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Opinion of the European Economic and Social Committee

The potential of geothermal energy for the green transition

(own-initiative opinion)

(C/2025/111)

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1. Conclusions and recommendations

1.1. Geothermal energy sources are constant, reliable, do not depend on weather conditions and can be used to produce heat or electricity continuously, around the clock. This can be particularly important in reducing energy system volatility.

1.2. Geothermal energy production has extremely low greenhouse gas emissions, thus reducing the continent's dependence on fossil fuels and facilitating its decarbonisation, thereby making a significant contribution to achieving the EU's 2050 climate neutrality goals.

1.3. The potential of geothermal energy in Europe is significantly untapped. Therefore, the EESC calls on the Commission to draw up a general European strategy for geothermal energy development in order to harness the potential of geothermal energy.

1.4. The EESC emphasises the following key points regarding geothermal energy:

— it is a local energy source, which means energy produced, stored and consumed locally;

— the integration of it into the European energy grid can contribute to the flexibility and stability of the energy system;

— by using local geothermal resources, regions can reduce their dependence on both locally produced and imported fossil fuels, leading to reduced air pollution and more stable and lower energy prices;

— as local energy, it does not require a national network infrastructure, thus reducing network loss and exposure to natural disasters and human factors (political, war);

— it promotes the development of independent and self-sufficient local energy communities and households to participate in local energy production independently of central energy suppliers;

— as cheap, predictable energy, it can help address poverty and the depopulation of rural areas;

— notwithstanding higher initial investment costs, geothermal heating and cooling, which already has a levelised cost of energy (LCOE) lower than fossil fuels, can help combat energy poverty in some regions.

1.5. The EESC believes that investments in geothermal power plants will not work without Member State intervention: government funding and incentives are needed to attract and de-risk initial investments. Changes in energy policy or financing may affect the economic attractiveness of geothermal projects. The EESC recommends that the guidelines set out in Article 23 of the revised Renewable Energy Directive ([1]) be used to speed up the implementation and financing of geothermal projects.

1.6. Long-term impact assessments are necessary for optimising investments, and legal certainty is required for the operation of geothermal power plants. National legal conflicts such as ownership, mining and water problems need to be resolved.

1.7. It is necessary to accurately identify risks related to environmental impacts and to ensure that the construction of geothermal power plants is pursued with the involvement of local communities, thus increasing public acceptance. It is important to stress that the environmental and climate benefits of geothermal energy outweigh the risks as it is one of the best renewable energy sources in terms of land use, resource use and import dependency.

1.8. The EESC calls on the Commission to launch a European programme to assess geothermal energy production areas in order to meet its drilling data needs. A publicly accessible geothermal database would fill a gap, where the data could be used to decide in which European areas it is worth investing in geothermal energy.

1.9. The development of geothermal energy has great potential for innovation. The EESC therefore proposes the following innovations:

— introducing the 'fifth freedom of the single market' ([2]) to enhance geothermal research, innovation and education across the EU in order to exploit synergies and economies of scale;

— establishing a joint research and development fund for the development of geothermal potential;

— using existing public and private funding to stimulate geothermal investments;

— support for start-ups, innovative enterprises and pilot projects;

— exploiting synergies with other sectors/instruments: combination of geothermal + solar energy, hydrogen production (non-electrolyte), water/energy storage in old, abandoned mines (brownfield exploitation).

1.10. The EESC calls on the Commission to remove regulatory barriers to planning and permitting needs. Instead of a fragmented and dispersed approach, introduce a concentrated and rapid one-stop-shop for licensing.

([1]) Directive (EU) 2023/2413 of the European Parliament and of the Council of 18 October 2023 amending Directive (EU) 2018/2001, Regulation (EU) 2018/1999 and Directive 98/70/EC as regards the promotion of energy from renewable sources, and repealing Council Directive (EU) 2015/652 (OJ L, 2023/2413, 31.10.2023, ELI: http://data.europa.eu/eli/dir/2023/2413/oj).

([2]) 'The addition of a fifth freedom to the existing four, to enhance research, innovation and education in the Single Market.' – see *Much more than a market*, report by Enrico Letta.

2. **General comments**

Geothermal energy as an obvious technology for a rapid and inclusive energy transition

2.1. Geothermal energy is rooted in the internal heat of the Earth, which comes from heat released during the formation of the planet. It provides huge amounts of renewable energy year-round that can be used for renewable heating, cooling, electricity generation and energy storage, or even for sustainable extraction of minerals such as lithium. It is highly unlikely that the EU will achieve its decarbonisation targets for the heating and cooling sector without significantly accelerating the use of geothermal energy.

