EUROPEAN GEOTHERMAL ENERGY COUNCIL

Consultation on an EU strategy for liquefied natural gas and gas storage

September 2015

EGEC CONTRIBUTION

Description

EGEC is the voice of Geothermal in Europe.

More than 120 members from 28 countries, including private companies, national associations, consultants, research centres, geological surveys, and public authorities, make EGEC the strongest and most powerful geothermal network in Europe, uniting and representing the entire sector.

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Question 5: The Energy Union commits the EU to meeting ambitious targets on greenhouse gas emissions, renewable energy and energy efficiency, and also to reducing its dependency on imported fossil fuels and hence exposure to price spikes. Moderating energy demand and fuel-switching to low carbon sources such as renewables, particularly in the heating and cooling sector, can be highly cost effective solutions to such challenges, and ones that Member States will wish to consider carefully alongside decisions on LNG infrastructure. In this context, do you have any evidence on the most cost efficient balance between these different options in different areas, including over the long term (i.e. up to 2050)?

The European Geothermal Energy Council very much welcomes this question. Indeed, moderating energy demand and fuel-switching to renewables, particularly in the heating and cooling sector, can be highly cost effective solutions to security of supply, and ones that Member States will wish to consider carefully alongside decisions on LNG infrastructure.

Regarding the idea of taking a cost-optimal approach, this could indeed be the right approach and should be assessed with the 2050 horizon in mind, taking into account lock-in effects of investments outside the three 'no-regrets options', i.e. more RES, more energy efficiency, smarter energy infrastructure.

However, with existing market conditions (e.g. persisting fossil fuel subsidies, lack of carbon pricing in non-ETS sectors, regulated prices, and barriers for new entrants in the heat sector in competition with incumbent utilities) any cost-optimal methodology may not lead to the best choice for the general interest. In this regard, the internal energy market should go beyond electricity and natural gas so as to ensure fair and full competition, including in the heat sector. Additionally, it should be noted that cost-benefit analyses often fail to capture key factors such as pollution, local economic development, security of supply, etc.

EGEC would like to stress that cost-optimality is also being investigated by the EC in the framework of the forthcoming EU Heating and Cooling Strategy. This work is very much welcome. The Energy Union represents a unique opportunity to address security of supply, decarbonisation, competitiveness, and energy efficiency in a more integrated way. In the past, this has not always been the case, including at national and regional level.

Against this background, EGEC is not aware of studies comparing LNG infrastructure, renewable heat and energy efficiency. However, some studies have attempted to assess the cost-optimal level between renewable/waste heat supply and demand reductions. They show that at a certain level the marginal cost of further reducing demand is higher that supplying sustainable / renewable heat.

Two studies investigating cost-optimality between energy efficiency and domestic heat supply are the following:

- Heat Roadmap Europe 2050;
- Co2online study

Current economic models used for policy-making do not seem to capture recent and future trends in the heat sector, especially for small-scale installations, and should be refined so as to fully capture the combined economic potential of the existing building stock in terms of energy efficiency and renewable heating and cooling. The EU Heating and Cooling Strategy and the review of the EU baseline scenario represent two great opportunities to bridge the gap.

The starting point should be to identify and analyse the state of play and trends in terms of:

a. Heating and cooling consumption and heat devices broken down by end-user, source, and technology ;
b. The building stock, with information broken down by category, age, location, ownership, etc.
c. Technology costs and resource assessment.

This information will serve as crucial basis for developing a number of scenarios assessing the potential and optimal level between different options.

Question 4: Given uncertainties over future gas demand, how would you assess the risk of stranded assets and lock-in effects (and the risk of diverting investments from low carbon technologies such as renewables and delaying a true change in energy systems) and weigh those against risks to gas security and resilience? What options exist in your view to reduce and/or address the risk of stranded assets?

Question 18: Given uncertainties over future gas demand, how would you assess the risk of stranded assets (and hence unnecessary costs), lock-in effects, the risk of diverting investments from low carbon technologies such as renewables, delaying a transition in energy systems and how would you weigh those against risks to gas security and resilience? What options exist in your view to reduce the risk of stranded assets?

