Interreg
Danube Region

Co-funded by the European Union

Danube GeoHeCo

Danube GeoHeCo

Fostering the implementation of shallow geothermal hybrid heating and cooling systems in the Danube Region

Brochure
June 2026

Directional well drilling; Photo by InnoGeo Research and Service Ltd.

Acknowledgement

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Legal disclaimer

Project Title

Fostering the implementation of shallow geothermal hybrid heating and cooling systems in the Danube Region

Project Acronym: Danube GeoHeCo

Danube GeoHeCo aims to increase the uptake of shallow geothermal energy in the Danube Region by fostering robust transnational cooperation and coordinated promotion and support actions. The purpose of proposed activities is to achieve ambitious EU energy and climate targets by 2030 and consequently 2050.

The project fosters the integration of shallow geothermal solutions into existing fossil-fuel based domestic HC systems, raise awareness and enhance capacities.

Danube GeoHeCo project partnership

The Danube GeoHeCo project partnership is formed by 13 project partners from Austria (1), Slovenia (2), Croatia (2), Hungary (2), Romania (1), Slovakia (1), Serbia (3) and Bosnia and Herzegovina (1). The broad geographic spread of project partners (countries), encompassing a variety of geological, geothermal, climate conditions, assures transferability and applicability of the project results across the Danube Region and even beyond.

The partnership comprises Medjimurje Energy Agency Ltd. (Croatia), CROST Regional Development Nonprofit Ltd. (Hungary), University of Zagreb's Faculty of Mining, Geology and Petroleum Engineering (Croatia), Hochschule Burgenland (Austria), Local Energy Agency Pomurje (Slovenia), Geological Survey of Slovenia (Slovenia), InnoGeo Research and Service Ltd. (Hungary), Slovak Centre of Scientific and Technical Information (Slovakia), Technical University of Cluj-Napoca (Romania), Faculty of Engineering, Kragujevac (Serbia), Regional Economic Development Agency for Šumadija and Pomoravlje (Serbia), Regional Development Agency Bačka (Serbia) and LIR Evolution (Bosnia and Herzegovina).

Photo by Medjimurje Energy Agency Ltd.

Additionally, the project is enriched by engagement of 15 associated strategic partners who are representing local, regional, and national authorities, higher education institutions and associations and are contributing to the project with their expertise. Their involvement adds value to the project by integrating their knowledge and experience into its outcomes and enhancing its impact in the focus area.

The included Associated Strategic Partners are:

- Medjimurje County, Croatia

- Ministry of Foreign Affairs and Trade, Hungary
- Croatian Hydrocarbon Agency, Croatia
- Provincial government of Burgenland, Austria
- National consortium of energy agencies of Slovenia, Slovenia
- Municipality of Moravske Toplice, Slovenia
- Association of Hungarian District Heating Enterprises, Hungary
- Technical University of Košice, Slovakia
- Alba Iulia Municipality, Romania
- Slovenian Water Agency, Slovenia
- City of Kragujevac, Serbia
- Provincial secretariat for energy, construction and transport, Serbia
- Environmental Protection and Energy Efficiency Fund of the Republic of Srpska, Bosnia and Herzegovina
- City of Laktaši, Bosnia and Herzegovina
- University of Belgrade, Faculty of Mining and Geology, Serbia

With a planned duration of 30 months starting in January 2024, the project emphasizes collaboration across partner countries, institutions, and pilot locations. Key stakeholders, including governmental decision makers, representatives of small and medium-sized enterprises, contractors, nongovernmental organizations and the public are integral for the project'ss' success.

About the Danube GeoHeCo project

The Danube GeoHeCo project is funded under the Interreg Danube Region Programme 2021–2027, with a total project value of 2,481,000.00 EUR (co-financed by the European Union in the amount of 1,984,800.00 EUR, or 80%).

Danube GeoHeCo main project objective

The main objective of Danube GeoHeCo project is to increase the penetration of shallow geothermal energy in the Danube Region through initiating a robust transnational cooperation of promotion and support actions. The purpose of proposed activities is to achieve ambitious EU energy and climate targets by 2030 and consequently 2050. The project will foster the integration of shallow geothermal solutions into existing fossil-fuel based domestic HC systems, raise awareness and enhance capacities.

Danube GeoHeCo project approach is based on three specific objectives:

1. **Design and technology optimization of shallow geothermal hybrid heating and cooling systems.**
2. **Community-led planning for utilization of shallow geothermal heating and cooling potential.**
3. **Digital platform and virtual marketplace for fostering shallow geothermal hybrid heating and cooling.**

Energy power systems in the Danube Region are mainly based on fossil fuels. To sever energy dependence and confront climate change, municipalities, regions, governments and the EU are forced to reconsider their energy supplies and shift to renewable energies (RE).

Switching fossil fuel-based heating and cooling (HC) systems to geothermal (or other renewables) is a long, capital-intensive process and the availability of most base-load RES is confined regionally.

The Danube GeoHeCo project identifies this problem and intends to increase the use of one RES that is available throughout Europe with very little geographical limitations and low CAPEX: that of shallow geothermal energy (SGE) through the integration of SG solutions into existing HC systems.

Hybrid HC systems are cost-efficient and easy to adapt; therefore, they could foster a high-level reduction of fossil fuel consumption throughout the Danube Region and beyond. To contribute to this goal, the Danube GeoHeCo project is set out to advance the market penetration of SG solutions and, through the cooperation of project partners (PPs) from different countries in investments, capacity building and knowledge exchange, the project intends to increase the level of expertise and number of professionals available for the sustainable transformation of the energy sector.

Danube GeoHeCo actions

The Danube GeoHeCo project foresees and initiates the active role of local and regional authorities in applying effective community-led planning approaches which is a key step in engaging relevant stakeholders.

To stimulate and promote the integration of shallow geothermal solutions, PPs jointly carry out high-visibility investments, developed a Transnational Action Plan which defined actions for fostering shallow geothermal projects and formulated recommendations for removing bottlenecks neglected in existing planning documents. The technological segments of SGE usage for HC purposes was investigated and as a result an IT decision support tool for designing optimal use of hybrid HC systems was developed.

Photo by RDA Backa

The project included pilot investments at demonstration sites, awareness raising and knowledge transfer activities and developed a digital platform with a built-in virtual marketplace.