2.2. Geothermal energy is theoretically available anywhere, but the possibilities and efficiency of its utilisation can vary significantly in different geographical areas (see geothermal potential). It also depends on the structural and geological characteristics of the Earth (the thickness of the Earth's crust and the heat flow operating in it), the geothermal gradient (the rate of temperature rise below the surface of the Earth) and geological conditions and the presence of water as a transfer medium.

2.3. Geothermal energy is often referred to as a 'sleeping giant', referring to its untapped potential across Europe. According to a report by the European Commission's Joint Research Centre, in 2021 the EU's gross geothermal electricity generation capacity exceeded 1 GWe ([3]), while net capacity was 877 MWe. The EU's geothermal electricity production was 6 717 GWh, or 0,2 % of electricity in the EU. The installed capacity of the geothermal district heating and cooling sector was 2,2 GWth ([4]) in 2021. Overall, geothermal energy accounted for 2,8 % of renewable energy used for primary energy production for district heating and cooling in the EU in 2021 ([5]). The rate remains stable year after year. However, geothermal energy continues to show a dynamic trend, with new projects and increased supply at national level across Europe in Germany (50 %), Poland (15,6 %) and Hungary (11 %) ([6]).

2.4. Geothermal power plants are one of the few renewable energy technologies that can provide continuous, stable baseload energy and can be operated stably over long periods of time, while at the same time being used as a flexible energy source to balance intermittent renewable energy sources, including solar and wind energy.

2.5. Geothermal energy sources are local and do not require large quantities of materials imported from third countries, so their use will reduce energy imports and dependency, costs and emissions, and make Europe's energy system safer, more stable and more cost-effective.

2.6. The main technologies for the production of geothermal energy are geothermal heat pumps that harness heat in close proximity to the ground, and deep geothermal energy production, which typically reaches hot, geothermally active layers through wells drilled thousands of metres deep. Heat pumps can be built almost anywhere in Europe, but deep geothermal power generation is only available in certain countries/regions. It is important to focus our attention on easily achievable results, so while increasing the utilisation of geothermal energy, we should focus on the installation of geothermal heat pumps that are accessible to everyone.

Geothermal energy is an untapped resource in Europe

2.7. Geothermal energy is a huge, largely untapped resource in Europe, offering significant opportunities for the continent for a sustainable energy transition.

([3]) 'GWe' means gigawatts-electric.
([4]) 'GWth' means gigawatts-thermal.
([5]) DHC Market Outlook 2024.
([6]) Geothermal energy in the EU by the EPRS.

2.8. According to Eurostat data, around 50 % of energy consumption in the EU is used for heating and cooling buildings, and approximately 75 % of this energy comes from fossil fuels ([7]). According to the European Geothermal Energy Council (EGEC), geothermal energy can provide around 25 % of heating and cooling consumption and around 10 % of electricity consumption in Europe ([8]).

2.9. In addition to heating various buildings, geothermal hot water is used in greenhouses, drying crops, de-icing roads, supporting industrial processes such as pasteurisation of milk, and heating water in fish farms, not to mention medicinal purposes. The development of greenhouse agriculture and geothermal-based aquaculture can increase food production considerably ([9]).

2.10. The utilisation of geothermal energy is constantly evolving: some promising applications include thermal energy storage (TES) and the construction of enhanced geothermal systems (EGS).

2.11. However, despite its favourable characteristics, geothermal energy extraction faces challenges:

— There is often a lack of capacity in licensing agencies and cumbersome authorisation procedures;

— Easily accessible geological data or data on energy use are also often lacking;

— Due to a lack of technological knowledge, feasibility studies sometimes do not focus on the total lifetime cost, which underestimates the lifetime of geothermal power plants compared to solutions with shorter lifetimes, which may seem cheaper. Few countries provide statistics on the numbers of installed GHPs, geothermal district heating and cooling systems, etc.;

— Financial risk reduction is typical for larger projects, especially new entrants, which carry resource and project development risks.

European plans and targets for the deployment of geothermal energy

2.12. Europe aims to reduce emissions by at least 55 % by 2030 ([10]) and by at least 90 % by 2040 ([11]).

2.13. The revised Renewable Energy Directive (RED III ([12])) raised the renewable energy target to 42,5 % by 2030 and EU countries have set a target of 45 %. Article 23 of the Directive introduced a binding sub-target for renewable heating and cooling capacity, which should increase by 1.1 percentage points per year in all Member States between 2026 and 2030.

2.14. On 18 January 2024, the EP issued a resolution on geothermal energy ([13]), praising heat pumps and geothermal energy technologies and 'calling on the Commission to present an EU geothermal strategy providing concrete guidance to Member States and local administrations to accelerate the deployment of geothermal energy...'.

2.15. The EU's solar strategy ([14]) states that 'to achieve the EU's 2030 targets, energy demand from solar heat and geothermal energy will need to at least triple'.