The risk of stranded assets and lock-in effects in fossil fuels infrstructure is indeed very high. There is evidence of overcapacity in terms of gas import infrastructure, notably for liquefied natural gas.

Therefore, further infrastructure dedicated to natural gas is very much a questionable option. Not only because of the existing overcapacity, but also because it fails to go beyond the very short-term, and because it is incompatible with the objective to decarbonise the economy (the fourth pillar of the Energy Union). It is not possible to solve problems by using the same kind of thinking we used when we created them.

The solution must be sustainable as well as economically viable in the long-term. It requires a holistic approach, structural reforms and political courage. In a nutshell, the solution lies in the three no-regrets options identified by the European Commission in the Energy Roadmap 2050, namely a) a substantially higher share of renewables (including fuel switch from gas to renewable heat), b) energy efficiency, and c) smarter infrastructure.

Geothermal energy is of particular interest to replace natural gas and reduce the need for further infrastructure, including LNG. Geothermal is available 24 hours a day, all throughout the year and all over Europe. According to the Heat Roadmap 2050, 25% of the EU population, mostly located in Central and Eastern Europe, lives in areas suitable for geothermal district heating. Additionally, geothermal systems supported by heat pumps can be installed everywhere else. For more information about geothermal applications to replace natural gas see Annex I.

In this framework, there is a need to remove the remaining technology and market barriers hampering the development of renewables for heating and cooling, which can easily substitute natural gas, thereby improving security of supply. In terms of concrete regulatory measures in the framework of the review of existing legislation, the European Geothermal Energy Council brings forward the following proposals:

→ *In the upcoming revision of EU Regulation on security of gas supply, Member States should be required, as part of their Preventive Action Plan, to establish a strategy to reduce gas consumption and to link this strategy with policy planning for reducing energy demand and for switching from gas to renewable energy sources. This would improve the consistency of energy*

policies across Europe in line with the Energy Union and help the transition away from fossil fuels.

→ *In line with Article 14 of the RES Directive, Member States (especially in Central and Eastern Europe) must launch large national information campaigns to increase awareness of consumers on the benefits of switching from fossil fuels to renewable heat and facilitate access to information regarding suppliers and installers. Beyond 2020, existing measures should be strengthened, addressing the existing building stock. Regarding the post-2020 governance, the EC should update the list of indicators, including one on heating & cooling supply, one on prices for heating, one measuring the energy dependency.*

→ *In terms of R&D, the EU should continue supporting technological development, especially in areas that can improve security of supply. More attention should be paid to the energy system as a whole, to the development of smart thermal grids, and to new industrial processes which are able to decarbonise the non-ETS sectors. RD&I in renewable heat technologies is needed to reduce costs, enhance system performance and facilitate the integration of RHC into existing infrastructure. It is also necessary to increase the temperature level of RHC and cover additional industrial sectors.*

Question 13: What opportunities or challenges do the supply projections for different sources, in particular LNG and pipeline gas and low carbon indigenous sources, present for the use of gas storage / for gas storage operators?

Given the similarities between the underground gas storage and the geothermal sector in terms of technologies, geosciences, exploration/drilling technics, and workforce skillset, industries involved in underground gas storage can easily be involved in the geothermal energy sector, which in turn has the potential to absorb the surplus workforce, and to offer long-term employment in a renewable energy sector with large potential.

Always regarding underground gas storage, it is worth mentioning the potential conflict for the use of underground resources between different uses. In this regard, the European Parliament's resolution (2011/2309(INI) urges public authorities to introduce underground regional planning in order to optimise resource allocation between geothermal energy, shale gas, carbon capture and storage (CCS) and possible other underground uses, and thereby maximising the benefits of our underground resources for society.

ANNEX I: Geothermal applications to replace natural gas in the heat and power sectors

1.1 Geothermal applications to replace natural gas in the residential and tertiary sectors

Geothermal can be harnessed and distributed through efficient technologies such as district heating and /or heat pumps. There are already 1.3 million ground source heat pumps (GSHP) installed in Europe. As shown in Box 1, replacing gas boilers with GSHP is already a cost-efficient solution for residential buildings. Another option is the direct use of geothermal resources through small and large scale district heating systems. Box 2 depicts an example from Hungary in which geothermal replaces natural gas in a large district heating system.

