Towards carbon-neutral heat markets

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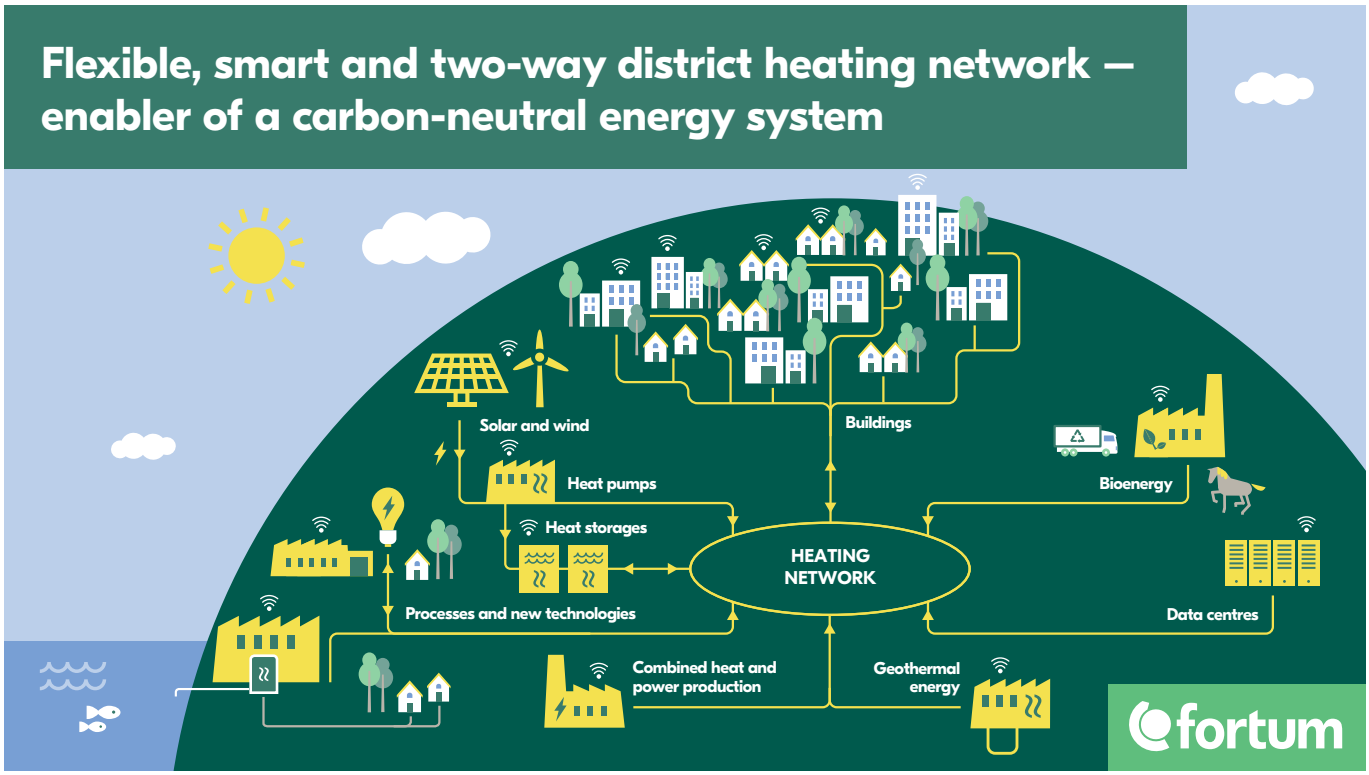
Heating and cooling in Europe is the biggest energy end-use sector, representing about half of the total energy consumption. Heating and cooling is responsible for approximately 40% of Europe's carbon emissions. It also represents a bigger share of household spending than electricity utilised for other purposes.

Heating and cooling is produced and consumed for the purposes of space heating and cooling, cooking and supplying hot water in buildings, as well as for industrial processes. Space heating and cooling, including hot water consumption and cooking, account for about 66% of the total heating supplied in the EU. This amounted to an estimated final energy consumption of about 3,886 TWh (334 million TOE) in 2017.

Residential sector accounts for 45% of total heating and cooling consumption in Europe.

District heating and cooling is one of several solutions to supply heat and cooling to end users.

