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## Vision 2050

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State of Play of District Heating & Cooling Markets

1. Introduction

In 2022, Euroheat & Power Country by Country becomes the District Heating & Cooling Market Outlook, a comprehensive overview of the district heating and cooling sector in Europe and beyond. This publication has become a reference for District Energy data, widely used by national and European policymakers, regulators, energy consultants, engineering companies, utilities, researchers and other players in the district energy market.

The District Heating & Cooling market Outlook reflects the natural evolution of the Country by Country from a deliverable initially based on quantitative data, to a more detailed overview of the recent business and regulatory developments in respective markets. From the renovation of the building stock, energy taxation policies, geographical conditions and local incentive schemes – the factors affecting the district energy industry vary from one country to another.

This year’s edition is also enhanced with a whole new chapter on “National DH transition pathways”, which gathers detailed information on the district energy transition for 10 selected markets: Austria, Czech Republic, Denmark, Finland, France, Germany, Italy, Slovenia, Sweden and the Netherlands.

The local nature of district heating and cooling makes collecting data a challenging and complex exercise. Different data reporting practices and obligations across different countries using varying statistical methods reflect the fragmented nature of the district energy industry. Consequently, there is a lack of consistent, detailed and comparable data on district heating and cooling at the European and international levels. The scarcity of available institutional data on district energy is even more apparent when compared with extensive data sets published regularly by Eurostat and the International Energy Agency on the power and transport sectors.

High quality, detailed statistics are fundamental for the district heating and cooling sector, at a time when some of the most crucial policy and investment decisions are being made to put the world on track of achieving climate-neutrality before the end of the century. District Energy is by nature a technology with high up-front costs, which is why investors active or wishing to enter a new market benefit from solid perspectives on local market trends, technology development and potential consumer outreach. This is especially relevant for the district cooling segment, which has witnessed significant growth in recent years. Recently, the conflict in Ukraine and subsequent EU energy crisis have pushed governments to reconsider their dependence on Russian gas, shedding light on the urgent need to deploy sustainable and home-grown heating and cooling solutions such as District Energy. Mapping the potential of heat resources in key European and neighbouring markets and fine-tuning our knowledge on their respective transition pathways away from fossil-fuels, has become a political imperative.

District heating has the potential to be at the centre of the decarbonisation of the heating and cooling sector, and contribute to strengthening Europe’s energy resilience and security. Locally owned and a
flagship of the European energy industry, district heating and cooling has tremendous potential to grow in Europe and could provide up to 50% of the heat demand in Europe by 2050\(^1\).

It is a true European solution, adapted to various energy mixes and enabling the development of multi-energy heating networks capitalizing on local resources (CHP, waste to energy, geothermal, solar thermal, sustainable biomass, wind and solar). DHC is also a gateway to deploying more renewable heat in our homes: the seven European countries with the highest national shares of renewable heating and cooling also have the highest shares of district heating in their heat markets (Iceland, Sweden Estonia, Finland, Latvia, Denmark, Lithuania).

In the next decade, deploying district heating and cooling will be critical to gradually phase out fossil fuels supply in heating: a recent assessment by Agora Energiewende with the help of Artelys, TEP Energy and Wuppertal Institute found that district heating could have a technical potential to achieve around 125 TWh (~12.5 bcm) in gas savings in Europe, already by 2027. The recent announcements in Denmark and Netherlands are a good reminder of this.

Year on year, developing more accurate and complete data on the sector will help unlocking the full potential of District Energy in Europe and beyond, mobilizing the industry and policy maker around a joint vision.

The District Heating and Cooling market outlook is published as an online tool. This flexible format allows Euroheat & Power’s team to edit content and add updated information as it becomes available – thus adapting to the rapidly developing and changing district heating and cooling market worldwide. The publication is expected to contribute to the ongoing public debate about the future and potential of district heating.

2. Methodology

The District Heating and Cooling Market Outlook is based on an extensive questionnaire completed by members and associates of Euroheat & Power at international level. As a result of feedback and support from our members and users, the questionnaire has been improved to ensure that, where possible, district heating and cooling statistics are comparable across countries and include the most important and relevant indicators.

Quantitative questions were supplemented by qualitative descriptions of individual markets, providing details about the latest industry trends, regulatory environment and various challenges and opportunities.

It is important to note that, due to different national data gathering practices, some information is not available in specific countries. This is particularly evident in the district cooling sector which, despite a significant increase in the amount of data provided since the 2017 edition, is still at an early stage in most countries and is not monitored as extensively as district heating or combined heat and power.

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\(^1\) Heat Roadmap (2018)
3. District heating

1.1. Introduction

Heating is by far the largest energy consumer, accounting for over 50% of Europe’s annual final energy consumption. Most of the European heat is still generated using fossil fuel-based sources, almost half of which is natural gas. The climate crisis and the recent Ukraine conflict have highlighted the need to accelerate the decarbonisation of the heat market. In 2019, District Heating and Cooling represented 12% of the European heat market, with over a third of DHC energy supplies from renewable and bio-energy sources.

By allowing the integration of clean and flexible energy sources, district heating is an integral part of the effort to reduce the sector’s dependence on fossil fuels and cut down CO₂ emissions. Renewables currently account for about 18% of the global primary energy consumption - especially geothermal, biomass, biodegradable waste, and solar energy. In comparison, Europe is leading the decarbonisation pathway for the sector. The share of renewables in heating and cooling already account for 28.9%. When incorporating industrial waste heat, the share of renewable and climate-neutral sources rises to 30.6%. Additionally, low-temperature modern networks can potentially integrate 100% renewable sources to supply energy-efficient buildings.

The importance of renewable electricity-powered large heat pumps connected to district heating networks is also clearly demonstrated by the 2050 country Roadmaps, confirming the potential of this technology to further integrate renewable heat sources (such as geothermal), and harvest the potential of renewable electrification. Furthermore, the large untapped potential of waste heat from industrial and commercial activities, could meet most of Europe’s heat demand and result in considerable efficiency gains. In this innovative landscape, excess heat recuperation from hydrogen production is gaining increasing traction from the industry. Finally, integrating various sources of renewable electricity, district heating offers an effective energy storage solution: one that can absorb excess renewable electricity and help balance the grid. The cost-efficiency of thermal energy storage is also very promising, compared to electric-based storage solutions.

