the binding target of 72% renewable energy in final energy use in 2014 (Orkustofnun, 2015a). As the heat and electricity sectors in Iceland are almost fully renewable, the national renewable policies are mainly focused on the transport sector.

7.2.2 Policy and regulation impacting heating sector

The Icelandic government has encouraged the utilization of geothermal energy as far back as the 1940's. An Icelandic National Energy Fund has already since the 1960s offered loans to fund the initial cost of drilling and exploration of geothermal energy. If the initial drilling turns out to be unsuccessful, the loan defaults to the state. This policy promoted the expansion of geothermal energy.

In more recent years space heating in residential buildings has been subsidized by the state in areas where district heating is not reachable. End-users living in areas where district heating is not available are encouraged (through subsidies) to invest in heat pumps.

7.2.3 Policy and regulation impacting district heating

The utilisation of geothermal ground resources is regulated by the Act on Survey and Utilisation of Ground Resources, as well as the Nature Conservation Act and the Planning and Building Act.

District heating is regulated mainly by the Energy Law. District heating is considered to be monopoly business, and utilities receive monopoly licenses from the national regulator, and specific regulation applies to each license. It is required that at least 51% of the district heating company is publicly owned. District heating tariffs are regulated by the Ministry of Industry and Innovation, with advice from Orkustofnun. The tariffs vary, but the price of heat generally reflects the cost of production, distribution and sales.

The main regulatory bodies are introduced in Table 10.

Table 10: Icelandic district heating related authorities and organisations

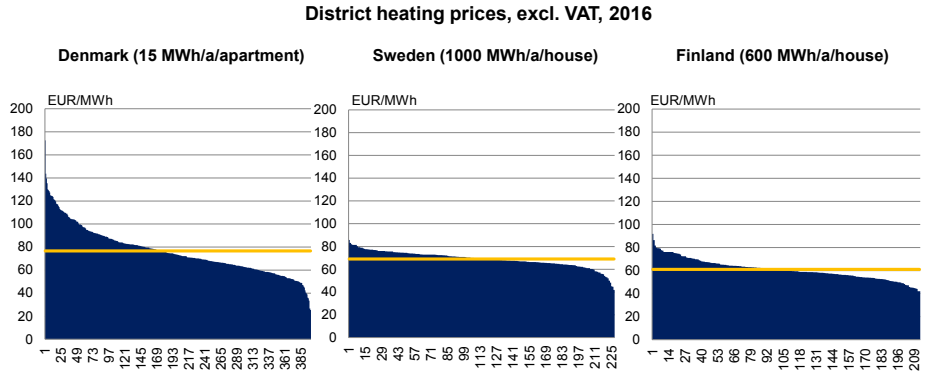
Actor	Role
The Ministry of Industry and Innovation	The Ministry covers all sectors of ordinary business and economic activity, including the energy sector.
The National Energy Authority (OS)	A government agency under the Ministry of Industry and Innovation. OS main responsibilities are to advice the Ministry and Government on energy issues, to license and monitor the development and exploitation of energy and mineral resources.
Iceland Geothermal Cluster Initiative	An industry based cooperation group, working to improve and stimulate the competitiveness of the Icelandic geothermal energy sector. The organisation represents the geothermal sector with more than 50 members.
Samorka	A federation of the Icelandic electricity industry, district heating, waterworks and utilities. The organisation promotes the interests of its members and works towards public authorities. The federation is part of the Iceland Geothermal Cluster Initiative.

In Iceland the metering is also carried out on building level. Many district heat companies measure the volume of water, and the billing is based on this measure. As the source of the heating is mainly the geothermal heat, there is variation in the temperature levels, and typically the higher temperature networks only measure and bill based on energy content. As in other Nordic countries, also in Iceland new meters are remotely readable.

8. District heating prices in the Nordic countries

District heating prices in the Nordic countries vary more within the country than between countries. In Figure 35, the district heating prices for apartment buildings in Denmark, Sweden and Finland are presented. The figures present the prices of a large number of the district heat companies, with the most expensive one on the left-hand side and lowest cost in the right-hand side. The average price in Denmark is about 80 EUR/MWh and 60 EUR/MWh in Finland, in Sweden between the two. The pricing principles and regulation in each country has been discussed in detail in the previous chapters.

Figure 35: District heating prices for apartment buildings, excl. VAT, 2016

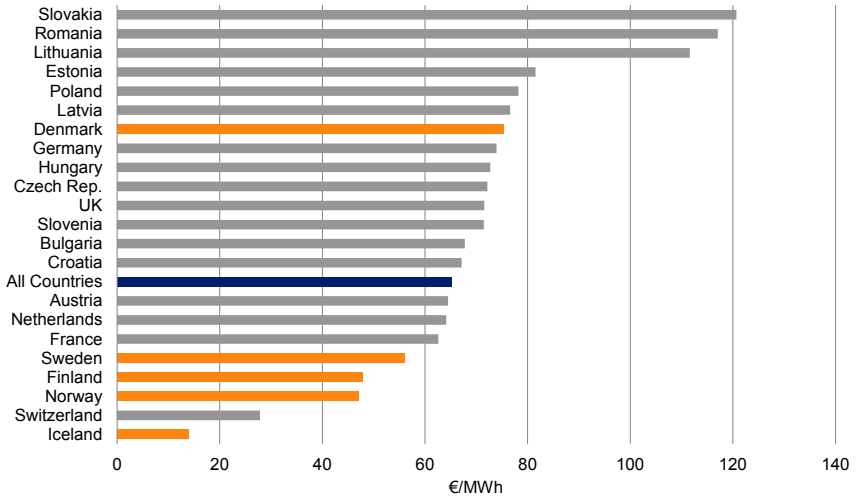


Source: Energitilsynet (2016b); Finnish Energy (2016), Swedish District Heating Association (2016b).

The figure above also shows that the variation in district heat prices is large especially in Denmark. Also in Finland and Sweden there is a lot of variation between the highest and lowest prices, mainly reflecting the cost of heat production and transmission costs. In densely populated city areas district heating can usually be organized efficiently and with low cost, but also the availability of affordable local fuels or waste heat is reflected in the prices.

When comparing the consumer price corrected district heat prices in the European countries, the Nordic countries (except Denmark) stand out with lower than average heat prices. Figure 36 present the consumer price corrected district heat prices in Europe based on publicly available information.

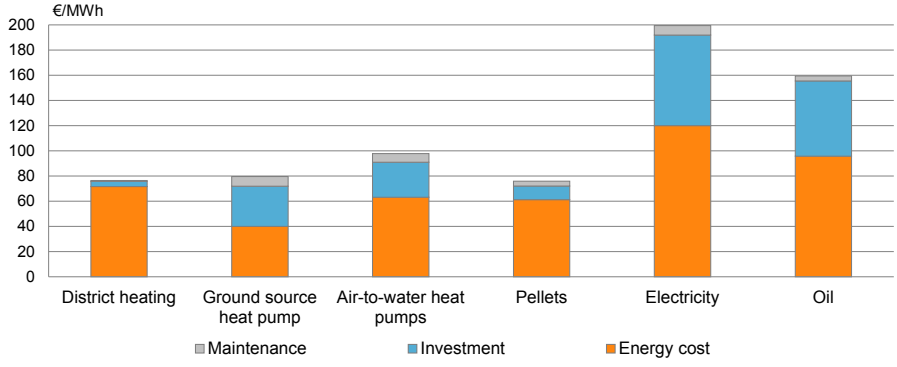
Figure 36: Consumer corrected district heat prices in the European countries in 2013 (excl. VAT)



Source: Energiforsk: 2016:316, corrected with Eurostat comparative price levels.

From the consumer point of view, the options for heating have varying cost structure, but in many cases there are several options for heating with total costs on same level. Figure 37 presents the total cost of different heating options for a new apartment house in Finland. Due to the building requirements, different heating technology choices result in different requirements for insulation of the buildings. The difference in insulation cost is taken into account in the investment costs, increasing the cost for direct electricity heating for example.

Figure 37: Competitiveness of different heating technologies for a new apartment house, example from Finland



Source: Pöyry analysis.

The figure shows that the cost of district heating for an apartment building is roughly on the same level as pellet heating, and very close to ground source heat pumps. There are several examples where also apartment building have chosen ground source heat pump system for the heating also when district heating is available.

9. Integration of electricity and heating sectors in the Nordics

Increasing share of intermittent renewable electricity generation, such as wind and solar power, increases the need for demand flexibility and storage of electricity. During windy periods, there is abundancy of electric power in the Nordics, and the electricity prices are very low or in some hours even negative. The subsidized investments into renewable electricity generation partly drive the electricity market prices down, and the profitability of condensing power generation has decreased, which has led to closing down of power plants. As a result, there is increasing need for energy storage, but also need to cut the peaks in power demand.

The large share of district heating and CHP generation especially in Finland, Sweden and Denmark already constitute an important source of peak-shaving and energy storage. Utilising district heating instead of electricity for heating (directly or in heat pumps) reduces the demand for electricity during peak times. In the Nordic countries, the demand peaks are very much concentrated on the cold winter days, when both household and industrial demand is at highest. The heat and electricity demand have a strong correlation. When district heat is produced with CHP plants, the electricity is produced in relation to heat demand, and therefore CHP production can provide electricity at the times of peak demand.

