National action plan for retrofitting DH networks in Denmark

upgrade DH

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Abbreviations

CHP: Combined heat and power

DH: District Heating

HP: Heat Pumps

1 Introduction

The overall objective of the Upgrade DH project is to improve the performance of district heating (DH) networks in Europe by supporting selected demonstration cases for upgrading, which can be replicated in Europe.

The Upgrade DH project supports the upgrading and retrofitting of DH systems in different climate regions of Europe, covering various countries: Bosnia-Herzegovina, Denmark, Croatia, Germany, Italy, Lithuania, Poland, and The Netherlands. In each of the target countries, the upgrading process was initiated at concrete DH systems of the so-called Upgrade DH demonstration cases (demo cases). The gained knowledge and experiences are further replicated to other European countries and DH systems (replication cases) in order to leverage the impact.

Core activities of the Upgrade DH project include the collection of the best upgrading measures and tools, the support of the upgrading process for selected district heating networks, the organisation of capacity building measures about DH upgrading, financing and business models, as well as the development of national and regional action plans.

This document specifically focuses on the **development of a national action plan** for the retrofitting of inefficient district heating networks **in Denmark** and includes the results of the retrofitting approaches (see also the *District Heating Handbook* developed within the project [1]).

As a background information, Denmark has a long tradition of district heating, with one of the highest market shares in the world, 64,8% in 2018, with a share of 99% in its capital city, Copenhagen. Danish district heating is also characterised by a high share of renewable energy, it has grown from 34,4% in 2005 to 58,9% in 2017 [2].

The report finds the situation of the DH sector in Denmark to be very satisfying from the renewable and efficiency perspective, it only adds **minor recommendations** to the developments that are already ongoing and efforts to further decarbonisation and efficiency.

More specifically, COWI undertook a comprehensive review of the current policy framework relevant for energy and industry, heat production and distribution (Chapter 2). Several economists (from Danish Climate Council and similar) suggest reorganising the DH regulatory framework. This will mean reducing restrictions, for example removing taxation on waste heat, and instead of using CO_2 taxes to push the market, encouraging the climate friendly solutions. Other recommendations focusing on production, distribution and end-use are presented in Chapter 3 “Proposed action plan”.

The document was shared with representatives of the Danish District Heating Association, which has widely contributed to the plan (Chapter 4).

2 Current policy framework

The Danish energy sector has been developing throughout several decades towards a more sustainable and efficient system. Early on, the focus was on using district heating as a way of utilising waste heat from industry, power production, waste incineration and similar, to reduce the use of oil in the aftermath of the two oil crises in the 1970s. This resulted in the creation of many new district heating systems in Denmark. Today, more than 400 district heating systems are in operation. The Danish systems use either a renewable energy source, heat pumps and/or CHP. The reason for this development was a strong political will. Denmark has therefore a long tradition of district heating, with one of the highest market shares in the world, 64,8% in 2018, with a share of 99% in its capital city, Copenhagen. Danish district heating is also characterised by a high share of renewable energy, it has grown from 34,4% in 2005 to 58,9% in 2017 [1].

Denmark has modern, well maintained heat grids and production and is the home of many leading equipment, technology, and consulting companies, as well as contractors ensuring a performant value chain. In Denmark, financing of new DH projects, even higher risk ones, such as waste heat is common and a lot easier than in other countries.

The broad consensus on the necessity of decarbonisation, both from politicians and from the public, ensures the support for changes towards a more sustainable society.

The report finds the situation of the DH sector in Denmark to be very satisfying from the renewable and efficiency perspective, it only adds minor recommendations to the developments that are already ongoing efforts to further decarbonisation and efficiency.

2.1 The new Danish Climate Agreement for energy and industry

In December 2019, Denmark has set to reduce its CO_2 emission by 70% (compared to 1990 levels) by 2030. This new ambitious target is higher than the EU target (55% compared to 1990 levels). This announcement has been followed up by the publication of a proposal for a Climate Law stating how the target should be monitored and achieved [3].

Negotiations with various sectors and at Parliament level have followed to determine how this target can be achieved and what will the contributions of the different sectors be.

As a follow-up to the political agreement on the first Danish Climate Law, a new Climate Agreement for energy and industry has been agreed upon on the 22nd of June 2020 by parties representing a broad majority (93%) in the Danish Parliament. This agreement, together with a recent agreement on waste and circular economy, contributes to Danish reductions of approx. 3.4 million tonnes CO_2-equvialents annually by 2030. Among other things, the agreement entails an expanded carbon tax scheme as well as broader revision of green taxation to ensure that carbon pricing becomes the main driver for carbon reductions in Denmark [4].