1.2. Business performance and sector growth

Notwithstanding the benefits outlined above, district heating still represents a relatively small share of the EU’s heating market. The 10 000 European heat networks currently meet around 12% of the EU’s heat demand. This is, however, above the global average which, according to figures published by the IEA in 2021, currently stand at 8.5%. It clearly shows that the deployment of district heating and cooling is more developed in Europe than in other parts of the world.

The share of district heating varies significantly from one region to another e.g., district heating is by far the most common heating solution in the traditionally cold-winter countries in North/Eastern Europe (Nordic and Baltic regions, Poland, etc.) whereas it still plays a minor role in Southern and some

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2 District heating and cooling in the European Union (Tilia, 2022)
3 District heating and cooling in the European Union (Tilia, 2022)
4 ReUseHeat
5 Source: Interreg “District Heating in North-West Europe A Guide for Energy Consumers"
Western European countries (e.g., The Netherlands, United Kingdom). Overall, the largest district heating market in Europe is in Germany, followed by Poland and Sweden.

Approximately 60 million EU citizens are currently served by district heating, with an additional 140 million living in cities which are already equipped with at least one district heating system. It highlights the strong potential of District Energy solutions to meet the challenge of urban densification and transitioning European buildings away from fossil-fuel heating. According to the Heat Roadmap Europe data, if the urbanisation trend continues and appropriate investments are put in place, district heating could meet almost half of Europe’s heat demand by 2050.

1.1.1. District heating Sales to Customers (in GWh)

![Interactive chart available here](image_url)

District heating sales, the actual amount of heat delivered to final customers. It is one of the key business indicators for assessing the size of the sector.

As shown by the graph above, district heating sales remain constant, without significant variations for most countries. Although there was a slight decline in some countries (such as Sweden, Finland and France) in 2015, this was quickly reverted. The uncharacteristically warm winter in 2014 (the warmest on record for Sweden and France and the second warmest for Finland) can partially explain the slight decline in sales. All the countries have experienced significant growth since 2017 and greatly surpassed their figures in 2013.

It is worth noting that the 2019 figures show once again a slight decline in sales in countries like Denmark, the Czech Republic, Austria and Lithuania. This can, in part, be attributed to the Covid-19 pandemic which forced many businesses around the world to close for several months. Nevertheless, the decline is marginal for most countries, and in the case of France, Norway and Spain, sales went up on that year.

Despite the slight decline in sales in some countries in both 2017 and 2019, the resilience of the market is clear. The realisation of the potential for District Energy in Europe will rely to a considerable extent
on the ambition of the current Fitfor55’ package, a legislative package currently under negotiation at EU level.

Some key proposals part of the Fit for 55 Package, published by the European Commission in 2021 and currently under discussion by EU policymakers, are very positive for the sector. They include:

- a coordinated framework for the integration of waste heat,
- a push for EU cities above 20,000 citizens to conduct heat planning, emphasis on DHC’s ability to ensure efficiency and stability of the renewable electricity system through CHP/Power-to-heat and integration of RES-electricity as well as heat from new uses of electricity (Power-to-X),
- equal treatment of “on-site” and “nearby” renewable generation for building decarbonisation,
- the extension of the EU ETS system to the building sector and accountability of RES-heat in meeting increased building sector targets.

Furthermore, it will be interesting to examine the extent to which the current push to move away from Russian gas will impact district heating sales. In EU countries such as Austria, the Netherlands, Denmark and the Flemish region of Belgium, the progressive phase-out of individual fossil boiler solutions and mandatory connection to heat networks or heat pumps has been announced.

1.1.2. Trench Length in KM for transport & Distribution Network

The total length of heat distribution networks provides an additional indicator of the growth and potential of the sector. Most importantly, this demonstrates investors’ outlook and their trust in the future of the sector since investments in district heating are made with a long-term business model in mind.
As shown in the charts above, the upward trend continues which is very positive for the sector. While most countries either increased or maintained the length and have developed their networks at the rate of previous years, Germany has seen an exponential growth in 2019. Such growth clearly indicates trust is growing in those markets which may result in further investments in the coming years.

**DH share in energy sources used to satisfy residential heat demand (%)**

Source: Euroheat & Power - 2022 CbC • Created with Datawrapper
Comparing the district heating market share with other heating solutions such as individual natural gas boilers, electrical heating, central biomass heating, heat pumps and others is an important indicator of its strength.

As demonstrated by the graphs above, there is a big disparity in the share of district heating in Europe. It originates in different climates, determining the heat demand, political and economic factors, urbanisation, and energy policy with differentiated responses to the global oil crisis of 1973 and 1979.

On the one hand, in Northern and Eastern European countries such as Denmark, Sweden and Finland over 60% of the population is served by district heating networks. For instance, in Denmark, after the first oil crisis a decision was taken to drastically improve energy efficiency through the development of combined heat and power (CHP). The country adopted its first heat planning legislation in 1979 and several afterwards, which resulted in the progressive increase of the district heating market share to 68% in 2019.

On the other hand, in Southern countries such as Portugal and Spain where winters are relatively warmer district heating networks are less developed. The need for sustainable cooling rises rapidly across Europe due to an increasing commercial and industrial demand, as well as more frequent heat waves episodes.

The greatest increase market share in 2019 was in Sweden where figures had greatly declined since 2015 with low electricity prices driving more customers to choose electric heating. There has been a considerable uptake since then, and the share of district heating and cooling has now surpassed the figures in 2013. Norway has also seen noticeable increase in the same year.

1.3. Sustainability

District heating has been garnering more attention from policymakers at the EU level in recent years due to its potential to mitigate CO₂ emissions and contribute to energy security in the continent. This is a testimony to the growing interest in the sector, at European level and beyond. With great power, comes great responsibilities: which also means that the sustainability credentials of DHC are under stronger scrutiny.

