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Korlátolt Felelősségű Társaság



Report

Activity A 3.2

Interregional workshop on geothermal energy applications in residential and commercial heating

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Interreg
Europe



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the European Union

Green4HEAT



Pannon Novum
West-Transdanubian Regional
Innovation Nonprofit Ltd.

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- PP04 West Pomeranian Region (Poland)
- PP06 Public Regional Energy Entity of Castilla y León (Spain)
- AP07 University of Patras (Greece)
- PP08 Pannon Novum West-Transdanubian Regional Innovation Nonprofit Ltd. (Hungary)
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Executive summary

This document reports the results of the interregional workshop held in **Győr (Hungary)** as part of the **Green4HEAT project**, which promotes the deployment of sustainable heating solutions, with a focus on **geothermal energy**. The workshop brought together regional partners, technical experts, and public authorities to exchange knowledge, observe local implementations, and identify actionable strategies for expanding geothermal heating across participating territories.

The report captures key insights from expert discussions, peer learning sessions, and site visits, emphasizing both practical experiences and strategic policy considerations. It is structured as follows:

Section 1 introduces the Green4HEAT project and outlines the purpose and structure of the workshop, including the main learning objectives and partner participation.

Section 2 provides an overview of the **geothermal energy landscape** in participating regions, highlighting resource potential, policy support, and innovation trends that frame local development opportunities. Additionally, as an example, explores **Hungary's geothermal district heating (DH)** systems.

Section 3 presents observations from on-site visits to the **Bőny Heat Centre in Győr** and the **geothermal heating project in Mosonmagyaróvár**. These case studies illustrate different models of geothermal deployment—urban district heating and community-based systems—highlighting technical setups, stakeholder roles, and integration with local energy strategies.

Section 4 summarizes workshop discussions on the practical application of geothermal energy in both **industrial** and **residential** settings. This includes insights on decarbonizing heat-intensive industries, scaling building-level systems, and the use of enabling technologies such as **heat pumps and smart controls**.

Section 5 explores the cross-cutting barriers identified across regions—such as permitting delays, limited funding, and technological gaps—and outlines policy responses, investment strategies, and institutional support mechanisms to accelerate geothermal uptake.

Objectives, context, and key insights

The project

The Green4HEAT project addresses the EU's challenge to reduce fossil fuel use for heating and cooling buildings, which accounts for approximately 30% of the EU's energy consumption. Currently, fossil fuels dominate heat production (~77%), leading to high greenhouse gas emissions and reliance on imported energy. The project aims to support eight participating EU countries (Greece, Belgium, Latvia, Poland, Slovenia, Spain, Hungary, and Lithuania) in transitioning to sustainable district heating (DH) systems by promoting renewable energy sources (RES), waste heat utilization, and modernizing outdated DH networks.

The strategic importance for Green4HEAT regions lies in accelerating the adoption of geothermal energy as a sustainable heating and cooling solution. This aligns with the EU's goals to reduce reliance on fossil fuels, lower greenhouse gas emissions, and enhance energy independence. Geothermal energy offers significant advantages, including scalability, adaptability, and the ability to integrate into modern district heating (DH) systems.

Key strategic benefits for Green4HEAT regions include:

1. Improved territorial heat planning: Geothermal energy supports better heat distribution planning and promotes the use of renewable energy sources (RES), such as low-grade geothermal and solar power.
2. Expansion of low-temperature heat networks: Geothermal energy facilitates the deployment of modern DH networks and thermal energy communities, enhancing energy efficiency and sustainability.
3. Investment in green technologies: Geothermal systems attract public and private investments, driving the transition to renewable heating solutions.
4. Regional collaboration: Sharing best practices and knowledge across Green4HEAT territories fosters innovation and capacity building, addressing challenges like limited infrastructure and regulatory barriers.

The workshop

The interregional workshop conducted under Activity 3.2 of the Green4HEAT project provided valuable insights into the current state, challenges, and opportunities surrounding geothermal energy applications in residential and commercial heating. The event successfully brought together regional stakeholders, technical experts, and policymakers to reflect on real-world applications and policy

frameworks, fostering a deeper understanding of how geothermal energy can play a pivotal role in the green heating transition across partner territories.

The workshop aimed to support several key Green4HEAT objectives, including:

- Enhanced territorial heat planning and increased integration of renewable energy sources (RES): Discussions emphasized the strategic role of geothermal energy in improving local heat planning and reducing dependency on fossil-based heating. Participants highlighted the need for improved mapping and data collection to unlock geothermal potential at the territorial level.
- Expansion and acceleration of low-temperature heat networks and thermal energy communities: Case studies and presentations illustrated how shallow and medium-depth geothermal systems can be effectively integrated into low-temperature district heating (DH) networks. The scalability of these systems and their compatibility with energy communities were central themes throughout the workshop.
- Investment in green heating and cooling technologies: A strong focus was placed on the investment landscape. Participants explored financing mechanisms, including public-private partnerships and EU funding streams, that can help drive geothermal deployment. Lessons were drawn from successful funding models applied in other European regions.

Thematic sessions addressed critical topics such as the integration of geothermal energy into modern DH systems, regional geothermal resource potential, and the identification of policy and regulatory pathways to support wider adoption. These discussions revealed a shared recognition among partner regions of the importance of streamlining permitting processes, improving public awareness, and aligning national and local policy instruments.

State of the art: Geothermal potential and policy pathways in Green4HEAT regions

Geothermal energy resources and use in Green4HEAT territories

Geothermal energy presents a valuable opportunity for sustainable heating across Europe, offering a low-carbon alternative to fossil fuels. Within the Green4HEAT project regions, geothermal potential varies widely in terms of resource availability, development stage, and practical application—reflecting the diverse territorial, regulatory, and policy landscapes of each partner. Advancing the use of geothermal energy requires not only technological innovation but also supportive policy frameworks tailored to local and national contexts. This section explores the current status, challenges, and future prospects for geothermal deployment across the Green4HEAT regions, with a focus on both technical progress and the policy drivers, barriers, and opportunities shaping each territory's path toward sustainable heating.

Greece – East Macedonia and Thrace

Greece with its unique geology—marked by active fault lines and volcanic activity—boasts abundant underground heat that can power homes, businesses, and farms sustainably. Geothermal resources are spread across the country, from volcanic islands like Milos and Nisyros to northern regions such as Central and Eastern Macedonia and Thrace (REMTH), and even parts of the Aegean like Chios and Lesbos.

This energy comes in different temperature ranges:

- Low-temperature sources (30–99°C) are ideal for heating buildings, greenhouses, and spas.
- Medium to high-temperature sources (100–300°C) can generate electricity and provide industrial heat.
- Very high-temperature resources—still largely untapped—offer promise for future energy innovation.

Currently, geothermal energy use is growing in Greece:

- Around 43 MWth are used for agriculture and greenhouses, including drying crops in places like Neo Erasmio.
- Another 43 MWth are used powers thermal spas at over 70 facilities.

- Ground-source heat pumps (GSHPs) are the predominant use with 191 MWth.
- Cities like Alexandroupolis are piloting district heating systems based on geothermal energy.

More than half of Greece's known geothermal fields are located in Eastern Macedonia and Thrace (REMTH), mostly low temperature, making them perfect for local heating solutions. Yet, despite the enormous potential, geothermal deployment in the region remains modest. The main barriers include:

- High upfront costs for drilling and infrastructure
- Complex and lengthy permitting procedures
- Low public and business awareness of geothermal benefits
- Limited investment incentives for smaller players

However, recent policy reforms and EU-supported funding mechanisms aim to remove these roadblocks. The National Energy and Climate Plan (NECP) has set ambitious targets for renewable energy, including 100 MW of geothermal electricity capacity by 2030. Key national and regional initiatives include:

- A digital One Stop Shop to streamline permitting processes.
- Access to public land for geothermal use
- Tax incentives and subsidies to lower investment risks
- Support for energy communities, encouraging collective use of geothermal energy in heating and farming.

REMTH, as a geothermal resources-rich region, has the potential to become a flagship for sustainable heating in Greece. With targeted policy support, greater visibility, and collaboration among national and local actors, geothermal energy can play a critical role in reducing emissions, lowering energy costs, and strengthening local economies.

Belgium – Province of Antwerp

The Province of Antwerp, located above the geologically favourable Campine Basin, is emerging as a focal point for geothermal energy in Belgium. Both deep geothermal exploration and heating applications are gaining momentum.