2.16. The recently adopted Electricity Market Regulation ([15]) included geothermal energy as one of the key technologies for decarbonising energy.

([7]) *Share of energy from renewable sources* by Eurostat.
([8]) *Geothermal Now: Priorities for the EU's 2024-2029 mandate*, manifesto by the EGEC.
([9]) Report on *Uses of geothermal energy in food and agriculture* by the FAO.
([10]) 'Fit for 55' Communication.
([11]) *Securing our future – Europe's 2040 climate target and path to climate neutrality by 2050 building a sustainable, just and prosperous society* (COM(2024) 63 final).
([12]) Directive (EU) 2023/2413 of the European Parliament and of the Council of 18 October 2023 amending Directive (EU) 2018/2001, Regulation (EU) 2018/1999 and Directive 98/70/EC as regards the promotion of energy from renewable sources, and repealing Council Directive (EU) 2015/652 (OJ L, 2023/2413, 31.10.2023, ELI: http://data.europa.eu/eli/dir/2023/2413/oj).
([13]) EP resolution on geothermal energy (2023/2111(INI)).
([14]) EU Solar Strategy (COM(2022) 221 final).
([15]) Proposal for a Regulation on the EU's electricity market design (COM(2023) 148 final): https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52023PC0148.

2.17. The Net Zero Industry Act ([16]) proposed measures to ensure that by 2030 the manufacturing capacity of certain strategic net-zero technologies, such as heat pumps and geothermal power plants, in the EU approaches or reaches at least 40 % of the EU's annual deployment needs.

2.18. In addition to increasing the share of renewable energy sources and reducing emissions, we need to involve everyone in the green transition and reduce energy poverty. It is necessary to examine how the Social Climate Fund (SCF) can support the use of geothermal energy by providing direct support to the most vulnerable groups, such as households in energy poverty, and district heating plants using geothermal energy must be included in the Social Climate Plans prepared by the Member States for the implementation of the SCF to reduce heating and cooling costs and emissions.

3. **Specific comments**

3.1. Both households and European businesses need affordable and easily accessible energy. Geothermal district heating systems, interconnected geothermal and advanced closed-loop systems are essential for the decarbonisation of heating, including fossil-based district heating systems. Without the contribution of geothermal energy, we will not be able to reduce emissions and achieve the renewable energy targets.

3.2. ***Geothermal energy that provides secure and affordable low-greenhouse-gas-emission energy***

3.2.1. The development and exploitation of geothermal energy as a clean energy source can contribute to achieving the EU's decarbonisation goals, as its greenhouse gas emissions are very low:

— unlike other renewable energy sources, geothermal energy sources are permanent, weather-independent;

— it is particularly suitable for heating and cooling buildings, but can also provide thermal energy for certain industrial processes;

— it can also produce clean electricity at high temperatures;

— it can reduce the EU's dependence on imported fossil fuels;

— the development of the sector can create new, green jobs;

— it can promote the economic development of regions rich in geothermal resources and strengthen spatial planning.

3.3. ***Geothermal energy in the Energy Union***

3.3.1. The single market is a fundamental pillar of European integration, harmonising national legislation and promoting economic growth, prosperity and solidarity. In the last crisis, we sensed the lack of coordination in the energy markets. In previous opinions, the EESC has stressed ([17]) the importance of digitalisation of the energy system, market reform ([18]) and the future of electricity supply and pricing in the EU ([19]), as well as citizen participation and a just transition.

([16]) Proposal for the Net Zero Industry Act (COM(2023) 161 final).

([17]) Opinion of the European Economic and Social Committee on the Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions on Digitalising the energy system — EU Action Plan (COM(2022) 552 final) (OJ C 184/93, 25.5.2023, p. 93).

([18]) Opinion of the European Economic and Social Committee on the proposal for a Regulation of the European Parliament and of the Council amending Regulations (EU) 2019/943 and (EU) No 2019/942 as well as Directives (EU) 2018/2001 and (EU) 2019/944 to improve the Union's electricity market design (COM(2023) 148 final — 2023/0077 (COD)) (OJ C 293/112, 18.8.2023, p. 112).

([19]) TEN/837 - The future of the supply and pricing of electricity in the EU.

3.3.2. Despite its obvious advantages, geothermal energy still plays a very limited role in the EU's renewables-based energy mix. Despite the fact that the geothermal energy potential of some European areas is very high, we often solve the problem of keeping our households warm or cool in these areas with individual, often polluting solutions.

3.4. *Rare materials obtained by building geothermal power plants*

3.4.1. The EU's industrial production and energy production are highly dependent on raw materials, most of which come from third countries. These raw materials are an obligatory part of the functioning of the European economy, have significant exposure and (negatively) affect the competitiveness of the European Union.