In the times of low electricity demand, and low electricity prices, many CHP plants can produce only heat by bypassing the turbine. As a result, the CHP plants have the potential to down-scale the electricity production. The district heating network can also store energy, as it is possible to load the network with heat in diurnal level. Many networks also have additional storage capacity (such as water tanks/caves) which increases their potential to adjust the CHP production.

In many cities in the Nordic countries, part of district heat is produced with heat pumps. This also provides the possibility to adjust the electricity need according to demand and prices. In the times of high electricity prices, the pumps can be turned off and instead heat produced with fuels in heat-only-boilers or CHP plants.

In the abundance of electricity, also district heat could be produced from electricity in electric boilers. There are some peak boilers in district heat networks or industry utilizing electricity, but they have not been widely used. Partly this is due to electricity taxation: the electricity used for the heat production in taxed quite heavily in the Nordic countries, which increases the cost of heat production.

Best practice:

Energy optimization company Leanheat is optimising the indoor conditions and energy use

Leanheat is a Finnish service developer and provider of analytics for energy optimization for multi-family houses and district heating systems. Leanheat offers building owners optimization tools that reduce the cost of heating and enable preventive maintenance of buildings. The services are based on installing sensors in each flat and controlling the conditions centrally. The energy use is optimised not only for the buildings requirements, but the company also collaborates with district heating companies and can offer load-shifting services that enable building owners to take advantage and improve energy saving with dynamic pricing of district energy.

Leanheat uses artificial intelligence to optimally control building HVAC systems. The company promises to improve living conditions, minimizes maintenance work and at the same time saves 10-20% in energy consumption within a short payback period. One of the services is demand response implementation for district heating and cooling users.

(Leanheat 2017).

10. Nordic views towards EU's heating and cooling policy

The heating and cooling sector in the Nordic countries shares some common approaches and fundamentals of the market, although there is also some variation from country to country. The common approaches towards the proposed regulation have been identified based on the interviews of regulatory bodies and market actors in different countries as well as the country specific market analysis. In many topics, there were somewhat differing views from country to country, and also within a country based on the interviewed persons and the organizations they present. This chapter describes the common and also differing views towards the selected topics. The persons interviewed during this study are presented appendix I. The interviews were carried out only for a selected group of people, and therefore the results are not comprehensive, but rather serve as a starting point for further discussions. Any opinions presented in this chapter are Pöyry's own interpretations and do not necessarily reflect the views of all Nordic countries and all parties.

10.1 Renewables-based, efficient and secure heating and cooling

10.1.1 EU Winter Package and Heating and Cooling Strategy background

There are several articles promoting the use of renewable energy in heating and cooling sector in the Winter Package directive proposals. According to the Renewable Energy Directive proposal, renewable energy supplied for heating and cooling should increase by at least 1 percentage point annually in national share of final energy consumption between 2021 and 2030 (RED proposal, Article 23). According to the RED proposal Article 24, producers of renewable heating and cooling, and waste heat from industry should have an open access right to local district heating and cooling systems and a possibility to deliver heating and cooling to end-customers. Customers of "non efficient district heating and cooling" systems should be allowed to disconnect from the system to produce renewable heating or cooling themselves, or to switch to third-party renewable or waste heat supplier (RED Proposal, Article 24).

Security of supply is one of the priorities in the Heating and Cooling Strategy: the energy imports and dependency should be reduced. This is especially important for the Member States that use gas for heating and rely on a single supplier.

10.1.2 *Nordic approaches*

Renewables share in heating and cooling

In the Nordic countries, the share of renewables in the heating and cooling is already quite high, varying from somewhat below 40% in Denmark to 80% in Iceland, and there are ambitious national targets for emission reductions and increasing the share of renewables in the energy mix. In the district heating sector, the district heating networks have a large variation, as there are many cities where the heat is even entirely based on renewables, and in other cities fossil fuels are still largely used. Fossil fuels are also still used in building specific boilers especially in Denmark and Finland. As reflected in the national policies and targets, all the Nordic countries are looking for solutions to replace fossil fuels with other energy sources, and the countries have identified that this target applies also to heat sector. Currently this target is promoted with high taxation of fossil fuels, support for renewables and emissions trading. Also, Norway is planning to ban use oil for heating, and Finland is banning coal use for energy production.

Based on the interviews carried out as part of this study, the target to increase the share of renewables in heating sector in Europe is considered important in the Nordic countries. However, the interviewees raised a concern that there should be enough flexibility in achieving the target on national level. When the share of renewables is already very high, further increases in renewables share could be costly. Several interviewees pointed out that the target for renewables share increase in heating should be a 10 year target for 2021–2030 (10% RES share increase in heating) instead of an annual target. In addition, it was brought out that countries and players that have already reached a very high renewables share (e.g. 80%) should not need to apply the proposed 1 pp/a target. Flexibility to decide on measures, e.g. fossil fuel taxation, should be kept to member states.

Many of the interviewees referred to EU's overlapping energy and climate targets and the need to ensure that the EU emissions trading system is not further undermined with e.g. extensive renewables support schemes in heating sector included in ETS. From their perspective, the main policy measures for increasing the share of renewables should be the emissions trading system, which covers to a large extent the district heating sector. With increasing CO_2 prices, biomass and other renewable energy sources become competitive and can replace most of the fossil fuels without any additional measures. However, due to the current low prices in EU ETS, the potential of ETS was also questioned by some respondents. Outside the ETS-sector, the choice of renewable sources is promoted mostly with taxation and in some cases investment support. The need to decrease the emissions in this sector follows from the EU national targets for the non-ETS sector. Based on interviews and country analysis, additional targets for renewables could be introduced to this sector, but the emission reduction targets should be the primary targets and measures can be set nationally.

Third-party access of renewable energy to heating and cooling network

Heating delivered by the district heating networks plays important role in all the Nordic countries except Norway, and even in Norway the district heating market has grown rapidly due to rather new waste to energy –plants. Therefore the proposed third-party access of renewable energy to heating and cooling networks is important from the Nordic perspective. Based on the current market structure and heat market legislation, it appears to be difficult to implement the access in the way it is proposed in the Renewable Energy Directive proposal. It would require significant changes to legislation and to the operating model of district heating currently. Also the advantages of this proposal appeared to be not clear from the Nordic perspective, because district heat production is already largely based on renewables, waste heat or waste incineration. Many respondents raised a concern that in these cases, a third party access might not increase the utilization of renewables. Also in the current DHC systems, the waste heat from industries and e.g. data centers is utilized in several locations especially in Sweden and Finland. In addition, there are new concepts developed to utilize also waste heat from buildings directly in district heating.

All of the interviewees saw that allowing a third party to sell directly to the end-customer would require major regulatory changes. Currently the district heating companies typically own (or rent) and operate the heat network, produce the heat (but can also buy heat from other producers), and sell heat to end-customers. Third party access would require a separate fee for heat transmission, and this could even lead to the need to unbundle production, sales and transmission. Compared to the electricity markets, district heating is very local and the networks are small and not connected. There are hundreds of small separate district heating networks, so compared to the electricity network for example, the situation is very different. The regulatory burden could increase the cost of district heat, which would have to be passed on to the heat users. This could decrease the competitiveness of district heating and result in switching to other heat technologies, such as heat pumps and ground heat.

The regulation varies slightly from country to country, but typically there are already possibilities for a third-party heat producer to negotiate about access to network. Waste heat is already utilized in a large number of heat networks. The heat is, however, typically sold to the district heating company, not directly to the heat users. As this kind of approach is already utilized, it would require significantly less regulatory changes: third-party access could be organized so that the renewable heat can be sold to the network, but not necessarily directly to end-customers. The competition in the heat market also guarantees that whenever there is renewable or waste heat available with competitive cost, there is incentive for the district heat company to utilize it to lower the cost of heat.

As a summary, based on interviews and market analysis, the current approaches in the Nordic countries already have resulted in the utilization of waste heat and renewable heat whenever commercially viable, but regulation allowing a third party to sell heat directly to end-customers could be difficult to implement. However, this topic would require a careful analysis and identification of new approaches to promote the utilization of all renewable and waste heat sources with a reasonable cost for consumers.

In the case of district cooling, it was pointed out that cooling is more business to business market, where consumer protection is not needed. Cooling is already produced largely from waste energy sources and renewables, or with efficient tri-generation.

Security of supply

As the share of fossil fuels has been decreasing significantly, and is still decreasing due to existing regulation and e.g. the renewal of emissions trading directive, the security of supply has been less discussed in the Nordic countries compared to many other European countries. Nordic countries use rather high level of domestic energy resources for the heating and cooling which comes mainly from using domestic renewable energy carriers such as biomass, geothermal energy, heat pumps and waste-to-energy (Norway also electricity based on hydropower and other non-fossil sources). In Iceland the space heating and cooling is already almost import independent as it is largely based on locally produced geothermal energy. However, those Nordic countries still using imported fossil fuels are considering new policy measures to replace fossils with renewable energy sources.

