ABSTRACT

The GeoCamb project is set within the context of the energy transition aimed at reducing Belgium's dependency on fossil fuels and achieving the European Union's climate objectives for 2030. These objectives include a significant increase in the share of renewable energy, with a particular focus on decarbonizing heating and cooling, which account for 50% of energy consumption. In this framework, geothermal energy, particularly the use of Cambrian formations in the Brabant Massif, offers strong potential. However, the development of such systems remains limited due to among others geological complexity, lack of data on the basement rocks and important upfront costs.

The primary objective of GeoCamb was to assess and demonstrate the geothermal potential of Cambrian rocks beneath Brussels and the Brabant provinces. This project aimed to characterize these formations from geological, geophysical, and hydrogeological perspectives while evaluating the energy needs of public buildings that could benefit from these systems. By employing a multidisciplinary approach, GeoCamb combined subsurface exploration, 3D modelling, hydrogeological testing, and the analysis of the thermal demand profiles of buildings. Concurrently, the project focused on collaboration with public and private partners to optimize the use of available data and expand scientific knowledge. Special attention was given to public buildings, which represent strategic opportunities for demonstrating geothermal energy as a sustainable energy source.

The project followed several key phases. First, an extensive collection of existing data was carried out. This information was consolidated into a database that gathered a total of 107 boreholes in the Cambrian bedrock. In parallel with the geological survey, an extensive seismic noise campaign was conducted using seismic nodal sensors. This allowed to better map the top of the Brabant Massif below Brussels region, especially under sites where the bedrock was unexplored by drillings. Next, a participatory "win-win" approach enabled collaboration with ongoing projects to pool resources and results. Among the flagship initiatives, five case studies were conducted, such as the Paul Henri Spaak (PHS) building and the Gandhi site in Molenbeek, to assess the feasibility of geothermal systems. Parallel to these efforts, modelling studies were performed at the Tour & Taxis site to examine potential interactions between open systems located in different aquifers.

The project's results highlighted the strong geothermal potential of the Cambrian basement. Exploratory boreholes, including the one at Molenbeek, confirmed that the basement depth gradually increases from south to north below Brussels and that the basement rock exhibits a high thermal conductivity, reaching 3.8 W/mK in some areas. Analyses of pumping tests revealed variable hydraulic flows, reflecting heterogeneous fracturing of the basement. These characteristics are favorable for implementing geothermal systems, whether closed-loop (BTES) or open-loop (ATES). However, closed-loop systems appear to be better suited to dense urban environments like Brussels, while open-loop systems are more appropriate for larger-scale projects where accessible aquifers are available.

The case studies demonstrated the effectiveness of these technologies. At the Gandhi site in Molenbeek, although the study was limited to a pre-feasibility assessment, the results provided crucial insights for considering a geothermal system as part of future renovations. Finally, an impact study and simulations at Tour & Taxis showed limited interactions between systems in different aquifers but emphasized that thermal balance at the building level is essential to maintain long-term efficiency.

In conclusion, the GeoCamb project underscores the untapped potential of the Cambrian basement for shallow geothermal energy in Belgium. Its findings highlight the need for continued exploration and an enhanced, centralized database of geothermal project parameters (hydro-geological, thermal, energetical, …). GeoCamb also advocates for increased awareness among policymakers and private actors to encourage support and investment in these technologies. Lastly, the project emphasizes the importance of pilot systems in public buildings as a lever to promote sustainable energy and reduce Belgium's carbon footprint.

Keywords: Geothermal energy, open systems, closed systems, Cambrian, Paleozoic, Brabant Massif