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Geothermal Energy Use, Country Update for Belgium

Estelle Petitclerc[1], Ben Laenen[2], David Lagrou[2], Hans Hoes[3]

[1] Geological Survey of Belgium, Jenner street 13, 1000 Brussels, Belgium

[2] VITO, Boeretang 200, 2400 Mol, Belgium

[3] Terra Energy, Rauwelkoven 87B, 2440 Geel, Belgium

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ABSTRACT

Geothermal energy currently represents a very low percentage of the national energy mix in Belgium and is dominated by exploitation of low temperature resources. A number of initiatives to stimulate a sustainable future development of the shallow geothermal energy sector in Belgium are being implemented. Nevertheless the deep geothermal potential is recognise in the Campine and the Mons basin (Hoes et al. 2012, Loveless et al. 2015, Licour 2012). In order to explore this potential, a new deep geothermal project was launched in September 2015 in Mol (northern Belgium).

1. INTRODUCTION

The sedimentary basins to the North (Campine basin) and South (Namur-Dinant basin) of the Brabant Massif provide the largest potential for deep geothermal energy. The largest potential is localized in the thick sequences (up to 900 m) of Devono-Carboniferous platform carbonates in these basins (Loveless, 2015). In Flanders, the Campine region is the most attractive area for deep geothermal extraction where Dinantian Limestones are located at a depth of 1 to 6 km. In September 2015, VITO (Flemish Institute for Technological Research) started drilling an exploration well for a deep geothermal pilot project at the Balmatt site in Mol. The first well was successfully completed in January 2016, reaching the Carboniferous Limestone Group at a depth of 3175 m. Formation temperature at a depth of 3600 m reached 138°C and production tests confirmed the geothermal potential of the limestones. In March 2016, drilling of well MOL-GT-02 started. In addition to the Balmatt project, VITO conducted seismic exploration in a large part of Limburg to explore the geothermal potential the Carboniferous Limestone Group in the eastern part of the Campine basin.

The current exploration activities indicate that plans for deep geothermal energy are currently on the cusp of a take-off similar to shallow geothermal energy. In parallel to the exploration activities, developments in legislation and incentives from the regional governments are being made. In the context, the ALPI project was launched in 2015 to evaluate appropriate financial instruments and incentives to be implemented in the different legal framework of the three Belgians regions.

The shallow geological setting in Belgium is highly diverse and therefore widely suitable to different GSHP applications. The shallow thermal potential started to be valorized by research projects in the third regions (Flanders, Brussels and Wallonia). Efforts are now underway by the Belgian Geological Survey in the BruGeoTherMap project to explore in details the Brussels subsurface in order to improve shallow potential maps and valorize the geothermal energy. Shallow geothermal applications were for years a clear growth market, partly because Belgium is lagging behind regarding geothermal project development in comparison to other Western European countries. Nevertheless, after years of growth, since 2014 a marked decrease was observed (following European trends).

2. DEEP GEOTHERMAL ENERGY

2.1 Policy development

In January 2016 the Flemish Government approved an update of the decree deep subsurface. This update involves the addition of a chapter on the exploration for and production of geothermal energy and a section on a structure vision of the deep subsurface. It regulates the application of deep geothermal energy in Flanders. The amendment of decree is now being submitted to the Flemish Parliament. The implementation act with further regulations is expected in 2016.

The guidelines of the decree are that permits of the Flemish Governement will be needed for exploration and production deep geothermal energy, surmounted by an environmental permit. An exploration and exploitation licence will only be granted if it is likely that the geothermal energy can be produced in a responsible manner. The license area is so defined that it covers the entire area in which influences of exploitation are expected. The exploration permit will be valid for 5 years. The Licensee must have sufficient technical and financial resources prove before to start any drilling activity.