As previously mentioned, heating and cooling account for half of the energy demand in the EU. DHC represents 12% of that share with 28.9% being covered by renewables. The figure is even higher if industrial excess heat is taken into consideration. According to the influential think tank Agora Energiewende⁶, district heating would need to supply 20% of heat in buildings by 2030, with 50% of it supplied by RES and waste heat. This is particularly encouraging considering that Europe is a world leader in the use of renewables for district heating.

The EU currently produces more waste heat than the demand of its entire building stock. Although it remains marginal compared with renewables (currently represents 1.7% of the heat supply in Europe), tapping into waste heat could greatly contribute to the sustainability of the sector. According to Heat

Roadmap Europe, up to 25% of the DH could be supplied by industrial heat\(^7\). Furthermore, urban waste heat from data centres, metro stations, tertiary buildings, and waste-water treatment plants can meet more than 10% of the EU’s total energy demand for heating and hot water. The substantial potential of waste heat recuperation from hydrogen should also be considered.

Please note that the graph above does not show all the markets. Due to space constraints, only the top 13 countries are displayed. Additionally, as previously explained, we rely on contributions from national associations and companies for data collection. Unfortunately, we have not yet received data from Poland, one of the largest district heating markets. Euroheat & Power is working hard to remedy the situation and will make the data available if/when it receives it.

Nonetheless, the data above illustrates the considerable progress many countries have made over the last five years in integrating renewable sources into their district heating systems. For instance:

- the share of renewable heat has grown from 42% in 2011 to 63% in Denmark in 2019,
- in Finland more than 40% of district heating is carbon free
- in France the average renewable and recovered energy rate exceeded 60% in 2020
- Lithuania reported a decrease of around 70% CO\(^2\) emissions from the heating and cooling sector since 2000
- Both Sweden and Croatia have seen considerable growth in the share of renewable energy in DH

All these countries have experienced rapid RES growth and identified increased biomass production as well as supply diversification as a contributing factor. The graph below shows the supply fuel mix in the EU in 2018.

1.4. Unlocking the potential of DHC

In an effort to identify potential obstacles to the development of DHC at national level, contributors were asked to identify and summarise key barriers in their respective markets. A wide range were listed, most of which pertaining to a specific regulatory and/or fiscal development. However, some barriers are common among most countries and can be grouped into the following categories:

- **Cogeneration** – A large share of the heat in district heating systems is generated in cogeneration plants (CHP) which produce both electricity and heat from either fossil fuels or renewables. The low electricity prices in most of the European countries have an adverse effect on investment as many CHP operators are facing substantial financial losses.

- **Legal & policy frameworks** – The substantial investment required to cover the upfront costs of district heating systems can be prohibitive. On the other hand, several countries still lack a level playing field to drive the most energy-efficient and sustainable heating solutions. Legal certainty and sound policy frameworks are, therefore, crucial. However, several contributors identified fragmented and unstable legislative frameworks in their respective markets as one of the main reasons preventing more investments on new projects.

- **Long term planning** – The expansion of district heating networks requires long-term planning and a systematic approach, which according to Euroheat & Power members is lacking in some countries.

- **Awareness-raising** – In countries where the uptake of district heating is still relatively low, key decision-makers are not yet fully aware of the multiple benefits of district heating. Policy decisions are made based on cost and without considering broader environmental and societal advantages. The lack of awareness and knowledge is particularly evident in the district cooling sector.
4. District cooling

The growing need for cooling, especially in the tertiary sector is evident across Europe. Buildings – such as hospitals, shopping malls and data centres which need cooling energy all year round - represent the largest target group for district cooling. Additionally, demand for residential building especially during hot summer days, is also increasing. Recent heat waves have driven consumers to purchase individual solutions for comfort cooling which directly impacts peak electricity demands.

In the wake of the financial crisis, European projects were put on hold, but a new wave of projects can now be discerned inspired by the need to develop more efficient and clean cities. Adequate cooling supply is also becoming a prerequisite for the service sector. In this perspective, District Cooling can provide tailored solutions using local resources to provide a wide range of benefits for real estate developers and urban development.

France and Sweden remain, by far, the largest markets with both producing around 1 TWh of cooling. The data below shows key information about the growth of the cooling market in Europe:

- In Austria, between 2009 and 2019, heating supply companies invested an average of €10 million annually, in district cooling. District cooling sales already reached 192 GWh in 2019
- In Copenhagen, Denmark district cooling contributed to reducing the CO2-emission by almost 70% compared to traditional technologies. It is also expected to reduce costs by up to 40 %, according to HOFOR
- Finland reported a growing need for cooling in the buildings, especially in the tertiary sector. Service buildings and office buildings form the largest customer target group for district cooling. For example, hospitals, shopping malls and data centres need cooling energy all year round. There is also a growing need for cooling in residential buildings during hot summer days
- District cooling is under constant development in France and demand is growing. In 2019, 24 cooling networks delivered approximately 1 TWh of cooling to 1,400 through 225 km of networks. 93% of cooling deliveries are intended for tertiary buildings (offices, hotels, museums, airports, hospitals)
- District cooling still remains sparsely developed in Germany. While it has received growing attention by utilities in recent years, project planning and development has not yet taken off on a broader scale across the country
- As the demand for cooling is growing in Sweden, DC remains resilient and its market share has slightly increased in recent years. The total sales of DC were approximately 1 TWh in 2019 (990 GWh) and is expected to increase by more than 50% by 2030. Swedish DC systems use free cooling (19%), excess cooling from large heat pumps (25%), surplus energy from industries and waste incineration (27%) along with cooling from efficient cooling machines (28%).

A comprehensive assessment of the evolution of cooling demand is necessary to ensure public policies are developed to address them in the most efficient way. It is assumed, too often in public discourse that higher efficiency from stand-alone solutions can provide the solution. However, by exploiting high-efficiency processes, renewable sources and energy streams otherwise not valued, district cooling can be five to ten times more efficient.
Additionally, District cooling can play a key role in smoothing out peak demands from increasing electrification shares across sectors. It reduces the need for electrification as it can tap into alternative sources (e.g., free cooling from rivers and the sea). This flexibility is expected to yield significant benefits as demand for cooling increases.

