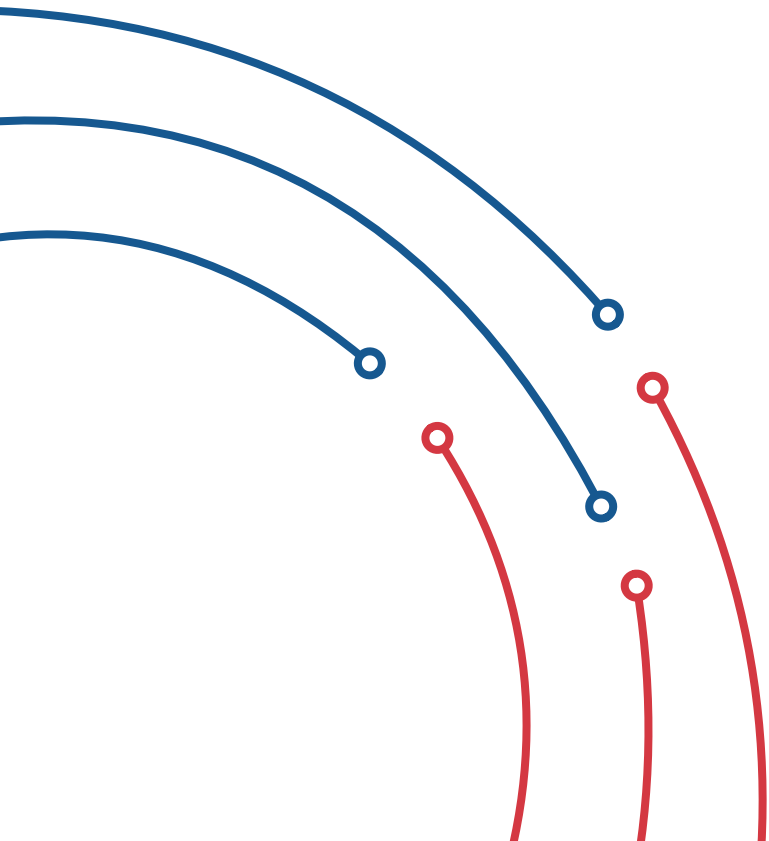
The European Geothermal Strategy and Action Plan

Making Europe competitive, secure and affordable



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The **European Geothermal Energy Council** (EGEC) is a not-for-profit organisation promoting all aspects of the geothermal industry. Founded in 1998, its objective is to facilitate awareness and expansion of geothermal applications across Europe by shaping policy, improving investment conditions and steering research.

EGEC is listed in the European Transparency Register No. 11458103335-07

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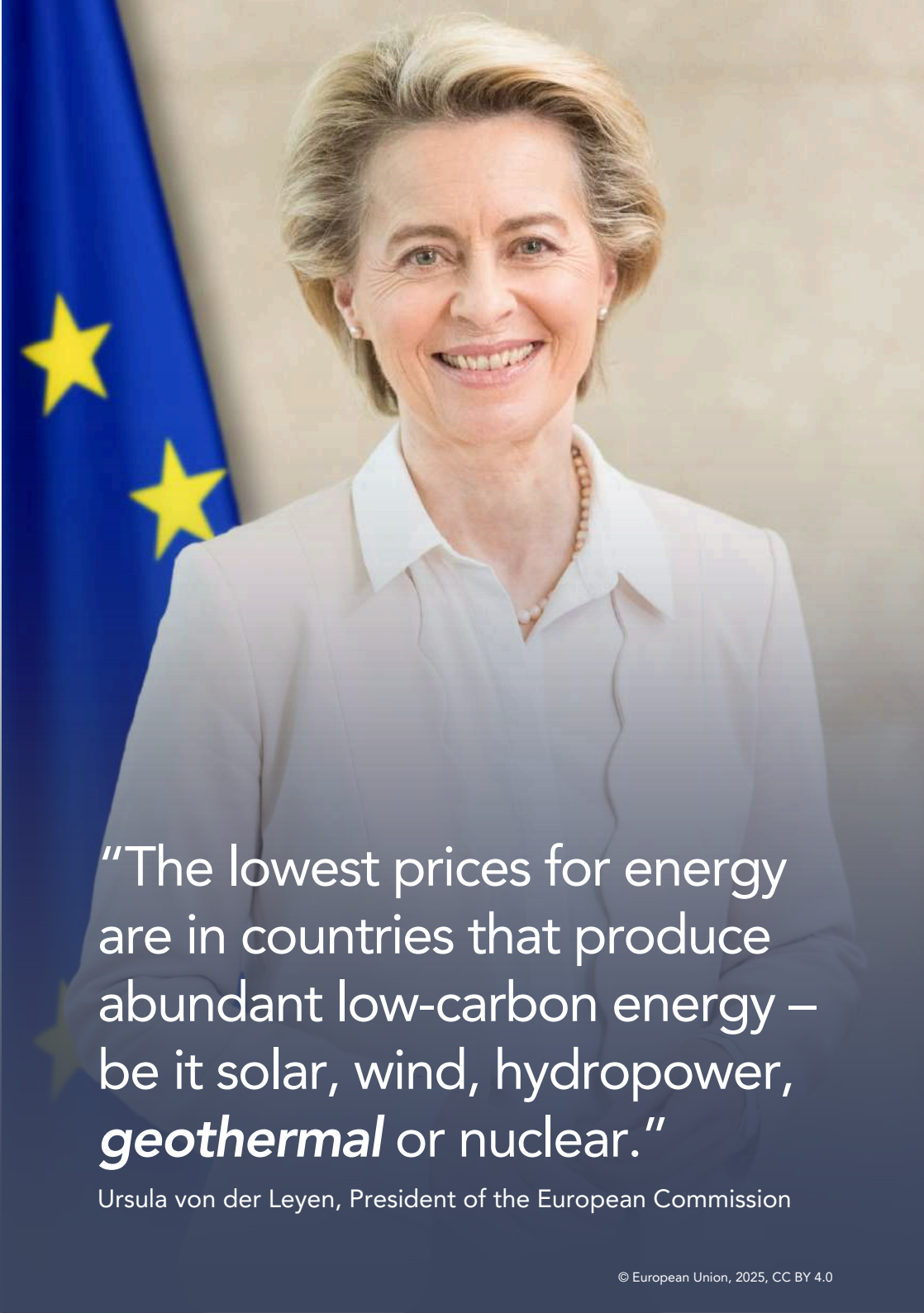


"The lowest prices for energy are in countries that produce abundant low-carbon energy – be it solar, wind, hydropower, ***geothermal*** or nuclear."

Ursula von der Leyen, President of the European Commission

Executive Summary

Geothermal energy is a treasure. The heat beneath our feet powers us. It also keeps us warm in the cold and cool in the heat. Geothermal provides abundant and reliable supplies of cost-effective renewable electricity, heating and cooling. It is the source for the least land-intensive and most cost-effective energy storage, as well as the most sustainable means of extracting lithium and other minerals. Moreover, it also represents a major opportunity for creating quality jobs and for equipment manufacturers, who will play a critical role in scaling geothermal technologies across global markets. However, it currently contributes only a fraction of its potential. This is about to change. The IEA forecasts a global doubling of geothermal energy capacity in the coming years everywhere except Europe.[i] Urgent course correction is required to avoid such a catastrophic failure, which would have dire consequences for European energy security, competitiveness and socio-economic prosperity.

The European Union cannot afford to continue ignoring the enormous potential of geothermal energy.

The International Energy Agency has called on all governments to "move geothermal up the energy policy agenda" by "making geothermal energy more prominent in national energy planning; developing dedicated goals and technology roadmaps".[ii] In 2024, the European Parliament was the first EU institution to call for an "***EU geothermal strategy*** giving concrete guidance to Member States and local administrations".[iii] Europe's energy ministers also called on the European Commission to publish "***a dedicated European Geothermal Action Plan*** with measures to facilitate geothermal projects and to accelerate the deployment of geothermal energy," in the Energy Council conclusions on geothermal energy (2024).[iv]

Geothermal energy is in Europe's DNA. Both Geothermal electricity plants and geothermal heat pumps were born in Europe. The Draghi Report[v] recognised it as one of the few remaining sectors where Europe has a competitive advantage and huge innovation potential, based on its "*Made in Europe*" supply chain, European technical expertise, and vast and proven capacity for technological development. Europe must build upon this proud legacy, especially as many other countries are entering the race to lead the geothermal industry.

The European Geothermal Energy Council (EGEC) calls on the European Commission to present an investment-oriented strategy and action plan focused on installing **250 GW of capacity by 2040.** It should harmonise European actions to complement national and local initiatives. The following elements are essential:

- A **dedicated European Geothermal Strategy and Action Plan**, to be published in the first quarter of 2026.
- The establishment of an EU target for **250 GW of geothermal electricity and heat capacity by 2040**.
- A **European Geothermal Charter**, which codifies the 2040 target and launches the **Geothermal Industrial Alliance** to manage its delivery.
- Targeted **European financial instruments to leverage private capital**.
- Measures to make **permitting processes** more efficient and faster, as well as improving access to **geological data**.

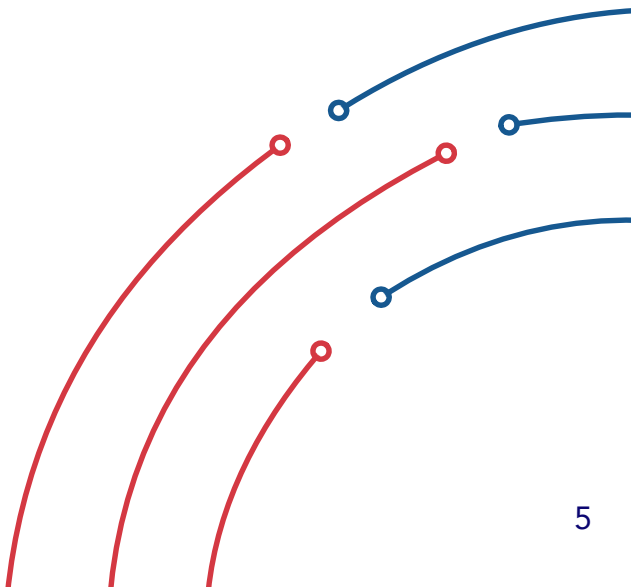
- **Sectoral or tripartite agreements** with key energy consumers to ensure European industry remains competitive, cities and rural communities transition to local and cost-effective renewable energy resources rapidly, and fortify the resilience of Europe's defence and agriculture sectors.