3.4.2. The development of geothermal power plants does not require significant and rare critical raw materials in Europe, so their exploitation does not increase Europe's dependence. At the same time, the extraction of rare materials (e.g. lithium, sulphur, etc.) that can be extracted during the construction of geothermal power plants offers exciting opportunities for geothermal energy production.

3.5. *Geothermal energy investments*

3.5.1. The European economy also requires social cohesion and participation in investment. Indeed, investments in geothermal energy can involve European citizens and municipalities, who can then take ownership of this energy source and participate in its exploitation themselves.

3.5.2. The initial costs of exploring, drilling and building geothermal power plants or heating systems are high. The drilling success rate is low, so this poses a risk to investments, which may discourage investors from drilling. High initial investments and long amortisation periods create uncertainty about the long-term profitability of geothermal projects. France and Netherlands operate financial risk reduction programmes. The EESC calls on the European Commission to facilitate peer learning among the Member States to scale up such schemes across Europe, and also to set up a dedicated EU joint research and development fund for the development of geothermal potential.

3.6. *Geothermal energy and the environment*

3.6.1. The environmental and climate benefits of geothermal energy outweigh the risks. The geothermal power plant is environmentally friendly, the energy generated is renewable, with minimal greenhouse gas emissions and a moderate footprint compared to fossil fuels and most renewable resources. When used sustainably, geothermal energy can be available for a long time, as geothermal heat is constantly replenished by radioactive decay of minerals in the Earth's interior.

3.6.2. However, the development of geothermal power plants is associated with geological risks:

— The use of geothermal resources can lead to subsurface changes that can cause subsidence or other geotechnical problems;

— Pumping water out of geothermal reservoirs or pumping it back can trigger microearthquakes, especially in advanced EGS.

3.6.3. The construction of geothermal power plants entails environmental risks:

— In regions with water scarcity, the need for significant amounts of water for pumping and heat transfer can be problematic.

— Although geothermal energy is considered clean, toxic gases such as hydrogen sulphide and dissolved minerals and chemicals can be released during use, which must be disposed of.

3.7. ***Geothermal energy and territoriality***

3.7.1. The efficiency and availability of geothermal energy can vary greatly depending on the geological composition and thermal characteristics of the area; therefore its availability is very location-dependent. High-temperature reservoirs suitable for energy production are often located in geologically active regions, which may limit the geographical availability of these resources.

3.7.2. The exploitation of geothermal energy can create jobs locally and promote the development of the local economy. Municipalities can support local businesses with low-cost energy, making them attractive in the race to relocate businesses.

3.8. ***Geothermal and digital transformation***

3.8.1. Geothermal energy investment requires a very high amount of upfront data. Investors need geological data, preliminary investment maps, databases, or area data exchange before actual drilling, which is not currently available.

Companies that have been exploring for decades by drilling for oil and gas sometimes have important data and experience. To enable the development of geothermal energy, it is important that companies share this data with local and central government authorities. The EESC recommends setting a deadline after which drilling data collected by private companies would become public, taking into account the protection of private data assets.

3.9. ***Strengthening the skilled workforce in the development of geothermal energy***

3.9.1. One of Europe's greatest challenges is meeting the skilled workforce needs of a changing economic structure, which limits workers' support for investment in Europe.

3.9.2. The European hydrocarbon industry brings many workers into the labour market. Due to their skill profile, workers have good opportunities to fill the jobs created by investments in geothermal energy.

3.9.3. In addition to exploiting the potential of geothermal energy, a well-founded social dialogue is needed.

3.10. ***Innovation and R&D in the field of geothermal energy***

3.10.1. As the EESC has stated in several opinions, R&D and innovation are the future of our competitiveness. Technological progress and innovation, the development of new drilling technologies and techniques can reduce the costs and risks of geothermal development. Part of the existing research and development funding at EU level, including the STEP initiative ([20]), should be earmarked for the development of geothermal energy.

3.11. ***Geothermal energy and licensing system***

3.11.1. The development of geothermal projects requires extensive licensing and environmental review, which can be time-consuming and costly.

3.11.2. European authorisation procedures appear to be

— fragmented by country and authority;

— rooted in/dominated by the traditional 'mining license' approach (see mechanical, deep mining safety aspects);

— dispersed and transported through successive processes under several authorities.

([20]) Strategic Technologies for Europe Platform.

3.11.3. Harmonising and simplifying construction regulations can reduce housing costs, but must not compromise environmental, social, or occupational safety rules or undermine aesthetic architectural values that contribute to people's well-being.

Brussels, 23 October 2024.

The President
of the European Economic and Social Committee
Oliver RÖPKE