How can the EIB and the EU financial mechanisms support the decarbonisation of district heating?

Exemplary cases in central and eastern Europe

Contact for more information:

Anna Roggenbuck
Policy officer
CEE Bankwatch Network
annar@bankwatch.org

Case studies developed by:
Magdalena Klarenbach
Education and Research
Energiaklub Hungary
CEE Bankwatch Network

The EU's policy framework and challenges in the decarbonisation of district heating

The heating and cooling sector accounts for half of the EU's energy consumption, and both district heating and individual heating are still dominated by fossil fuels and inefficiently burned biomass. According to Eurostat data, only 22 per cent of heating and cooling is generated from renewable energy.[1] The EU's Energy Roadmap 2050 emphasises that the decarbonisation of this sector, through increasing its efficiency and use of renewable energy sources, is key to the success of the EU's climate neutrality strategy: 'Renewable heating and cooling are vital to decarbonisation. A shift in energy consumption towards low carbon and locally produced energy sources (including heat pumps and storage heaters) and renewable energy (e.g. solar heating, geothermal, biogas, biomass), including through district heating systems, is needed'.[2] The EU Strategy on Heating and Cooling was adopted in 2016 to integrate the issue of efficient heating and cooling into EU energy policies.

In particular, district heating and cooling currently represents around 10 per cent of the heat demand across the Union, with large discrepancies between Member States.[3] The highest shares of district heating in final energy demand for heating and hot water can be found in Denmark, Sweden and Finland, whereas in

---

[1] European Commission, Heating and cooling, *European Commission,* accessed 8 March 2022.

[2] European Commission, *Energy roadmap 2050*, (COM(2011) 885 final, *European Commission*, 2012.

[3] European Parliament and Council of the European Union, Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources, *EUR-Lex*, 12 December 2018.

central and eastern Europe the share varies from 7 per cent in Croatia to 42 per cent in Lithuania.[4] On average, the share of district heating networks is higher in northern, central and eastern Europe than in western European countries. In general, district heating is still heavily dominated by the use of fossil fuels, mostly gas and coal (though this is falling).[5]

The district heating sector can significantly contribute to the decarbonisation of heating and cooling because, where it is cost-effective and feasible, it is more energy efficient than individual solutions and it enables renewable energy deployment at a lower cost. Expansion and transformation to sustainable district heating systems brings environmental and socio-economic benefits such as clean air, resource efficiency, convenience for individual consumers and the development of the local green economy.

Multiple challenges, however, must be overcome to transform inefficient district heating systems, and project developers and financial and technical assistance must address these. A holistic approach to this should take into account the need to integrate district heating systems with other parts of the energy system, such as through combined heat and power production; the need to increase the efficiency of demand and supply for both heating and cooling; and the possibility to integrate a variety of energy sources into a single heating system and increase the system's flexibility (for example, combining waste heat from local industry with renewable sources). Every system will have its challenges based on national and regional differences.

At the EU level, a legal framework is in place for directing and coordinating district heating modernisation. The Renewable Energy Directive requests that Member States encourage local and regional administrative bodies to include heating and cooling from renewable sources in the planning of city infrastructure and ensure that guidance is available during the planning, design, building and renovation of industrial, commercial or residential areas.

National energy and climate plans should include strategies and measures through which the European Union Member States address energy efficiency, renewable energy and greenhouse gas emissions reductions in the district heating sector. The first assessments of the plans show that Member States plan to increase efficiency of district heating systems and deploy more renewable energy sources; however, only a few showed an expected increase in demand from district heating systems.[6]

Member States should have also conducted and submitted their national assessments of the potential for energy efficiency in heating and cooling to the European Commission by end of 2020. These assessments should include a description of the role of efficient heating and cooling in long-term emissions reductions and existing related policies and measures. Information on district heating transmission installations, both existing and planned, should also be included, accompanied by an assessment of the potential for reducing heat losses

---

[4] Brian Vad Mathiesen, et al., *Towards a decarbonised heating and cooling sector in Europe: unlocking the potential of energy efficiency and district energy*, *District Energy in Cities Initiative*, November 2019.

[5] Ibid. See for example Figure 2-6. Share of fuels in EU-28 district heating production, page 30.

[6] Agne Toleikyte and Johan Carlsson, *Assessment of heating and cooling related chapters of the national energy and climate plans*, EUR 30595 EN, Publications Office of the European Union, 2021.

in existing district networks and decentralised and centralised technical solutions for high-efficiency heating and cooling.[7]

The EIB's policy and financing for the decarbonisation of district heating

The European Investment Bank's (EIB) energy lending policy was renewed in 2019. It recognised that renewable heat was at a relatively early stage of adoption and noted that, along with energy efficiency, renewable generation capacity in this sector will have to increase.

The EIB's policy committed the Bank to continue financing the expansion and rehabilitation of district heating networks and to provide project preparation and implementation support to public authorities and promoters developing strategies to decarbonise district heating systems.[8]

As a rule, the EIB excludes fossil fuels from its financing, which also applies to district heating. However, as an exception, gas-fired co- or tri-generation projects may still be eligible if they meet certain energy efficiency criteria and if they result in emissions of less than 250 grams of CO_2 per kilowatt hour (kWh) in the production of power. However, projects that lead to an increase in the combustion of coal, peat, oil or non-organic waste are not eligible for financing. In addition, investments in district heating and cooling rehabilitation are eligible if they meet the definition of an 'efficient district heating and cooling system', as defined by the EU Energy Efficiency Directive.

Between 2019 and 2021, the EIB provided, in 10 EU countries and two countries outside the EU, over EUR 1.2 billion for energy projects with components that may relate to district heating, such as steam and air conditioning supply, heat production plants, heat supply and combined heat and power production. This includes over EUR 20 million provided to smaller projects through financial intermediaries. The exact sum for district heating and cooling could not be compiled because there is no specific NACE code[9] for district heating and cooling.

The EIB's Climate Bank Roadmap 2021-2025 recognised the need to continue providing technical assistance to project developers. Existing technical assistance mechanisms like European Local Energy Assistance (ELENA), Joint Assistance to Support Projects in European Regions (JASPERS) and Project Advisory Support Service will be available for district heating project developers.

Since it was established in 2009, ELENA has supported around 25 projects related to district heating rehabilitation and development. However, only three of them were located in central and eastern Europe – two in Slovenia and one in Poland. JASPERS has assisted around 36 projects concerning district heating, including

[7] European Commission, Annexes to the Commission recommendation on the content of the comprehensive assessment of the potential for efficient heating and cooling under Article 14 of Directive 2012/27/EU, C(2019) 6625 final, *European Commission*, 25 September 2019.

[8] Point 47. The European Investment Bank, *EIB energy lending policy*, *The European Investment Bank*, 15 November 2019.

[9] NACE codes are the common name used to refer to the industry standard classification system used in the EU. Their full name is the Statistical Classification of Economic Activities in the European Community.

district heating systems' rehabilitation, the integration of co-generation power plants and energy efficiency in district heating. JASPERS provided assistance 26 times in Romania, four times in Croatia, two times in both Lithuania and Cyprus and once each in Serbia and Slovakia.

Making financing available for district heating decarbonisation: exemplary cases

Think tanks, research centres and NGOs have conducted extensive policy analyses of the needs of district heating systems modernisation, both at the EU level and in individual Member States. The analyses indicate that systems across the EU must be efficient. In central and eastern Europe specifically, efficiency needs to be increased simultaneously with undertakings related to renewable energy, waste heat and combined heat and power integration. The existing systems form a good base for further expansion and the establishment of new systems for connecting more buildings.

This will require investments in the upgrade and expansion of district heating transmission infrastructure and renewable heating and cooling production units. Technical assistance, advice and international cooperation and exchange can also positively contribute to this transformation. The biggest challenge to financing this, especially for small communities, is the upfront costs: renewables are often more expensive, and the investment payback time is long.

Because investments in clean district heating are intensive and long-term, it is crucial to use available financing mechanisms. For complex investments in district heating networks, there are increasingly available funding mechanisms aimed at introducing fourth generation solutions in heating or modernising existing district heating networks and assisting in energy efficiency measures. There are various EU funds, international finance institution mechanisms, and other donors including development banks and agencies (KfW, USAID, GIZ, the World Bank) that national and local authorities can use, whether for the initial stages when they need technical assistance, for new project design and development, or for existing district heating system modernisation.