The agreement contains the following initiatives, those relevant for the DH sector:

- Green building heating
  - Phase out of individual oil and gas boilers
  - Higher taxes on fossil fuels for heating and lower on electricity for heating
  - Expanded use of waste heat
  - Greener district heating
- Biomass sustainability criteria enshrined in law
- Renovation of the building stock
- Investments in future green technologies: Power-to-X (PtX)
- Support for biogas and other green gasses as well as energy efficiency [4].

In December 2020, the wide coalition of parties in the parliament continued the negotiation and settlement of the revised climate agreement, with specific focus to the energy and CO_2 taxation, named “green tax”.

The aim of reducing 70% of the CO_2 emission by 2030 is still in place, and to reach that it was decided to support the companies' green transition adding extra 700 mil. DKK between 2021 and 2025.

Regarding the green tax reform, the energy tax will be applied in two phases. Between 2020 and 2022, the energy tax will be increased by 6 DKK/GJ for companies that use fossil fuels and it will continue until 2025. From 2023 to 2025, the energy tax will be also applied to sectors that did not consider it (e.g. agriculture and horticulture). At the same time, efforts are being made to convert the energy tax into a more direct and uniform tax based on CO2 emissions, even though a final decision was not made. It was decided that a group of experts is formed in the beginning of 2021 to prepare proposals for the design of a uniform CO_2 regulation. During 2021, the group of experts will report and establish principles for the CO_2 emission regulation [5].

2.2 Production

During the last years, the focus has been on converting fossil fuel CHP plants, for example transforming coal fired plants in biomass CHP. This was initiated through a subsidy for power production from biomass CHP along with high taxes on fossil fuels. Several major coal-fired CHP plants in the major cities have already been converted and the last three coal-fired CHP plants are planned to be closed before 2030 (coal-fired boilers are not used for space heating in Denmark anymore).

However, Denmark long-term plan is to shift away from biomass CHP towards other renewable energy sources and renewable electricity-based heat pumps. Heat pumps are attractive in Denmark because of the increasing share of fluctuating wind and solar power production. Heat pumps have been supported by decreasing the tax on electricity several times during the last few years, which will continue in the coming few years. In 2022, the tax on electricity will be decreased from more than 100 €/MWh less than 10 years ago to 20 €/MWh. Despite the already significant reduction, the tax is expected to be lowered even further.

Other ways of supporting heat pumps have been the high taxes on fossil fuels and the restrictions on the construction of biomass boilers. As of now, heat pumps are in general seen as the most relevant future district heat production solution. The focus on heat pumps in also part of a quite explicit strategy saying that Denmark should be electrified.

Other district heating supply solutions are based on waste heat from data centres, waste heat produced by the introduction of Power-to-X systems and deep well geothermal heat. Some waste heat projects were abandoned as waste heat was taxed. However, the Danish government is reversing this policy and soon waste heat taxes will be significantly reduced. Earlier, the tax had been linked to the cost of waste heat that the district heating company pays to the waste heat supplier. Now, the tax will be set at a fixed level and the level will depend on whether the waste heat can be certified. The requirement for waste heat certification is meant to ensure all efficiency measures are put in place, so only unavoidable waste heat is recovered.

Another issue when trying to utilise waste heat is the location of the waste heat production and the district heating network/consumer. The producer – waste heat supplier – sometimes is located near a power station because of a dependence on a high security of supply and demand. However, power stations are not always necessarily near district heating networks. Therefore, district heating companies need to build a transmission pipes to be able to take advantage of the waste heat. To secure this investment, a kind of guarantee fund from the state may be established, covering any loss if the supplier of waste heat shuts down. Another possibility is for the state to demand that major industries with an expected waste heat production should be located near a district heating system. For example, new data centres

can be built close to a district heating network, so that the district heating company more easily can be connected and use the waste heat as heat source for the network.

2.3 Distribution

Most district heating companies intensely work to decrease heat losses from district heating pipe networks. However, many smaller systems still suffer high heat losses, accounting for more than 30% of its heat production. Many systems use high supply temperatures, even though temperatures in Danish DH, in an international comparison, are quite low. Of course, high temperatures in the network are never desirable but with thermal heat production, it has not been an issue delivering high temperatures for the network. This has also resulted in a situation where there can be hydraulic challenges if trying to decrease the supply temperature. In many cases this can be improved – and sometimes even significantly. Using hydraulic software to monitor the flow, temperatures, etc. in the system is extremely efficient to decrease the supply temperature.