10.2 Integration of district heating and cooling into the electricity system

10.2.1 EU Winter Package & Heating and Cooling Strategy background

The Renewable energy directive proposes that electricity distribution system operators (DSOs) would be required to assess at least biannually, with district heating or cooling system operators, the potential of district heating or cooling systems to provide balancing and other system services (incl. demand response and storing of excess renewable electricity). (RED Proposal, Article 24).

The Heating and Cooling Strategy also lifts up the role of the heating and cooling sector in offering flexibility to the energy system by cheaply storing thermal energy. Also CHP production is seen an important measure to increase energy efficiency, produce electricity (often with renewable sources) based on demand, and offer stable and reliable source of both heat and electricity.

10.2.2 Nordic approaches

The heating market analysis and the interviews reveal that the Nordic countries have recognized the benefits and the potential of DHC systems to provide balancing power and other system services. Although the Nordic countries have large hydro power capacity to balance the electricity demand and supply, also in the Nordic area the integration of intermittent renewable electricity generation, especially wind, to the electricity system increases the need for demand flexibility and other means to balance

the demand and supply of electricity. Heating and cooling sector is considered to offer means for energy storage with low cost.

Due to current high share of district heating, especially the role of district heating system in contributing to the electricity system balancing was highlighted in the interviews. The demand for electricity in the Nordic area is peaking during the coldest winter days. During those times, also the district heating demand is highest, and the CHP capacity is utilized with maximum capacity. When the demand for electricity is low, the electricity production can be bypassed or heat can be produced with heat-only boilers or heat pumps in the system. District heating systems also allow the heat to be stored in the district heating networks and separate heat storages, which is not possible with electricity.

On the other hand, the Nordic countries are facing challenges with CHP production due to low electricity prices, which has made even CHP production uneconomic. With the high share of intermittent renewable, especially wind production, there is less room for CHP in the market. From the electricity system point of view, it would be important to maintain the CHP production in the system. A well-functioning emissions trading system instead of renewable electricity support can be one option to improve the position of CHP in electricity system.

In addition to CHP, district heating is also produced with large-scale heat pumps in the Nordic countries. The use of heat pumps is optimized based on electricity prices, and typically heat is produced with heat pumps when the electricity prices are low. During electricity peak demand times, heat pumps can be switched off and heat can be produced with CHP plants and heat-only boilers. In addition, district heat can be produced with electricity boilers directly to utilise excess electricity production e.g. on windy days. The use of electricity for district heat production can be promoted with lower taxation of electricity in heat production, as some of the Nordic countries do.

The premises for the wide utilization of district heating in the Nordic countries are partly improved with efficient town planning, where the energy solutions are taken into account in an early stage. Co-operation of energy companies and town planning make it possible to plan areas suitable for district heating, and e.g. waste heat can be utilized better when large heat consumers are located close to waste heat sources. Also decentral heat production can be efficiently utilized when taken into account in town planning.

10.3 Consumer protection and role

10.3.1 EU Clean Energy Package & Heating and Cooling Strategy background

The EU Heating and Cooling strategy lifted up the need to emphasize the role and rights of the consumer in the heating market context (COM (2016) 51 final). Also, the Energy Efficiency Directive Proposal (COM (2016) 761 final) on heat metering and billing, as well as the district heating specific Article in Renewable Energy Directive proposal (COM (2016) 767 final) emphasize the customer role and rights.

According to the Energy Efficiency Directive proposal, multi-apartment and multi-purpose buildings with district heating and cooling should install individual meters for each building unit if considered cost effective. In new buildings of or when a building undergoes major renovation, individual meters shall always be provided – no clear cost-effectiveness criteria. New meters should be remotely readable by 2020. Existing meters and cost allocators should be adapted to be remotely readable by 2027.

The Renewable Energy Directive proposal states that district heating and cooling suppliers should provide information to end-consumers on their energy performance and the share of renewable energy in their systems, and customers of "non-efficient district heating and cooling" systems should be allowed to disconnect from the system to produce RES heating or cooling themselves, or to switch to third party RES/waste heat supplier (RED Proposal, Article 24).

10.3.2 Nordic approaches

Disconnection from district heating, heat price and other consumer protection measures

The Nordic countries mostly have a market based approach for heating and cooling sectors, and district heating. In general, there has not been a need to mix social policy and energy policy, and also the taxation levels for fossil fuels are high compared to most other European countries. As the concept of "energy-poverty" is not really relevant in the Nordic countries, the energy cost is not compensated for households, but instead social system supports if needed. Therefore, high taxation of fossil fuels and electricity has been accepted.

District heating and cooling pricing is based on costs of heat production and transmission and includes high taxes for fossil energy. In Denmark there is price regulation, and also to some extent in Norway, but the prices reflect the cost in all countries. The district heating companies need to provide openly information on their operations to the customers, and there are generally strong rights for the consumers to complain if they find pricing unfair.

In the Nordic countries, there is quite strong position of the consumer in choosing the heating and cooling methods. Denmark is to some extent exception, but if there is a connection obligation, the prices are regulated for consumer protection. In Finland and Sweden, there are no obligations to connect to the district heating, and building owners can freely choose their heating source. Disconnection is allowed also in Norway, where there is in some cases obligation to connect to the network. Price regulation in Norway, is based on the cost of competing heating source, but applied only with obligation to connect.

Due to the differing approaches in the Nordic countries, the views towards the disconnection right and other consumer protection measures vary from country to country. Interviewees especially in Finland and Sweden, with the most liberal markets, find the consumers' freedom of choice an important aspect which should be further promoted in Europe. On the other hand, it was observed that the long term investment

perspective for district heating should be kept in mind to be able to transform the district heating systems to low-carbon systems where fossil fuels are still used.

Metering of district heating

In the Nordic countries, a lot of effort has been put lately for the measuring of heat use. New meters are all remotely readable and there is even hourly level consumption information available without any significant delays. Based on these experiences, the interviewees considered it useful to introduce remotely readable meters, and the proposed schedule was generally not considered too tight for replacing the existing meters. However, this view applies only for the building level measuring. On building-unit (flat) level, the views in the Nordic countries mostly contradict with the Energy Efficiency Directive proposal.

Concerning the building-unit level measuring, it is not a common practice to measure heat use on flat level in Nordic countries. Only in Denmark there is flat-level metering, and also then it is not the district heating company measuring heat use. Recent investigations in Sweden (e.g. Boverket 2015b) show that individual metering and billing would not be cost-effective and could in many cases even in increase energy use.

Especially in Finland and Sweden the view was that the energy efficiency in the buildings can be best promoted with building level investments (e.g. insulation improvements, new windows) and there is also potential for smart, whole building level services to optimize the indoor conditions of the buildings instead of controlling the unit level energy use. The inhabitants can mainly save in the hot water use, but adjusting too much the temperatures at individual flat level can have even adverse impacts on energy efficiency. Either separate service companies or the district heating companies can optimize the indoor conditions for the whole building and even take into account the whole energy system view. The inhabitants could even pay a fixed fee for the energy provider, which would then have the incentive to invest in energy efficiency of the building as the income is fixed and not dependent on the amount of heat sold. Similarly, when the heat cost is billed as part of the flat rent, the land-lord of the building would have the incentive to invest in energy efficiency. Some respondents also pointed out that in old buildings heat piping is built in a way that it would be difficult to install metering in individual flats. Thus the possible energy efficiency gains may become costly due to high installation costs, and the savings in energy bill would not cover the costs.

In summary, all of the interviewees expressed their concerns that measuring heat use on flat level might not be efficient and necessarily bring the benefits in energy efficiency. However, this does not apply to hot water use, the consumption of which the consumers can impact themselves largely. There are technical solutions to measure the flat level water use, and the measuring could be taken into wider use to reduce the hot water use.

Sources

BBR, 2015. Boverkets föreskrifter om ändring i verkets byggregler (2011:6) – föreskrifter och allmänna råd. Available at: https://rinfo.boverket.se/BBR/PDF/BFS2015-3-BBR-22.pdf

Boverket & Energimyndigheten, 2016. Underlag till den andra nationella strategin för energieffektiviserande renovering. Ett samarbete mellan Boverket och Energimyndigheten. ET 2016:15. Available at; http://www.energimyndigheten.se/globalassets/energieffektivisering/program-och-uppdrag/forslag-pa-uppdaterad-strategi-for-energieffektiv-renovering.pdf

Boverket, 2015a. Förslag till svensk tillämpning av nära-nollenergibyggnader. Definition av energiprestanda och kvantitativ riktlinje. Rapport 2015:26. Available at: http://www.boverket.se/globalassets/publikationer/dokument/2015/forslag-till-svensk-tillampning-av-nara-nollenergibyggnader-2.pdf

Boverket, 2015b. Individuell mätning och debitering i befintlig bebyggelse. Rapport 2015:34 Regeringsuppdrag. Available at: http://www.boverket.se/globalassets/publikationer/dokument/2015/individuell-matning-och-debitering-i-befintlig-bebyggelse.pdf

Bundgaard, Dyhr-Mikkelsen, Larsen, Togeby 2013. Energy Efficiency Obligation Schemes in the EU – Lessons Learned from Denmark International Association for Energy Economics.