Key territorial projects include the following:

- Mol Balmatt site: A flagship deep geothermal project tapping into resources at 3.5 km depth with temperatures of 140–150°C. While the site demonstrates strong potential and serves as a research and educational hub, it has faced serious operational challenges, including induced seismicity, water flow inconsistencies, and proximity to radioactive waste sites.
- Geo@Turnhout: A residential geothermal heating initiative aimed at low-emission urban development.
- Beerse industrial site (Johnson & Johnson): An example of geothermal application in the private sector, showcasing industrial decarbonization.

Nevertheless, the Flemish energy market is characterized by a risk-averse investment climate. Key obstacles include:

- Seismic risks and public opposition linked to safety concerns.
- Uncertain water flows and subsurface conditions, which complicate project viability.
- Regulatory complexity, including lengthy permitting and restrictive eligibility criteria for subsidies.
- High upfront capital costs, especially for heating infrastructure.

The Call Groene Warmte subsidy program provides up to €7 million per call for green heat projects, but uptake remains limited due to administrative burdens and lack of risk mitigation tools such as insurance tied to CO₂ reduction outcomes.

Overall, accelerating the use of geothermal energy in building heating applications requires an integrated approach that includes measures such as:

- Streamlined regulations and simplified permitting to reduce project lead times.
- Risk-sharing instruments, including insurance and public guarantees, to attract private investment.

- Expanded access to subsurface data, to improve feasibility assessments and reduce technical uncertainty.
- Mandatory seismic studies and proactive communication strategies to build public trust and social license.

Latvia – Vidzeme Planning Region

Latvia possesses significant, though largely untapped, geothermal energy potential—particularly in low-enthalpy resources and ground-source heat pump (GSHP) technologies. While the country lacks high-temperature geothermal reservoirs suited for electricity generation, its shallow geothermal capacity offers a promising pathway for sustainable heating in residential, commercial, and public infrastructure.

Geological assessments have identified promising geothermal layers in regions such as Eleja and Jelgava, with subsurface temperatures reaching up to 60°C. Although deeper geothermal sources (beyond 1.5 km) may be also exploitable, the most practical and scalable applications lie in shallow geothermal systems. GSHPs, well-matched to Latvia’s cold climate and existing building stock, could play a central role in decarbonizing heat supply, especially when integrated with solar PV and storage.

Nevertheless, the deployment of geothermal systems remains limited due to several critical barriers: high upfront investment costs, low public and political awareness, limited integration into district heating systems, and a lack of robust supporting policies. While EU renewable energy directives and funding mechanisms have improved the overall policy landscape, Latvia still lacks a dedicated national geothermal policy. This absence, combined with bureaucratic hurdles and limited local expertise, undermines investor confidence, and slows progress.

The **Vidzeme Planning Region** exhibits both considerable potential as well as challenges pertaining to geothermal energy adoption in Latvia. With low geothermal gradients and insufficient subsurface data, the region faces higher exploration costs and investment risks—particularly for district heating applications. Nonetheless, Vidzeme’s rural municipalities and small towns are ideally positioned to benefit from shallow geothermal solutions as they seek alternatives to imported fossil fuels.

Despite this, uptake remains minimal. Technical know-how is scarce, public awareness is low, and financial incentives are underdeveloped. Moreover, the region’s geothermal potential is further constrained by a lack of targeted support instruments—such as risk-sharing mechanisms, streamlined permitting processes, and dedicated capacity-building programs. These shortcomings reflect broader national challenges but also highlight where territorial approaches should focus on.

Regional development strategies already include geothermal in pilot project portfolios, and EU cohesion policy offers funding opportunities. However, to convert this strategic intent into action, Latvia must implement targeted interventions:

- **Nationally**, policy reforms are needed to clarify geothermal energy's role in the energy transition, offer tailored financial instruments, and reduce regulatory friction.
- **Regionally**, feasibility assessments, awareness campaigns, and technical training can unlock bottom-up momentum, enabling municipalities in Vidzeme and beyond to act as early adopters.

Poland – West Pomeranian Region

Poland's West Pomeranian Region is a front-runner in the application of geothermal energy, particularly in district heating, with towns like Pyrzyce and Stargard providing examples of geothermal energy applications. These municipalities have successfully integrated geothermal resources into their public infrastructure, demonstrating the viability of this renewable energy solution even amidst challenges. However, the expansion and future success of geothermal heating in the region are closely tied to both local innovation and supportive policy frameworks.

The **Pyrzyce** Geothermal Heating Plant, established in 1996, is one of Europe's oldest systems, drawing geothermal water from a depth of 1,640 meters at a temperature of 64°C. Despite the highly saline brine, which posed operational challenges, the plant has thrived due to technical innovations, such as soft acidification and reinjection in a closed loop. Presently, the plant meets 60% of the town's heating demand, providing a sustainable, low-emission solution. Continued investment in infrastructure, including the addition of a second well in 2017, has reinforced Pyrzyce as a benchmark for geothermal heating in the region.

Similarly, **Stargard's** geothermal heating plant, operational since 2005, has transformed from financial instability to a model of expansion and innovation. The plant, which initially faced challenges with financial sustainability, gained momentum after a 2011 management transition to the operator G-Term. Leveraging EU co-financing, the addition of a 12 MWth heat pump between 2017 and 2020 significantly increased capacity and improved efficiency. The plant now covers over 62% of the town's heat demand across a 76.5 km network. This success story underscores the importance of EU financial support, policy backing, and local leadership in scaling geothermal infrastructure.

While the operational success of Pyrzyce and Stargard is clear, challenges remain in expanding geothermal district heating across the region. High costs related to expanding district heating networks and retrofitting aging infrastructure are key obstacles. These challenges, however, are met

with a supportive policy environment, including Poland's commitment to energy transition and access to EU cohesion funds. EU financial support has been pivotal in the upgrades to the Stargard plant, illustrating the essential role of public funding in fostering geothermal development. Bureaucratic hurdles continue to constitute an obstacle to the proliferation of geothermal energy systems. Slow administrative procedures and a lack of robust financial incentives for private investors remain significant barriers to further geothermal expansion. To overcome these, policy reforms focusing on streamlining approval processes and enhancing public-private cooperation will be crucial. Accelerating these reforms would help unlock the full potential of geothermal energy in the region, promoting wider adoption across Poland and possibly inspiring further regional energy transitions.

Slovenia – Municipality of Postojna

Slovenia is gradually considering geothermal energy as a key element in its renewable energy transition, with growing interest in both direct-use applications and ground-source heat pumps (GSHPs). The country's most significant geothermal potential lies in the northeastern Pannonian Basin, where deep aquifers reach temperatures of 100–150°C. Towns like Lendava and Murska Sobota have successfully harnessed this resource for heating residential buildings, greenhouses, aquaculture, and spa tourism. Meanwhile, GSHP systems are gaining traction in urban and residential areas nationwide, offering efficient and low-emission heating and cooling solutions.

However, expansion of geothermal energy across Slovenia faces several challenges, particularly outside the high-potential northeast areas. Key barriers include:

- High upfront costs for drilling and infrastructure
- Complex geology, especially in karst regions with carbonate rock formations
- Regulatory and permitting bottlenecks
- Limited public and institutional awareness

To address these, Slovenia has introduced several enabling measures, including:

- Streamlined permitting procedures
- New funding instruments, supported by EU structural and cohesion funds
- The development of a national 3D geological model, enhancing exploration accuracy

Municipality of Postojna is located outside the primary geothermal zones; however, the region still holds promise—especially for decentralized geothermal heating. Its carbonate rock formations could

support applications such as district heating and agricultural use, particularly in areas lacking existing centralized heat infrastructure.

While current barriers include a lack of detailed geothermal mapping, limited technical capacity, and insufficient stakeholder awareness, Postojna is well-positioned for the implementation of pilot initiatives. As Slovenia works toward its 2030 renewable energy goals, Postojna could act as a testbed for innovative geothermal solutions, such as cascading heat use or low-temperature network designs tailored to local geological conditions.

Spain – Castilla y León

Castilla y León (CyL), despite the lack of high-temperature geothermal fields, but it has become a hub for low-temperature geothermal innovation—particularly through ground-source heat pumps (GSHPs) used in homes, public buildings, and agriculture.

