Geothermal Energy Use, Country Update for Belgium

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ABSTRACT

Geothermal energy is progressively gaining ground in Belgium, with tailored strategies emerging across its three Regions. Wallonia has undertaken a comprehensive modernization of its regulatory instruments, set ambitious renewable heat targets, and initiated large-scale subsurface exploration. Flanders is reinforcing its leadership in deep geothermal by targeting new geological formations, while improving shallow geothermal integration and subsurface governance. In the Brussels-Capital Region, efforts focus on incorporating shallow geothermal into urban energy planning through spatial zoning, technical potential mapping, and system monitoring.

A suite of regional and European research projects (e.g. GEOCAMB, DESIGNATE, MORE-GEO, URGENT) have played a pivotal role in de-risking geothermal development by providing interdisciplinary tools that address geological complexity, economic feasibility, and environmental performance. Nevertheless, geothermal energy accounted for only 3.3% of Belgium’s renewable heat production in 2023, highlighting the need for accelerated deployment - especially in deep systems.

Achieving carbon neutrality by 2050 will require stronger political commitment, harmonized regulatory frameworks, and targeted financial incentives. Ongoing pilot projects and scientific advances confirm geothermal energy's potential to become a cornerstone of Belgium’s sustainable heating transition.

1. INTRODUCTION

In the context of Belgium’s commitment to climate neutrality by 2050, geothermal energy is receiving increasing attention as a sustainable solution for heating and cooling. Although its contribution to renewable heat production remains modest - 3.3% in 2023 - recent developments signal a turning point. The three Regions are engaging in distinct yet complementary initiatives to unlock the geothermal potential of both shallow and deep subsurface resources.

Wallonia is revising its legislative framework, promoting geothermal district heating, and exploring the reuse of abandoned coal mines. Flanders is consolidating its experience in deep geothermal energy, enhancing subsurface governance, and supporting large-scale deployment of shallow systems. Meanwhile, the Brussels-Capital Region is integrating shallow geothermal into regional planning tools and assessing its technical potential through zoning and decarbonisation studies.

This paper provides a comprehensive overview of the current status of geothermal energy in Belgium, with a focus on policy and legal frameworks, market trends, and the outcomes of major research projects. Special attention is given to interregional dynamics, technical innovations, and remaining barriers to scale-up. By doing so, the article aims to inform future strategies for geothermal deployment and contribute to the broader energy transition discussion in Belgium.

2. POLICY AND LEGISLATION

2.1 Brussels

While the Walloon and Flemish Regions implemented their driller certification systems a few years ago, the certification procedure is expected to be introduced in 2025 for the Brussels-Capital Region.

2.2 Flanders

In Flanders, the policy on deep geothermal did not change since the country update from 2022 (Dupont et al. 2022). Licensing for geothermal projects deeper than 500 m TAW is regulated by the Flemish Decree of 8 May 2009 concerning the deep subsurface. It follows a two steps procedure with exploration and production licenses. These grant the exclusive rights for exploration of and production from a 3D volume in the subsurface, respectively. The standard validity period of the exploration permit is 5 years. Based on the results of the exploration, the license holder has to define a production plan, which is required for a production license. In addition, an environmental permit is needed for drilling and for the construction and operation of the geothermal installations.

Flanders stimulates the development of deep geothermal through the Ecologiepremie and investment subsidy. Moreover, an insurance system for geological risk is in place since 2018.

Shallow geothermal projects can apply for financial support through the green heat call in case they meet the specifications for a useful green heat installation. To qualify for the investment subsidy, a project must have a gross thermal capacity of more than 300 kW_{th} (or an extension of more than 300 kW_{th}).

2.3 Wallonia

In the Wallonia's Air-Climate-Energy Plan (PACE 2030), adopted by the Walloon Government on 21 March 2023, the target for renewable heat production by 2030 is 15.6 TWh, representing a 180% increase compared to the (2023) situation. The technological mix below outlines the main development directions based on the technical and economic potential identified for each sector. All technologies and sectors are involved in achieving this objective: solar thermal, heat pumps, geothermal energy, and biomass. The implementation of district heating networks will also contribute to meeting the renewable heat targets, particularly for biomass and geothermal energy. The 2030 targets for deep and mine geothermal energy amount to 251 GW_{th}, while the target for heat pumps (all types combined) is 2037 GW_{th}.

The Walloon Regional Policy Declaration (RPD) 2024–2029, adopted in July 2024, mentions the development of thermal energy networks, particularly district heating networks, as part of the energy transition. However, geothermal energy is not explicitly mentioned. The RPD outlines the adoption of a management strategy for the various networks, including district heating, and proposes to simplify administrative procedures to accelerate investments. Financial support mechanisms are also envisaged, along with an adaptation of the EPC (Energy Performance Certificate) system to better integrate these networks.

Wallonia has implemented several key measures in 2021 to promote geothermal energy as part of its heat strategy:

- Promotion of thermal energy networks: The strategy adopted in March 2021 encourages the development of heating and cooling networks powered by renewable sources, including geothermal energy.
- Financial support for district heating projects: Wallonia has launched calls for projects to fund the development or expansion of thermal energy networks using resources such as geothermal energy. These initiatives aim to decarbonize cities, neighborhoods, and business parks.
- Ambitious targets for renewable heat in the PACE 2030 (see above).

These measures reflect Wallonia's commitment to integrating geothermal energy into its energy mix as part of a transition toward more sustainable heat sources.

2.3.1 Legislation SGE

In Wallonia, the regulatory framework for open-loop shallow geothermal systems was updated by the Government Decree of 10 April 2024. The aim of this revision is to facilitate the development of shallow geothermal energy while ensuring the protection of groundwater resources. One of the main changes is the creation of a new category (rubric 41.00.05) specifically dedicated to systems involving the reinjection of groundwater as part of open-loop geothermal installations. This category is subdivided as follows:

- Installations with a capacity of ≤ 10 million m^3/year and a depth of ≤ 500 metres, classified as class 2 of environmental permit.
- Installations exceeding these thresholds are classified as class 1 of environmental permit.

Additionally, the existing rubric 45.12.01 governing deep drilling operations has been modified to include reinjection-specific subcategories:

- Reinjection boreholes with a depth ≤ 500 meters, now also classified as class 2.
- Boreholes exceeding this depth remain in class 1.

These modifications allow certain installations to be reclassified from class 1 to class 2, thereby simplifying administrative procedures for low-impact, shallow geothermal projects. However, the Walloon Economic, Social and Environmental Council has expressed concerns about the coherence and maturity of the overall regulatory framework, suggesting that further refinement is still required. This reform represents a step forward in enabling more widespread adoption of geothermal energy in Wallonia, particularly for low-temperature, shallow-depth applications.

The regulatory framework for closed-loop systems was also simplified: the installation of these systems is now subject to a simple notification to the competent authorities (cities). However, if the installation is located within a groundwater catchment protection zone, a class 2 environmental permit is required.

2.3.2 Legislation DGE

The new Walloon Subsoil Resources Management Code, adopted on March 14, 2024, provides a comprehensive legal framework for the exploration and exploitation of deep geothermal energy in Wallonia, defined as thermal energy extraction from depths greater than 500 meters.