5. Conclusions

On average, 80% of EU households energy demand is directed towards space heating & cooling, and water heating⁸. Despite the potential to be at the forefront of decarbonisation efforts, the sector is still heavily reliant on fossil fuels. The climate crisis and the ongoing conflict in Ukraine have further demonstrated the urgency to accelerate the decarbonisation of the heating sector.

Pursuing more ambitious climate and energy goals – namely achieving climate neutrality by 2050 - requires a faster heat transition. The deployment of locally sourced, sustainable heating solutions such as district heating is key to ensuring more renewable and sustainable heat in our homes. The seven European countries with the highest national shares of renewable heating and cooling, also have the highest shares of district heating in their heat markets (Iceland, Sweden Estonia, Finland, Latvia, Denmark and Lithuania). It is a clear indication of the direct correlation between district heating and renewables shares.

![Renewable energy used for heating and cooling](source)

District heating adapts to national energy specificities and enables decarbonisation through the integration of a wide range of local renewable energy sources (RES) such as biomass, geothermal or solar energy, and the use of various forms of waste heat and cold that otherwise would remain untapped (industries, data centres, etc.). Additionally, it fosters important energy efficiency gains.

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⁸ Energy consumption in households - Statistics Explained (europa.eu)
through the integration of excess heat that would otherwise be wasted or the storage of thermal heat to be used during peak demand periods.

As highlighted in the Commission’s strategy on energy system integration, “the coordinated planning and operation of the energy system across multiple energy carriers, infrastructures, and consumption sectors – is the pathway towards an effective, affordable and deep decarbonisation of the European economy […] Modern low-temperature district heating can connect local demand with renewable and waste energy sources, as well as the wider electric and gas grid – contributing to the optimisation of supply and demand across energy carriers.”

The adoption of the ambitious provisions on heating and cooling included in the Fit for 55 Package – notably the renewable energy directive, the energy efficiency directive, the emissions trading system and the energy performance of buildings directive – as well as new State aid rules, which will in principle provide an easier access to aid for modernisation and deployment of DHC systems, will be critical to drive the expansion and modernisation of efficient DHC in the next 5 years.

Furthermore, concrete measures can be undertaken to further expose the potential of efficient DHC under REPowerEU and national recovery and resilience plans. DHC has tremendous potential to grow in Europe, drive the heat transition and provide up to 50% of the heat demand by 2050 (from 13% today).

**Vision 2050**

6. **Introduction and methodology**

This year, for the first time, Euroheat & Power’s District Energy Market Outlook publishes a new section, which focuses on how the district heating sector aims to achieve full decarbonisation by 2050, in line with the objectives of the European Green Deal and the pledge signed by our members back in 2019.

This analysis includes information on national heat decarbonisation plans from ten selected European countries, such as Austria, Czech Republic, Denmark, Finland, France, Germany, Italy, Slovenia, Sweden and The Netherlands. The objective is to gain further knowledge on the most promising solutions and transition pathways towards a sustainable heating system, fit for 2050.

While this is not an exhaustive overview of the overall EU district heating market, it includes quantitative data on projected transition pathways across the 10 surveyed countries, related to GHG emissions projections, energy mix and the market share of district heating for the years 2030, 2040 and 2050. The data was collected from a questionnaire completed by members of Euroheat & Power, in which quantitative questions were supported by qualitative descriptions of individual markets, particularly focusing on the challenges and opportunities for the sector.

It is important to note that, because of the differences in the development of the sector among the countries considered, some information was not available in specific countries. On top of this, because some countries have pledged to fully decarbonise well before 2050 (Austria, Denmark, Finland and Sweden), projections are only provided up to certain years.
### 7. Transition pathways for District Heating and Cooling in Europe

Four out of ten of the countries analysed plan to decarbonise their heat markets well before 2050. These include:

- Austria: full decarbonisation by 2040
- Denmark: full decarbonisation shortly after 2030
- Finland: full decarbonisation by 2035
- Sweden: full decarbonisation by 2030

For three of those countries (Denmark, Finland and Sweden), there is a strong correlation between the capacity to phase out fossil fuels from their heating markets and having a very well-developed district heating sector. This is because district heating is an efficient technology, which allows to make the most out of locally available renewable heat and carbon-neutral heat sources such as waste heat. It helps speed up the decarbonisation towards climate neutrality. For the remaining other countries, the process may take a bit longer if not supported by the right policy frameworks at both national and European levels, taking into account national diversities and availability of energy sources.

Despite national differences though, we see a general decrease in CO2 emissions in the sector, particularly as of 2030, which is linked to a growing integration of waste heat and renewables, accompanied by an acceleration in the phase out of fossil fuels in heating. This is also expected to be accompanied by the refurbishment and modernisation of existing networks, which will lead towards more low-temperature or fourth generation district heating networks.
In terms of the market share, we see a substantial increase specifically in those countries where the sector is currently less developed (e.g., The Netherlands), whether in those countries that already have a well-established district heating market, such as Denmark, Sweden and Finland the market share continues to increase at slower pace.

Overall, projections from Heat Roadmap Europe shows that the overall market share of district heating at the EU level is expected to increase from the current 13% to 30% in 2030 and 50% in 2050.
The section below provides a detailed analysis on CO2 emissions, energy mix and market share projections at national level for each of the countries under the scope of this analysis.

8. Overview of national DH transition pathways

**Austria**

**Overview**

Austria aims at decarbonising the national heat market by 2040. The Austrian DH sector is on track to reach such goal, being already coal free since 2021 and on schedule to phase out oil and natural gas by 2030 and 2040 respectively.

This will need to be accompanied by a deep renovation of the national building sector combined with robust heat planning, which is key to identify the potential for the expansion of the DH sector.