As part follow up to the COP21, the 21th April 2016 the Walloon government has approved a guidance note aimed at the implementation of a legal framework for the development of geothermal energy in Wallonia. This legal framework will take the form of a decree and will implement specific measures to jointly achieve the following objectives: 1- Protect the resource; 2- To develop a renewable energy source through the creation of public heating networks; 3 - Develop a new industrial activity in Wallonia, via a policy to stimulate industrial investment and encourage economic expansion.

Furthermore, as provided for regional policy statement, implementation of the legal framework will reflect the will of the Government to recognize geothermal as “service of public interest” especially given the sector's development need that is closely related to the research and preservation of the common heritage. Soon, a following committee will be set up to work on drafting the decree. And finally, the achievement of a legal framework for geothermal energy in Wallonia will be a step towards a decarbonised Wallonia.

2.2 Balmatt

The Flemish Institute for Technological Research (Vito) has been preparing the region’s first large-scale deep geothermal energy project for about five years. They first mapped in detail the deep subsurface of the region to a depth of more than 4 km, mainly using seismic data. Vito’s prognosis was that hot water could be found at a depth of about 3.5 km, at a temperature of more than 120°C.

In September 2015 Vito launched a pilot project at Mol - Donk. After a successful first drilling (September 2015 - January 2016), VITO has launched the second drilling in March 2016. The first well reached a depth of 3 610 m. For the second well, VITO wants to reach the same depth, but ‘deviated’ in order to reach the top of the reservoir at a distance of about 1,5 km of the first well.

Thanks to the second well, VITO will have a production and an injection well. This will be the basis for the construction of a geothermal doublet. According to the schedule, the additional drilling will take four months. Afterwards, a second production test and a prolonged circulation test are planned. If all goes according to plan, VITO will be the first to make use of deep geothermal energy by September 2017.

This geothermal doublet will produce between 12 and 17 megawatt of thermal energy or 1,5 megawatt electric energy; enough to supply about 5000 households and several companies. The final goal is a to extend the geothermal plant with additional wells in order to supply heat towards the neighboring villages of Mol and Dessel and to produce electricity.

2.3 ALPI

Finance is one of the main critical issues for the development of a low carbon society especially during times of economic recession. Closing this green investment gap will require policy intervention. The ALPI project will concentrate on analysing and designing relevant instruments to accelerate the transition towards a low carbon society. Five case studies were set-up to cover different economic sectors (electricity, housing, transport, green public procurement and geothermal energy), with a common methodology.
As a showcase of emerging technologies in Belgium, the Hasselt University and the Geological Survey of Belgium are investigating the regional potential for geothermal electricity production. Deep geothermal energy appears to be currently on the edge of a take-off. But the actual emergence of this technology is subject to developments in legislation and incentives from regional governments. Different risk/return expectations across stages of the investment continuum exist and the financial structures that are employed at each stage may require different types of public support.

The investigation starts with a broad stakeholder consultation (policy makers, sector federations, industry, researchers, banking sector, investors, etc.). A techno-economic evaluation then is realized by real options valuation. As the development of deep geothermal energy is a complex process, a detailed stochastic calculation is made of a project decision tree. The decision tree replicates the consequent development of different deep geothermal energy projects, with their different success rates and interdependencies in terms of technological knowledge accumulation, decreasing uncertainty for single basins, and increasing public acceptance.

This approach allows to investigate measures, such as insurances or government guaranteed, to reduce project risk, in order to increase the interest of investors in this sector. Secondly, this approach is combined with an evolutionary step development to analyze the potential growth of the sector over the coming decades. Finally, different fiscal measures are designed in collaboration with stakeholders, and their effectiveness to stimulate the transition to a low carbon society is evaluated. Giving the high geological uncertainty, this combined geological-economic analysis is arguably the most realistic way to calculate project performance, and simulate the future development trajectory of the geothermal sector subjected to different policy measures.

3. SHALLOW GEOTHERMAL ENERGY

A very recent EU-FEDER project was launched in January 2016, BruGeoTherMap to valorize the shallow geothermal potential in Brussels area. Smart Geotherm and Geotherwall projects described in the country update for EGC2013 are still under progress (Hoes et al., 2013).