Located above the Duero Basin, CyL enjoys stable subsurface temperatures and favourable geological formations that make it well-suited for geothermal heating applications. Systems using vertical or horizontal ground loops are already in place across the region, with over 465 installations recorded as of 2013. These small-scale systems are especially popular in residential buildings but are also used in service and industrial sectors. In some locations—like Villalonquéjar (Burgos)—natural aquifers between 70°C and 80°C are already heating buildings. Meanwhile, areas near León, Salamanca, and Valladolid show promise for even deeper geothermal opportunities, potentially unlocking next-generation solutions like Enhanced Geothermal Systems (EGS).

CyL is also home to cutting-edge geothermal innovation. The Santa Bárbara Foundation has explored combining geothermal energy with residual heat from mining infrastructure, and hybrid systems that include solar and biomass. Even more forward-looking is a local initiative blending geothermal with Compressed Air Energy Storage (CAES), boosting energy storage efficiency from 20% to up to 70%. These pioneering efforts show how geothermal can go beyond heating—contributing to energy diversification and resilience. However, Castilla y León's geothermal sector is still in its early stages, with no large-scale district heating systems yet operational. A major reason is policy and financial barriers. The region faces challenges like fragmented regulation, outdated Mining Law restrictions, limited public-private coordination, and a lack of targeted funding mechanisms.

Nationally, Spain supports renewable energy through broad strategies that encourage regional efforts, but in practice, geothermal remains underprioritized. Unlocking its full potential in CyL will require stronger institutional frameworks, simplified permitting procedures, and financial tools such as co-

funding for demonstration projects, incentives for building developers, and support for community energy initiatives.

Presently, interest in geothermal is growing—both in public institutions and among private actors. Local research teams such as GEEDS and GIRTER are leading efforts to bridge the gap between science, policy, and practical implementation. At the same time, educational campaigns, events, and stakeholder workshops are helping raise awareness and support. By combining geological assets, technical expertise, and policy reform, Castilla y León is well positioned to become a national leader in low-carbon heating.

Lithuania

Lithuania is gradually emerging as a geothermal energy player, with increasing momentum in shallow geothermal systems and strong alignment with the country's broader goals for energy independence and decarbonization. Though still in an early stage of development, geothermal energy is increasingly used for heating purposes—particularly in regions like Klaipėda—thanks to expanding residential and institutional applications.

Over the past several years, Lithuania has seen steady growth in the use of shallow geothermal heating systems, especially for single-family homes, schools, and public buildings. This trend reflects increasing public awareness of geothermal energy's cost-efficiency and environmental benefits, as well as improved access to technology and EU-supported financing instruments. The Klaipėda region stands out as a regional leader, capitalizing on local support and favourable subsurface conditions to advance small-scale geothermal applications.

Despite this progress, the potential of geothermal energy for district heating remains largely untapped. Lithuania has only one operational geothermal district heating plant, located in Klaipėda. This plant demonstrates the feasibility of geothermal-based district heating but has not yet been widely replicated due to a range of institutional and structural barriers.

Lithuania benefits from overarching EU climate and energy targets, as well as intermittent national funding for renewable energy projects. However, deployment of geothermal heating is hindered by several critical issues:

- Lack of a national geothermal roadmap, which limits strategic coordination across agencies and regions.
- Weak stakeholder coordination, especially between municipalities, utilities, and private investors.

- Limited policy integration, with geothermal often sidelined in urban planning and energy system design.

The existing policy environment supports isolated pilot projects, but long-term scalability will require a shift toward systemic integration of geothermal into national energy and climate planning.

To unlock the full potential of geothermal energy, Lithuania should:

- Develop a national geothermal strategy that outlines technical priorities, funding mechanisms, and regulatory alignment.
- Scale up pilot projects, particularly in urban and peri-urban zones with high heating demand.
- Improve cross-sector coordination among municipalities, grid operators, and developers.
- Embed geothermal planning into urban development frameworks, alongside solar, biomass, and energy efficiency measures.

Hungary – West-Transdanubian Region

Hungary's West-Transdanubian Region stands out for its strong geothermal potential and long-standing tradition of using underground heat—especially for spas, agriculture, and local heating systems. Located in the geologically rich Pannonian Basin, the region benefits from moderate- to high-temperature thermal waters ranging from 50°C to 100°C, which are well-suited for direct-use applications such as greenhouse heating, balneotherapy, and municipal heating.

Towns like Győr, Mosonmagyaróvár, Lenti, and Vasvár already showcase working geothermal systems, proving the resource's value for both public services and economic sectors like tourism and agriculture. However, despite this solid foundation and Hungary's technical expertise in geothermal development, broader deployment—particularly of large-scale district heating systems—remains limited.

Several key challenges slow progress: high upfront investment costs, limited public awareness, and a slow, outdated permitting process. These barriers prevent more communities and investors from embracing geothermal energy on a larger scale.

To unlock this potential, a combination of targeted initiatives is being proposed:

- A dedicated geothermal development fund to reduce financial risk.
- Simplified, modernized permitting procedures to shorten project timelines.

- Incentives for public-private partnerships that bring municipalities, businesses, and energy providers together.
- Educational campaigns to raise awareness and build trust around geothermal energy's long-term benefits.

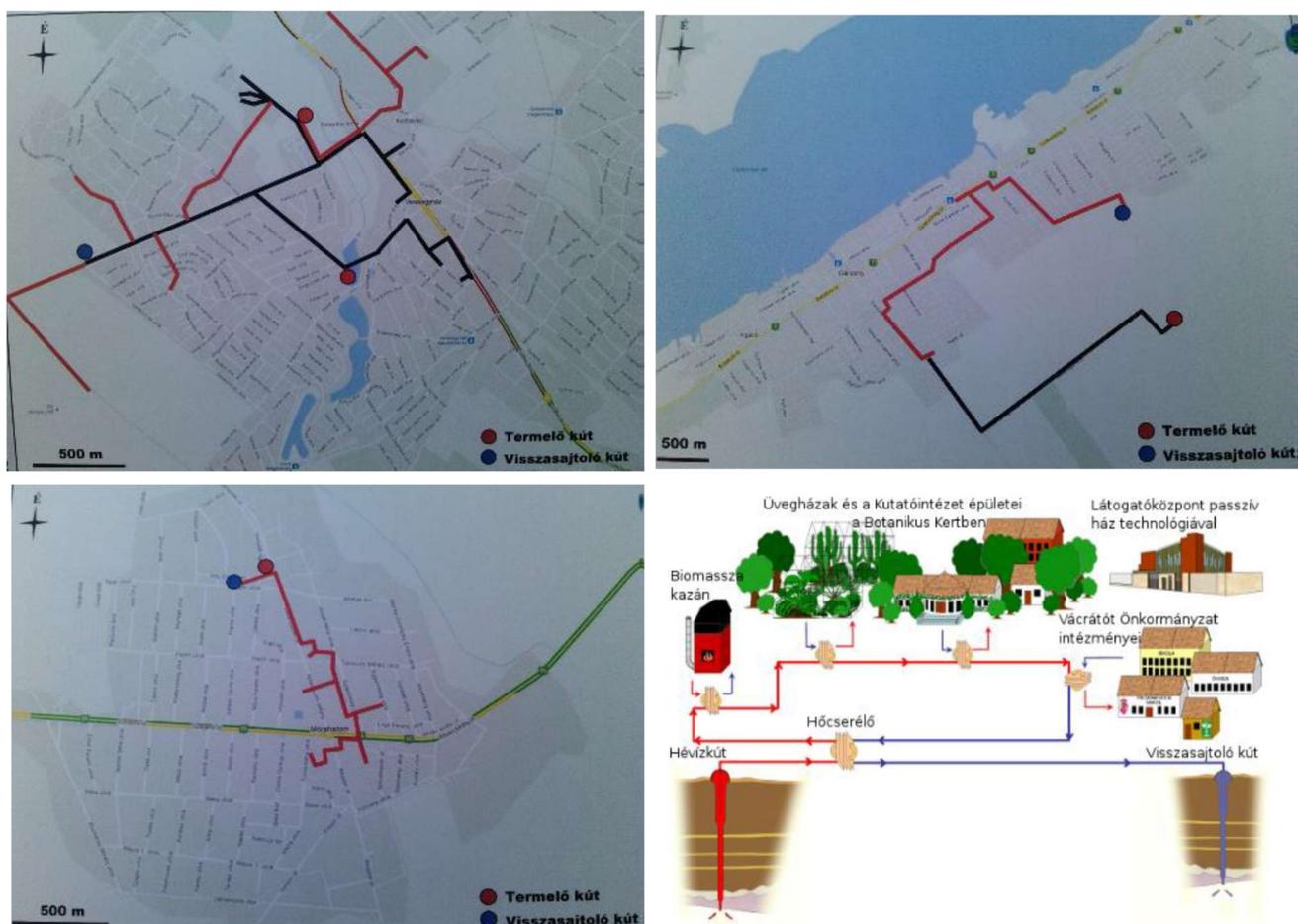
These efforts align with Hungary's **National Geothermal Concept**, adopted in 2024, which aims to double the country's geothermal energy use by 2030. The plan supports energy independence, affordability, and climate action through:

- State-backed loans for geothermal drilling and infrastructure.
- Focus on municipal and agricultural heating systems.
- Support for innovative geothermal technologies.
- Promotion of energy communities through tools like virtual net metering.