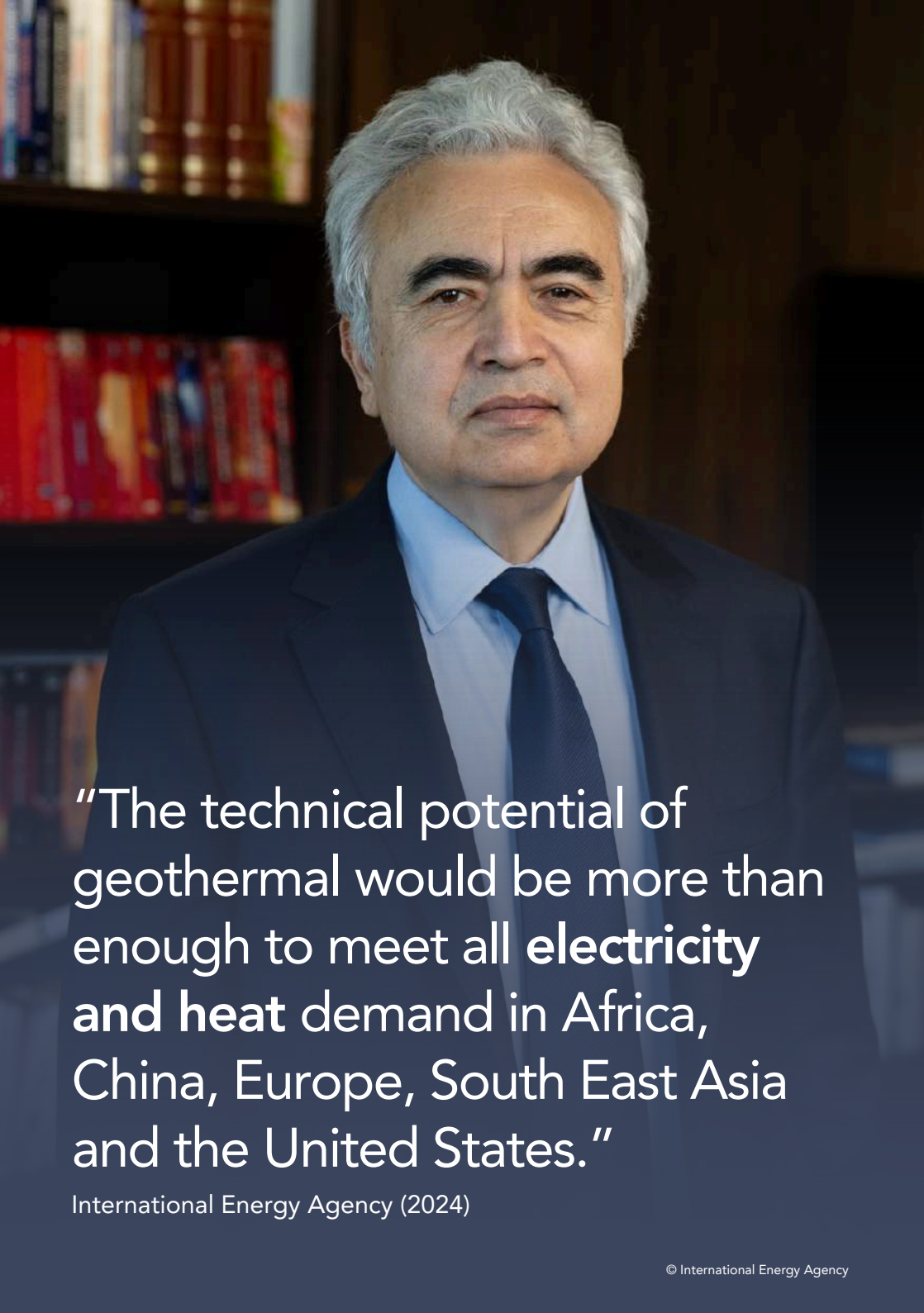
- Peer-to-peer guidance to facilitate governments in developing **national roadmaps** to remove barriers, accelerate investments and build local supply chains.

- European instruments to support value chain development in **local manufacturing and skilled professionals**.

- Include geothermal energy as a central pillar of the **Global Gateway** and the **Global Energy Transition Forum**.

- Improvements to the collection and presentation of **market data and statistics.**





"The technical potential of geothermal would be more than enough to meet all **electricity and heat** demand in Africa, China, Europe, South East Asia and the United States."

International Energy Agency (2024)

The purpose of the dedicated European Geothermal Strategy and Action Plan

The European Geothermal Energy Council (EGEC) outlines the essential elements of an investment-oriented European Geothermal Strategy and Action Plan. The objective must be to shape regulatory and financial rules to build mature market frameworks for geothermal heating, cooling, electricity, storage and sustainable raw materials extraction to flourish across Europe. The European Geothermal Strategy and Action Plan will be evaluated by its ability to deliver:

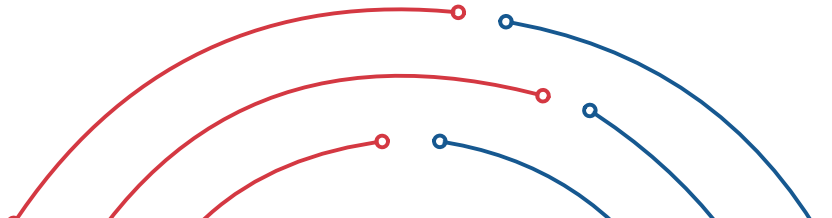
a) **Volume of investments**: The objective is to reach 250 GW of geothermal capacity by 2040. This requires an additional 206 GW of new capacity in addition to the 44 GW already installed in 2024.

b) **Energy security**: Each MW of "Made in Europe" geothermal heating, cooling, electricity, and storage makes Europe's energy system safer, resilient and more cost-effective. The Strategy and Action Plan should lead to a reduction of 22,5 BCM of imported gas by 2040.[vi]

c) **Climate and renewable targets**: Geothermal provides a cost-effective means to achieve the 2050 climate neutrality target stipulated in the European Union's Climate Law as well as the EU's renewable energy targets for 2030 and beyond.

These outcomes will be achieved by:

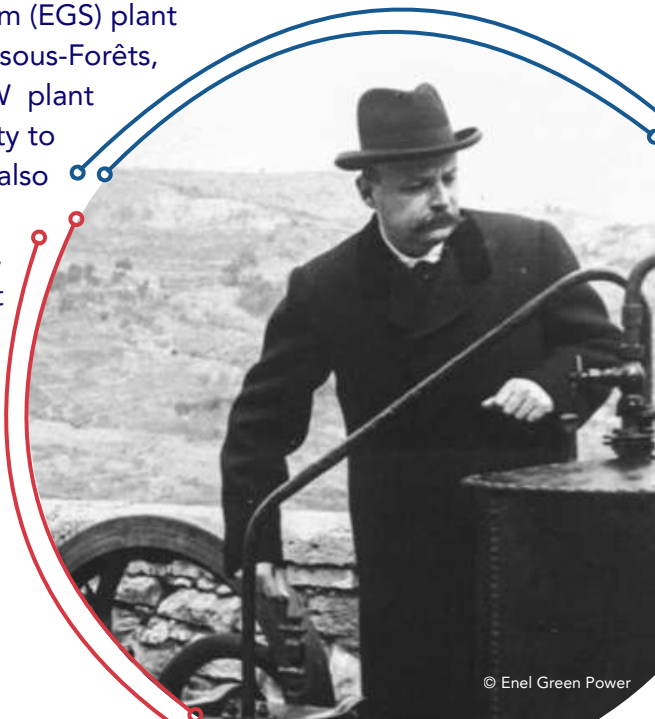
1. A **dedicated European Geothermal Strategy and Action Plan**, to be published in Q1 2026.
2. The establishment of an EU target for **250 GW of geothermal capacity by 2040**.
3. A **European Geothermal Charter**, which enshrines the 2040 target and launches the **Geothermal Industrial Alliance** to manage its delivery.
4. Targeted **European financial instruments** to leverage private capital.
5. Measures to make **permitting processes** more efficient and faster, as well as improving access to **geological data**.
6. **Sectoral or tripartite agreements** with key energy consumers to ensure European industry remains competitive, cities and rural communities transition to local and cost-effective renewable energy resources rapidly, and fortify the resilience of Europe's defence and agriculture sectors.
7. Peer-to-peer guidance to facilitate governments in developing **national roadmaps** to remove barriers, accelerate investments and build local supply chains.
8. European instruments to support value chain development in **local manufacturing and skilled professionals.**
9. Include geothermal energy as a central pillar of the **Global Gateway** and the **Global Energy Transition Forum**.
10. Improvements to the collection and presentation of **market data and statistics**.



The case for a dedicated European Geothermal Strategy and Action Plan

Geothermal electricity plants and geothermal heat pumps were born in Europe. Prince Piero Ginori Conti tested the first geothermal power generator in 1904 in Larderello, Italy. Peter von Rittinger, who was head of a department in the Austrian government's Ministry of Agriculture and Mining, developed the first geothermal heat pump in 1857, which was patented by Heinrich Zoelly in Switzerland in 1912.[vii] The Draghi Report (published in September 1994) recognised geothermal energy as one of the few remaining sectors where Europe has a competitive advantage and huge innovation potential.[viii]

Europe is also the birthplace of commercial-scale next generation geothermal. The first commercial-scale Advanced Geothermal System (AGS) is in Geretsried, Germany. It will supply 8.2 MW of electricity in 2025 and 64 MW of heat from 2026. The first single well AGS system will be completed in 2026 and supply the district heating system in Aalborg, Denmark, for a minimum of 30 years. Furthermore, the first Enhanced Geothermal System (EGS) plant was commissioned in Soultz-sous-Forêts, France, in 2008. The 2.4 MW plant supplies renewable electricity to 2,400 inhabitants. Europe is also the leading exporter of key EGS technologies to the U.S.A, currently the most significant market for rapid deployment of geothermal power.

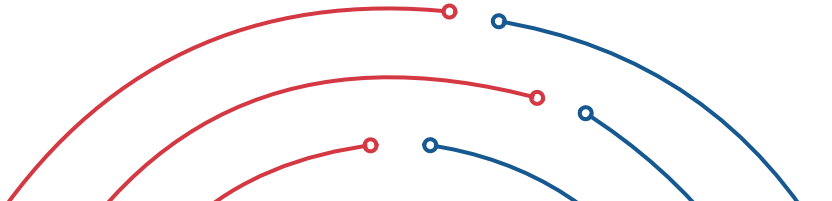


Prince Piero Ginori Conti

Such a rich history, cultural heritage and leadership are the best foundations to tap into the enormous potential of geothermal energy to secure Europe's energy system resilience and independence with abundant supplies of affordable energy for all consumers. Europe's technological leadership is a great asset for its global competitiveness.

The lack of **political and public visibility** has significantly undermined geothermal development across Europe. Other countries, namely China, India and the USA, are already demonstrating how to grow their geothermal industries domestically and for overseas investments. These countries have dedicated strategies, action plans and institutional support to deliver geothermal energy as a mainstream option.

The **USA's Department of Energy** published an overarching strategy in 2019. The GeoVISION report outlined the goal of realising the potential of geothermal energy, which was 28 million Geothermal HPs, 320 GW of geothermal district heating and cooling, and 8.5% of total electricity supply (20% of renewable electricity).[ix] This led to the Federal government's Multi-Year Program Plan for fiscal years 2022-2026, which was prepared by the Geothermal Technology Office of the Department of Energy, and set targets for 60 GW of geothermal electricity capacity by 2050, 17,500 collective heating and cooling systems and geothermal heat pumps in 28 million households by 2050.[x] Two specific Federal government strategies outlined targeted measures to achieve these targets - Pathways to Commercial Liftoff: Next-Generation Geothermal Power (2024) and Pathways to Commercial Liftoff: Geothermal Heating and Cooling (2025).