Overall, the decarbonisation of the heat market will require heavy investments, which could benefit from funding support mechanisms. On DH specific, there is a potential for geothermal energy to be exploited, however, because of existing legal constraints, it is overly complicated to access available resources and make the most out of this sustainable source of energy. Therefore, a push in the right direction to spur the use of geothermal both at national and European levels will truly benefit the uptake of this renewable energy source in the sector.

**GHG emission projections**

GHG emissions in the DH sector are expected to reach 2050 kton in 2030 and to be reduced to 500 kton in 2040. Residual emissions in 2040 is due to emissions from waste incineration and potentially biomass.

<table>
<thead>
<tr>
<th>Year</th>
<th>GHG Emissions</th>
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<tbody>
<tr>
<td>2030</td>
<td>2050 kton</td>
</tr>
<tr>
<td>2040</td>
<td>500 kton</td>
</tr>
<tr>
<td>2050</td>
<td>0 kton</td>
</tr>
</tbody>
</table>
Energy mix projections

Natural gas, biomass and industrial waste heat are expected to be the main sources of energy in the DH sector in 2030. Whereas, in 2040 the biggest share of energy used in DH will come from green gas, industrial waste heat, biomass as well as geothermal energy and heat pumps.
District heating market share projections

Projections for the market share of DH in the years 2030, 2040 and 2050 are set to 25, 30 and 35% respectively.

Czech Republic

Overview

Czech Republic pledged to phase out coal in the district heating (DH) market by 2030. To do so, the country plans to increase the share of renewable energy sources in the heating and cooling sector to 30.7% by 2030, with the possibility to further increase it, depending on the rise of ambitious at the EU level. As mentioned in the European Commission’s assessment of the Czech National Energy and Climate Plan (NECP), the increase of renewables in the heating sector could be further promoted by focusing on the modernisation and decarbonisation of DH networks, while exploiting available domestic renewable energy sources and maximising the use of waste heat.\(^9\)

Furthermore, national projections show that carbon emissions can be decreased by more than 60% by 2030, compared to 2019, and being on track to reach climate neutrality by 2050. However, supportive policy and financial instruments are needed to achieve these goals, both at national and the EU level. In particular, a uniform CO2 price across the heating sector to ensure a level-playing field in the heating market is needed, together with access to funding and investments, and clear rules for State Aid approval process.

GHG emission projections

GHG emissions in the DH sector are expected to decrease to 161 g/kWh in 2030, 71 g/kWh in 2040 and 0 g/kWh in 2050, as presented in the table below.

<table>
<thead>
<tr>
<th>Year</th>
<th>Emission (g/kWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2030</td>
<td>161</td>
</tr>
<tr>
<td>2040</td>
<td>71</td>
</tr>
<tr>
<td>2050</td>
<td>0</td>
</tr>
</tbody>
</table>

Energy mix projections

The graphs below show the fuel mix projections expected in the DH sector in 2030, 2040 and 2050. According to the projections, solid biomass and geothermal are set to play a major role as the sector decarbonises, followed by biomethane, solar thermal and green hydrogen.

\(^9\) EC assessment of the final national energy and climate plan of Czechia
By nuclear we refer to the use of excess heat from two nuclear power plants in Temelin, Southern Bohemia and Dukovany, Southern Moravia.

**District heating market share projections**

DH is already quite widespread in Czech Republic, and according to national projections the market share is set to further increase by 40, 43 and 47% in 2030, 2040 and 2050 respectively.

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**Denmark**

**Overview**

According to the National Energy and Climate Plan, Denmark set a legally binding target to reduce greenhouse gases by 70% by 2030 (relative to 1990 level), in order to make the country on track to reach net zero emissions by 2050 at the latest. DH has been identified as one of the key technologies to achieve these targets.

While national legislation has been quite helpful so far for the further uptake of DH, progresses made at the EU level within the context of the Fit for 55 and RePower EU, and more generally the EU Green Deal, will surely have a heavy impact on the future of the sector.

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10 Danish National Energy and Climate Plan (2019)
According to a study run by Aalborg University in 2021 on the future of Denmark’s heating sector, district heating should be expanded as natural gas and oil are being phased out and as new urban areas emerge. The goal should be to expand district heating from the current 56% of the total heat demand in buildings to somewhere between 63-70% in 2045. The report further recommends that up to 260,000 buildings with natural gas boilers and 44,000 with oil boilers should be converted to district heating by 2045. The report also stresses that by 2030 the expansion of district heating should accelerate to achieve the 70% target as cost-effectively and energy-efficiently as possible. In this expansion, the transition towards low temperature, or 4th generation district heating, should be prioritized.

**GHG emission projections**

According to projections by the Danish Energy Agency, not taking into account new policy developments, the DH sector is expected to emit 0.49 g/kWh by 2030, corresponding to 0.7% of Denmark total emissions. These emissions are expected to reach zero, shortly after 2030.

<table>
<thead>
<tr>
<th>Year</th>
<th>Emission (g/kWh)</th>
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<tr>
<td>2030</td>
<td>0.49</td>
</tr>
<tr>
<td>2040</td>
<td>0</td>
</tr>
<tr>
<td>2050</td>
<td>0</td>
</tr>
</tbody>
</table>

**Energy mix projections**

The DH sector is expected to be completely free from oil, coal and gas by 2030. By that year, the renewable share is expected to be achieved through the use of biomass and heat pumps, whereas the remaining part will be achieved by industrial waste heat recovery and waste incineration, as presented in the table below. The growth of heat pumps in DH, together with the use of waste heat recovery, is expected to reduce the sector’s consumption of biomass beyond 2030 as shown is the graphs below.

![Denmark 2030 Energy Mix](image)

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11 Danish Energy Agency - Roadmap: udfasing af naturgas til rumvarme (2020)
District heating market share projections

According to a study by the Aalborg University published in 2021\textsuperscript{12}, around 260,000 gas and 44,000 installations in Denmark will be converted to DH by 2028. This will bring the market share of DH to reach around 70\% by 2030. The share is expected to remain quite stable in 2040 and 2050.