COM (2016) 51 final. Communication from the Commission to the European Parliament, the Council, the European economic and social committee and the committee of the regions. An EU Strategy on Heating and Cooling {SWD(2016) 24 final}. Available at: https://ec.europa.eu/energy/sites/ener/files/documents/1_EN_ACT_part1_v14.pdf

COM (2016) 767 final. Directive of the European Parliament and of the Council on the promotion of the use of energy from renewable sources (recast).

COM (2016) 761 final. Proposal for a Directive of the european parliament and of the council amending Directive 2012/27/EU on energy efficiency. Available at: http://ec.europa.eu/energy/sites/ener/files/documents/1_en_act_part1_v16.pdf

COM (2016) 765 final. Proposal for a Directive of the european parliament and of the council amending Directive 2010/31/EU on the energy performance of buildings. Available at: http://ec.europa.eu/energy/sites/ener/files/documents/1_en_act_part1_v10.pdf

COM (2016) 773 final. Communication from the commission. Ecodesign Working Plan 2016-2019. Available at: http://ec.europa.eu/energy/sites/ener/files/documents/com_2016_773.en_.pdf

Council Directive 2003/96/EC of 27 October 2003 restructuring the Community framework for the taxation of energy products and electricity (Text with EEA relevance) Available at: http://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32003L0096&from=en

DBdistrict heating (2016). Information on the role of the organization. Available at: http://dbdh.dk/about-dbdh/

Danish Energy Agency (2016). Årlig energistatistik 2015. Available at: https://ens.dk/service/statistik-data-noegletal-og-kort/maanedlig-og-aarlig-energistatistik

Danish Energy Agency (2015). Regulation and planning of district heating in Denmark. Available at: https://stateofgreen.com/files/download/1973

Danish Energy Agency & State of Green & DBdistrict heating (2015). District Heating – Danish experiences. Available at: https://stateofgreen.com/files/download/1674

Dansk Fjernvarme (2016a). Nøgletal Benchmarking 2015. Available at: http://www.danskfjernvarme.dk/viden-om/aarsstatistik/benchmarking-statistik-2014-2015

Dansk Fjernvarme (2016b). Information on the role of the organization. Available at: http://www.danskfjernvarme.dk/sitetools/english

Dir. 2015:25.Kommittédirektiv. Översyn av energipolitiken. Available at: http://www.energikommissionen.se/app/uploads/2015/06/Dir.-2015.25-Översyn-av-Energipolitiken.pdf

Danish NEEAP, 2014. The 3rd Danish National Energy Efficiency Action Plan Under the Energy Efficiency Directive. Available at: https://ec.europa.eu/energy/sites/ener/files/documents/2014_neeap_en_denmark.pdf

Danish NEEAP, 2016. Denmark's annual reporting under Article 24(1) of the Energy Efficiency Directive. Available at: https://ec.europa.eu/energy/sites/ener/files/documents/DK%202016%20Energy%20Efficiency%20Annual%20Report_en.pdf

Danish Energy Agency, 2016. Denmark's annual reporting under Article 24(1) of the Energy Efficiency Directive. Available at: https://ec.europa.eu/energy/sites/ener/files/documents/DK%202016%20Energy%20Efficiency%20Annual%20Report_en.pdf

Danish NREAP, 2015. Danish report under Directive 2009/28/EC concerning progress in the use and promotion of energy from renewable sources. Available at: https://ec.europa.eu/energy/en/topics/renewable-energy/progress-reports

Danish Energy Association. Why obligations schmes are the solution for european member states during the financial crisis. Available at: www.danskenergi.dk/~/media/EU/Why_obligations_schems.ashx

Ea Energianalyse (2015). Energiafgifter og –tilskud. Overblik og analyse. Available at:

http://energiplanfyn.fmk.dk/fileadmin/user_upload/Subsites/Energiplan_Fyn/Afgifter_-_overblik_og_analyse.pdf

EFKM, 2012. Aftale mellem regeringen (Socialdemokraterne, Det Radikale Venstre, Socialistisk Folkeparti) og Venstre, Dansk Folkeparti, Enhedslisten og Det Konservative Folkeparti om den danske energipolitik 2012-2020. Available at: http://old.efkm.dk/sites/kebmin.dk/files/klima-energi-bygningspolitik/dansk-klima-energi-bygningspolitik/energiaftale/Aftale%2022-03-2012%20FINAL.doc.pdf

Energiankenævnet (2016). Information on the role of the organization. Available at: http://www.energianke.dk/Menu/Om-ankenaevnet

Energy efficiency agreements web-page, 2017, Available at: http://www.energiatehokkuussopimukset2017-2025.fi/en

Energiföretagen Sverige (2016). Information on the role of the organization. Available at: http://www.energiforetagen.se/om-oss/

Energiklagenævnet (2016). Information on the role of the organization. Available at: http://www.ekn.dk/

Energimarknadsinspektionen (2016b). Utvärdering av branschinitiativet Prisdialogen Ei R2016:05. Available at: http://ei.se/Documents/Publikationer/rapporter_och_pm/Rapporter%202016/Ei_R2016_05.pdf

Energimarknadsinspektionen (2016a). Information on the role of the organization. Available at: http://ei.se/sv/ei-s-verksamhet/Eis-uppdrag-och-styrning/

Energimarknadsinspektionen (2016c). Särskilda rapporter. Available at: http://www.energimarknadsinspektionen.se/sv/Publikationer/Arsrapporter/

Energimyndigheten & Tillväxtverket (2016). Nationella regionalfonds- programmet. Available at: http://www.energimyndigheten.se/energieffektivisering/program-och-uppdrag/nationella-regionalfondprogrammet/,https://eu.tillvaxtverket.se/download/18.66174814155169 2c5bea8b13/1468399512906/OP+Nationella+programmet+EN+version.pdf

Energimyndigheten (2016a). Energistatistik för småhus, flerbostadshus och lokaler 2015. Available at: http://www.energimyndigheten.se/statistik/den-officiella-statistiken/alla-statistikprodukter/

Energimyndigheten (2016b). Information on the role of the organization. Available at: http://www.energimyndigheten.se/om-oss/

Energimyndigheten (2016c). Energiläget I siffror 2016. Available at: http://www.energimyndigheten.se/nyhetsarkiv/2016/nu-finns-energilaget-i-siffror-2016/

Energimyndigheten (2015a). Energistatistik för småhus 2014. Available at: http://www.energimyndigheten.se/statistik/den-officiella-statistiken/alla-statistikprodukter/

Energimyndigheten (2015b). Energistatistik för flerbostadshushus 2014. Available at: http://www.energimyndigheten.se/statistik/den-officiella-statistiken/alla-statistikprodukter/

Energimyndigheten (2015c). Energistatistik för lokaler 2014. Available at: http://www.energimyndigheten.se/statistik/den-officiella-statistiken/alla-statistikprodukter/

Energistyrelse, 2016, Store varmepumper i fjernvarmeforsyningen, Available at: https://ens.dk/sites/ens.dk/files/Varme/store_varmepumper_i_fjernvarmeforsyningen_final.pdf

Energitilsynet (2016a). Information on the role of the organization. Available at: http://energitilsynet.dk/tool-menu/english/tasks-in-brief/

Energitilsynet (2016b). Energitilsynets prisstatistik for fjernvarmeområdet. August 2016. Available at: http://energitilsynet.dk/fileadmin/Filer/0_-_Nyt_site/VARME/Prisstatistik/2016/Xprisstatistik_til_udgivelse.pdf

Energy Analyses (2015): The Danish Experience with Integrating Variable Renewable Energy. Study on behalf of Agora Energiewende. Availabe at: https://www.agora-energiewende.de/fileadmin/Projekte/2015/integration-variabler-erneuerbarer-energien-daenemark/Agora_082_Deutsch-Daen_Dialog_final_WEB.pdf

Finnish competition and Consumer Authority, 2017, Competition control and advocacy, Available at: http://www.kkv.fi/en/facts-and-advice/competition-affairs/

Finnish Energy. 2015a, Kaukolämmön tuotanto ja polttoaineet, Available at: http://188.117.57.25/energia-ja-ymparisto/kaukolampo-ja-kaukojaahdytys/tuotanto-ja-polttoaineet

Finnish Energy, 2015b, Rakennusten jäähdytysmarkkinat, Available at: http://energia.fi/files/399/Rakennusten_jaahdytysmarkkinat_18-12-2015.pdf

Finnish Energy, 2016a, Kaukolämpötilasto, taulukot (XLS). Available at: http://energia.fi/ajankohtaista_ja_materiaalipankki/materiaalipankki/kaukolampotilasto.html

Finnish Energy, 2016b, Kaukojäähdytystilasto, statistics on district cooling capacity, Available at: http://energia.fi/ajankohtaista_ja_materiaalipankki/materiaalipankki/kaukojaahdytystilasto.html#material-vie

Finnish Energy. 2017, Finnish Energy as an organisation, Available at: http://energia.fi/en/finnish_energy_as_an_organisation

Finnish NEEAP, 2014, The 3rd Finnish National Energy Efficiency Action Plan Under the Energy Efficiecny Directive. Available at: https://ec.europa.eu/energy/sites/ener/files/documents/2014_neeap_en_finland.pdf

