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Unlocking Geothermal Energy Potential in Romania

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Title

Unlocking Geothermal Energy Potential in Romania

A study by

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About EPG

Energy Policy Group (EPG) is a non-profit, independent think-tank specialising in energy and climate policy. EPG does evidence-based policy analysis on the decarbonization of the energy, industry, buildings and transport sectors. Its geographical focus is mostly the European Union and Southeast Europe, yet its analyses are informed by the global market, technology, and geopolitical trends. EPG is based in Bucharest, Romania, where it was founded in 2014.

About CATF

Clean Air Task Force (CATF) is a global nonprofit organisation working to safeguard against the worst impacts of climate change by catalysing the rapid development and deployment of low-carbon energy and other climate-protecting technologies. With 30 years of internationally recognised expertise on climate policy and a fierce commitment to exploring all potential solutions, CATF is a pragmatic, non-ideological advocacy group with the bold ideas needed to address climate change. CATF has offices in Boston, Washington D.C., and Brussels, with staff working virtually around the world.

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Key Findings

Geothermal energy could contribute to improving access to reliable and dispatchable energy in Romania. The country is deemed to have untapped geothermal potential, yet unlocking this potential requires forward-looking policy and investment. Strategic documents such as the National Energy and Climate Plan (NECP) and the Long-Term Strategy (LTS) make only limited reference to geothermal energy, indicating that its role in the national energy system should be reconsidered. Several conclusions emerge from the present study of Romania's geothermal potential:

- **Romania's geothermal potential remains largely untapped.** Despite favourable geological conditions, geothermal energy contributes only marginally to the national energy mix and is primarily limited to district heating and spas.
- **Regulatory and administrative barriers continue to slow deployment**. Fragmented permitting procedures, overlapping licensing requirements, lack of legal clarity on the reuse of oil and gas infrastructure, and outdated subsurface data significantly increase project risk and development timelines.
- **Geothermal heat can have lower production costs and carbon emissions compared to fossil-based systems,** as projected by existing district heating projects such as those in Oradea and Beiuș (Bihor county).
- **Capabilities in the oil and gas industry can accelerate market development.** Existing expertise, infrastructure, drilling capabilities, and abandoned wells offer a strong foundation to reduce costs, de-risk exploration, and scale both conventional and next-generation geothermal technologies.
- **The availability and accessibility of geological information remain insufficient.** Subsurface data is fragmented, difficult to access, and inadequate for the development of comprehensive geothermal resource maps. Improving data aggregation and expanding public access to geological information could significantly reduce exploration risk and improve investment visibility.
- **Early-stage financial risk remains the primary barrier to investment.** High upfront drilling costs, uncertainty about resource validation, and limited availability of dedicated financial instruments constrain private sector participation. Risk-sharing mechanisms such as drilling insurance schemes or specific geothermal financing vehicles could play an important role in accelerating deployment.
- **Romania's regulatory framework is not yet fully adapted to next-generation geothermal technologies.** Existing legislation is primarily resource-based and focused on conventional geothermal systems, creating ambiguity with respect to enhanced geothermal systems and closed-loop applications, where fluid extraction is not the defining parameter.
- **Public institutions could play a more active role in accelerating geothermal development**. Coordinated national mapping initiatives, improved data dissemination, targeted financial support, and the establishment of geothermal test beds could reduce uncertainty and facilitate deployment.

Executive Summary

This report assesses the current state and potential of geothermal energy. At the EU level, geothermal energy is gaining strategic relevance due to its ability to provide firm, clean heat and electricity. However, despite recent policy momentum under initiatives such as REPowerEU and the anticipated European Geothermal Strategy and Action Plan, deployment remains limited because of high upfront costs, regulatory complexity, and insufficient subsurface data.

Romania holds large untapped geothermal resources, particularly in the western region. Nonetheless, the sector remains underdeveloped, accounting for only a marginal share of the energy mix and is largely limited to district heating, spas and, more recently, projects aimed at heating public buildings in well-known geothermal areas. Existing district heating projects, such as in Oradea and Beiuș, demonstrate economic advantages, including lower heat production costs and reduced greenhouse gas emissions. However, the absence of a coherent policy framework, fragmented permitting processes, and outdated geological data continue to hinder large-scale developments.

Technological advancements, particularly in next-generation geothermal systems such as Enhanced Geothermal Systems and Advanced Geothermal Systems, offer a pathway to overcome geographical constraints. Research is currently underway in multiple countries, with next-generation technologies advancing into ever-higher temperature environments. Such innovations significantly expand the potential resource base and may enable geothermal power generation in Romania. The oil and gas sector is a key enabler, providing transferable expertise, infrastructure, and access to financing. The reuse of abandoned wells alone could reduce drilling costs by up to 50%, drastically improving project viability.

The report identifies structural barriers to development, including high exploration risk, limited access to finance, lack of risk mitigation instruments, and regulatory misalignment with geothermal specificities. Stakeholder consultations confirm that administrative fragmentation, unclear licensing regimes, and inadequate incentive structures are among the main obstacles faced by developers.

To unlock the geothermal potential, the report proposes a set of targeted policy measures. These include streamlining permitting procedures, improving access to and quality of subsurface data, aligning taxation with energy output rather than extracted volumes, and introducing dedicated financial instruments such as drilling insurance. Other recommendations focus on integrating next-generation geothermal technologies into the legal framework, leveraging oil and gas assets, and preparing workforce capabilities.

All-in-all, geothermal energy represents an opportunity for Romania to enhance energy security, decarbonise heating and electricity, and diversify its energy mix. Tapping into this potential requires coordinated policy action, regulatory reform, and targeted investment to address existing market and institutional barriers.

Sumar executiv

Prezentul raport analizează stadiul actual și potențialul viitor al energiei geotermale în România, într-un context mai extins al decarbonizării. În Uniunea Europeană, geotermalul capătă o relevanță strategică datorită capacității sale de a furniza energie termică și electrică curată și constantă. Cu toate acestea, în pofida impulsului politic generat de inițiative precum REPowerEU și de așteptata Strategie și Plan de Acțiune European pentru Energie Geotermală, implementarea rămâne limitată de costurile inițiale ridicate, complexitatea cadrului de reglementare și insuficiența datelor privind resursele din subteran.

România dispune de resurse geotermale importante, în special în regiunea de vest a țării. Cu toate acestea, sectorul rămâne slab dezvoltat, având doar o pondere marginală în mixul energetic și fiind utilizat în principal pentru termoficare stațiuni balneare, și, mai recent, în proiecte care vizează încălzirea clădirilor publice din zone cu potențial geotermal bine cunoscut. Proiectele existente de termoficare, precum cele din Oradea și Beiuș, demonstrează avantaje economice, inclusiv costuri mai reduse pentru producția de căldură și emisii mai scăzute de gaze cu efect de seră. Dar absența unui cadru de politici coerent, procesele fragmentate de autorizare și datele geologice învechite continuă să împiedice dezvoltarea la scară largă.

Progresele tehnologice, în special în domeniul sistemelor geotermale de nouă generație, precum Enhanced Geothermal Systems (EGS) și Advanced Geothermal Systems (AGS), oferă posibilitatea de a depăși constrângerile geografice ale proiectelor geotermale. Cercetarea în aceste domenii este în desfășurare în multe state, iar noile tehnologii sunt testate în condiții de temperatură tot mai ridicate. Aceste inovații extind semnificativ baza potențială de resurse și ar putea permite inclusiv producerea de energie electrică din surse geotermale. Sectorul de petrol și gaze reprezintă un facilitator important, prin expertiza transferabilă, infrastructura existentă și accesul la finanțare. Reutilizarea sondelor abandonate ar putea reduce costurile de foraj cu până la 50%, îmbunătățind viabilitatea economică a proiectelor.

Raportul identifică principalele bariere structurale pentru dezvoltarea sectorului, inclusiv riscul ridicat asociat explorării, accesul limitat la finanțare, lipsa mecanismelor de reducere a riscurilor și nealinierea cadrului de reglementare la specificul energiei geotermale. Consultările cu actorii din sector confirmă că fragmentarea administrativă, regimurile neclare de licențiere și structurile de stimulare insuficiente reprezintă principalele obstacole întâmpinate de dezvoltatori.

Pentru valorificarea potențialului geotermal, raportul propune un set de politici publice: simplificarea procedurilor de autorizare, îmbunătățirea accesului la datele de subsol și a calității acestora, alinierea sistemului de impozitare la energia produsă și nu la volumele extrase și introducerea unor instrumente financiare dedicate, precum mecanismele de asigurare pentru foraj. Recomandările vizează și integrarea tehnologiilor geotermale de nouă generație în cadrul legislativ, valorificarea activelor din sectorul de petrol și gaze și dezvoltarea competențelor profesionale necesare sectorului.

Energia geotermală reprezintă o șansă pentru România de a-și consolida securitatea energetică, a decarboniza producția de energie și diversifica mixul energetic. Valorificarea sa necesită politici coordonate, ajustarea cadrului de reglementare și investiții dedicate.

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Acronyms

AGS	Advanced Geothermal Systems
ANRMSG	National Agency for Mineral Resources, Petroleum and Geological Storage
CEE	Central and Eastern Europe
CHP	Combine Heat and Power
DH	District Heating
EED	Energy Efficiency Directive
EGS	Enhanced Geothermal Systems
EPG	Energy Policy Group
IEA	International Energy Agency
IGR	Geological Institute of Romania
NECP	National Integrated Energy and Climate Plan
NZIA	Net Zero Industry Act
RED	Renewable Energy Directive
RES	Renewable Energy Sources
SHR	Super-Hot Rock
UNFC	United Nations Framework Classification

1. Introduction: the EU policy environment

The European Commission has identified geothermal energy as a component of its broader decarbonisation agenda. Under the REPowerEU, AccelerateEU plan and the Green Deal Industrial Plan, the Commission has committed to accelerating the deployment of geothermal projects, particularly in the context of growing concerns regarding competitiveness, energy affordability and energy security following the 2022 energy crisis Calls for the development of an EU Geothermal Action Plan have intensified in recent years, with European institutions and industry stakeholders advocating for a coordinated framework to accelerate geothermal deployment. Proposed priorities include scaling up geothermal electricity generation and district heating, improving access to financing and de-risking mechanisms, streamlining permitting procedures, and strengthening geological data availability by 2030 and 2050 (European Commission, 2025). To support these objectives, funding is channelled through instruments such as the Innovation Fund and the Cohesion Funds to support next-generation geothermal that could unlock resources in regions previously considered unsuitable, dramatically expanding Europe's geothermal footprint.

More recently, against the backdrop of geopolitical tensions linked to the conflict involving Iran, the EU announced support measures for geothermal energy through de-risking methods and compilation of geological data (European Commission, 2026). These developments signal that geothermal is moving from a niche technology toward a more strategic component of Europe’s energy agenda given its ability to provide a firm source of energy that can effectively displace fossil fuels.

Nonetheless, geothermal energy still receives far less attention compared to other renewables. Many reputable sources of policy research covering the energy transition still group geothermal energy into the “other” category of renewable energy sources (IEA, 2024), (JRC, 2024). This lack of analytic and policy focus affects the sector’s development prospects. There is also a lack of standardisation across infrastructure, parts, and resources: while a classification of geothermal energy resources under the United Nations Framework Classification (UNECE, 2022) has been in place since 2016, the United Nations Framework Classification on Climate Change noted that only 9% of the global Nationally Defined Contributions mention geothermal energy, and governing documents that standardize processes and set immediate objectives are largely lacking (UNFCCC, 2023).

Still, the EU has progressed in bolstering geothermal energy. Investments in geothermal heat rose by 34% in 2024 (year-on-year) and the EU NECPs indicated a potential 33% growth in geothermal electricity production by 2030 (EGEC, 2024). However, much of this investment has been private and independent of policy guidance, as many Member States have yet to introduce forward-looking plans for sectoral development. Among the main EU documents addressing geothermal energy are the following:

- **The Net Zero Industry Act (NZIA, 2024):** Recognises geothermal as one of the net-zero technologies and includes certain geothermal-related equipment, components and industrial applications within the broader scope of net-zero technology manufacturing and deployment.

- **The revised Energy Efficiency Directive (EED, 2023):** Mentions geothermal as a relevant technology for heating and cooling applications, particularly in the context of efficient district heating and the decarbonisation of the heating and cooling sector.
- **The REPowerEU Plan (2022):** Lists geothermal heat as a viable solution for district heating and community heating projects, and addresses the establishment of a large-scale skills partnership for the sector.
- **The revised Renewable Energy Directive (REDIII, 2023):** Highlights shallow geothermal as an important heat source for heat pumps and identifies large-scale geothermal as applicable to district heating. It also covers certification requirements for geothermal installers. A third mention of geothermal regards the official accreditation of installers of geothermal energy infrastructure.
- **The AccelerateEU (2026):** Recognises geothermal's potential for decarbonisation of heating and cooling, especially district heating and cooling, and its ability to insulate homes from price shocks. It also underlines the Commissions commitment to setting up databases and derisking schemes.

1.1. Expected EU initiatives on geothermal

Despite occasional mention of geothermal, the proposed measures are largely insufficient, so that the technology is only playing a peripheral role in the EU decarbonisation plans. This prompted the Council and the European Parliament to urge the Commission to publish a Geothermal Energy Action Plan (Council of the European Union, 2024) (European Parliament, 2024) to capitalise on its many positive qualities:

Characteristics of geothermal's power generation profile: it contributes to security of supply, sustainability, and affordability objectives; reduces dependence on energy imports; facilitates the integration of variable renewable energy sources (RES) through the provision of baseload power.

Availability and versatility: many EU Member States (MS) possess untapped geothermal resources. Importantly, geothermal energy can play an important role in rural areas. Both shallow and deep geothermal applications can contribute to reducing emissions in the buildings sector and are relatively easy to integrate into district heating systems.

The documents calling for progress on the field of geothermal energy – particularly that of the Council of the EU – corroborate the idea that geothermal energy is largely neglected, facing burdensome permitting procedures, limited technical expertise, widespread absence of subsurface data, and the lack of a skilled workforce. As a result, the EU Geothermal Action Plan addresses, among others, the following areas of interest:

Risk mitigation schemes and other development guarantees: financial guarantees or risk mitigation schemes that address the risks posed by early-stage development costs; applications in district heating and cooling; instruments and support schemes for geothermal energy; support of equipment providers; international know-how exchange.

Guidance and best practices for investment: integrated national, regional, and local planning of infrastructure; the role of geothermal energy in grid balancing on the long run; public awareness about geothermal energy, with deeper involvement of rural communities and local governments in project development; information on best practices and geological and environmental risks of geothermal development, and corresponding mitigation measures.

Best practices on permitting: streamlining and digitalisation of permitting and licensing procedures, possibly by designating a single point of contact between public authorities and developers; legally separating geothermal energy from other mineral resources; standardising of permitting procedures across the EU.

Workforce expansion: retraining and reskilling programs and vocational education targeting former O&G industry workers; higher education specialisations on geothermal energy development, alongside research and innovation programs.

Facilitation of data sharing, including the expansion of subsurface data availability: both the EU and the Member States should facilitate access to maps, subsurface data, and geoscientific data; availability of data on the status of district heating systems, allowing for better coordination between public authorities and geothermal developers; standards on industry data collection and reporting.