Practical applications of geothermal DH: Hungary's example

Hungary's long-standing tradition of utilizing geothermal resources is reflected in a growing number of district heating (DH) projects across the country. These practical examples demonstrate the feasibility and effectiveness of tapping into low-to-moderate temperature geothermal reservoirs for local energy needs. The geothermal DH systems in towns such as Veresegyháza, Gárdony, Mórahalom, Vácrátót, and Besenyszög exemplify diverse applications tailored to local geological and urban contexts.

In **Veresegyháza**, two geothermal wells have been developed to support the municipality's heating needs. The first well reaches a depth of 1,462 meters and produces water at 67 °C, while the second, slightly shallower at 1,202 meters, delivers water at 66 °C. Together, they form the backbone of a robust geothermal heating system that reduces dependence on fossil fuels and enhances energy resilience in the community.



1 Geothermal wells for local heating services at a) Veresegyháza (top left), b) Gárdony (top right), and c) Mórahalom (bottom left), and d) Vácrátót (bottom right)

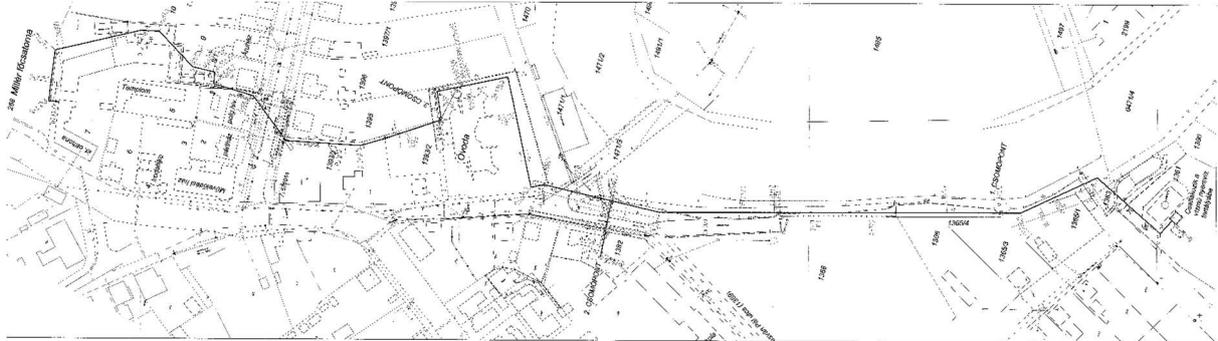
Gárdony, a lakeside town, operates a geothermal well at a depth of 746 meters with a water temperature of 64 °C. Despite being shallower than Veresegyháza's wells, this resource is sufficient to support a local DH system, showcasing how even moderate depths can yield viable heating solutions when paired with appropriate system design and thermal demand profiles.

In **Mórahalom**, the geothermal well is drilled to a depth of 1,260 meters and provides water at 63 °C. This installation supports both public and residential heating services and aligns with Mórahalom's broader strategy of leveraging geothermal energy for municipal sustainability.

Vácrátót offers another example of efficient geothermal use with a well reaching 860 meters and delivering water at 63 °C. This system supports local heating infrastructure while contributing to regional renewable energy targets.

Finally, **Besenyszög City** highlights the potential of geothermal DH even at relatively low temperatures. Here, geothermal water at 55 °C is distributed through an 850-meter-long district

heating network. This project underlines the versatility of geothermal applications, especially in small-scale settings where the thermal load is compatible with lower-temperature sources.



2 Besenyszög City's potential geothermal DH

Collectively, these examples illustrate Hungary's commitment to geothermal energy as a reliable, local, and sustainable heating solution. The varied depths and temperatures of the wells demonstrate that geothermal DH systems can be effectively designed to match local resource characteristics and community heating needs. Moreover, they serve as replicable models for other regions with similar geological conditions or energy transition ambitions.

Site visits

As part of the workshop, partners and stakeholders took part in site visits across Western Transdanubia to explore operational and under development geothermal district heating systems. These visits brought theoretical discussions into tangible context, allowing participants to directly observe how geothermal energy is deployed at different scales—both in an established urban system and in an emerging, community-scale project. These experiences highlighted key enabling factors such as local leadership, technical innovation, financing strategies, and social engagement.

Observations from the Bőny Heat Centre in Győr

Urban integration of geothermal energy

The visit to the Bőny Heat Centre near Győr provided a firsthand look at how geothermal energy can be effectively integrated into a mid-sized urban district heating system. The city of Győr has become a flagship example of how deep geothermal resources can be harnessed at scale to deliver reliable, low-emission heating to both residential and industrial users. With a population of approximately 132,000, Győr operates one of Hungary's most advanced geothermal heating systems. Managed by PannErgy, the system sources hot water (98–101 °C) from wells drilled 2,430–2,580 meters deep, with a yield of about 1,080 m³/h. This geothermal energy has partly replaced natural gas from the energy mix, contributing to a major reduction in CO₂ emissions—nearly 67,000 tonnes annually at full capacity.

Key insights from the site visit included:

- **Strong municipal and corporate cooperation:** The success of the geothermal system in Győr was made possible through close collaboration between the municipality, the district heating provider GYŐR-SZOL, and the private operator PannErgy. Their long-term partnership and clear commitment to sustainability were essential in securing public support and financing.
- **Data-driven and risk-aware development:** The system employed extensive geological and feasibility studies, which reduced exploration risk and ensured optimal well placement. This rigorous planning approach was highlighted as a best practice for other cities considering utilising geothermal energy.
- **Smart infrastructure:** The shift to geothermal heat included upgrades to pipelines, heat exchangers, and in-building heating systems. The Bőny Heat Centre uses smart control systems to ensure efficient operation and monitor performance in real time.

- **Public engagement and trust-building:** The city ran awareness campaigns to educate residents on the benefits of geothermal energy. Transparent communication and visible environmental results—such as emissions reductions—played a key role in gaining social acceptance.

Insights from the visit at Mosonmagyaróvár

Community-scale geothermal for sustainable urban heating

The second site visit took place in the geothermal heating project in Mosonmagyaróvár, located in a small but forward-looking town in northwestern Hungary. This project stands out for its ambition to almost replace the local district heating system's reliance on gas-fired boilers with geothermal energy, positioning the town as a pioneer of low-carbon heat transition at the municipal level.

Though the system was still under construction at the time of the visit, participants were able to view key infrastructure components and learn about the project's development pathway, technical features, and expected benefits.

Key observations included:

- **Broad use of geothermal energy in district heating:** The system is designed to cover approximately 85% of the town's annual heat demand through geothermal energy, using a 2,300-meter-deep production well and a reinjection well. This makes Mosonmagyaróvár a rare case of near complete decarbonization of urban heating.
- **Technical and economic ambition:** With a planned thermal capacity of up to 10 MW, the system combines deep geothermal extraction (at temperatures around 83 °C) with a modern heat transfer centre and insulated pipelines. This design ensures long-term operational stability—with a lifetime of at least 40 years—and a drastic reduction in CO₂ emissions (up to 7,500 tonnes annually).
- **Government support and strategic financing:** The project, with a total budget of 3.2 billion HUF (approx. €8 million), is backed by substantial national funding, covering more than two-thirds of the cost. The presence of strong governmental support was seen as critical for de-risking and enabling such a transformative infrastructure investment in a smaller municipality.
- **Early-stage learnings and potential replication:** While construction was ongoing during the visit, technical teams and local authorities shared valuable insights into permitting, drilling supervision, and system integration. The collaboration with Arctic Green Engineering Services (formerly Mannvit) was emphasized as a key success factor, providing international expertise for design and implementation.