1.2 Geothermal and other RHC can replace natural gas for process heat

Renewable heating and cooling technologies can replace gas for industrial processes. For example, this can be the case in the sector of food and tobacco production, which is the third biggest industrial consumer of gas (around 16%)[1]. Indeed, the sector's industrial processes only require temperatures up to 400°C, and more than 50% of its heat demand is lower than 100°C. This could be easily covered by geothermal and other RHC sources[2].

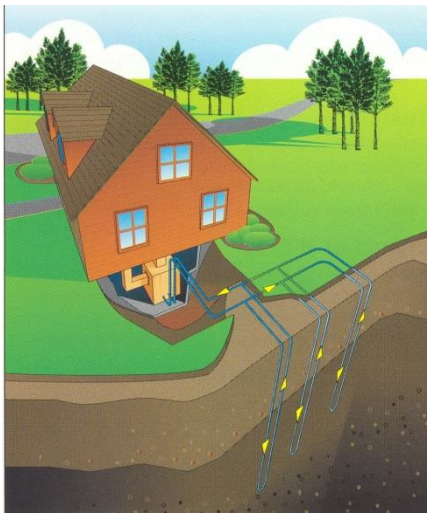
Geothermal energy has been used extensively in the agricultural industry for the last three decades, notably for commercial out-of-season production of vegetables, flowers and fruits. Box 3 illustrates the case of the Netherlands, where geothermal is gradually replacing gas in greenhouses.

Geothermal energy can also supply heat for industrial processes. Box 4 overleaf provides an example of a bio-refinery from France. In the next years, with further R&D and other enabling policies will enable deep geothermal technology, notably through innovative Enhance Geothermal Systems, to cover higher temperature heat demand for industry.

[1] European Commission, "In-depth study of European Energy Security", Commission SWD (2014)330, 2.7.2014, p.39.
[2] European Technology Platform, "Strategic Research and Innovation Agenda for Renewable Heating and Cooling", 2013, p.52.

Case study 1

Replacing gas boilers with geothermal heat pumps: a cost-efficient solution in residential buildings



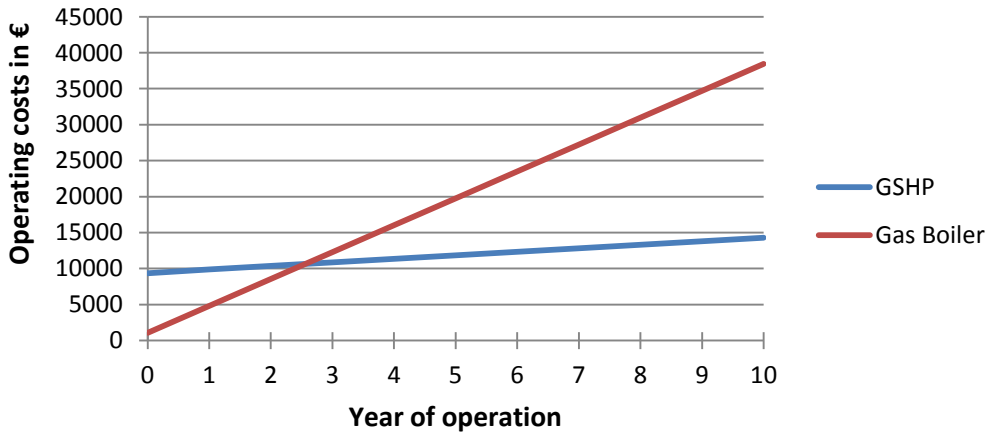
Single-family house: opting for geothermal heat pump or gas boiler?

A study published in 2012 by the Lithuanian Energy Institute demonstrates the tremendous benefits of replacing gas boilers with ground source heat pumps (GSHP) in residential buildings. The aim of the study was to compare the overtime performance and costs of a ground source heat system with a gas boiler system in cold weather conditions.

