In Poland, three of the country's ten district heating networks were commissioned in 2024, adding a combined capacity of 35 MWth. In Kołło, the operator Geotermia Kołło inaugurated a 17.4 MWth geothermal plant in the first quarter of 2024, expected to generate around 5.5 GWh (0.5 ktoe) in its first year of operation.

MIASTO KOŁO

+0.3%

The growth of primary energy production
from geothermal energy in the EU27 between 2023 and 2024

GEOTHERMAL ENERGY BAROMETER 2025

A study carried out by EurObserv'ER.

According to EurObserv'ER, the contribution of geothermal energy within the European Union remained broadly stable between 2023 and 2024, with primary energy production steady at around 6.6 Mtoe. This renewable resource is mainly used for heating, less often for cooling, and for power generation, depending on aquifer temperatures. At present, the most dynamic sector is heating, driven by the development of new geothermal district heating networks, whose output rose by 4.6% between 2023 and 2024, reaching 993.4 ktoe. Conversely, geothermal electricity generation decreased slightly in 2024 (–0.9%), due to reduced output from Italian plants, which account for just over 90% of Europe's geothermal power production.

6.2 TWh

The electricity production
from geothermal energy in the EU27 in 2024

993.4 ktoe

The heat consumption
from geothermal energy in the EU27 in 2024

Geothermal energy harnesses heat stored underground, which can be used to heat buildings, supply cooling, produce domestic hot water, or generate electricity. The technologies and applications vary depending on the temperature of the soil or aquifers being tapped. Deep geothermal energy generally exploits subsurface water reservoirs with temperatures ranging from 30 °C to 150 °C, most often located at depths between 500 and 3 000 meters. These deep aquifers—geological formations that are porous or fractured and saturated with water—are usually found in sedimentary basins of sand, sandstone, limestone, or chalk. Their thermal properties often make it possible to transfer heat directly, without a heat pump. However, very high-capacity heat pumps can also be installed to enhance the performance of a district heating network by raising the delivered temperature and making fuller use of the geothermal resource. Heat extraction from aquifers is usually organized around a geothermal "doublet," consisting of a production well to draw up the resource and a reinjection well to return the cooled fluid.

When aquifer temperatures range between 30 °C and 150 °C, geothermal heat can be used to supply urban district heating networks, or directly heat individual homes, apartment blocks, or agricultural facilities. When temperatures range from 90 °C to 150 °C, electricity can also be generated using binary-cycle technology. In such plants, the extracted geothermal fluid—whether liquid or gaseous at the surface—transfers its heat to a secondary working fluid with a boiling point below 100 °C. This secondary fluid vaporizes, and the resulting steam drives a turbine to produce electricity. Such plants may also operate in combined heat and power (CHP) mode, providing both electricity and heat to a network. When aquifers exceed 150 °C and reach up to 250 °C, typically at depths greater than 1 500 meters, the water emerges at the surface as steam, which can directly power turbines to generate electricity. This is referred to as high-enthalpy geothermal energy, mainly found in volcanic regions or at the boundaries of tectonic plates.

So-called "geothermal" heat pumps, which extract shallow heat from the ground or from near-surface aquifers (shallow geothermal), are not included in official geothermal energy statistics (from Eurostat or other statistical agencies). They are instead grouped under the category of "ambient energy." Consequently, heat pumps and the energy they produce are excluded from this barometer.

At EU level, geothermal primary energy production remained practically unchanged between 2023 and 2024, at 6.6 Mtoe. Final consumption of geothermal energy—covering electricity, heating, and cooling—was also stable, reaching about 1.5 Mtoe in 2024: 533.4 ktoe from electricity generation (equivalent to 6.2 TWh) and 993.4 ktoe from heating and cooling. However, EurObserv'ER points out that this overall stability conceals two opposing trends: a slight decline in electricity generation and steady growth in heating and cooling consumption.

A particular feature of geothermal energy is that final energy delivered to consumers is much lower than the available primary energy, since a large portion of the underground heat cannot be captured—especially when converted to electricity. For example, power plants using medium-temperature aquifers often operate at an effective efficiency of only 10–15%, much lower than the theoretical Carnot limit. Even for direct heating applications, losses occur during pumping, transfer, and distribution, which reduce the actual amount of heat delivered to end users. The significant gap between primary and final energy therefore reflects both the inherent physical limits of conversion and the unavoidable technical losses involved in geothermal energy use.