FORTUM'S VISION FOR HEATING AND COOLING



Highlights

- As the biggest energy-consuming sector, heating and cooling deserves better policies to enable it to contribute to decarbonisation and economic wealth.
- Better statistics and quality of available information on the sector is needed.
- Regardless of the regulatory approach the competition between different heating and cooling options should be enhanced. Consumers should be able to choose between different alternatives, also in terms of their environmental footprint.
- Fair competition between different heating and cooling solutions implies equal treatment in legislation and regulation (decarbonisation, renewables, access to heat supply and consumption, building codes, zoning and city planning, etc.).
- District heating and cooling operators should come up with new innovations related to technologies and services as well as with new business concepts to meet customer demands.
- Innovations are also needed to couple heating and cooling with other related sectors, especially electricity. Since CHP production, heat storage, large-scale heat pumps and electric boilers contribute significantly to increasing balancing needs of the electricity market, it is important to create and incentivise mechanisms for sector coupling.
- To safeguard fair competition, different regulations must treat suppliers equally, and regulatory overlaps should be removed. This applies to environmental regulations, including CO_2 reduction measures (participation in ETS and/or CO_2 taxation schemes) and other fiscal measures.
- When district heating is the subject of cost-based price regulation, any incentives to meet policy objectives, customer engagement, system optimisation and security of supply are not as easy to implement as markets with liberalised pricing.

Enabling decarbonisation in heating and cooling markets

National heating and cooling markets in the EU are very different from each other, due to the varying climate conditions and available supply alternatives. The owners and tenants of residential, tertiary and industrial buildings are the core customers. To satisfy the heat demand created by the customers, a number of supply options are in use. The most significant are district heating, direct electricity heating, heat pumps, and individual gas, pellet or coal boilers.

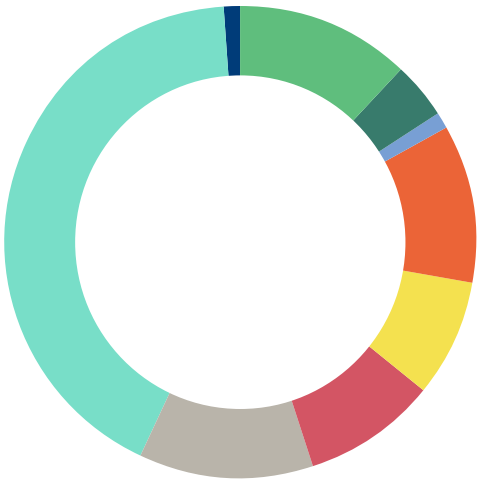
In Europe, the highest share of the primary energy is used heating and cooling purposes; unfortunately, however, the supply is not yet very clean. In 2017, less than 20% of the overall EU-level heat supply was based on renewables. That indicates the magnitude of the efforts needed to eventually become decarbonised.

District heating (DH) currently represents up to 10% of the total heat supply in the EU. It has been acknowledged that DH could and should take a scalable and thus extremely important role in the decarbonisation of the heating markets.

Contributing to the established energy and climate policy targets requires the heating and cooling markets to be developed. The current policy focus must be widened and improved. It must cover the whole heat sector and enhance equal operational and regulatory conditions for all the market participants, including DH. That would create a level playing field and enable competition between alternative sources of heat supply.

We believe that increasing competition between different heating methods benefits customers and

HEATING AND COOLING FINAL ENERGY DEMAND BY CARRIER IN EU28



Oil 12%
Other Fossil 4%
Solar thermal 1%
Biomass 11%
Coal 8%
District heating 9%
Electricity 12%
Gas 42%
Heat pumps 1%

Most of the thermal energy is produced from fossil fuels (66%) and only 13% comes from renewable energies. Electricity and district heat together supply 21% of heat, which may or may not be renewable, depending on local circumstances.