Finlex, 1996, Laki sähkön ja eräiden polttoaineiden valmisteverosta 30.12.1996/1260, Available at: http://www.finlex.fi/fi/laki/ajantasa/1996/19961260

Finlex, 2010, Laki uusiutuvilla energialähteillä tuotetun sähkön tuotantotuesta 30.12.2010/1396, Available at: http://www.finlex.fi/fi/laki/ajantasa/2010/20101396

Finlex, 2013, Laki Energiavirastosta 13.12.2013/870, Available at: http://www.finlex.fi/fi/laki/ajantasa/2013/20130870

Fjärrvärmenämnden (2016). Information on the role of the organization. Available at: http://www.energimyndigheten.se/om-oss/organisation/fjarrvarmenamnden/

Foreningen Danske Kraftvarmeværker (2016). Information on the role of the organization. Available at: http://www.fdkv.dk/

Fortum, 2017. Open District Heating. Available at: https://www.opendistrictheating.com/

Göteborg Energi, 2016. Fjärrvärme. Available at: http://www.goteborgenergi.se/Privat/Produkter_och_priser/Fjarrvarme/Miljo

Helen. 2013, Helsingin Energialle kansainvälinen ympäristöpalkinto, Available at: https://www.helen.fi/uutiset/2013/helsingin-energialle-kansainvalinen-ymparistopalkinto/

Helen, 2016, Helen rakentaa Helsinkiin uuden, suuren lämpöpumppulaitoksen, Available at: https://www.helen.fi/uutiset/2016/lampopumppulaitos/

Helen, 2017a, Katri Valan lämpöpumppulaitos, Available at: https://www.helen.fi/helen-oy/tietoa-yrityksesta/energiantuotanto/voimalaitokset/katri-vala/

Helen, 2017b, Uutta voimaa – Kohti hiilineutraalia tulevaisuutta, Available at: http://blogi.helen.fi/helenin-lampopumppulaitos-on-valmiudessa-kysyntajoustoon-huippukulutustilanteissa/

Icelandic Ministry of Industry and Commerce (2016). Presentation: Iceland – A leader in the use of Renewable Resources. Held by Ragnheiður Elín Árnadóttir. Minister of Industry and Commerce. Presentation received from Ministry of Industries and Innovation on 30 November 2016.

LBK nr 1288 af 27/10/2016. Bekendtgørelse af lov om fremme af vedvarende energi. Available at: https://www.retsinformation.dk/pdfPrint.aspx?id=184376

Linklaters, 2016. European Commission presents Energy Winter.

Package 2016. Available at: http://www.linklaters.com/pdfs/mkt/brussels/161202_Newsletter_Energy.pdf

Konkurrensverket (2016). Information on the role of the organization. Available at: http://www.konkurrensverket.se/konkurrens/vara-uppgifter/

Leanheat (2017) Company web-pages: www.leanheat.com

Ministry of Economic Affairs and Employment, 2016, Government report on the National Energy and Climate Strategy for 2030, Available at: http://urn.fi/URN:ISBN:978-952-327-199-9

Ministry of Economic Affairs and Employment, 2017, Energy, Available at: http://tem.fi/en/energy

Ministry of Environment, 2017, Rakennusten energiatehokkuutta koskeva lainsäädäntö, Available at: http://www.ym.fi/fi-fi/maankaytto_ja_rakentaminen/lainsaadanto_ja_ohjeet/Rakennuksen_energiatehokkuutta_koskeva_lainsaadanto

Naturvårdsverket (2012). Delrapport: Underlag till en svensk färdplan för ett Sverige utan klimatutsläpp 2050. Rapport 6487. Available at: http://www.naturvardsverket.se/Documents/publikationer6400/978-91-620-6487-7.pdf?pid=3795

Orkustofnun (2015a). Legal Framework and National Policy for Geothermal Development in Iceland.

Orkustofnun (2015b). Iceland. A Leader in the use of Renewable Resources. Available at: https://www.norden.org/en/theme/new-nordic-climate-solutions/cop21/events-1/geothermal-direct-use/flyer-iceland-a-leader-in-renewable-resources

Orkustofnun (2016a). Final Heat Use in Iceland 2015 by District Heating Area. OS-2016-T004-01. Available at: http://www.os.is/gogn/Talnaefni/OS-2016-T004-01.pdf

Orkustofnun (2016b). Statistics received by Pöyry from OS directly.

Orkustofnun (2017b). Heat Pumps. Available at: http://www.nea.is/geothermal/direct-utilization/heat-pumps/

Orkustofnun (2017a). Space Heating. Available at: http://www.nea.is/geothermal/direct-utilization/space-heating/

Prime ministers office, Finland (2015) Programme of Prime Minister Sipilä's Government. Government publications 12/2015. Available at: http://valtioneuvosto.fi/en/sipila/government-programme

Regeringskansliet (2016a). Överenskommelse om den svenska energipolitiken. Ramöverenskommelse mellan Socialdemokraterna, Moderaterna, Miljöpartiet de gröna, Centerpartiet och Kristdemokraterna. Available at:

http://www.regeringen.se/49cc5b/contentassets/b88fod28eboe48e39eb4411de2aabe76/energioverenskommelse-20160610.pdf

Regerignskansliet (2016b). Överenskommelse om Sveriges mål för energieffektivisering. Available at: http://www.regeringen.se/pressmeddelanden/2016/11/overenskommelse-om-sveriges-mal-for-energieffektivisering/

Regeringssammanträde (2014). Sveriges tredje nationella handlingsplan för

energieffektivisering. Available at: https://ec.europa.eu/energy/sites/ener/files/documents/Sweden_NEEAP_2014_SE%202-84.pdf

Regerignskansliet (2016). Sweden's annual report for 2016 under Article 24(1) of Directive 2012/27/EU of the European Parliament and of the Council on energy efficiency. Available at: https://ec.europa.eu/energy/sites/ener/files/documents/SE%202016%20Energy%20Efficiency%20Annual%20Report_en.pdf

SFS 2015:517. Förordning (2015:517) om stöd till lokala klimatinvesteringar. Available at: http://www.riksdagen.se/sv/dokument-lagar/dokument/svensk-forfattningssamling/forordning-2015517-om-stod-till-lokala_sfs-2015-517

SFS 2008:263. Fjärrvärmelag (2008:263). Available at: http://www.riksdagen.se/sv/dokument-lagar/dokument/svensk-forfattningssamling/fjarrvarmelag-2008263_sfs-2008-263

SFS 2014:266. Lag (2014:266) om energikartläggning i stora företag.

Svensk författningssamling 2014:266. Available at: http://www.riksdagen.se/sv/dokument-lagar/dokument/svensk-forfattningssamling/lag-2014266-om-energikartlaggning-i-stora_sfs-2014-266

SFS 1977:439. Lag (1977:439) om kommunal energiplanering. Available at: http://www.riksdagen.se/sv/dokument-lagar/dokument/svensk-forfattningssamling/lag-1977439-om-kommunal-energiplanering_sfs-1977-439

SFS 2009:1577. Förordning (2009:1577) om statligt stöd till energikartläggning. Available at: http://www.riksdagen.se/sv/dokument-lagar/dokument/svensk-forfattningssamling/forordning-20091577-om-statligt-stod-till_sfs-2009-1577

SFS 2016:385. Förordning (2016:385) om bidrag till kommunal energi- och klimatrådgivning. Available at: https://www.riksdagen.se/sv/dokument-lagar/dokument/svensk-forfattningssamling/forordning-2016385-om-bidrag-till-kommunal_sfs-2016-385

Skat, 2017, E.A.4.3.9.1 Betingelser for og omfang af afgiftslempelse, Available at: http://www.skat.dk/SKAT.aspx?oID=2061612&chk=214126

Skatteministeriet (2016). Indeksering af energiafgifter. Available at: http://www.skm.dk/skattetal/beregning/afgiftsberegning/indeksering-af-energiafgifter

Skatteverket (2016). Rot- och rutarbete website. Available at: https://www.skatteverket.se/foretagochorganisationer/skatter/rotochrutarbete.4.2ef18e6a12566odb8b080002674.html

Skatteverket, 2017, Lägre skatt för industriell verksamhet, Available at: https://www.skatteverket.se/foretagochorganisationer/skatter/punktskatter/energiskatter/verksamhetermedlagreskatt/industriellverksamhet.4.18e1b10334ebe8bc80002009.html

State of Green, 2015. From sustainable biomass to competitive bioenergy. Available at: https://stateofgreen.com/files/download/8535

State of Green, 2016. District Energy. Available at: https://stateofgreen.com/files/download/9499

Statistics Finland (2016). Statistics Finland /Calculation model for space heating and sources from table 8.1.

Statistics Finland & Finnish Energy Industries (2016). Production of electricity and heat. District heat production, GWh by Year, Data and Fuel.

Statistics Finland & Finnish Energy Industries & Association of Finnish Local and Regional Authorities (2016). Kaukolämmön tuotanto ja kulutus muuttujina Vuosi, Tiedot ja Kaukolämpö.