CEE Bankwatch Network collected examples of successful modernisations of district heating and cooling systems conducted with the support of the EU's and the EIB's financial mechanisms under the 2014 to 2020 Multiannual Financial Framework. For the subsequent framework (2021 to 2027), the following funding sources are available: LIFE / Clean Energy Transition; Horizon Europe; European structural and investment funds (ESIF); and InvestEU, comprising of the InvestEU Fund (integrating all centrally managed financial instruments) and advisory and technical advice mechanisms. The InvestEU Fund is a successor of the European Fund for Strategic Investments and will be a guarantee fund for which the European Investment Bank will be the main financial partner, benefitting from 75 per cent of available guarantees. Other financial institutions, including national promotional banks and the European Bank for Reconstruction and Development, will have access to the Fund at the level of 25 per cent of its guarantees.

The analysed case studies show how available finance and technical assistance mechanisms can support district heating rehabilitation and development, their transformation from fossil fuels to renewable energy sources, and the deployment of innovative technologies. We present case studies from Poland, Hungary and Lithuania that represent the efficient use of renewable energy, waste heat and technical assistance.

In Hungary, in the small municipality of **Bóly**, an innovative solution consisting of three pipeline systems has been built in the city centre. This has made the utilisation of thermal energy much more efficient. With the help of three-stage recovery, it is possible to extract 30 per cent more energy from thermal water. This three-stage geothermal energy utilisation system is currently unique in Hungary.

Geothermal energy for district heating is also used in **Szentes**, a town of 28,000 inhabitants in southern Hungary. Cascade-type utilisation, which includes several stages and different heat utilisation modes, was deployed to maximise the heat recovered. Continuous development and expansion has made it possible for Szentes to base its district heating supply fully on geothermal energy throughout the year, providing almost 90,000 Gigajoules (GJ) of heat. The system only needs a small amount of safety gas reserve capacity in case of extreme weather conditions. The use of geothermal energy contributes significantly to meeting the municipality's sustainable energy and climate goals.

In Lithuania, the **Vilnius District Heating** company received an EIB loan for investments in network modernisation and the installation of biomass boilers, and a minimal amount for gas boilers. This should improve the efficiency of the network, thus reducing demand.

Szczecin, a city of 400,000 inhabitants in northern Poland, is developing the first fifth generation district heating and cooling network in the country. It has been implemented with Horizon 2020 support and will serve as an example for how to create a smart and low-temperature district heating system using locally produced waste heat.

Finally, ELENA supported the **Polish National Energy Conservation Agency's (KAPE)** pre-investment services for providing technical assistance to enterprises from the heating district sector. KAPE works with its customers, taking into account their needs as well as local fuel availability data. The final investments vary from modernisation of a dedusting system to a fourth generation district heating system with extensive use of renewable energy sources and the construction of heat storage facilities. Support from ELENA is a significant tool for facilitating the energy transition of the small and medium-sized district heating companies in Poland. It will increase KAPE's capacity to manage and improve coordination and will enable it to provide the needed technical and financial advice to beneficiaries who develop projects for modernising heat production.

Recommendations

- The EU should financially and technically support the transition of district heating networks only to sustainable renewable sources, preventing conversions from coal to another fossil fuel.

- More emphasis needs to be placed on technical assistance and creating more widely accessible and versatile technical assistance arrangements to help smaller investors such as municipalities, small municipal utilities and energy communities develop truly clean, innovative projects across the EU and its neighbourhood.

- The potential for more widespread use of local renewables and recycled excess heat capture needs to be explored and mapped out more thoroughly in technical assistance and project economic assessments. However, there should be very strict rules and restrictions for the use of biomass.
- The sustainability criteria of bioenergy need to be stricter and the climate impacts from biomass burning need to be assessed in order to prevent the massive use of biomass and ensure advantageous implementation of other renewable energy sources.
- Technical assistance and financial mechanisms should promote higher generations of district heating systems (fourth generation and above), which use lower temperatures of supply water and would thus enable the wider use of renewables and seasonal accumulation technologies.
- The ‘energy efficiency first’ principle must be a horizontal priority in all energy and infrastructure investment programmes. Support for district heating systems should go hand in hand with the renovation of buildings.

Geothermal district heating system in Bóly, Hungary

History of geothermal energy utilisation in Bóly

Bóly is a small town in Southwest Hungary with less than 4,000 inhabitants, but a patterned geothermal district heating system. This serves as a good example for how to use geothermal energy in an efficient way.

Source: Gábor Szita, Energy utilization of thermal water

The beginnings of geothermal energy use in Bóly were almost due to chance. Uranium ore was explored on the outskirts of the settlement in 1982, and an 84°C thermal water reservoir was found at a depth of 1,300-1,400 metres. However, the utilisation of the water body for heating had to wait a long time thanks to restrictions on its use due to the nearby thermal bath in Harkány.

Encouraged by the success of the first drilling, the local government decided to drill another thermal well in 2004 in the city centre as part of a tender. However, this well quickly became empty. Even at a depth of 1,500 metres, they could not reach the Triassic limestone subsoil, which had been found nearby at a depth of 1,300 metres. The municipality had received EU (Special Accession Programme for Agricultural and Rural Development (SAPARD)) support for drilling a thermal well and using geothermal energy in heating, so a solution had to be found somehow.

Fortunately, at a depth of about 600 metres, the Miocene limestone rock layer also contained thermal water, but the outflow temperature of this water was only 42°C. In order to be able to utilise this thermal water without heat pumping, low temperature (underfloor) heating systems had to be designed and implemented in buildings.[10] The consumers of geothermal energy thus became the library, the town hall and the primary school. The library already had underfloor heating, but in the latter two it had to be built as part of the investment. They managed to find a way for secondary utilisation of thermal water too, since chilled thermal water was used to fill the school's pool. The total amount of utilised geothermal energy was 1.5 terajoules per year (TJ/year).

The operation of the system started in 2005. Water was extracted from the thermal well by a submersible pump because the resting water level was low. In the degassing tank located after the well, a small amount of gas was separated from the thermal water, which was transferred by controlled pumps to the three buildings. In the buildings the water transferred heat to the underfloor heating via a heat exchanger. The process was controlled by a power line communication (PLC) control system.

Development of the new three-stage geothermal based district heating system

After the completion of the geothermal utility construction in 2005, the municipality of Bóly started preparations for a much larger-scale geothermal project. They wanted to utilise the high-temperature geothermal field located two kilometres from the western edge of the city, the existence of which had been previously proven by geological exploration. With the new thermal water source of almost 80°C it was possible to supply significantly more consumers than before.

In 2006, the municipality successfully applied for the development of a district heating system based on geothermal energy within the framework of the National Development Plan and the Environmental Protection and Infrastructure Operational Programme. Local government received a total of HUF 239 000 000 (approximately EUR 900 000) in non-refundable grants, from which 75 per cent was from EU sources and 25 per cent from national sources. The additional self-sufficiency part was HUF 96 000 000 (approximately EUR 360 000), ensured through a successful EU Self-Sufficiency Fund submitted to the Ministry of the Interior.

The primary goal of the investment was to eliminate the use of fossil energy in all municipal buildings and other public institutions using thermal water for heating, and to reduce CO_2 emissions. The project did not include additional energy efficiency investments in buildings.

First of all, a new production well was necessary to provide enough geothermal energy to operate the district heating system, as the water flow and temperature of the former thermal well (40°C) were unsuitable for reasonable expansion.

[10] Design temperature for underfloor heating: 38/30 °C at -15 °C outdoor temperature

The municipality commissioned external expert companies to design and build the electricity supply, deepen the thermal well, and build the transmission lines and heating centres, which were carried out as part of the programme in 2007 and 2008:

- as an innovative solution, three pipeline systems were built in the city centre, tmaking the use of thermal energy much more efficient – this three-stage geothermal energy utilisation through a cascade system is currently unique in Hungary,
- two new thermal wells were established, a production well (1,590 metres; 80°C; volume flow: 60m^3/h; with a submersible pump) and an injection well (1,500 metres),
- the total length of the installed transmission line was 7 kilometres,
- heating centres have been set up in different locations (with plate heat exchangers, control valves, measuring and control devices, etc.),
- Eight new institutions were connected, and a reserve capacity of 20 per cent remained in the system,
- two additional buildings were connected to the thermal water system later.