source: Heat Roadmap Europe

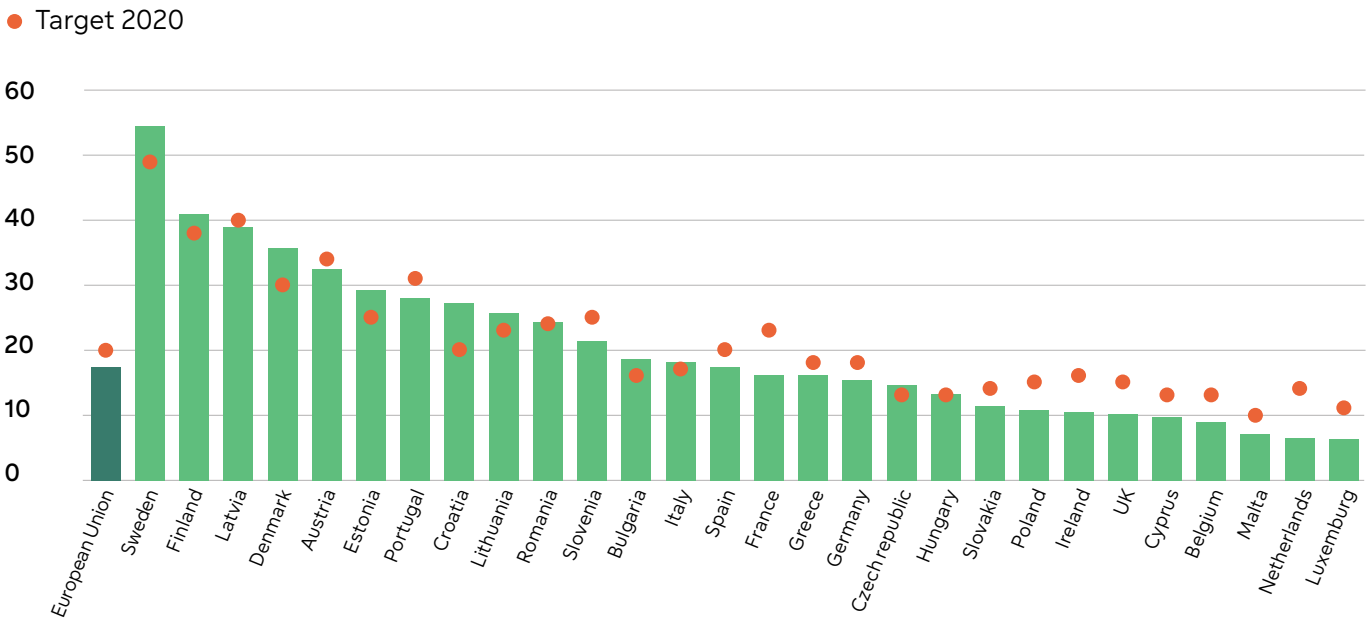
suppliers alike which normally leads to better service levels and promotes innovations in technologies and business/service concepts.

The importance of proper incentives and enablers for the customers, enabling them to influence their own environmental footprint as well as the price tag of their heating and cooling consumption, cannot be overlooked. To enable conscious decisions at the customer level it is crucial to provide them with clear, readily available and transparent information about the heat sector. Customers must have access to the full information about the energy and environmental performance of their heat supply source.

An open and honest dialogue between customers, suppliers and decision makers is necessary to provide the swift and sustainable changes needed to transition to low-carbon heating and cooling markets. Ambitious policy targets, effective regulatory steering and efforts based on common vision will lead to the necessary decarbonisation of the heat sector, benefitting customers, operators and the whole society.

The upcoming implementation of the Clean Energy for all Europeans package should be planned with the aim to enable smart utilisation of waste heat and renewables within the scopes of district heating networks. This implies certain changes to the existing national regulatory schemes, providing incentives leading to decarbonisation of the systems.