Through the successful implementation of the planned activities, the project has achieved tangible and measurable results and outputs, generating sustainable benefits that support the attainment of project objectives while contributing to the priorities of the funding programme and the wider strategic goals of the European Union. The main project results and outputs include the following:

Result 1 - Organizations with increased institutional capacity due to their participation in cooperation activities across the borders

Number of partner and associated strategic partner (ASP) organizations that are committed to continuous cooperation and collaboration in order to support transition of fossil fuel based producing regions through integration of shallow geothermal solutions into existing conventional fossil-fuel heating and cooling systems and by tackling main bottlenecks which hinder successful implementation of such systems and their penetration into existing markets after project end. This will be ensured through long-term cooperation agreement which was established between PPs and ASPs.

Result 2 - Joint strategies and action plans taken up by organizations

Starting implementation of prepared Transnational Action Plan outlining concrete measures and initiatives for fostering SG use. It'ss' aimed at obtaining at least three Letters of Intent from relevant stakeholders to apply development proposals from Plan during project implementation or up to 1 year after its completion. PPs with ASP assistance carry out policy advocacy to put the Transnational Action Plan into practice as follows:

- assist implementation of development proposals on SGE utilization conceived during deployment desk meetings,
- present priorities and development actions outlined by the Transnational Action Plan to the relevant regional and national authorities and lobby for their implementation,
- present outcomes of the Transnational Action Plan on the Steering Group Meeting of the Energy Priority Area (PA2) of the EU Strategy for the Danube Region,
- advocating widespread acceptance of SGE utilization in the EUSDR territory,
- promote the developed Plan through dissemination events and accompany the implementation of the Plan on regional, national and transnational level.

Result 3 - Solutions taken up or up-to-scaled by organizations

The IT decision support tool will be made accessible to a wider range of stakeholders in the Danube Region. UNIZG-RGNF will be responsible for future maintenance and management of the access rights. PPs and ASPs are committed to applying the IT tool when developing SGE utilization projects and they will disseminate the IT tool and its features among their partners and clients. Application of the community-based transnational planning model for linking local/regional planning process with relevant tools in practice will be made available to make it easy for government officials and other organizations to promote participatory planning. The web-based digital platform will be maintained by FB with all PPs and ASPs contributing to the continuous update of the knowledge and market database. This collaboration will be stipulated in the long-term cooperation agreement. All PPs encouraged relevant stakeholders to register to the digital platform and to join the virtual marketplace.

Output 2.1. Community-based transnational planning model

The output 2.1. - Community-based transnational planning model for launching local and regional shallow geothermal projects in form of a solution implies the establishment of a coordinated, community-led and transnational framework that supports the wider uptake of shallow geothermal energy (SGE) solutions through structured stakeholder engagement, planning tools, and policy integration across the Danube Region. It was achieved as a result of the joint project partners efforts with active engagement of local, regional and national stakeholders relevant for shallow geothermal energy sector, while its achievement is fully elaborated through preparation of deliverables: D.2.1.1 Community-based transnational planning model for fostering shallow geothermal energy utilization in hybrid heating and cooling systems; D.2.1.2 Deployment desks established for stakeholder engagement.

Community-based transnational planning model for fostering shallow geothermal energy utilisation in hybrid heating and cooling systems

Danube GeoHeCo project partners developed Community-based transnational planning toolkit. The purpose of transnational planning toolkit is revising and creating new policy instruments to support integration and uptake of shallow geothermal solutions at regional and local level. The transnational planning toolkit identifies all relevant stakeholders and all recommended techniques for the effective involvement of the relevant stakeholders, including various local, regional and national meetings, forums, online consultations, site visits etc.

Together, these two deliverables constitute the full achievement of the project output O2.1, proving both the conceptual creation and the operational rollout of the community-based planning model for fostering shallow geothermal energy use in hybrid heating and coaling systems.

Output 2.2. Report on experiences of elaborated pilot regional development proposals focusing on utilization of shallow geothermal potential

Report on experiences of elaborated pilot regional development proposals focusing on the utilization of shallow geothermal potential presents the pilot implementation of the community-based transnational planning model developed within the Danube GeoHeCo project.

Photo by REDASP Kragujevac

The output documents how this model was tested in practice through the establishment and operation of Deployment Desks in eight participating countries and regions across the Danube area. The pilot actions were designed to create a coordinated, community-led, and transnational framework that supports the wider uptake of shallow geothermal energy (SGE) solutions, particularly in hybrid heating and cooling systems. To achieve this, key stakeholders – including municipalities, regional and national authorities, energy agencies, businesses, technical experts, and civil society organizations – were actively engaged in a structured co-creation process aimed at preparing the development proposals tailored to local and regional contexts.

Photo by Medjimurje Energy Agency Ltd

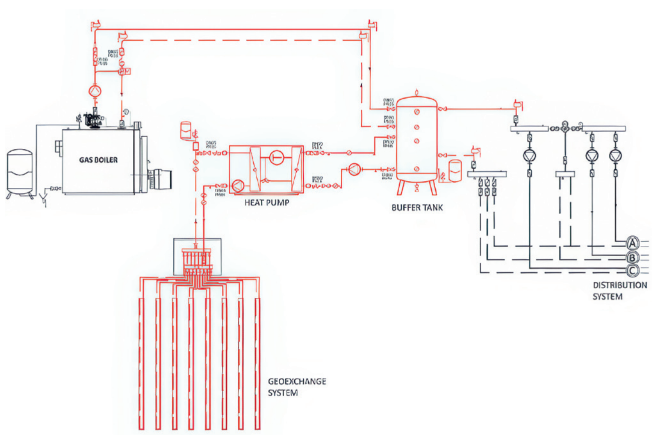
The activities covered under Output 2.2 included stakeholder mapping and engagement, the organization of pre-deployment and deployment desk meetings, the application of a common methodology and planning tools, and the adaptation of SGE solutions to specific territorial, institutional, and market conditions. Through this hands-on testing, project partners jointly validated the applicability and effectiveness of the community-based planning model in real-life settings. Output 2.2 captures practical experiences from the pilot implementation, highlights key findings, and identifies lessons learned from the transnational testing process.

These insights provide a solid evidence base for the preparation of the Transnational Action Plan and support the future replication and scaling-up of the model across the Danube Region. The successful achievement of this output is fully demonstrated and further elaborated through Deliverable D.2.2.1, Report on deployment desk meetings as pilot implementation of the community-based transnational planning model.