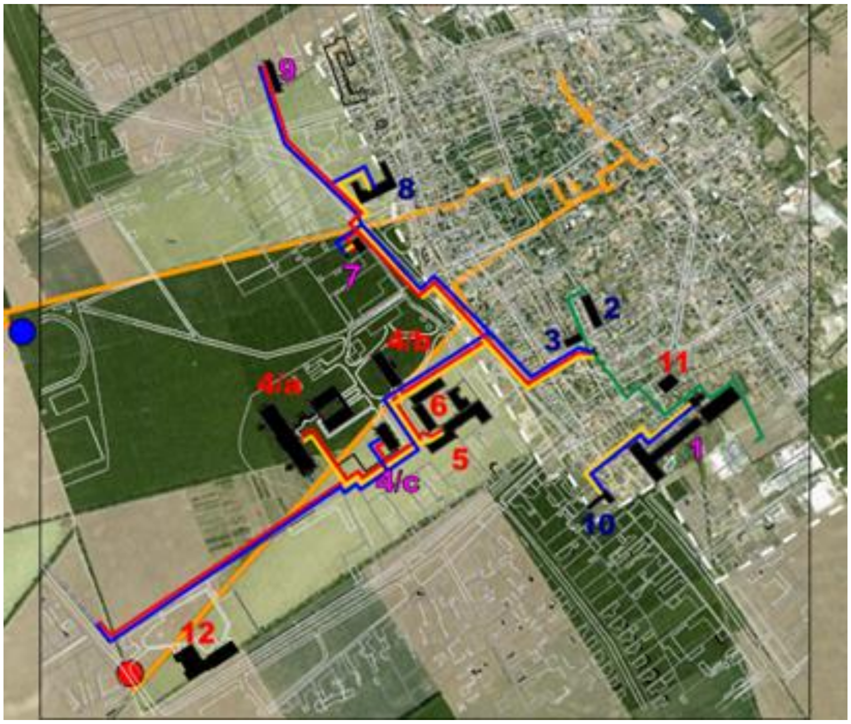
The newly built geothermal pipeline network passed by the headquarters of a famous local agricultural company. The laying of the transmission line was still pending when the company applied for and received permission from the municipality to connect their office building to the geothermal heating network at their own expense.

Although originally the geothermal programme did not include the conversion of the town hall's heating system, after a brief economic assessment, the local representative body decided to develop a low-temperature heating system for utilising cooled thermal water in the building; thus, the Town Hall was also included in the geothermal system. The work was carried out along a comprehensive building modernisation programme.

In 2010, a new geothermal heating programme was carried out to take advantage of the 20 per cent remaining capacity of the district heating system. They managed to provide heat for underfloor heating systems, domestic hot water production and the technological heat demand of the three halls in the Bóly Industrial Park (8,400 m^2) that are owned by the municipality. In 2013, new facilities, the waiting area of the bus stop and the building of the small castle were connected to the system too. The current system, including the transmission lines, is still suitable for serving additional customers who may connect later.

Operation of the Bóly geothermal system

The operation of the entire district heating system is controlled by a computer monitoring system. After primary recovery, the cooled thermal water is transported for secondary and tertiary recovery on the district heating pipelines before being led to the injection well. With the help of the three-stage recovery, using the same amount of water, they are able to extract 30 per cent more energy from thermal water. Fortunately, in the case of Bóly, re-injection does not encounter significant difficulties, because the water comes from bedrock and cracked rock. After heat recovery, the thermal water is re-injected into the same rock layer, so no surface pollution occurs.



Red dot – production well; blue dot – injection well
Red numbers – primary consumers
Purple numbers – secondary consumers
Blue numbers – tertiary consumers
Source: Gábor Szita, Energy utilization of thermal water

The total heat demand of the consumers in the district heating system is about 19,000 GJ/year. It is fully covered by the geothermal energy produced by the new thermal well, including transmission losses, which are very low (maximum 2 °C). The amount of thermal water used in the system is 125,000 cubic metres per year (m^3/year.

A total of 685,000 m^3/year natural gas can be saved by the renewable energy-based district heating in Bóly, with the additional electricity demand of 58,800 kilowatt hours per year (kWh/year) required for operation.

The reduction of atmospheric emissions during the operation of the district heating system is 1,325 tonnes (t) peryear CO_2, 1.5 t/year NO_x and 1.4 t/year SO_x.

The main lesson learned from the project is clear: ***It is a misconception that only very hot thermal water is suitable for heating purposes. The Bóly geothermal utility project proves that with careful planning, even very low temperature water can be used economically, and can be recycled and used up to three times.***

Further goals

The aim is to make the use of thermal energy more balanced on an annual basis and to use the reserve in the system effectively. Therefore, the town plans to involve additional industrial users, and also plans agricultural developments based on geothermal energy.

Nevertheless, the implemented geothermal system works so well that its return on the investment would be good even without the support received.

References

Bólyi Közös Önkormányzati Hivatal, Geotermikus Energiára Alapozott Távfűtő Rendszer Kialakítása, *Bólyi Közös Önkormányzati Hivatal*, accessed 22 April 2022.

J. Pálné Schreiner, *Települési termálvíz készletek fenntartható és optimális használata a területfejlesztések tükrében*, Pécs, 95, 2014.

Magyar Geotermális Egyesület, Öt település polgármesterének tapasztalatai, *Magyar Geotermális Egyesület*, 1 January 2016.

Porció Műszaki Fejlesztési és Vállalkozási, Bóly, *Porció Műszaki Fejlesztési és Vállalkozási*, accessed 22 April 2022.

Geothermal district heating system in Szentes, Hungary

History of geothermal energy utilisation in Szentes

Szentes is a town of 28,000 inhabitants located in southeast Hungary on the Hungarian Great Plain. It has a very long history of the utilisation of geothermal energy. The first well drilling in Szentes was carried out in 1958. They were searching for oil, but at a depth of 1,735 metres a thermal water source was found that delivered 1,700 litres of thermal water each minute with a temperature of 71 °C.

In part due to this intensive hydrocarbon exploration, the number of thermal-water wells discovered in the area rapidly increased. This process led to the development of some famous thermal water centres, such as that at Szentes. Szentes is internationally recognised as a textbook example of the direct use of geothermal energy. The first cascade-type use of geothermal, which includes several stages and different heat utilisation modes to maximise the heat recovered, was implemented in Szentes. Initially, communal heating, domestic hot water production, balneological utilisation, and later heating of greenhouses in agriculture took place in and around Szentes.

In 2000, the town's district heating provider set up a thermal water heating centre, which was supplemented in 2010 with another thermal well, thus converting the district heating system from a natural gas-based system to a full geothermal energy-based one. The Szentes Városi Szolgáltató Kft. modernised almost the entire district heating system within the framework of tenders from Hungary's Environment and Energy Operational Programme (KEOP) (EU funding) between 2010-2012. The total cost of the reconstruction work was HUF 133 000 000 (approximately EUR 500 000). An additional HUF 135 000 000 (approximately EUR 500 000) was spent on the expansion of the district heating system. Both developments were financed by EU sources and bank loans. The intensity of the subsidy was 50 per cent. The design, permitting process and construction were carried out by external expert companies.

A variable mass flow system has been developed for more optimal operation.[11] Within the framework of the KEOP project, three service heating centres were separated and about 3,000 metres of district heating lines were replaced with more modern technology. As a result, the transport heat loss was also reduced, which made the whole system more energy efficient.

The local bath shut down its gas boilers and instead switched to thermal water heating in its tents. Simultaneously with the investment, a thermal leachate collection pipeline was built to return the water from the three wells for further heat recovery: it provides heating for greenhouses across an area of 5 hectares. The

[11] This is a system in which every final heat recipient receives as much heat as needed and not more.

thermal water is cooled below 30 ˚C before being transferred to the Kurca River through the Talomi canal, so no heat pollution occurs in natural surface waters.