Support for geothermal electricity generation: promotion of deep (next-generation) geothermal power production, separating regulations for large-scale mining processes from next-generation geothermal energy; special permitting regimes for next-generation geothermal.

2. Types of geothermal technology

Geothermal energy refers to heat extracted from the Earth's crust. It derives from trapped subsurface energy resulting from the planet's initial formation, and energy from radioactive decay. This energy source has been utilised by human beings for millennia for space and water heating, and more recently in scaled centralised systems that provide widespread residential and industrial access to thermal and electric energy. As power grids have accommodated more and more variable renewable energy sources, the problem of dealing with intermittency in grids has created demand for firm sources of renewable energy, which has had geothermal power garner significant interest.

2.1. Geothermal heat production

Conventional geothermal energy systems extract heated water from underground deposits, pull the fluids to the surface, and either introduce it directly into a delivery network (direct-use applications) or use steam to generate electricity, if the underground water temperature is sufficiently high. Most conventional geothermal energy systems in Europe are used for heat provision rather than electricity generation, since high-temperature geothermal energy deposits are accessible only in certain regions. Geothermal water at lower temperatures (below 150ºC) can be fed directly into the delivery network, having direct-use applications for district heating, agriculture, industrial processes, and more.

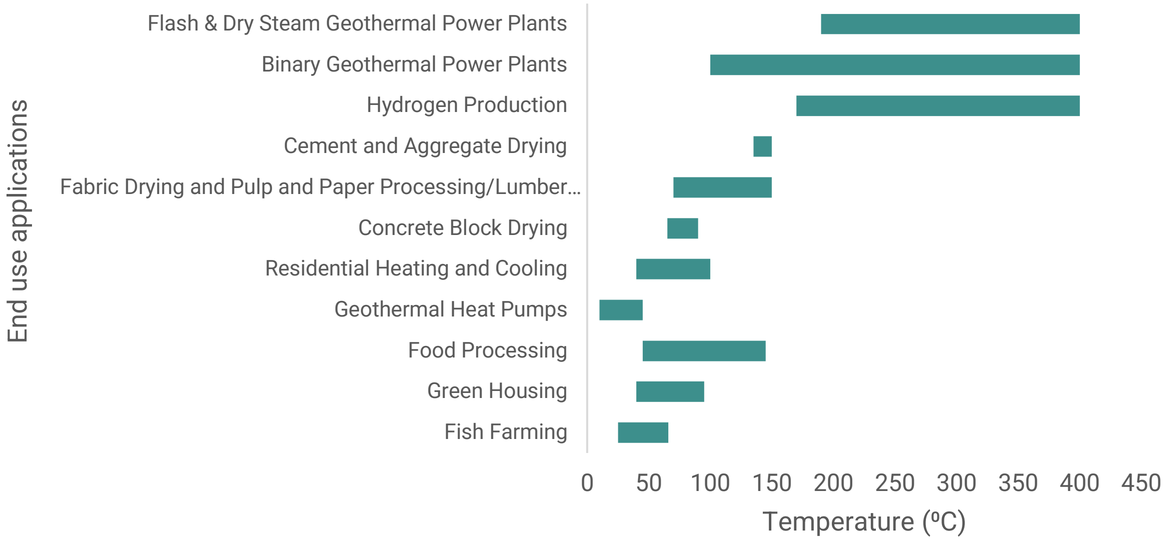

Figure 1. Geothermal resources temperature spectrum and associated end use applications

Source: (U.S. DOE, 2019)

Conventional geothermal energy systems (also known as **hydrothermal systems**) simultaneously require three environmental characteristics (U.S. DOE, 2019) to be viable:

- Subsurface heat

- Subsurface rock permeability
- Groundwater presence at depth

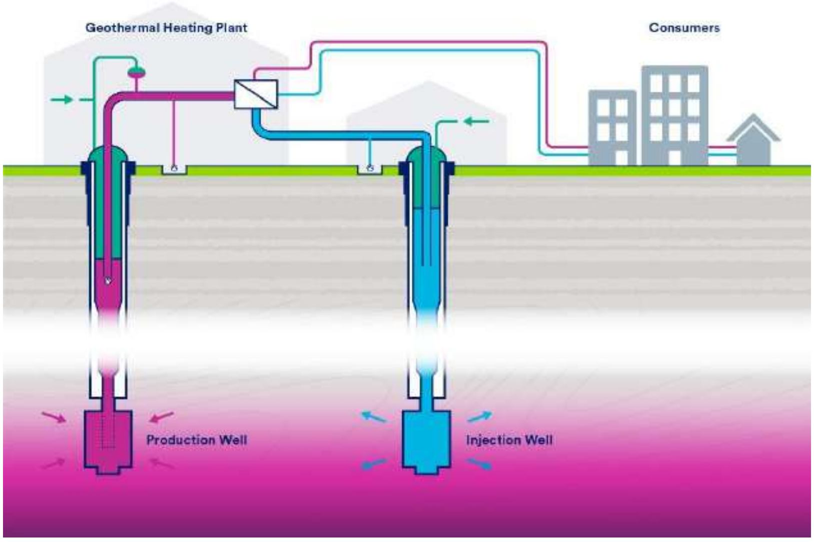

Figure 2. Illustration of conventional geothermal heat production

Source: CATF

2.2. Conventional geothermal electricity generation

Geothermal electricity production, on the other hand, is receiving growing attention across international energy markets seeking reliable, low-carbon sources of power that can complement variable renewable generation. Unlike wind and solar, geothermal power plants provide continuous baseload or flexible dispatchable electricity, making them particularly valuable for system stability, security of supply and price stability. This renewed interest is reflected in new exploration programmes, innovation funding and stronger policy support in both advanced and emerging markets.

In conventional systems, electricity production is typically associated with higher-temperature resources, with binary cycle technologies enabling power generation from fluids of at least 100°C (in highly efficient plants), while flash steam and dry steam plants require temperatures above 180–200°C. As temperatures rise, project economics improve, expanding the range of viable applications from small-scale to large utility-scale geothermal facilities. Continued technological progress, particularly in heat transfer technologies and advanced drilling methods, is expected to further widen the potential for geothermal power generation in Europe.

At temperatures where water is close to the boiling point, electricity production becomes viable, although for most plants water temperatures are around 150ºC in order to compensate for heat losses during extraction. While all geothermal power plants use steam from underground energy to turn a turbine, there are different methods to convert geothermal heat into force.

2.2.1. Surface facility types

There are three widely used technologies for this process:

Dry steam power plants being – the most basic power generation technology, which extracts high temperature geothermal steam and use it to spin a turbine before being condensed and reinjected.

Flash steam power plants – relate to high-temperature geothermal located at depth, where fluids remain in a liquid state because of the high underground pressure. As the fluid rises toward the surface, pressure gradually decreases, causing part of the liquid to rapidly vaporise into steam inside a flash tank. The steam is then directed to a turbine to generate electricity, after which it condenses and the remaining fluid is reinjected into the reservoir to sustain the geothermal resource. This method allows for better pressure regulation, giving the plant operator with more control over the production capacity.

Binary cycle geothermal power plants – is one of the most recent technological developments, enabling power generation from geothermal resources below 150°C, although such cases remain relatively limited. This method involves extraction of high temperature geothermal water, but without evaporation. Instead, the extracted water is fed through a heat exchanger, and then reinjected directly after cooling due to the previous heat transfer, while a second water cycle is used to turn the turbine before cooling and then running through the exchanger again. This allows for the concentration of heat, making geothermal resources with temperatures below 150ºC viable in the right circumstances.

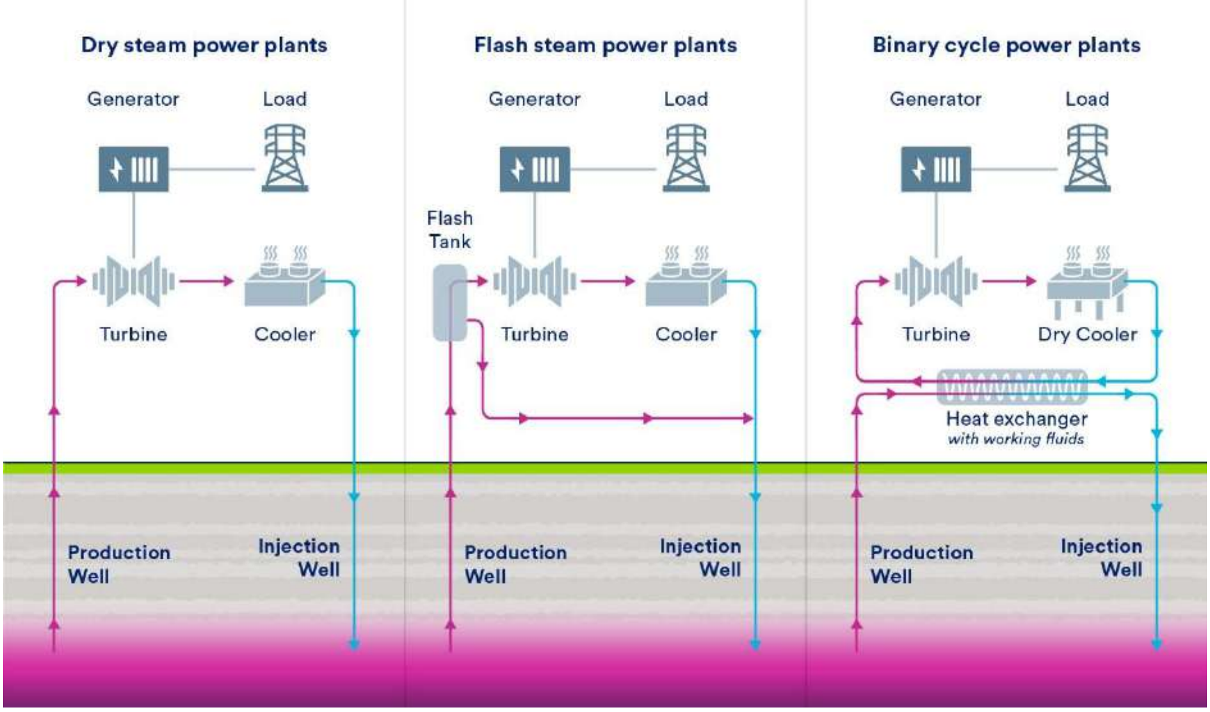

Figure 3. Geothermal power plant configuration: dry steam, flash steam and binary cycle

Source: CATF

2.3. Fundamental dynamics of geothermal energy

Despite the advantages of geothermal energy, it has yet to be scaled to the level of other RES technologies. The average geothermal district heating system in the EU and the US has a generative capacity of about 17 MWth (ETIP Geothermal, 2024), and the average geothermal power plant worldwide is estimated to a range between 30 and 35 MWe (Global Energy Monitor, 2025). However, there is significant data variance, with most of the largest plants being concentrated in just a handful of countries with notably high-quality resources, produced by natural phenomena such as volcanic activity or colocation with fault lines:

Table 1. Largest geothermal electricity plants

Project Name	Location	Generative Capacity, MWe	Date of Commissioning	Source
The Geysers Geothermal Complex	California, United States	725	1960	(Calpine, The Geysers, n.d.)
Larderello Geothermal Complex	Tuscany, Italy	117.6	1913	(Enel Green Power, n.d.)
Cerro Prieto Geothermal Complex	Baja California, Mexico	570	1973	(Envisioning, n.d.)
MakBan Geothermal Facility	Batangas, Philippines	195	1979	(AboitizPower, n.d.)
Sarulla Geothermal Power Plant	North Sumatra, Indonesia	330	2018	(Sarulla Operations ltd., n.d.)
Hellisheiði Power Plant	Hengill, Iceland	303	2006	(Power, n.d.)

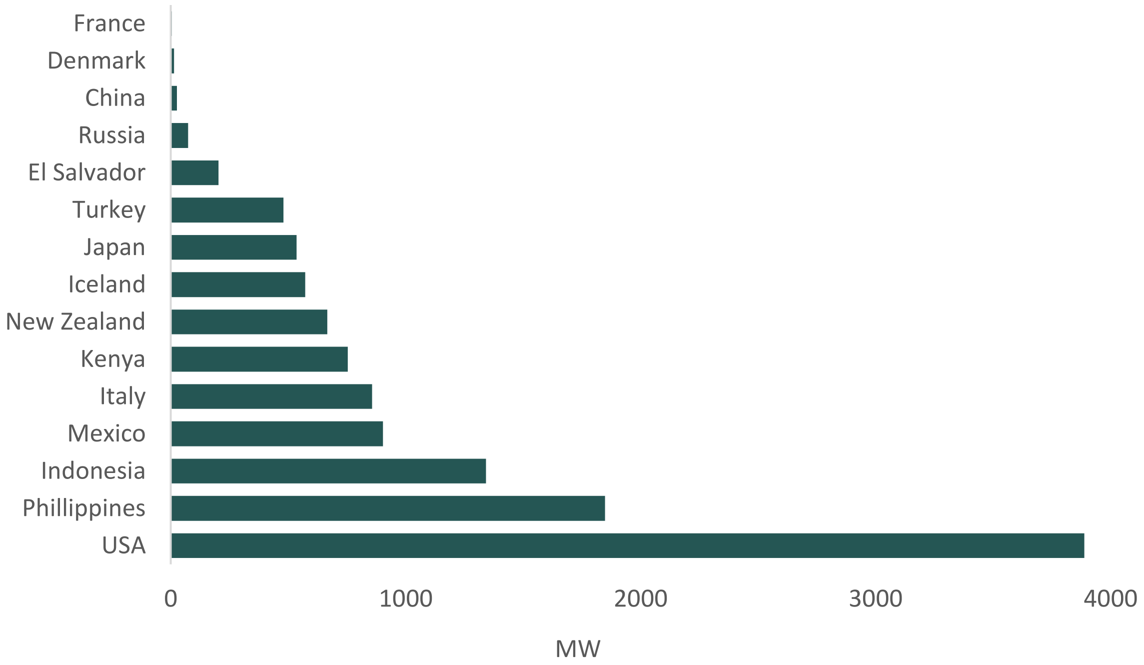

Figure 4. Total size of geothermal power plants in MWe according to country

Source: (WRI, 2025)

For most countries – even those with developed geothermal sectors – the aggregate generative capacity of geothermal power plants is dwarfed by that of geothermal heat production, which itself is small compared to other sources of power. Presently, geothermal energy makes up only 0.8% of global energy demand, despite the universal presence of subsurface heat. We must, therefore, grasp the technical and economic limitations of this technology.

2.3.1. Limitations to geothermal energy availability

High-energy density in geothermal resources. Energy density is relevant for both types of power generation, as it can be a limiting factor on the facility size and render development economically unfeasible. Although there have been recent binary cycle projects that allow the concentration of heat from lower-temperature sources, this is a recent development, of limited adoption. Most geothermal facilities with energy densities high enough to produce electricity are located in countries with particularly favourable environmental characteristics, such as high concentrations of heat at relatively shallow depths (e.g., volcanic activity). Absent high concentrations of heat, geothermal plants have to compensate by extracting water at higher volumes, impacting both the project's CAPEX and the OPEX, due to necessary facility size increases and higher pumping rates.