The **Chinese government** has incorporated geothermal targets in its Five-Year Plans (FYP) for the last two decades. The 11th FYP (2006-2011) sought to develop 1,1 billion square meters of new geothermal heating and cooling systems and increase geothermal power generation capacity by 500 MW by 2020.[xi] Sinopec Green Energy Geothermal Development was established in 2006. This is a joint venture between Sinopec Star and the Icelandic geothermal company - Arctic Green Energy.[xii] They have drilled over 1,000 geothermal wells and provided geothermal services to the equivalent of 100 square km of energy demand in 70 cities and municipalities in seven of the nine Northern Chinese provinces.

Furthermore, a Professional Technical Committee on geothermal energy standardisation was established in 2016 and is responsible for standardisation of approaches and processes relating to issues such as: resource exploration and evaluation; drilling and completion engineering; heating and cooling; power generation; and utilisation of produced water and resource protection.[xiii] The Sino-Icelandic Geothermal Technology R&D Centre was established by the Chinese and Icelandic governments. The expertise developed led to the Sino-Icelandic JV, which was established in 2023, to take this Chinese-Icelandic geothermal expertise globally.[xiv]

The **Indian government's National Policy on Geothermal Energy** was published in 2025 after extensive stakeholder consultation with the industry and consumers. This ensures all aspects of the geothermal family – electricity, collective heating, geothermal heat pumps, and mineral extraction - were incorporated alongside the needs of investors. The Plan's vision is to "To establish geothermal energy as one of major pillars of India's renewable energy landscape, contributing significantly to national climate commitments, 2070 Net Zero Goal, and energy security". The Plan seeks international expertise to accelerate its growth by incorporating and tailoring global best practices. This should be a significant opportunity for the EU to grow its export markets.[xv]

"We began life as a European Coal and Steel Community. We are now a European community of wind turbines, solar panels, and **geothermal** generators."

Dan Jørgensen, European Commissioner for Energy and Housing

The European Commission plans to publish an **Electrification Action Plan** alongside a **Heating and Cooling Strategy** in the first quarter of 2026. In order to realise the enormous potential of geothermal across the EU for electricity, heating, cooling, storage and critical raw materials, it is vital that the Commission complements these strategies with a **dedicated Geothermal Strategy and Action Plan**. Failing to fully seize this opportunity would lead to a number of significant risks:

- **Political visibility and support**: Political support is a precondition for the mass deployment of all geothermal solutions. It underpins consumer confidence and investor certainty. The lack of a dedicated Strategy and Action Plan would deprive geothermal of the political visibility granted to other clean technologies supported by the EU, such as wind, solar PV, hydrogen, and biomethane, for example. Furthermore, it would undermine avenues for constructive engagement with major competitors, such as China, India and the USA, as well as the growth of export markets.

- **Insignificant impact on investments**: The European Commission included a target to triple geothermal and solar thermal energy by 2030 in the European Solar Energy Strategy (2022), but this has had an insignificant impact on investments in geothermal energy to date. There is also confusion from consumers and the industry on whether this target is for geothermal and solar thermal combined or separately.

- **Different obstacles, different applications**: Whilst there are common issues across the family of geothermal applications, such as permitting and data availability, there are specific issues relating to geothermal electricity and mineral extraction – capacity auctions, grid connections, additional permitting requirements, sustainable finance taxonomy, support schemes, etc. – which need to be addressed coherently.

- **Ignores geothermal electricity**: Geothermal is the only non-combustible baseload or dispatchable renewable electricity source and requires dedicated attention. 1 GW of geothermal electricity is operational across the EU. An additional 50 power plants are in development, and a further 193 geothermal power plants are at the design stage in countries such as Croatia, France, Germany, Hungary and Italy, with traction gaining in new markets such as Greece and Spain.[xvi]

- **Splits the geothermal industry**: Heat pumps are expected to be covered in the Electrification Action Plan to meet the EU's new electrification target. It is unclear if Geothermal Heat Pumps (Geothermal HPs), the largest segment of installed geothermal capacity in Europe, are to be included. Geothermal HPs are often ignored in general heat pump policy and their efficiencies are often misappropriated. These issues continue to weaken growth in the deployment of Geothermal HPs.

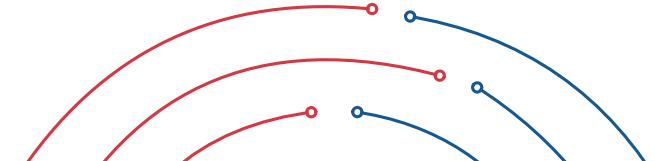
- **Diminishes the benefits of geothermal cooling**: Cooling is expected to be covered by the Electrification Action Plan because of its impact on electricity demand and electricity grids. Geothermal Heat Pumps and geothermal district cooling systems are the most efficient and effective applications because they can either avoid electricity consumption altogether using passive cooling, which is sometimes referred to as 'free geothermal cooling', or use the least quantities of electricity to produce the highest quantities of cooling due to their unique efficiencies.

- **Jeopardises the upscaling data centres, AI and future proofing of Europe's competitiveness**: As the demand for data centre infrastructure accelerates across Europe, geothermal energy stands out as a strategic solution that saves both energy and water. It offers clean, programmable, and baseload electricity, cooling and storage of waste heat below ground, which ensures both sustainability and reliability for this energy-intensive sector.

- **Undermines the positive benefits geothermal brings to Europe's electricity grids:** Grids are covered by the Grids Action Plan and the Electrification Action Plan. Geothermal reduces the need to expand electricity grid capacity and it benefits grid operators, consumers and improves affordability by providing stability with permanent and reliable supplies of renewable electricity, displacing significant quantities of electricity through large-scale renewable heating and cooling systems; and providing the most cost-effective and least land intensive storage. In the USA, the National Oak Ridge Laboratory has estimated that using geothermal heating and cooling networks would save up to USD 607 billion from avoided grid build-up and associated service costs. [xvii]

- **Threatens local jobs and manufacturing**: Geothermal is one of the few renewable energy sectors with a robust global export of European expertise and technologies. In the framework of the EU's Net-Zero Industry Act, Europe's leadership in advanced manufacturing must play a pivotal role in scaling geothermal technologies. Geothermal is recognised as one of the key strategic clean energy solutions essential for achieving industrial decarbonisation and energy sovereignty.

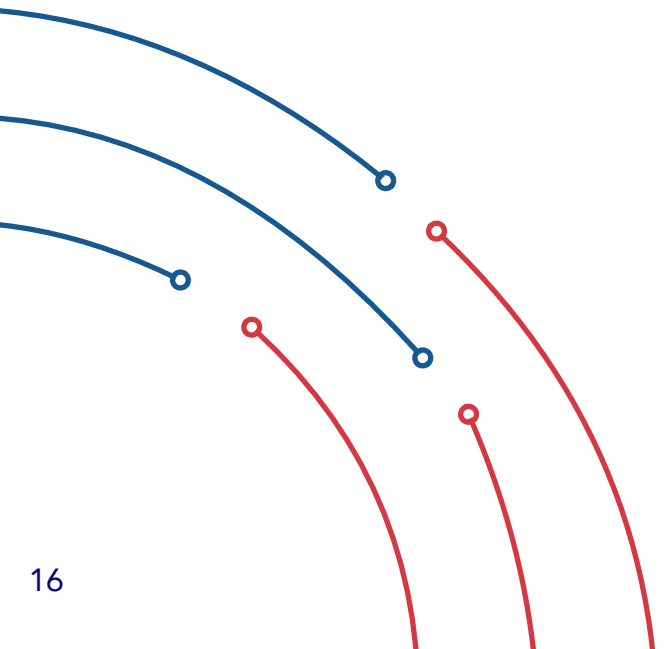
- **Endangers Europe's defence**: Geothermal energy offers a compelling opportunity for the European defence sector to align operational resilience with the EU's climate and energy security goals. As a stable, low-carbon, and locally sourced energy, geothermal systems can support the EU's efforts to decarbonise defence infrastructure while enhancing strategic autonomy. Military installations, particularly those in remote or high-demand environments, require reliable baseload energy. Geothermal technologies can meet this need. Moreover, geothermal heating and cooling systems can be integrated into military housing, logistics hubs, and command centres, contributing to long-term cost savings and emissions reductions. Investing in geothermal energy also supports the EU's commitment to dual-use innovation, where civilian technologies bolster defence capabilities. By prioritising geothermal in defence energy planning, the EU can demonstrate leadership in sustainable security and climate-smart defence policy.



Recommendation 1:
Publish a dedicated European Geothermal Strategy and Action Plan in Q1 2026

The European Geothermal Action Plan should be a distinct communication, similar to the Wind Action Plan (COM(2023) 669) or the Hydrogen strategy for a Climate-Neutral Europe (COM(2025) 125 final), which is aligned with the Electrification Action Plan and the Heating and Cooling/Clean Heat Strategy.

It should define the barriers to mass deployment and development of mature markets for all geothermal technologies, and then identify concrete actions to address these barriers.



The Vatican City uses geothermal heating and cooling

A '250 GW by 2040' target

Growth targets, combined with effective implementation measures, are the optimal solution for technological commercialisation and market maturity. A geothermal energy target for Europe will focus policy attention on the required solutions to bridge the current gulf between niche applications and mass market deployment. It will act as an important signal for local decision makers, companies and investors.

Renewable hydrogen, wind, solar PV, biomethane and hydronic heat pumps have all benefited from European targets (see Figure 1). These targets have focused EU and national policy responses aimed at their market penetration rates and supply chain development. Geothermal energy, given its many benefits, merits a similar approach.