STM, 2016. Regeringsgrundlag, Marienborgaftalet 2016. For et friere, rigere og mere trug Danmark. 2016/18:5. Available at: http://stm.dk/multimedia/Regeringsgrundlag2016.pdf

SWD(2016) 24 final (2016). Commission staff working document. Review of available information . Accompanying the document : Communication from the Commission to the European Parliament, Economic and Social Committee and the Committee of EU Strategy for Heating and Cooling . Available at: https://ec.europa.eu/energy/sites/ener/files/documents/1_EN_autre_document_travail_service_part1_v6_0.pdf

Swedish Government Bill 2008/2009:162. En sammanhållen klimat- och energipolitik – Klimat. 2008/09:162. Available at: http://www.regeringen.se/49bb9e/contentassets/cf41d449d2a047049d7a34f0e23539ee/en-sammanhallen-klimat--och-energipolitik---klimat-prop.-200809162

Swedish Government Bill 1994:1776. Lag (1994:1776) om skatt på energi. Available at: http://www.riksdagen.se/sv/dokument-lagar/dokument/svensk-forfattningssamling/lag-19941776-om-skatt-pa-energi_sfs-1994-1776

Swedish District Heating Association, 2004. Spillvärme från industri till fjärrvärmenät. Available at: http://www.svenskfjarrvarme.se/Global/Rapporter%20och%20dokument%20INTE%20Fj%C3%A4rrsyn/Ovriga_rapporter/Energitillforsel_och_Produktion/Spillvarme-fran_industrin_till_fjarrvarme_2004_5.pdf

Swedish District Heating Association (2016a). Tillförd energi för produktion av fjärrvärme 1980 – 2015 (xlsx). Available at: http://www.svenskfjarrvarme.se/Statistik--Pris/Fjarrvarme/Energitillforsel/Tillford-energi-utveckling-1980-2012/

Swedish District Heating Association (2017). Fjärrkyleleveranser 1996-2014.xlsx. Available at: http://www.svenskfjarrvarme.se/Statistik--Pris/Fjarrkyla/

Swedish District Heating Association (2016b). Fjärrvärmepriser större flerfamiljshus , kr/MkWh inkl. moms, 2015-2016. Available at: https://www.energiforetagen.se/statistik/fjarrvarmestatistik/fjarrvarmepriser/

Svensk Fjärrvärme (2013). Svensk fjärrvärmes system för kvalitetsmärkning av fjärrvärmeleverantörer- REKO fjärrvärme. Available at: http://www.svenskfjarrvarme.se/Global/Marknad/Reko/Reglerna%20i%20Reko%20fj%C3%A4rrv%C3%A4rme.pdf

Swedish NEEAP, 2014. The 3rd Swedish National Energy Efficiency Action Plan Under the Energy Efficiency Directive. Available at: https://ec.europa.eu/energy/sites/ener/files/documents/2014_neeap_en_sweden.pdf

Swedish NREAP, 2015. Sweden's third progress report on the development of renewable energy pursuant to Article 22 of Directive 2009/28/EC. Available at: https://ec.europa.eu/energy/en/topics/renewable-energy/progress-reports

Thema, 2014, Input to strategy on demand flexibility in the Nordic countries, Available at: https://tem.fi/documents/1410877/2717655/THEMA_Final_report_2014-24_Input_to_strategy_on_demand_flexibility_in_the_Nordic_countries.pdf/0a4c2945-e18e-4f0d-a718-762db76cb2dd

Vero, 2017, Sähkön ja eräiden polttoaineiden vero, Available at: https://www.vero.fi/fi-FI/Yritys_ja_yhteisoasiakkaat/Valmisteverotus/Valmisteverolajit/Sahko_ja_eraat_polttoaineet

VTT, 2014, Low Carbon Finland 2050 –platform, Available at: http://www.vtt.fi/inf/pdf/technology/2014/T165.pdf

Sammenfatning

Inledning

Uppvärmning och kylning av byggnader och inom industrin står för hälften av EU:s energiförbruk. 75 % av värmen och kylan i EU genereras fortfarande med fossila bränslen medan endast 16 % genereras med förnybar energi. Enligt EU-kommissionen ska uppvärmnings- och kylningssektorn kraftigt minska sin energiförbrukning och användningen av fossila bränslen för att uppfylla EU:s klimat- och energimål. (COM (2016) 51 final)

EU:s värme- och kylstrategi (COM (2016) 51 final) publicerades i februari 2016. Senare, den 30 november 2016, publicerade EU-kommissionen sitt Vinterpaket som innehåller flera direktivförslag. Flera av dessa förslag har inverkan på värme- och kylsektorerna.

I de nordiska länderna spelar värmen en viktig roll på energimarknaderna på grund av det kalla klimatet. En hel del har redan gjorts för att energieffektivisera värmeproduktionen och -konsumtionen samt för att minska utsläppen. För att sprida dessa erfarenheter och god praxis i Europa samt för att identifiera ytterligare behov av samarbete inom Norden valde Nordiska ministerrådet Pöyry Management Consulting för att identifiera eventuella gemensamma synpunkter i de nordiska länderna på EU:s värme- och kylstrategi samt Vinterpaketets förslag. Denna rapport innehåller resultatet från Pöyrys analys av den nuvarande uppvärmnings- och kylningsmetoderna samt regleringen i de nordiska länderna och beskriver resultat av intervjuer som Pöyry har genomfört med nordiska lagstiftare och representanter för energiindustrin. Rapporten fokuserar särskilt på uppvärmningsmarknaden i Norden och fjärrvärme på grund av dess centrala position i Norden. Uppfattningar som presenteras i denna rapport baseras på Pöyrys tolkningar och återspeglar inte nödvändigtvis Nordiska ministerrådets åsikter, politik eller rekommendationer.

EU:s värme- och kylpolitik

EU har förbundit sig till ett hållbart, konkurrenskraftigt, säkert och koldioxidfritt energisystem. Energiunionen samt den klimat- och energipolitiska ramen för perioden 2020–2030 innehåller ambitiösa mål för att minska utsläppen av växthusgaser (med minst 40 % till 2030 jämfört med 1990), att öka andelen förnybar energi (med åtminstone 27 %) och att företa energibesparingar på 30 % till 2030. För att ta itu med de särskilda behoven för att minska utsläppen inom uppvärmnings- och kylningssektorn föreslog kommissionen en värme- och kylstrategi (COM (2016) 51 final)

som ett första steg i att utforska utmaningarna inom sektorn och lösa dem med EU:s energipolitik.

Den 30 november 2016 publicerade Europeiska kommissionen flera direktivförslag i Vinterpaketet. Huvudförordningen för uppvärmnings- och kylningssektorerna finns i direktivet för förnybar energi och energieffektivisering. Särskilt viktiga förslag ur värmesektorns synvinkel i förslaget till direktiv för förnybar energi är

- förslaget om att sträva efter att öka andelen förnybar energi inom värme- och kylsektorn med 1 procentenhet per år
- förslaget om tillgång av spillvärme och förnybar värme till fjärrvärme- och fjärrkylsystem
- förslaget om att förstärka avstängningsrättigheterna för och informationsspridningen till fjärrvärme- och fjärrkylkunder
- förslaget att eldistributionsoperatörer samt fjärrvärme- och fjärrkylsystemoperatörer tillsammans vartannat år bör bedöma potentialen inom fjärrvärme- och fjärrkylsystemen för att erbjuda elbalansering och andra systemtjänster.

Förslaget till energieffektiviseringsdirektiv som kräver mätning av värmeanvändningen för värme eller hett vatten på enhetsnivå i byggnader med en central källa är särskilt viktigt för fjärrvärmesektorn.

Värmemarknaderna i Norden

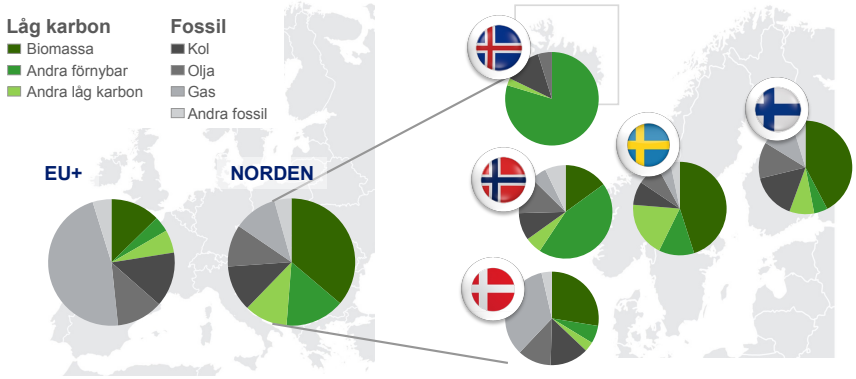
Alla de nordiska länderna har utvecklat sina egna värme- och kylsystem baserade på lokala behov och resurser. Till exempel Norge använder, med sina stora vattenkraftresurser en stor andel el i uppvärmningen medan Island baserar uppvärmningen på geotermisk energi. Finland och Sverige använder biomassa från skogen. Danmark använder också gas. Trots skillnader i resurser har de nordiska ländernas uppvärmnings- och kylningsmarknader flera gemensamma faktorer, såsom:

- En stor andel förnybar energi i uppvärmning och kylning.
- En ganska stor andel av inhemska energiresurser används för uppvärmning och kylning, såsom biomassa, geotermisk energi, värmepumpar och avfallsförbränning (i Norge även el baserad på förnybar vattenkraft).
- En ganska stark position för konsumenterna att välja uppvärmnings- och kylningssystem samt lösningar – ganska liberala och öppna marknader.
- Fjärrvärme spelar en viktig roll i alla nordiska länder utom i Norge. Även i Norge har fjärrvärmemarknaden vuxit snabbt på grund av nya avfallsförbränningsanläggningar.