Both a GSHP and a gas boiler were installed in the same single family house (180m^2) in Kaunas, Lithuania. With a coefficient of performance (COP) of 3.95[3], the GSHP had a heating capacity of 13 kW and of 24kW for the gas boiler. Between the months of October and April, the average ambient temperature was as low as - 4.64°C.

Results:

- The electricity consumption of the GSHP was on average of 732kWh per month and 24 kWh per day.
- **Installation costs:** installation costs of the ground source heat pump amounted to €9372, compared to €1100 for the gas boiler.
- **Operating costs:** operating the geothermal heat pump only cost €494/year, while operating costs of the gas boiler amounted to €3735/year.
- **In spite of lower installation costs, the gas boiler becomes more expensive than the GSHP after less than 3 years of operation.**
- **After 10 years of operation, total expenses related to the gas boiler are 2.7 times higher than the ones related to the ground source heat pump.**



Graph : *Comparison of the operating costs of a ground source heat pump and of a gas boiler in a single-family house in Lithuania*

Source: Zinevicius, F. and Aleksandravicius, T.A., "Single family house: Heat Pump or Gas Boiler?", Energetika, Vilinius, 58(4), pp.195-199. Available here: http://www.lmaleidykla.lt/ojs/index.php/energetika/article/viewFile/2560/1406

[3] The coefficient of performance (COP) of a ground source heat pump measures its efficiency. In the case of a GSHP with an average COP of 4, this means that for every unit of energy used to power the system, four units are supplied as heat.

Case study 2

Replacing natural gas with deep geothermal in district heating systems

Where: Miskolc, Hungary **What**: District heating plant operated by Pannergy – 55 MWth

Objective: To replace natural gas consumption of and hazardous material emissions from the city's central heating plant with renewable energy, which would ultimately ensure a cleaner and more liveable city for the inhabitants of Miskolc.

Key data:

The thermal water reserve in the Mályi Well lays at a depth of approx. 2300 meters, and the resurgent water served as an excellent basis for drilling operations in terms of both yield (150 l/s) and temperature (105°C). The heat output of the thermal wells is transmitted to the heat consumers via pipelines and heat exchangers, while after cooling down the fluid is re-injected.

Project period: 2010 – 2013; Total investment cost is €25.000.000; Magnitude of the grant from EU ERDF and grant schemes funded from Hungary's central budget: HUF 1.7bn (€5.4m); Total amount of GHG reduction approximately 150-200ton/year (estimation).

Replicability: Over 25% of the EU population lives in areas directly suitable for Geothermal District Heating in the EU. There is a large potential in Central and Eastern Europe, including Hungary, Poland, Slovakia, Slovenia, the Czech Republic, and Romania, where existing heat networks are well developed.