Moving towards the increasing use of heat pumps in Danish district heating systems, the focus on network supply temperatures increases as well.

For several years, energy companies (heat, power, and gas) in Denmark have been subjected to a national target for energy savings. This meant that all companies should achieve some level of energy savings each year. Reduction could be achieved by reducing supply temperature in the distribution system.

There are not many other policies in the field of efficiency for district heating networks, but there is no evidence this has led to systematic inefficiency or focus on it. However, if, during the next few years, the Danish district heating systems will need to do benchmarking reporting, this will increase focus on heat loss and operating costs.

For now, each district heating company will have its own strategy when it comes to low temperature district heating. The first step in the process of reducing the supply temperature in the district heating network can be to develop a pipe renovation plan. This will include information on pipe age, type, and quality. Then, whenever going into a specific area to renovate pipes, this area should possibly be re-established as a low temperature district heating area. However, a careful evaluation of the building stock is required as it might limit the possible transition towards lower temperature supply.

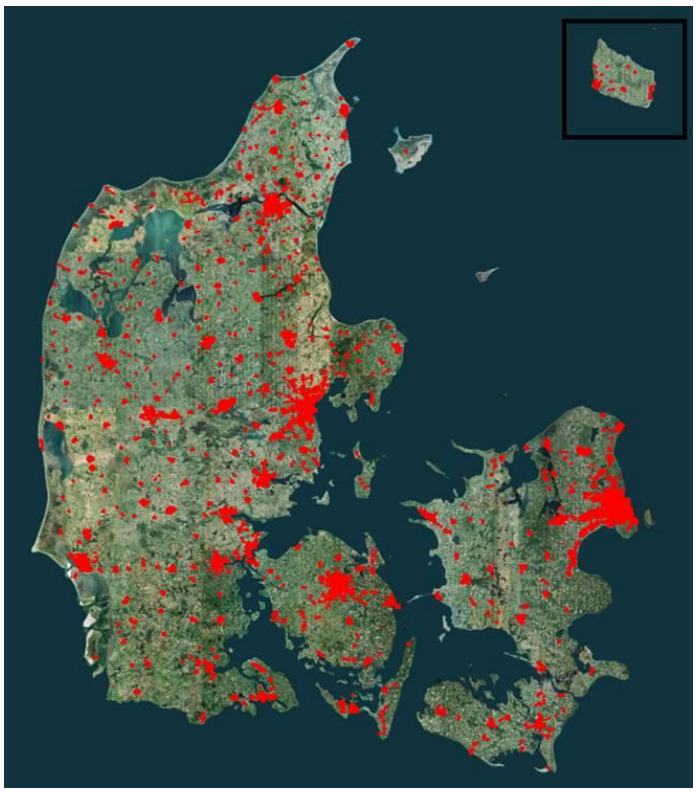

Figure 1 Map of areas in Denmark supplied by district heating [6].

3 Proposed action plan

Several economists (from Danish Climate Council and similar) suggest reorganising the DH regulatory framework. This will mean reducing restrictions, for example removing taxation on waste heat, and instead of using CO_2 taxes to push the market, encouraging the climate friendly solutions [7]. Today CO_2 taxes have some influence. However, this is found to be insufficient for Denmark to reach the target of 70% CO_2 emissions reduction by 2030. The Danish Climate Agreement for energy and industry is already outlining some promising avenues to improve and upgrade the existing district heating infrastructure. The Danish District Heating Association has widely contributed to the plan, in order to profile the sector as a frontrunner, delivering a substantial part of the emission reduction with at least 90% of district heating consumption based on energy sources other than coal, oil or gas by 2030.

3.1 General framework and taxation

- The Danish Climate Agreement for energy and industry will already enable a favourable framework for the decarbonisation of the heating and cooling sector in general and facilitate the upgrade of DHC-installations.

What can be expected from the implementation of the Climate Agreement:

- Ban on oil and natural gas boilers in the building sector. This will be supported by an increase in taxes on fossil heating fuels (to €30/MWh) and accompanied by subsidies from 2021 to 2030 for conversions to greener heating solutions, including the expansion of DH grids.
- Current obligations to use gas, placed on consumers, should be abolished and that an obligation in the heat planning system, to include fossil heating options in the socio-economic analyses, should be removed.
- Analysis of the consequences of the ban of the use of oil and gas by 2030, in individual solutions and in the DH sector, should be carried out.