Photo by InnoGeo Reasearch and Service Ltd.

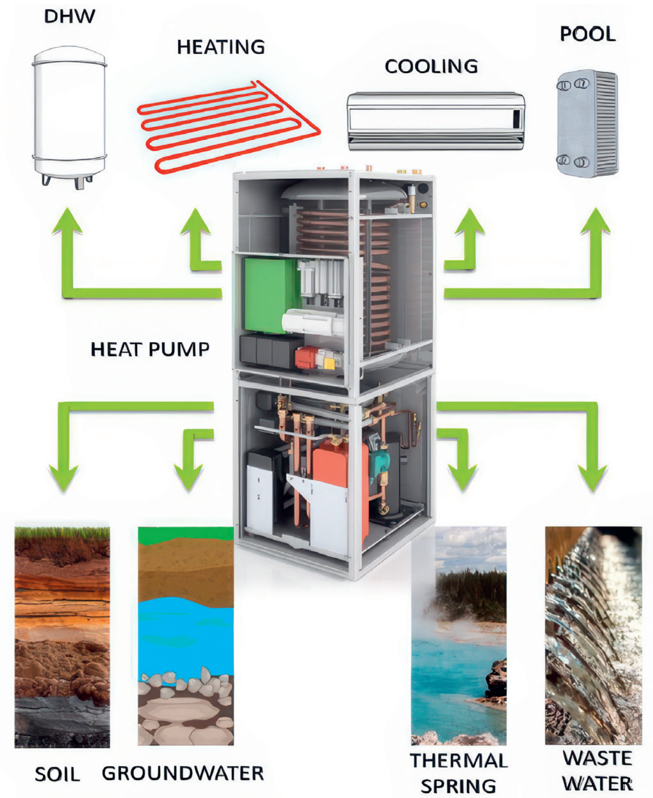
Danube GeoHeCo Partners created comprehensive Factsheets and Infographics

Danube GeoHeCo project partners have produced comprehensive Factsheets and Infographics summarizing the essential criteria and key parameters for designing effective shallow geothermal systems, as outlined in the Criteria Catalogue to optimize shallow geothermal hybrid heating and cooling systems. These resources are intended to provide detailed insights for stakeholders involved in the implementation and optimization of such systems.



Report on Criteria Catalogue for optimization of shallow geothermal hybrid systems

Danube GeoHeCo partner countries jointly created a criteria catalogue as an input for the design and technology optimization of the shallow geothermal hybrid heating and cooling systems in the partner countries Austria, Bosnia and Herzegovina, Croatia, Hungary, Romania, Serbia, Slovakia and Slovenia as well as for the European Union, where applicable, in the C„riteria catalogue for optimization of shallow geothermal hybrid systems“.



The report will contribute to the development of IT decision support tool in the project and selection of the specific pilot sites which will install hybrid shallow geothermal heating and cooling system.

Community - based transnational planning model for fostering shallow geothermal energy utilization in hybrid heating and cooling systems

Danube GeoHeCo project partners developed Community - based transnational planning toolkit. The purpose of transnational planning toolkit is revising and creating new policy instruments to support integration and uptake of shallow geothermal solutions at regional and local level. The transnational planning toolkit identifies all relevant stakeholders and all recommended techniques for the effective involvement of the relevant stakeholders, including various local, regional and national meetings, forums, online consultations, site visits etc.

Deployment desks established for stakeholder engagement

The Danube GeoHeCo project partners have worked on establishing deployment desks in eight participating countries, as part of Specific Objective 2 (SO2). These desks aim to engage relevant stakeholders from both public and private sectors to promote the adoption of shallow geothermal energy (SGE) in hybrid heating and cooling (HC) systems. The document „Deployment desk established for stakeholder engagement“ outlines the steps taken to achieve these objectives, the methods used to engage stakeholders, and recommendations for future implementation. Deployment desks are a key element in fostering regional cooperation and advancing the use of SGE technologies.

Country	Confirmed stakeholders (short list)
Austria	13
Bosna and Herzegovina	46
Croatia	29
Hungary	47
Romania	31
Serbia	27
Slovakia	25
Slovenia	21
Total	**239**

Methodological transnational framework to involve relevant market stakeholders

As already addressed multiple times, the Danube GeoHeCo project aims to promote the utilization of shallow geothermal energy in the Danube Region by integrating renewable energies, namely geothermal energy into existing heating and cooling systems. Within the activity 3.1 Project partners prepared M„ethodological transnational framework to involve relevant market stakeholders" with the main goal to involve relevant stakeholders in the heating and cooling (HC) market to support shallow geothermal energy-based hybrid systems. The framework stipulated the engagement of stakeholders from both the supply side (manufacturers, distributors, installers) and the demand side (public and private organizations with HC needs).

THE ROMANIAN INVESTMENT PILOT LOCATION

Building name: UTCN - Swimming Complex
Location: Splaiul Independenței no. 8, Cluj-Napoca
Building type (school, etc.) University
Total investment value: 40.000 EUR
Funding source: Interreg Danube Region Programme
Timeline: 01.01.2025–30.06.2026
Contact person/Title of the institution: Radu A MUNTEANU | TUCN Partner Coo

Pilot Project title

Heat pump with boreholes to the DHW preparation system

Pilot investment overview

The Romanian pilot investment is implemented at the Technical University of Cluj-Napoca Swimming Complex, located at 8 Splaiul Independenței Street, Cluj-Napoca. The objective is to install a 15kW geothermal heat pump system connected to three 100m vertical boreholes for domestic hot water preparation, replacing part of the existing gas-boiler-based DHW production and improving the energy performance of the swimming complex.

Photo by TUCN

According to the technical simulations, the heat pump will supply approximately 35 MWh/year of useful thermal energy, while consuming only 6–8 MWh/year of electricity; therefore, it will avoid roughly 36.8 MWh/year of natural gas input compared with a 95% efficient boiler, resulting in a net final energy reduction of about 28.8–30.8 MWh/year for the covered DHW load. Using indicative emission factors of 0.202 tCO_2/MWh for natural gas and 0.25 tCO_2/MWh for electricity, this corresponds to an estimated net CO_2 reduction of about 5.4–5.9 tCO_2/year: avoided gas emissions ≈ 7.4 tCO_2/year, minus heat pump electricity emissions ≈ 1.5–2.0 tCO_2/year.