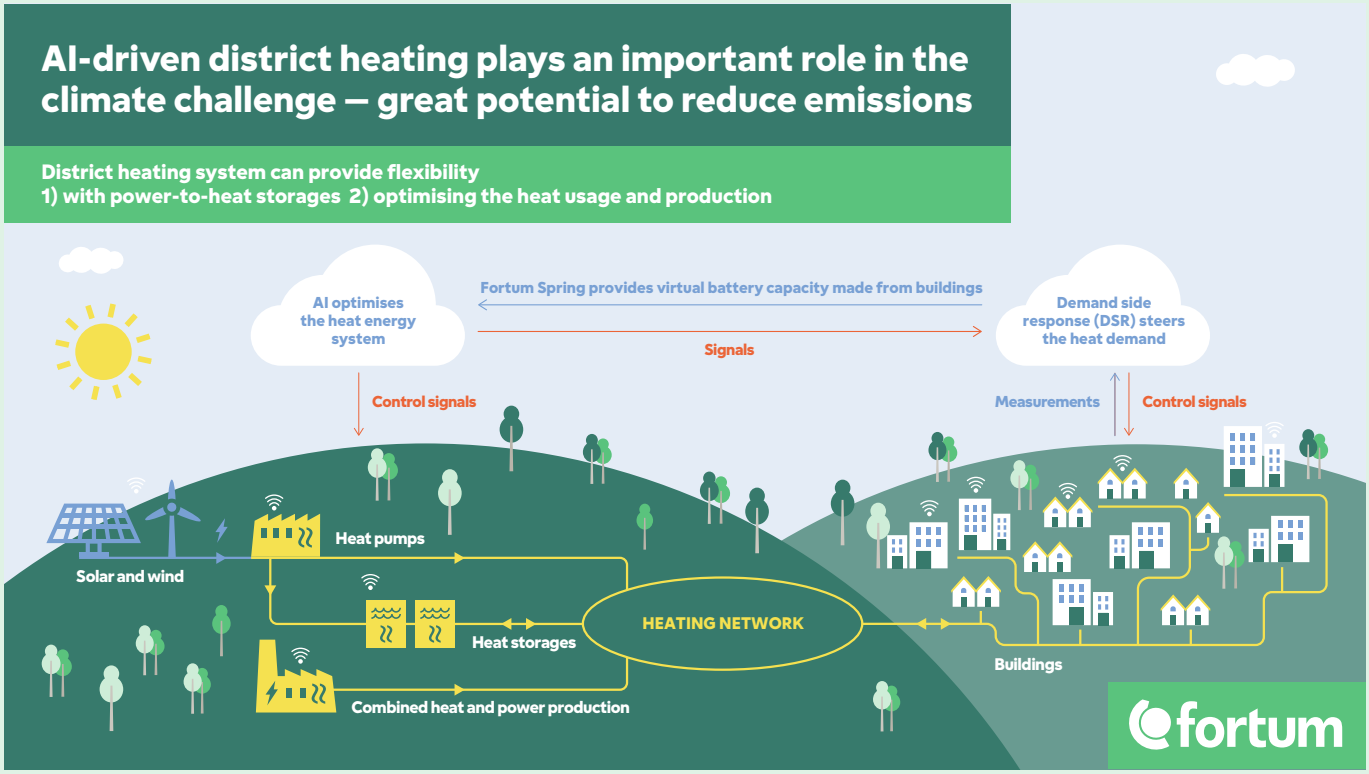
SHARE OF ENERGY FROM RENEWABLE SOURCES IN THE EU MEMBER STATES 2017



source: Eurostat

CASE

Artificial intelligence (AI) to optimise the entire district heating system



Fortum has developed artificial intelligence (AI) to optimise the district heating system and its operations; this will enable the flexible district heating system of the future.

Our AI predicts the heat demand of our customers, steers the usage of storages and guides the control room in the optimal utilisation of assets. In practice, and already now, this often also means the prioritisation of carbon-neutral production.

AI has already been implemented in Fortum's district heating systems in Finland, the Baltic countries, Poland and Norway.

AI development work and the integration into operations continues. Artificial intelligence will enable automation of district heating when electrification increases the amount of controllable units as the energy system becomes more complex. It can provide mechanisms for the frequency market and cost efficiently decrease investment needs for the electricity distribution network.

This way, the district heating system becomes an enabler of flexibility for the electricity system, carbon-neutral energy system and, eventually, a cleaner world.

CASE

Carbon-neutral district heating for Espoo in the 2020s

The City of Espoo and Fortum signed an agreement to make Espoo's district heating carbon-neutral in the 2020s. Carbon-neutral heating is the single most important factor in reducing greenhouse gas emissions in Espoo.

Currently almost 25% of Espoo's district heat production comes from carbon-neutral energy sources such as biomass and excess heat. In 2020 Fortum's new bio-heating facility will replace an old coal-fired boiler and thus reduce CO2 emissions by up to 90,000 tonnes per year, which is about 14 per cent of the current CO2 emissions created by district heat production in Espoo.

We at Fortum are building carbon-neutral district heating with a special focus on non-combustion and electrifying heating technologies. The share of non-combustion production is targeted to exceed 30% by 2023. Our new solutions are based on our two-way district heating network, which enables us to operate as a flexible part of the future sustainable and smart energy system, for example in energy recycling and storage. We are already utilising excess heat from sewage water, data centres and other buildings in our two-way district heating network. We are also examining the possibilities of geothermal heat and heat storages; the Suomenoja power plant already operates an 800-MWh heat accumulator. We also provide our customers and end-users solutions to save energy and control building temperature conditions.

We are currently testing district heating demand side response with shopping centers, schools and some apartment houses in Espoo.

Heating and cooling in Fortum

Fortum is a major supplier of district heating in the Nordic countries, Poland, the Baltic countries and Russia. Fortum has a total of about 3,400 kilometres of district heat pipes in these countries.