Location constraints. As previously indicated, conventional geothermal power plants demand the overlap of three environmental characteristics: groundwater, subterranean heat, and permeable subsurface rock structures. Additionally, if a plant is intended for direct-use applications, it is further limited in that it must be situated close to the offtaker in order to avoid excessive heat losses during transport.

High sunk costs and barriers to entry. Geothermal energy also faces risks similar to O&G developments, as there is always the chance that exploration does not yield viable results. Furthermore, the payoff is lower than O&G developments, making the sunk costs incurred during exploration higher relative to the payoff. Besides, geothermal energy suffers from some of the most convoluted permitting processes and longest development timelines among RES technologies, having to undergo both mining and power plant development licensing processes, which causes development to take around seven years on average (ESMAP, 2012), and going up to 20 years on occasion (IEA, 2024).

Early-stage risk. Low-quality information on subsurface geothermal resource creates an asymmetric risk/reward scenario that disincentivises developers from exploration. Drilling exploratory boreholes is one of the most expensive components of the development process from total expenditures – around 15% (World Bank, 2020) of total costs and going as high as 40% in more challenging environments. As map coverage becomes more prevalent and drilling costs subside, geothermal exploitation would certainly expand, but the expected value of the endeavour is still low, with losses being totally unrecoverable absent some form of insurance or risk-sharing, which is both rare and expensive.

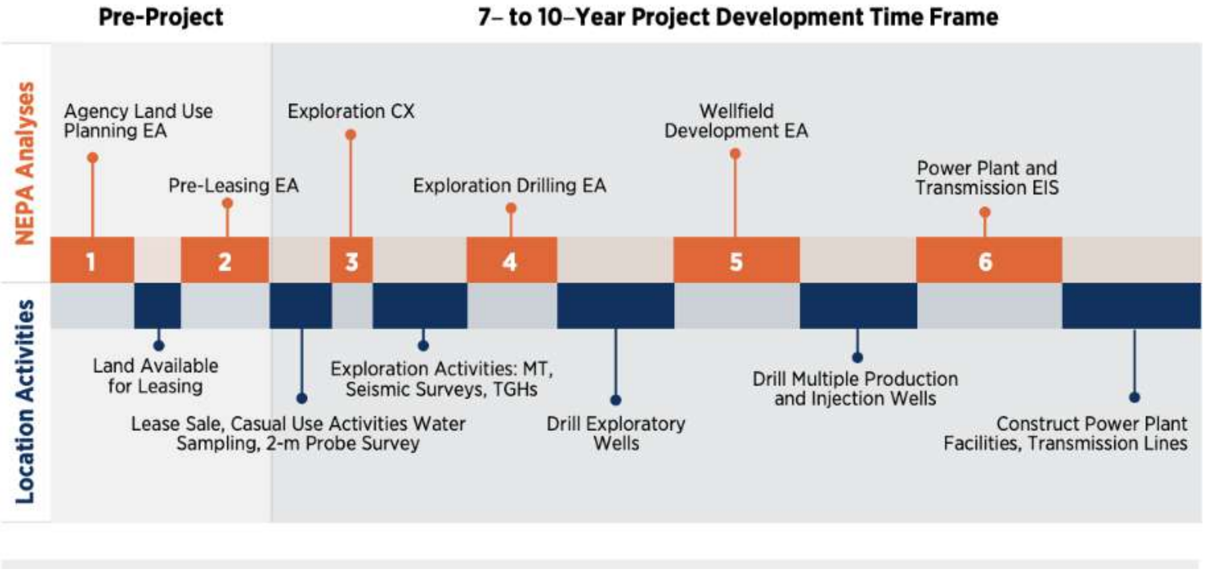

Figure 5. Example timeline of a geothermal project on federal lands, illustrating that a single location could trigger National Environmental Policy Act analysis six separate times

Source: (U.S. DOE, 2019)

Figure 5 presents an indicative development timeline for a geothermal project, pointing out that full implementation may extend over 7-10 years. The figure highlights that geothermal deployment is a multi-stage process which begins well before construction, requiring early land access, leasing procedures, preliminary assessments and exploration planning. It also illustrates the interaction between regulatory approvals and technical activities throughout the project cycle. Key stages include resource exploration, seismic and geological surveys, exploratory drilling, field development, production and injection wells, and the construction of generation facilities and grid connection infrastructure. The timeline indicates that permitting, drilling and infrastructure delivery are determinants of project duration and investment risk.

2.4. Geothermal energy projects distribution in the EU

In Europe, geothermal projects included in the INNERSPACE framework are distributed geographically as illustrated in Figure 6. The spatial pattern shows a strong concentration of projects in more Central and Western rather than CEE. Western Europe also presents relevant clusters, notably in France, the Netherlands, and Northern Italy, with more limited deployment in the Iberian Peninsula and the Nordic regions. This reflects, on one hand, the geological potential and, on the other hand, the levels of national policy support and investment in geothermal energy. Romania is included with projects in the Bucharest area, Râmnicu Vâlcea, and the Western part of the country. However, other than the projects in Oradea and Beiuș, the facilities mainly serve local uses, particularly spa and balneotherapy applications[1].

The clustering of projects highlights areas with established geothermal ecosystems and favourable subsurface conditions, including sedimentary basins and tectonically active zones. For example, the Pannonian Basin and parts of the Upper Rhine Graben stand out as hotspots with dense project activity. In contrast, regions with fewer points indicate either lower resource potential or earlier stages of market development.

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[1] Balneotherapy applications refers to the therapeutic use of mineral and thermal waters for medical treatment, rehabilitation, wellness and preventive healthcare purposes.

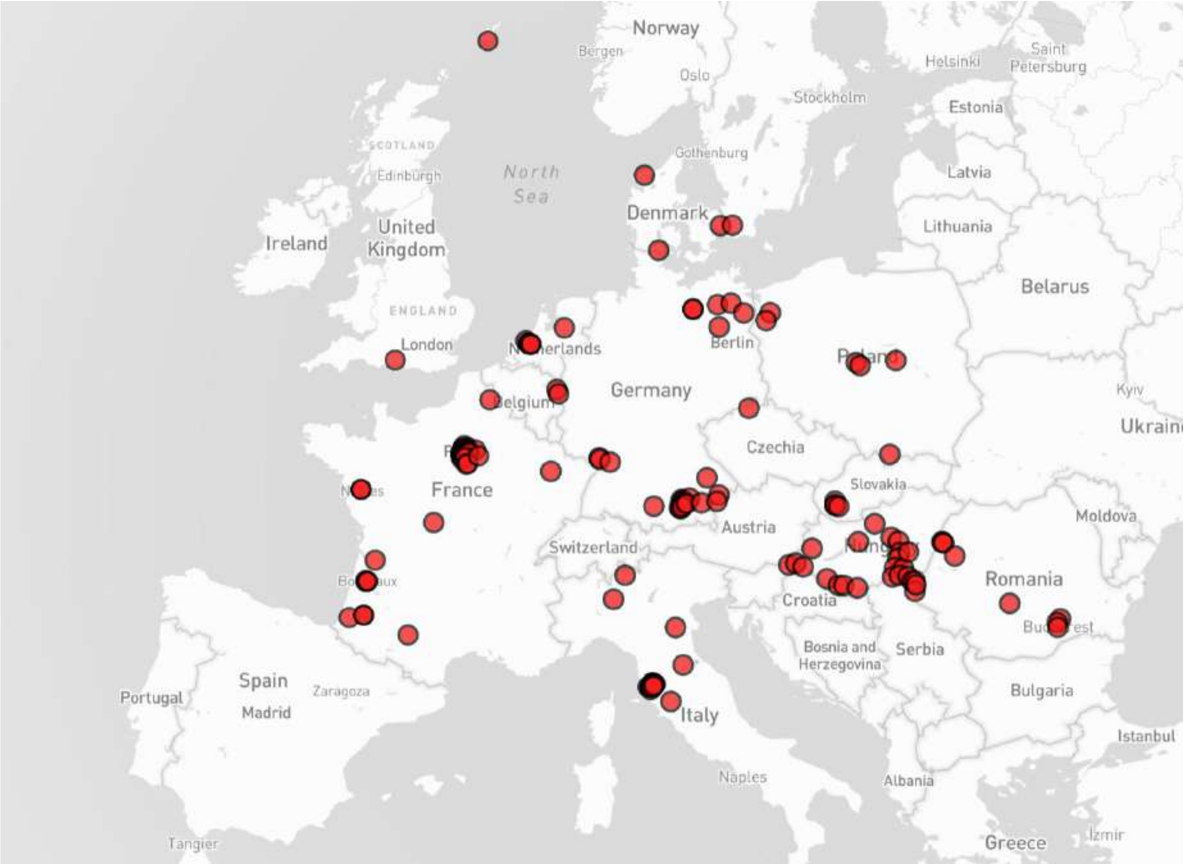

Figure 6. Geographic distribution of existing geothermal projects

Source: (GeoMap, 2026)

An EMBER analysis (EMBER, 2026) shows that around 43 GW of geothermal electricity potential in the EU could be developed by 2050 at costs below those of gas-fired power. The study presents that a significant share of these potential falls below EUR 100/MWh, making it directly competitive with gas generation, whose short-run marginal costs were estimated between EUR 90 and 150/MWh in 2025.

Yet EMBER emphasizes that this cost-competitive potential is not evenly distributed across Europe, with countries such as Hungary and France standing out in terms of volume, while others show more limited but still relevant opportunities. Deployment remains constrained by investment risks, regulatory barriers, and limited market maturity, indicating that targeted policy support is essential. For Romania, the report estimates that around 800 MW of installed capacity could achieve costs below EUR 100/MWh.

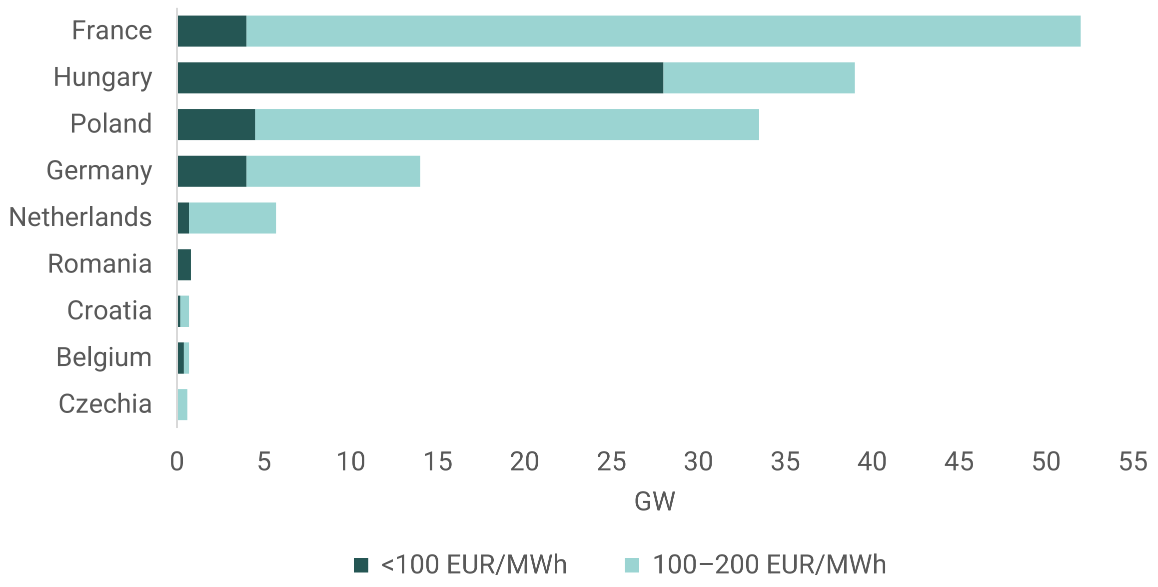

Figure 7. Geothermal potential in the EU at costs below gas-fired generation

Source: EPG processing of EMBER data (EMBER, 2026)

The **geothermal energy barometer** (EurObser-ER, 2025), presented geothermal energy production across the EU in 2024 in terms of primary energy, electricity generation, and heat consumption. Italy clearly dominates the geothermal electricity sector, having by far the highest installed capacity and output, exceeding 5.6 TWh. Germany and France stand out in terms of heat production, driven by extensive district heating networks and direct use. Netherlands, Hungary, and Poland also show strong geothermal heat deployment, reflecting favourable geological conditions and sustained policy support. Overall, the map highlights a dual structure in Europe, with electricity production concentrated in a few countries, and heat use being more geographically widespread.

Romania ranks around 10th in the EU, according to this dataset, with a relatively modest geothermal footprint compared to leading countries. Its geothermal activity consists almost entirely in heat production, with no electricity generation. The existing capacity mainly serves local district heating systems and balneological uses, rather than large-scale energy supply.

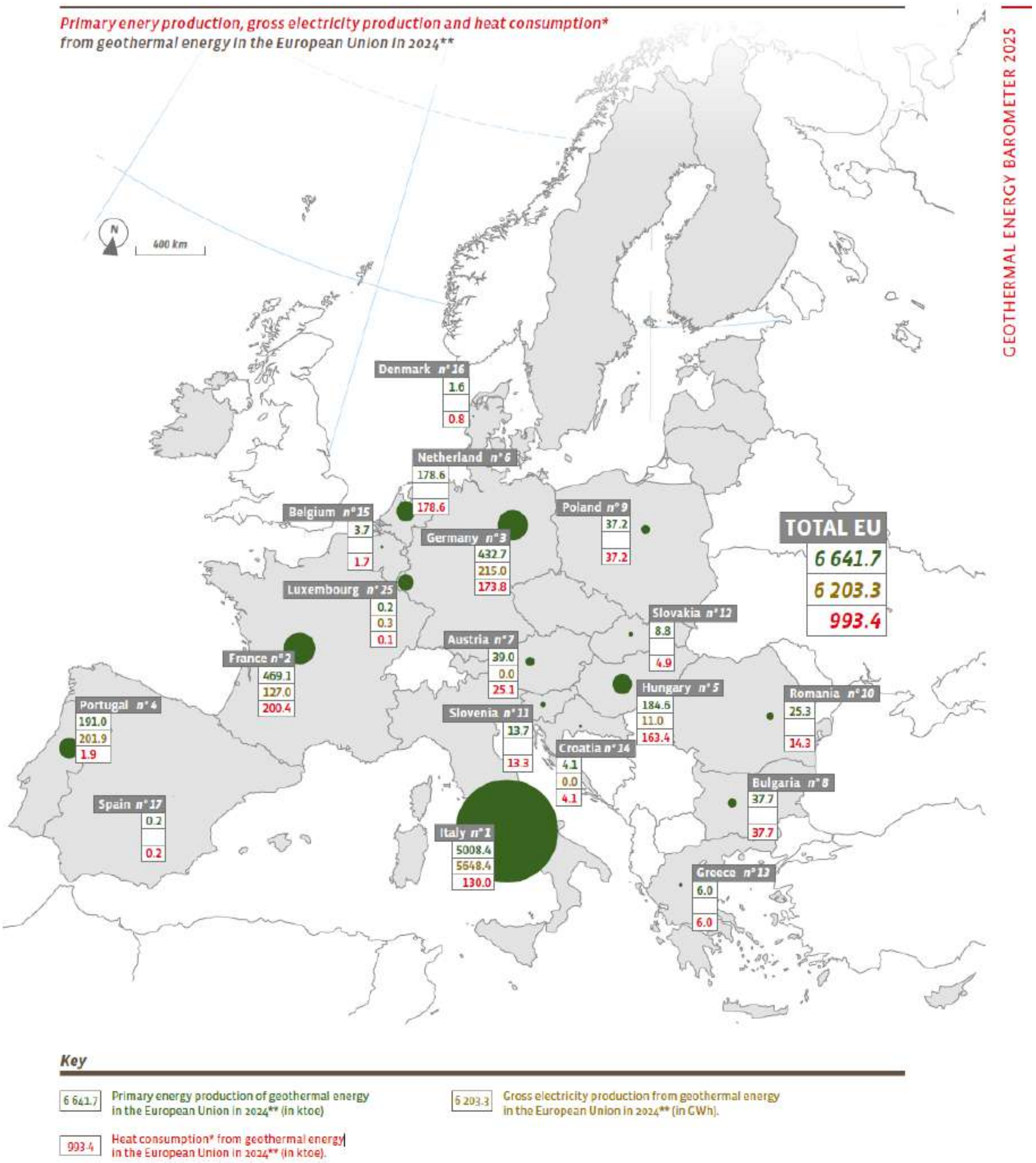

Figure 8. Geothermal energy production and use in the European Union by country, 2024

Source: (EurObser-ER, 2025)

Eurostat data for the 2015-2024 indicate that geothermal heat production in Europe has seen a steady upward trend, more than doubling over the analysed timeframe. This reflects the growing role of geothermal in the decarbonisation of the district heating systems through shallow geothermal applications and heat pumps.

