Addressing Thermal Interference and Regulatory Gaps related to Geothermal Heat Pumps Across European countries

Javiera Chocobar [1], Kai Zosseder [1], Cornelia Steiner [2], Marlon Brancher [2]
[1] Chair of Hydrogeology, Technical University of Munich
[2] Competence Unit Geoenergy, GeoSphere Austria, Hohe Warte 38, Vienna, Austria
javiera.chocobar-villegas@tum.de , kai.zosseder@tum.de , Cornelia.Steiner@geosphere.at , Marlon.Brancher@geosphere.at

Importance of GHPs for a Sustainable Energy Future in Europe

The transition to renewable energy in the EU is key to achieving carbon neutrality, and geothermal heat pumps (GHP) are a more efficient and versatile technology in reducing the use of fossil fuels. However, challenges such as harmonised regulation need to be addressed to encourage their adoption across EU. The GeoBOOST project is working on these issues, with the aim of developing a legal and technical framework to prevent interference in open and closed loop systems.

A comprehensive review was conducted of studies that assessed thermal interference between adjacent GHP systems and their impact, as well as the applicable regulations in the EU countries involved in the project.

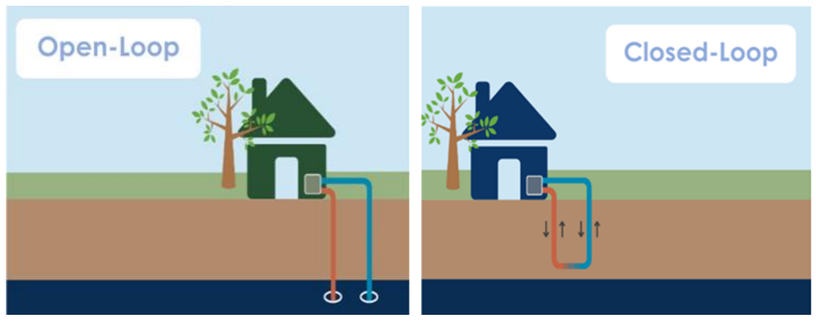

Figure A: Installation of an open loop system using groundwater for heat transfer (**left**). This can be configured to operate with a well, pond or lake. Installation of a closed-loop system extracts heat from the ground (**right**). It uses a continuous loop to transfer water (or antifreeze solution for cold climates) to the ground and back to the geothermal. The water is recirculated through a pressurised pipe rather than adding new water. Several installation options are available: horizontal, slinky and vertical.

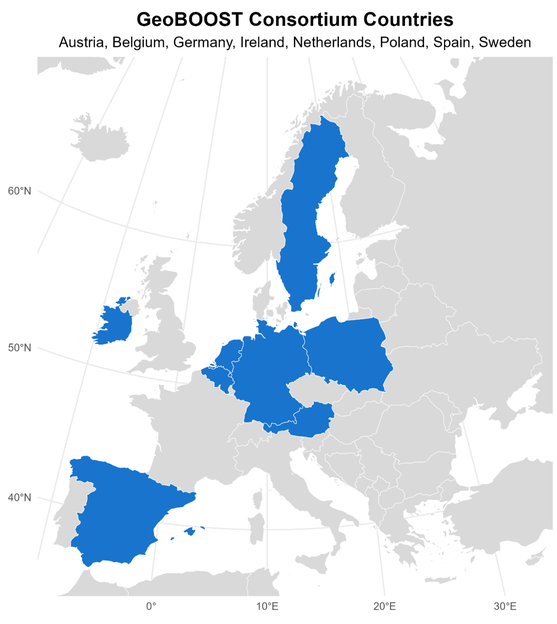

Figure B: The GeoBOOST project consortium countries.

Thermal Interference: a Challenge for Efficiency

Thermal interference occurs when several geothermal heat pump systems are close to each other or to groundwater users, which causes thermal plume overlapping and decreases their efficiency. In densely populated areas or areas with high GHP demand, it is essential to manage these interferences. A robust regulatory and technical framework would help to plan systems, ensuring proper spacing, efficient resource management and continuous monitoring, preserving the efficiency and sustainability of geothermal resources in the long term.