This Code recognizes subsurface resources, including deep geothermal reservoirs, as common goods under the administration of the Walloon Region. It introduces exclusive permits for exploration (10 years) and exploitation (30 years), both renewable once. These permits are designed to regulate activities while ensuring public participation through mandatory public inquiries. To ensure sustainable management, the Code establishes several key instruments:

- A Strategic Subsoil Resource Management Plan, which acts as an underground zoning tool. It allows the Government to make informed decisions, following public consultation, to prioritize projects in the public interest.
- A Subsoil Council, composed of multiple stakeholders, which advises the Government on projects involving subsurface resources.
- An Independent Scientific Committee, which supports the Council by providing expert assessments of the technical and environmental aspects of proposed projects.
- A centralized Subsoil Database, intended to consolidate and make accessible all geological and geotechnical data for improved transparency and governance.
- The Code prohibits certain high-risk practices, such as hydraulic fracturing, in order to protect the environment and groundwater resources. It explicitly excludes shallow geothermal systems (≤ 500 meters) from its scope, which are governed under separate regulations.

In summary, the new Code aims to promote deep geothermal energy development in Wallonia, while ensuring a responsible, transparent, and environmentally sound use of subsurface resources for the benefit of current and future generations.

3. CURRENT SITUATION

In 2023, modern renewable energy sources accounted for 11.68% of Belgium's total final energy consumption, according to the International Energy Agency (IEA.2023). Within the renewable heat sector (Figure 1), geothermal energy contributed 3.3% of the total heat generated from renewable sources (IEA, 2023). While these figures reflect a modest integration of renewables, they also highlight Belgium's ongoing dependence on fossil fuels. This underscores the importance of enhanced policy support and strategic investment to accelerate the shift towards a more sustainable and diversified energy mix.

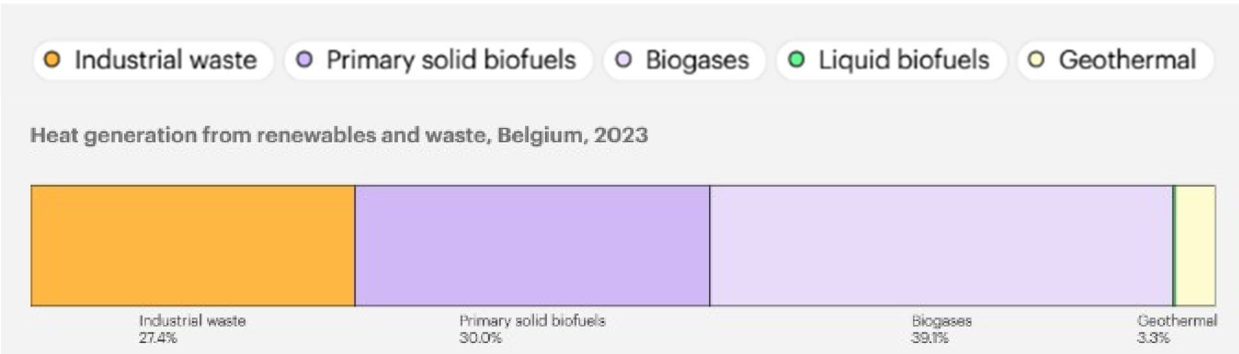

Figure 1: Heat generation from Renewables and Waste in Belgium (IEA 2023, CC BT 4.0).

3.1 Belgian heat pump market

According to the EHPA report *"Pump it Down – Why Heat Pump Sales Dropped in 2024: A Country-by-Country Breakdown"* (March 2025), Belgium saw a sharp decline in heat pump sales in 2024. Sales of hydronic heat pumps dropped by 40%, while monobloc units fell by 60%, marking an all-time low compared to the peak years of 2021 and 2022. This downward trend, already evident in 2023, has been driven by a combination of economic and policy-related factors.

The high cost of electricity—almost four times more expensive per kWh than natural gas—has significantly reduced the financial appeal of heat pumps for consumers. This has been compounded by inflation, elevated interest rates, and general economic uncertainty, all of which have discouraged investment in renewable heating technologies. Moreover, inconsistent policy measures—such as changing VAT rates and reversals in heating regulation decisions—have further eroded consumer confidence. Misleading media coverage has also contributed to public misunderstanding and skepticism around heat pump systems.

In an effort to reverse this trend, the federal government announced on 7 February 2025 a temporary VAT reduction on the supply and installation of heat pumps, lowering the rate from 21% to 6%. At the same time, the VAT rate for the installation of fossil fuel boilers (gas, oil, etc.) was increased from 6% to 21%.

3.2 Geothermal HP installed in Belgium

There is currently no comprehensive national or regional database managed by public authorities that fully documents geothermal heat pump (GSHP) installations in Belgium. As a result, annual sales estimates of geothermal heat pumps are obtained from the Belgian Heat Pump Association, which provides valuable market insights in the absence of official figures.

To estimate the number of operating systems (Table E), we used the reporting obligations introduced in recent years as a starting point. These obligations have led to a growing number of registered installations, particularly for shallow geothermal systems, allowing for better visibility of installed capacity than in the past. However, the available data remain incomplete: (1) many systems were installed before reporting was required, (2) some were incorrectly registered or not identified under the “geothermal energy” category, and (3) others were never reported at all.

Closed-loop systems are especially underreported, and those that are registered typically lack details on installed thermal capacity. Moreover, no systematic follow-up exists to compare planned performance with actual output, as the current registry is limited to basic drilling data.

To estimate the total installed capacity, we combined the number of known installations with a typical average capacity per unit. For residential systems, an average capacity of approximately 10 to 15 kW_{th} per heat pump was used, based on industry standards and available documentation. This allows for a rough estimation of total geothermal heating capacity in Belgium compared to previous years.

In the future, enhanced documentation of installed geothermal systems - ideally including thermal capacity, energy performance, and system type - will be crucial for informed policy-making and infrastructure planning. Achieving this goal will require additional time, financial resources, and administrative support.

3.3 Brussels

3.3.1 Shallow Geothermal Energy

In the Brussels online database available through the geoscientific tool (Brugeotool), installations are classified into three categories: operational or existing systems, permits under review, and permits granted. However, for ease of reading, the latter two categories are grouped under the label *"ongoing projects"* on the map in Figure 2.

- For Aquifer Thermal Energy storage (ATES), the inventory includes 5 operational projects, 10 permits currently under review, and 8 permits that have already been granted, resulting in a total of 23 projects.
- For closed systems (& Borehole Thermal Energy Storage, BTES) systems, there are 47 operational projects, 25 permits under review, and 83 granted permits, bringing the total to 155 projects.