By contrast, geothermal electricity production in the EU registered a slight decline over the same period, which is largely explained by developments in Italy, the EU's main producer of geothermal electricity and host of the majority of geothermal power plants. Even limited variations in the Italian geothermal electricity output significantly influence overall EU-level statistics. No new geothermal power plants were constructed, while the sector began to stagnate due to the ageing of the historic geothermal fields in Tuscany.

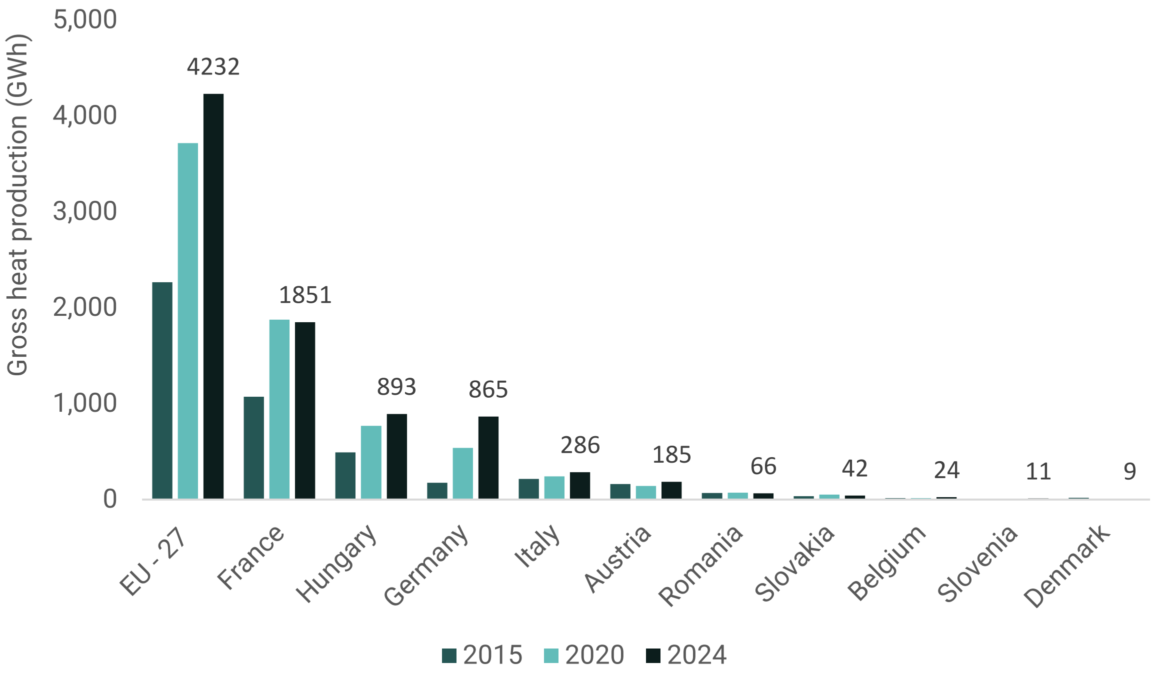

Figure 9. EU gross heat production by countries

Source: EPG, based on Eurostat data

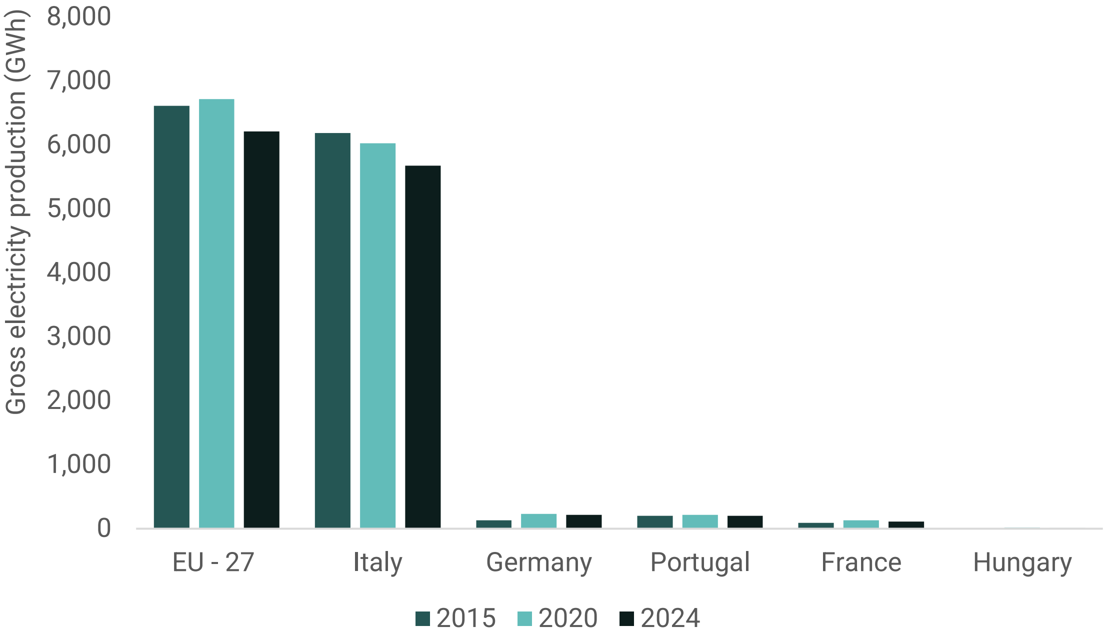

Figure 10. EU gross electricity production by countries

Source: EPG, based on Eurostat data

3. Geothermal technology advancement

One option for policymakers to support the expansion of the geothermal sector is to facilitate the scale-up of next-generation technology, as significant cost reductions are unlikely to occur without wider deployment and market uptake. For power generation, current CAPEX costs for shallow EGS are high; academic studies (Graham et al, 2022) put them- within a range of EUR 7,600 -- 8,500/kW. These are large in comparison to hydrothermal plants, with a global average range around EUR 2,900 – 5,600/kW (JRC, 2024). (JRC, 2024)

Although they are currently expensive, next-gen technologies solve for locational constraints by removing the need for groundwater and porous subterranean rock deposits, allowing vast areas of land to become viable geothermal generation sites. Presently, large offtakers such as Google are among those willing to pay the premium, because they highly value 24/7 power availability. The potential benefits of these technologies are massive, bolstering large investments, both public and private, in R&D projects meant to bring down the cost of development, as exemplified by the USD 1 billion investment in FERVO energy in the U.S. (U.S. DOE, 2024) (Techcrunch, 2025).

3.1. Enhanced Geothermal Systems (EGS) and Advanced Geothermal Systems (AGS)

Next-generation geothermal comes in two variations, both relying on subterranean heat for power generation:

EGS, which involves drilling two boreholes, followed by the injection of a hydraulic fluid into the subsurface rock to create cracks and fissures. As the network of fissures grows, a critical level of interconnectivity is reached whereupon a circuit is formed from the point of injection to the point of extraction (U.S. DOE, 2019). Water is subsequently pumped through the fissure network, where its temperature is increased by the ambient heat of the subsurface rock formation, and then extracted for application.

AGS/CLGS (Closed-Loop Geothermal Systems), which involves repeated drilling of two boreholes that take a horizontal turn at depth before meeting, forming an underground network of pathways for water to flow through (U.S. DOE, 2019). Functioning on the same principle as EGS, AGS developers create an artificial closed-loop circuit through which water is run, heated, and extracted at high temperature to be applied in electricity generation or heat provision. The difference lies in how the underground heating network is created.

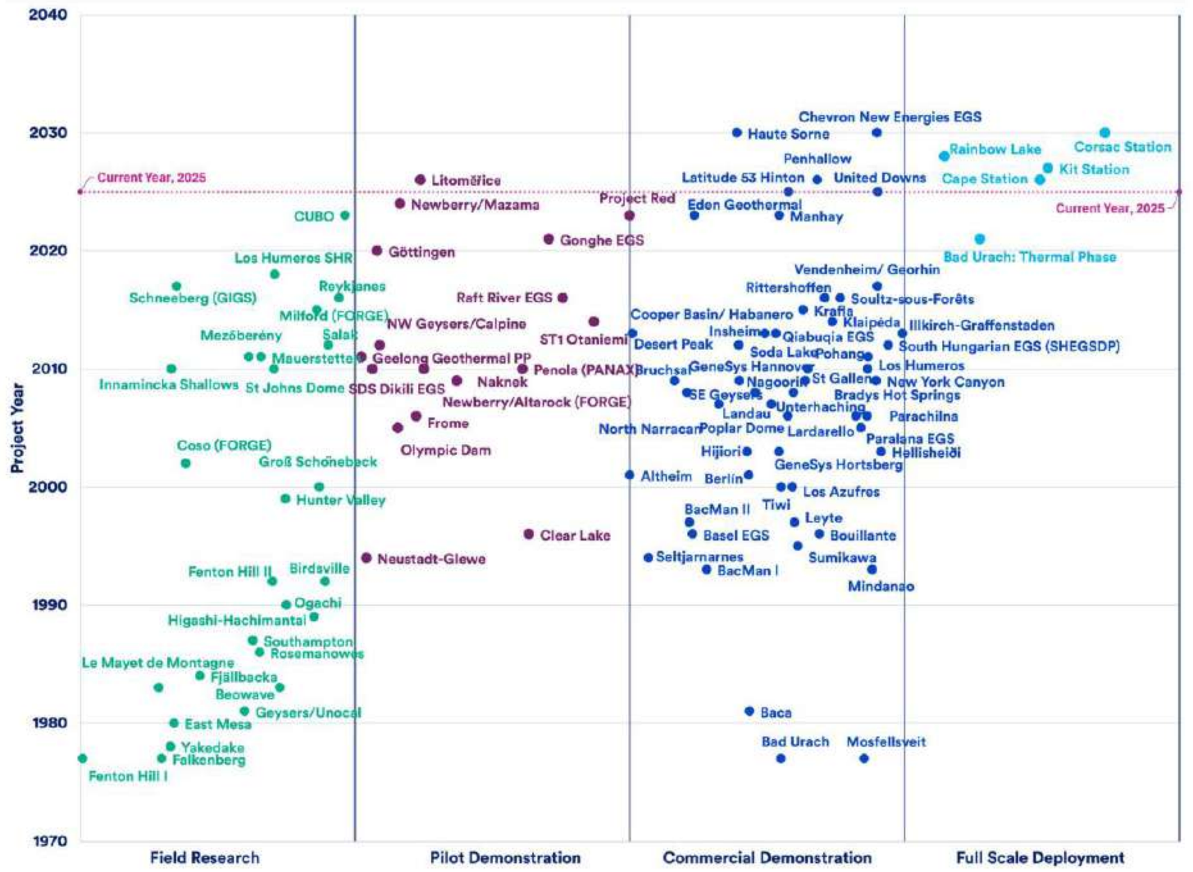

Figure 11. EGS projects by year, stated purpose, and commercial achievement

Source: (CATF, 2025).

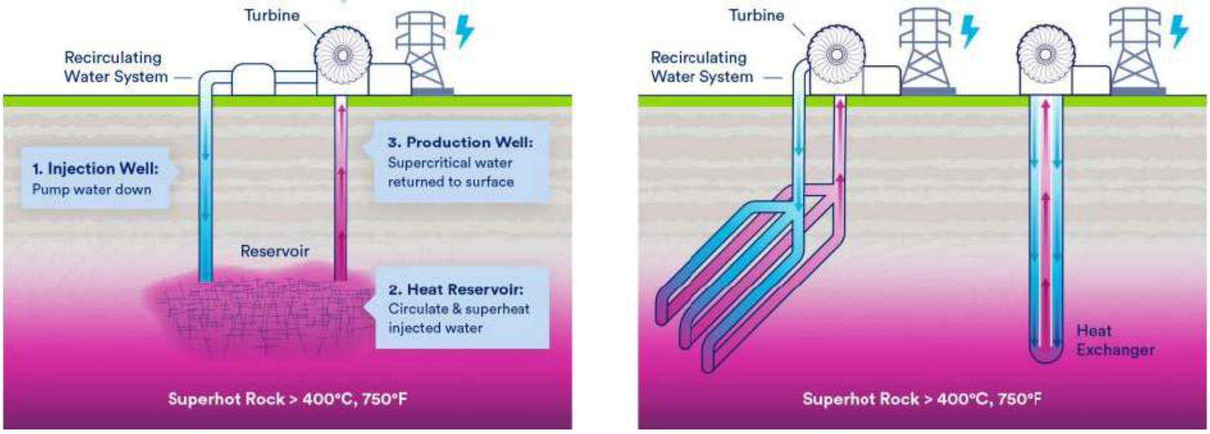

Figure 12. Illustrative design of open-loop (EGS) and closed-loop (AGS) technologies

Source: (CATF, 2025)

Most of the development costs for EGS and AGS come from the need for deeper drilling compared to conventional geothermal energy, rather than from reservoir formation itself. This is needed to access significantly higher levels of underground temperatures. Still, the costs of both technologies have steadily gone down as testing has progressed. This is especially visible in EGS technologies, which have been under development for 50 years and are now nearing commercial viability (CATF, 2025).

Excluding cost reductions, other advances that next-generation R&D need to yield are reduction of seismic risk, improvement of horizontal drilling at depth for EGS and AGS, and increasing public awareness.

Apart from the aforementioned FERVO project, multiple examples of test beds can be found throughout North America and Europe. These can be broken down into commercial and technological test beds, with the former working towards lowering investment costs through scaling the findings of the technological test beds, and the latter developing improvements to the technology without having to maintain profitability, typically at a smaller scale.