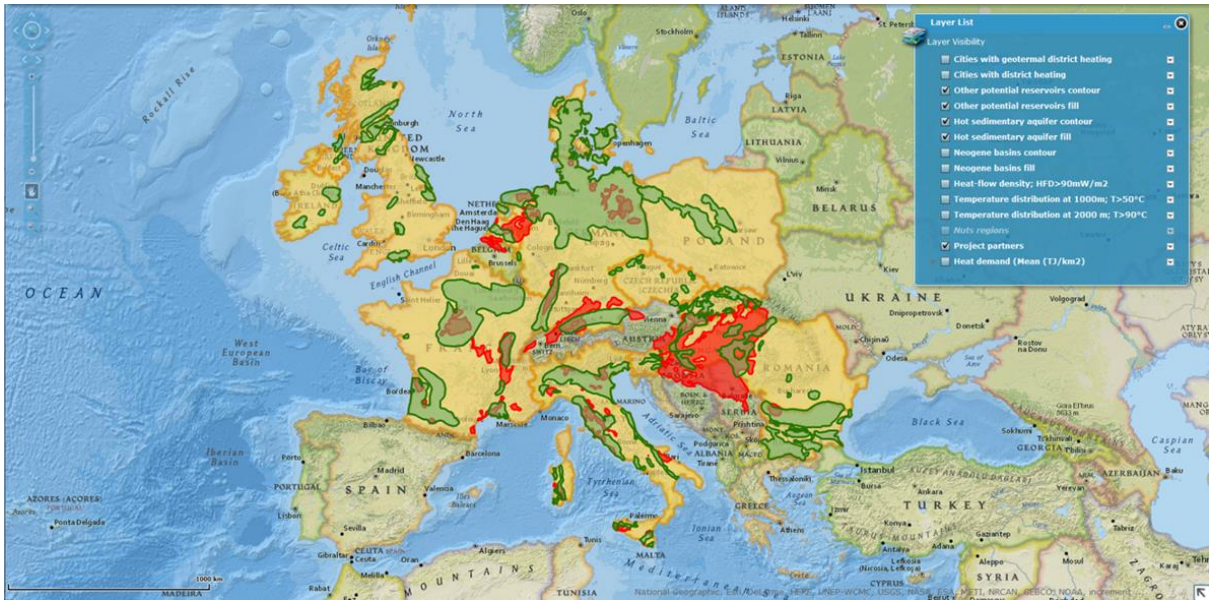


Figure : **Potential for Geothermal District Heating in 14 EU countries**. Source: www.geodh.eu

Case study 3

Geothermal heat plants in horticulture

Where: The Netherlands **What:** Geothermal heat for greenhouses

Geothermal district heating in Green Well Westland

Objective: The Dutch horticulture sector is one of the top global leaders in terms of innovation and trade with international partners. Being a stable pillar of the Dutch economy, horticulture represents around 400.000 jobs and accounts for a yearly production value of €8 bn. Relying extensively on natural gas, the sector's energy costs represent about 20% to 30% of its total production costs. Therefore, one of today's challenges for Dutch horticultural companies is to achieve a more efficient and sustainable use of energy, notably through the uptake of renewables such as geothermal district heating.

Key data: There are today 9 geothermal systems operating projects in the Dutch horticultural sector representing an installed capacity of 100 MWth. 2 new deep geothermal projects are planned in the next 3 years accounting for an additional capacity of more than 30MWth. The development of geothermal in horticulture is very promising as the country has a good potential in terms of geological resource were the sector is most dynamic.

Benefits: Although it is still a rather new technology in the Netherlands, geothermal installations offer many advantages. They provide a great opportunity to significantly lower energy costs and protect companies from volatile natural gas prices. Geothermal systems are also particularly attractive thanks to a favourable regulatory framework combining existing insurance scheme for geological risks and competition-based support schemes (i.e. SDE+, "Encouraging Sustainable Energy Production").

Case study 4

Enhanced geothermal systems for industrial processes

Where: Rittershoffen France **What:** ECOGI- Geothermal heat plant for a bio-refinery

Objective: This geothermal project was initiated in 2011 and is on-going. It is designed to deliver power of 24 MWth to the "Roquette Frères" bio-refinery in Alsace, in order to cover around 25% of the process heat needed on this industrial site.

Key data. The project is supported by ADEME, the Conseil Régional d'Alsace and SAF Environnement. The drilling of the first vertical well started in autumn 2012. The well reached a final depth of two and a half kilometres end of 2012 within a deep fractured basement.

The reservoir temperature met predictions, with temperatures above 160°C. A second well was drilled in 2014, and the plant will be in operation in the coming months.

Replicability: The development of enhanced geothermal systems, a proven technology since 2007, opens new routes for providing, amongst other things, medium and high temperature heat for industrial processes across Europe. More support for deploying this innovative technology is, however, needed.

1.3 Geothermal power and other flexible RES technologies can replace the use of natural gas for flexible generation

The main advantage of geothermal power is its base load capability. In contrast to other volatile renewables, geothermal power plants are dispatchable and can produce around 8000 hours per year. This means a capacity factor of over 90%[4].

Geothermal power can contribute to reduce the amount of fossil fuels the EU imports, foster local development, decarbonise our electricity sector, and diversify Europe's energy mix. It can also provide protection against volatile and rising electricity prices. Contrary to some other types of base-load power plants, geothermal plants are also flexible and reliable, i.e. available under any circumstances. Thanks to these features, geothermal technologies could therefore positively contribute to stabilising the electricity grid.

Traditionally, geothermal power plants have been built to operate continuously at maximum output (baseload). However, they can also be designed to be dispatchable, meaning capable of responding to system operators' needs.