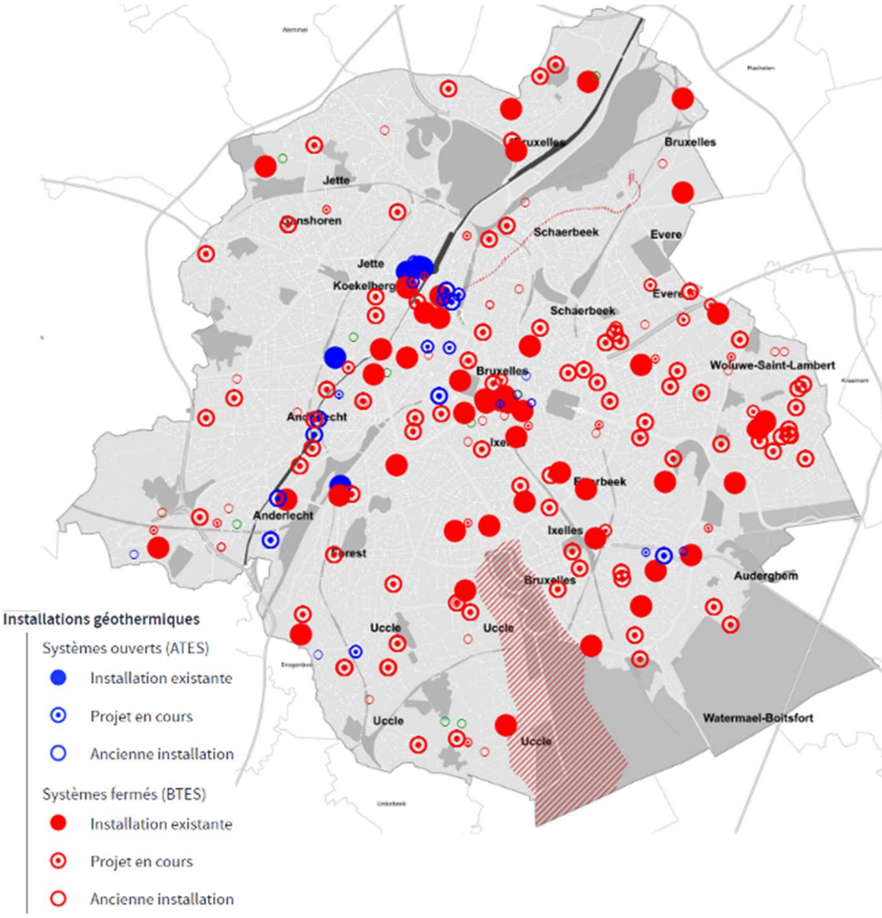

Figure 2: Maps of shallow geothermal systems permitted at Brussels (January 2025).

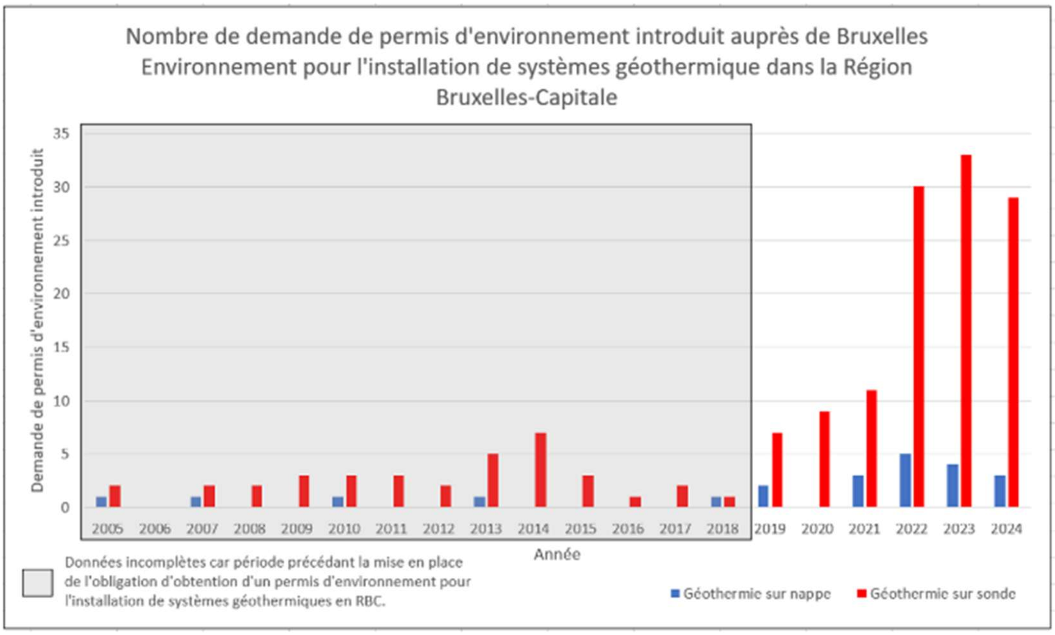

Figure 3: Number of geothermal permit applications submitted to Brussels Environment since 2005.

The Figure 3 illustrates the number of geothermal permit applications submitted to Brussels Environment. It is important to note that this data does not reflect the number of operational geothermal systems in the Region, but rather the applications introduced, regardless of whether the projects were ultimately completed.

Since 2019, an environmental permit has been mandatory for the installation of any geothermal system, which ensures the reliability of data from that year onward. For the period prior to 2019, open-loop geothermal systems were recorded under the category of water abstraction, which makes the data for this category relatively complete and reliable. However, closed-loop systems were only registered if the associated heat pump was subject to classification, resulting in incomplete data for these installations before 2019.

Additionally, permit applications for projects that were later cancelled or not implemented are not included in Figure 3.

3.3.2 Comparative study on renewable sources for heating and cooling

Brussels Environment has carried out several studies to identify the most appropriate renewable heating solutions in the specific context of our Region. These studies pursue a dual objective: achieving carbon neutrality by 2050 and phasing out fossil fuels for building heating.

The decarbonization study consists of three parts:

- A first study that assesses heating and cooling solutions at the regional level.
- A second study focusing on the potential to develop district heating networks.
- A third study aiming to identify the barriers to the development of renewable heat.

The purpose of these studies is to inform Government discussions and eventually support the development of a regional heat plan, which will be integrated into the next Air-Climate-Energy Plan. This heat plan should help identify new measures and map the most suitable heating solutions for each building, based on its location, characteristics, and use.

One of the solutions studied in the first report concerns very low energy geothermal systems (both closed and open loop). To this end, a dedicated internal study was conducted (Agniel,2024). The Brussels-Capital Region (BCR) has a recognized geothermal potential within the first 200 to 300 meters of depth. Beyond that depth, deep geothermal applications are considered highly limited due to the low permeability of the Paleozoic basement rock. As such, only very low-temperature geothermal systems are currently feasible in the region.

The study quantified the gross technical potential of shallow geothermal energy using both closed-loop and open-loop systems:

- Closed-loop systems (borehole fields):
  - Gross technical potential (to 200 m depth): 23’300 MW_{th} and 43’000 GWh/year
  - After exclusion of constrained areas (protected zones, built environment, etc.): 12’600 MW_{th} and 23’310 GWh/year
- Open-loop systems (ATES):
  - The combined theoretical potential across three aquifers (Bruxellien, Landénien, and the Paleozoic basement) was estimated at 2.2 GW_{th} of extractable power and 2921 GWh/year of extractable energy

These figures represent an optimistic assessment assuming maximum land availability and no overlapping between geothermal exploitation areas. Nonetheless, they clearly indicate that shallow geothermal energy could play a significant role in supporting the energy transition in Brussels, especially in heating and cooling sectors.