Tabl. n° 1

Primary energy production from geothermal energy in 2023 and 2024 (in ktoe)*

	2023	2024*
Italy	5 051.0	5 008.4
France	456.6	469.1
Germany	397.5	432.7
Portugal	191.0	191.0
Hungary	181.0	184.6
Netherlands	162.4	178.6
Austria	35.5	39.0
Bulgaria	37.1	37.7
Poland	32.8	37.2
Romania	25.3	25.3
Slovenia	13.9	13.7
Slovakia	8.7	8.8
Greece	7.6	6.0
Croatia	14.5	4.1
Belgium	3.7	3.7
Denmark	1.7	1.6
Spain	0.2	0.2
Total EU 27	6 620.6	6 641.7

** Estimate.* ***Source: EurObserv'ER 2025.***

HEAT AND COOLING PRODUCTION

Geothermal energy has multiple applications in heat production. Its primary use remains the heating of homes and commercial buildings via district heating networks, but it is also used in agriculture (heating greenhouses, drying crops, etc.), aquaculture, swimming pool heating, and cooling. Due to this diversity of uses, the thermal capacity of installations is not always monitored precisely or regularly by official sta&tistical agencies.

The European Geothermal Energy Council (EGEC) tracks the number and capacity of geothermal heating and cooling networks across Europe and within the EU. In 2024, Europe had 412 operational district heating networks in 29 countries, including 21 EU member states, as well as Iceland, Turkey, Switzerland, the United Kingdom, Serbia, Georgia, North Macedonia, and Norway, with a total installed thermal capacity of just over 6 GWth. The EU alone had 308 operational geothermal heating and cooling networks in 2024, with a combined capacity of about 2.4 GWth (up from 2.3 GWth in 2023).

According to EGEC, eight new urban geothermal heating and cooling systems were commissioned in the EU in 2024 (ten in Europe), representing an additional installed capacity of at least 110.1 MWth (+32.1 MWth in 2023). In detail, Poland commissioned three new geothermal plants (+34.8 MWth), the Netherlands one plant (40 MWth), France one plant (+16.6 MWth and 9.7 MWth of cooling), Greece one plant (+7.5 MWth), Romania one plant (+1.5 MWth), and a small installation in Spain whose capacity was not reported. EGEC notes that the four EU countries with the most geothermal district heating networks are France (80), Germany (40), the Netherlands (33), and Italy (30). A detailed country-by-country breakdown is available in EGEC's Geothermal Market Report 2024, published in July 2025.

At the EU level, heat production from the transformation sector—essentially the heat sold through district networks—is estimated by EurObserv'ER at 363.7 ktoe in 2024 (344.8 ktoe in 2023). In addition, heat directly consumed by end-users is estimated at 629.7 ktoe in 2024 (604.8 ktoe in 2023). Thus, the total geothermal heat consumed in the EU-27 reached 993.4 ktoe in 2024 (949.5 ktoe in 2023), representing growth of 4.6 %. The 2024 data are preliminary, based on EurObserv'ER questionnaires, and will be consolidated at the end of 2025 when published by Eurostat.

The commercial Eavor-Loop™ project in Geretsried, Bavaria (Germany) is scheduled to be commissioned in 2026. This innovative system, fully closed and fracking-free, is based on four loops (eight wells) drilled to depths of up to 4 500 meters. The unit is expected to be commissioned at the end of 2026, with an output of 64 MW of heat and 8.2 MW of electricity, avoiding 44 000 tonnes of CO_2 emissions per year.

UNAMBIGUOUS SUPPORT IN FRANCE

France is among the EU countries that have developed two deep geothermal sectors: one dedicated to heat (and cooling) production, and the other to electricity generation. In 2024, geothermal energy contributed approximately 200.4 ktoe to heat consumption, mainly in three regions: Grand Est, Nouvelle-Aquitaine, and Île-de-France. According to the French Association for the Promotion of Geothermal Energy (AFPG), deep geothermal energy is predominantly exploited through district heating networks, which account for 89% of the energy produced, or about 6% of the total