Case study 5

Ensuring baseload and flexible supply of electricity with deep geothermal power plants

Where: Sauerlach, Bavaria, Germany **What:** Combined geothermal heat and power plant operated by the city of Munich

Picture: Sauerlach plant (source: Stadtwerke München)

Key data: In January 2014, the largest geothermal power plant in Germany, located near Munich, was put into operation. Operated by a public utility company of Munich (Stadtwerke München), it supplies around 16,000 households in the city of Munich and provides the inhabitants of Sauerlach with the option to connect to geothermal district heating. The new plant has an electrical capacity of around 6MW and a thermal output of 5 MW. The plant providing heating and power derives water with a temperature of around 140°C from wells with a depth of 5 km.

Objective: The Sauerlach geothermal plant represents a true stepping stone for the city of Munich towards achieving its objective of running 100% on green energy by 2025. Thanks to favourable geological conditions (i.e. the Molasse Basin) and the proximity to a large number of potential consumers, the Munich region is one of the best regions in Germany for the development of geothermal.

A geothermal power plant can be used in partial load operation and, especially with new binary technology, can quickly ramp their output up and down on demand (see figure overleaf).

Even changes in the range of 20 -100% with a speed of 2% per second could be achieved with proper management of turbine and by-pass valves, as has already been implemented according to the requirements of German legislation.

[4] The capacity factor is the ratio of the actual output of a power plant over a period of time and its potential maximum output if it had constantly operated at full nameplate capacity.

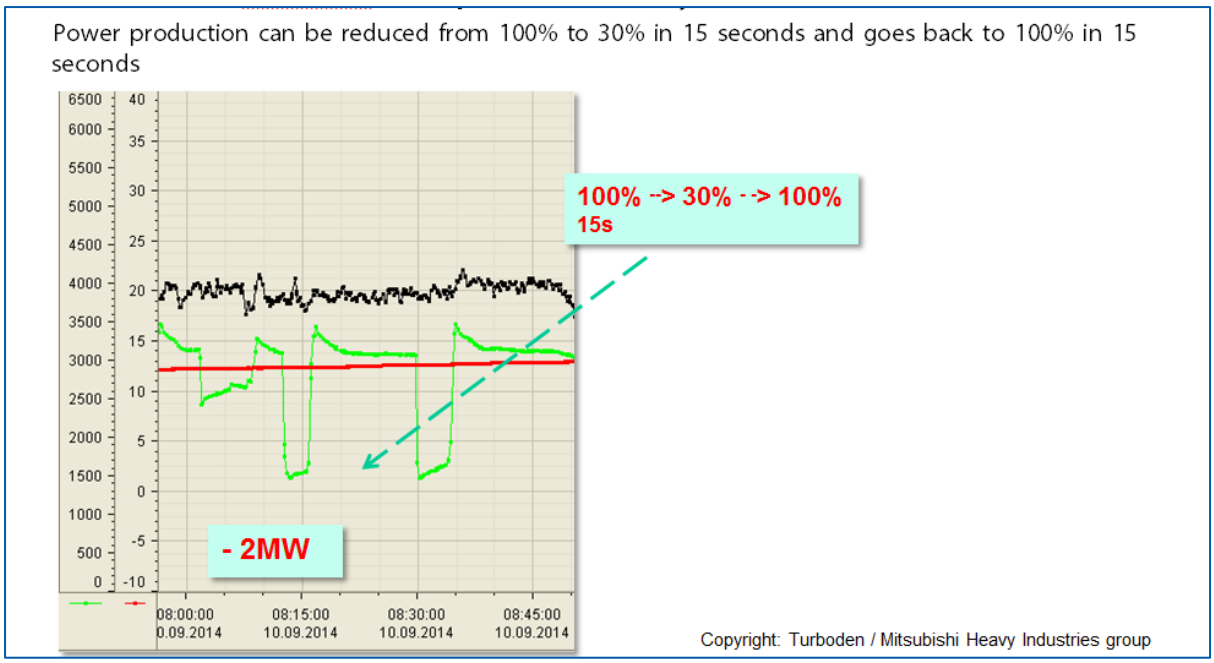


Figure : **Flexibility from geothermal**: Experience from Germany shows how geothermal power production can be reduced from 100% to 30% in 15 seconds and go back to 100% in 15 seconds

Geothermal resources can also be used for the combined generation of heat and power, and be connected to local district heating systems. Extra flexibility stems from the fact that the respective shares of heat and power from the geothermal resource can be adjusted, and from the possibility to convert a surplus of RES electricity to heat- including the option of heat storage.