3.3.3 "Zoned Vision"

As part of the Brussels-Capital Region's energy transition, the Energy Task Force 2050 - composed of Brussels Environment, Sibelga, and Brugel - has been mandated in 2022 to identify the conditions and solutions for the decarbonisation of heating and cooling. A central goal is the development of a zoned heat vision for 2050, which entails identifying, for each area of the region, the most appropriate heating solutions: either collective systems such as district heating networks or individual solutions at the building or unit (PEB) level. The vision of the Task Force was published in April 2024 (Brussels Environment 2024).

This work is aligned with the European obligations under Directive 2023/1791 on energy efficiency, which requires Member States (and regions in Belgium) to periodically assess their heating and cooling needs and determine the most effective solutions. An initial study, completed in 2023, provided a macroscopic evaluation of the decarbonisation potential across the region, focusing primarily on energy-related aspects without yet considering environmental impacts.

To address this, a follow-up public contract was launched in January 2025, aiming to refine the heat zoning vision by integrating environmental constraints such as biodiversity, air and water quality, soil impacts, and noise pollution. This is particularly crucial given that heating accounts for nearly 50% of energy consumption in the Brussels-Capital Region.

Expected outcomes include a technology-building type matrix, maps identifying areas suitable for district heating or individual solutions, and a formal opinion from Brussels Environment on the necessary trade-offs between environmental impacts and decarbonisation goals. These deliverables will contribute to the next Regional Air-Climate-Energy Plan to be drafted in 2026 and adopted in 2027. The resulting maps and data will be published via the Geodata platform and shared publicly to guide long-term regional energy planning.

3.4 Wallonia

3.4.1 Shallow geothermal energy (SGE)

According to the 2023 energy balance reports from the Walloon administration, 1860 geothermal heat pumps are officially reported operational in Wallonia, representing a total thermal capacity of 24.1 MW_{th} and an energy production of 35.29 GWh (Public Service of Wallonia Source).

As part of its Walloon energy policy for 2030, the Walloon Government had already launched a first call for SGE projects in July 2021, with the new Ottignies Hospital project selected for a budget of € 2.326 million. A second call for shallow geothermal projects was launched in July 2022, resulting in the selection of 33 projects with a total budget of € 30.5 million. Two projects have already been completed: the Emergency Department of the CHR in Namur and the Mundo building in Louvain-la-Neuve. The remaining 31 projects are currently underway.

The SGE potential of the Walloon region was assessed through the Geowal project (ended in 2023). As part of this project, the following tasks were carried out:

1) Collection and analysis of existing data;
2) Creation of a SGE database;
3) Assessment of the estimated technical and economic potential at the scale of Wallonia;
4) Development of a shallow geothermal potential map in Wallonia;
5) Drafting of a reference guidance document to support the implementation of shallow geothermal systems;
6) Proposal of a concrete action plan to promote the sustainable development of this sector in Wallonia.

Figure 4 and 5 illustrate the Walloon technical SGE potential for closed and open systems, respectively.

In addition to the technical SGE potential, the cross-analysis of surface heat demand data, considered as potentially coverable by geothermal shallow technology, with technical potential data made it possible to estimate the net potential of closed and open loop systems for the residential and tertiary sectors. The analysis was carried out based on estimations of coverable demand under various scenarios defined as either favorable or unfavorable for the years 2022, 2030, and 2050.

3.4.2 Geothermal energy from abandoned coal mines

In 2018, the Walloon Region commissioned a study to evaluate the geothermal potential of its abandoned coal mines. The findings were encouraging, particularly regarding the use of mine water as a sustainable source of heating and cooling. The study identified significant geothermal potential in the basins of Charleroi, Mons, and Liège, sufficient to justify the development of this energy resource in Wallonia. Based on conservative assumptions, the total technical potential was estimated at 1690 GWh, distributed across the four main coal basins as follows: Mons (486 GWh), Centre (259 GWh), Charleroi (501 GWh), and Liège (444 GWh). This level of potential would be enough to support the implementation of at least 11 projects comparable to the one in Heerlen, the Netherlands (Harcouët-Menou et al. 2020).

On this basis, and as part of Wallonia's Recovery Plan, SPW Energy launched three public calls for tenders in autumn 2021 for feasibility studies of geothermal projects in the three basins of Charleroi, Mons, and Liège. VITO and the Walloon universities UMONS and ULiège were selected to carry out these studies.

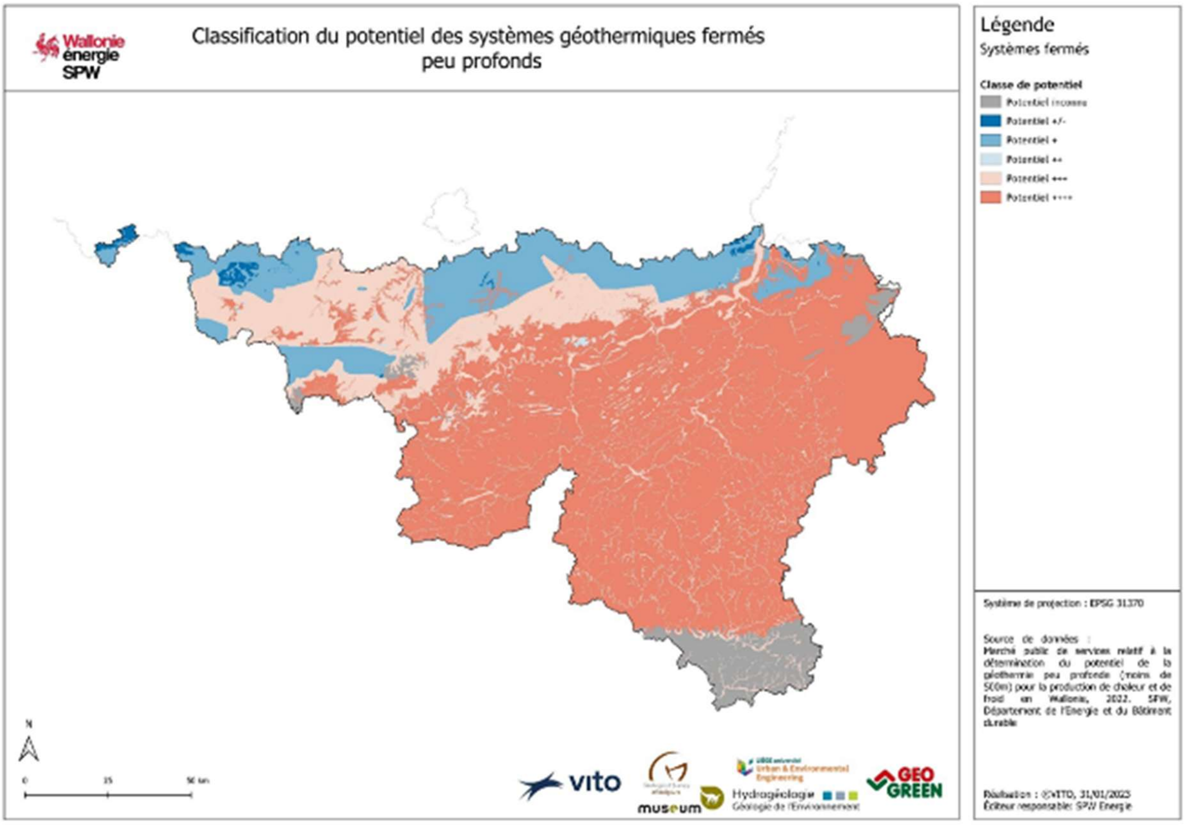

Figure 4: Walloon technical SGE potential for closed-loop systems classified in 5 categories ranked from low (blue) to high favorability (in red).