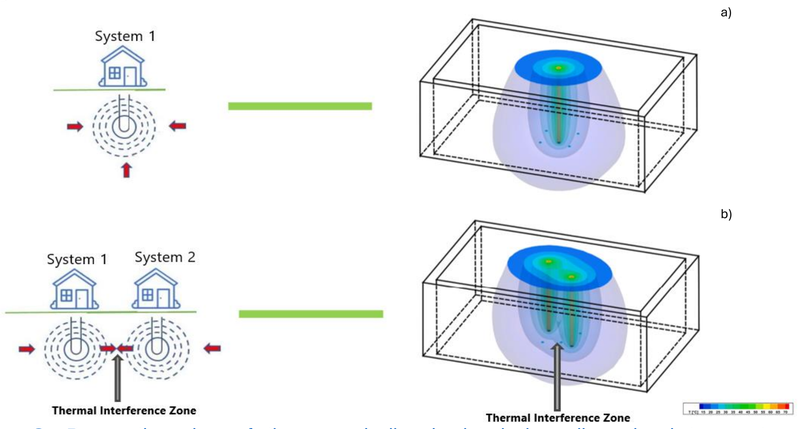

Figure C: Perspective view of the numerically simulated three-dimensional temperature distribution after 120 h for different cases of BHE interaction operating together. **a)** only one installation and **b)** two installations(1).

Regulatory Challenges Across Europe

A narrative and integrative review of studies on thermal interference between adjacent GHP systems and its impacts, as well as applicable EU regulations, was conducted. Surveys were also conducted in the participating countries on their regulations. The results indicate that thermal interference can significantly reduce the efficiency of systems if it is not considered in planning. The regulatory review shows wide variations in legal requirements to ensure system efficiency and sustainable management of the geothermal resource, highlighting the lack of standardisation and difficulties in the application of reporting practices.

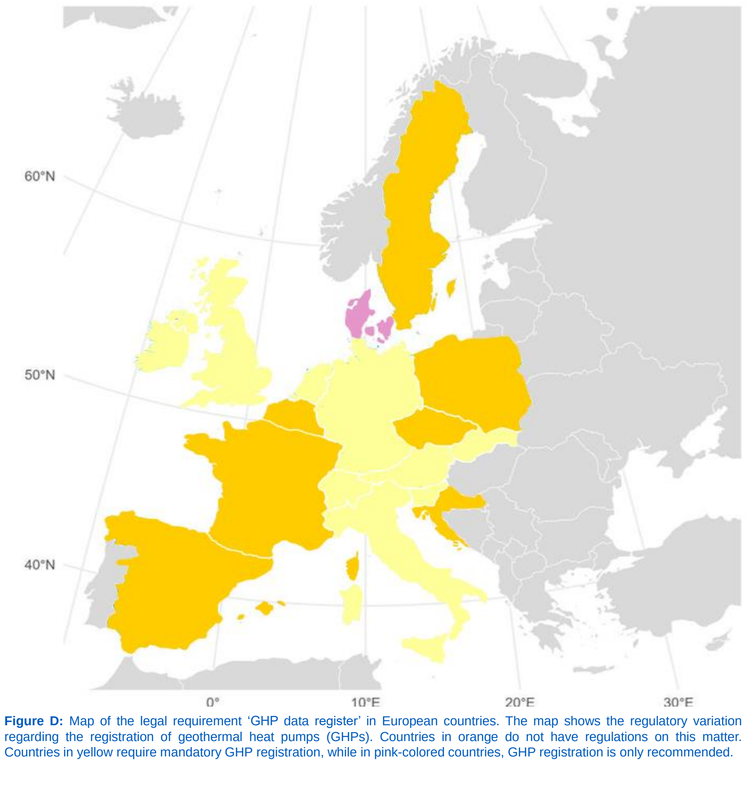

Figure D: Map of the legal requirement 'GHP data register' in European countries. The map shows the regulatory variation regarding the registration of geothermal heat pumps (GHPs). Countries in orange do not have regulations on this matter. Countries in yellow require mandatory GHP registration, while in pink-colored countries, GHP registration is only recommended.

Proposed Solutions: Implement a standardised data collection structure

In response to the results found, a holistic approach is proposed to address thermal interference and regulatory challenges, enabling more efficient and compliant GHP systems planning. A key component of this initiative is a robust data collection structure to harmonise data from various regions, which has the potential to allow for more accurate assessments and improved framework reliability.

Data template sheets for data collection & sharing

The data sheets for the GHP systems provided herein serve as templates showing (3):

- Parameters that we recommend to be generated or collected in at least state-wide or better country-wide databases;
- How the generated data could be shared with third-party users.