- **Community-focused energy transition:** The project was framed as a strategic move not only for climate objectives, but also for local energy affordability and supply security. Once operational, the system is expected to reduce heating prices and shield residents from fossil fuel price volatility—offering a strong case for geothermal energy as a socially equitable energy solution.

Overarching takeaways from site visits

The contrasting yet complementary geothermal projects in Győr and Mosonmagyaróvár provided rich insight into what makes geothermal heating systems successful across different urban contexts. From these visits, the following overarching takeaways emerged:

Leadership and long-term vision

Whether in a city or a town, committed leadership from municipal authorities, technical experts, and private partners and a long-term approach is vital to project success—from planning through to operation.

Tailored system design

Geothermal solutions must be adapted to local geological conditions, heat demand profiles, financial resources, and governance structure. As a result, there is no one-size-fits-all solution, which can be directly adopted in all EU territories; instead, territorial authorities need to improve their capacity to pinpoint locally adapted solutions.

Robust planning and technical expertise

The sustainability of the geothermal projects can strongly benefit from early-stage feasibility assessments, risk mitigation strategies, and the cooperation with experienced engineering partners who can guide design and permitting processes.

Integrated infrastructure approach

Geothermal systems perform best when integrated with upgraded pipelines, smart control systems, and complementary technologies—highlighting the need to consider the exploitation of geothermal energy resources as part of a broader energy ecosystem.

Social acceptance through transparency

Public communication of the benefits of geothermal energy (e.g., cleaner air, lower costs), and inclusive decision-making in the planning, implementation and operation of geothermal projects represent some key approaches to earning public trust and ensuring long-term user acceptance.

Industrial and residential applications of geothermal energy

Background of the workshop

The interregional workshop on geothermal energy applications in residential and commercial heating served as a key milestone in the Green4HEAT project. Its primary purpose was to strengthen partner understanding of geothermal technologies, facilitate interregional knowledge exchange, and support the formulation of actionable policy recommendations aimed at increasing the uptake of geothermal energy within participating regions.

The workshop brought together a diverse range of stakeholders—from public authorities and policymakers to technical experts and project implementers—to discuss the untapped potential of geothermal energy across Green4HEAT territories. Since geothermal energy represents a low-emission, locally available, and highly scalable solution for heating, the event sought to create a shared vision for its wider integration into regional energy strategies.

Focus areas

The discussions were structured around several thematic focus areas, each chosen to highlight different dimensions of geothermal energy project deployment, namely:

Geothermal energy integration in modern District Heating (DH) systems

Participants explored how the use of geothermal energy, particularly through large ground source heat pumps and shallow geothermal systems, can enhance the sustainability, efficiency and flexibility of DH networks. In this context, presentations emphasized the scalability of these systems and their ability to meet diverse heating needs across urban and rural contexts.

Assessment of geothermal potential in Green4HEAT regions

The workshop highlighted the geographic and technical opportunities present in partner regions. Through shared examples and stakeholder inputs, participants assessed the current state of geothermal exploration in their territories and identified natural resources, technological solutions, and infrastructural assets that can support greater geothermal deployment.

Barriers and enablers in geothermal adoption

A critical focus was placed on identifying and understanding barriers to the implementation of geothermal projects—such as low public awareness, fragmented permitting procedures, high capital

investment requirements, and gaps in infrastructure. These discussions also included case studies and peer insights showcasing how similar challenges have been addressed in other European contexts, with the aim of pinpointing transferable good practice that can be replicated in project territories.

Policy pathways and institutional support

Emphasis was placed on the role of effective policy measures in facilitating geothermal development. In this context, participants reviewed existing regulatory frameworks and successful policy measures, aiming to distil lessons that could be translated into practical recommendations for Green4HEAT territories.

Investment strategies for green heating transitions

Recognizing that the availability of financing is a key determinant in project success, the workshop included targeted discussions on how to attract public and private investment in district heating projects that employ geothermal energy. In this context, participants examined EU funding opportunities and national incentives that can provide additional funding sources, and innovative business models that can bolster the sustainability of geothermal energy-based initiatives in the heating and cooling projects.

Industrial applications for geothermal energy

One of the key discussions during the workshop centred on how geothermal energy can move beyond residential heating and play a critical role in decarbonizing industry—especially in sectors that rely heavily on thermal energy, such as agriculture, food processing, and manufacturing.

In this context, the following case study from the Hungarian city of Szeged was presented and discussed by the participants. The case study concerned a growing geothermal network that provides clean, renewable heat to homes and public buildings. What's particularly interesting is the current plan to extend this network to serve nearby industrial sites, thus providing insights into how a city-wide geothermal project can evolve to support the local economy. Similarly, in the village of Bázakerettye, a pilot project that provides heating for large public buildings using geothermal energy has been successfully implemented, highlighting the possibility of employing geothermal energy in industrial-scale applications even in rural settings.

A number of innovative strategies were discussed to enhance the applicability of geothermal energy in industry. A key technological solution is the integration of **heat pumps** into geothermal systems, particularly in cases where the geothermal water still retains residual thermal energy after its initial

use. Heat pumps can extract additional energy from this lower-temperature return flow, thus significantly **extending the usable heat capacity** of a system. This approach not only maximizes energy use but also enhances system efficiency, making geothermal energy more suitable for industrial processes that require consistent and high levels of heat output.

Key lessons and insights

One major advantage for countries in Central and Eastern Europe is their **existing oil and gas infrastructure**. This pertains to old wells, once drilled for the extraction of fossil fuels, which could be potentially utilised for exploiting local geothermal resources. In this context, repurposing these wells can save time and significantly reduce exploration costs; countries like Hungary and Poland are well-positioned to take advantage of this legacy infrastructure, which can dramatically reduce exploration costs and accelerate deployment timelines. However, it was noted by a number of participants that current regulatory and licensing frameworks do not yet support this kind of repurposing, creating regulatory and administrative barriers that can cause additional delays and increase the required investments for the exploitation of geothermal fields.

An additional challenge that was mentioned by the participants concerns the issue of matching geothermal energy potential with industrial needs. Factories and processing plants typically require high, stable temperatures—often above what shallow or medium-depth geothermal systems can provide. Here, **low-temperature heat pumps** play a vital role: they are engineered to efficiently operate even when geothermal water temperatures fall below conventional thresholds, thus **broadening the operational range** of geothermal energy for industrial applications.

Participants also stressed the importance of system reliability. Industrial processes can't afford downtime, so geothermal systems must be able to deliver consistent, in terms of energy flow, heat. In many cases, this means combining geothermal with other energy sources in **hybrid or bivalent systems**, such as integrating heat pumps with existing gas boilers. This ensures that **peak demands** are met without interruption and offers an **energy-flexible solution** that adapts to variable geothermal yields.

A recurring theme in the discussions was the issue of **investment risk**. While geothermal energy systems are a technology that has been applied successfully, a number of industrial stakeholders consider it a high-risk technology in comparison with fossil fuel-based heating technologies. High upfront costs, coupled with the risks of mapping and exploiting geothermal fields, make businesses hesitant to invest, without additional incentives. In this context, financial models incorporating **payback period analysis** were explored. For example, systems enhanced with heat pumps can achieve **payback in as little as 7–8 years** under favourable interest conditions, but this may extend

significantly if financing terms are less advantageous—highlighting the importance of policy incentives and low-interest financing schemes.

Overall, the key conclusion that emerges from these considerations is that industrial applications of geothermal energy are feasible, but they are dependent on parameters such as the location and temperature of the geothermal field, the type of industrial application, and the ability to integrate **advanced heat pump technologies** that increase system flexibility and output efficiency.

Residential applications of geothermal energy

Geothermal heating has already proven to be a scalable and low-carbon solution for residential and public buildings, both at small (i.e., individual buildings) and large scale (i.e., entire neighbourhoods). Throughout the workshop, case studies from across Europe were presented, which showcased the ways in which geothermal energy has been applied—this included large-scale urban networks as well as targeted pilots in schools and municipal buildings.

The sections below highlight the key insights shared by the workshop's participants.

Approaches in Green4HEAT territories

In Poland, cities like Stargard and Pырzyce demonstrate what large-scale geothermal district heating can achieve, with networks supplying over half of the local population. These systems are deeply embedded in municipal infrastructure and offer a model for other regions aiming for wide-scale replication.