Figure 1: European technology targets

Technology	Target	Initiative
Biomethane	35 BCM annually by 2030	Repowered plan COM(2022) 108 final
Renewable Hydrogen	Producing 10 million tonnes and importing 10 million tonnes by 2030. By 2050, cover around 10% of the EU's energy needs	Repowered plan COM(2022) 230 final
Hydronic Heat Pumps	Install at least 10 million additional heat pumps by 2027 and 30 million by 2030	REPowerEU plan COM(2022) 230 final
Solar	Almost 600 GW of solar photovoltaic by 2030; need to install, on average, 45 GW per year	EU Solar Energy Strategy COM(2022) 221 final
Synthetic Fuels	SAF share at EU airports of 6% by 2030	REGULATION (EU) 2023/2405 ensuring a level playing field for sustainable air transport (ReFuelEU Aviation)
Wind	Globally, annual wind capacity additions should reach at least 329 GW per year until 2030.	European Wind Power Action Plan COM(2023) 669 final
	Installed capacity of at least 60 GW of offshore wind in 2030 and 300 GW in 2050	EU Strategy to harness the potential of offshore renewable energy for a climate neutral future (SWD(2020) 273 final)

The geothermal sector and energy consumers are calling for a standalone target of **250 GW** of installed geothermal capacity by 2040.[xviii] This would build on the 44 GW of existing capacity, which comprises:

- 1 GW of electricity in the EU
- 37.5 GW of Geothermal HPs
- 5.5 GW of geothermal district heating and cooling.[xix]

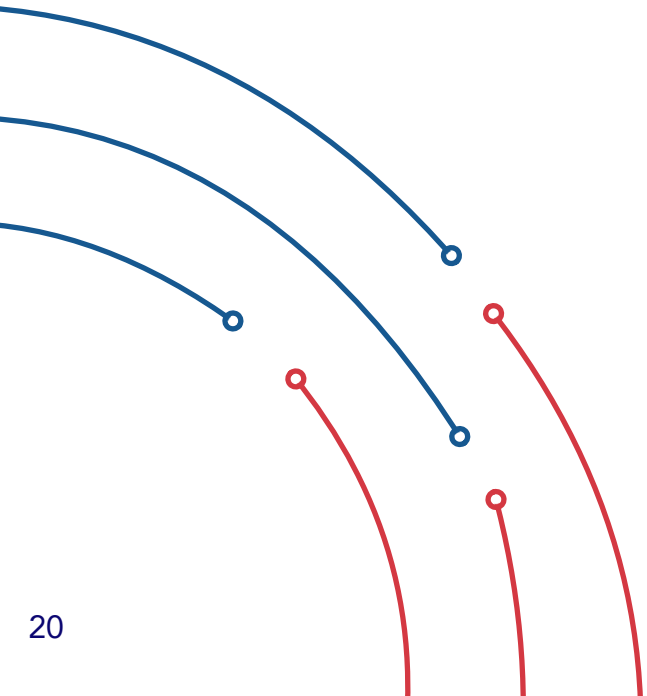
An additional 50 GW of geothermal is expected to be installed in Europe by 2030. This growth can be secured by the effective implementation of existing EU legislation, actions outlined in national geothermal roadmaps, as well as the accelerated growth of networked and standalone geothermal HPs, geothermal district heating and cooling systems, direct-use heat-only plants, geothermal power plants and next generation geothermal.

These trends are outlined in **EGEC's Geothermal Market Report 2024**, which indicates significant production pipelines: 50 geothermal electricity plants are in development, and a further 193 are in early planning stages. These investments are in countries such as Croatia, France, Germany, Italy and Hungary, as well as in new markets, like Greece and Spain. An additional 6 GW of geothermal district heating and cooling systems are expected to become operational by 2030.[xx]

The role of the European Geothermal Strategy and Action Plan is to triple this 50 GW growth by 2040. It will build upon the national targets set by the governments of Austria, Croatia, France, Germany, Hungary, Poland and Portugal. The strategy and action plan will expedite better, faster and more efficient permitting processes, nurturing a larger pool of skilled professionals, targeted financial flows, new EU financial instruments including guarantees and grants to de-risk investments, geothermal-specific Contracts for Difference (CfDs) coupled with sectoral agreements with key consumer groups such as cities, manufacturing industry, data centres, housing associations, district heating providers, the agriculture and defence sectors.

Recommendation 2:
Establish an EU-wide target of 250 GW of installed geothermal energy capacity by 2040

This target will focus policy, attract necessary investment, and drive advances in areas like permitting and leveraging private capital.



The Palais de l'Élysée in Paris converted to geothermal heating and cooling in 2024

Geothermal Industrial Alliance

Considerable advances in market maturity can be achieved by a process of organised peer-to-peer knowledge sharing as well as co-creation between regulators, industry, financiers and consumers. These aspects underpin the Geothermal Industrial Alliance that was recommended both by Energy Ministers from the EU Member States and also by Members of the European Parliament.

The structure of the Geothermal Industrial Alliance should be based on those of the Biomethane Industrial Partnership, the Battery Alliance, the High-Level Group on North Seas Energy Cooperation, the Pentalateral Energy Forum (PENTA) and other successful platforms.

The core aspects of this structure are outlined below:

European Geothermal Charter

This is a commitment by governments, industry and the European Commission to implement the recommendations of the Energy Council conclusions and the European Parliament's Opinion. It will be modelled on the Wind and Solar PV Charters, as agreed in December 2023 and April 2024 respectively. It will outline commitments by the geothermal industry, EU Member States and the European Commission to deliver the activities outlined in the European Geothermal Action Plan. These will form the basis of the Geothermal Industrial Alliance and the specific workstreams to deliver the agreed outcomes.

Geothermal Industrial Alliance Board & Secretariat

The Board is comprised of the Workstream leads, Member States and the European Commission. EGEC will be responsible for all secretarial activities.

Workstreams

These will deliver the core elements of the Geothermal Charter.

- **Workstream 1**: **National Roadmaps** – Peer-to-peer capacity to develop national geothermal roadmaps and foster collaboration.

- **Workstream 2**: **Permitting and Data Collection** – Sharing of best practices and co-creating processes and systems for all geothermal application types.

- **Workstream 3**: **Finance** – Improve existing EU instruments and design new ones encompassing financial risk guarantee schemes, geothermal-specific CfDs, and State Aid, etc.

- **Workstream 4**: **Cities and Rural Communities** – Sectoral agreement to advance collective heating and cooling systems (networked geothermal, energy communities and district heating systems and/or combined heat and electricity).

- **Workstream 5: Industry** – Sectoral agreements for process heat and electricity.

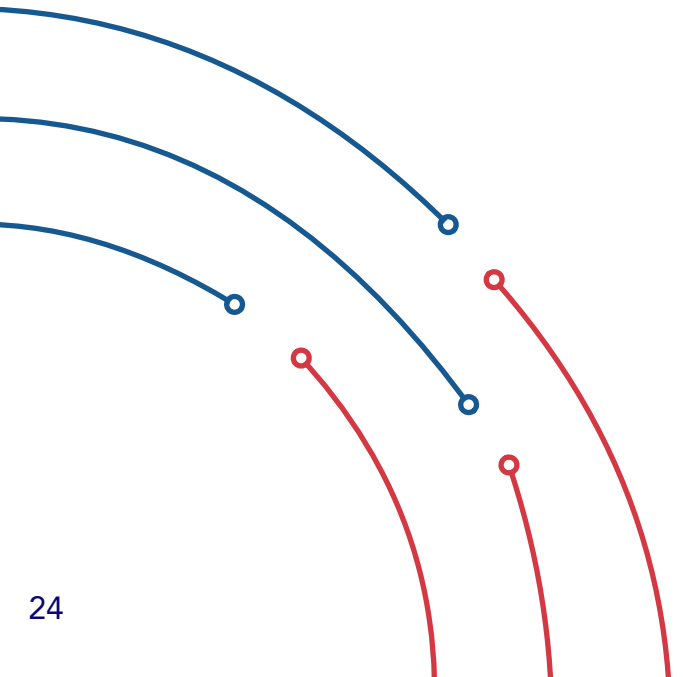
- **Workstream 6: Agriculture –** Sectoral agreements for process heat and electricity.

- **Workstream 7: Electricity** – Support energy providers to invest in geothermal power generation alongside the efficient electrification of heating and cooling.

- **Workstream 8: Market and Value Chain –** Statistics, skills and manufacturing.

Recommendation 3:
Launch the European Geothermal Charter and establish a Geothermal Industrial Alliance

The European Geothermal Charter and Geothermal Industrial Alliance must be launched alongside the publication of the dedicated European Geothermal Strategy and Action Plan.



NATO's headquarters in Brussels uses geothermal heating and cooling

Leveraging Private Capital

Geothermal, like other renewable energy technologies, has relatively higher upfront capital costs and, at the same time, minimal operational costs. These attributes are paired with very long lifetimes, which sets it apart from other renewables. Geothermal requires targeted public-sector support in the interim period before it reaches market maturity and parity with existing technologies.

The recently agreed Electricity Market Design[xxi] legislation prescribed two-way contracts for difference to support new geothermal electricity plants. The geothermal industry warmly welcomes this initiative. EU solutions are now required to address the rest of the geothermal sector. These measures are outlined in Figure 2.

Figure 2: Geothermal financing instruments

New Instrument	Output
European Financial Risk Guarantee Scheme	An EU-wide risk guarantee scheme is required to address short and long-term resource risk.
Grants (repayable) for geological data gathering	Geological data gathering to reduce the need for financial products for risk mitigation.
Next generation geothermal fund	Commercialisation of next generation geothermal technologies to deliver competitively priced renewable electricity and heat.
Guarantees to upscale or build new manufacturing capacity	Increase in current or new operational manufacturing capacity in Europe.
Geothermal electricity-specific CfDs	These will incorporate the main features of geothermal electricity systems – high load factors, grid stability, storage, flexibility, sustainable mineral extraction, etc.
Modification to existing instruments	**Output**
Dedicated geothermal energy calls in the EU Innovation Fund	Commercialisation of all geothermal technologies.
Electricity grid, heating and cooling infrastructure	Ensure the Grids Package, TEN-E and associated proposals provide financial for local heat infrastructure and remuneration for geothermal heating and cooling systems impacts on grids.
Clean Industrial Deal State Aid Framework (CISAF)	Adapt State Aid guidelines to explicitly recognise geothermal energy's risk profile and allow targeted support for deployment, drilling, resource confirmation, innovation and industrial uptake.
Sustainable finance taxonomy	Geothermal is placed on the same level as wind, solar PV and ocean energy.
Advisory services/guidance	**Output**
Advisory Agreement with the European Investment Bank	Targeted technical assistance and development of programmatic funding for geothermal project classes.
Renewable Heating and Cooling Purchase Agreements (RHCPAs)	Guidance from the European Commission and capacity building for key consumer segments such as municipal governments, industry and agriculture and data centres.

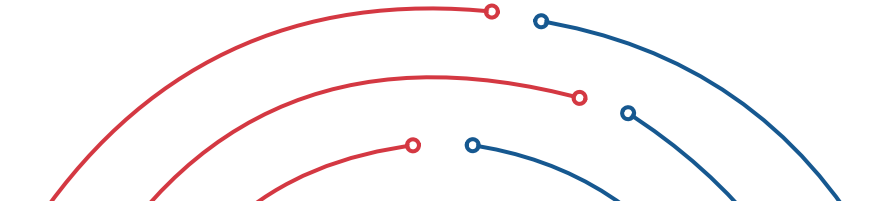
Financial risk mitigation guarantees

Risk products are dependent on the levels of market maturity, which is measured in terms of:
i) Depth, breadth and accessibility of geological data and knowledge about resource potential.
ii) Volume and diversity of plants in operation or under development, and of project developers.
iii) Efficiency of permitting and licensing procedures; and
iv) Robustness of regulatory and financial frameworks.