\textsuperscript{12} Varmeplan Danmark (2021) - En Klimaneutral Varmeforsyning
Finland

Overview

Finland aims to become carbon neutral by 2035. In 2019 the Finnish Government approved a legal act banning the use of coal for energy production by 1 May 2029. This ban is set to have a considerable impact in the DH sector considering that coal is mainly used in combined heat and power (CHP) plants. Incentives and support schemes are planned for those DH companies that plan to phase out coal by 2025. Coal is expected to be replaced by a renewable energy sources and waste heat, mostly coming from industrial heat recovery. DH is considered among the best and fastest routes to achieve climate neutrality in the heating sector in Finland, however, in order for it to continue to modernise and decarbonise, the role of waste heat recovery should be promoted and supported, and sustainable biomass should continue to be considered a renewable energy source.

GHG emission projections

GHG emissions in the DH sector are expected to be cut down to 17.50 g/kWh by 2030 and to be further cut in order to reach zero by 2035, in line with the national goal to fully decarbonise the sector by 2035.

<table>
<thead>
<tr>
<th>Year</th>
<th>GHG Emission (g/kWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2030</td>
<td>17.50</td>
</tr>
<tr>
<td>2040</td>
<td>0</td>
</tr>
<tr>
<td>2050</td>
<td>0</td>
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</tbody>
</table>

Energy mix projections

The graphs below show the fuel mix projections expected in the DH sector in 2030 and 2035. According to the projections, biomass, industrial heat recovery and ambient heat are set to cover the biggest share of DH, with high expectations laying on geothermal and hydrogen solutions as well as small modular nuclear reactors to potentially play a role in the years to come. The use of some fossil fuels is still to be considered for peak loads.
*Renewable energy sources refer to biogas, bio waste, geothermal, ambient energy

**District heating market share projections**

The DH market is relatively mature in Finland, and according to national projections the market share is set to further increase to 45 and 50% between 2030 and 2050.

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**France**

**Overview**

In its National Climate and Energy Plan, France aims to achieve a 38% share of renewable energy in the heating sector by 2030 and to completely phase out the use of coal in the sector by 2028. 13 To do so, it has identified DH as one of the key solutions to achieve these goals.

According to the Heat Roadmap Europe report, the district heating sector in France could really help the country decarbonise its heating sector by 2050 by allowing the use of a large variety of heat sources, both renewable and excess sources of heat, while also creating a strong link to the electricity sector, allowing for not only the decarbonisation of the district heating sector itself but also further integration of renewable electricity into the wider energy system. 14

The projections on the DH market in France include two different scenarios, which differ slightly in the evolution of national heating needs to achieve carbon neutrality in 2050, reflecting different balances between efficiency on the one hand and technological innovation on the other.

The two scenarios below, which will be called A and B, are based on data from the study "Transitions 2050" led by ADEME (French Environment Agency), which presents four scenarios for achieving carbon neutrality by 2050. These four scenarios (Frugal Generation, Territorial Cooperation, Green Technologies, Restorative Betting) include hypotheses on the energy efficiency of buildings, technological evolutions and associated development models.

**GHG emission projections**

According to projections received, in both scenarios A and B, DH is set to reach 67 g/kWh of CO2 emissions by 2030, which will decrease to 31 g/kWh in 2040 and 0 g/kWh in 2050 accordingly.

<table>
<thead>
<tr>
<th>Year</th>
<th>GHG Emissions (g/kWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2030</td>
<td>67</td>
</tr>
<tr>
<td>2040</td>
<td>31</td>
</tr>
<tr>
<td>2050</td>
<td>0</td>
</tr>
</tbody>
</table>

**Energy mix projections**

13 French National Climate and Energy Plan
14 Heat Roadmap France (2018)
The Heat Roadmap Europe report shows a big potential for geothermal energy, large-scale heat pumps and waste heat recovery as the sector decarbonise and upgrade. This is in line with the energy mix projections of both scenarios A and B as presented below.

The forecast mix relies on renewable biomass (42% for scenario A), reflecting the identified resource potential while the share decreases as supply sources diversify depending on energy efficiency levels (34% for scenario B). DH has the unique capacity to valorise waste heat available resources to meet heating needs, and thus reduce the energy consumption of the territory. These mixes take this into account by integrating a high proportion of recovered energy (27% in scenario A, and 22% for scenario B). The latter is based on a strong increase in industrial waste heat, as well as, to a lesser extent, on an increase in this recovery from the waste to energy plants and data centres. These two sources of renewable and recovered energy already represented respectively 21% and 28% of the energy mix of DH in 2020. Geothermal energy remains the third renewable energy source (6% in 2020) and its share will increase significantly in line with the identified potential and the coupling with heat pumps.

By 2050, the mixes will also take into consideration the rise of other climate neutral energy sources such as biogas, solar thermal, as well as electricity with the use of heat pumps. This phenomenon is especially visible in scenario B where the share of these new renewable and decarbonised energies reaches 27% of the mix. Although the technical and economic potential of the technological options remains difficult to predict, such a scenario can also include options such as decarbonated hydrogen or sequestration technologies (CCS/CCU).

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25 Ibid
** Other renewable and decarbonised energy sources include Solar, green gas, Biogas, power to x, renewable electricity and potential new technologies.

### France 2030 - Scenario B

- Natural gas - 27%
- Biomass - 25%
- Geothermal - 7%
- Waste heat - 35%
- Other renewable and decarbonised energy sources* - 5%

### France 2040 - Scenario A

- Biomass - 37%
- Natural gas - 12%
- Waste heat - 24%
- Geothermal - 14%
- Other renewables and decarbonised energy sources* - 12%

** Other renewable and decarbonised energy sources include Solar, green gas, Biogas, power to x, renewable electricity and potential new technologies.
Other renewable and decarbonised energy sources include Solar, green gas, Biogas, power to x, renewable electricity and potential new technologies.
District heating market share projections

Projections on the share of DH in 2030, 2040 and 2050 are set to reach 10, 15 and 20% by these dates in both scenarios A and B.