In 2010, within the framework of a Norwegian Fund tender, eight public buildings (mainly kindergartens and schools) switched to the geothermal energy based hot water district heating system from their individual natural gas-based systems. In 2019, the House of Culture and Youth also joined the district heating network.

Currently, the district heating network covers a relatively large part of the town, but there are still further expansion opportunities.

The operation of the geothermal heating system in Szentes

In Szentes, district heating is provided indirectly through plate heat exchangers. The district heating provider produces heating water and domestic hot water in heating plants and heating centres. The central heating control electronics continuously adjust the heating water temperature to the current outdoor temperature, while keeping the hot water temperature at a constant value.

In addition to the central district heating provider, some institutions in the town, such as the hospital, utilise thermal water through their own thermal wells to provide heating and hot water. There are two wells in Szentes owned by the hospital and three by the district heating provider.

The Szentes region has also become the centre of agricultural use of geothermal energy. There are a total of 37 thermal wells located in the administrative area of Szentes, all filtered on Pannonian shallow-water deltaic sandstone. The water temperature of all wells is above 60 °C, of which 23 are between 90-99 °C. The annual water abstraction is 5.5 million cubic metres.

In Szentes, the heat demand of two large and several smaller companies, as well as the heating of 60 hectares of greenhouses and foil tents, is provided by 20 to 25 production wells with a total installed capacity of 65 megawatts (MW). The total annual use of geothermal energy in Szentes, including agricultural use, is 1,200 terajoules (TJ).

Reaching the 100 per cent goal

Continuous development and expansion have made it possible for Szentes to base its district heating supply 100 per cent on geothermal energy throughout the year, providing almost 90,000 Gigajoules (GJ) of heat. The system only needs a small amount of safety gas reserve capacity in case of extreme weather conditions. The use of geothermal energy contributes significantly to meeting the municipality's sustainable energy and climate goals.

Along with the use of geothermal energy, city leaders constantly support the renovation of municipal buildings to reach higher energy efficiency level, and also try to optimise and reduce energy consumption in these buildings with the help of awareness raising campaigns and the operation of an energy monitoring system. In those public buildings where no energy efficiency investments have been made in the last 10 years (insulation, replacement of windows, etc.), the Sustainable Energy and Climate Action Plan of Szentes recommends the implementation of these measures until 2030.

Public buildings, residential buildings, agricultural sites, service providers and industrial operators alike benefit from the use of geothermal energy. They utilise clean, local, emission-free energy in their heat supply, which operates in a predictable system. Moreover, the operation of the district heating system in Szentes is one of the cheapest in Hungary. The annual cost of heating and hot water production per apartment in Szentes is about 60 per cent of the national average price. In total, 1,400 flats are heated with geothermal energy in the town, using three production wells.

Town	Name of district heating system	Primary energy conversion factor	Share of renewable energy
Szentes	Szentes District Heating System	0.0235	0.9902

Statistics, Szentes District Heating System

The geothermal-based service is able to provide district heating on a 100 per cent renewable energy basis up to -6 °C; only at temperatures below this is the need for reserve-based natural gas capacities.

In 2019, due to the mild winter, the geothermal rate was 100 per cent. No fossil energy-based production was required in district heating in Szentes.

The electricity needed for operation of the thermal wells is partly supplied by two 50 kilowatt (kW) solar photovoltaic systems. This further increases the share of renewables in the operation of the system.

Further plans – re-injection and expansion

Re-injection of water into porous reservoirs is primarily an economic issue.[12] The first porous sandstone reinjection experiment in Hungary was carried out in 1978. Since then, only 11 per cent of all energetically extracted thermal water has been fed back, including feeding back into cracked, fissured reservoirs.

In Szentes, re-injection is currently unresolved, resulting in a significant surface environmental load. Several experiments took place in the past with a double-trained production-injection moulding well, but the re-injection experiments were unsuccessful. Although some surveys confirm that the quality of Szentes's thermal water does not cause environmental damage, the problem needs to be resolved in the future.

[12] Re-injection to thermal reservoir is preferred from environmental point of view in order to avoid injecting the used water to surface water reservoirs, which may cause negative environmental impacts.

In recent times, several attempts have been made to submit applications for support for the construction of injection wells in Szentes, but the current geothermal district heating subsidies in Hungary are focused on the construction of new systems. Additional investments in existing systems are less eligible for support.

The local energy plan of Szentes proposes the further expansion of the town's district heating network, with the involvement of additional municipal buildings and condominiums. The construction of the new pipeline system and the conversion of individual heating systems would be very costly and need significant support, but at the same time it could help to further reduce the town's CO_2 emissions and reach their climate goals.

References

Magyar Geotermális Egyesület, *Földhő Hírlevél*, no. 52-53, January, 2016.

T. Medgyes, B. Kóbor, and J. Szanyi, 'Geothermal district heating projects in the South Great Plain', *Conference of the Hungarian Academy of Sciences*, 8 October 2015.

János Nagygál, A termálvíz hasznosítása és nehézségei 50 év tükrében, Miskolc, 28 April 2011.

J. Szanyi, A. Nádor, and T. Madarász, 'A geotermikus energia kutatása és hasznosítása Magyarországon az elmúlt 150 év tükrében', *Földtani Közlöny*, 151/1 (2021): 79–102.

J. Szanyi, M. Kurunczi, B. Kóbor, and T. Medgyes, Korszerű technológiák a termálvíz visszasajtolásban: Kutatási eredmények és gyakorlati tapasztalatok, *InnoGeo Kft*., 202, 2013.

Gábor Szita, Termálvíz energetikai hasznosítása, 2016.

Szentes Városi Szolgáltató KFT, Távhőszolgáltatás, accessed 22 April 2022.

Annamaria Nador, A geotermikus energia kihasznlsnak helyzete lehetsgei A geotermikus, Országos Bányászati Konferencia, Egerszalók, 19-20 March 2015.

The Vilnius district heating system

In Lithuania today, the largest provider of heat is the Vilnius District Heating company (AB Vilnius Šilumos Tinklai). The company is currently managed by the municipality and is in the process of receiving a EUR 43 million investment from the European Investment Bank primarily for upgrading their grid system to make it more energy-efficient and for the construction of new biomass and gas boilers. The Vilnius District Heating company prides itself on its commitment to transforming its system to be at the forefront of decarbonising heat systems in the EU. This effort has potential and many positive attributes, but overdependence on biomass could be risky in the long term, and other measures to develop alternative renewable heat sources and improve energy efficiency need to be pursued simultaneously.

The history of district heating in Vilnius

The Vilnius District Heating system dates back more than 60 years. Currently, the total length of the district heating network is 733 kilometres, providing heat to 204,000 households. Households, including multi-family apartment houses, account for 68 per cent of the consumed heat from district heating; the rest is made up of commercial properties and public buildings. The demand for heat annually is 2,916 gigawatt hours (GWh) of which 72 per cent is supplied by the Vilnius District Heating company and the rest from independent producers.

According to the Vilnius District Heating company, there are currently eight independent heating producers in Vilnius. Seven of those use biomass, which produces 220 megawatts (MW) of heat, with 180 MW of additional biomass generation currently being built. Additionally, there is the Ignitis combined heat and power plant, which uses waste-to-heat and biomass, producing 240 MW of thermal capacity.

The demand for heat in the winter is around 800 MW, but in 2020 demand reached 1,117 MW during a particularly cold spell. In the summer, the demand is around 130 MW. Unlike in most of the country, the demand for district heat in Vilnius is on a slight increase despite ongoing energy efficiency efforts. This is largely due to the network adding new customers, who had been using primarily wood or coal in their home furnaces, to the grid. There is a support scheme in place to incentivise these customers to stop using cheaper solid fuels and instead connect to the grid. The ultimate aim is to have 90 per cent of all buildings in Lithuanian cities receive heat from the district heating network by 2050.