Deep geothermal energy projects, especially those requiring hydrothermal resources, involve three or sometimes four main stages of upfront capital investment:

1. **Exploration:** This focuses on finding the geothermal resource and identifying the most suitable drilling location.
2. **Drilling:** This represents, on average, between 40-60% of total project costs over their lifetime.
3. **Installation construction:** This centres on the cost of building the energy plant with equipment (to supply electricity, heating, cooling or combined electricity and heating).
4. **Infrastructure:** This may be required where an insufficient heat network or electricity grid is in place. On average, 1 kilometre of a district heating and cooling network costs around €1 million.[xxii] The cost for grid connections varies depending on location.

Public-sector risk mitigation measures are required in the interim period before market maturity is achieved. Upon attainment of market maturity, private sector providers will be able to offer competitively priced risk-sharing or insurance products.



These products are designed to address the bankability of a geothermal investment due to concerns such as:

- **Securing the short-term resource**, which centres on the risk of failing to find an economically viable geothermal resource, and
- **Long-term risk**, which centres on the potential reduction of the resource before the end of its expected lifetime.

The budget provided for a risk mitigation scheme must be sufficient to support the ramp-up of deep geothermal energy projects. The insurance conditions themselves should stipulate that a project must meet certain implementation parameters. This includes the potential for insufficient reservoir temperature or inadequate flow rates for commercial exploitation. If only partial success is achieved, additional investments may be required, such as further exploration, well improvements, the drilling of new wells, or the procurement of equipment (e.g. heat pumps).

The main design principles are as follows:

1. Scope: The risk mitigation scheme should cover between 70% and 90% of the total drilling costs.

Figure 3: Risk register

Category	Scale	Definition
Level 1	Low	Known resources
Level 2	Medium	Partially known zones with available data
Level 3	High	Unexplored zone, requiring a new exploration campaign

2. Premiums: These should be a minimal percentage of drilling costs to attract a large and diverse pool of participants, with a track record in delivering drilling services.

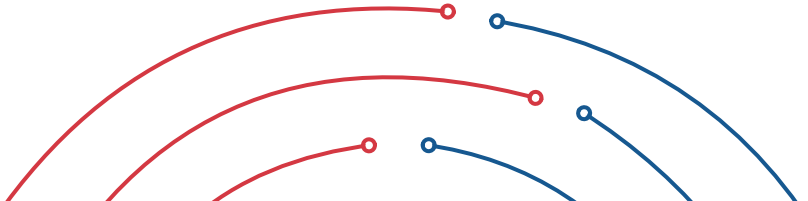
3. Capitalisation: At least €4 billion seed funding should come from the Innovation Fund.

Finance for geological data exploration

Specific financial instruments for geological data exploration are required to support the transition from category three to two to one on the Risk Register (see Figure 3).

Exploration reduces the risk of not finding a suitable resource. This data gathering should be financed by grants, repayable grants or guarantees in a PPP scheme, as well as tax reductions by the entities that obtain the geological data. Making data accessible increases opportunities for commercialisation, inclusivity and maintenance of environmental standards. An example of this comes from the INFOMAR marine mapping programme conducted in Ireland. A Report, conducted by PWC on the INFOMAR marine mapping of Ireland's waters in 2008, indicated the financial benefits of making data available and free of charge, in this case for the Irish government. The report concluded that it ensured no one was excluded from using the data for decision-making processes. Furthermore, the cost of the data available - €2 million – was equal to the estimated benefits. [xxiii]

To ensure consistency, structural support for EuroGeoSurveys' **project GSEU** is required. This is crucial for establishing a permanent Geological Service for Europe to guarantee continuous development and integration of vital geological data and services. This will promote a harmonised approach to subsurface data, resource assessment and infrastructure planning and identify new areas to explore. This is essential for scaling up geothermal deployment and reducing fragmentation across Europe.



Commercialisation of next generation geothermal systems

The IEA has stated that next generation geothermal technologies are "*sufficient to meet global electricity demand 140-times over*". They estimate that targeted policy support could deliver an 80% reduction of the cost of next generation geothermal by 2035.[xxiv]

The European Commission must initiate a **funding programme to mainstream next generation geothermal systems**. The relevant industry stakeholders commit to delivering competitive price ranges from the shared learning, supply chain development, and associated regulatory reforms from 35 projects greater than 30 MW of electricity or combined heat and electricity.[xxv] Assuming each commercial-scale project receives between €50-€91million of public funding (The EU's Innovation Fund provided €91 million for the estimated €268 million investment in Geretsried), this would require an **EU financial commitment of €1,75 billion - €3,2 billion in grants, guarantees or performance-related guarantees**. The use of public finance is justified to leverage private capital, ensuring knowledge sharing and lowering energy costs for industry, cities and agriculture. Between 2017 and 2025, around $4 billion have been invested in geothermal electricity in the USA. Leveraging private capital through a balanced mix of equity and debt has proven to be a key driver for scaling projects. Notably, $1.7 billion was raised in Q1 2025 alone to accelerate developments. In line with the Draghi Report, which highlights the vast potential of private capital, similar strategies should be implemented in Europe.

Building manufacturing capacity in Europe

The European Investment Bank (EIB) has used counter guarantees to support investment in the manufacturing of equipment for Europe's wind industry.[xxvi] Counter guarantees of other similar products can be used in geothermal technologies to ensure completion of extensions to or new manufacturing capacity.

Geothermal electricity CfDs

Geothermal Contracts for Difference (CfDs), which recognise multiple services (grid stability, renewable heat, flexibility, sustainable mineral extraction, storage, local supply chains, etc), could play a positive and valuable role. This aspect is crucial for investors in geothermal electricity generation, as it facilitates access to credit lines and enhances project bankability. Stable and predictable power purchase agreements (PPAs), especially the 24-7 PPA market, are essential to ensure project viability and alignment with the envisaged targets.

EU Innovation Fund (EUIF) call for geothermal

Only two geothermal projects – The Eavor Loop™ on Advanced Geothermal Systems (AGS)[xxvii] and ScaleUp on large-scale underground tank thermal energy storage[xxviii] - have been awarded funding from the EU Innovation Fund in over a decade of its operation. This is insufficient to meet Europe's energy security, affordability and competitiveness. A **dedicated EU Innovation Fund call for innovative geothermal technology development** and commercial-scale demonstration is essential for Europe's energy security, affordability and competitiveness. The call must consider the unique characteristics of geothermal projects, including their long lifetimes. Today, the EUIF only evaluates projects over a 10-year period, yet some geothermal systems have a technical lifetime of 30-60 years, which justifies the higher capital expenditure (CAPEX) than other technologies. The short period (10 year) that EUIF evaluates projects over is disadvantageous to geothermal projects that have much longer lifetimes.

Grids package

The upcoming Grids Package, and its legal framework in the Trans-European Networks for Energy (TEN-E) legal basis, should ensure that local heating and cooling grids are also financed as they increase energy system resilience and reduce the impact on new grid build and maintenance. The Oak Ridge National Laboratory in Tennessee (USA) concluded that networked geothermal and standalone geothermal HPs are the most efficient and cheapest form of electricity-based space heating, hot water and cooling. They concluded that up to USD 607 billion would be saved from avoided grid build-up and associated service costs by deploying geothermal HPs and networked geothermal in 68% of existing and new building floor space across the USA.[xxix] A further $19 billion per year would be saved from avoided heating fuel purchases, amounting to €513 billion from 2023 to 2050.[xxx]

Therefore, the Grids Package, especially the Demand Response Measures, must provide clear incentives for the use of geothermal HPs, networked geothermal, geothermal district heating and cooling systems and direct-use geothermal heat for use in industry, when electrifying heating and cooling in the built environment. One third of the EU's distribution grids are over 40 years old, to the Eurelectric Grids 4 Speed report.[xxxi] Grid investment, especially in local distribution grids, must be fit-for-purpose in an increasingly decarbonised, decentralised and digitalised electricity system. Due to this rapidly evolving context, specific policy measures should promote an anticipatory grid build-out and long-term planning at the national level, supporting National Energy and Climate Plans all along their lifespan. Guidelines on regulatory incentives for forward-looking grid build-out (anticipatory investments), including de-risking investments should be included in the upcoming Grids Package.

Clean Industrial Deal State Aid Framework (CISAF)

To fully unlock the potential of geothermal as a strategic clean energy source, the European Commission should prioritise dedicated funding within the CISAF Clean Industrial Deal State Aid Framework, ensuring that geothermal technologies receive targeted support to accelerate deployment, innovation, and industrial uptake across Member States.

Sustainable finance taxonomy

The EU Taxonomy for Sustainable Finance has yet to channel significant flows of private capital into geothermal energy. There are two reasons for this. Firstly, geothermal applications are required to meet a life-cycle CO_2 threshold, but this rule is not applied to other renewable energy technologies such as wind, solar PV and ocean energy.[xxxi] It is important that these thresholds are removed to ensure equality amongst renewable energy technologies, considering the majority of geothermal projects in the EU have near zero emissions.

Advisory service agreement with the EIB

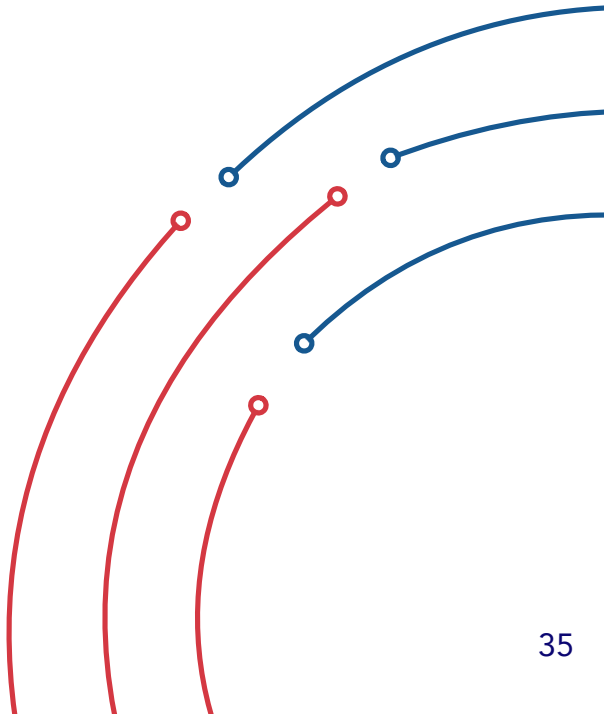
This will allow the EIB to directly or indirectly provide targeted advisory services to enable the EU to meet its upcoming target of geothermal electricity, heating, cooling, storage, lithium and other raw material extraction investment targets.[xxxiii] It is based on similar arrangements that have been made with Hydrogen Europe and the Solar Impulse Foundation.

Renewable Heating and Cooling Purchase Agreements (RCHPAs)

The RCHPA market is less well developed than the market for Power Purchase Agreements (PPAs). Governments were invited to design their own rules, guidance and support measures to drive these contracts in the recently revised Renewable Energy Directive.[xxxiv] However, guidance from the European Commission is required to outline a legal framework and raise awareness of this market.

Recommendation 4:
Provide a consistent financial framework for geothermal energy investments, including under the Clean Energy Investment Strategy and the Grids Package

A consistent financing architecture will reduce project risk, unlock private capital and accelerate geothermal's contribution to Europe's energy security, affordability and decarbonisation.