Geothermal operators can therefore offer ancillary services to system operators and provide valuable short and long-term flexibility at a regional level, a step between centralised and decentralised systems. This is one of the many benefits which are not well known, meaning that geothermal power is not sufficiently taken into consideration in energy policies and planning.

Electricity production from geothermal has its roots in Europe; the first test dates back to 1904 at the Larderello dry steam field in Italy, where the first commercial power plant was inaugurated in 1913. Since then, the development of geothermal power technology has been continuous, mainly in high enthalpy regions such as Tuscany, Iceland, France (Guadeloupe) and Portugal (the Azores).

For several decades, thanks to the optimisation of binary system technology, geothermal electricity has also been produced using lower temperatures. Moreover, with Enhanced Geothermal Systems (EGS), a breakthrough technology proven since 2007, geothermal power can potentially be produced anywhere in Europe.

There are now 68 geothermal power plants in Europe, with 51 of these located in EU Member States, mainly in Italy. The installed capacity in the EU is over 1 GWe. The NREAPs project a geothermal electricity production in the EU-28 of 11 TWh in 2020.

According to the recent GEOELEC resource assessment, in 2030 the economic potential of geothermal power in the EU amounts to 34 TWh. Thanks to economies of scale, innovative drilling concepts and cost reduction, the economic potential in the EU grows to approximately 2570 TWh in 2050 (potentially covering as much as 50% of the projected electricity produced in the EU) and

more than 4000 TWh including Iceland, Turkey and Switzerland. This at ≤100 EUR/MWh all costs included.

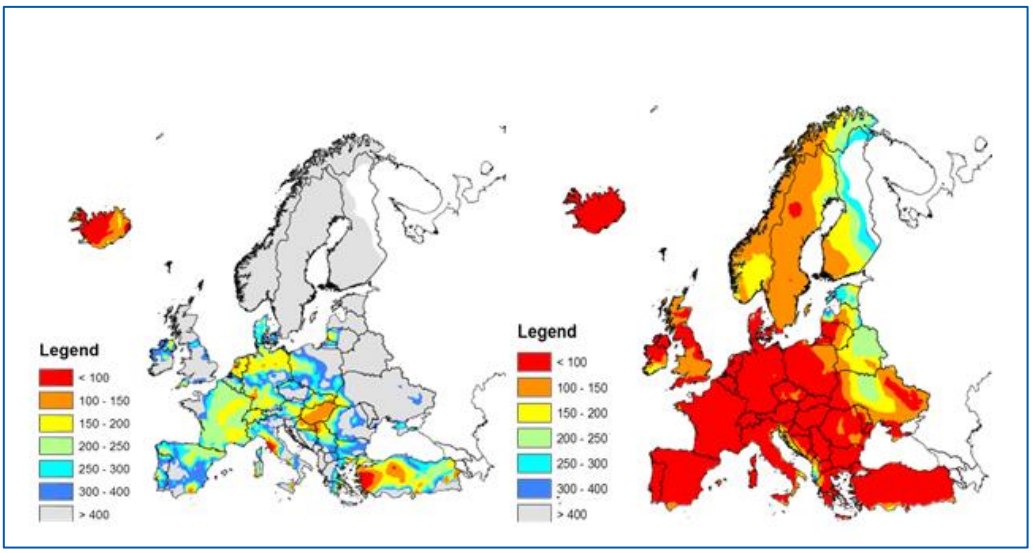


Figure: Geothermal power, Economic potential (MWh/€) in 2030 (left) and 2050 (right). Source: GEOELEC project. Final report available online: http://www.geoelec.eu/wp-content/uploads/2014/01/GEOELEC-report-web.pdf

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