Is Hungary and Slovakia's district heating future in hot water?

Geothermal water pipes in Szetav, Hungary

Heat counts for half of all energy use in the EU,[1] but most of it is produced by fossil fuels – including gas or coal. Much of the gas used in Europe has been supplied by Russia, but as a consequence of Russia's full-scale invasion of Ukraine, the EU's dependence on Russian gas for heat and power is no longer believed to be sustainable. This has been formalised through the European Commission's REPowerEU proposal. This is in addition to the European Green Deal's Fit for 55 package, which aims to reduce the EU's greenhouse gas emissions by at least 55 per cent by 2030. Together, the urgency to find solutions on how to produce heat from renewable and sustainable sources is higher than ever before.

[1] European Commission, Heating and cooling. Heating and cooling constitutes around half of the EU energy consumption, *European Commission*, accessed 1 August 2022.

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One means to do so is to expand district heating from its current share of 10 per cent of heat supply. District heating in densely populated areas, if modernised and made to operate at lower temperatures, can be more efficient than individual heat boilers and has the potential to incorporate more renewable sources into the energy supply. Today, the concentration of district heating is primarily in two regions of the continent, the Nordic countries and central and eastern Europe (CEE). The Nordic countries have developed their district heating systems in the past thirty years and have modern, low-temperature systems that incorporate various renewables such as biomass,[2] heat pumps, solar thermal, heat storage and waste heat recovery. Lower-temperature heating systems provide the same level of thermal comfort but are more energy efficient and have less heat losses than older, high-temperature systems and can usually incorporate more renewable sources which do not produce as high temperatures as fossil fuels.

The CEE region has relied on district heating for over a century. Their systems generally operate on higher temperatures fuelled by fossil fuels, primarily gas and coal. Technologies such as industrial-sized heat pumps, solar thermal or heat storage are still underutilised in the region, and nearly all the district heating systems in the region still use high-temperature systems that are not compatible with these renewable heat technologies. However, one renewable heat technology, geothermal, has significant potential for widespread use in the region, even in the existing high-temperature systems.

Geothermal energy originates from the sub-surface of the earth and is accessed through boreholes drilled into natural reservoirs of hot water which is then pumped to heat exchangers. There are two types of geothermal technology, shallow and deep. Shallow geothermal usually requires drilling to around 150 metres; deep geothermal wells' depth can go from 150 metres to 5,000 metres. Deep geothermal can reach quite high temperatures (up to 200 °C), but only exists in certain places with the right geological conditions – yet its temperatures can be so high that it can also be used as a source for combined heat and power plants. Shallow geothermal is much cooler (up to 30 °C). It typically needs to be used in conjunction with a heat pump to provide space heating, yet it can be used in much more versatile situations.[3]

Geothermal heating has existed in Europe for centuries, particularly in the spa and agricultural industry, but today it is increasingly being used for district heating. One of the areas with major potential for deep geothermal is the Pannonian Basin, which includes Hungary, Slovakia, south-eastern Poland, western Ukraine, western Romania, northern Serbia, the tip of north-east Croatia, north-eastern Slovenia and eastern Austria. It is widely agreed amongst experts that this Basin has major geothermal heat potential, and the further development of geothermal wells for district heating there is already underway, albeit slowly.[4]

The most mature of these systems is in Hungary, followed by Slovakia, although pilot projects exist in the other countries. For instance, from 2017 to 2019, there was a project under the EU's Strategy for the Danube Region,

[2] Biomass used in district heating is not always renewable nor sustainable depending on the forestry practices of the sources. However, a further investigation into the issues of biomass fueled district heating goes beyond the scope of this case study.

[3] Gregor Goetzl, MUSE – Differences between deep and shallow geothermal energy, *GeoERA*, 22 July 2020.

[4] Annamária Nádor, Attila Kujbus, Anikó Tóth, Geothermal Energy Use, Country Update for Hungary, *European Geothermal Congress 2019*, 14 June 2019.

DARLING-e, which developed a transnational strategy for the uptake of geothermal heating and cooling in the Danube region. The strategy included parts of Hungary, Slovenia, Croatia, Bosnia and Herzegovina, Serbia and Romania, all of which have the geological potential for geothermal.[5]

To learn more about the existing geothermal district heating systems in the region, CEE Bankwatch Network undertook fact-finding missions to Hungary and Slovakia in January and May 2022 to meet with experts and see the operational systems in Galanta and Veľký Meder, Slovakia and Szeged, Veresegyház, Hódmezővásárhely, Hungary.