R&D efforts mostly concentrate on improving the processes used to make the underground circuits and drilling cost reductions. Drilling, which already constitutes up to 50% of total project costs (NREL, 2022), is a major source of expenses in the development of next-generation geothermal energy due to higher drilling depths, reaching up to 75% of project costs in some scenarios.

Although large-scale commercial deployment of EGS or AGS technologies remains limited, numerous pilots, demonstrations and early commercial projects have been developed worldwide since the 1970s. Examples of some of the most recent and well-known are listed in Table 2.

Table 2. Next-generation geothermal energy projects

Project Type	Name	Installed Capacity, MW	Date of commissioning	Source
Commercial projects and test beds (EGS)	Fervo Energy - Project Red (Nevada, USA)	3.5	2023	(Canary Media, 2023)
	DOE/Ormat Brady Field EGS demo (Nevada, USA)	1.7	2002	(POWER Magazine, 2013)
	Soults-sous-forets (Strasbourg, France)	1.7	2016	(MDPI (Geosciences), 2021)
Technology test beds (EGS)	DOE/Ormat - Desert peak EGS (Nevada, USA)	26	2013	(POWER Magazine, 2013)

Project Type	Name	Installed Capacity, MW	Date of commissioning	Source
Commercial test beds (AGS/CLGS)	Eavor Europe (Bavaria, Germany)	8.2 MWe, 64 MWth	2025	(POWER Magazine, 2026)
	Coso Greenloop (California, USA)	1	2019	(California Energy Commission, 2020)
Technology test beds (AGS/CLGS)	Eavor Lite (Alberta, Canada)	N/A	2019	(ThinkGeoEnergy, 2024)
Dedicated laboratories	Utah FORGE (Utah, USA)	N/A	2015	(Elsevier, 2024)
	Bendretto underground laboratory (Ticino, Switzerland)	N/A	2019	(ETH Zurich, 2025)

The Eavor project in Bavaria, Germany, stands out as the most advanced example of AGS technology. It began supplying electricity to the grid in late 2025, bring the first commercial application of closed-loop geothermal technology in Europe. The system extracts heat directly from deep rock formations without relying on geothermal fluids, using engineered subsurface loops. It reaches depths of around 4,500 m and is designed for about 8.2 MW electricity and 64 MW heat. Although not a superhot rock system (SHR), the project is highly relevant for SHR development, as it shows that heat from deep rock formations can be harnessed through engineered geothermal solutions rather than relying solely on naturally occurring reservoirs.

3.2. SuperHot Rock (SHR) Geothermal

Building on the knowledge that temperatures universally rise with increasing depth, albeit at varying gradients, future development of drilling technology would make even deeper wells economically feasible, opening up access to superhot rock energy. At temperatures above 374ºC (≥374°C in brines), water takes a supercritical state, where it retains the properties of both a fluid and a gas and carries substantially more energy. These heat deposits can be found at varying depths, ranging from 2 km to more than 10 km, with future innovation necessary to make this resource available in more places throughout the world.

Access to superhot rock energy greatly improves the commercial feasibility of electricity generation through geothermal energy, due to the high energy content. Another important application for SHR is in CHP generation, which would allow further maximisation of the utility provided by the high energy content of heater water. While SHR is yet to become a widely utilised resource, significant testing has been conducted, with eight notable R&D projects running across multiple continents (CATF, 2022). Additionally, SHR can be utilised using EGS and AGS technologies, with an R&D project intended to demonstrate dry SHR feasibility scheduled for the near future.

The Iceland Deep Drilling Project (IDDP) is one of the more advanced research initiatives aimed at unlocking SHR energy. The project focuses on drilling to extreme depths to reach temperatures above 374°C – and has actually reached temperatures of 426°C, although the waters were deemed unusable. The project has progressed to its third stage, IDDP-3. Additional field and program efforts include initiatives in New Zealand, Japan, Iceland (IDDP-3/SHiFT), Italy, and the U.S., reflecting growing global momentum toward SHR demonstration.

Table 3. Notable research, testing, and demonstration sites

Name	Commissioning date	Source
Iceland Deep Drilling Project (IDDP-2), (Reykjanes, Iceland)	2017	(Friðleifsson et al., 2020)
Iceland Deep Drilling Project (IDDP-3), (Hengill, Iceland)	Expected: 2026	(Orkuveitan, 2026)
JSCGP (Candidate areas: Kakkonda-Tohoku-Kyushu, Japan)	Expected: early 2030s	(Asanuma, 2022)
DESCRAMBLE (Larderello, Italy)	2018	(European Commission/CORDIS, 2023)
Quaise Project Obsidian (Oregon, USA)	Expected: 2030	(Quaise Energy, 2026)
Mazama/Newberry SHR EGS (Oregon, USA)	Expected: 2026	(U.S. DOE, 2025)
GeoShot (Taupo, NZ)	Expected: post 2030	(Kānoa , 2026)

4. CEE overview of geothermal energy

Several CEE countries have incorporated geothermal energy into their national energy and climate plans. Among those Member States, the presence or absence of a dedicated strategy does not appear to follow resource endowment, as evinced by Poland. What does emerge as a pattern is that countries with more developed geothermal sectors exhibit more precise and ambitious goals defined within their NECPs.

Romania's NECP coverage of geothermal energy (European Commission, 2024). Although Romania currently has 150 MW of installed geothermal capacity, the NECP does not outline any specific plan for the sector. The NECP offers conflicting projections of geothermal energy consumption and production as a share of total RES.

While some significant geothermal projects in Romania have received public finance, such as the geothermal district heating system in Oradea, this was not the result of a dedicated geothermal energy strategy, but rather a local initiative using EFTA-derived funding sources. Nonetheless, the plan acknowledges the potential of geothermal energy for both heat and electricity generation, but requires more specific definitions of future policy interventions, be they regulatory reforms or financing packages.

Bulgaria's NECP coverage of geothermal energy (European Commission, 2024). Geothermal energy is frequently listed in tandem with heat pumps. Bulgaria makes no mention of the potential for geothermal electricity generation in its NECP, listing only its potential for heat generation via district heating systems, which indicates a predisposition towards shallow geothermal energy.

Beyond district heating, the NECP also associates geothermal energy with building decarbonisation, renewable heating and cooling targets, and the wider deployment of heat pump solutions in the residential and public sectors. In this respect, geothermal features more as a supporting technology for the decarbonisation of heat supply than as a standalone strategic pillar with dedicated capacity targets, financing instruments or a roadmap for electricity generation. The overall framing recognises the geothermal's potential, but only in general policy terms.

Hungary's NECP coverage of geothermal energy (European Commission, 2024). Hungary is seated on a portion of the earth's crust that is half the average thickness compared to the rest of Europe (22-26km), with a heat flow gradient that is 2-2.5x higher than the global average (50-80^{0}C/1km). Geothermal heat already represents 6.5% of renewable sources of heat, with the government planning a doubling of capacity through state support schemes, such as the Hungarian Earth Heat Concept (Ministry of Energy, 2024).

The main applications of geothermal energy are in district heating systems, shallow geothermal heat pumps, and geothermal electricity generation, with total heat and electricity generation foreseen double. The city of Szeged illustrates geothermal energy integration into a local district heating and cooling system, with an investment of EUR 70 million allowing the DH system to halve its GHG emissions.

Poland's NECP coverage of geothermal energy (European Commission, 2024). While detailed mention of targets for geothermal heat and power is not explicit in Poland's NECP, electricity generation, integration in district heating and cooling systems, and shallow geothermal heat pumps are cited as viable technological means to increase Poland's RES share of final energy consumption from 26% to 32.1% by 2030.

Poland has instated a geothermal energy support scheme, *Poland Geotermia Plus* (National Fund for Environmental Protection and Water Management, 2019), with a total funding commitment of EUR 167,58 million by 2028, divided equally between grants and loans, exclusively available for the construction or modernisation of geothermal generators (heat and electricity).

The conspicuous absence of attention paid to geothermal energy in the NECPs of Bulgaria and Romania is likely attributable to the low maturity of the technology in these countries. Historical uses of geothermal energy were limited mostly to spa towns where geothermal resources are accessible at the surface, and also because the density of these resources is lower than their neighbours' geothermal. Furthermore, the historic uses of alternative fuels, compounded by the milder climates of these countries, made the development of geothermal projects historically less necessary.

4.1. Geothermal in national policy frameworks – beyond the NECP

To address the NECP targets, Poland and Hungary have both put in place geothermal energy strategies which provide useful examples of how the sectoral objectives set in NECPs can be operationalised by addressing the obstacles identified in the EU Parliament and Council's calls to action for a geothermal energy strategy.

Hungary's geothermal energy strategy (Energiaügyi Minisztérium, 2024) targets an increase in geothermal's share of heat production from 6.5% (1.7 TWh) in 2022 to 12% (3.3 TWh) in 2030. A principle of the strategy is cascading heat utilisation by connecting uses in agriculture, industry, and residential heating (individual and centralized) to the same generator, with the goal of expanding the market and reducing waste heat.

Geothermal water typically undergoes a reduction in temperature when used. Therefore, passing the same unit of fluid through multiple offtakers could allow for far higher use efficiency in terms of kWth/m^3 and a far higher rate of return per m^3. A key obstacle to geothermal power generation identified by the strategy is the high geological risk (>60%) involved in development, which is equivalent to the rate of failure of exploration/development due to the non-viability of the resource due to absence or the unsuitability of subsurface conditions.

The proposed measures involve a synthesis of market expansion and development risk reduction: the expansion of cascading usage for existing geothermal energy systems over a course of 2 - 4 years, increasing investment in district heating and electricity generation over the course of the next 4 - 6 years, tuning the financial environment to the nature of geothermal investments, increasing state support for new geothermal applications, and expanding research and data collection on geothermal resource.

In accordance with these objectives, the Hungarian government established financing sources for the expansion of geothermal energy for the areas of high geological risk, geothermal developments with cascading use, a scheme of grants and loans for geothermal energy, and investments in municipal district heating systems totalling EUR 422 million (2026 exchange rates), with a 2026 allocation of about EUR 95 million.

Poland's geothermal energy strategy (Ministerstwo Klimatu i Środowiska, 2021) was a response to the objectives set in its NECP, with the purpose of offering a practical roadmap for meeting the geothermal energy targets. The strategy does not prescribe goals for energy consumption or production shares, being rather a development plan for the technology. By and large, it can be broken down into two areas:

- **Technology and applications,** consisting of improvements to EGS technology, deep borehole heat exchangers, and underground thermal energy storage. Added to this is an expansion of applications for shallow geothermal energy (through heat pumps, waste heat, mine heat, etc.), high-temperature (above 100ºC) and low-temperature (+/-45ºC) geothermal heat.
- **Risk management and scaling.** Like the Hungarian geothermal strategy, the Polish one foresees the expansion of research and data collection on geothermal resources, combined with multiple risk-mitigation schemes that address both long-term and short-term development risks.

4.1.1. Geothermal energy projects in CEE

Podhale geothermal district heating system (Poland): With a capacity of 94.8 MWth, the Podhale region's geothermal plant is Poland's largest. It delivers heat to approximately 2,000 buildings, dispersed across a DH network of pipes that is about 75 km long, primarily within the city of Zakopane. Geothermal water is extracted through five wells, built sequentially over the project's lifetime between 1981-2013. Financing for the plant was sourced largely through multilateral and development financing institutions such as the World Bank, EU funds, the US Agency for International Development, local administrative funding, and private investors, with an even split between grants/subsidies and standard loans. Besides, the development of a 7 km-deep research well began in 2023 (GeoDH, 2015) (European Geothermal Congress, 2025).

Szeged geothermal district heating system (Hungary) previously ran entirely on gas. The displacement of gas generation with geothermal energy allowed the conversion of 50% of the district heat to renewable sources, as well as a 60% reduction in GHG emissions. The district heating network covers 215 km of pipes and serves more than 27.000 households and 433 non-residential buildings, i.e. 30% of the city's population. Total costs amounted to EUR 80 million, with 40% of funding sourced from the EU's Regional Development Fund and 60% from private investors. The exact capacity of the geothermal portion of the district heating system in unclear, but the total capacity of the DH systems is 224 MWth (CROWDTHERMAL Project, 2021).

Oradea geothermal district heating system (Romania). The geothermal generation capacity of Oradea's DH system is 18 MWth, built with an investment of EUR 19 million and covering about 15% of the energy consumed by the municipality. The system utilises two injection and two reinjection wells that reach a depth of about 2,800 meters. This capacity could power 6,000 apartments if it were a standalone system. The financing for the project came primarily from EU funding, which provided EUR 15 million, with the rest derived from local/national sources, with energy production costs at EUR 30/MWh in 2026 (ThinkGeoEnergy, 2025) (Consiliul Local al Municipiului Oradea, 2022).

Septemvri-Varvara district heating network (Bulgaria) was installed in 2025, with foreseen future extensions. The village has a population of about 8,000 residents and contains the country's largest geothermal energy distribution system, serviced by about 18.7 km of pipes and having a capacity of about 3.6 MWth. Other geothermal residential heating systems exist, but are limited to ground-source heat pumps, with deep geothermal energy being hardly used outside of spa towns (Netherlands Agricultural Network, 2024), (Thermaflex, 2025).

4.2. Geothermal in the more developed Germany and Italy

Analysis of other EU Member States with more developed geothermal energy infrastructures suggests a consistent pattern that wherever geothermal energy is easily accessible and applicable, policy and sector development tend to follow. Italy and Germany, two of Europe's most developed geothermal markets, serve as the reference cases.

Both countries are considerably more decentralised than the CEE Member States, meaning that regional and local initiatives often complement national strategies, especially in areas of high resources. The policies presented below are illustrative rather than exhaustive, as a fuller picture would require examining the sub-national level, too.

Germany's coverage of geothermal in its NECP is relatively sparse, addressing it only regarding broader renewable energy consumption targets (Federal Ministry for Economic Affairs and Climate Action, 2024). The treatment differs by end use. For electricity, the NECP projects a decline in geothermal energy's share of total renewable energy consumption from 0.1% to less than 0.05%, which likely reflects higher growth of other renewables.

For heat, Germany's NECP envisions an increase in consumption for "other renewable energies" (a category that includes solar thermal, ambient heat, renewable district heating, and geothermal) from 5.2% in 2024 to 26.6% by 2050 which, if growth is distributed proportionally across technologies, implies more than a fivefold increase in final consumption of geothermal heat. Figures on geothermal heat consumption in Germany produced by the IEA (IEA, 2025) suggest that it makes up a majority of the "other renewable energies" category, with shares of total heat consumption coming from geothermal energy and solar thermal energy at 5.916 TWh (5.8%) and about 100 GWh, respectively.

Italy's coverage of geothermal energy in its NECP is far more extensive and forward looking than almost any other EU country (European Commission, 2024). It envisions a growth in geothermal electricity and heat production from 5.9 TWh to 7.5 TWh (electricity) and 1.44 TWh to 2.42 TWh (heat), respectively, between 2021 and 2030. Outside of broad objectives for production, the NECP identifies geothermal energy as an area of focus for innovation and development.