The data sheets, based on two formats (4), were created for the following systems: borehole heat exchangers (BHE), groundwater heat pumps (GWHP), horizontal collectors (HOR), and thermal energy geostructures (TEG).

Template sheet - Format 1: This format aims to capture both **i**nstallation-level and **c**omponent-specific details of the installations. It is ideal for studies requiring detailed information on individual system components, allowing comprehensive analysis within a single structure (3).

i_id	i_name	i_commissioning_date	i_status	i_n_heatpumps	…	c_borehole_id	c_borehole_x_coordinate	c_borehole_y_coordinate	c_borehole_depth	c_borehole_diametre	…
bhe_001	a	01-12-10	decommissioned	1	…	bhe_001_01	503505	235002	100	150	…
bhe_001	NA	NA	NA	NA	…	bhe_001_02	503512	235019	110	150	…
bhe_002	b	02-12-10	operational	1	…	bhe_002_01	523701	239801	90	120	…
bhe_003	c	03-12-10	operational	2	…	bhe_003_01	520001	219010	115	150	…
bhe_003	NA	NA	NA	NA	…	bhe_003_02	520002	219011	115	150	…
bhe_003	NA	NA	NA	NA	…	bhe_003_03	520003	219012	110	150	…
bhe_003	NA	NA	NA	NA	…	bhe_003_04	520004	219013	90	150	…
…	…	…	…	…	…	…	…	…	…	…	…

Template sheet - Format 2: This format provides a high-level outline of geothermal installations. It simplifies the documentation and sharing process, as detailed component-specific information is not considered. This aggregated presentation of data is advantageous for summaries or comparative analyses of geothermal installations that focus on the general characteristics of the system rather than on the minutiae of component-specific data (3).

installation_id	installation_name	x_coordinate	y_coordinate	commissioning_date	status	n_heat pumps	thermal_capacity	thermal_energy_delivered_heating	thermal_energy_delivered_cooling	eflh_heating	…
bhe_001	a	503500	235000	01/12/2010	decommissioned	1	10	28	NA	2470	…
bhe_002	b	470300	235000	02/12/2010	operational	1	5	14	NA	2470	…
bhe_003	c	520002	219000	03/12/2010	operational	2	20	56	NA	2070	…
bhe_004	d	553503	234803	04/12/2010	operational	1	7	19.6	NA	2470	…
bhe_005	e	513504	194804	05/12/2010	operational	1	10	NA	28	NA	…
bhe_006	f	503505	234805	06/12/2010	operational	1	10	25	14	1340	…
bhe_007	g	483506	214806	07/12/2010	planned	1	5	14	NA	2470	…
…	…	…	…	…	…	…	…	…	…	…	…

Conclusion & Outlook

This study highlights the importance of developing a sound legal and technical framework in Europe, emphasising the need for increased data collection, monitoring and standardisation of geothermal heat pumps (GHPs) in the EU, which is fundamental for integrating renewables and achieving carbon neutrality. The proposed data templates underline the benefits of generating primary data in a uniform way across the EU. Their introduction represents a practical step towards closing the data gap. The adoption of this framework will improve the visibility of geothermal projects, facilitate planning and accelerate the uptake of GHP, thereby boosting the growth of the sector and ensuring that EU sustainability targets are met the growth of the sector and ensuring that EU sustainability targets are met.

References

1. Chocobar, J., Zosseder, K. (2024). Framework for technical and legal assessment of thermal interference and optimised planning of open- and closed loop GHP systems. Deliverable D3.1 of the GeoBOOST project (Boosting geothermal heat pumps to mainstream cost-effective and efficient renewable heating and cooling in buildings).
2. Wang, B., Beyer, C., Aydin, M., & Bauer, S. (2024). Experimental and numerical investigation of thermal interactions between high-temperature borehole heat exchangers in unsaturated and low permeable soil. Applied Thermal Engineering, 248, 123184.
3. Brancher, M., Steiner, C. (2024). Reporting and monitoring geothermal heat pumps in Europe. Deliverable D2.2 of the GeoBOOST project (Boosting geothermal heat pumps to mainstream cost-effective and efficient renewable heating and cooling in buildings).
4. Kleppmann, M. (2017). Designing data-intensive applications: The big ideas behind reliable, scalable, and maintainable systems. " O'Reilly Media, Inc."

Co-funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or CINEA. Neither the European Union nor the granting authority can be held responsible for them.