- The current tax on waste heat will be significantly reduced and eliminated from electricity-based waste heat (as electricity is expected to be 100% renewable by 2030, e.g. from data centres, supermarkets etc.) as well as from other waste heat sources covered by a certification scheme to ensure energy efficiency at supplier's site.
- From January 1. 2021, the tax on electricity for heating purposes will be reduced to the EU minimum (€1 MWh non-business//€0.5 MWh business). This is expected to incentivise expanded use of HPs both individually and in district heating systems.

Recommendations on additional measures:

- Facilitate legislation to enable more "pro-sumers" with local co-production using local renewable energy sources (e.g. Solar thermal, PV and Heat Pumps)

3.2 Economic regulation of the DH sector

The agreement acknowledges that the DH sector will play an important role in the future supply of energy and in integrating sectors to achieve greater decarbonisation.

- Some aspects of the current heat planning obligations and restrictions on DH producers should be changed or abolished.
- The current cost+ monopoly regulation of the sector must be modernised in order to facilitate a cost effective and climate neutral transformation of the sector while maintaining economic efficiency and consumer friendly prices. The government will, in the second half of 2020, initiate political negotiations to discuss different models. It is expected that the government will propose a regulatory framework involving revenue caps and benchmarking and general requirements increase productivity. The DH sector is concerned that the proposal will create unnecessary bureaucracy burdens and that it will hamper the desired green transformation.

3.3 Production

- Ensure the wider utilisation of waste heat

What can be expected from the implementation of the Climate Agreement:

- Removal of the taxes on waste heat will make the waste heat cheaper and feasible in more projects.

Recommendations on additional measures:

- Improve the organisational and contractual setup in waste heat projects.
- Incentivise the use of waste heat: rule of public procurement.

- Ensure the development of other sources of renewable heat, in particular solar heat and geothermal

- Ensure more heat production from large scale heat pumps (HP)

What can be expected from the implementation of the Climate Agreement:

- Reduction of the electricity taxation (see point 3.1)
- Funds to be allocated to establish schemes to ensure consumer confidence in HPs and compulsory certification of HPs to be considered.

While these measures are expected to foster investments in individual HPs as well as large HPs, electric boilers and waste heat in DH, they may, however, lead to lower investments in geothermal energy, solar heating and biomass in DH.

In general, there is a tendency to promote and focus on the individual solutions and disregard the system approach. This is still reflected in building codes and energy taxation (heat pumps favoured).

Moreover, there is a risk that the competition between district heating and individual heat pumps, in suburban areas, to be substantially increased, including areas traditionally deemed suitable for DH.

Recommendations on additional measures:

- Regulations on low temperature requirements when renewing pipelines.
- Mandatory pipeline renovation plans with focus on low temperature levels in the district heating systems.
- Temperature optimisation and SMART controls in district heating systems.
- Mandatory benchmarking reporting: with increased focus on heat loss, temperature levels, operation cost and heat prices.
- Introduction of flexible electricity tax and tariffs for large DH HPs.

3.4 Distribution

- Reduction of heat losses in the pipes (this matter is not directly included in the Climate Agreement, but from the experience acquired by COWI, it is a factor that needs to be carefully evaluated. Most of the DH companies already work on the reduction of heat loss and network optimization; however, to support that, the regulator should consider that in the regulation).
- Renovation of the buildings can lead to reduction of heat demand and possibility of lowering the supply and return temperature in the network.
- The introduction of new digital tools allows the optimization of the heat distribution with a consequent reduction of the supply temperature in the network. Furthermore, it is a combination of smart metering solutions and consumption prognosis can lead to a better refurbishment of old pipes and identification of consumers with faulty operation in the DH installations.
- Develop supplementary tariff elements that motivate to reduce peak demands, ensure low return temperature and enablement of low temperature districts.

3.5 End-use

- Promote the efficient use of energy in the renovation of the building stock

What can be expected from the implementation of the Climate Agreement:

- The agreement will ensure a more efficient efforts on energy efficiency in both industry and the buildings. Impose requirements on energy savings for public buildings towards 2030. These initiatives build on a green housing agreement, where approx. €4 billion was put towards renovation of the building stock together with looser reins for the municipalities and regions, making way for unusual and exceptional investments in energy.

Recommendations on additional measures:

- Exploitation of load levelling measures to reduce peaks by smart controls (e.g. idling space heating in domestic housing, in periods where need for heating domestic hot water is high) - “flex-sumers”

4 Promotion of the action plan and recommendations

The document was shared with representatives of the Danish District Heating Association, who provided their comments and confirmed that the recommendations are generally in line with national policies and the DDHA advocacy work.

For more information on the Danish district heating model, please consult https://danskfjernvarme.dk/sitetools/english/the-danish-model.

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