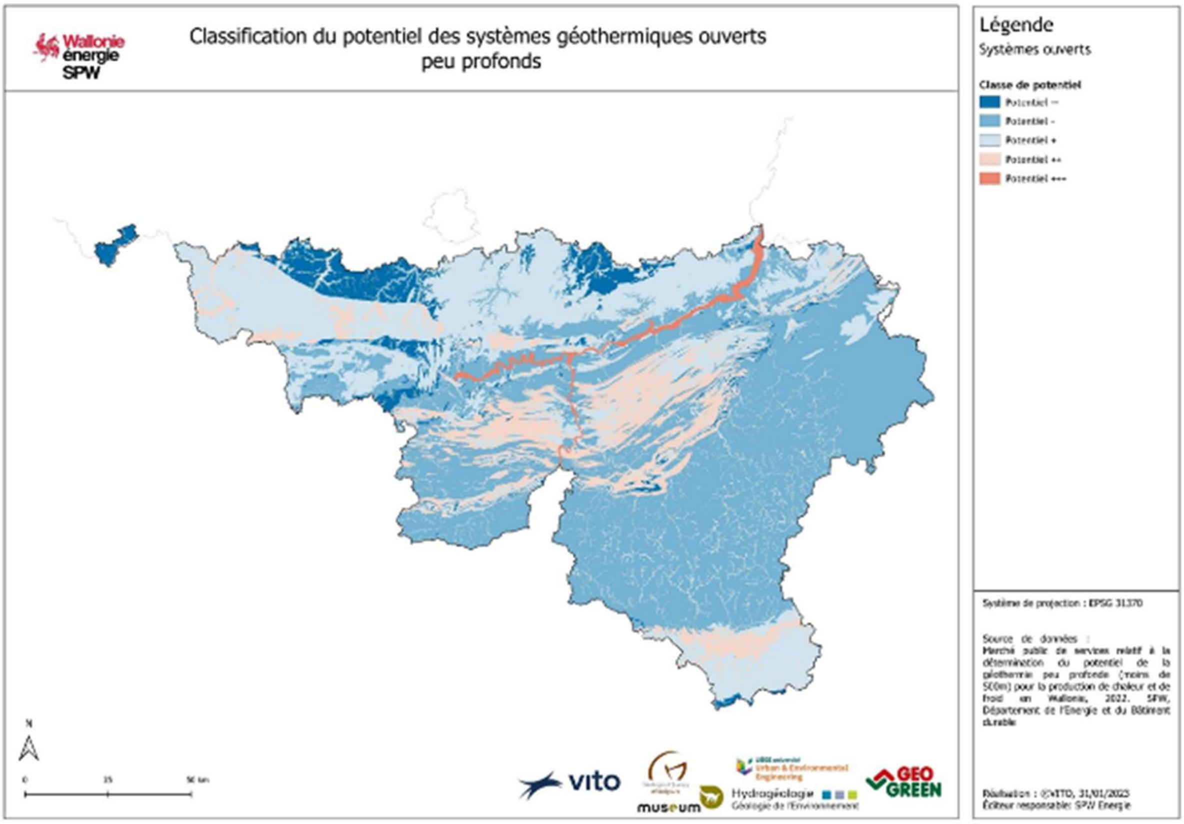

Figure 5: Walloon technical SGE potential for open systems classified in 5 categories ranked from low (blue) to high favorability (red).

For all three basins, feasibility studies adopted a consistent methodological approach (Harcouët-Menou et al. 2025). The proposed concept involved harnessing the former coal mines for both heat extraction and thermal energy storage, in combination with a fifth-generation heating and cooling network. First, for each basin, the most promising site to conduct the feasibility study was selected based on surface demand and local geothermal potential preliminary information. Second, within the defined perimeters of each site, detailed surface demand and subsurface data was compiled and analyzed. Baseline scenarios for thermal energy production and storage were established, along with the identification of priority buildings for connection to the network. The behavior of the mine water reservoir as a response to the baseline scenarios was modeled and the business case analyzed. The studies concluded with an assessment of the technical and economic feasibility of potential future pilot projects, including a summary of the key risks identified.

The Glain/Saint-Nicolas site within the Liège coal basin located above the *Patience et Beaujonc* coal mines was identified as the most promising location for a pilot project in Wallonia. The overall information regarding this feasibility study is available in the report (Harcouët-Menou et al. 2024). A call for projects for the Liège basin pilot project was launched in July 2024 by SPW Energy (see the potential for the Liège coal basin in Figure 6). This call is part of the Walloon Recovery Plan (Project 79) and has a budget of € 11 million. Proposals were submitted in January 2025 and are currently being examined. The pilot-project is currently scheduled to be operational in 2029.