European Investment Bank funding

On 25 May 2021, the EIB and the Vilnius District Heating company announced that the Bank will invest EUR 43 million in the Vilnius Heating Capex Programme for upgrading, renewing and refurbishing the district heating network through smart meters, new connections and the construction of new biomass and gas district heating boilers. According to the EIB, the majority of the investment will focus on network modernisation and the installation of biomass boilers, and a minimal amount in gas boilers. This should improve the efficiency of the network, thus reducing demand. It will also ensure further use of biomass in the Lithuanian heat sector.

Challenges for district heating in Vilnius

Biomass is the primary fuel source for district and residential heat in Lithuania, reaching around 75 per cent of all generation. According to the Lithuanian Biomass Association, the share of biomass in district heating is around 73 per cent and in individual households around 80 per cent. Therefore, the potential of biomass for heating in Lithuania has almost reached capacity, because fossil fuels have to a large extent already been replaced by biomass.

Due to the wide availability of local biomass, it is significantly the cheapest option for district heating. In 2019, the price of biomass was half that of oil or natural gas. According to the Vilnius District Heating company, gas is used in Vilnius only for peak load needs when demand is at its highest in the winter. In addition, for the past four to five years, Lithuania has been importing cheaper biomass from Belarus in the Baltpool Market, an international biomass exchange operating in Lithuania, Latvia, Estonia, Poland, Denmark, Sweden and Finland, which impacts the domestic demand. Through this system there is no preferential treatment of heating sources in the grid, including for national sources, as the cheapest source goes first.

Biomass resources

Lithuania has large biomass resources, as around 33 per cent of the land is covered by forests.[13] According to Remigijus Lapinskas, formerly of the European and Lithuanian Biomass Association, the logging volume is around 70 per cent of the annual forest growth rate. The forest area in Lithuania is not shrinking, but forest characteristics are changing as naturally regenerating forests are being replaced by temporarily unstocked and/or planted forests (FAO, 2020). Only around 1 per cent of Lithuanian forests are 'strictly protected', meaning that any type of cutting is prevented, and an additional 18 per cent is 'protected', meaning that most clear cuttings are prohibited while thinnings and sanitary cuttings are allowed.[14]

In Lithuania, only low-quality wood, such as whole trees without roots, or energy crops and logging residues, respectively known as category SM2 or SM3 according to Baltpool standards, is usually used as biomass for heating. In the last few years, higher quality wood of the SM1 category, stemwood and residues from the wood processing industry, have also been used, as some stemwood in the forest has been damaged by insects such as beetles. Ninety-seven per cent of biomass is harvested from Forest Stewardship Council (FSC) certified forests, including the biomass imported from Belarus. Additionally, there is potential for reducing the share of forest biomass in the energy mix by increasing the utilisation of residual straw and grass biomass from the maintenance of agricultural areas and grasslands. This would also have a much lower negative impact on biodiversity than forest biomass.

[13] Lithuanian State Forest Service, *Lithuanian Statistical Yearbook of Forestry 2016*, Official Statistics Portal, December 2017.

[14] X. Pang, et al., 'Forest bioenergy feedstock in Lithuania — Renewable energy goals and the use of forest resources', Energy Strategy Reviews 24: 244-253 (2019).

Sustainability of biomass

The share of renewable energy in final energy consumption in Lithuania at the moment is 34 per cent, 71 per cent of which is supplied by biomass.[15] This means biomass will play a huge role in the renewable energy share of Lithuania and in the short term, it is extremely difficult for Lithuania to reach its renewable energy target without it. Despite this, burning wood biomass also emits greenhouse gases, and while the carbon will eventually be absorbed again by new trees as they grow, the process can take up to 100 years.

From a biodiversity perspective, forest bird species with a preference for naturally regenerating forest habitats are highly sensitive to intensified forest management practices such as clear cutting. Ambitious climate change mitigation that relies on intensified logging and biomass use might therefore have long-lasting negative effects on forest biodiversity.[16] Recently, a working group for a national agreement on forest policy was created and one of the main concerns was the impact of logging on biodiversity during bird breeding season, which is when forest operations in Lithuania are typically done.

Waste-to-heat combined heat and power plant

In 2021, the state-owned utility company Ignitis opened the UAB Vilnius waste-to-energy cogeneration plant, known as the Vilnius combined heat and power plant (CHP). It will be one of the suppliers for the Vilnius District Heating company. The plant has a capacity of 70 MW, of which 16 to 20 MW is for electricity and 51 to 55 MW for heat production. The facility should operate at 100 per cent capacity for an estimated average of 8,000 hours a year, generating 34 to 39 GWh of heat and 8 to 15 GWh of electricity a month. The plant should cut the share of municipal waste disposed in landfills to under 10 per cent by 2023. Another goal is the reduction of 10 per cent of the current greenhouse gas emissions from the Lithuanian waste sector; however, CO_2 balancing might be highly questionable due to the intensive CO_2 emissions from the waste transport and incinerating operations.

Gas

The role of fossil gas in heating has decreased in Vilnius in the last decade due to the national policy priorities of reducing the country's dependence on direct gas imports from the Russian Federation, the closure of older gas-fired combined and heating plants and the steep increase in the use of biomass for district heating.[17] Additionally, the Vilnius District Heating company plans to phase out gas completely by 2030.

[15] International Renewable Energy Agency (IRENA), Final Renewable Energy Consumption, *International Renewable Energy Agency,* 2018.

[16] Ulla Mörtberg, Xi-Lillian Pang, Rimgaudas Treinys, Renats Trubins and Gintautas Mozgeris, 'Sustainability Assessment of Intensified Forestry — Forest Bioenergy versus Forest Biodiversity Targeting Forest Birds', *Sustainability* 13, no. 5: 2789 (2021).

[17] International Energy Agency, *Lithuania 2021 - Energy Policy Review*, *International Energy Agency*, 2021.

The Vilnius Combined Heat and Power Plant 3 (CHP3) was closed in 2016. CHP 3 was built in the mid-1980s and was the primary source of energy in the district heating system, producing 79 per cent of the heat in the 1998 heating season. It had an electrical capacity of 360 MW and a thermal capacity of 570 MW.[18]

Vilnius Power Plant-2 (CHP 2) is still in operation. It has an electrical capacity of 29 MW and thermal capacity of 939 MW. Its main fuel source is natural gas – three steam boilers. In the mid-2000s, the plant was retrofitted by replacing gas with biomass combustion in one steam boiler (60 MW).[19] According to representatives from the Vilnius District Heating company, CHP2 now operates only in the winter to satisfy peak demand for heating in Vilnius.

Energy efficiency and building renovation

In general, Lithuania wants to improve energy efficiency, a key element of the Lithuanian Energy Independence Strategy and its 2021-2030 national energy and climate plan. Adopted in 2018, the strategy wants to ensure that by 2030 primary and final energy intensity is 1.5 times and by 2050 about 2.4 times below the 2017 level. The industry, building and transport sectors are the places where they believe the most cost-efficient gains could be made. However, the European Commission assessed Lithuania's contribution to the EU target as of 'modest ambition.' Furthermore, according to the International Energy Agency, five times more investment would be necessary and the rate needs to be drastically sped up to meet the 2030 target.

Further goals

In Vilnius there are still major gains to be made from improving energy efficiency and building renovations. Today, on average the pipes are 30 years old, while some are even up to 50 years old. That is why the primary target of the EIB's support will go to the renovation of the grid. Some programmes are in place to tackle energy renovation in Vilnius, such as complex energy renovation for multi-storey houses or more generally in Lithuania via the housing energy efficiency agency.[20] The EU participates in these efforts, with EIB support for national programmes[21] or private lending schemes.[22] More recently, the government has planned a EUR 218 million investment from its COVID-19 recovery plan to support the production of modular elements for renovations from organic materials and provide support to citizens for renovation.

[18] World Bank, Project appraisal document on a proposed loan in the amount of EUR 19,000,000.00 (equivalent to $17,100,000.00) to the Vilnius District Heating company with a guarantee of the republic of Lithuania for the Vilnius district heating project, *World Bank,* 27 July 2001.

[19] Biofit, Retrofit of Vilnius CHP Plant-2 (Lithuania), *Biofit*, accessed 10 March 2022.