- Ambitiösa nationella framtidsmål för utsläppsminskningar och för att öka andelen förnybar energi i energimixen.
- Hög beskattning av fossila bränslen som används i uppvärmning – en befintlig huvudsaklig åtgärd för att minska utsläppen inom uppvärmningssektorn.

Andelen bränslen som används för uppvärmnings- och kylningssektorn i de nordiska länderna jämfört med EU:s genomsnittliga bränsleförbrukningsnivå presenteras i figur 1. Figuren innefattar bostads- och tjänstesektorn samt industriell uppvärmning och kylning. Den stora andelen förnybara bränslen och bränslen med låga koldioxidutsläpp är märkbar i alla nordiska länder jämfört med EU:s genomsnitt.

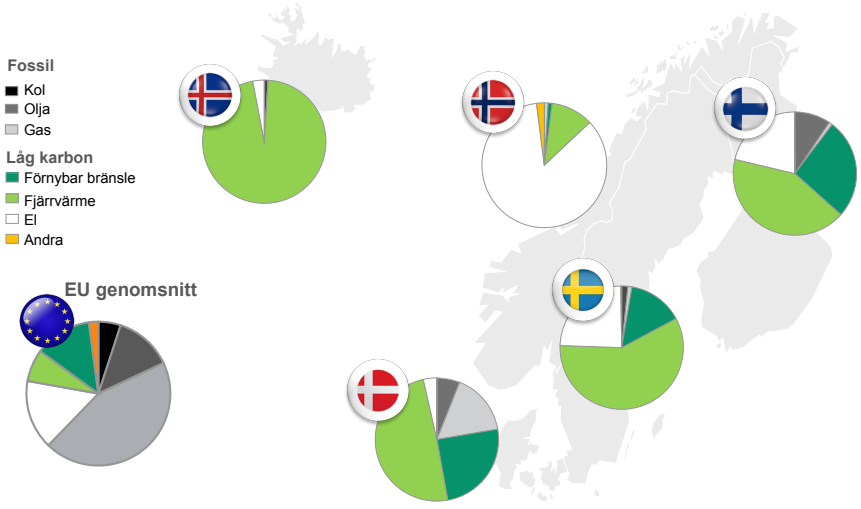
Figur 1: Slutliga energikällor inom uppvärmning och kylning (inklusive industrin) i EU och Norden (2012)



Källa: SWD 2016.

De nordiska länderna har en hög andel av fjärrvärme inom värmesektorn. Andelen olika värmekällor för bostads- och servicesektorn visas i figur 2. Användning av fossila bränslen i direkt uppvärmning av byggnader är mycket liten i alla nordiska länder jämfört med EU-genomsnittet.

Figur 2: Energikällor som används i bostads- och tjänstesektorns uppvärmning (Norden 2015, EU-genomsnittet 2012)



Källor: Nationell statistik, SWD 2016.

Den öppna och liberala värmemarknaden i Norden återspeglas i rättigheterna att till- och frånkoppla fjärrvärmesystemet samt i fjärrvärmens prissättning. Prissättningsmetoderna för fjärrvärme i Norden presenteras i figur 3. I Finland och Sverige är fjärrvärmepriserna inte reglerade, det finns ingen skyldighet att ansluta till fjärrvärmesystemet och frånkoppling är tillåtet. I Danmark och Island kan anslutningen vara obligatoriskt och frånkoppling är inte alltid tillåtet. Priserna är reglerade i Danmark. I Norge finns det i vissa fall skyldighet att ansluta till fjärrvärme med reglerade priser och i andra fall ingen skyldighet och ingen prisreglering. Städerna och kommunernas roll är dock viktigt i alla länder vilket gör utvecklingen av fjärrvärme och utnyttjande av spillvärme samt lokala resurser möjliga t.ex. med stadsplanering som innefattar energiperspektiv.

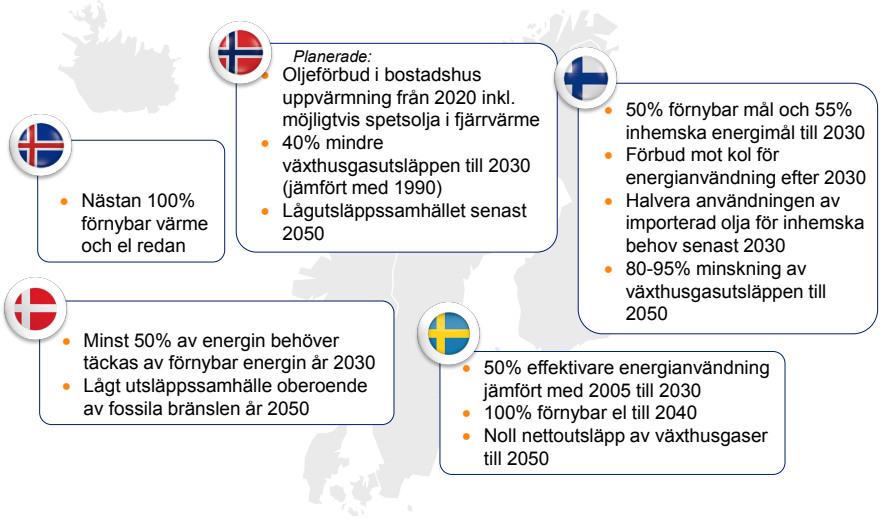
Figur 3: Approacher till fjärrvärmeprissättning

Källa: Pöyry analys.

En nordisk syn på EU:s värme- och kylpolitik

De nordiska länderna har alla en ambitiös nationell politik för att minska utsläppen och energiförbrukningen. Vikten av värmesektorn redovisas i de nationella strategierna. De nationella strategierna kan med beaktande av lokala resurser och lösningar fungera som viktiga verktyg för att främja minskade koldioxidutsläpp. Några av de viktigaste målen för uppvärmnings- och kylningssektorerna i de nordiska länderna visas i figur 4. Målen kan realiseras till exempel med nationella beskattningsbeslut, stödsystem eller till och med begränsningar att använda vissa fossila bränslen som föreslås i Finland och Norge.

Figur 4: Nationella energi- och klimatmål i Norden



Källor: Pöyry analys, nationella politik.

Baserat på intervjuerna skulle många av de nordiska aktörerna gärna se EU:s utsläppshandelssystem (ETS) som huvudåtgärd för att minska utsläppen i fjärrvärmesektorn i framtiden. Byggnaders uppvärmning baserad t.ex. på värmepannor med fossila bränslen ingår inte i ETS, men inom dessa sektorer är de nationella målen att minska utsläppen strikta och den höga fossila bränslebeskattningen samt vissa stödåtgärder främjar klimatmålen.

Fjärrvärme och CHP har varit viktiga energikällor (värme, kyla och el) i de nordiska länderna under en lång tid. Användningen av fjärrvärme istället för el för uppvärmning minskar behovet av el, men framför allt spetsarna i efterfrågan, eftersom efterfrågan på el är högst på de kallaste vinterdagarna. När fjärrvärme produceras med CHP, produceras el mest under hög efterfrågan. Fjärrvärmenäten möjliggör värmelagring och värme kan lagras även i separata värmelager till en låg kostnad jämfört med lagring av elektricitet. Därför har fjärrvärme också en viktig roll för elsystemet.

Med hänsyn till de många fördelarna med fjärrvärme och kraftvärme skulle det vara viktigt att upprätthålla fjärrvärme och kraftvärme i energisystemet även i framtiden. Många nordiska länder anser att detta bör göras med marknadsbaserade metoder. Eftersom det inte finns några restriktioner för att koppla från fjärrvärme i vissa länder är det viktigt att det finns lika villkor för alla uppvärmningsmetoder. Därför borde reglering som möjligen kan öka kostnaderna för fjärrvärme analyseras mycket noggrant. Många av de intervjuade var oroade för att den föreslagna skyldigheten att mäta värmeanvändningen på enhetsnivå och tredje parts tillträde av förnybar energi till DHC-system kan resultera i denna typ av extra kostnad.

När det gäller reglerade tredjepartstillträde till DHC-system, tyckte ingen av de intervjuade att det var fördelaktigt i den föreslagna formen. De tillfrågade såg att det inte skulle ge fördelar, särskilt i situationer där fjärrvärme redan är baserad på spillvärme, avfallsförbränning eller förnybara energikällor. Det aktuella formatet av

förslaget skulle också kräva stora regeländringar, även åtskillnad av produktion, försäljning och överföring av fjärrvärme. Detta skulle öka kostnaderna och minska konkurrenskraften för fjärrvärme.