The challenges/problems (before the investment)

Before the investment, the UTCN Swimming Complex relied mainly on two large natural gas boilers (2 × 1600 kW) for domestic hot water preparation, as well as for the swimming pools, HVAC system, and auxiliary heating needs. This created a high dependence on fossil-fuel-based heat supply, with significant energy demand, operating costs, and associated CO_2 emissions. The building also had a substantial annual energy consumption, with 262,532 kWh/year of electricity and 1,905,544.77 kWh/year of thermal energy, while some technical systems, such as mechanical ventilation, were described as old and outdated. Although a BEMS system was installed, it was mainly used for data collection and did not yet provide active control functions, limiting the building's capacity for automated energy optimisation.

In addition, the domestic hot water demand was high, estimated at around 24 m³/day, requiring continuous thermal energy input to maintain DHW at about 35°C. These conditions highlighted the need for a more efficient, renewable-based solution capable of reducing gas consumption, lowering operating costs, and decreasing the environmental impact of the complex.

The solution

The implemented solution is a ground-source / water-to-water geothermal heat pump system integrated into the domestic hot water preparation system of the UTCN Swimming Complex in Cluj-Napoca. The system uses shallow geothermal energy extracted through vertical boreholes to heat one of the two existing 4,000 L DHW storage tanks, while the second tank remains connected to the existing gas boilers as backup.

The main equipment includes a geothermal heat pump with a nominal thermal capacity of about 15 kW. The selected unit provides 16.35 kW at B0/W35 and 14.75 kW at B0/W55, with an electric power demand of 3.25–4.67 kW and a COP of 5.03 at B0/W35 and 3.17 at B0/W55. The geothermal field consists of three vertical boreholes, each 100 m deep, arranged in line at 5 m spacing. Each borehole includes a sealed U-type PE100 geothermal probe, DN 40 mm, with antifreeze fluid circulating through the pipes to extract heat from the ground. The estimated extractable thermal power is 13.5–16.5 kW for the full borehole field. The investment also included adaptation of the existing DHW system through a new heat exchanger, circulation pumps, hydraulic connections, geothermal manhole, distributor-collector, shut-off valves, filling/emptying valves and automation elements. A dedicated LMC320 heat pump controller manages DHW production, compressor operation, the 3-way valve, backup heating, and anti-Legionella treatment at 60°C. Simulations indicate that the heat pump can supply approximately 35 MWh/year of useful thermal energy, with an annual electricity demand of 6–8 MWh/year and estimated COP values of 4.5–7 over a 25-year operating period.

Summary

The pilot geothermal heat pump system is expected to cover up to 50% of the domestic hot water demand of the UTCN Swimming Complex, replacing part of the heat previously supplied by gas boilers. Simulations show that the system can deliver approximately 35 MWh/year of useful thermal energy, with an annual electricity consumption of only 6–8 MWh/year and an estimated COP in the range of 4.5–7, confirming stable and efficient long-term operation. Compared with a 95% efficient gas boiler, the geothermal heat pump avoids approximately 36.8 MWh/year of natural gas input, resulting in a net final energy saving of about 28.8–30.8 MWh/year, equivalent to roughly 78–84% energy savings for the covered DHW load. Based on indicative emission factors, this corresponds to an estimated net CO_2 reduction of approximately 5.4–5.9tCO_2/year, or about 73–80% lower emissions for this part of DHW production.

The expected operating cost savings are estimated at €5,000–7,000/year for a less efficient heat pump and €6,000–8,000/year for a more efficient unit, with an estimated payback period of 3–4 years for the main investment components. The solution also improves operational reliability and user comfort by providing more stable DHW production, while the existing gas boilers remain available as backup during peak demand.

Conclusion / Key Message

The pilot investment demonstrates that shallow geothermal heat pump technology can significantly reduce natural gas use, energy costs, and CO_2 emissions while ensuring reliable domestic hot water production in a high-demand public building.

THE HUNGARY INVESTMENT PILOT LOCATION

Building name: Headquarters of the District Heating Company of Szeged
Location: 4 Vag str. 6724 Szeged, Hungary
Building type (school, etc.): Office building
Total investment value: 100,000EUR
Funding source: Interreg Danube Region Programme and private investment
Timeline: 01.11.2025–01.06.2026
Contact person/Title of the institution: Dr. Tamas Medgyes / InnoGeo Ltd.

Pilot Project title

Geothermal based district cooling pilot at the customer centre of SZETAV

Pilot investment overview

The aim of the investment is to try utilizing the summer waste heat of the geothermal water for cooling by installing an adsorption chiller and testing the operation's efficiency in the customer centre of the DH Company.

The challenges/problems (before the investment)

The customer centre of the District Heating Company of Szeged (SZETAV) is situated in the non-insulated building of the company's headquarters in the North Town housing project of Szeged. The building is a single-story office with 4,737 m^3 of air (1600m^2) using 768,815GJ of heating energy in the winter and 9MWh of cooling energy in the summer (average of the last 3 years): the customer centre occupies the central area of the building at its main entrance. Adjacent to the building is the North 1/A heating plant – the plant uses gas boilers and geothermal energy to provide heat and domestic hot water to the North Town district of Szeged including the SZETAV office. The geothermal water enters the plant at 94°C (70m^3/h) and gets re-injected between 40–50°C depending on the outside temperature in the winter, but its summer use is even less resulting in very a significant amount of excess energy being unused. (There's only DHW production in the summer and that means even higher return temperatures: warm water being less dense than cold this puts pressure on injection operations too.)

Photo by InnoGeo Reasearch and Service Ltd.

With hundreds of fossil-fuels based DH systems across Europe and a general need for cleaner, import-independent, renewable energy, projects including RES integration in DH's are bound to spring up in many cities, regions and countries. At the same time winters are getting milder and summers hotter thus the need for cooling too increases across the Danube Region.

The solution

Prepare the main section with key information (technical data) about the implemented solution, including:

- the type of system installed (eg., air-to-water, water-to-water heat pump, etc.)
- details on the installed equipment (main units, capacity, key components)
- any additional upgrades carried out alongside the investment (eg., insulation improvements, automation/control systems, integration with solar energy, etc.)

Note: Ensure that clear and relevant photos of the implemented investment are included, showing the installed equipment, system components, and any visible upgrades.