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In September 2024, a second geothermal district heating network was inaugurated in Champigny-sur-Marne, (Île-de-France). According to its operator, Coriance, Champigny 2 has a geothermal capacity of 16 MWth—the same as Champigny 1—supplemented by a 2.2 MW heat pump. Construction, which began in 2022, included 9.2 kilometers of piping and two wells drilled to a depth of 1 800 meters into the Dogger formation (69.4 °C; 350 m³/h).

energy distributed via these networks nationwide. Geothermal energy is also used to heat swimming pools, greenhouses, industrial facilities, and certain agricultural operations. Outside of district networks, AFPG counts: 2 swimming pools, 2 aquaculture farms, 1 agricultural site, 4 buildings for space and domestic hot water heating, and 1 industrial installation—the Ecogi plant in Rittershoffen, which continuously supplies steam to the agro-food company Roquette Frères. The heat capacity of geothermal installations is estimated by the SDES (Data and Statistical Studies Service) at 529 MWth in 2024 (485 MWth in 2023).

The geothermal district heating network in the Pleyel district of Saint-Denis (Île-de-France), accounted for by EGEC in 2024 was officially commissioned on 22 December 2023. The Île-de-France region notes, however, that operations began in late June–early July 2023, reaching full operational capacity by the end of the year, and thus achieving optimal performance in 2024. According to Engie, the network delivers 24.4 MW of heat and 14.2 MW of cooling, with geothermal energy covering 68% and natural gas 32%. The geothermal contribution therefore amounts to 16.6 MWth for heat and 9.7 MWth for cooling. The project included drilling 11 shallow aquifer geothermal wells paired with reversible heat pumps (thermo-frigo-pumps), along with the extension of the existing 10 km network. This infrastructure will supply up to 30 MWh/year of heat and 10 MWh/year of cooling for the future ZAC Pleyel area, converted from the Olympic and Paralympic Village, as well as the Pleyel Tower, which has been transformed into a hotel. Eventually, 609 000 m² of buildings will be connected, equivalent to 1 952 housing units. The plant prevents the emission of 4 747 tons of CO_2 per year. The total cost of 29 million euro is partially funded by ADEME Île-de-France, SOLIDEO, and the region. In September 2024, a second geothermal district heating network was inaugurated in Champigny-sur-Marne (not yet counted by EGEC). According to its operator, Coriance, the geothermal capacity of Champigny 2 is 16 MWth (same as Champigny 1), complemented by a 2.2 MW heat pump. Construction, begun in 2022, included 9.2 km of network and two wells drilled to 1 800 m into the Dogger formation (69.4 °C; 350 m³/h). The plant supplies 75% of distributed heat, equivalent to 5 477 housing units, with an annual output of 59 GWh, avoiding 9 500 tons of CO_2 per year. In June 2025, Coriance announced a 3.9 million euros investment to upgrade the Champigny 1 network: the cogeneration plant will be replaced by two heat pumps totaling 4.7 MW, raising the renewable share from 70% to 84%. These improvements will further reduce emissions by 2 200 tons of CO_2 annually, bringing the total savings to 13 300 tons.

France has set ambitious targets for geothermal energy, which enjoys strong political consensus. The multiannual energy plan (PPE2) sets a goal for 2028 of 4–5.2 TWh (343.9–447.1 ktoe) of final consumption of heat from deep geothermal energy. The AFPG, however, forecasts a production of around 3.66 TWh (314.8 ktoe) by that date.

In 2023, the government reaffirmed its commitment to reviving the sector through a national action plan aimed at making France a European leader in both energy and industrial terms.

The 15–20 year goal is to produce sufficient geothermal heat to replace 100 TWh/year of gas, more than Russia's imports before 2022. A key part of the plan involves identifying and developing underexploited deep aquifers to create new geothermal doublets for district heating networks. ADEME and BRGM emphasize the need to explore other geological horizons in Île-de-France beyond the Dogger, such as the Trias and Lusitanian formations, as well as other sedimentary basins: Aquitaine Basin, Southeast Basin, Bressan Graben, Rhône Corridor, Limagne, and Hainaut. These explorations are essential to increasing the share of deep geothermal energy in France's national energy mix.