The Groupama Stadium (Olympique Lyonnais) uses geothermal heating and cooling

Permitting and data

Improving the efficiency of permitting processes is essential to the pace and scale of geothermal investments. There is a direct correlation between more accessible and accurate geological data and the risk profile of geothermal systems. Reducing the risk of failing to find a suitable geothermal resource is a key element in the process of making geothermal even more cost-effective. Reducing administrative and subsurface risks is essential, in order to attract more private investments in geothermal and accelerate its deployment.

To simplify permitting processes, the following is required:

- Adapt national legislations on extractive industries, on energy and environment, to set a framework for geothermal development and to allow time-sensitive permitting for geothermal projects where permits are required.

- Support capacity-building activities to reinforce resources and expertise in permitting authorities. An EU community of permitting practitioners will facilitate the exchange of best practices to ensure environmental standards are maintained without delaying applications for geothermal installations.

- Develop continuously updated codes, standards and guidelines on good practices and use these for capacity building with permitting agency experts.

Permitting for Geothermal Heat Pumps

The following issues must be addressed in the European Geothermal Strategy and Action Plan:

- **Renewable Acceleration Areas (RRAs):** These were prescribed in the 2023 Renewable Energy Directive. However, the progress for geothermal heat pumps has been limited. The French geological survey (BRGM) employs the best practice of creating a digital map, identifying the conditions for shallow geothermal energy systems (with drilling depths of up to 200m).
  - A simple declaration of an installation which can be sent to a municipal government by email.
  - A simple declaration plus an expert opinion in areas where there are other uses for the subsurface, such as metros, sewage systems, etc.
  - A permit is required in sensitive areas such as unique geological structures or competing factors below ground.

- **Geolocating geothermal sites on digital maps:** Geolocating geothermal systems in a region has a direct impact on improving the efficiency of the permitting process. It indicates the type of systems in operation, their location, consumer and size. It increases awareness of geothermal HPs and avoids interference (when one system is too close to another and undermine geothermal HP system performance). The BruGeoTool, operated by the Belgian Geological Survey, is an open-source software example and should be replicated by other countries and regions.

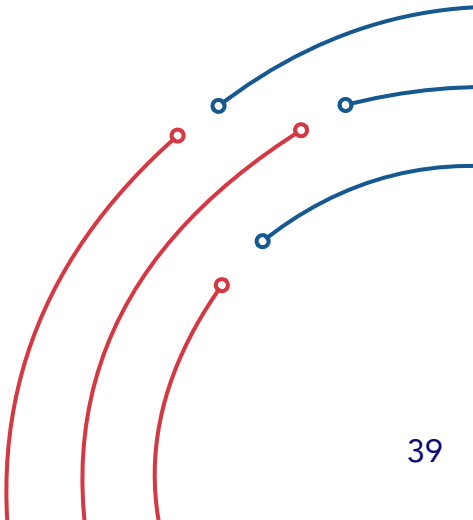
- **Environmental impact perceptions:** In some instances, there is a perception that geothermal has negative impacts on drinking water reservoirs and water consumption. This perception needs to be addressed in a coordinated manner with water authorities. In Germany, the government, water authorities and the national geothermal industry hosted capacity building sessions to alleviate these concerns. This is the ideal model for replication through the Geothermal Industrial Alliance.

Deep Geothermal permitting

Deep geothermal power and/or heat projects are regulated by energy and environmental laws and require permits. Permitting is regulated by legal frameworks historically established for extractive industries, and sometimes adapted for geothermal. Croatia, Denmark, Germany, France, Hungary, Italy, the Netherlands and Poland have established special geothermal chapters in their respective national legislation relating to extractive industries. Bulgaria has also prepared legislation, which is awaiting final approval.

Even with these reforms, the permitting process is still cumbersome as separate permits are required for exploration, for drilling, and finally for exploitation of the resource. The German government is in the process of legislating new permitting laws in its **Geothermal Accelerator Act**. These seek to remove permitting obstacles for geothermal energy and the expansion of large-scale heat pumps. It implements the 2023 Renewable Energy Directive on geothermal HPs up to 50 MW, which includes a three-month permitting ceiling as well as other requirements on infrastructure.

The Croatian Hydrocarbon Agency has taken a leadership role in developing deep geothermal, utilising expertise from the hydrocarbon industry.[xxxv] It is involved in carrying out seismic surveys, auctions for geological exploration licenses, and attracting project developers with consumers. This coordination is vital in growing markets for deep geothermal energy.



This highlights the numerous challenges with deep geothermal energy with a longer process for permitting. The main hurdles are:

• **Complexity:** Geothermal energy is regulated by many entities and regulations, dealing with extraction from underground and the surface as an industrial application, but also for the environmental, planning, water and energy regulations. Large-scale (deep) geothermal energy sometimes requires several **permits** – one for **exploration** and the second for **exploitation** of the renewable resource. Additional permits are required for drilling and for the **construction of the geothermal heat or electricity plants** and the connection to the district heating and electricity networks. In addition, national permitting rules and EU provisions on the Environmental Impact Assessment are often interpreted and applied differently within countries leading to unnecessary uncertainty for project development and investors.

• **Capacity:** Skillsets required for geothermal assessment are often underutilised or there is a lack of qualified professionals at national, regional and local levels to undertake the necessary checks and approvals. This is compounded by a lack of harmonised terminology across the EU, and even sometimes within Member States. These factors create avoidable administrative delays and bottlenecks.

• **Engagement:** There is a lack of consistency and clarity in the information required from project developers, which causes delays. Furthermore, transparent and time-sensitive processes are required to manage potential legal challenges and subsequent mediation in an application.

• **Timescale:** The permitting process can take between 3-10 years. In the case of Italy, permits for power generation took over 15 years.

European Commission guidance, based on best practices for "one-stop shops" or time-bound coordination structures to fast-track procedures by applying environmental screening and the principle of tacit approval would ensure consistency in the application of the EU's environmental standards.

Harmonisation or mutual recognition of standards, technologies and techniques

This is an effective way of normalising techniques, technologies and practices for developers, permitting agencies, financiers and consumers. Industry or public-private entity-led guides can be upscaled into cross-border tools and used to build capacity across Europe. For example:

- BRGM & INERIS Guide of best practices to manage induced seismicity on deep geothermal operations.[xxxvi]
- BVEG & DGMK Guideline on the Economic Assessment of Geological Risks of deep geothermal projects. [xxxvii]
- The Geothermal Well Design guidelines from Geothermie Nederland, the deep geothermal industry association in the Netherlands.[xxxviii]
- The International Association of Drilling Contractors (IADC) Well Drilling Guidelines, which "distinguish well types and define the necessary equipment, standards, processes, and training for their safe and efficient construction and operation".
- GEOGUIDEN: A guide for municipal administrators to help them harmonise applications for geothermal projects. This was produced by the Swedish Drilling Association, the Swedish Geothermal Energy Center, the Geological Survey of Sweden (SGU), and the Swedish Cooling and Heat Pump Association (SKVP).

Capacity building of permitting agencies, fostering mutual recognition of standards, is a vital activity for the European Geothermal Alliance.

Geological data transparency

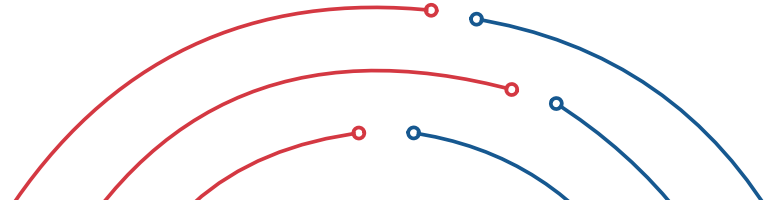
The use of Europe's subsurface is shifting from the extraction of fossil fuels to clean and sustainable geothermal energy. To make this shift successful, we need to thoroughly understand what's beneath our feet. This means having accurate digital geological data and a deep understanding of the subsurface to properly evaluate the technical and economic potential of all geothermal resources.

The greater the quantity, quality and accessibility of geological data the greater the likelihood of cost-effective geothermal project development as it is a crucial de-risking tool. To facilitate access and allow for a quicker evaluation of the subsurface potential for geothermal projects, easy and free of charge access to publicly available data via digital tools is key.

Privately obtained subsurface data should become publicly available, but only after a predefined period (a few years). It is necessary to incentivise data collection by private actors by safeguarding their intellectual property and allowing them to utilise any data they collect.

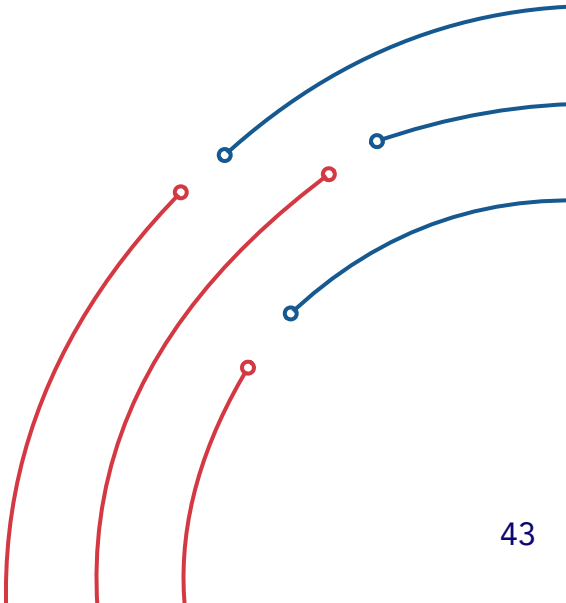
The **European Geological Data Infrastructure (EGDI)** platform forms part of a geological service for Europe provided by EuroGeoSurveys, the European association of geological surveys. EGDI aims to serve all publicly available geological data to facilitate smoother geological de-risking, as well as improve the permitting process for project developers and consumers seeking to make geothermal energy investments. It is a foundational pillar of the geothermal industry and of the European Geothermal Strategy and Action Plan.

It is essential to fund the acquisition of new subsurface data through public exploration campaigns, especially in areas with less data coverage. This will ensure an even and reliable knowledge of the subsurface over Europe, minimizing exploration risks. Grants, guarantees, tax exemptions and capital gains write-offs are some of the tools required to address permitting, data collection, geological de-risking and environmental stewardship.



Recommendation 5:
Establish a dedicated workstream on permitting and subsurface data in the Geothermal Industrial Alliance

This workstream must be tasked with streamlining cumbersome regulatory processes and ensuring the quality, accessibility, and harmonization of geological data across Europe, which is essential for reducing risks and accelerating private investment.



The Microsoft Global Campus in Redmond (USA) uses geothermal energy

© news.microsoft.com/redmond-campus/

Sectoral Agreements

Sectoral Agreements, which are made between the geothermal industry, the relevant European sectoral association, EU institutions and funders, are essential to addressing the needs of energy consumers for reliable supplies of cost-effective geothermal heating, cooling and electrical power. The main consumers, who have different requirements and approaches to investment, are outlined below.