Description

The pilot repurposes waste geothermal heat for summer cooling through an adsorption chiller installed at the North/1A heating plant in Szeged. The system provides summer cooling for the customer offices of the local District Heating Company (SZETÁV) with a 45kW nominal capacity. The system's auxiliary electricity demand is covered by PV panels providing for a nearly zero-emission cooling cycle. The operation transports chilled water supplied to HQ via insulated pipelines with a COP ~0.8. The system is complemented with a cooling tower, a buffer tank and PV integration.

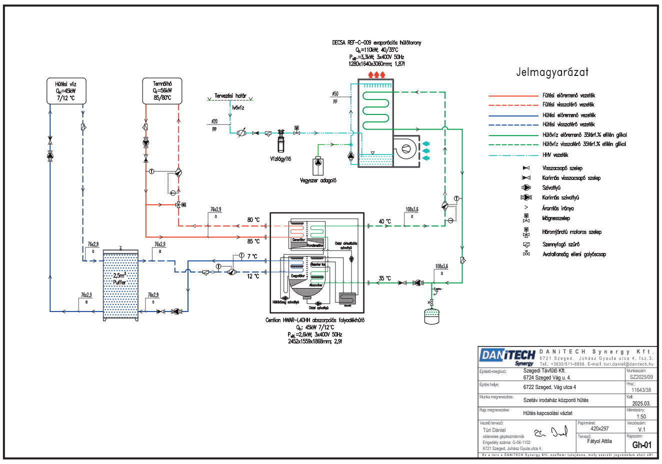


Photo by InnoGeo Reasearch and Service Ltd.

Summary

The Szeged pilot tests the centralized production and distribution of chilled water to the headquarter of the municipal district heating company. A first step towards residential district cooling the pilot is aimed to study how geothermal based adsorption chillers can reduce peak electricity demand and improve energy efficiency, integrate renewable and waste energy sources with a potential to mitigate urban heat island effects and reduce refrigerant use.

- Cost of geothermal cooling: ~0.075 €/kWh
- Conventional AC: ~0.08 €/kWh (EU avg.)
- Lower reinjection temperature (–5°C) → reduces pumping cost
- Fully renewable operation (geothermal + PV)
- Contributes to EU decarbonization goals

Explanation

The pilot tests a thermally driven refrigeration cycle using low grade energy sources (in this case, waste geothermal heat). The refrigeration cycle is like compression chillers, but compression chillers use electric compressors while in adsorption chillers the heat source drives the evaporation. It is a low electricity consumption operation that utilizes low-grade / waste heat, reduces CO_2 emissions, uses environmentally friendly refrigerants and has a long lifetime (20–30 years) with a reliable, durable technology.

As SZETAV provides service to 28,000 apartments and 400 non-residential end-users many of whom personally frequent the office such an investment will have a huge lighthouse potential and offer excellent opportunity to outreach to the public and educate locals about renewables. Also, given that there are 8 other systems with similar operations in Szeged alone (where water is extracted at 94°C and injected at around 50°C) this pilot will serve as blueprints at elsewhere in the city and well beyond. Through the investment SZETAV will cut operation costs of its headquarters, further decrease gas use and emissions while InnoGeo and the consortium will gain experience in planning and implementing geothermal based cooling.

Conclusion / Key Message

InnoGeo's geothermal based adsorption chiller pilot is a first step towards residential district cooling in Szeged."

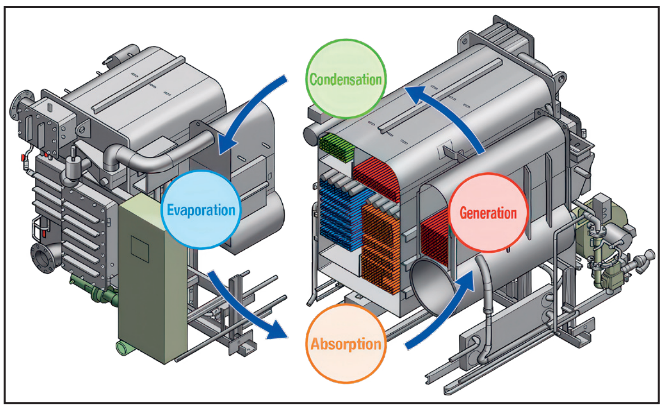


Photo by InnoGeo Reasearch and Service Ltd.

THE SLOVENIAN INVESTMENT PILOT LOCATION

Building name: Kindergarten Martjanci

Location: Martjanci 36a, 9221 Martjanci, Municipality of Moravske Toplice, Slovenia

Building type (school, etc.): Public educational building (kindergarten)

Total investment value: 39.984,95 EUR

Funding source: Co-founded by the European union (80 %) in the frame of Interreg Danube Region Programme

Timeline:

Preparation and design: 2024

Public procurement: June 2025

Implementation: July–August 2025

Commissioning: September 2025

Opening ceremony: 10 November 2025

Contact person/Title of the institution: Bojan Vogrinčič, Local Energy Agency Pomurje (LEA Pomurje)

Pilot Project title

Hybrid shallow geothermal heating system in Kindergarten Martjanci

Pilot investment overview

The pilot investment was implemented at the Kindergarten Martjanci in the Municipality of Moravske Toplice, Slovenia, in cooperation between LEA Pomurje, the Geological Survey of Slovenia (GeoZS), and the municipality of Moravske Toplice. The project involved the installation of a hybrid shallow geothermal heating system, including two 100 m borehole heat exchangers and a heat pump integrated with the existing oil boiler. The main objective was to improve energy efficiency, reduce fossil fuel consumption, and lower CO_2 emissions while demonstrating a replicable solution for public buildings.

The challenges/problems (before the investment)

Before the investment, the Kindergarten Martjanci relied on an outdated oil-fired heating system (heating oil boiler), resulting in high operational costs and significant CO_2 emissions. The system operated without any integration of renewable energy sources and offered limited energy efficiency. Additionally, the building lacked modern control and optimisation mechanisms, leading to suboptimal performance and increased energy consumption. The absence of alternative heating solutions and the discontinued district heating connection further highlighted the need for a more sustainable and reliable system.

Photo by LEA Pomurje

Photo by LEA Pomurje

Photo by LEA Pomurje

The solution

The implemented solution is a hybrid shallow geothermal heating system based on a ground-source (brine-to-water) heat pump integrated with the existing oil-fired boiler.