När det gäller förslag till fjärrvärmemätningskravet tyckte de intervjuade att det är viktigt att mäta energianvändningen noggrannare på byggnadsnivå, men mätning på enhetsnivå skulle inte ha stora fördelar och kunde även ha kontraproduktiv påverkan. Energieffektiviteten kan bäst främjas med investeringar på byggnadsnivå och en optimering av energianvändningen. På enhetsnivå kan de boende främst spara i användningen av varmt vatten.

Appendix I

Table 11: Interviewed persons

Country	AGEE Working group, Contact person
Finland	Pentti Puhakka, TEM
Sweden	Björn Telenius, Regeringskansliet Instead of AGEE members: Fredrik von Malmborg, Anette Persson
Norway	Jon-Audun Kvalbein, Ministry of Petroleum and Energy Bjorg Bogstrand, Ministry of Petroleum and Energy
Denmark	Jacob Byskov Kristensen, Energistyrelsen Instead of AGEE member: Signe Marie Enghave, Energistyrelsen
Iceland	Ingvi Már Pálsson, Ministry of Industries and Innovation Instead of AGEE member: Helga Barðadóttir

Table 12: Organisations

Country	Organisation	Name
Sweden	SABO	Per Holm
Sweden	Energiföretagen	Erik Thornström
Finland	Finnish Energy	Jari Kostama
Iceland	Samorka	Sigurjón N. Kjærnested
Iceland	Orkustofnun	Jónas Ketilsson
Norway	Norsk Fjernvarne	Trygve Mellvang-Berg
Norway	NVE	Birger Bergesen
Norway	ENOVA	Øyvind Leistad
Denmark	Dansk Energi	Thomas Capral Henriksen
Denmark	Dansk fjernvärme	Birger Lauersen

Appendix II: Interview questions

Background

Pöyry Management Consulting team will conduct interviews in each Nordic country to identify views of the Nordic countries on the common Nordic goals and key priorities in the EU heating and cooling policy context. Pöyry will interview both regulators and industry. The work is conducted for the Nordic Council of Ministers.

Heating and cooling consume half of the EU's energy. 84% of heating and cooling is still generated from fossil fuels while only 16% is based on renewable energy. The EU has in its recent Heating and Cooling Strategy (February 2016)[13] emphasized that in the future the sector should be decarbonized and made more energy efficient. Also, the energy imports and dependency should be reduced, and energy costs for households and businesses cut. The Strategy also highlights possibility for new innovations in integrated energy systems, including heating and cooling.

On 30th November 2016 the EC published a so called Winter/Clean Energy Package[14] that includes several Directive proposals also relating to the heating and cooling markets and overall EU 2030 energy and climate policy goals. The Winter Package's legislative Proposals will go through the Ordinary Legislative Procedure before becoming binding Union legislation. The average length of the Ordinary Legislative Procedure is around 18 months. However, in the case of complex legislative Proposals, the procedure might take longer. The ongoing Maltese Presidency of the Council of the EU is expected to prioritize the revision of the Energy Efficiency Directive and the Energy Performance of Buildings Directive. Discussions on the Proposals on the Renewable Energy Directive will most probably be opened during the second part of the Presidency (April–June 2017).

Key questions

Against the above described background, what in your opinion should be the ideal way to regulate heating and cooling markets at the EU and your country level:

- to increase the share of RES in the sector?
- to make the sector more energy efficient?

---

[13] The Heating and Cooling Strategy can be found at:
https://ec.europa.eu/energy/sites/ener/files/documents/1_EN_ACT_part1_v14.pdf

[14] Background material to the EU Winter Package/Clean Energy Package can be found at:
http://ec.europa.eu/energy/en/news/commission-proposes-new-rules-consumer-centred-clean-energy-transition

- to reduce the energy imports and dependency in the sector?
- to reduce costs for consumers in the sector?
- to increase new innovations in the sector?

Are there any heating and cooling related best practices or new innovations used in your country that could contribute to the increase of RES, energy efficiency, security of supply and consumer cost savings at EU level?.

Are the proposed policy measures in the Winter Package the right way forward to regulate the heating and cooling markets? If not, what would be good regulatory measures? *(please find below information about the main heating and cooling related proposals in the Winter/Clean Energy Package, as well as more specific questions).*

Specific questions & Winter Package details

EU Winter Package – Renewable Energy Directive Proposal

- How should the EU 2030 renewables targets be implemented to heating sector?[15]
  - What are the benefits and obstacles of the proposed target of 1% increase in the share of renewables in heating and cooling annually (RED prop. article 23)?[16]
  - How this target should be implemented?
- What would be the impact of renewable and waste heat third-party access to the district heating networks (RED prop. article 24)?[17] What kind of impact would the right to disconnect from the DH network have on your country´s DH market?
- What is the current DH third-party-access regulation like in your country (which Act/Acts and what?)?
- What is the current DH disconnection right regulation like in your country (which Act/Acts and what?)?

---

[15] A Union-wide minimum target of 27% share of renewable energy in gross final consumption by 2030. Member States have to reach a minimum national share of renewable energy in gross final consumption of between 10% and 49%. If a Member State fails to reach its targets, payments must be made into a fund used to launch competitive bidding procedures for renewable projects. Member States will be allowed to statistically transfer amounts of renewable energy among themselves.

[16] The share of RES energy supplied for heating and cooling should increase by at least 1 percentage point annually in national share of final energy consumption. The increase may be implemented through one or more of the following options: a. Physical incorporation of RES in the energy and energy fuel supplied for heating and cooling; b. Direct mitigation measures such as installation of highly efficient RES H&C systems in buildings or RES use for industrial heating and cooling processes; c. Indirect mitigation measures covered by tradable certificates carried out by another economic operator such as an independent RES technology installer or energy service company providing RES installation services.

[17] Producers of RES heating & cooling, and waste heat from industry should have an open access right to local district heating and cooling systems and a possibility for these 3rd parties to deliver H&C to end-customers. Customers of non "efficient district heating and cooling" systems should be allowed to disconnect from the system to produce RES heating or cooling themselves, or to switch to 3rd party RES/waste heat supplier.

- What could be the impact of the required assessment of the potential of district heating or cooling systems to provide electricity balancing and other system services (RED prop. article 24)?[18]
- District heating and cooling suppliers should provide information to end-consumers on their energy performance and the share of renewable energy in their systems (RED prop. article 24). Would this requirement have any impact in your country?

EU Winter Package – Energy Efficiency Directive Proposal

- What could be the impact of a Member State level 1.5% annual energy savings target for 2021–2030 in your country (EDD Article 7)?[19]
- The EED proposal also proposes improving metering and billing of energy consumption for consumers with centralized heating and cooling (EED prop. Article 9).

Individual metering in multi-apartment houses and cost allocation for individual consumptions:

- What are the benefits and possible obstacles?
- What would be an alternative approach to achieve same results?
- Any changes required in your country based on regulation, and possible implications?
- What is the current status of metering in your country?

- New meters and cost allocators installed shall be remotely readable by 2020. Existing meters and cost allocators should be adapted to be remotely readable by 2027.
- Would there be any changes required in your country based on this proposal, and what would be possible implications?
- What is the current status of remote metering in your country?

[18] Member States shall require electricity distribution system operators to assess at least biannually, in cooperation with the operators of district heating or cooling systems in their respective area, the potential of district heating or cooling systems to provide balancing and other system services, including demand response and storing of excess electricity produced from renewable sources and if the use of the identified potential would be more resource- and cost-efficient than alternative solutions.

[19] Each member state should calculate the 1.5% annual energy savings target for 2021-2030 by multiplying 1.5% with the energy sales (to final customers by volume) average over the previous three years prior to 1 January 2019.

EU Winter Package – Other (EPBD & Ecodesign & Ecolabelling)

- EPBD proposal includes vision for the decarbonisation of buildings by 2050, with specific milestones in 2030. It also rules that the long-term building renovation strategies will become part of the integrated national energy and climate plans and will be notified by Member States to the Commission by 1 January 2019 for the period post 2020. The strategy will cover the renovation of the national stock of residential and non-residential buildings.
  - What is your view on a need and impact of such long-term building renovation strategy?
  - Is there something else in the EPBD proposal that is "alerting"?
- Ecodesign & Ecolabelling related provisions include 1. Minimum energy efficiency requirements for air heating and cooling products; and 2. Standardisation requests in support of ecodesign measures for solid fuel boilers and local space heaters.
- Do you have a view of these possible future requirements and their possible impact?

Nordic Council of Ministers
Ved Stranden 18
DK-1061 Copenhagen K
www.norden.org

Nordic heating and cooling

According to the EU Commission, the heating and cooling sector must sharply reduce its energy consumption and cut its use of fossil fuel in order to meet the EU's climate and energy goals. In the Nordic countries, a lot of effort has already been put to make heat production and consumption energy efficient and to decrease the emissions. To disseminate these experiences and good practices wider in Europe, and to identify further needs for co-operation, this study attempts to identify the common approaches of the Nordic countries towards the EU's heating and cooling strategy and Winter Package regulation. This report describes the results of the work based on Pöyry's analysis of the current heating and cooling sector practices and regulation in the Nordic countries, and interviews of the regulators and energy industry representatives from each country.

9 789289 349918