Capitalisation of otherwise undervalued resources such as SHR, AGS, and EGS is explicitly mentioned, with reference to Italy's scientific and industrial strength in the sector as important facilitators. The NECP also considers wider sectoral development by placing attention on industrial and skills development, given NZIA's focus on geothermal technology. Funding is also proposed through the Social Climate Fund, in addition to the possibility of providing tax credits to DH systems that implement geothermal technology.

Italy and Germany have both implemented regimes of support for geothermal energy development. Both countries make a distinction between geothermal energy and other mineral resources. In Italy, a separate law provides that while in Germany geothermal energy is still governed by the mining law but with a separate designation and different rules compared to other minerals.

Germany's administrative streamlining scheme for geothermal energy (Deutscher Bundestag, 2025)**.** The draft strategy for the governance of geothermal energy (BT-Drs. 21/1928) envisages simplification of the process of licensing prescribed under the German Federal Mining Act and the German Water Resources Act. (CMS, 2026)This avoids significant financial expenses that would be otherwise incurred by public authorities and private enterprises. The estimated aggregate compliance costs reductions for businesses fall into two categories: (1) those arising strictly from compliance and taxes, fees, and other forms of payments, and (2) those arising from bureaucratic obligations (time spent waiting for responses from authorities). Reductions in administrative costs are also noted.

These savings result from the following modifications:

- According to the mining law, mining authorities can consider that other authorities involved in the licensing procedure accede to issuance if they have not responded to a request within two months; the requirement of an operating plan can be waived if the development project is considered low risk; the responsibility of overview for operating plans is centralised under the mining authority; the frequency requirement for the submission of an operating plan is reduced; operators are allowed to close public insurance; a single point of contact is set for the approval of construction of heat storage facilities; a four-week deadline is set for authorities to demand an operating plan for drilling for shallow geothermal projects; the registration procedure is digitalised.
- According to the water resources law, permits granted for the construction of geothermal energy storage shall be equated under the water resources management law; authorities responsible for the appointment of project managers no longer have to wait for a request by a higher authority; residential heat pumps drawing on groundwater no longer require permits for groundwater usage; surface-level geothermal energy storage units no longer require water usage permits if they are situated in contact with groundwater.

Italy's geothermal energy support scheme (MASE, 2024) defines and standardises, among other technologies, the geothermal projects which can apply for financial support, which is ensured through an added levy on consumer power bills, equivalent to a feed-in tariff. The reception of financing depends on being relatively advanced in the permitting process, which consists of: a construction and operation license, a definitive estimate regarding connection to the electricity grid, compliance with environmental and performance requirements.

The award of a tariff is based on a competitive tender, whereby each plant submits (within the tariff pool that corresponds to its generative capacity) a request for a tariff which indicates the extent to which they are willing to go below the reference tariff. The offer with the greatest tariff reduction is the winner. The possible final values of received tariffs are:

- **EUR 135/MWh** for plants with generation capacities lower than 1 MW.
- **EUR 99/MWh** for plants with generation capacities between 1 and 20 MW.
- **EUR 85/MWh** for plants with generation capacities of over 20 MW.

Besides, the program offers premiums for plants that fulfil certain criteria:

- **EUR 30/MWh** for plants with the capacity for total reinjection of geothermal fluids into the original rock formations.
- **EUR 15/MWh** for plants with the capacity to remove 95% of the H_2S and Hg contents.
- Up to **EUR 200/MWh** for "pilot plants" – to be understood as test beds.

4.2.1. Streamlining permitting processes vs. financial support

The characteristics of geothermal energy development with high upfront capital costs, significant early-stage exploration risk, and technical complexity render certain support schemes more effective than others in addressing the sector's specific financing constraints.

The initiatives taken by Germany and Italy address those aspects of geothermal energy's business model that grow into pain points when placed in their national contexts. Germany's policy reduces CAPEX and complexity, while Italy's reduces risk (though not the risk of early-stage prospection and development), increases the revenues throughout the project's lifetime, and improves the expected value of an exploratory borehole, thereby improving the project's valuation.

Italy is known for having some of the highest quality geothermal resources in Europe, and a deep knowledge of geothermal development for both heat and electricity generation. The fact that the sector is highly developed allows it to use an offtake insurance mechanism.

On the other hand, the German policy initiative is more of a response to the needs of companies to navigate the country's administrative divisions, as the policy lowers the pressure on local authorities and centralizes responsibilities under the federal government.

5. Scale-up potential for geothermal in Romania

In spite of a long history, Romania’s geothermal remains small. Only 0.02% of Romania’s energy mix originates from geothermal (IEA, 2023), with applications of geothermal energy largely recreational. Currently, non-recreational geothermal energy production is limited to district heating systems. Aside of that, about 80% of the 220 wells drilled since 1965 are artisanal wells, for personal or communal usage (INEA, 2017). These boreholes are often used either for recreational purposes or to provide space heating to an individual residence. Both district heating and artisanal wells can be found in and around the Western regions of Romania or spa towns in the Carpathian Mountains.

5.1. Geothermal energy resources in Romania

Romania's highest-quality geothermal resources are concentrated in the westernmost regions of the country, with additional occurrences scattered across the Carpathians and in areas east of Bucharest. These geothermal energy deposits have a temperature that generally ranges from 60-120^{0}C measured at 3,000m deep. There are other large deposits of lower-temperature (40-120^{0}C) geothermal resources in the Northern Carpathians and in the south of the country, but these have been exploited to a lesser extent than the others. There are district heating systems operating on geothermal energy in Oradea and Sânmartin, Beiuș and Nădlac (Orașul Nădlac, 2012)

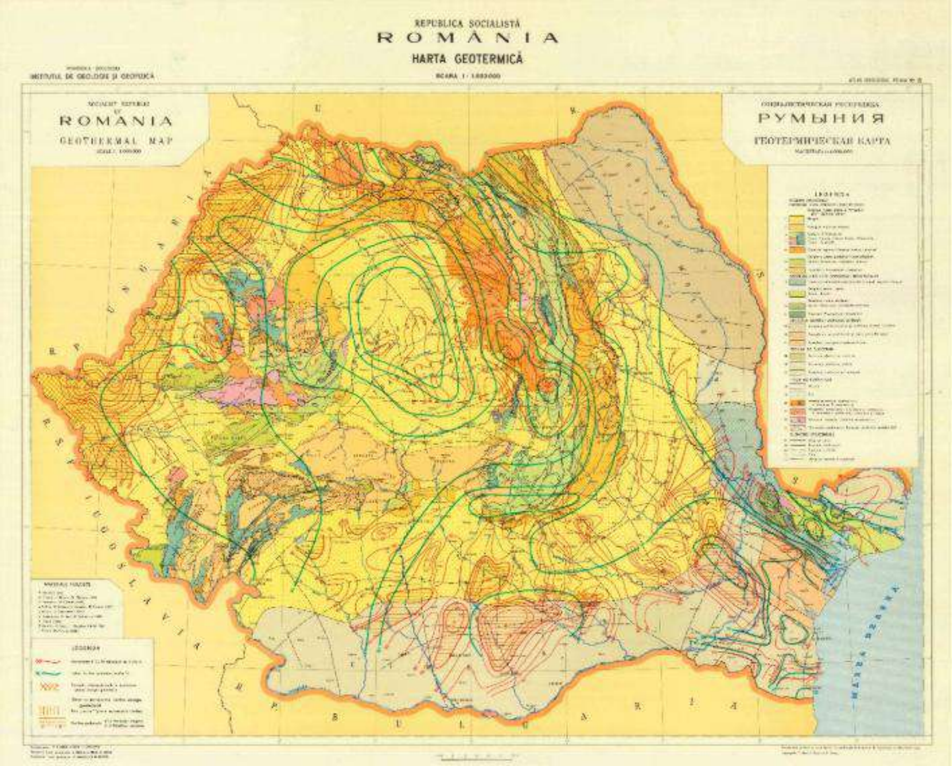

Figure 13. Geothermal structure of Romania, isotherms and high-potential zones

Source: IGR - Geological Atlas of the Socialist Republic of Romania

5.1.1. Geothermal electricity generation potential in Romania

Although there are presently no commercial geothermal power generators in Romania, surveys have identified wide areas in the country where geothermal electricity production could work. This depends on the presence of water at above 140^{0}C which, at depths less than 3,000 m, could only occur in some parts of Western Romania – according to the maps of the Geological Institute of Romania (IGR) maps – or around Băile Tușnad (a spa town in central Romania). As yet, though, no confirmation of commercially viable resources of this type has been made.

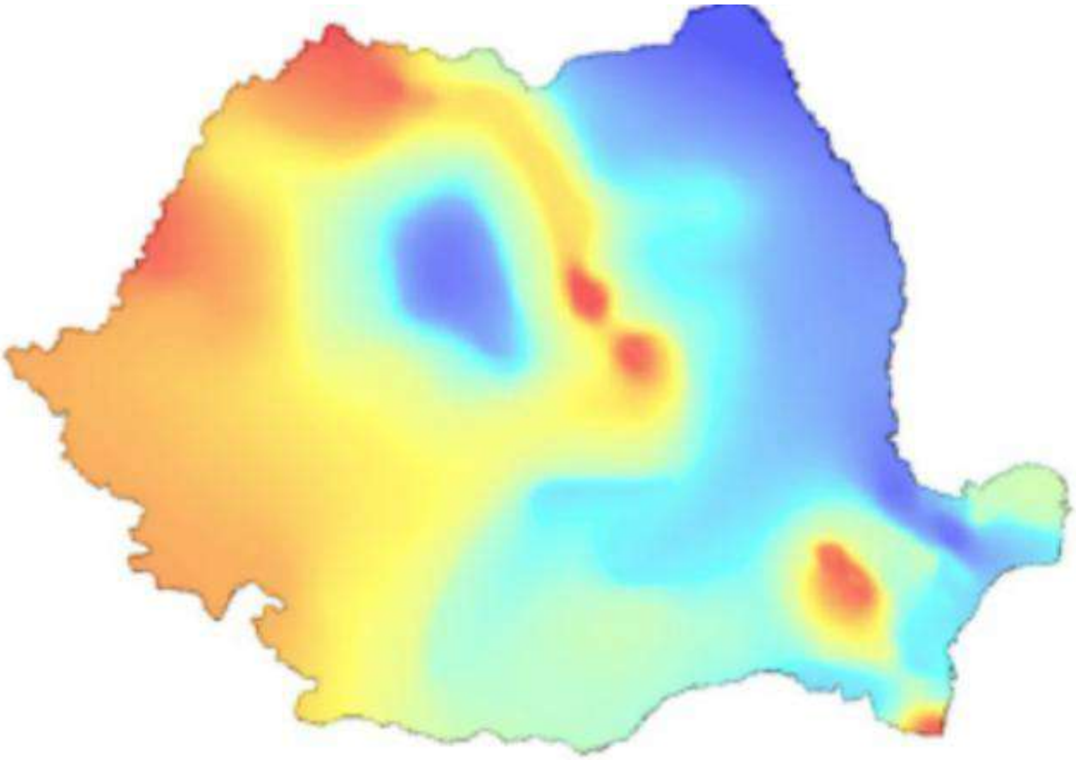

Figure 14. Heat Flow Density Map of Romania

Source: (IGR, 2025)

In a 2025 analysis carried out within the GeoAlliance project by the Faculty of Geology and Geophysics, a series of more updated geothermal maps were presented (University of Bucharest, 2025). According to the authors, these results should be interpreted with caution due to the limitations of the available modelled data. Greater access to data from exploration and exploitation areas would enable the development of results with a higher degree of accuracy.

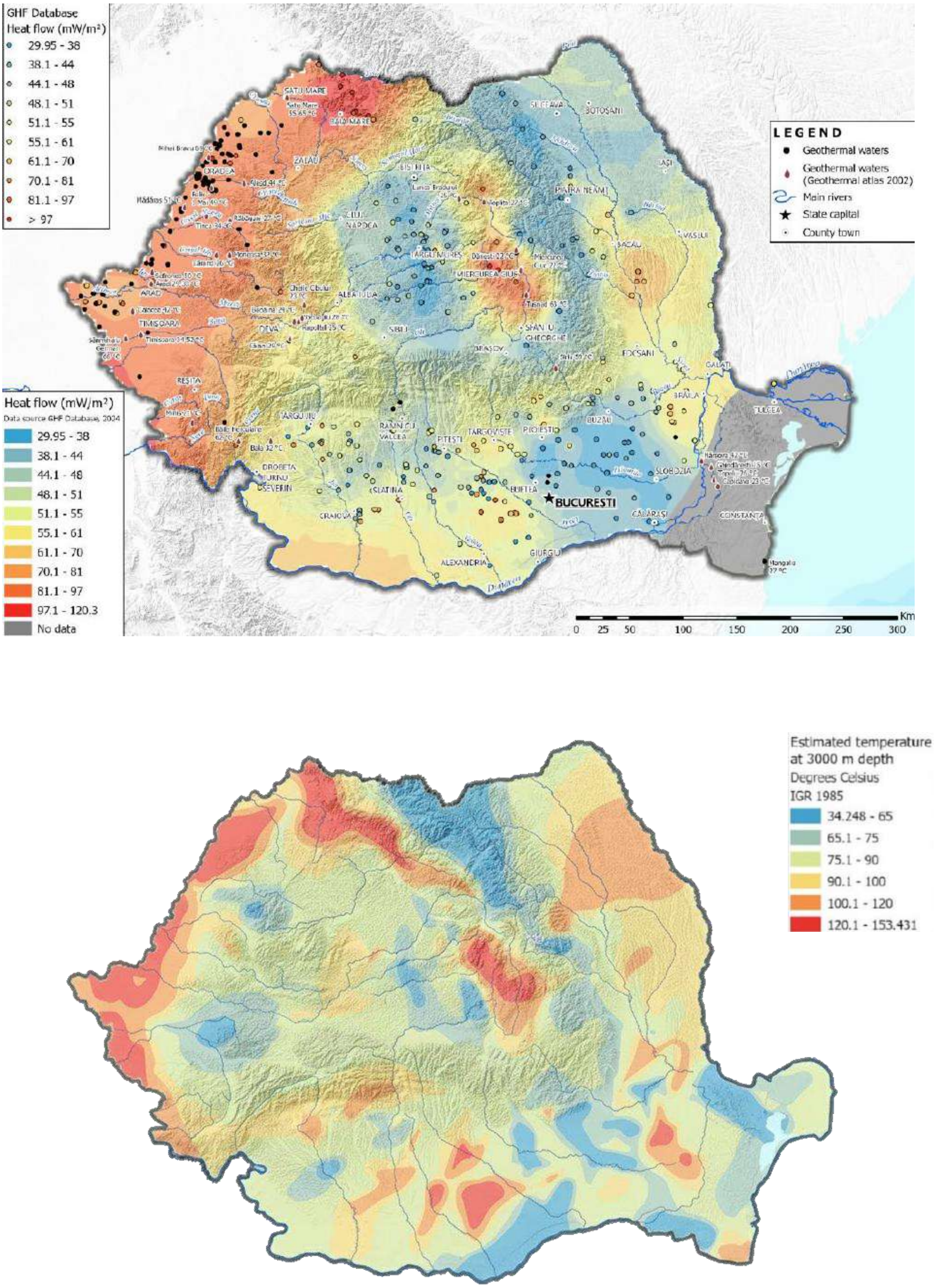

Figure 15. Estimated subsurface temperature at 3000 m depth

Source: (University of Bucharest, 2025)

5.1.2. Geothermal projects in Romania

Most of Romania's producing geothermal wells date from last century. By 2017, only 10 wells had been dug in the preceding decade, of which three were non-producing and two served as reinjection wells for the geothermal energy generation systems in Oradea and Beiuș (Icelandic National Energy Authority, 2017). Wells reach a maximum depth of 3,100 m, with the most productive ones located in the western regions. The commercial applications of the energy yielded by geothermal wells is used mostly for spa and district heating, with the latter achieving notable cost reductions to the systems that have adopted it.