The geothermal system includes two vertical borehole heat exchangers (BHEs), each approximately 100 metres deep, installed using down-the-hole drilling technology and equipped with single U-tube PEHD collectors. The boreholes are spaced 12 metres apart and grouted to ensure long-term thermal stability and environmental safety.

The installed geothermal heat pump (18 kW capacity) is designed to cover the majority of the building's annual heating demand (approx. 40 MWh/year), while the existing oil boiler (103,2 kW) is retained as a backup and peak-load source, forming a bivalent hybrid system. The existing radiator heating system remains unchanged, ensuring compatibility and cost-efficiency.

The system includes advanced control and monitoring, enabling optimisation of operation between the heat pump and boiler depending on demand and external conditions. A Thermal Response Test (TRT) confirmed favourable subsurface thermal conductivity (approx. 4.2–4.4 W/mK), influenced by groundwater flow, ensuring efficient long-term operation.

Simulation using the GeoHeCo IT decision support tool shows stable operation over a 25-year period, with a coefficient of performance (COP) between 5 and 7 and annual electricity consumption of approximately 7.5 MWh.

The solution significantly reduces fossil fuel use and CO_2 emissions while providing a reliable and replicable model for public buildings.

Summary

The implementation of the hybrid shallow geothermal system significantly improved the energy performance of the Kindergarten Martjanci.

The geothermal heat pump is expected to cover most of the annual heating demand (approx. 40 MWh), reducing the reliance on the oil-fired boiler to peak-load periods only. This results in an estimated reduction of fossil fuel consumption by 90–100%.

Consequently, CO_2 emissions are reduced by approximately 50–60%, depending on operational conditions, while annual electricity consumption for the heat pump is estimated at around 7.5 MWh. The system achieves a seasonal performance factor (COP) between 5 and 7, indicating high energy efficiency.

In economic terms, the building is expected to achieve operational cost savings of approximately 30–40%, primarily due to reduced fuel consumption and improved system efficiency. Additionally, the new system provides more stable indoor temperatures and improved control, enhancing user comfort for children and staff.

Overall, the pilot demonstrates a substantial improvement in energy efficiency, environmental performance, and operational reliability, while providing a replicable model for similar public buildings.

Photo by LEA Pomurje

New Geothermal Heat Pump integrated with Existing Oil Boiler

Photo by LEA Pomurje

Explanation

The system uses heat stored in the ground to warm the building. Pipes placed deep underground collect natural heat from the soil, even during winter. A heat pump then increases this temperature and transfers the heat into the building's existing heating system (radiators). When extra heat is needed, the existing oil boiler automatically supports the system. This ensures reliable, efficient, and environmentally friendly heating throughout the year.

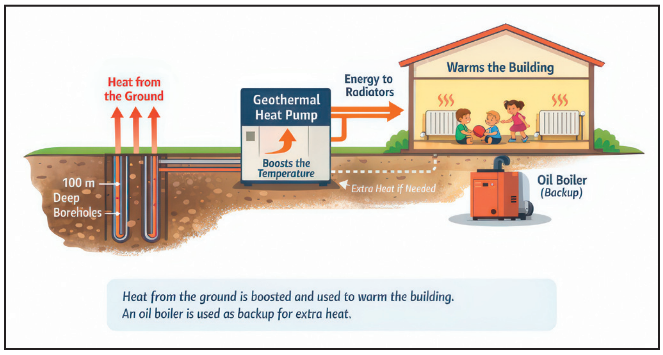


Photo by LEA Pomurje

Based on the technical data for the Kindergarten Martjanci pilot project, here are the key benefits of the new hybrid geothermal system:

- ✓ **Lower energy bills** – drastically reduces reliance on expensive heating oil.
- ✓ **Environmentally friendly** – slashes CO_2 emissions by transitioning to renewable energy.
- ✓ **Long-term cost efficiency** – provides stable heating prices over a 25-year lifespan.
- ✓ **Reliable operation** – hybrid integration ensures heat even during extreme peak cold.
- ✓ **High efficiency** – achieves a seasonal COP of 5 to 7, far outperforming traditional boilers.
- ✓ **Thermal sustainability** – groundwater flow ensures the earth's heat is naturally replenished.
- ✓ **Minimal maintenance** – geothermal heat pumps require less upkeep than oil burners.
- ✓ **Local demonstration** – serves as a proven model for other public building renovations.

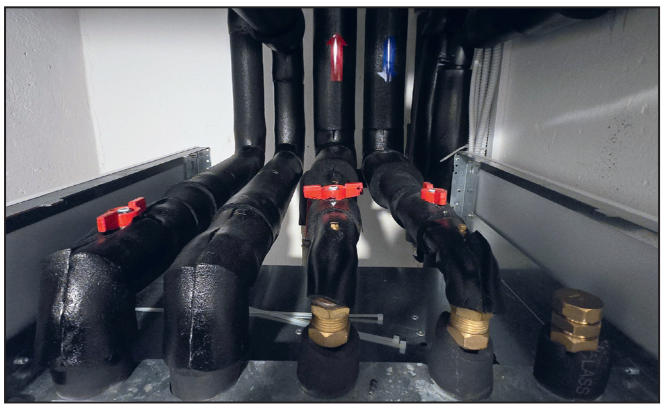


Photo by LEA Pomurje

Conclusion / Key Message

This pilot investment demonstrates that hybrid geothermal systems are a technically stable and highly efficient solution for decarbonizing existing public infrastructure in rural areas.

THE AUSTRIA INVESTMENT PILOT LOCATION

Building name: Kulturzentrum Güssing (KUZ)
Location: Schulstraße 6, 7540 Güssing, Austria
Building type (school, etc.): Cultural centre
Total investment value: EUR 40,000.00
Funding source: Interreg Danube Region Programme, DRP0200244 – Danube GeoHeCo, co-funded by the European Union
Timeline: 2024–2026
Contact person/Title of the institution: LIB – Landesimmobilien Burgenland GmbH

Pilot Project title

Deep Energy Retrofit and Renewable Heating /Cooling Upgrade of Kulturzentrum Güssing

Pilot investment overview

The Austrian pilot site is the Cultural Centre Güssing (Kulturzentrum Güssing, KUZ for short), a landmark cultural centre in Güssing, Burgenland. The project focuses on a deep energy retrofit of the historic octagonal hall together with a semi-circular open-air stage extension and the integration of modern energy systems. Its main objective is to improve the building's energy performance, significantly increase the share of renewable energy, and demonstrate a sustainable solution for cultural infrastructure.