In these and other examples, workshop participants highlighted the growing role of **heat pumps** in enhancing geothermal district heating systems. Instead of wasting the lower-temperature return water after initial heat extraction, **strategically deployed heat pumps** allow operators to extract additional thermal energy. This **increases overall efficiency** and enables geothermal systems to cover a broader share of residential heating needs, especially in periods of low geothermal output or peak demand.

On the other hand, the adoption of geothermal energy solutions in countries such as Latvia, Slovenia, and Belgium, is still mostly in the early stages. Most applications are currently limited to smaller systems or individual public buildings. However, even these early-stage pilots are proving valuable, offering visible examples of geothermal energy's benefits, and serving as stepping stones to broader adoption.

Public buildings as strategic entry points

A recurring aspect mentioned by many partners was the value of public buildings, such as schools, hospitals, and municipal facilities, as the first areas for the demonstration and deployment of geothermal energy-based district heating systems. These buildings typically have steady heat demand, are centrally managed, and the implementation of geothermal energy-based project is typically associated with fewer bureaucratic hurdles. In this context, projects in Hungary and Slovenia have provided case studies of how these facilities can successfully anchor early-stage geothermal networks, building public awareness and institutional experience.

Technological enhancements, like **heat exchangers** and **low-temperature heat pumps**, are often deployed in such settings to maintain stable temperatures and ensure compatibility with existing heating infrastructure. These systems are particularly beneficial in retrofitting older buildings, making geothermal viable even when high input temperatures are no longer available.

Challenges in multi-family housing

Multi-family buildings, the most typical form of housing, present unique challenges, since they are often characterised by fragmented ownership structures, which makes it difficult to coordinate retrofits or transition to district heating systems. Concerns about disturbance or inconvenience caused to residents during the installation or retrofitting of heating systems, unclear cost-sharing practices, and administrative complexity continue to stall progress in this segment—even in geologically favourable areas.

To avoid these issues, some municipalities are focusing on new residential areas that are currently under development, since designing geothermal systems from the outset allows for the integration of **low-temperature district heating and smart technologies**. Incorporating **heat pumps in bivalent configurations**, which combine geothermal with gas or electric backups, further enhances system resilience. These setups help optimize energy use while ensuring uninterrupted comfort for residents.

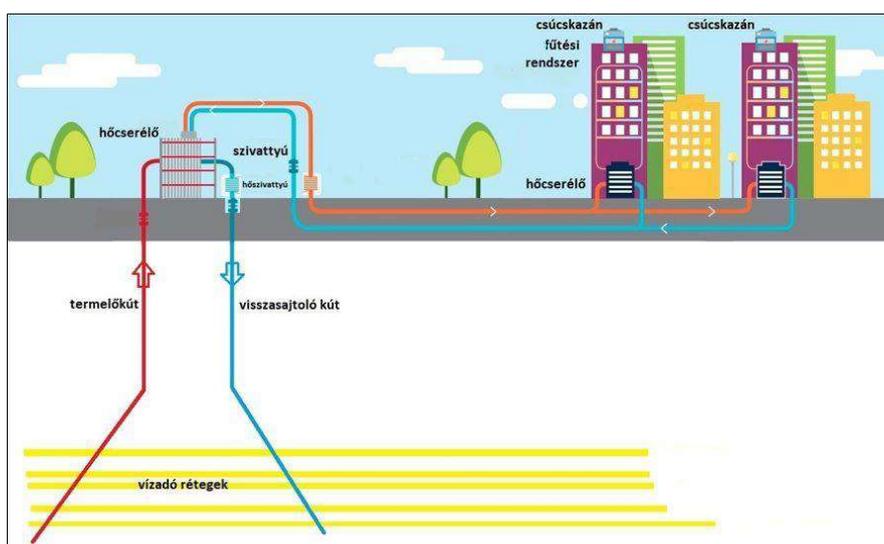
Real-world examples, like the **GeoWasteHeat** system in Nagyatád or the shallow **open loop system** in Mohács, illustrate how geothermal energy—supported by heat pump technology—can serve **both heating and cooling** needs across multi-building residential or cultural sites. These projects showcase the scalability and environmental impact of hybrid geothermal systems, even with **longer payback periods**, especially when supported by local incentives or integrated with renewable electricity sources like solar PV.

Heat pumps and system innovation

In regions where deep geothermal is not accessible, heat pumps have emerged as a **key enabler** for expanding geothermal energy use—particularly in shallow geothermal applications. Their flexibility and efficiency make them ideal for **residential heating, retrofitting projects, and low-temperature geothermal systems**.

Extending heat capacity with heat pumps

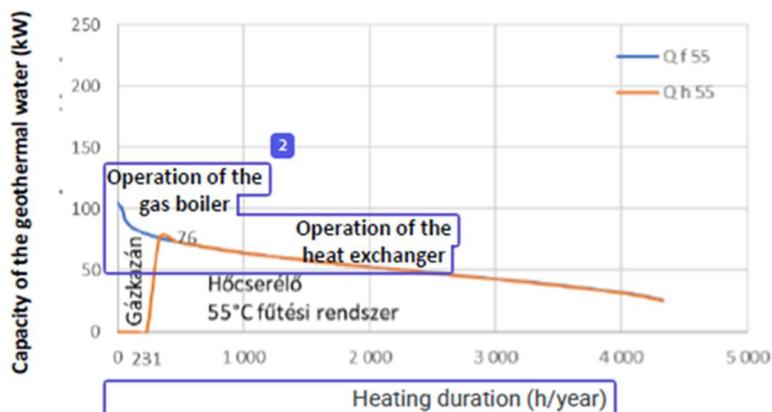
One of the key innovations in geothermal district heating (DH) systems lies in the **strategic use of heat pumps to extend the system's overall heat capacity**. This is especially valuable in setups where **return geothermal water still retains residual thermal energy** after initial heat extraction. Rather than discarding this underutilized heat, heat pumps extract additional energy from it—**significantly enhancing system efficiency**.



3 Heat pumps systems to efficiently transfer heat.

Heat exchangers play a crucial role in this process, acting as intermediaries that facilitate efficient thermal transfer between the geothermal water and the building’s heating system. This allows for a **stable temperature distribution**, even when operating with lower-temperature sources.

Heating duration diagram

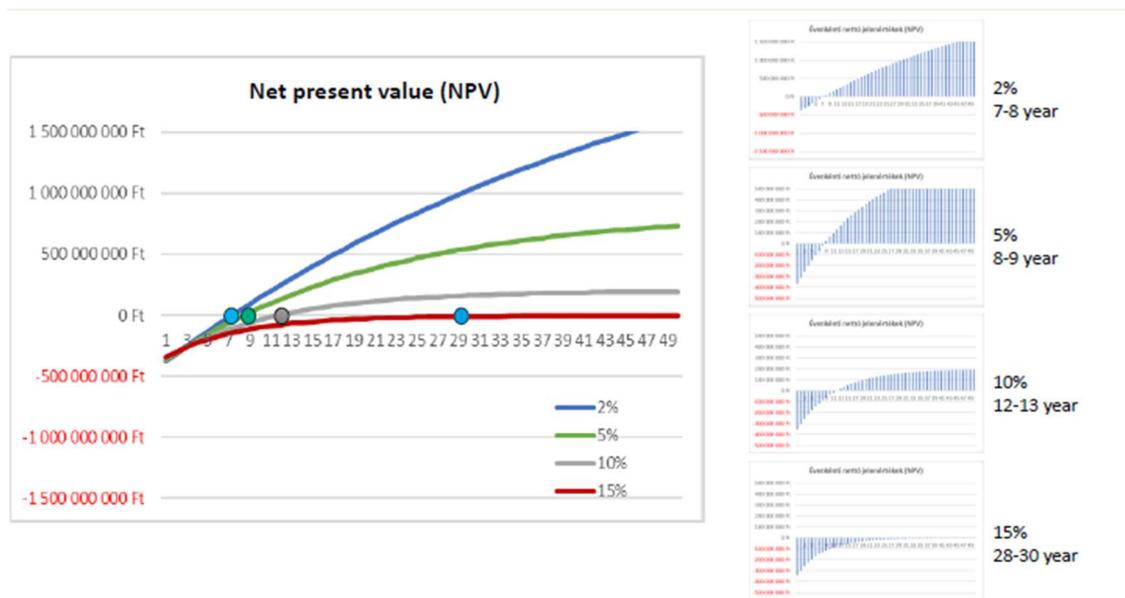


4 Heat duration diagram

To accommodate the unique temperature profile of geothermal sources, **low-temperature heat pumps** are specifically engineered to function efficiently even when **geothermal water temperatures fall below conventional thresholds**, thereby expanding the usable thermal range.