- Oradea's DH system generates about 15% of total heat production using geothermal energy and produces it at about 75% of the cost of other methods of generation in the DH system, according to the system operator.
- Beiuș's DH system generates 100% of its total heat production using geothermal energy. The 2025 price in Beiuș was approximately five times lower than the unsubsidised district heating price per gigacalorie in Bucharest, which owns the largest district heating system and serves half of all consumers nationwide.

The price case for geothermal district heating is clearest in Beiuș, the only system in Romania supplied entirely by geothermal energy. Against a national average consumer price of EUR 58/MWh (ANRE, 2025) excluding VAT and already reflecting municipal subsidies, Beiuș charged EUR 30/MWh, with actual production costs of just EUR 14.22/MWh (Consiliul Local al Municipiului Beiuș, 2024).

Direct comparisons with other Romanian systems are complicated by the fact that most are fossil fuel-based and heavily subsidised, so consumer prices do not reflect true production costs. In Oradea, where geothermal covers a share of a larger mixed system, stakeholder consultations point to meaningful savings as well, though these cannot be precisely quantified. The planned addition of 50 MW of capacity in Oradea nevertheless signals that the economics are considered sound.

5.2. Geothermal funding opportunities

Various sources of funding have been used for the development of geothermal energy in Romania, with the following among the most notable:

Table 4. Dedicated financing vehicles including geothermal energy

Project Name	Emitting Authority	Geographic coverage	Funding Source	Investment Amount	No. Applications
Just Transition Fund: Gorj County allocation (MIPE, 2023)	MIPE	Dolj, Galati, Gorj, Hunedoara, Mures,	Just Transition Fund	EUR 33 million	N/A

Project Name	Emitting Authority	Geographic coverage	Funding Source	Investment Amount	No. Applications
		Prahova counties			
POIM Call: "Supporting investments in power and heat generation capacities based on biomass, biogas and geothermal energy" (MIPE, 2020)	MIPE	National	Large Infrastructure Operation Program (2014-2020)	EUR 124 million	49 – 35 were contracted
PDD Call: "Applicant's Guide for Geothermal Energy – New Projects" (Oportunități UE, 2025)	MIPE	Less developed regions	Sustainable Development Fund	EUR 30 million	28
State aid scheme for geothermal	Ministry of Energy	National	Modernisation Fund	EUR 28 million	The call not yet been launched

6. The role of Oil & Gas in the geothermal sector

The O&G industry currently maintains a sizeable foothold in the geothermal sector. About 15% of global capacity is owned either wholly, partially, or indirectly by O&G companies (IEA, 2025). Other than standalone geothermal energy developers, only integrated utility companies have a larger global market share than the O&G industry.

Important synergies can result through the integration of the two sectors. O&G companies are some of the largest corporations in the world and uniquely positioned to develop geothermal energy. The argument for their market entry is that they would provide the sector with scaled operators, financial profiles and know-how suitable for the development timeline.

This would also allow the O&G sector to act as a market maker for secondary services or other companies that occupy niche segments of the supply chain, such as mapping-only firms, equipment developers, etc. But indeed, the reason why the O&G sector is viewed more favourably than other scaled sectors such as utilities, which can arguably provide similar capital and scale advantages as the O&G sector, is because of their technical expertise. Aside from being able to reduce costs and improve development processes, technical know-how also translates into salient R&D, especially for drilling. This is key to the long-term growth of the geothermal energy sector, and the adoption of its next-generation variants.

6.1. Economic advantages of the O&G industry

A key advantage held by the O&G industry lies in its deep pockets and access to financing. This allows O&G companies to manage the payback profiles of geothermal investments. The exploratory well-drilling phase has an average success rate of ca. 50%, which means that firms need to be able to regularly risk large amounts of capital. In the long term, though, the law of large numbers applies, and margins begin to reflect the expected value of the investments. This is only doable for highly capitalised companies, as the downside of such investments extends beyond financial losses and may threaten the company’s financial stability.

Furthermore, the geothermal energy sector benefits from economies of scale. As more individual plots of land are mapped (subsurface information is aggregated mainly through the submitted findings reports), larger areas can be inferentially assessed for geothermal resource presence. This raises the expected value of the average development within a certain geography, which can be catalysed by the entry of a large O&G company.

6.2. Technical advantages of the O&G industry

Compatibility of technical infrastructure and skills speaks for the entry of the O&G players into the geothermal energy sector. Some reconfigurations would certainly be required, but the barriers to entry for O&G companies are otherwise extremely low. This is both an economic opportunity and an advantageous strategic choice. First, assuming that the geothermal energy sector will further expand, O&G would enjoy a first mover advantage. Second, given the overall reduction of O&G activity on the European continent, the geothermal sector provides a welcome diversification strategy for O&G firms.

Assets such as human capital and machinery can be repurposed towards geothermal energy production relatively easily when they would be otherwise removed from balance sheets, allowing the companies to retain a sound level of performing assets. Certain elements of property, plant, and equipment can have their expected value increase if the O&G companies decide to repurpose them into geothermal production facilities. There have been multiple instances of non-producing boreholes reconverted into viable geothermal wells at little cost.

6.3. Geothermal energy-applicable O&G infrastructure

There are between 50,000 to 60,000 O&G boreholes in Romania (Ecologic, 2025). Many of these have been lost track of, as records were not kept meticulously. Besides, information on hydrocarbon resources is likely to be classified a state secret, and therefore publicly inaccessible. Fortunately, Romanian law states that boreholes of this type become state property once abandoned, meaning that the responsible authorities could re-license and operationalise them without the need for new drilling investment. As mentioned above, such wells have been proven to be convertible to geothermal energy wells under the right subsurface conditions.

Romgaz states that 30% of its onshore boreholes are deeper than 2,000 m, with a current average exploratory well at 2,555 m. Relatively small but constant decommissioning rates add new abandoned wells to the national stock each year (Romgaz, 2025). Even if resource conditions are not optimal for conventional geothermal production, the use of existent boreholes could seriously reduce the cost of next-generation geothermal energy production. Given Romania's average heat gradient of 30ºC/km in depth, next-generation geothermal electricity production could possibly be developed up to 5000 m, with a drilling cost reduction of up to 50% using abandoned boreholes. For the regions with higher heat gradients, the cost reduction could be even larger.

OMV Petrom has positioned geothermal energy as a pillar in its transition toward low-carbon activities. At group level, OMV has already moved beyond pilot discussions and is actively developing large-scale geothermal projects, especially in Austria. The most advanced initiative is the joint venture *deeep* with Wien Energie, which targets up to 200 MW of geothermal capacity and the development of several plants capable of supplying heat to around 200,000 households (OMV, 2024). This model combines upstream O&G expertise, drilling and subsurface analysis, with district heating integration, creating a replicable framework for other markets.

The experience gained in Austria, including drilling campaigns, reservoir identification, and integration into DH systems is directly relevant for Central and Eastern Europe. OMV has expanded geothermal exploration activities beyond Vienna, including seismic campaigns in Styria, confirming its intention to scale this business line. The company aims to build a strong geothermal portfolio, targeting around 1 TWh of geothermal production by 2030, positioning geothermal alongside wind and solar projects in its decarbonisation strategy.

In Romania, OMV Petrom has begun exploring geothermal opportunities, including early-stage discussions on potential projects, e.g. in Timișoara. While no large-scale developments comparable to those in Austria have been announced, the company's strategic direction indicates clear interest in replication. OMV Petrom benefits from strong subsurface expertise, extensive oil and gas data, and an increasing focus on low-carbon investments.

Given Romania's geothermal potential and the presence of district heating systems, particularly in urban areas, the Austrian model could be adapted to local conditions, including heat supply in cities like Timișoara. However, progress depends on improvements to the regulatory and fiscal framework, which currently constrains the deployment of integrated geothermal projects.

6.4. Geothermal energy skills in Romania

Romania's geothermal energy industry employed approximately 300 people in 2023 in either direct or indirect jobs (EurObserv'ER, 2026), which is considerably below the number likely to graduate in all technical degrees related to the geothermal sector. This likely has an effect on the employment decisions of recent graduates, who are aware of the limited demand for workforce in the sector and may opt for other career paths.

Meanwhile, the O&G industry, the likely destination for most technical graduates that studied geothermal energy, employed 24,600 people in 2019 (FPE, 2024) Since the release of these figures, the hydrocarbons industry has expanded, with capacity being committed to the development of the Neptun Deep offshore gas field. Moreover, the higher salaries and career progression offered in the O&G industry makes it more attractive than the geothermal sector. Indeed, most technical experts working in geothermal energy are nearing retirement, without clarity on who will replace them. Incentivising more trained professionals to working in the geothermal energy sector should therefore be a priority for policymakers.

Table 5. Status of geothermal energy skills in Romania

University	Undergraduate degree	No. of enrolled students	University total	Source
Petroleum and Gas Engineering University, Ploiești	Petroleum and Gas engineering	122 (2025)	270	(Facultatea de Ingineria Petrolului și Gazelor, 2025)
	Petroleum and Gas engineering (part-time)	55 (2025)		
	Transport, stocking, and distribution of hydrocarbons	51(2025)		
	Geology of petroleum resources	32 (2025)		

University	Undergraduate degree	No. of enrolled students	University total	Source
University of Bucharest	Geology	31(2024)	116	(Universitatea din București, 2025)
	Geophysics	20 (2024)		
	Geological engineering	65 (2024)		
Babes-Bolyai University, Cluj-Napoca	Geology	41 (2024)	74	(Facultatea de Biologie și Geologie, 2025)
	Geological engineering	33 (2024)		
Al. I. Cuza University, Iași	Geology	8 (2023)	28	(Facultatea de Geografie și Geologie, 2023)
	Geological engineering	20 (2023)		
University of Petroșani	Mine engineering	15 (2025)	77	(Facultatea de Mine, 2025)
	Topography of mining	22 (2025)		
	Mining construction	40 (2025)		

Enrolment figures should not be interpreted as equivalent to the annual number of graduates. Not all enrolled students complete their studies, while graduation rates may vary significantly between programmes and universities. Consequently, the actual number of graduates entering sectors relevant to geothermal energy is likely to be lower than the total enrolment figures presented above

6.5. Lessons from the O&G sector

As indicated, geothermal energy lacks sufficient presence in the national strategies, being largely limited to ad-hoc initiatives, despite mentions as an important source of renewable energy. A coordinated approach to both national and regional development critically requires a classification and standardisation of resources, practices, and infrastructure.

The O&G sector provides examples for the importance of such documents. Take, for example, the Petroleum Resource Management System (Society of Petroleum Engineers, 2018). Through a classification of underground reserves, O&G companies are given a universal framework to assign expected values to their resource holdings, granting managers, auditors, and financiers a universal evaluation language for investments. The geothermal sector already has some resources on which policymakers can build, such as the aforementioned UNFC (UNECE, 2022) classification. Policymakers should not so much focus on the development of new standards and practices, as on ensuring that the existent ones are applied consistently by the local professional ecosystem – and mainly by those responsible for producing, aggregating, and disseminating information on national geothermal resources.

7. Stakeholder consultation – findings

This report was documented with a combination of desktop research and stakeholder consultations, the latter being highly relevant for the findings' depth and reliability. To inform the analysis, stakeholder consultations were conducted, engaging the main actors in the country's geothermal sector: central and regulatory authorities, DH system operators that are primary offtakers of geothermal energy, research institutes and academia, O&G companies, as well as other commercial organisations and independent technical experts.

The stakeholder dialogue consisted in structured interviews covering relevant aspects of geothermal development, tailored to the specific domain of each participant. The questionnaires were semi-standardised, with ministries, regulatory authority, academia and industry stakeholders receiving similar formats adapted to their roles, ensuring both comparability and relevance. The interviews followed predefined themes, yet remained flexible and allowed for deviations whenever certain topics proved more salient or required deeper exploration. This approach enabled the capture of both targeted input and broader stakeholder perspectives, providing a comprehensive understanding of the sector. The findings are presented in the Table 5, reflecting input from eleven stakeholders.

Table 6. Stakeholder interview highlights

Main findings of the 11 interviews
Policy framework
• Romanian authorities demonstrate limited engagement in the geothermal sector compared to other sources of energy
• The administrative responsibility for geothermal energy is fractured among several authorities, causing confusion and contradictions
• Legislation should be modified so that unused O&G ground installations can be repurposed for geothermal energy applications. Current legislation is opaque
• The provision of funding can be constrained by state aid rules
• Local administrations are the primary recipients of financial support for geothermal projects
• Financing can only be provided for technologies the state is familiar with, i.e. conventional geothermal
Challenges for project development
• The lack of centralised information is a major challenge to geothermal energy development (in terms of heat maps)

- Subsurface information held by official bodies should be made publicly available and accessible
- Geothermal project development is complex, leading many potential developers to opt for other opportunities
- Some early-stage (surveying and exploratory borehole drilling) financial risk reduction through policy would be possible, yet not completely
- Geothermal energy applications to electricity generation are limited due to high initial CAPEX
- There are very few companies that can drill boreholes in Romania, and the supply of geothermal-specific equipment is limited
- Gathering micro-level subsurface information is considered too expensive for developers
- Well reinjection is the most important environmental concern for geothermal energy development in Romania
- Seismicity is still a concern

Opportunities for development

- Stakeholders of the geothermal energy sector would be able to make usable maps given existent information is aggregated
- The potential benefits to be gained through collaboration between the geothermal energy sector and the O&G sector are very significant
- Geothermal waters in Romania tend to be extracted at a low temperature even in areas considered to have the best resources
- Next generation geothermal energy is not really familiar to the Romanian geothermal sector
- Romania's geothermal energy resources are better suited for heat production
- Geothermal district heating costs about 75% less than gas district heating
- Labour supply is decreasing

Although useful in providing novel information, stakeholder consultations were nonetheless a mere part of a larger research effort. In this report, information obtained from stakeholder consultations is primarily used is establishing an order of priorities for the identified issues. More specifically, stakeholder consultations have led us to conclude that the three most important challenges facing the development of the geothermal sector in Romania are:

- **The lack of information** on geothermal energy resources. Stakeholders mentioned the need for maps, datasets, and other resources to be used at pre-prefeasibility stages.
- **Limited engagement from public authorities** on geothermal energy. The absence of dedicated legislation and a clear policy framework was consistently identified as a key source of sectoral uncertainty
- **Insufficient incentives for geothermal** energy development to drive sector growth, with uncertainty on permitting and the fiscal regime, regulatory gaps, and the absence of national strategic direction – all adding to project costs and investment risk.