Geothermal Cities Sectoral Agreement

Urban and rural municipalities have driven the geothermal collective heating and cooling market for decades. More and more municipal governments are turning to geothermal to deliver their Sustainable Energy & Climate Plans (SECAPs) commitments under the European Covenant of Mayors. Legislation will also play a role. Municipalities with populations greater than 45,000 inhabitants are required, by the Energy Efficiency Directive (Article 25 of Directive 2023/1791), to produce local heat and cold plans to meet local requirements. Geothermal is very attractive because of its scalability, long-life spans and predictable pricing, combined with the ability to combine with other energy sources to avoid technology lock-in, reduce greenhouse gas emissions, minimise surface footprints and improve air quality.

The main challenges are:

- **Capacity:** Few local authorities have the capacity and expertise to prepare adequate renewable heating and cooling plans.
- **Geothermal collective heating and cooling system design:** They often lack the expertise to design geothermal heating and cooling systems.

- **Technical Assistance gap:** They require technical assistance to bridge the gap between designing heating and cooling plans and the bankability of these plans.[xl]

- **Financing and business models:** There are many issues related to the type of financing required and the limitations of municipal governments. These issues require guidance from the European Commission on the key design principles of Renewable Heating and Cooling Purchase Agreements (RHCPAs) and template public-private partnership business models, as well as the use of the financial risk guarantees to develop resources.

The core elements of this sectoral agreement are:

- **Geothermal Cities Partnership:** This will be the one-stop shop for municipalities, social/public housing providers and district heating and cooling providers seeking to invest in geothermal. It provides access to official guides, peers who are able to provide advice and guidance, industry and access to finance.

- **Peer-to-peer awareness and capacity building**: Capacity building: Industry standards and guides for the design of geothermal systems, and technical assistance to bankable investments.

- **Financial aggregation**: The European Commission, European Investment Bank (EIB), European Bank for Reconstruction and Development (EBRD) and other public and private funding institutions will be invited to join this Committee.

Geothermal Industry Sectoral Agreement

Geothermal systems could cater for different manufacturing needs. For example, the chemical sector has specific requirements for process heat at different temperatures and volumes. The industry is already moving, in part, to avoid the costs of purchasing EU Emissions Trading System Allowances. In 2024, Vulcan GmBH and BASF signed a Memorandum of Understanding to explore the use of geothermal energy at BASF's Ludwigshafen site. A potential 300 MW of CO_2-free steam is required, of which 4 million metric tons could be produced at the site annually. This would save 800,000 metric tons of CO_2. This equates to a financial saving of €62 million based on the EU ETS closing price on 16 September 2025 of €77,51. The project will also seek to provide a domestic supply of chemical-grade lithium.

The chemical sector provides a good working example of the Tripartite Agreements outlined in the Affordable Energy Action Plan.[xli] Janssen Pharmaceutica installed a geothermal heating and cooling system on its Beerse Campus, Belgium, in 2022. This was part of Johnson & Johnson's commitment to achieve an 80% greenhouse gas emission reduction by 2050. Wells were drilled to depths of 2.4 km and accessed 85 °C hot water for use in a 3.5 km heat network. The tripartite agreement was concluded between Janssen Pharmaceutica, the Flemish Agency for Innovation and Entrepreneurship (VLAIO) and the European Regional Development Fund (ERDF).

The **Industrial Decarbonisation Bank (IDB)** and targeted calls from the EU Innovation Fund are pivotal to this. A dedicated call from the IDB is required to demonstrate geothermal in low and medium-temperature industrial processes requiring temperatures of between 50 - 200 °C.

The core elements of this sectoral agreement are:

- **Industrial Decarbonisation Bank**: This will guide the industry the services provided, business models and funding structures.
- **Finance**: This will come from a combination of EU funds, government agency funds and European financial aggregation.

Geothermal Data Centres Sectoral Agreement

The electricity consumption of data centres in the EU was 76,8 TWh in 2018. This is expected to increase to 98,5 TWh by 2030, a 28% increase which would account for 3,2% of final electricity consumption in 2030, according to the European Commission. Reducing water consumption, installing efficient cooling systems and storage solutions for the waste heat from these centres is crucial. Geothermal is one of the main go-to solutions for this sector in the USA. For example, Microsoft's campus in Redmond (Washington, USA) installed 875 boreholes over 220 miles of piping in a large geothermal HP system for heating and cooling in its Thermal Energy Center.[xlii] In 2023, Google signed a Power Purchase Agreement with Fervo for 24-7 carbon-free electricity.[xliii] Meta signed a 150 MW geothermal power agreement with Sage Geosystems in 2024.[xliv] Geothermal provides electricity, cooling and the possibility to store in the underground excess heat for data centres. Moreover, geothermal cooling solutions reduce pressure on water resources. Geothermal energy is integral to the expansion of data centres and the growing range of related services and products.

The Aruba data center in Bergamo (Italy) uses a geothermal cooling system

Geothermal Defence Sectoral Agreement

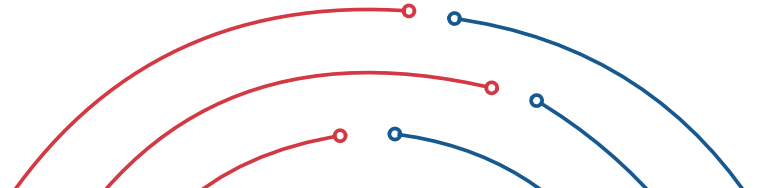
Military establishments are critical to Europe's security and sovereignty. Geothermal energy is playing an increasingly important role in providing secure and resilient energy supplies. The USA's Department of Defense, which manages the Air Force, Army, Navy, and Marines, has a programme for the mass deployment of geothermal electricity, heating and cooling.[xlv] The German Federal Armed Forces invested in a geothermal system for its Staufer Barracks in Pfullendorf, Baden-Württemberg. This supplies 95% of the energy used in the plant.[xlvi] The French Air Force base in Bordeaux-Merignac is also converting to geothermal energy.[xlvii] The European Commission's proposal for the 2027-2034 Multiannual Financial Framework identified defence expenditure as a new European priority. It is important that new rules incorporate geothermal.

District Heating and Cooling Sector Agreement

The European Commission's Joint Research Centre can convene strategic dialogues with the District Heating and Cooling (DHC) sector to outline the use of geothermal resources in their decarbonisation pathways, similar to the INCITE project, which will build capacity and technical assessments to guide investments.[xlviii]

The objectives will be:

- **System data:** All first and second-generation district heating systems will be mapped to allow for specific focus on those that can be converted to geothermal and the need for building renovations.
- **Finance:** A combination of EU funds, European financial aggregation and private sector capital will be catalysed for each geothermal investment.



Geothermal Agriculture Sectoral Agreement

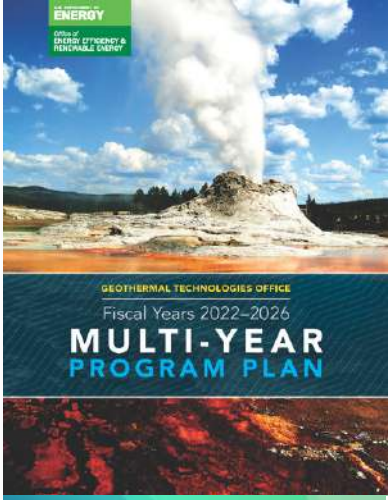
Agriculture producers, particularly those in the horticulture and aquaculture sectors, have turned to geothermal heating and cooling as a source of local and stable energy prices and to reduce their greenhouse gas emissions. Many EU Member States have identified geothermal as an eligible renewable energy funding source in their Common Agriculture Policy Strategic Plans.

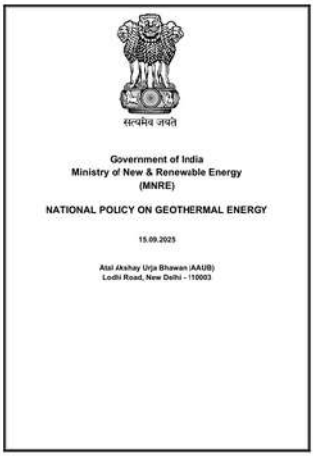
The core elements of this sectoral agreement are:

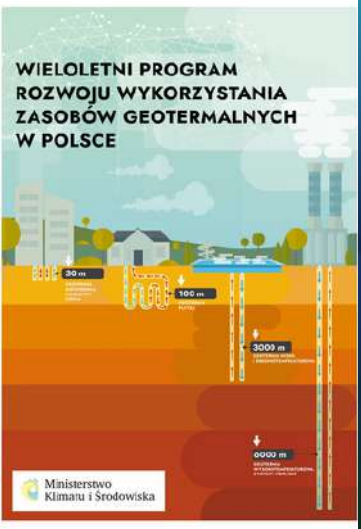
- **Awareness raising:** Outreach to horticulture and aquaculture service providers. This can be supported by leading governments and companies in the field as well as peer-to-peer engagement.
- **Guidance on designing individual and collective geothermal systems:** This will facilitate the design of geothermal systems and the selection of the appropriate business models.
- **Finance:** A combination of EU funds, European financial aggregation and private sector capital will be catalysed for each investment.

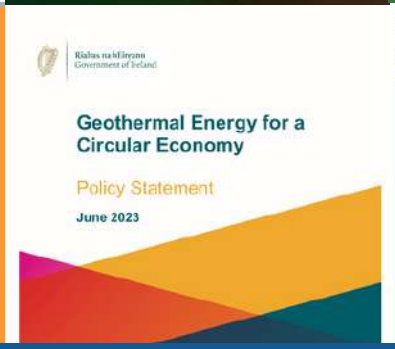
Recommendation 6:
Develop Geothermal Sectoral Agreements in the framework of the Geothermal Industrial Alliance

These agreements must be tailored to address the distinct needs and challenges of key end-users by providing targeted support in areas like capacity building, finance, and technical assistance.









Austria, Croatia, France, Germany, Hungary, Ireland, Poland and Portugal, as well as China, India and the USA have produced national geothermal roadmaps.

National Geothermal Roadmaps

Austria, Croatia, France, Germany, Hungary, Ireland, Poland and Portugal have already launched their own national geothermal roadmaps to address specific issues and highlight those that require EU support. Whilst these are important measures, some of these roadmaps have been designed without a shared European objective.

Each national roadmap focuses on specific barriers and issues. For example, the Polish roadmap seeks to give the country a competitive advantage by specialising in borehole and aquifer storage, as well as minewater projects, to capitalise on its coal mining legacy.[xlix] Meanwhile, the French geothermal roadmap identifies 50 targeted actions, in 8 priority areas, to nurture their domestic market and meet the 100 TWh target as well as positioning French industry to capitalise from growing markets in Europe and abroad. Action 3A aims to increase the visibility of geothermal drillers. The main stakeholders in France – industry, trainers, qualification and certification bodies - were tasked with developing a national training and certification framework. This led the *Ecole Française de Forage* (EFF) to announce a new training programme for geothermal drillers in 2025. Furthermore, the training is provided in French for all French speakers in Luxembourg, Belgium and Switzerland. This is the type of cross-border cooperation the Geothermal Industrial Alliance is expected to foster. The German roadmap identifies a suite of legislative reforms which are incorporated into the Geothermal Acceleration Act, which is currently going through Germany's Federal Parliament.