Germany

Overview

The objective set by the German Government is to reach 50% share of renewable energy in the heating sector in 2030, and DH is set to play a key role in the achievement of this target. However, in order for DH to succeed as a key enabler of the energy transition, the sector requires a clear regulatory framework, both at the EU and national levels, which could incentive long-term investment decisions. This would have an impact on both the expansion of existing networks and the uptake of sustainable energy sources.

As mentioned in the National Climate & Energy Plan\textsuperscript{16}, the future of DH is set to change dramatically in the next few years due to the phase out of coal, which currently still covers a relevant part of the energy used to produce DH in the Germany, and the uptake of several sustainable energy alternatives, which will be outlined in the “energy mix” section.

GHG emission projections

According to projections by the Federal Environment Agency, DH is set to reach 148 g/kWh of CO2 emissions by 2030, which will decrease to 83.5 g/kWh and 0 g/kWh in 2040 and 2050 accordingly.

<p>| | |</p>
<table>
<thead>
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<tbody>
<tr>
<td>2030</td>
<td>148 g/kWh</td>
</tr>
<tr>
<td>2040</td>
<td>83.5 g/kWh</td>
</tr>
<tr>
<td>2050</td>
<td>0 g/kWh</td>
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</table>

Energy mix projections

Energy mix projections for DH supply is set to have a rapid decline of the most polluting fossil fuels together with a rapid expansion of renewables until 2030. The intermediate phase-out of hard coal and lignite will largely be carried by an expansion of natural gas which will reach its peak supply in 2025 at 53% before shrinking to 44% in 2030. Between 2030 and 2050 natural gas, will be supplemented by a stark increase of various renewable energy sources – in particular geothermal energy and industrial waste heat – large scale heat pumps and electric boilers with their combined market share rising from 22% in 2030 to 48% in 2040 and finally 63% in 2050.

The inclusion of climate neutral hydrogen will also increase sharply after 2035, making it the second most important heat supply technology in 2045 after heat pumps, with 18%. While the generation by bioenergy will remain stable in absolute terms ranging between 10 and 12 TWh, the importance of biogenic waste will decrease after 2030.

\textsuperscript{16} German National Energy and Climate Plan (2020)
Germany 2030

- Industrial waste heat - 5%
- Geothermal - 10%
- Solar thermal - 6%
- Electric boilers - 3%
- Heat pumps - 14%
- Hydrogen - 5%
- Natural gas - 66%
- Bioenergy - 11%
- Biodegradable waste - 13%
- Non biodegradable waste - 10%
- Lignite - 2%
- Hard coal - 4%

Germany 2040

- Industrial waste heat - 10%
- Geothermal - 16%
- Solar thermal - 12%
- Electric boilers - 5%
- Heat pumps - 33%
- Hydrogen - 14%
- Natural gas - 41%
- Bioenergy - 12%
- Biodegradable waste - 11%
- Non biodegradable waste - 2%
District heating market share projections

Projections on the share of DH in 2030, 2040 and 2050 are set to reach 18, 20 and 30% by these dates accordingly.

Italy

Overview

Due to climatic reasons, DH is mainly developed in the North-Centre part of Italy and absent in the South. Projections show that the share of DH is set to increase only in these areas in the future.

While data on DH after 2030 are not yet available, the information received so far, which is based on a study run by the Polytechnics of Milan and Turin in 2020, shows that there is a huge potential for the development of DH in Italy and that this technology is set to play a key role in achieving the country’s decarbonisation goals.

Establishing a policy framework that would support and incentive the use of DH against standalone solution in cities, accompanied by funding and support mechanisms, would surely help the sector grow in the medium and long-term.

GHG emission projections

The overall heating sector’s emission reduction foreseen by the National Energy in Climate Plan is of an annual reduction of 0.9 Mtoe/year, with an average increase of about 0.4 Mtoe/year of thermal energy from renewable energy sources in final energy consumption.
The study run by the Polytechnics of Milan and Turin shows that by investing in the expansion of DH, Italy could save up to 15 MT of CO2 each year, while also reducing the concentration of NOx and other pollutants in urban areas equal to removing 8 million cars per year.

**Energy mix projections**

The graph below describes the current status of the energy mix of the sector in 2020. Since there are no future projections, we cannot provide a precise graph. However, we can highlight key aspects.

The phase out of coal in the DH sector is expected by 2025. In 2030 the biggest share of energy used in DH will come from waste heat, waste to energy and renewable energy sources, including biomass, geothermal and solar thermal energy. Both geothermal and solar are expected to grow respectively up to 28,9% and 5,4% in 2030. In the same year, the biggest part of the composition of the energy mix will be represented by heat recovered 57.8%.

**Slovenia**

**Overview**

While the DH is not highly developed in Slovenia, in future’s projections, the sector is set to play a greater role than it is today and will also act as a key connecting factor between the heating and the electricity generation sectors with renewable gases and hydrogen.
Accelerating the development of DH has been identified as one of the key priorities and challenges, in the field on climate and energy policy, to decarbonise Slovenia in the National Energy and Climate Plan. Slovenia is currently working on a national district heating action plan.

**GHG emission projections**

Projections for emissions coming from the DH sector in Slovenia are set at 3200, 1000 and 0 kiloton for 2030, 2040 and 2050 respectively.

<table>
<thead>
<tr>
<th>Year</th>
<th>Kiloton</th>
</tr>
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<tbody>
<tr>
<td>2030</td>
<td>3200 kton</td>
</tr>
<tr>
<td>2040</td>
<td>1000 kton</td>
</tr>
<tr>
<td>2050</td>
<td>0 kton</td>
</tr>
</tbody>
</table>

**Energy mix projections**

Slovenia, as mentioned in its NECP, aims to increase by 1% per year the share of renewable energy sources and surplus heat in DH by 2030. By this year, most of the energy used to produce DH will come from hydrogen, renewable energy sources and a mix of gaseous, solid and liquid fuels as displayed in the graph below.