OUR OPERATIONS

We produce heat in CHP plants, heat-only boilers, heat pumps as well as using recovered heat

We supply district cooling in Estonia, Sweden and Finland

We provide heating in several cities in Europe and Russia:

- In Finland: Espoo, Kauniainen, Kirkkonummi, Tuusula, Järvenpää and Joensuu
- In Poland: Wrocław, Częstochowa and Płock
- In Baltic countries: Jelgava, Parnu, Tartu and small networks in Lithuania
- In Norway: Oslo - Fortum Oslo Varme
- In Sweden: Stockholm - Stockholm Exergi
- In Russia: Novogorny, Chelyabinsk, Tyumen

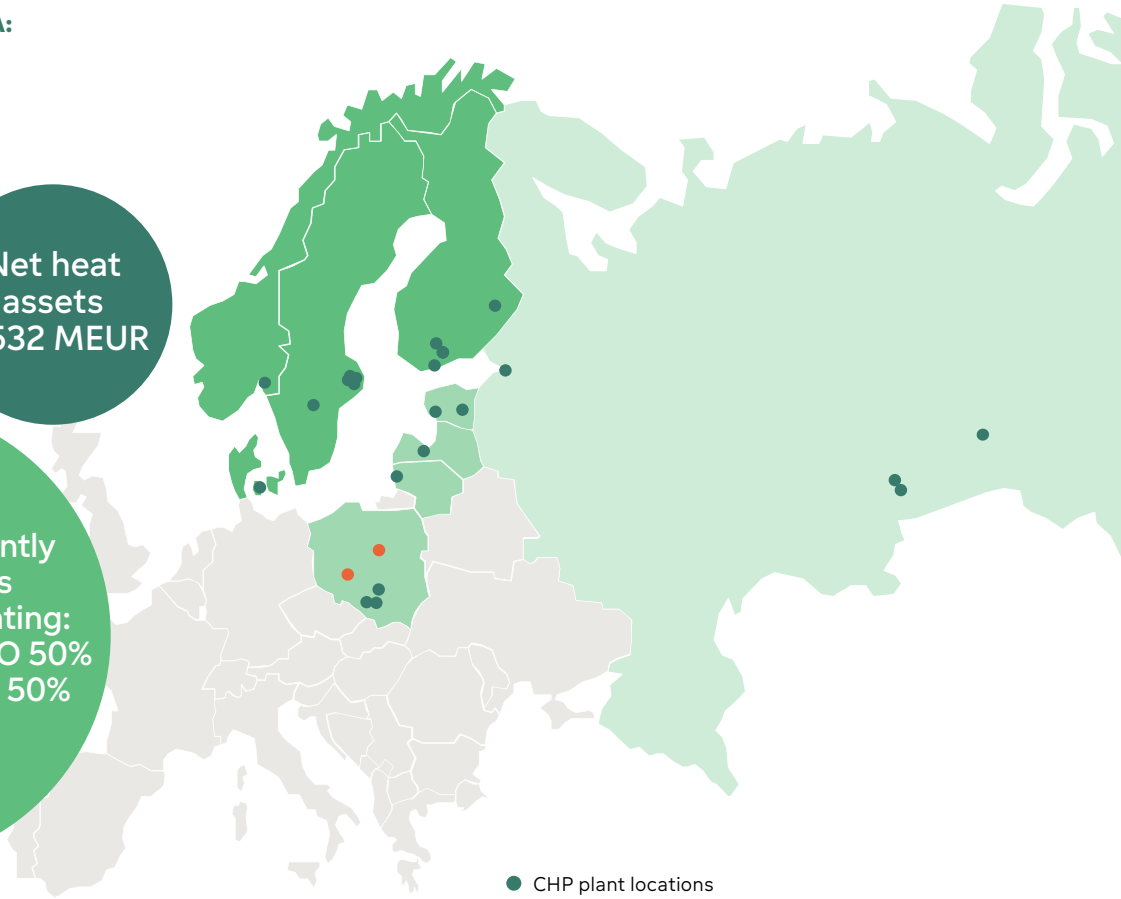
KEY FIGURES, AS OF 2018

CITY SOLUTIONS AND RUSSIA:

DH sales 31.5 TWh and ~800 MEUR

Net heat assets 6,532 MEUR

Fortum's share in jointly owned companies providing district heating: Fortum Oslo Varme, NO 50% Stockholm Exergi, SE 50% TGC-1, RU 29.5%



CHP plant locations

District heat supply/networks w/o own production

More information about our power plants: www.fortum.com/powerplants

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