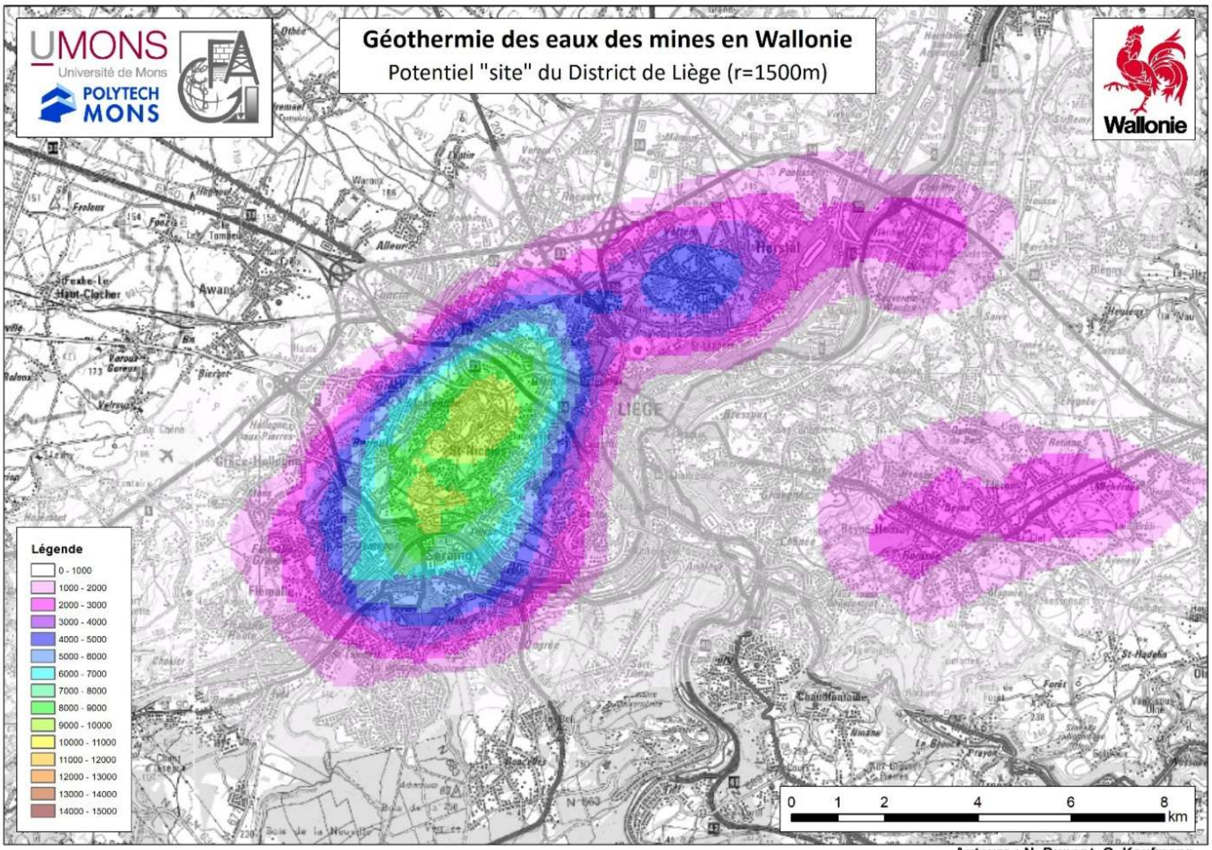

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Figure 6: Potential of a geothermal mining project in the Liège coal basin (considering a project footprint with a radius of 1.5 km). Source : Harcouët-Menou et al., 2024.

3.4.2 Deep geothermal energy (DGE)

In response to climate and environmental challenges, the Walloon government is committed to achieving carbon neutrality by 2050 at the latest (including a 95% reduction in greenhouse gas emissions compared to 1990 levels). This goal is based on a progressive emissions reduction trajectory, with an interim target of a 55% reduction in greenhouse gas emissions by 2030 compared to 1990.

To achieve its energy goals, Wallonia will need to adopt geothermal energy on a broad scale and initiate the development of this renewable sector within the region. Currently, geothermal energy represents only a small fraction of the energy mix, even though resources are available in the Haine-Sambre-Meuse industrial corridor for deep geothermal applications and across the entire region for shallow geothermal systems. Its use

To assess the geothermal potential in Wallonia, gathering primary subsurface data remains essential. A pivotal part of this process involved seismic data acquisition under the DGE-ROLLOUT project (Interreg North-West Europe), completed in October 2023. This initiative generated several new cross-border seismic profiles, which have substantially reduced geological uncertainties, particularly along the BE/GE and BE/NL borders. These data supported the integration of mapped areas of the main geothermal reservoir target, the Dinantian formation, and fostered knowledge sharing about potential geothermal aquifers.

In Wallonia, the Geological Survey of Belgium (GSB) conducted 63.5 km of seismic surveys across Namur's eastern and western regions in December 2022, focusing on the extent of Dinantian limestones beneath the Midi-Eifelian Fault. Findings from this survey shed light on the geometry of the fault and the potential for Dinantian limestone occurrences at depths of up to 4-5 km, as well as Givetian-Frasnian carbonates at shallower depths (2-3 km) in the Condroz region. Additionally, reprocessing and reinterpretation of the Dekorp 1A line indicated a strong potential for Dinantian carbonates at depths suitable for deep geothermal exploration in the Eupen area.

Building on these promising results, the Walloon government has greenlit further large geophysical investigations in 2024. The WALSCAN project will gather approximately 400 km of seismic lines across three key areas: Charleroi, Liège, and Verviers/Eupen (Figure 7). Coordinated by GSB, WALSCAN brings together experienced partners like UMONS, ULG, and EPI Ltd, who contribute extensive expertise in geophysics, geothermal energy and regional geology. Scheduled for early 2026, the seismic campaign will concentrate on identifying Dinantian carbonates at varying depths (1.5 km to 4 km) within densely urbanized areas, which align with regions of high energy demand.

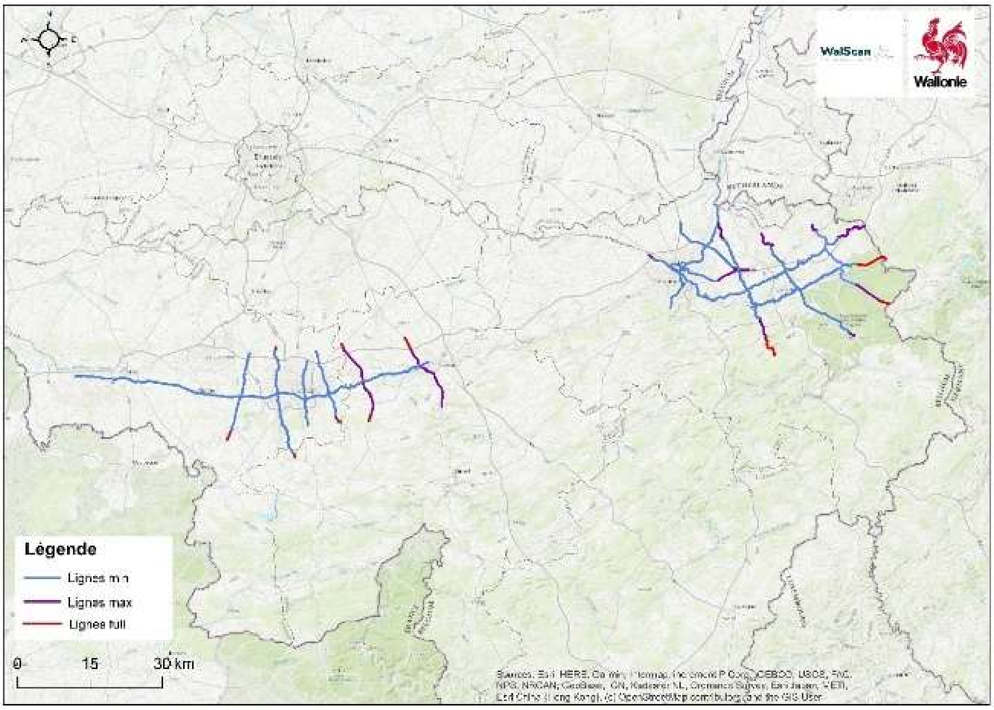

Figure 7: Planned seismic lines in Wallonia in 2026 (WALSCAN project).

3.5 Flanders

In 2024 two deep geothermal projects were in operation in Flanders: the geothermal plant at VITO's Sustainability Park in Mol, and the geothermal plant of Janssen Pharmaceutica in Beerse. Production at the VITO geothermal plant was restarted at low flow rate in October 2024 after a suspension due to a felt earthquake on 16 November 2022. An overview of the status of the VITO geothermal project is given in Broothaers et al. (2025). The geothermal plant of Janssen Pharmaceutica was officially inaugurated on 16 October 2023. Together, the two produced an estimated 24GWh of thermal energy in 2024 (Clymans and Vermeiren 2024).

In 2024, two new exploration licenses were granted for deep geothermal: one in the region of Wielsbeke, and one in the region of Bredene. Both regions lay within the province of West-Vlaanderen and target Paleozoic basement rock.