Examples of geothermal-based district heating in Slovakia and Hungary

Veľký Meder, Slovakia

A small town takes advantage of its geothermal potential

Veľký Meder's geothermal district heating system became operational in 2016, making the town the fourth in Slovakia to replace its existing district heating system with geothermal. Approximately 1,300 households are connected to district heating. There is one well with a depth of 2,450 metres, a flow rate of 10.4 liters per second (l/s) and a temperature of 92 °C. It provides the heat supply for residential buildings and public buildings like a hospital, a school, a kindergarten and an urban cultural centre. After the heated water is used to heat the buildings, the cooled water travels about 1.3 kilometres through pre-insulated pipes to a water park, which is fully owned by the municipality.

Geothermal water well in Veľký Meder, Slovakia

[5] Enrico D'Ambrogio, Christiaan van Lierop, Renewed EU Strategy for the Danube Region (EUSDR), *European Parliamentary Research Service*, March 2022.

The municipality owns both the network and geothermal energy production as well as some gas boilers for peak coverage. According to the municipality, owning both the production and supply of the heat allows them to manage the capacities of the system internally, which is ultimately an advantage as it makes them more efficient and independent.

The Slovak Regulatory Office for Network Industries regulates the price of district heating for each heat provider individually, which is a decisive factor for the final consumer. In February 2022, many businesses requested to connect to the geothermal district heating system as the prices were significantly lower than those of gas. It is the municipality that will ultimately decide, but the businesses would like to be connected by the next heating season. Connection costs are a matter of agreement, but in principle, they are at the cost of the heat provider. However, compared to gas, geothermal is not easy to expand, as the supply is limited to the geological conditions. The municipalities prioritise municipal enterprises and give their consent for further connection only if it does not endanger the heating for the inhabitants and the municipal water park, which is a significant attraction for the town.

Szeged, Hungary

The third largest city in Hungary converts its gas-based district heating to geothermal

Szeged is a city in the south of Hungary with a population of around 162,000 and is home to one of the biggest district heating projects in Europe that has made the switch from a fossil-gas-based system to geothermal. The district heating is provided by Szetav, a company which is 51 per cent privately owned, 49 per cent municipality owned. It cooperates with GeoSZ, the geothermal service provider who owns and operates the wells and drilling operations.

Geothermal heating plant in Szeged, Hungary

The system covers approximately 27,000 apartments and 433 public buildings, which is about 50 per cent of the city. There are 27 wells, all of which use a triplet reinjection system which has two wells for reinjection and one well for extraction. The wells range from 1,700 to 2,000 metres in depth with a flow rate of 70 cubic metres per hour (m^3/h). The total supplied energy is approximately 844,000 gigajoules (GJ) per year. The water pumped from the production well to the heat plants is around 90 °C. From there, it goes to heat exchangers, and after it is pumped to connected buildings. The return temperature of the water from the buildings is around 70 °C and is eventually returned to the ground through the reinjection wells at a temperature of around 50 °C.

According to Szetav, the entire city could be heated by geothermal but they are at capacity for what can be heated with the current temperature of 90 °C. If they were to expand, the buildings would need to be able to use lower temperatures of heat which would require significant renovations of the buildings or use in new buildings that are designed for a lower-temperature heating system.

The price of heat is set centrally by the Hungarian government, and as of July 2022, gas was substantially subsidised. Therefore, even though the operational price of geothermal has become substantially lower than that of gas, customers do not see that advantage reflected in their bills and there is little incentive to improve energy efficiency in either the system or through building renovations.

Geothermal water plant in Szeged, Hungary with new, more efficient radiators for local residences

Financing of geothermal district heating systems

The EU does not have standard financing and pricing models for developing geothermal district heating and both can vary greatly at both the national and local levels. Financing geothermal projects is one of the biggest barriers to its widespread development as exploration and drilling are very costly, making upfront investments very high. In addition, there is always the risk that the costly exploration phase will not be successful, and thus geothermal is still considered high-risk by financiers and governments. Another significant barrier cited by the geothermal industry is the lack of insurance available for drilling operations. One example cited during an interview with a geothermal developer was that the drilling rig could only be insured while being transported to its location and not during operation, thus adding significant risk to financiers. One reason cited for the lack of such insurance was that there are not enough geothermal projects to make up a critical mass for insurers in case of different types of failure.

Despite its high upfront costs, its operational costs are quite low – usually a fraction of those for a fossil-fuel-based district heating system. Additionally, deep geothermal's potential to be used for both heat and electricity production also increases its benefits. According to the Slovak Environmental Policy Institute, when analysing the impacts of the Fit for 55 package, they found that geothermal was the most expensive renewable heat source but when used in combined heat and power, its prices were lower than both biogas and heat pumps.[6]

Apart from the aforementioned DARLING-e project, which is financed from the EU's Horizon 2020 programme for technological development and pilot projects, there are no dedicated EU funding sources specifically earmarked for deploying and modernising geothermal infrastructure. EU funding for geothermal district heating is available through the Cohesion Policy, but this is contingent on Member States including geothermal projects in their operational programmes. For instance, in 2020 the European Commission approved a EUR 150 million scheme in Romania to construct and upgrade district heating systems to renewables, including geothermal.[7] The Recovery and Resilience Facility is another source of funding for Member States to support geothermal district heat. Now the Commission is encouraging Member States to use these funds in light of the new REPowerEU plan to reduce dependence on Russian fossil fuels, which includes a suggestion that Member States further support measures to integrate geothermal energy in modernised district and communal heating systems.