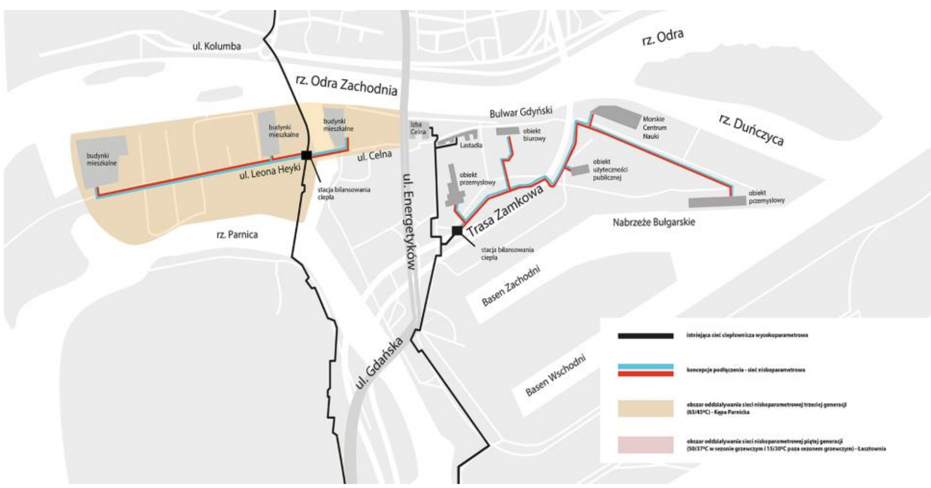
[20] BETA – Housing Energy Efficiency Association, About us, *BETA*, accessed 10 March 2022.

[21] Ministry of Finance of the Republic of Lithuania, 'Lithuania to generate up to EUR 500 million for energy efficiency with EIB', *My Government*, 10 May 2016.

[22] European Investment Bank, 'Lithuania: New support for energy efficiency in multi-apartment buildings', *European Investment Bank*, 16 March 2017.

Łasztownia: a new era for district heating in Poland

The era of fifth generation district heating has begun in Poland: in 2020, Szczecin and Szczecińska Energetyka Cieplna (SEC) together with the Marshall of the West Pomeranian Voivodeship and the Prof. Jerzy Stelmach Maritime Center of Science (Morskie Centrum Nauki of Jerzy Stelmach in Szczecin (MCN)) signed a contract for the supply of heat using state of the art technology.[23] The investment will be implemented on Łasztownia, a river island in Szczecin. The city of Szczecin bought the island in 1283. In the second half of the 13th century, it began to be used for port purposes (goods storage and granaries). During World War II, almost all of the island's buildings were destroyed. Today, the city of Szczecin is developing this area by organising a project in Łasztownia to revive the area around the Oder river.[24] The Prof. Jerzy Stelmach Maritime Center of Science will be a multimedia science and education facility devoted to sailing and boat building, as well as the history of these activities in the Baltic Sea. It will have a permanent exhibition with interactive science and technology elements.



Łasztownia: project location (in organge). Source: E.ON, Energy Infrastructure Solutions Polska

Fifth generation district heating and cooling networks

The innovative aspect of the Łasztownia project is the creation of an intelligent district heating system based on ectogrid technology, a type of fifth generation network. It was developed by the Swedish energy company

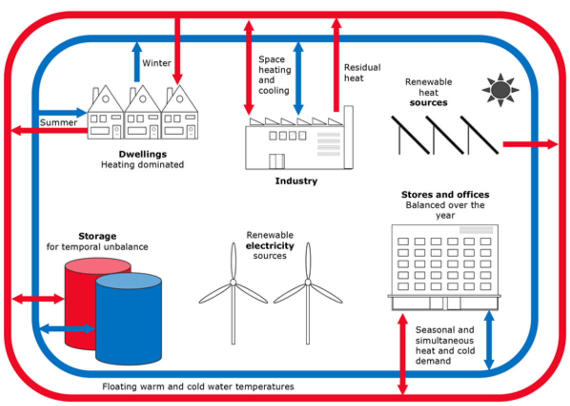
[23] Szczecińska Energetyka Cieplna, Projekt Łasztownia, accessed 22 March 2022.

[24] Łasztownia, O projekcie, accessed 22 March 2022.

E.ON, a shareholder and partner in the project. Ectogrids reuse waste heat to provide the grid with warmth.[25] In one year, the amount of waste heat generated by a medium-sized supermarket in Europe is equivalent to the demand of around 200 buildings. Supermarkets are not the only producers of large amounts of waste heat. Air conditioners, industrial processes or chillers in data centers also raise the temperature in cities, creating what is known as a 'heat island effect'.

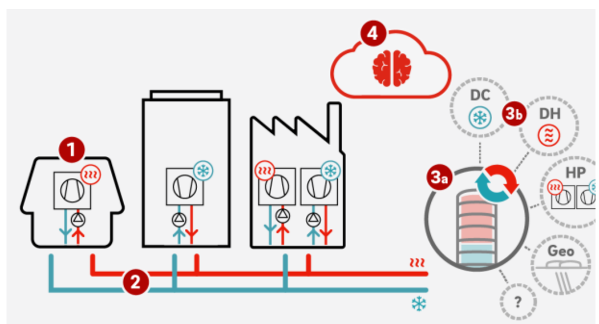
Ectogrid technology has the ability to provide both heating and cooling to buildings from the same grid by maximising the use of excess energy. This is accomplished through a system of heat pumps and/or cooling units that raise or lower the temperature depending on the needs of the building. E.ON also solves the problem of fluctuating energy supply and demand by storing energy when it is not being used. In addition to the pumps and cooling equipment, the ectogrid includes two pipes – a hot and a cold stream.[26]

A circular representation of a fifth generation district heating and cooling system. The network is balanced over the year, with warm return flows from cooling supply and cold return flows from heating supply covering as much of the demand as possible. Any residual heat or cold demand is supplied using renewable sources.[27]



Ectogrid:[28]

1. *Heat pump/cooling machine*
2. *Low-temperature grid*
3a. *Passive balancing unit*
3b. *Active balancing unit*
4. *Intelligent control*



[25] Szczecińska Energetyka Cieplna, Projekt Łasztownia.

[26] E.ON, The technology behind E.ON ectogrid™, accessed 22 March 2022.

[27] Stef Boesten, Wilfried Ivens, Stefan C. Dekker, and Herman Eijdems, '5th generation district heating and cooling systems as a solution for renewable urban thermal energy supply', *Adv. Geosci.* 49: 129–136, 2019.

[28] E.ON, The technology behind E.ON ectogrid™, accessed 22 April 2022.

The difference between an ectogrid and a traditional grid is that an ectogrid facilitates heat exchange rather than the linear transport of heat or cold from supplier to consumer between connected buildings. Storage facilities, which act as buffers, fill temporary gaps between demand and supply. Transport pumps and heat pumps allow for the integration of renewable sources, particularly during periods of high renewable electricity availability. During periods of lower renewable electricity availability, heat supply can rely on (local) buffers and the thermal mass of buildings. Sources with a large thermal radius, such as shallow geothermal energy, can be distributed throughout the city, making optimal use of available heat and cold.[29] By allowing the temperature to flow freely, the temperature in the warm pipe can be increased if this is beneficial to accommodate higher temperature sources. As in electricity networks, thermal networks can then act as virtual storage for prosumers. The system optimises the temperature by allowing heat to flow freely and ultimately maximising the overall efficiency of the system. In the case of heating, water is drawn from a hot pipe, with a small amount of energy required to raise it to the correct level. Cool water is then returned to the cooling pipe to be reused for cooling if required.[30]

The potential demand for heat in Łasztownia reaches 3 megawatts (MW),[31] and for cold 2 MW. The first section of the fifth generation district heating system will be 750 metres long and will fulfill MCN's energy demand for 400 kilowatts (kW) of heat and 600 kW of cold. In summer, the network will supply consumers with a temperature of 15 °C to produce cold, and in winter with low-temperature heat at a temperature of 50 °C.[32]

The benefits of fifth generation district heating and cooling networks

A grid with a low supply temperature such as an ectogrid has several advantages. Such a system is able to provide both cooling and heating (from one integrated system) due to the ability to recycle waste heat. In addition, it allows all possible types of excess heat to be recovered. The network is flexible enough to handle buildings from different eras. Urban low-grade excess heat can be recovered directly without the need for heat pumps in fifth generation systems, unlike in traditional high-temperature district heating. Further important arguments for creating such networks are zero carbon emissions and zero air pollutant emissions on site. Fifth generation district heating and cooling networks are bidirectional so that different stations can simultaneously extract or deliver heat from the network, providing both heating and cooling services regardless of the network temperature.[33]

[29] E.ON, The technology behind E.ON ectogrid™.