Many systems adopt a **bivalent configuration**, combining **geothermal heat pumps with existing gas boilers**. This hybrid design increases **system flexibility and resilience**, ensuring energy supply during peak heating periods or when geothermal yield is lower—**without compromising comfort or performance**.

From a financial standpoint, **payback periods for heat pump-enhanced geothermal systems vary significantly** depending on interest rates and financing conditions. With favourable interest rates (e.g., 2%), projects can recoup investments within **7–8 years**. However, at higher rates (e.g., 15%), **the payback period may stretch to 28–30 years**, underscoring the importance of **supportive policy frameworks and financial incentives**.



5 Payback periods of heat pump enhanced systems

Ground source heat pumps

Ground-source heat pumps are particularly effective at tapping into **shallow geothermal energy** without requiring deep or expensive drilling. These systems are gaining traction in **Hungary, Latvia, and Lithuania**, being deployed in both **retrofit projects** and **new residential developments**. While their **installation costs are relatively high**, they boast **lower operational costs** due to their high efficiency.

That said, the requirement for ground access makes their deployment **challenging in dense urban areas**, where space limitations or regulatory hurdles may prevent subsurface work.

Cold water geothermal heat pump systems (open loop)

A subset of shallow geothermal solutions includes **cold water open loop systems**, which use **naturally available groundwater or surface water** as a heat exchange medium. These systems typically involve circulating water through a subsurface pipe network, transferring thermal energy to and from water-to-water heat pumps via heat exchangers. These are well-suited to **urban and agricultural environments** with abundant shallow aquifers.

Key characteristics of these systems include:

- **Heating capacity:** Ideal for systems ranging from approximately 150 kW to 1–2 MW.
- **Investment costs:** Moderate, mainly involving the drilling of production and reinjection wells up to 150 meters deep.

- **Water requirements:** A consistent groundwater yield of 300–400 litres per minute is essential.
- **System performance:** Seasonal Coefficient of Performance (SCOP) for heating ranges from 3.5 to 5.5, and Seasonal Energy Efficiency Ratio (SEER) for cooling ranges from 4.5 to 7.5.

A notable application is the **Silk Factory Cultural Quarter in Mohács, Hungary**, which incorporates this technology to heat and cool several buildings, including an event centre, innovation hub, and sports complex. Utilizing a groundwater supply of approximately 400 l/min at 12–14°C, the system delivers a heating capacity of 162 kW and achieves a SCOP of 3.8 for heating and a SEER of 6.7 for cooling. It replaces around **42,000 Nm³ of natural gas annually**, resulting in energy cost savings of approximately **9.2 million HUF/year (EUR 23,000)**. Despite a relatively long **payback period of 22.7 years**, the project illustrates the long-term value and environmental benefits of geothermal solutions for public and cultural buildings.

Retrofit and integration challenges

Despite their benefits, **integrating heat pumps into existing infrastructure** is not always straightforward. In countries like **Poland and Hungary**, where traditional district heating systems run on **high temperatures**, retrofitting for low-temperature heat pump compatibility demands **comprehensive planning**—including **building envelope renovations** and **thermal system re-engineering**. These technical and financial complexities continue to act as **barriers to broader municipal adoption**.

Hot water geothermal heat pump systems (GeoWasteHeat)

A further innovation in this area is the use of **medium-temperature effluent water** (20–50°C) for heating via **GeoWasteHeat systems**. These systems are particularly well-suited for industrial or municipal wastewater reuse, integrating high-efficiency heat pumps and often paired with renewable electricity sources, such as solar PV, to further reduce carbon footprints.

Hot water GHP systems utilize medium-temperature effluent water (20–50°C), often sourced from thermal baths, industrial processes, or existing geothermal systems. These systems deliver higher heating temperatures and are well-suited for retrofits and multi-building applications.

Key features:

- Heating capacity: ~300 kW to ~3–5 MW.
- Technology: Specialized water-to-water heat pumps.
- Efficiency: SCOP = 5.0–7.0.

- Heating temperature: Max 82°C.
- Water yield requirement: $\geq 300\text{--}400$ l/min.
- System requirements: Piping network, underground buffer tank, automation, and control systems.

The GeoWasteHeat system in **Nagyatád**, Hungary, serves as a leading example. Using effluent water at 50°C, the system supplies 571 kW of installed heating capacity across five buildings, with the ability to expand up to 530 kW to additional structures. A key innovation is its integration with a solar photovoltaic system that generates 159,966 kWh/year, entirely covering the 147,444 kWh/year electricity demand of the heat pumps. With an impressive SCOP of 6.0, the system displaces approximately 94,000 Nm³ of natural gas annually, along with 20,400 Nm³ for future expansions. This results in annual energy savings of 51 million HUF (EUR 127,500) and a remarkably short payback period of 5.9 years. The Nagyatád project highlights how **synergies between geothermal and renewable electricity** can enable scalable, cost-efficient, and low-carbon energy solutions for multi-building applications.

Adoption of innovations

To simplify deployment and lower upfront costs, a range of **technical innovations** are being tested and adopted:

- **Modular heat pump systems**
- **Plastic geothermal loop piping**
- **Hybrid systems combining geothermal with solar thermal or biomass.**

Additionally, the use of **real-time monitoring, AI-driven optimization, and digital twins** is expanding. These tools support **predictive maintenance**, extend **equipment life**, reduce **downtime**, and enhance **user engagement**.

Given these trends, participants agreed that **targeted incentives**—including **grants, low-interest loans**, and **policy support**—are essential to scale up adoption across **GREEN4HEAT territories**. This is especially relevant in less mature markets or where upfront investment remains a barrier.

System design and preparatory processes

Both shallow open loop and GeoWasteHeat systems rely on meticulous design and preparatory work to ensure efficiency and longevity. These include:

- Detailed **archive research** and **geophysical investigations**.
- Construction and **testing of production and reinjection wells**.
- **Hydrogeological modelling** to understand water flow and heat transfer dynamics.
- Market analysis to align system output with local heating and cooling demands.
- Final **engineering design** tailored to site-specific conditions.

Sustainable, scalable, and cost-effective solutions

Together, these geothermal innovations reflect a broader trend in decarbonizing thermal energy systems. By combining **low- to medium-temperature geothermal sources** with **advanced heat pump technologies** and **renewable electricity integration**, these systems can meet modern energy needs while significantly cutting greenhouse gas emissions and operational costs.

Hungary's experience, particularly in Mohács and Nagyatád, showcases practical, scalable models that other regions with similar geological and infrastructural conditions could replicate. As the demand for clean energy continues to rise, such geothermal applications offer a compelling path toward achieving climate and energy efficiency targets in both residential and commercial settings.

Challenges, opportunities, and policy pathways

The transition to sustainable district heating across Europe requires an integrated approach to overcome technical, and regulatory barriers in project territories. This section outlines the key findings from the Green4HEAT interregional workshop, consolidating the case studies, good practices and insights provided by the participants, while proposing actionable strategies and policy measures to accelerate the deployment of geothermal energy-based heating systems at the local and regional level.

Territorial challenges and opportunities

While geothermal energy presents a promising pathway for decarbonizing the heating and cooling sector, its deployment is uneven due to regional disparities in available geothermal fields, existing infrastructure, policy environments, and public acceptance of district heating and geothermal energy technologies.

Challenges across Green4HEAT regions

The section discusses some key challenges that inhibit the broad exploitation of geothermal energy for heating purposes in project territories. These have been based on the input provided by the participants and the discussions that took place during the workshop.

Geological and technical barriers

Several regions encounter significant constraints, of geological nature, that impede the feasibility and affordability of geothermal energy exploitation. As a case in point countries like Belgium and Slovenia, geological complexity—such as karstic formations, fractured rock systems, and heightened seismic sensitivity—poses serious engineering and environmental risks during drilling operations. Furthermore, in seismic-prone zones, the potential for induced earthquakes has raised public and regulatory concerns, adding an extra layer of scrutiny and delay to project approvals.