EU funding for geothermal in Slovakia had previously been very limited. According to one geothermal developer in the country, it was effectively impossible to use EU funding for geothermal, but this should change in the next years as both the EU's Just Transition and Modernisation Funds have been approved to support geothermal energy sources. EUR 13 million will go to promoting, prospecting and surveying geothermal sources as a part of the Programme Slovakia (ESIF 2021+), which was approved in June 2022. Slovakia will receive approximately EUR 3.89 billion from the Modernisation Fund by 2030, with EUR 169.5 million of this

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[6] Ján Dráb, Marek Engeľ, Katarína Nánásiová, Analýza vplyvov balíka Fit for 55, *Inštitút environmentálnej politiky*, March 2022.

[7] European Commission, State aid: Commission approves €150 million Romanian scheme to support investments in district heating systems based on renewable energy sources, *European Commission*, 6 November 2020.

disbursed in October 2021 and March 2022. Approximately EUR 94.5 million will be allocated to modernising energy systems, including energy storage and efficiency improvements (rehabilitation) and the extension of district heating and cooling networks. The Just Transition Fund may potentially support the connection of geothermal sources to the district heating system of Košice, the second largest city in Slovakia.

In Hungary, EU funding has played an increasing role in recent years. Through the Hungarian Environment and Energy Operational Programme (KEHOP), some geothermal projects have been supported. It is yet to be seen if more EU funding through the Resilience and Recovery Facility, the Modernisation Fund, or the Just Transition Fund will be allocated for geothermal development.

In addition to the aforementioned EU funds, both Hungary and Slovakia are eligible for cooperation with the European Investment Bank (EIB) or European Bank for Reconstruction and Development (EBRD) to finance geothermal-based district heating. Both the EIB and EBRD regularly finance district heating projects in the region, typically the renovation of systems and adding new renewable sources. However, neither bank has invested in geothermal in either country. In Hungary, one developer of geothermal heating claimed that in the past there had been some interest from the EIB in investing but the specific investment required an audit which was impossible at the time, as they hadn't even reached the drilling stage yet. None of the geothermal developers we met had any experience with the EBRD, although the Bank finances many geothermal projects in Turkey.

Geothermal water well in Veresegyház, Hungary

Environmental concerns of geothermal heating

Geothermal is considered a renewable energy, but in order for it to be truly renewable, the water extracted must be returned through reinjection back to the water reservoirs; otherwise, there can be significant depletion of the water level or pressure in the wells. Additionally, the water contains gases that are released in the process of extraction. The dangers of both of these issues will vary from individual project to project based on their geology; therefore, considerations on how to deal with them also vary greatly between countries and projects but should not be underestimated when developing geothermal heating sources.

Water reinjection

Water reinjection and how it is done is important for several reasons. If the water is not reinjected into the reservoir but only emitted to surface recipients like lakes, rivers, or channels, this risks chemical pollution like salinisation as well as thermal pollution if the temperatures are not similar to the surface waters. Reinjecting water back into the reservoir also improves the geothermal project's energy efficiency, as it helps to stabilise the pressure and recharges the water supply.[8] However, water reinjection is technically a very difficult process and is thus very costly.

In Slovakia, reinjection of water is done sporadically and only when the water deposits have been depleted. Generally, if the deterioration of water deposits is not expected and it is assumed that the surface water will not be negatively impacted, no reinjection wells are planned. Therefore, most often, the used geothermal water is directly discharged into waterways, which can cause the thermal and chemical pollution of surface water. There is no legislation prohibiting this currently, although in June 2020, a Water Policy Concept until 2030[9] was approved, which aims to prepare the methodology and rules for geothermal water management by 2026.

The Hungarian geothermal industry is much more experienced with reinjection. The procedure is not covered by national legislation, but many developers still do it despite its higher costs, primarily so as to not prematurely exhaust the water sources. On average, reinjection wells are just as expensive as extraction wells; therefore, it can double or triple the costs, as some extraction wells have two reinjection wells. In order to encourage more reinjection wells to be developed, one geothermal developer recommended that it be financially incentivised, either through support for new wells or penalisation of projects without them.