[30] Ibid.

[31] The figures given (financial and technical) reflect the investment situation as of December 2021.

[32] Cleaner Energy editors, 'W Szczecinie powstanie pierwsza w Polsce sieć ciepłownicza 5. Generacji', *Cleaner Energy*, 4 August 2020.

[33] Cleaner Energy editors, 'W Szczecinie powstanie pierwsza w Polsce sieć ciepłownicza 5. Generacji'.

SWOT analysis applied to fifth generation district heating and cooling technology[34]

Strengths	**Weaknesses**
- Allows for the recovery of low-temperature excess heat and include low enthalpy renewable energy sources - Bi-directionality: simultaneously provides both heating and cooling services throughout the year - Modularity, flexibility and resiliency to a change of boundary conditions (building level efficiency, loads) - Negligible thermal losses because of the low-temperature difference between the pipes and the ground - Pipelines can be uninsulated - Pipelines can be made of polymeric materials - The ground and the network can be used as thermal storage	- Substations are more expensive than those in previous generations of district heating - The installation of individual domestic hot water tanks is needed - Low ΔT between supply and return pipes leads to larger pipeline diameter and storage thermal capacity - High pumping costs per unit of energy due to small operative ΔT and higher fluid viscosity - Electricity costs (and related primary energy consumptions) for HPs
Opportunities	**Threats**
- New business model for the energy market - Conversion of an existing high-temperature network is possible in theory and needs important verifications - Synergy with seasonal storage (lower losses, though also lower ΔT) - Decarbonisation target can be achieved by utilities or municipalities by developing this kind of infrastructure - New energy concept at a district level may lead to a high primary energy savings target by means of a light renovation of buildings - Higher interaction with the electric sector (possible usage of heat pumps for demand-side management)	- The approach in design and sizing adopted in traditional district heating systems needs to be reviewed - The COP35 of the heat pump can be too low, depending on the type of the building heating system and on network supply temperature - In case of dependence on seasonal storage, there may be a lack of space - Installation is invasive both for the pipelines and user substations

[34] Adapted from Simone Buffa, Marco Cozzini, Matteo D'Antoni, Marco Baratieri and Roberto Fedrizzi, '5th generation district heating and cooling systems: a review of existing cases in Europe', *Renew Sustain Energy Rev* 104 (2019), 504-522.

[35] Electrical coefficient of performance

Financial information

General construction costs of the Professor Jerzy Stelmach Marine Science Center in Szczecin:[36]

- Project value: PLN 132 396 773 (gross)
- Contribution of European funds (Regional Operational Programme): PLN 97 622 564

Fifth generation district heating in Łasztownia:[37]

- General costs: TBD
- EU financing: Horizon 2020 (project title: Renewable and Waste Heat Recovery for Competitive District Heating and Cooling Networks, contract number 857811): EUR 293 125
- Project value: EUR 18 925 308
- EU contribution EUR 14 999 481

Conclusion

Integrated, intelligently controlled energy networks can contribute to the decarbonisation strategy that European countries are pursuing by reducing carbon emissions, improving air quality and lowering energy costs for users. Fifth generation district heating and cooling technology is still a new field and the know-how is in the hands of only a few companies. It offers the possibility of using local thermal energy sources, thus making it an alternative to monopolistic district heating and cooling system concepts. However, according to the information received, there is still a lack of technical standards and guidelines for designers and knowledge on how to optimise and control the operation of such systems. In the case of SEC, the contract signed with MCN is a manifestation of this strategy aiming to create a smart, low temperature district heating system in Lasztownia. Marian Nowakowski from SEC explains how the system will work to achieve this: 'We will use return water. The heat, which is distributed by means of hot water, comes back to the power plant at a temperature of several dozen degrees. We want to use this heat again and additionally cool it in the third generation network'.[38]

[36] Morskie Centrum Nauki im. prof. Jerzego Stelmacha, Projekt: Budowa Morskiego Centrum Nauki w Szczecinie im. prof. Jerzego Stelmacha, accessed 22 March 2022.

[37] Cordis, Renewable and Waste Heat Recovery for Competitive District Heating and Cooling Networks, accessed 22 March 2022.

[38] 24kurier.pl, Nowa era ciepłownictwa. Nowatorska technologia na Łasztowni, accessed 22 March 2022.

The ELENA programme - support for energy transformation in Poland

The district heating system in Poland

District heating covers over 40 per cent of Poland's households and is one of the largest systems in the European Union. At present, there are 399 licensed heating companies in Poland.[39] These companies all work locally, meaning that there is no nation-wide domestic heating market, as there is for electricity and gas.

Basic data on licensed district heating companies in Poland, 2018

Number of licensed enterprises	No.	399
Installed capacity of heat sources	MW	55,209.6
Power ordered by customers	MW	34,577.4
Length of district heating networks	km	21,367.6
Employment	full-time	29,116
Total heat sales	TJ	358,801.1
Heat discharged to district heating networks	TJ	267,222.2
Heat sold from district heating networks	TJ	233,674.1
Share of 'vertically integrated' companies	%	approx. 80
Participation of enterprises in the form of limited liability companies	%	94.5

Source: Raport o ciepłownictwie systemowym 2020, Izba Gospodarcza Ciepłownictwo Polskie

Poland's district heating sector suffers from a lack of political commitment resulting from the dispersed structure of the government, social sensitivity to the costs of heat and the politicisation of the use of conventional energy sources. According to Forum Energii's 2019 report *Heating in Poland*: 'The lack of a coordinator who would take a holistic view of the heating sector has resulted not only in poor air quality, but also in low energy efficiency of buildings, high primary energy losses and lack of development impulses for small and medium-sized enterprises cooperating with construction and heating'.[40] Furthermore, the system lacks a long-term energy efficiency policy and needs to be modernised, which has been held back by underpricing heat simultaneously with a lack of financing and mistakes in the privatisation of heating

[39] Izba Gospodarcza Ciepłownictwo Polskie, Cieplownictwo bez środków na transformację - głównym powodem stan prawa i praktyka regulacyjna, *Izba Gospodarcza Ciepłownictwo Polskie*, 2020.

[40] Forum Energii, Heating in Poland, *Forum Energii*, 2019.

companies in the 1990s. As a result, currently around 80 per cent of heating companies in Poland (responsible for producing 38 per cent of the system's heat) are categorised as inefficient.

The Polish government has focused only on controlling heat prices, without creating a vision for the sector's development. It is necessary, however, to set modernisation goals for the heat industry in the 2030 perspective and to develop mechanisms to support their implementation and business models that introduce changes'.[41] Polish heat producers must meet EU legal requirements for heat production such as:

- the EU's Medium Combustion Plants (MCP) Directive on limiting emissions of certain pollutants into the air from medium combustion plants;
- the EU's 2014 Guidelines on State aid for environmental protection and energy 2014-2020, which require investments in the environment and energy must meet energy efficiency criteria; and
- the European Union Emission Trading System (EU-ETS), under which district heating plants are obliged to purchase emission allowances equal to the number of tonnes of CO_2 emitted in a given year.[42] Heat producers in large cities usually have the financial and human resources to meet the requirements. Small and medium-sized enterprises in Poland's district heating sector, on the other hand, face many difficulties in doing so.[43]

The ELENA programme

European Local Energy Assistance (ELENA) is an initiative of the European Commission implemented by the EIB in the framework of Horizon 2020. The main objective of the support offered through ELENA to public authorities and private entities is to implement energy efficiency, renewable energy and sustainable transport, leading to a reduction of CO_2 emissions.[44] In practical terms, ELENA grants may be used to improve internal know-how and capacity (by adding new staff) or to pay external experts for technical assistance. Grants may not be used to co-finance investments.[45] This will allow small and medium-sized enterprises to adapt to the new regulations, while increasing their competitiveness in the domestic market. 'It is with these challenges in mind that the National Energy Conservation Agency applied for funding for pre-investment services, was selected to implement the ELENA programme as the so-called final beneficiary, and acts as the National Investment Project Integrator (KIPI)', explains Zbigniew Kidawa, Deputy Director at KAPE

[41] Ibid.