Despite several incentives/grants by regional and federal governments, market of shallow geothermal development isn't grown in the way it was expected over the past few years. The urge to fossil fuel independence has shrunk by falling energy prices over the past years. Current energy prices are very unfavorable for ground coupled heat pumps because the ratio electricity/gas price becomes greater, resulting in longer payback times.

3.1 Research projects

BruGeoTherMap

A major barrier to full implementation of the shallow geothermal potential is the poor knowledge of ground conditions. This leads to unfavourable cost comparisons and abandonment of many promising projects.

The BruGeoTherMap project aims to facilitate accessibility and the efficient use of shallow geothermal energy in the Brussels region, especially for commercial and residential sectors. It will have a leverage effect on sustainable construction sector and in particular on SMEs active in the area. Thanks to Brussels FEDER funding (*Fonds Européens de Developement Régional*) a consortium of all major actors in geothermal energy in the region were brought together (ULB, Brussels Environment, CSTC, VUB, GSB). Its willingness is to analyze and map geothermal potential for closed and opened systems at Brussels for a depth of about 200 meters. This four years project's starting point is to gather and consolidate in a single database all the knowledge on the Brussels underground. A 3D geological model of Brussels region is being finalized, while a hydrogeological model of aquifers is expected to end in mid-2016. An important exploration phase is included in the first two years of the project to acquire new data improving the geological and hydrogeological knowledge of Brussels. Several in-situ parameters will be measured by e.g. new piezometers implementation and monitoring, pumping tests, cores sampling, logging and enhanced thermal response test. These measurements will be implemented as far as possible on future private projects by a win-win approach. The idea is to be grafted on existing projects to avoid non-use of exploratory drilling and to significantly increase the number of data acquisition. Laboratory measurements will be realized in parallel to characterise the thermal properties of the Tertiary sediments and the Cambrian basement (Brabant Massif).The project partners plans to communicate intensively and to educate the public and professionals of the sustainable construction sector (designers, architects, installers).

3.2 Market

In Flanders the market is pushed towards the use of heat pump systems by different initiatives. Legislation is adapted since the end of 2014 in order to stimulate geothermal development. Permits are no longer necessary for all vertical loop drillings as long as you obey the depth criterion, which is 150m for three-quarters of the Flemish land area. Furthermore, there is an obligation for new buildings to meet a specific energy level (so called E-level) which is becoming stricter each year aiming for E30 by 2021. A ground coupled heat pump installation can attain a benefit for the E-level from 10 to 25 E-points. Additional, there is an obligation for the use of renewable energy sources (solar, biomass, heat pump, district heating). If not applied, an extra reduction by 10 E-points is necessary.

It is estimated that, at the end of 2015, more than 20.000 heat pump units are in operation in Belgium producing almost 432 GWh of heating. There are many triggers for the heat pump market to take a lift again during the following years (independency of fossil fuels, more difficult to reach the necessary and further decreasing E-level, evolution energy prices,…). Yet, the implementation of a ground coupled heat pump system has the major disadvantage of requiring a significant extra initial budget, which isn't within reach for everyone.

It is estimated that, at the end of 2018, nearly 25.000 heat pumps will provide 334 MW of heat and 542 GWh of heating in Belgium.

4. CONCLUSIONS

Five national, regional and cross-European projects have mapped shallow and deep geothermal potential and focused on the transferal of skills and education to the market. These show that despite being in an intra-continental setting, large regions of Belgium have potential for deep and shallow geothermal energy.

In September 2015, drilling of deep geothermal project at Balmatt, Mol was launched. Its success will be of great importance for the further development of deep geothermal energy sector in the whole territory.