The challenges/problems (before the investment)

Before the investment, the Kulturzentrum Güssing was an older building from 1977 that required extensive modernisation. The building was in need for a complete thermal and acoustic retrofit as well as replacement and upgrading of HVAC, electrical and lighting systems. At the same time, the building is protected as a historic structure, which limited possible facade-related thermal improvements because the visible concrete surfaces had to remain preserved.

The solution

The implemented solution consists of a comprehensive deep energy retrofit of the Kulturzentrum Güssing and the construction of a semi-circular open-air stage wing. The renovation includes complete thermal and acoustic refurbishment of the historic octagonal hall, a new glazed atrium roof, and the full replacement or upgrade of HVAC, electrical, and lighting systems.

The energy concept is centred on a ground-source heat pump system. The building is equipped with 34 vertical borehole heat exchangers arranged in two groups (21 + 13), each 120m deep, with a total design extraction capacity of 142.8kW. The main heat pump installed is a Viessmann Vitocal 350-G Pro C210 with 145 kW capacity using R-513A refrigerant.

The plant also includes a 3,000-litre buffer tank and a Viessmann ICEBAT UW 2.1/4/6 ice-storage system for peak shaving and free cooling. In addition, a district-heating interface with 210 kW is available for bivalent parallel operation. Alongside this, a 51.6kWp rooftop photovoltaic system was installed on the flat roof, consisting of 120 modules of 430Wp covering 240m², combined with a 50kW Huawei SUN20005–0KTL-M3 inverter.

The system is designed for around 80% on-site self-consumption, with maximum export of about 10kW. The project is expected to noticeably reduce the building's energy demand and significantly increase its renewable-energy share. For the renovated block, the energy certificate values are HWB 105kWh/m²a and fGEE 0.68. For the new block, the values are HWB 72kWh/m²a and fGEE 0.66. The renewable heat share is stated as more than 80%, based on the ground-source heat pump together with biomass-based district heating, and the photovoltaic contribution is reported as 452.9% (In other words, it means the project delivers about 4.529 times the minimum required PV contribution) compared to the minimum 20% requirement. The project also improves operational performance through peak-load management, renewable cooling and high on-site use of solar electricity. In the PV documentation, about 80% on-site self-consumption is expected, with only limited export to the public grid.

Summary

The system uses renewable energy from the ground through deep boreholes and transfers it to a heat pump, which provides heating for the building. In summer, the same system can also provide cooling. An ice-storage unit stores cooling energy when electricity from the PV system is available and releases it later, especially during evening events. At the same time, rooftop solar panels generate electricity for the building and support efficient operation of the technical systems.

Explanation

- ✓ lower energy demand
- ✓ more than 80% renewable heat share
- ✓ renewable electricity generation on site
- ✓ efficient heating and cooling from one integrated system
- ✓ peak-load reduction through ice storage
- ✓ high on-site self-consumption of PV electricity
- ✓ modernised technical infrastructure
- ✓ sustainable upgrade of a historic cultural building

Conclusion / Key Message

his pilot shows that even a protected historic cultural building can be modernised with efficient renewable heating, cooling and solar power while preserving its public function and architectural value.

Photo by LIB – Landesimmobilien Burgenland GmbH

THE CROATIAN INVESTMENT PILOT LOCATION

Building name: Pušćine Branch School
Location: Školska ulica 20, Pušćine, Croatia
Building type (school, etc.): School
Total investment value: 72.474,21
Funding source: Interreg Danube Region Programme 2021–2027 (80%), Croatian Ministry of Regional Development and EU Funds (10%), Medjimurje Energy Agency Ltd. (10%)
Timeline: March 2026 – May 2026
Contact person/Title of the institution: Alen Višnjić, Medjimurje Energy Agency Ltd. / Tomislav Kurevija, Faculty of Mining, Geology and Petroleum Engineering

Pilot Project title

Reconstruction of the existing heating system with cooling capability through the integration of a geothermal heat pump in the Pušćine Branch School

Pilot investment overview

The pilot investment includes the reconstruction (and upgrading) of the existing heating system in the Pušćine Branch School building through the installation of a geothermal heat pump (ground source heat pump) with capacity of 12 kW and the development of a borehole field consisting of two vertical borehole heat exchangers at depth of 110 m. Upon installation, the heat pump will assume the role of the primary energy source, while the existing gas boiler will remain in operation, with all accompanying safety and technical elements, as a backup heat source, activated below a defined bivalent point, thus together forming a hybrid geothermal system operating in bivalent parallel regime.

The challenges/problems (before the investment)

The existing heating system of the Pušćine Branch School has been designed in line with standard practices for buildings of this size and purpose in Croatia in 2007, however, a full reliance on a natural gas boiler as the sole heat source results in harmful CO_2 emissions and other harmful pollutants released into the environment.

The main challenge in implementing the pilot investment is achieving the compromise between an optimally designed geothermal system, the limited budget available for its construction and infrastructural constrains in the building. As a result, the borehole field is significantly undersized (240 m), and the existing high-temperature radiator system remains in use, which reduces heat pump efficiency. The system will therefore operate in a bivalent hybrid mode with a gas boiler backup and suboptimal operating temperatures (40–50°C). This leads to lower-than-expected energy savings and system performance but still provides valuable real-life data on hybrid geothermal operation under constrained conditions.

Photo by Medjimurje Energy Agency Ltd

Despite these limitations and considering the building is relatively new (2007) with installed underfloor heating and good insulation levels, it is particularly well-suited for the integration of a ground source heat pump, as such systems operate efficiently at lower supply temperatures, enabling higher energy efficiency. In addition to that, the proposed reconstruction ensures a significant increase in energy efficiency, a reduction in CO_2 emissions, and reliable system operation through the combination of renewable and conventional heat sources.

All of that was the main driver for initiating this pilot investment which will result in improved energy efficiency of the building and ultimately ensure more comfortable working conditions for teachers and improved comfort for children's stay during classes.