[42] Kaef, 'Największe wyzwania stojące przed ciepłownictwem', *Magazyn Biomasa*, 16 September 2021.

[43] Program wsparcia małych i średnich Przedsiębiorstw Energetyki Cieplnej (Program ELENA) KAPE, 2021.

[44] European Investment Bank, European Investment Bank Solutions for energy efficiency - 10 years of European Local Energy Assistance (ELENA), *European Investment Bank*, 20 June 2019.

[45] European Investment Bank, Solutions for energy efficiency. 10 years of European Local Energy Assistance (ELENA), *European Investment Bank*, 2019.

Poland's National Energy Conservation Agency (Krajowa Agencja Poszanowania Energii (KAPE)) was recently selected to implement an ELENA programme to support enterprises from the district heating sector. KAPE provides beneficiaries with consulting services delivered by a team consisting of engineers and economists with extensive experience in the energy sector. KAPE's deputy director Zbigniew Kidawa explains:

> In preparing the technical-economic-environmental analysis, KAPE works with its customers, taking into account their own considerations as well as local fuel availability data. Approaches vary. From a conservative approach... to very bold suggestions to build a [fourth] generation district heating system with extensive use of [renewable energy sources] and [the] construction of heat storage facilities.[46]

Entities that would like to use KAPE's support can become a direct beneficiary of KAPE or can receive support through the assistance of KAPE's selected subcontractors. They must provide the documentation necessary to implement the investment planned by the customer or themselves must become a participant in the ELENA programme. KAPE is currently implementing more than 20 projects for which it has already carried out feasibility studies; it has already secured support for co-financing the investments with aid funds. Construction and tender documentation is being completed for these projects. Further projects are also being accepted for implementation.

ELENA programme

<table>
<tr><td colspan="2">European Commission (Horizon 2020 programme)</td></tr>
<tr><td colspan="2">EIB (ELENA programme)</td></tr>
<tr><td>KAPE's
experts</td><td rowspan="3">Agreement between KAPE and heating company:
specifying the scope of KAPE's services,
a list of products, their value and deadlines.
the obligations of the nvestor in terms of supplying the necessary materials and the deadlines

Technical and financial consulting offered by KAPE:
feasibility study of heat source modernisation aimed at analysing the current situation and selecting an optimum modernisation alternative.
preparing documentation required to obtain an environmental decision for the selected heat source modernisation option.
a necessary audit and preparation and submission of an application for co-financing from available support programmes for the variant selected by the investor.
complete construction documentation for a heat source modernisation for a selected variant (including the full</td></tr>
<tr><td>70 per cent of support costs</td></tr>
<tr><td>Beneficiaries:
Small and medium-sized enterprises in the district heating sector in Poland</td></tr>
</table>

[46] Kaef, 'Największe wyzwania stojące przed ciepłownictwem'.

	scope of obtaining technical conditions, arrangements and decisions, including a building permit for the selected modernisation variant). complete tender documentation for the selected variant, including preparation of the ToR, construction design with the necessary technical conditions and permits
Goal: Modernisation to meet current requirements and preparation for upcoming changes in the energy market	
↓ waste heat from industry heat pumps geothermal solar collectors	↓ agricultural and forest biomass refuse-derived fuel (RDF) cogeneration and trigeneration heat accumulators

Source: Program wsparcia małych i średnich Przedsiębiorstw Energetyki Cieplnej (Program ELENA), KAPE, 2021

Examples of projects supported by KAPE's ELENA programme include:[47]

- The first project in Poland to produce heat, electricity and cooling from agricultural biomass (straw)
- Conversion of one district heating system from coal fuel to gas, biomass, and refuse-derived fuel (RDF),[48] as well as the design of a section of the heat network and the modernisation of a coal-fired district heating station with applications for funding from the National Fund for Environmental Protection and Water Management (Narodowy Fundusz Ochrony Środowiska i Gospodarki Wodnej - NFOŚiGW) programme
- Modernisation of a coal-fired boiler with gas and biomass
- Construction of a district heating system
- Replacement of coal-fired units with biomass and RDF
- Implementation of an innovative fourth generation district heating system with the lowering of district heating network temperature as well as the application of heat pump and solar collectors

The biggest concern is that the majority of projects on this list involve biomass and fossil gas. First, promotion of biomass as a sustainable fuel results in a deteriorating state of forest ecosystems. A recent report from the Polish ecological organisation The Workshop for All Beings notes: 'In the last 15 years (between 2004 and 2019),

[47] Program wsparcia małych i średnich Przedsiębiorstw Energetyki Cieplnej, Krajowy Integrator Projektów Inwestycyjnych, accessed 22 March 2022.

[48] Refuse-derived fuel (RDF) is a fuel produced from various types of waste such as municipal solid waste, industrial waste or commercial waste. According to KAPE, RDF is a rather niche solution; more relevant is cogeneration, i.e. the production of heat and electricity from the same fuel, which is present in almost all projects, and significantly increases their efficiency. An alternative solution is the use of solar energy from solar collectors and photovoltaic systems.

the amount of timber harvested in the EU Member States has increased by almost 25%'.[49] Even so, there should be very strict rules and restrictions for the use of biomass, as well as strict monitoring of the use of renewable energy sources in year-round energy production. The use of biomass for heating needs to be limited to peak loads.[50] Second, fossil gas is often called a clean, transition or bridge fuel, with the rationale that the combustion of gas only produces about half of the CO_2 produced by burning coal. Yet in 2015, gas was responsible for around 800 million tonnes of CO_2 emissions in Europe, representing around 25 per cent of all fossil-fuel related emissions in Europe.[51]

Financial and economic characteristics of KAPE's ELENA-funded project

- Total project cost: EUR 2 323 000
- ELENA: EUR 2 090 700[52]
- The maximum value of funding for a service offered by KAPE under the ELENA programme can be up to 70 per cent of the costs.[53]
- The average value of all pre-investment works under the ELENA programme is about PLN 900 000 of which ELENA can co-finance up to about 70 per cent, i.e. up to about PLN 600 000.

Environmental sustainability[54]

Energy efficiency	Annual total energy saved: 148 GWh
Renewable energy	Annual total: 115 GWh
CO_2 reductions	Annual total reduction: 102,000 CO_2 equivalent

[49] Michał Kolbusz, Augustyn Mikos, Lasy do spalenia. Prawdziwa cena energii, *Stowarzyszenie Pracownia na rzecz Wszystkich Istot*, 2022.

[50] Efficient District Heating and Its Support, Friends of the Earth-CEPA, 2021.

[51] Sonja van Renssen, 'How can gas contribute to the achievements of EU Climate targets?', *Energy Post*, 24 October 2018.

[52] European Investment Bank, ELENA Project Factsheet: The National Integrator of Investment Processes in District Heating Companies in Poland (KAPE), *European Investment Bank*, 27 September 2019.

[53] Program wsparcia małych i średnich Przedsiębiorstw Energetyki Cieplnej.

[54] European Investment Bank, ELENA Project Factsheet: The National Integrator of Investment Processes in District Heating Companies in Poland (KAPE).

Conclusion

Support from ELENA is a significant tool for the energy transition of small and medium-sized district heating companies in Poland. It will increase KAPE's capacity to manage and improve coordination and enable it to provide the needed technical and financial advice to beneficiaries. ELENA has also the potential to help ensure efficient heat production from clean energy and at the same time to modernise heat production.

This publication has been prepared with the financial assistance of the European Union. Its content is the sole responsibility of CEE Bankwatch Network and can under no circumstances be regarded as reflecting the position of the European Union.