Regional and Municipal Geothermal Roadmaps

Regional governments across Europe have also taken the lead in mapping their needs, potentials and roadblocks, as well as measures to develop their markets.

In the Netherlands, the **Province of North Brabant** produced a Geothermal Energy Acceleration Plan in 2024 to address the slow investment rate compared to other regions.[lii] The Plan includes four working groups which focus on: knowledge, information and communication; reducing development risks; investments in the Roerdalslenk area; and matching demand and supply. Specific actions are outlined in each of the working groups to ensure implementable solutions are tailored to the specific needs of the province.

In Germany, the **Munich city government** and its public energy company - Stadtwerke München (SWM) – are working to achieve carbon-neutral heating by 2040.[liii] SWM is one of the leading investors in geothermal systems, including innovative district cooling systems. The 2040 plan builds on this by identifying the opportunities for regional deployment and investment timescales to ensure residents, businesses and industry actively participate in the transition.[liv] An interactive map has been made available which indicates where geothermal sites currently exist as well as planned sites.[lv]

The government of **Northern Ireland** has established a Geothermal Advisory Committee to advise on the growth of the sector with coordinated action from the UK government, local agencies and the industry. A roadmap was commissioned to scope out "confidence-building actions that link sector potential with actual geothermal projects on the ground".[li] This led to a series of awareness-raising activities, such as, a partnership with the Rural Housing Association to make pilot investments with high replication potential. Exploration for a geothermal system for the Stormont Parliament building complex was recently completed. Exploration for potential resources for large-scale industrial/commercial geothermal energy systems and social housing projects is currently underway across the region.

The European Geothermal Strategy and Action Plan will provide a framework for the development of geothermal across Europe and globally. It will act as the springboard for countries and regions to design their own national roadmaps and focus on addressing specific domestic opportunities and challenges. This can be achieved through peer-to-peer knowledge sharing from countries that have already published national geothermal strategies.

Recommendation 7:
Facilitate the development of national, regional and municipal geothermal roadmaps

1. The Geothermal Industrial Alliance should provide a dedicated workstream to facilitate peer-to-peer guidance between governments that have developed geothermal roadmaps and those that have yet to do so - identifying local barriers and measures to unlock investments.
2. An additional workstream in the Geothermal Industrial Alliance should focus on facilitating geothermal roadmaps at the regional and city levels, as well as capacity building in energy agencies.

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ALDI and IKEA use geothermal heat pumps in their stores across Europe

© Alamy BD0DEA - IKEA, Ballymun, Dublin, Ireland

Market and Value Chain Development

A local and skilled workforce, combined with '*Made in Europe*' materials, is a core feature of the geothermal sector. The current workforce and expertise are European. Manufacturing and machinery are predominantly produced in Europe, too. The geothermal sector is also a consumer of European raw materials such as sustainable cement, steel and chemicals.

The EU is a net exporter of many services and equipment for geothermal technologies, including Organic Rankine Cycle (ORC) and heat exchanger manufacturers, facility constructors and, to a lesser extent, flash power turbine manufacturers. However, some sectors are dominated by non-EU companies, including pumps, valves, and control systems. Exploration and drilling services are expanding, also aided by the interest of the oil and gas industry.

The production of geothermal heat pumps is mainly European, with companies assembling components. However, compressors and electronic modules and increasingly being produced outside Europe, with imports from China doubling between 2021 and 2022. The USA is developing its domestic industry and has adopted a support system through the Inflation Reduction Act that will facilitate the installation of heat pumps in the US and also exports to Europe.

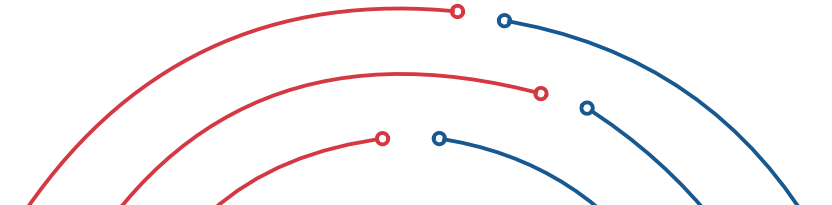
Market development

One of the main reasons why geothermal has received so little political attention is the lack of statistical data to inform policy decisions. There is no single indicator of geothermal electricity, heating, cooling or storage in the data compiled by Eurostat, for example.

European data on heat pumps undermines geothermal. It focuses on the number of units sold and does not distinguish between type – geothermal, air-source, etc - and, importantly, size and lifetime. Size is a good indicator of whether the heat pump is used for air conditioning, hot water or heating and cooling. The efficiencies of geothermal heat pumps, measured in Seasonal Performance Factors (SPF), are considerably higher, which means they have the least impact on electricity grids. This is the first point in Poland's national geothermal roadmap, which states, "*Their high efficiency means that they consume much less electricity than air-source heat pumps, thus avoiding large power draws from the grid (e.g., during heavy frosts, when using air-source heat pumps)*".[lvi] Furthermore, geothermal heat pumps can often provide more than one service: space heating, hot water and also passive cooling. Geothermal is also classed as "other" in European district heating data. Combined, it gives the impression that geothermal heating and cooling operations do not exist, which impacts negatively on consumer choice The Geothermal Industrial Alliance must be tasked to address the EU statistical data collection issue.

"Made in Europe" manufacturing

The EU's Net-Zero Industry Act (NZIA) promotes the development of net-zero acceleration 'valleys'. Geothermal industrial valleys will guarantee Europe's energy independence and energy security.



A single geothermal energy plant can produce electricity, heating, cooling, and raw materials, such as lithium, with a zero-carbon process. They represent a transformative concept poised to reshape Europe's economic landscapes. These systems aim to support the transition of regions from conventional energy sources to sustainable, self-reliant hubs for geothermal renewable energy to supply local energy generation, distribution, and consumption. Geothermal resource manufacturing of geothermal equipment is already made in Europe, allowing local supply of components and materials for geothermal technologies with European steel, cement, and chemicals. Reforms to the State Aid guidance are required to facilitate the development of Geothermal Industrial Valleys. Grants, loans and guarantees are required to support increased production in existing manufacturing lines and the construction of new facilities.

Moreover, **geothermal energy merits its own category in the NZIA**. At present, geothermal is listed alongside heat pumps. This means that the electricity, storage, sustainable mineral extraction and direct heating and cooling applications are not supported by the NZIA framework.

Workforce Development

Two changes are required:

- **Effective implementation of Geothermal HP driller training and certification**: Austria, France, Germany, Sweden and Switzerland are a few countries with national standards for geothermal heat pump drillers. They ensure high quality and should address the fears of water authorities and allow for mass deployment. Drilling certification is a requirement of the 2023 revision of the Renewable Energy Directive. As mentioned, the EEF Training programme has been opened to French-speaking drillers across Europe. Similar activities are required for other regions and linguistic groupings. Recognition of in-house training will also be explored with a standardised curriculum.

- **Capacity building in permitting agencies and municipal governments:** Increasing the pool of experts in permitting agencies is part of the process to make the timelines shorter, whilst ensuring the highest environmental standards are applied. As mentioned above, municipal governments are under increased pressure to plan and design heating and cooling systems. Capacity building and peer-to-peer exchanges are crucial to building understanding and confidence.

International cooperation

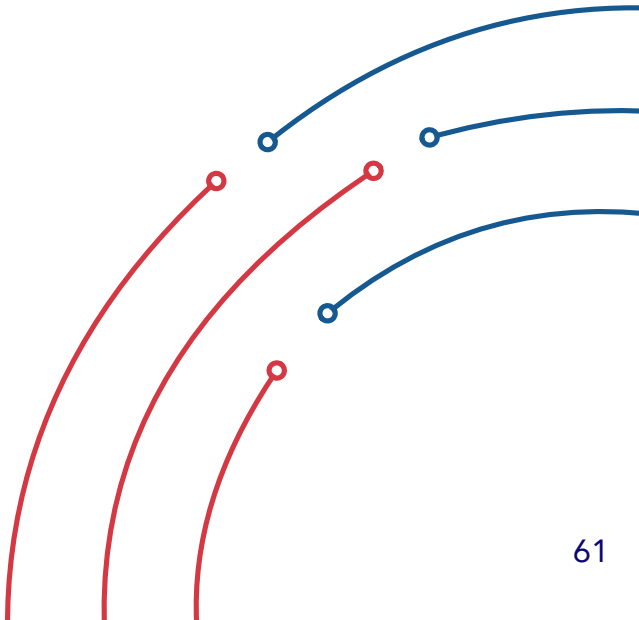
The EU's Global Gateway seeks to mobilise €300 billion for investment in sustainable infrastructure projects in energy, transport, health and education globally. This is the perfect opportunity to ensure the EU fulfils its core mission to bring and maintain peace in the world through inclusive energy transitions based on geothermal energy. This can also be achieved in collaboration with other international partners.

The rest of the world is also turning to geothermal. India is the latest major economy to publish a national geothermal plan. Ukraine's National Energy & Climate Plan includes a target to develop 40 MW of geothermal capacity by 2030. Countries such as Jordan, Tajikistan, Uzbekistan, Kyrgyzstan, Kazakhstan, Türkiye and Pakistan have participated in an IFC/World Bank initiative to develop networked geothermal systems through a programme of feasibility studies combined with access to concessionary finance or catalysing donor funding. Partnerships with these and other international entities will extend the reach of the Global Gateway and the reach of European expertise.

This will follow the path trailed for renewable hydrogen, in which the European Commission formulated Green Hydrogen Partnerships and memorandums of understanding to foster international markets in Egypt, Japan (which signed a geothermal Memorandum of Cooperation with the USA in 2023), Kazakhstan, Morocco, Namibia, and Ukraine. Association Agreements with Chile, India and Australia provide opportunities for geothermal market development to be prioritised alongside green hydrogen.[lvii]

Recommendation 8:
Support Market and Value Chain Development in the framework of the Geothermal Industrial Alliance

Strategic attention is needed to effectively dismantle existing market barriers, support manufacturing and workforce development, harmonise statistical data collection, and build export markets.



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xxvi These would operate on the same basis as the support provided for additional wind manufacturing capacity - see for instance the commitment from the EIB and its progress monitored by Wind Europe
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xxx Oak Ridge National Laboratory (2023) Grid Cost and Total Emissions Reductions Through Mass Deployment of Geothermal Heat Pumps for Building Heating and Cooling Electrification in the United States
xxxi See Eurelectric's Power Summit
xxxii Compare section 4.1, 4.3, 4.4 with 4.6 for electricity generation from solar PV, wind, ocean energy and geothermal. Section 4.18 (geothermal cogeneration), 4.22 (production of heat/cool from geothermal) in the Annex 1 of Regulation 2021/2139.
xxxiii This is similar to the 2021 agreement with Hydrogen Europe

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