The solution

The implemented solution in Pušćine Branch School is based on a geothermal heat pump that utilizes shallow geothermal energy through vertical borehole heat exchangers. The primary circuit consists of two boreholes, each 110 m deep, with a circulating water–glycol mixture that extracts heat from the ground at stable temperatures, ensuring reliable and efficient operation throughout the year. The system is centred around a ground source heat pump, which integrates key components such as the compressor, condenser, and heat exchangers, while the existing natural gas boiler with accompanying safety and technical elements remains in operation as a backup heat source, activated below a defined bivalent point. In the new system configuration, domestic hot water is produced using the integrated storage tank within the heat pump while the full system control is transferred to the heat pump control unit, enabling centralized system regulation, ensuring optimal performance across all operating modes and automatic switching between primary and backup heat source.

Photo by Medjimurje Energy Agency Ltd

The heat pump operates in a low-temperature regime (approximately 45/40°C, up to 50°C in peak conditions), enabling high efficiency when supplying the building's heating system. Heat is distributed via a hydraulically balanced network connected to radiators and/or underfloor heating, supported by circulation pumps and insulated piping to minimize thermal losses. To ensure stable operation and proper hydraulic separation, a 200-liter buffer tank is installed which functions as a hydraulic separator. To enable proper water circulation when the boiler operates, an additional circulation pump is installed between the gas boiler and the buffer tank. The overall installation incorporates optimized hydraulic design and thermal insulation of pipelines and components, which together reduce energy losses and improve overall system performance. The pilot investment also includes energy efficiency and system optimization measures, such as hydraulic balancing, use of modern low-consumption equipment, and compliance with safety and fire-resistance standards. In addition to that, upgrades to the building's electrical installations were done to ensure successful operation and integration of the newly installed hybrid system.

Summary

The analysis of the new thermo-technical system established through pilot investment implementation indicates that the ground source heat pump covers a substantial share of the annual thermal energy demand, while the gas boiler ensures operational reliability during peak load conditions.

This configuration reduces fossil fuel consumption and CO_2 emissions, while maintaining a high level of supply security. Despite the good technical feasibility of the solution, overall system efficiency is partially limited by the constrained project budget, existing high-temperature heating system (radiators) and the relatively low installed capacity of the heat pump, resulting in moderate energy and economic savings. According to the designer's projections, at Pušćine Branch School the implementation of a ground source heat pump system is expected to deliver measurable improvements in energy performance and environmental impact, although within the constraints of the existing building system. The projected energy savings are moderate, primarily due to the hybrid system configuration combining a geothermal heat pump with a conventional natural gas boiler, as well as the use of a high-temperature radiator system. Under these conditions, estimated energy savings range from approximately 15% to 30%, with the potential for higher savings in the future if the system would be fully optimized and adapted to low-temperature operation. In terms of operating costs, a reduction of around 17% annually is projected. This decrease is mainly associated with the partial replacement of natural gas consumption by geothermal energy. Additional cost reductions were identified as achievable in the long term through further system improvements and increased reliance on renewable energy sources. The projected reduction in CO_2 emissions follows a similar pattern, with an estimated decrease of approximately 15% to 25%.

Explanation

The new thermo-technical system operation is adapted to the climate conditions of continental Croatia and varies depending on outdoor temperature and building heat demand. During transitional periods (spring and autumn), when heat demand is relatively low, the heat pump independently covers the entire load, achieving high energy efficiency. As outdoor temperatures decrease and heating demand increases, the system enters a bivalent parallel operating mode, where the heat pump operates continuously at or near full capacity, while the gas boiler supplements the required thermal output. Under low outdoor temperature conditions (below the defined bivalent point), the gas boiler assumes the dominant role in covering peak heating loads, while the heat pump continues to operate within its technical limits (eg., minimum source temperature constraints). For extracting shallow geothermal energy from the ground using ground source heat pump, a borehole field system is implemented, consisting of two vertically drilled boreholes, each 110 m deep, spaced 7 m apart to minimize thermal interference between the boreholes. Each borehole is equipped with polyethylene U-tube heat exchangers, forming a closed-loop system in which the brine circulates without direct contact with groundwater or surrounding soil. During operation in heating mode, the brine absorbs thermal energy from the surrounding geological formations as it descends and circulates through the boreholes. The warmed fluid is then returned to the heat pump unit, where it passes through the evaporator. In this heat exchanger, the thermal energy from the brine is transferred to a refrigerant, causing it to evaporate at low temperature. The refrigerant is subsequently compressed, increasing its temperature and pressure, and then releases the absorbed heat in the condenser to the building's heating distribution system. After expansion, the refrigerant returns to the evaporator, completing the thermodynamic cycle. The geothermal borehole field acts as the primary heat source, while the internal heat exchangers ensure efficient and controlled energy transfer between the ground loop and the heat pump circuit.

Conclusion / Key Message

This pilot investment demonstrates a scalable and energy-efficient modernization model, enabling the transformation of existing heating (and cooling) systems into high-efficiency solutions based on renewable energy sources, namely shallow geothermal energy. The system contributes to improved energy security and independence by reducing exposure to volatile and unpredictable fossil fuel markets. The hybrid configuration also provides a reliable backup heating/cooling) option, ensuring continuous and stable operation under all conditions, while enabling significantly lower capital expenditure compared to fully optimized geothermal systems. The approach prioritizes system resilience, supply stability, gradual decarbonisation, and practical applicability within constrained investment conditions. In addition to mentioned above, this solution has a potential for replication across other buildings with similar characteristics. Therefore, Medjimurje County will be one step closer to becoming a greener, more energy-neutral, and sustainable region.

The Final Transnational Conference

The Final Transnational Conference of the Danube GeoHeCo Project was successfully held in Novi Sad, on 20th of May 2026., gathering representatives of European institutions, regional authorities, research organisations, universities, energy agencies, and geothermal experts from across the Danube Region.

The conference served as a platform for presenting the project's key achievements, exchanging knowledge and experiences, and discussing future pathways for the deployment of shallow geothermal energy systems for sustainable heating and cooling solutions in Europe.

The Final Transnational Conference confirmed the growing importance of shallow geothermal energy as a sustainable and innovative solution for accelerating the energy transition and strengthening renewable energy deployment across the Danube Region and Europe.

Photo by RDA Backa

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The Danube GeoHeCo project is funded under the Interreg Programme for the Danube Region 2021–2027, with a total project value of 2,481,000.00 euros (co-financed by the European Union in the amount of 1,984,800.00 euros, or 80%). The project implementation period is from January 1, 2024 to June 30, 2026.