8. Romanian legislation relevant to geothermal power

The development of geothermal power in Romania crosses multiple areas of jurisdiction. The major difference between the development of geothermal power as opposed to other power generators lies in the mining activity necessary for extraction, which poses distinct challenges in terms of economics, licensing, and environmental implications. The licensing process is fractured amongst multiple authorities, whose legal frameworks were designed towards mineral extraction. This creates misalignments between the energy developers' business models and the risk, fees, and development horizons imposed on them. The most important laws to consider are as follows:

Mining Law 85/2003, which sets out the fiscal framework and permits necessary for the extraction of geothermal waters, and the permits required for such facilities.

- It establishes a 5% mining royalty payable to the state for the exploitation of geothermal resources calculated based on the value and volume of extracted geothermal waters. The value of the waters is defined as the marginal cost of production plus a "reasonable allocation" of overhead.
- It establishes permits and licenses needed for extraction boreholes of geothermal waters: prospecting permit, exploration license, exploitation licenses.
- Development may only proceed upon proof of a development plan, a feasibility study, an environmental impact assessment with mitigation commitments, a social impact assessment with mitigation commitments, and a waste management plan.
- Additional conditions are that developers must have no debts towards the state and have set aside money for the impact mitigation actions they shall undertake as a result of their commercial activities.

GEO 163/2022 establishes geothermal energy as a source of renewable energy, allowing it to be subject to public support schemes for renewable energy production and consumption.

By comparison to the EU Member States with developed geothermal sectors, Romania has a low volume of regulations on the technology. Both Germany and Italy have statutes that define geothermal energy as distinct from other mineral resources and establish a separate governance system for it, whereas Romania lacks such provisions. The distinction is necessary due to the unique technical, economic, and environmental implications of the geothermal resource, while the most important regulation governing the geothermal domain in Romania still assumes that its primary application is recreational.

8.1. Royalty on the extraction of geothermal energy

The fiscal framework for the extraction of geothermal waters contains a degree of ambiguity. From a technical perspective, this stems from a lack of clarity in the methodology used to calculate the royalty, which is defined as the marginal production cost of one cubic metre of geothermal water plus a "reasonable allocation" of overhead costs. This creates a situation in which producers are able, to a large extent, to set their own reference costs. While district heating systems in Romania have a limited latitude to abuse this mechanism on account of legal obligations of cost disclosure, the financial structure for private geothermal water producers is considerably more difficult to evaluate, granting them a higher degree of discretion regarding the royalties they pay.

An even larger issue associated with the limited regulation of geothermal water pricing is the absence of transparent reference prices. The result is the use of bilaterally negotiated prices, which can lead to significant overcharging if geothermal energy producers and geothermal water suppliers are not vertically integrated.

Indeed, the fact that the levy is placed on volumes of extracted geothermal waters instead of the energy yielded by those waters is problematic. The implication is that taxation rates vary by location, whereby regions with low-temperature resources are taxed disproportionately in comparison to areas with high-temperature resources.

A taxation model based on energy production would engender more uniformity across systems, provide incentives for efficiency, and would be applicable to next-generation geothermal systems (for which the current wording creates major ambiguity). Germany and Italy have both adopted systems of taxation which provide both price formation and uniform coverage across systems and can serve as useful models for future changes.

8.2. Permitting procedures for the exploration and potential construction of a geothermal well

The facilities for geothermal water extraction, used in the production of geothermal energy, are governed by the Romanian Mining Law. The process of development is distinct from that of a typical renewable power plant, with largely differing permits and procedures that have the effect of an additional layer of permitting. Some permits are replicated during the plant development process, such as the environmental impact assessment, while others are entirely novel, the most important of which are the prospecting permit, the exploration license, and the exploitation license.

Developers do not really have a free hand in deciding where to work, as permit/license obtention requires a parcel of land to be designated either by the state, or by an individual entity and subsequently confirmed by the state. The difference between permits and licenses lie in the implications of exclusive usage, whereby multiple prospectors can operate on the same parcel, while explorers and extractors have sole rights.

8.3. Incentive structures under Romania’s current geothermal licensing regime

8.3.1. Disincentives to development

Most salient are the details of the prospecting permit. Although areas of land subject to prospecting do not need to be nominated/approved, the incentives to engage in this first step are complex. In terms of costs, the fees for a prospecting license currently stand at RON 320 (about EUR 62, April 2026 exchange rates) (Guvernul României, 2003) per km^2 per year. For reference, prospecting an area of 400-500 km^2 – the typical surveying area for geothermal development (IntechOpen, 2019) – would cost the prospector between from EUR 25,000 – 31,000 per year, excluding personnel fees.

All operators conducting prospection, exploration, or exploitation are obliged to report their findings to ANRMPSG on a periodical basis (Guvernul României, 2003). This information then becomes accessible upon the submission of a written request for the findings of a particular development. Access is granted given that the ultimate use of this information is limited to certain applications, such as for exploration or exploitation licenses (ANRMPSG, 2005).

While the holders of exploration licenses have the right to reserve access to the exploitation license, holders of prospecting permits only receive point advantages (maximum 20%, (Guvernul României, 2003)) during the tender process for exploration licenses. Thus, prospectors face the risk of paying the cost of the permit, labour, and administration for prospecting only to be undercut by other firms during the tender for the exploration license, if they manage to find resources, which is a significant first-mover cost.

8.3.2. Disincentives to mapping

Prospecting permits and exploration licenses are obtained by a competitive tender that is based on the operator's suitability, defined as financial health, technical capacity, and commitment to perform a minimum amount of work on the plot. These conditions provide no avenues of remuneration for companies that cannot execute the full process of development, locking out mapping-only firms from independent work. As it stands, mapping-only companies can only earn revenues through geothermal-related activities if they are contracted by a developer.

This is because the mapping-only firms are barred from holding exploitation licenses through the requirement to develop the plot, which they cannot meet. Although they can theoretically transfer their exploitation licenses in exchange for payment (which essentially constitutes ownership of a concession, given the holder can exclusively request an exploitation license), the chances of this happening are low. Potential buyers know that they can initiate a public tender for an exploitation license on a plot of land when its exploration license expires, for which no financial costs are incurred. As such, the only instance where a potential applicant for an exploitation license would want to buy an exploration license is when there is significant risk of losing the public tender.

The dynamic produced by current regulations also negatively affects mapping efforts. The only means to obtain subsurface information is through prospection and exploration of land areas. This requires the regular submission of reports that detail the operator's findings, which are compiled and managed by ANRMPSG, which has exclusive rights to their usage.

There are currently very few companies that can develop geothermal capacity from start to finish, and many of them are highly localized, working in specific regions of the country. The only companies that are both mobile and have extensive development capacities are the O&G

companies, but they are rarely involved in the geothermal energy sector in Romania. The result is a limited flow of information on geothermal resources entering the government databases, which has massive effects on the sector's development.

8.4. Comparisons with Germany and Italy

8.4.1. Levies paid for the extraction of geothermal energy

Federal Mining Act, Germany (13 August 1980) envisages a 10% royalty per kWh of electricity generated from geothermal energy – whose price is set in another law – currently standing at EURct 25 (Federal Ministry of Justice, 1980).

Water Act of the State of Mecklenburg-Vorpommern, Germany establishes a groundwater extraction tax at a rate of EURct 10/m^3, with a 90% reduction if the operator demonstrates reinjection capabilities (Landeshauptstadt Schwerin, n.d.).

FER2 support scheme, Italy provides above-market remuneration for the provision of electricity generated from geothermal energy, with different prices for different ranges of plant capacities (Ministero dell'Ambiente e della Sicurezza Energetica, 2024).

Noticeably, Germany's regulated price also doubles as a subsidy, with one kWh in Germany being sold at an average price of EURct 8.9, while geothermal electricity is sold at EURct 25 per kWh. Italy's FER2 policy also provides above-market rates for geothermal electricity via feed-in-tariffs. The most directly applicable model, though, is the German regional example of water pricing, where extractors pay a fixed sum per litre of water, with the price scaling down based on reinjection capabilities. This illustrates not only how water pricing can be implemented in a transparent manner, but also how levy exemptions can encourage developers to invest in more environmentally sustainable facilities.

8.4.2. Permitting procedures for exploration and construction of a geothermal well

Germany and Italy have taken measures to guarantee developers' ability to monetize their findings by concentrating all research processes in one license and providing the ability to obtain the subsequent exploitation license without competition.

Federal Mining Act, Germany (13 August 1980): The permitting process in Germany combines the equivalent of the Romanian prospecting permit and the exploration license into a single license, known as the exploration license. Holders are given priority in their applications for extraction licenses, which removes the risk of being undercut by a third party (Federal Ministry of Justice, 1980).

Legislative Decree, Italy (11 February 2010): The permitting process mirrors that of Germany, where exploration license applications require no prerequisite and comprise both prospecting and exploration, in addition to giving holders the ability to apply for an exploitation license without competition for a period of six months. The state also has the responsibility to maintain and publish all geothermal title and pending applications, presenting new applications immediately as they are submitted (Gazzetta della Repubblica Italiana, 2010).

9. Policy recommendations

9.1. Regulatory adjustments can reduce barriers for geothermal projects

Before moving to a broader policy framework, a set of changes to the geothermal permitting and licensing regime could be applied.

Romanian authorities should consider **streamlining or partially integrating the prospecting permit and exploration licence** for geothermal resource extraction into a single exploration licence, following the German, Italian, or Hungarian examples. Having both a permit and then a license with partially overlapping procedures creates a costly redundancy, both for developers and the agencies that administer them. Developers face project interruption and increased development horizons, raising the risk and costs drastically, while authorities suffer from limited information inflows regarding subsurface data and redundant administrative burdens that stretch resources thin.

The current volumetric **taxation of geothermal resources should be replaced with a system based on energy output**, in order to ensure a level playing field across different technologies. A volume-based approach disproportionately affects projects with lower-temperature resources, which require higher flow rates to deliver the same unit of energy. An energy-based framework would better reflect actual performance and would apply consistently across both conventional geothermal systems and next-generation technologies, including closed-loop and enhanced applications, where fluid extraction is not the defining parameter.

Public entities should be **exempt from permitting/licensing fees related to the surveying, mapping, publication, and dissemination of information**. If public entities must undertake significant mapping efforts, a tax – even a small one – can be prohibitive for universities or smaller municipalities. Furthermore, such taxes may reduce the efficiency of the publicly funded mapping effort, as they constitute a shift of revenues from one public entity to another public entity.

9.2. Build a modern ecosystem of geothermal data and de-risk resource discovery

For an efficient and cost-effective programme of geothermal data aggregation, Romanian authorities should strengthen cooperation between public institutions, research organisations, universities, and private developers. A coordinated framework for collecting, centralising, and disseminating subsurface information could improve the availability of usable geothermal resource data for municipalities and project developers.

While geological information is currently collected through individual prospecting and exploration activities and subsequently archived by ANRMPSG, both the overall coverage and accessibility of this information remain limited, constraining the development of comprehensive national geothermal resource mapping tools.

At present, geothermal data generation is largely dependent on individual project developments. As a result, geological information is collected in a fragmented manner and is often not made publicly accessible beyond regulatory requirements. **Expanding mechanisms for data sharing and aggregation help reduce exploration risks, improve resource visibility, and lower entry barriers** for future geothermal projects. Publicly supported mapping initiatives and coordinated geological databases could therefore play an important role in accelerating geothermal deployment.

Information held by public institutions should also become more accessible for research and strategic planning purposes. The access conditions could be expanded to facilitate the use of subsurface information by universities, research institutes, and public entities involved in the development of geothermal mapping tools or regional planning instruments. **Publishing aggregated and generalised geothermal resource data** could significantly improve transparency and support investment decision-making while remaining compatible with confidentiality and licensing requirements.

9.3. Policies to reduce drilling costs and early-stage financial risks

Mapping abandoned oil and gas wells in areas with high geothermal potential and granting concessions for their use in geothermal development will improve visibility of available resources and provide greater clarity on development opportunities. Such wells offer both commercial and research value for next-generation geothermal technologies, as their reuse can significantly reduce drilling requirements and lower development costs, with minimal financial burden on the state. They can also support conventional geothermal applications.

Policymakers should clarify the regulatory framework governing the **repurposing of decommissioned oil and gas wells for geothermal applications**. The current legislative framework contains significant ambiguities regarding the reuse of existing oil and gas infrastructure, creating legal uncertainty for potential developers and discouraging investment in geothermal conversion projects.

Offer drilling risk insurance in areas with high geothermal potential. Given that the state would likely adopt a risk-neutral position, such support would typically be partial, yet still valuable, as it can reduce the weighted average cost of capital, improve the expected value of projects, and incentivise more participation in the geothermal energy sector.

9.4. Facilitate the entry of next-generation geothermal technology

Certain aspects of the geothermal energy sector in Romania need to be adapted to the technical requirements of next-generation geothermal energy: the extension of resource mapping to lower depths, the reconfiguration of regulations governing licensing, and the establishment of efficient cost-reducing initiatives.

Introducing provisions for next-generation geothermal technologies into the mining law will improve clarity and predictability. This will enhance transparency in the permitting process, as these systems do not extract geothermal fluids and therefore clearly do not fall under the existing resource-based framework. Such an adjustment should be supported by shifting from a volumetric taxation model to one based on energy output, aligning the regulatory framework with both conventional and next-generation geothermal systems and removing ambiguity regarding their treatment under current legislation.

Set up a test bed for next-generation geothermal energy technologies on national territory. The state should designate a reasonably small area exclusively for R&D. This parcel of land could be operated as a “firing range”, whereby companies pay a fee for the right to develop their next-generation geothermal energy technologies for a period of time.

Despite previous success, the allocations of funding for geothermal energy typically allow for usage in numerous other activities, such as the development or modernization of district heating systems. This forces geothermal energy developers to compete against a number of other sectors for funding, cutting down the quantities they can obtain. Some possible policies to support geothermal energy therefore are:

- Creation of special purpose financing vehicles which draw from existent sources of funding for renewable energy. These should target the development parts that are favourable to geothermal energy, namely, the drilling process.
- Offer drilling risk insurance in areas with high geothermal potential. Given that the state would likely adopt a risk-neutral position, such support would typically be partial, yet still valuable, as it can reduce the weighted average cost of capital and improve the expected value of projects.

As in the case of other publicly supported energy sources, the use of offtake guarantees for heat and power, through schemes such as **Contracts for Difference, could be extended to geothermal energy**. Although such mechanisms are not typically applied to baseload generation, they could be tailored for geothermal by drawing on the design of nuclear.

9.5. Establish and improve the use of pipelines for the geothermal energy sector

Technicians with skills that are currently applicable to the geothermal energy sector are relatively few. This is a result of two overlapping dynamics: the options for formal education opportunities are limited; and the geothermal energy sector competes against the O&G sector for skilled labour, even though enrolment in O&G-specific degrees is declining globally. Policy interventions will likely be needed to establish an employment route in the geothermal energy sector at the time of graduation, which could include:

- Expansion of existing degrees with applicable knowledge for the geothermal sector. Currently, Romanian universities enrol fewer than 700 undergraduate students in geology and related disciplines with relevance for geothermal resource development.
- Establishing professional education programs for former O&G workers. Many employees on development sites work on time-limited contracts. Re-training could allow them to also work on geothermal energy projects.

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