The Department of Flemish Planning Agency for the Environment (VPO) recently commissioned 2 additional studies:

1) Prospective dynamic modelling for an optimal definition of volume areas in the deep subsurface of Flanders that will be published soon (Broothaers et al. 2025). This study aims to improve insights for the definition of license boundaries by means of dynamic reservoir simulations (Broothaers et al. 2025). As the reservoir volumes are quite limited in the deep subsurface of Flanders, the need to be very efficient in subsurface management is essential and will allow to learn more about efficiency from a doublet perspective, from a field development perspective and from the long-term perspective (thermal regeneration)

2) "Sustainable development of shallow geothermal energy in Flanders", VPO- D/2025/3241/112) (Dirix et al. 2025). It aimed to gather knowledge and formulate policy recommendations to optimize the large-scale implementation of shallow geothermal systems in Flanders. The study addressed three core aspects. First, the thermal conductivity of the Flemish subsurface was characterized. For this purpose, an extensive dataset was compiled, and measurement data and literature were analyzed in detail. Second, the impact of a high density of geothermal systems was examined, with attention to interference and risks to the ecosystem services provided by the subsurface. Literature data, practical examples, spatial studies, and analytical and numerical modelling were used for this purpose. Third, the implementation of collective geothermal systems in Flanders was evaluated based on five case studies, in which technical, financial, organizational, and legal preconditions were formulated. For each of the topics, a number of concrete policy recommendations were formulated.

3.5.1 Subsurface management

Belgium is a densely populated and relatively small country. An increase of interest in using the deep subsurface for energy and other resources creates the need for subsurface management. This management can have different goals, such as sustainability, energy and resource security, optimal use of resources, minimizing interference between activities etc., or finding an optimal balance between these individual goals. International research on and implementation by governments of this subject is still in an early phase. A research consortium of the Geological Survey of Belgium and the University of Antwerp is pioneering in a highly interdisciplinary approach which joins geological, economic, environmental and social sciences with three ongoing projects:

1. A Flemish government assignment for VPO on the societal impact of use of the deep subsurface, which will be concluded early 2025 (Campernolle et al. 2023).
2. Two projects funded by FWO (Research foundation of Flanders): MASSIF and DIAMONDS (with Ghent University and TU Delft) on sustainable management of the deep subsurface (Campernolle et al. 2025).

4. RESEARCH PROJECTS

4.1 GEOCAMB

The Geocamb project (Belgian Science Policy funding; 2019-2024) assessed the geothermal potential of Cambrian rocks beneath Brussels and the Brabant provinces, with a focus on public buildings (Petitclerc et al. 2024). A database of 107 boreholes in the Cambrian basement was compiled, supported by a seismic noise survey using nodal sensors to map the top of the Brabant Massif, particularly in previously unexplored zones.

Five case studies, including the Paul Henri Spaak building (European Commission) and the Gandhi site in Molenbeek, evaluated the feasibility of geothermal systems. At the Gandhi site, the pre-feasibility study highlighted promising conditions for future integration of geothermal energy in large renovations. Exploratory drilling confirmed that the depth of the Cambrian basement increases from south to north and revealed high thermal conductivity values (up to 3.8 W/(m·K)), along with heterogeneous fracturing, resulting in variable hydraulic flows. These characteristics support the suitability of both closed-loop (BTES) and open-loop (ATES) geothermal systems. Modelling interferences studies at Tour & Taxis showed limited interaction between systems in different aquifers, while underlining the need for thermal balance at the building scale.

The project highlighted the largely untapped geothermal potential of the Cambrian basement and emphasized the importance of continued subsurface exploration, improved data centralization, and policy support. Public buildings were shown to be key demonstration sites for fostering investment and accelerating the transition to low-carbon heating at Brussels and surroundings.

4.2 DESIGNATE

The Designate project (Belgian Science Policy funding; 2019-2024) aimed to support decision-making for deep geothermal energy projects in Belgium by developing interdisciplinary tools that account for geological uncertainty, economic risk, and environmental impact. Recognizing the complexity and financial risks linked to deep subsurface exploration (Welkenhuysen et al. 2024). Designate focused on creating integrated methods for techno-economic assessments (TEA), real options analysis (ROA), and dynamic life cycle assessments (LCA).

Five case studies - both real and hypothetical - serve as testing grounds for these tools, including sites in Mol, Turnhout, Mons, and former coal mines. The project develops fast reservoir simulation methods and decision trees to incorporate flexibility and uncertainty into project planning. Dynamic LCA is used to better capture environmental impacts over time, in contrast to static industry standards.

A key innovation is the adaptation of the PSS simulator, originally designed for CO_2 storage, to forecast geothermal project outcomes under various scenarios, including changes in energy prices and policy support. The results highlight that early-stage flexibility and risk integration are essential to improve project viability.

Geological conditions, particularly subsurface flow parameters, are shown to strongly influence both environmental and economic outcomes. Investment subsidies are identified as one of the most effective support measures. Ultimately, the project emphasizes that a well-integrated, site-specific approach combining geology, economics, and environment is critical to the success and scalability of deep geothermal systems in Belgium.

4.3 MORE-GEO

The MORE-GEO ERDF project, led by UMONS, began in 2017 and was completed in 2023. It was introduced in the two previous Country Update updates (Lagrou et al. 2019, Dupont et al. 2022). This project aims to develop a decision-support tool for the implementation of new deep geothermal projects in the *Coeur du Hainaut* area (SW Belgium).

This region is densely populated above the Dinantian geothermal reservoir. Given the relatively limited possibilities for reducing the energy consumption of buildings, which are on average quite old, demand for heat will remain high in the future. The deployment of district heating networks supplied by deep geothermal energy would therefore appear to offer a number of advantages in meeting the challenges of the energy transition in this area.

The first phase focused on new acquisitions to precise the structure and properties of the Dinantian reservoir in this region. These include the acquisition of a 2D seismic reflection campaign approximately 100 km long divided into 5 profiles named Hainaut2019 and a gravimetric survey along the new and former seismic lines (Campeol et al. 2025).

A new geological model of the reservoir has been built based on the data collected and new structural interpretations of the Variscan front. A regional hydrogeological model of the reservoir was then developed on the basis of this geological model, in order to simulate the effect of new geothermal doublets in this area. This regional hydrogeological model is used to simulate changes in the temperature field and hydraulic head within the geothermal reservoir following various scenarios (pumping and/or reinjection at various locations).

In order to provide a forecasting tool capable of exploring the impacts of project development decisions in different socio-economic scenarios, a simplified economic model has been implemented in the form of a code for evaluating the financial flows associated with a doublet project coupled to a district heating network. The scenarios are characterised by changes in heat demand and energy prices. The capital expenditure considered relates to the excavation of the doublet, the construction of the power station and that of the heating network. The calculation also takes into account the characteristics of the reservoir and the location of the project. A module relating to the drilling of a doublet integrates the information extracted from the reservoir model to determine the geometric characteristics of the doublet according to its location and to estimate the investment costs on this basis. The response of the reservoir to the additional solicitation represented by the doublet is assessed using the regional hydrogeological model.

The geological model of the reservoir synthesises a set of information and assumptions necessary for the development of deep geothermal energy in the *Coeur de Hainaut* area. This model will continue to be enriched by new observations and analyses. In particular, it should benefit from the results of advanced geophysical processing currently underway. The joint processing of gravimetric and seismic data shows great potential for improvement. Current simulations on the regional model indicate that placing doublets a few kilometres apart does not lead to significant interference, even beyond the lifetime of a doublet. They also show that a dozen doublets distributed over the area do not pose a problem of sustainability over a two-century time horizon and suggest that the reservoir could probably accommodate even more doublets.