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

	Geothermal Power Plants		Total Electric Power in the country		Share of geothermal in total electric power generation	
	Capacity (MW_e)	Production (GWh_e/yr)	Capacity (MW_e)	Production (GWh_e/yr)	Capacity (%)	Production (%)
In operation end of 2015 *			20000	67600	0	0
Under construction end of 2015	4.5					
Total projected by 2018						
Total expected by 2020						

* If 2014 numbers need to be used, please identify such numbers using an asterisk

Table B: Existing geothermal power plants, individual sites

Not yet applicable

Explanation to tables C, D1 and D2: 'Geothermal district heating or district cooling' (Geothermal DH plants) is defined as the use of one or more production fields as sources of heat to supply thermal energy through a network to multiple buildings or sites, for the use of space or process heating or cooling, including associated domestic hot water supply. If greenhouses, spas or any other category is among the consumers supplied from such network, it should be counted as district heating and not within the category of the individual consumer. In case heat pumps are applied in any part of such a network, the also should be reported as district heating and not as geothermal heat pumps. An exception is for distribution networks from shallow geothermal sources supplying low-temperature water to heat pumps in individual buildings; systems of this kind should be reported in table E. For table D2, please give information on large systems only (>500 MW_{th}); installations with geothermal source temperatures <25 °C and depth <400 m should be reported in table E.

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

	Geothermal DH plants		Geothermal heat in agriculture and industry		Geothermal heat for individual 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 2015 *	6,1	16.7	0.9	1,3				
Under constru-ction end 2015	12-17							
Total projected by 2018								
Total expected by 2020								

* If 2014 numbers need to be used, please identify such numbers using an asterisk

** Note: spas and pool are difficult to estimate and are often over-estimated. For calculations of energy use in the pools, be sure to use the inflow and outflow temperature and not the spring or well temperature (unless it is the same as the inflow temperature) for calculating the energy parameters, as some pool need to have the geothermal water cooled before using it in the pools.

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})	2015 produc-tion * (GW_{th}/y)	Geoth. share in total prod. (%)
SaintGhislain	SaintGhislain	1985	No	No	6,1	11	18	55

* If 2014 numbers need to be used, please identify such numbers using an asterisk

** 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 direct use other than DH, individual sites

Not applicable

Explanation to table E: 'Shallow geothermal' installations are considered as not exceeding a depth of 400 m and (natural) geothermal source temperatures of 25 °C. Installations with geothermal source temperatures >25 °C and depth >400 m should be reported in table D1 or D2, respectively. Distribution networks from shallow geothermal sources supplying low-temperature water to heat pumps in individual buildings are not considered geothermal DH *sensu strictu*, and should be reported in table E also.

Table E: Shallow geothermal energy, ground source heat pumps (GSHP)

	Geothermal Heat Pumps (GSHP), total			New (additional) GSHP in 2015 *		
	Number	Capacity (MW_{th})	Production (GWh_{th}/yr)	Number	Capacity (MW_{th})	Share in new constr. (%)
In operation end of 2015 *	20372	269,7	431,8	1269	18,5	12
Projected total by 2018	24893	334,3	541,9			

* If 2014 numbers need to be used, please identify such numbers using an asterisk

Table F: Investment and Employment in geothermal energy

	in 2015 *		Expected in 2018	
	Expenditures ** (million €)	Personnel *** (number)	Expenditures ** (million €)	Personnel *** (number)
Geothermal electric power	unknown	unknown		
Geothermal direct uses	-	-		
Shallow geothermal	27,7	98	35,3	124
total				

* If 2014 numbers need to be used, please identify such numbers using an asterisk

** 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 el. power	Geothermal direct uses	Shallow geothermal
Financial Incentives – R&D			Smart Geotherm, Flemish regional projects on renewable energy probability maps
Financial Incentives – Investment			Ecology premium (SME's), Subsidy from electricity/gas distribution operators, E-level support (when reaching extra low level), some local contribution from municipalities
Financial Incentives – Operation/Production			No actual support mechanisms
Information activities – promotion for the public			
Information activities – geological information			
Education/Training – Academic			
Education/Training – Vocational			SmartGeotherm project workshops BruGeoThermap

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	O	Other (please explain)