Gaseous emissions from geothermal water extraction

Geothermal water sources also contain naturally occurring dissolved gases such as carbon dioxide, hydrogen sulphide, methane and ammonia. Therefore, when geothermal water is pumped to the surface, these gases can be released as emissions. These emissions are typically substantially lower than emissions from mining fossil

[8] Danube Transnational Programme, Reinjection of thermal water, *Danube Transnational Programme*, accessed 1 August 2022.

[9] Ministry of the Environment of the Slovak Republic, Koncepcia vodnej politiky Slovenskej republiky do roku 2030 s výhľadom do roku 2050, *Ministry of the Environment of the Slovak Republic*, May 2022.

fuels such as gas,[10] yet still need to be considered when planning geothermal water extraction. Methane in particular is problematic as it is significantly more potent than carbon dioxide in accelerating climate change.[11]

In Hungary and Slovakia, there is no clear legislation on how to capture these gases. In Slovakia, the geothermal operators claimed that the gases were negligible and therefore did not monitor or report them. In Hungary, many geothermal operators voluntarily report their emissions. There are some initiatives by some municipalities to capture the methane that is released. For instance, in the town of Berekfurdo, it is captured and used to produce electricity in a combined heat and power plant. There are some initiatives by municipalities such as Kisújszállás, Tiszaföldvár, Karcag and Hajdúszoboszló, where gas-fired power plants are installed next to thermal wells and the methane is recovered to be used in those plants. These projects were implemented by Alteo Ltd., which is a private energy company working on renewable energy.[12]

Further development of geothermal heating in Slovakia and Hungary

In Slovakia, there are already two projects in the development stage. The largest is in Košice, which would be one of the biggest geothermal district heating systems in Europe. In its initial stage, it would produce 30 megawatts (MW), but could ultimately be scaled up to 90 MW with a 16-kilometre pipeline. There is the possibility that its EUR 90 million in expected costs could be co-financed by the EU's Just Transition Fund and the Recovery and Resilience Facility. Another project in the development phase is in Kežmarok. The estimates of the usable annual amount of heat obtainable from this project range from 38,512 to 50,432 megawatt hours (MWh). The expected costs are around EUR 3 million. The drilling will be followed by well tests to confirm expected parameters such as the temperature and yield of geothermal water.

There are no currently planned geothermal developments in Hungary. After the 2022 parliamentary elections in Hungary, there is a possibility that new calls for geothermal will be opened. But as there is no central authority that collects data on geothermal projects, information on this is scarce. Furthermore, the current imbalance in the Hungarian energy market due to the government's artificially set energy prices creates little incentive for public district heating companies to switch to geothermal. Unlike private customers, state energy companies receive subsidies and thus pay much less than the real market price, keeping prices low for residential consumers. In effect, this subsidy keeps the price of gas artificially low, creating little financial incentive for public district heating companies to switch to geothermal despite its lower costs. However, as of July 2022, this price cap on energy is in question and might be removed as the state can no longer afford to continue the subsidy. This could provide an opportunity for geothermal to become more competitive economically and thus more attractive to investors.

[10] Thráinn Fridriksson, Almudena Mateos Merino, A. Yasemin Orucu, Pierre Audinet, Greenhouse Gas Emissions from Geothermal Power Production, The World Bank, 15 February 2017.

[11] Enviro portál – Information portal of the Ministry of the Environment of the Slovak Republic, Geotermálna energia, *Enviro portál*, accessed 1 August 2022.

[12] Szalai Gyula, Termálvíz-kutak kísérőgáz hasznosítási lehetőségei, *Hidrogáz*, 8 May 2009.

Recommendations to policy makers and financial institutions

Getting rid of fossil-fuel-based heating will require time, investment, and quality planning and management. Deep geothermal can be a solution for district heating in the Pannonian Basin area, but to do so in a way that is environmentally sustainable and financially sound, we recommend:

1. Create public investment resources for geothermal exploration and operation that help reduce financial risk. Particularly the EIB and EBRD could adapt their policies to allow for more flexibility for geothermal exploration.

2. Standardise legislation at the European level for both water reinjection and gas capture from geothermal water mining. More investment should be done in research and development to figure out how to best deal with these gases and better measurement tools to ensure that geothermal extraction produces less emissions than traditional fossil fuels.

3. At the local and regional levels, treat heating systems systematically with significant sector coupling such as with spas and water parks. Additionally, apply the principle of 'energy efficiency first' and encourage deep renovations of buildings to allow them to use lower-temperature heating. This would allow for a cascade system to be used where water is reused for different purposes at different temperature levels.

4. Build and finance professional capacity for planning and decarbonisation of heating at local, regional and national levels. The region needs to improve the availability of energy information for planning purposes (e.g. credible regional database of buildings, quantification of the sustainable renewable energy source potential that takes into account local conditions, etc.).

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