4.4 URGENT

The URGENT project is a Horizon Europe project tackling the challenges of geothermal exploration with innovative, low-impact seismic technologies specifically designed for urban and noisy industrial environments. The project aims to improve the accuracy of underground mapping and reducing drilling risks. An electric low-impact seismic source emitting repeatable and low distortion acoustic signals over a broad frequency range, capable of reaching up to 4000 m deep geothermal reservoirs and innovative microelectromechanical systems (MEMS) based seismic sensors will be designed, built and tested. Additionally, exploration workflows that integrate these new technologies with advanced tools such as AI and machine learning will be developed. The ultimate goal of URGENT is to reduce exploration costs, improve drilling success rates, extend the lifespan of geothermal plants, and minimize seismic risk. The new tools and methods will be tested at three sites: the VITO geothermal plant (BE), the Batta site (HU) and the Konin site (PL). At the VITO site, a small-scale 3D seismic survey will be conducted to test and validate the new seismic acquisition technologies, methods and data (post-)processing techniques. Moreover, the existing seismic data and induced seismicity data will be used to develop and train AI & ML methods/techniques to recognise faults and finally represent the faults in 3D. The improved reservoir characterisation will be the basis for dynamic simulations to predict the reservoir's geomechanical behaviour across various production scenarios. The new characterisation tested on the VITO geothermal site will also aim to support the reduction of induced seismic risk for geothermal projects, contributing to reduce social apprehension about development of geothermal projects.

5. CONCLUSIONS

Geothermal energy in Belgium is progressing within a complex context shaped by economic, regulatory, and societal challenges. The country's diverse geology, its ambitious 2050 carbon neutrality targets, and growing interregional and European collaboration provide fertile ground for further development.

However, deployment - particularly of deep geothermal - remains slow. To accelerate the transition, clear political support, tailored financial instruments, and coherent subsurface governance are essential. The many pilot initiatives and ongoing research projects offer promising prospects to overcome current barriers and embed geothermal energy as a key pillar of Belgium's low-carbon heating future.

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Tables A-G

Table A: Present and planned geothermal power plants, total numbers

No geothermal power plants are currently planned or operating in Belgium.

Table B: Existing geothermal power plants, individual sites

No geothermal power plants are currently planned or operating in Belgium.

Table C: Present and planned deep geothermal district heating (DH) plants and other uses for heating and cooling, total numbers

	Geothermal DH plants		Geothermal heat in agriculture and industry		Geothermal heat for buildings		Geothermal heat in balneology and other	
	Capacity (MW_{th})	Production (GWh_{th}/yr)	Capacity (MW_{th})	Production (GWh_{th}/yr)	Capacity (MW_{th})	Production (GWh_{th}/yr)	Capacity (MW_{th})	Production (GWh_{th}/yr)
In operation end of 2024	25	19.06						
Under constru-ction end 2024	-	-						
Total projected by 2028	35	25						
Total expected by 2032	50-60	400-450	10-15					

Table D1: Existing geothermal district heating (DH) plants, individual sites

Locality	Plant Name	Year commis-sioned	CHP *	Cooling **	Geoth. capacity installed (MW_{th})	Total capacity installed (MW_{th})	2024 produc-tion (GWh_{th}/y)	Geoth. share in total prod. (%)
Wallonia, Saint-Ghislain	Saint-Ghislain	1985	N	N	6	16	14.03	86
Wallonia, Baudour	Douvrain	1985	N	N	4	4	3.15	100
Wallonia, Ghlin	Geothermia	2017	N	N	7	7	0.34	100
Flanders, Mol	Balmatt	2018	N	N (RI)	8	8	1.54	N/A
Flanders, Beerse	Janssen Pharma-ceutica (Johnson & Johnson group)	2023	N	N	?	?	?	?
total					25		19.06	

* If the geothermal heat used in the DH plant is also used for power production (either in parallel or as a first step with DH using the residual heat in the brine/water), please mark with Y (for yes) or N (for no) in this column.

** If cold for space cooling in buildings or process cooling is provided from geothermal heat (e.g. by absorption chillers), please mark with Y (for yes) or N (for no) in this column. In case the plant applies re-injection, please indicate with (RI) in this column after Y or N.

Table D2: Existing geothermal large systems for heating and cooling uses other than DH, individual sites

This information is not available.

Table E1: Shallow geothermal energy, geothermal pumps (GSHP)

	Geothermal Heat Pumps (GSHP), total			New (additional) GSHP in the year 2024		
	Number	Capacity (MW_{th})	Production (GWh_{th}/yr)	Number	Capacity (MW_{th})	Share in new constr. (%)
In operation end of 2024	53271 (est.) [1)]	575 (est.) [1)]	-	5003	44.6	-
Of which networks *						
Projected total by 2028						

* Distribution networks from shallow geothermal sources supplying low-temperature water to heat pumps in individual buildings (“cold” DH, Geothermal DH 5.0 etc.)

1) based on the estimated number of heat pumps that were installed at the end of 2018 and the number of newly installed heat pumps thereafter.

Table E2: Shallow geothermal energy, Underground Thermal Energy Storage (UTES)

This information is not available.

Table F: Investment and Employment in geothermal energy

	in 2024		Expected in 2028	
	Expenditures * (million €)	Personnel ** (number)	Expenditures * (million €)	Personnel ** (number)
Geothermal electric power				
Geothermal direct uses	30 (est.)	15 (est.)		
Shallow geothermal	80 (est.)	180 (est.)	95 (est.)	200 (est.)
total	110 (est.)	195 (est.)		

* Expenditures in installation, operation and maintenance, decommissioning

** Personnel, only direct jobs: Direct jobs – associated with core activities of the geothermal industry – include "jobs created in the manufacturing, delivery, construction, installation, project management and operation and maintenance of the different components of the technology, or power plant, under consideration". For instance, in the geothermal sector, employment created to manufacture or operate turbines is measured as direct jobs.

Table G: Incentives, Information, Education

	Geothermal electricity	Deep Geothermal for heating and cooling	Shallow geothermal
Financial Incentives – R&D	Yes[1)]	Yes[1)]	Yes[1)]
Financial Incentives – Investment	RC[2)]	RC[2)]	No[3)]
Financial Incentives – Operation/Production	No	No	No
Information activities – promotion for the public	No	Yes [4)]	Yes
Information activities – geological information	Yes [4)]	Yes [4)]	Yes
Education/Training – Academic	No	Yes [5)]	Yes [6)]
Education/Training – Vocational	No	No	Yes

Key for financial incentives:

DIS	Direct investment support	FIT	Feed-in tariff	-A	Add to FIT or FIP on case the amount is determined by auctioning
LIL	Low-interest loans	FIP	Feed-in premium		
RC	Risk coverage	REQ	Renewable Energy Quota		
TC	Tax credits	O	Other (please explain)		

1) if appropriate in certain regional/federal research program

2) only in Flanders and for geological/exploratory risk

3) except a public call for projects funded in Wallonia

4) as result of certain R&D projects

5) special courses organised at different universities

6) Integrated in courses on thermal systems