In other cases, including in parts of Spain and Latvia, the primary challenge is the lack of reliable or sufficiently granular geological data. Incomplete subsurface mapping increases exploration risk and discourages private investment due to uncertainty about the available geothermal energy resources. These limitations underscore the need for enhanced geological surveys, data sharing platforms, and risk mitigation schemes to facilitate pre-investment planning and increase the feasibility of projects. Consequently, each region requires a differentiated geothermal roadmap that reflects its geological realities, state-of-play with regards to geothermal mapping, and risk profiles.

Infrastructure constraints

Another major barrier lies in the nature of the existing heating infrastructure, particularly district heating (DH) systems. Many of these networks were originally developed for centralized, high-temperature fossil-fuel sources—typically coal or natural gas—and are technically incompatible with modern, decentralized, low-temperature geothermal inputs without substantial retrofitting. In countries such as Hungary and Latvia, these systems are widespread, and their inefficiency leads to high distribution losses and operational costs, while the renovation of the entire network requires significant financial resources.

The strong dependence on natural gas further complicates the energy transition, as entrenched supply chains and cost structures disincentivize the switch to renewable heat. Without significant public investment in infrastructure modernization, such as the installation of suitable pipelines for low-temperature water transfer and smart heat metering, the integration of geothermal energy remains financially and technically challenging. Coordinated infrastructure planning, combined with heat sector reform, will be critical to unlocking geothermal energy's potential in these territories.

Socio-political resistance and awareness gaps

Even in technically viable areas, the roll-out of geothermal energy systems often faces delays due to low public acceptance and policy hesitancy. Concerns over induced seismicity—regardless of actual risk level—have created social opposition in regions like Flanders (Belgium), which has stalled geothermal projects. Furthermore, misinformation or lack of familiarity with geothermal systems can fuel concerns about noise pollution, land use, or environmental impact, especially in areas with no prior exposure to deep geothermal installations.

Moreover, political support is uneven across regions, with some local authorities lacking the institutional mandate, technical expertise, or political capital to support geothermal initiatives. The absence of clear policy direction or incentive schemes further undermines momentum, particularly for small municipalities with limited human and financial resources. Addressing these social and institutional barriers requires proactive public engagement, demonstrator projects that showcase co-benefits for the adopters, and stronger alignment between regional policies and EU-level climate and energy targets.

Territorial opportunities

Existing data and infrastructure reuse

Some regions, such as Hungary and Poland, possess extensive geological data from past oil and gas exploration initiatives. This knowledge can be leveraged to identify viable geothermal resources, significantly reducing the costs and time associated with exploration. Additionally, the repurposing, where feasible, of old wells offers an opportunity to fast-track project development.

Cross-border learning and EU support

Transnational cooperation allows regions to benefit from shared technological solutions, coordinated infrastructure development, and exchange of experience. This collaboration is particularly valuable for smaller municipalities with limited internal capacity. In this context, the participation in EU-funded projects provides an excellent opportunity for public authorities to build up their capacities and pilot test innovative solutions in their territories.

Alignment with energy security and climate goals

Geothermal energy offers a low-carbon, reliable, and local source of heating, directly supporting EU climate neutrality goals and reducing reliance on imported fossil fuels. This strategic alignment enhances geothermal energy's appeal, amid concerns over energy security and fluctuating gas prices, and increases funding opportunities for potential investors and EU funding mechanisms.

Local and practical implementation strategies

Geothermal energy projects are inherently of localised nature; as a result, they must be tailored to each territory's existing infrastructure (including, existing networks, building stock, land uses), available resources, governance structures, and public sentiment.

Throughout the workshop discussions a number of practical approaches were identified by the participants, which can be adopted primarily by municipalities, project developers, and regional stakeholders to accelerate the roll out of geothermal energy-based district heating projects; these include pilot projects, technical support, urban planning alignment, and community involvement.

In detail the identified measures are the following:

Pilot projects in public and visible spaces

The installation of geothermal heating systems in high-profile locations, such as schools, municipal buildings, and recreational centres, can help in bolstering community awareness and acceptance,

along with any financial or environmental benefits. As a case in point, the city of Győr in Hungary has successfully used such public buildings to showcase the viability of geothermal energy for building heating.

Geothermal clusters

Municipalities can accelerate the exploitation of geothermal resources by establishing “geothermal clusters”, i.e., zones that are characterised by large geothermal fields, high heating demand density, and suitable building uses. These clusters can act as test beds for innovative technologies and can provide a paradigm that can be replicated by other initiatives in the area.

Technical assistance and one-stop-shops

Smaller municipalities or small companies (including citizen-led initiatives) often lack the technical expertise to assess the geothermal potential of an area and the feasibility of a district heating network or navigate complex regulatory landscapes. Thus, establishing centralized support services, such as regional energy agencies or technical advisory centres staffed with thematic experts, can provide critical assistance, and streamline the access to funding of investors.

Community involvement and co-ownership model

Public engagement and co-ownership mechanisms (e.g., energy cooperatives) are powerful tools for gaining local support and expanding the use of geothermal energy in the heating and cooling sector. In this context, the community-driven model adopted in Mosonmagyaróvár, Hungary, can serve as a successful example for fostering ownership, reducing opposition, and increasing long-term project viability.

Updates in urban planning and renovation policies

The strategies for the use of geothermal energy should be aligned with broader urban energy and renovation frameworks, as well as land use planning, to ensure policy effectiveness. Furthermore, coordinating the roll out of geothermal energy projects with building energy efficiency upgrades and urban regeneration initiatives can improve the efficiency and performance of geothermal systems and maximize funding synergies.

Policy and regulatory improvements

A robust policy framework is essential to unlock the full potential of geothermal energy. Participants in the workshop identified several regulatory and financial tools that can create a more enabling environment for geothermal investment and deployment. These measures are typically led by national governments, EU institutions, or financial bodies, and they aim to reduce systemic barriers and attract investment at scale.

In this context, the following measures were identified, largely emphasising on removing financial barriers, simplifying administrative processes, and ensuring that the workforce can support the expansion of geothermal systems.

Risk mitigation

Public guarantees, insurance schemes, and shared-risk mechanisms can be crucial to lower the financial barriers for early-stage projects, particularly in projects that face other uncertainties, such as available geothermal resources, social acceptance, and commercial prospects. Similarly, capital subsidies and grants, especially those linked to building renovations or district heating network upgrades, are essential to increase the financial viability of geothermal projects.

Tariff incentives and market integration

Creating favourable pricing mechanisms—such as feed-in tariffs for geothermal energy or integration of geothermal energy-based systems into regulated heat pricing—can improve investment returns for investors and motivate additional investments.

Simplified permitting processes

Regulatory streamlining is particularly important for shallow geothermal and small-scale systems. Participants emphasised the importance of pathways to reduce administrative delays for demonstration and pilot projects.

Indicative changes could include standardized procedures for applications, fast track approval for demonstration and pilot projects, and reduced or waived application fees for small-scale or pilot projects.

Workforce training and skills development

The growth of the geothermal sector directly depends on a skilled labour force. Training and reskilling/upskilling programs, vocational education, and certification schemes for geothermal drilling, heating system design, and network planning should be further advanced and mainstreamed.



Empowering municipal leadership

Local governments should be supported in leading geothermal projects through access to funding tools such as EU structural funds, green bonds, and energy performance contracting. Furthermore, efforts should be made to increase the capacities of local authorities and municipal companies in network design and operation, since enhancing municipal autonomy in project design and financing can accelerate deployment and ensure long-term sustainability.

Conclusion

The Green4HEAT workshop discussed the potential of geothermal energy in decarbonizing industrial and residential heating systems across the partnership's regions. Despite challenges such as geology, infrastructure, public perception, and regulatory frameworks, the opportunities presented by existing infrastructure, technological innovation, and cross-border collaboration are substantial. Effective local implementation strategies and supportive regulatory and financial frameworks at national and EU levels are crucial to overcome these barriers and unlock the widespread adoption of geothermal energy as a reliable, sustainable, and economically viable heating and cooling solution. The Hungarian experience with geothermal networks serves as a promising example of what can be achieved through thoughtful planning, innovative technologies, and cross-border collaboration.

To scale up geothermal energy, pilot projects in public buildings, targeted geothermal clusters, and technical assistance centres will be crucial. Strengthening regulatory and financial frameworks at national and EU levels, including risk mitigation schemes, targeted investments, and simplified permitting processes, is essential for attracting private investment and ensuring successful project implementation.

A coordinated approach between local, national, and EU actors, coupled with ongoing innovation in geothermal technologies, will be essential to realize the full potential of geothermal energy as a cornerstone of sustainable heating systems.