No projections are yet available for 2040 and 2050.

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17 Slovenian National Energy and Climate Plan
Sweden

Overview

By 2030 the Swedish district heating sector aims to have completely phased out fossil from DH and base most of its production on recovered energy, such as residual heat from industries, businesses and buildings, energy recovery of waste and fossil free renewable fuels.

Negative emissions are expected in the DH sector after 2030, thanks to installation of bioenergy with carbon capture and storage (BECCS) and waste incineration-CCS.

Furthermore, sector integration will be crucial for the overall energy transition of Sweden. District heating will play a key role as an enabler for the electrification of industry and transport sectors, by both relieving the electricity system during wintertime where increasing capacity constraints occur both locally and at national level, providing basis for further electricity production from CHP plants as well as make use of the potential of new waste heat sources from hydrogen production.

GHG emission projections

Despite the phase out of fossil fuels some GHG emissions are still expected in the DH sector in 2030 of 11.55 g/kWh. As of 2040, projections see the DH sector contributing to negative emissions of -79.4 and -115.6 g/kWh in 2040 and 2050 respectively.

<table>
<thead>
<tr>
<th>Year</th>
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<tr>
<td>2050</td>
<td>-115.6</td>
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</tbody>
</table>

Energy mix projections

No major changes are expected in the DH energy mix in the coming decades. Biomass, i.e. waste wood such as tops, branches, bark, sawdust, will continue to be the main fuel in Swedish district heating, together with energy recovery from waste incineration.

Model scenarios shows that waste heat will increase in the mix, and particularly in electrification scenarios, low temperature waste heat will increase from data centres. This will subsequently increase the use of large-scale heat pumps in the sector.

District heating market share projections

Since the Swedish DH market is rather mature, future market share projections are expected to reach 50% in 2030 and to only increase slightly in 2040 and 2050.
The Netherlands

Overview

The Dutch Government has set the goal to fully decarbonise the heating and cooling sector by 2050. The Dutch heating system has always relied considerably on natural gas and in order to switch from this model to a more sustainable one, the Government has adopted a so called “district-oriented approach”, which identifies DH as one of the key technologies to invest in to reach full decarbonisation, particularly in urban area.

While projections are only available for up to 2030, it is already possible to estimate that the current relatively low share of DH in the country will increase in the next decades, particularly if the right policy framework at the EU and national levels will be adopted, together with investments and funding measures aimed at accelerating the development and decarbonisation of the sector.

GHG emission projections

According to latest projections, DH in The Netherlands is set to emit 68,04 g/kWh in 2030, 36 g/kWh in 2040 and 0 g/kWh in 2050.

<table>
<thead>
<tr>
<th>Year</th>
<th>Emission (g/kWh)</th>
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<tbody>
<tr>
<td>2030</td>
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<tr>
<td>2040</td>
<td>36</td>
</tr>
<tr>
<td>2050</td>
<td>0</td>
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</table>

Energy mix projections

In 2030 about 25% of the energy mix used to produce DH is expected to come from bioenergy, 25% from residual heat coming from waste incinerators, 10% residual heat from industry like datacentres, about 10% from geothermal energy, another 10% natural gas, and a bit less than 10% from heat retraction from powerplants, the last 10% would most likely come from electricity, small scale CHP, ATES and aqua thermal energy.

Proper estimates for 2040 and 2050 do not exist at national level. One can only assume that the sources relying on fossil fuels like natural gas boiler and heat retraction from powerplants will reduce further towards 0 in 2050. However, it is good to underline that the DH market will grow so the addition of new heat sources will play a bigger role than the replacement of older ones.
District heating market share projections

Projections for the DH market share in 2030, 2040 and 2050 respectively are set to reach 14.5%, 26% and 37.5%, compared to the current 5.3%.

9. Objective 2050: key enablers at the European level

The DH sector is set to play a key role in achieving the ambitious EU energy and climate objectives, while contributing to the diversification of energy supply and the deployment of sustainable energy sources.

However, the pace and the success of the transition towards a fully decarbonised and sustainable sector will depend on some key aspects, such as:

- **Access to funding and investments** for new and retrofitting projects on district heating networks, aimed at speeding up the transition towards a more sustainable future for the sector. Aid must be available to modernise heating systems when there is a clear roadmap to climate neutrality.
- **Equal treatment of renewable energy sources and waste heat** used in heat networks. Industrial waste heat could cover at least 25% of district heating generation. In addition, there is significant heat recovery potential from tertiary waste heat sources, which could cover 10
% of the EU's total energy demand for heat and hot water. Promoting the use of waste heat in heat networks is key to decarbonise EU cities.

- **Implementing a uniform CO\textsubscript{2} price across the European heating sector** to ensure a level-playing field in the heating market. The same carbon cost must be paid regardless of the size of the installation when using fossil fuel. The current EU emission trading system (ETS) covers only large installations, leaving out of its scope most of heating sources at EU level, such as individual boilers fired with gas and oil.

- **Introducing mandatory heat planning for cities and communities.** Making heat planning mandatory will enable cities across Europe to assess the potential and make the best use of locally available resources. Cities with proper heat plans in place have harvested the combined potential of building renovation and the deployment of efficient/renewable heat networks providing cost-efficient and sustainable heating for their citizens.

- **Stop aid for new individual gas boilers in new buildings.** Individual fossil boilers are by far the least energy efficient heating solution and expose consumers to price volatility. District heating networks on the opposite combine renewables, waste heat and large-scale heat pumps making heating sustainable and efficient.

### 10. Conclusions

Although this analysis is not fully representative of the whole European Union’s district heating market, data collected show that the district heating sector has a key role to play in help achieve climate neutrality by 2050 and that all countries under consideration are on track to reach this ambitious target. However, in order for it to succeed as a key enabler of the energy transition, a stable and fair regulatory framework that incentivises long-term investment decisions is needed at both the EU and national levels. The revision of the Heating & Cooling Strategy, which dates back to 2016, is the first step in the right direction to pave the way for a faster and successful transition of the sector towards net-zero emissions.