GEOTHERMAL ENERGY BOOMING IN GERMANY

In Germany, geothermal energy is also experiencing significant growth, mainly for heat production. According to AGEE-Stat data, geothermal heat consumption increased by 6.9% between 2023 and 2024 in the country to reach 173.8 ktoe (i.e. 74.4 ktoe of derived heat and 99.4 ktoe of final energy consumption). According to the German Geothermal Association (Bundesverband Geothermie), as of 1 January 2025, the country had 42 deep geothermal plants (>400 meters), including 31 producing only heat, 9 operating in cogeneration, and 2 producing electricity only. The thermal capacity of heat-only plants is estimated at 408 MWth. The country also had over 170 spas supplied by geothermal energy.

As of January 2025, 16 installations were under construction and 155 were in the planning phase. Germany's geothermal potential is concentrated in three major geological zones—the North German Basin, the Upper Rhine Graben, and the Southern Molasse Basin—which offer favorable but heterogeneous conditions. Several exploration projects are supported by the federal government. Among them, the GIGA-M project (Großräumige Integrierte Gesamt-Analyse des tiefengeothermischen Potentials und seiner synergetischen Nutzung im Großraum München) aims to optimize the exploitation of the large deep geothermal potential to ensure climate-neutral heat supply for the Munich metropolitan area. The project focuses on exploring and better quantifying deep geothermal potential in the Munich area, currently tapped by around forty wells.

The municipal energy services company Stadtwerke München (SWM) aims to supply Munich's entire district heating from renewable sources by 2040, with the majority coming from geothermal energy. Other exploration campaigns are ongoing in Germany, such as the DemoCELL project in the northern basin, which aims to drill medium-depth wells to characterize the geothermal reservoir. This geothermal expansion in Germany is underpinned by strong political support. In August 2025, the federal government presented a draft law classifying geothermal energy as a priority public-interest project to facilitate and accelerate permitting processes.

POLAND, AN EMERGING MARKET FOR DEEP GEOTHERMAL ENERGY

In Poland, three out of the country's ten district heating networks were commissioned in 2024, adding a combined capacity of 35 MWth. In Koło, the opera-

Tabl. n° 2

Heat consumption* from geothermal energy in the countries** of the European Union in 2023 and 2024 (in ktoe)*

	2023			2024***		
	Total	of which final energy consumption	Of which derived heat**	Total	of which final energy consumption	Of which derived heat**
France	193.0	40.2	152.9	200.4	40.2	160.3
Netherlands	162.4	162.4	0.0	178.6	178.6	0.0
Germany	162.6	95.8	66.9	173.8	99.4	74.4
Hungary	159.0	85.4	73.6	163.4	85.4	78.1
Italy	132.2	107.8	24.4	130.0	106.0	24.0
Bulgaria	37.1	37.1	0.0	37.7	37.7	0.0
Poland	32.8	32.8	0.0	37.2	37.2	0.0
Austria	21.6	7.7	13.9	25.1	11.2	13.9
Romania	14.3	8.0	6.3	14.3	8.0	6.3
Slovenia	13.5	13.0	0.4	13.3	12.9	0.4
Greece	7.6	7.6	0.0	6.0	6.0	0.0
Slovakia	4.8	0.8	4.0	4.9	1.0	3.9
Croatia	4.2	4.2	0.0	4.1	4.1	0.0
Portugal	1.9	1.9	0.0	1.9	1.9	0.0
Belgium	1.7	0.0	1.7	1.7	0.0	1.7
Denmark	0.8	0.0	0.8	0.8	0.0	0.8
Spain	0.2	0.2	0.0	0.2	0.2	0.0
Total EU 27	949.5	604.8	344.8	993.4	629.7	363.7

** Heat consumption is equivalent to Final energy consumption in «Industry» and «Others sectors» except transport and gross heat production in the transformation sector. ** Gross heat production in the transformation sector. *** Estimation.* ***Source: EurObserv'ER 2025.***

tor Geotermia Koło inaugurated a geothermal plant in the first quarter of 2024 with a capacity of 17.4 MWth, expected to produce around 5.5 GWh (0.5 ktoe) in its first year of operation. The first well was drilled to 2 980 meters and the second to 3 905 meters, reaching a temperature of 90 °C and a flow rate of 86.4 liters per second. In addition to geothermal energy, the network is supplied by four coal boilers and one biomass boiler. Geotermia Koło Sp. z o.o. plans to meet about 80% of the annual heat demand with geothermal energy, the remainder coming from biomass (10%) and coal (10%). This project reduces coal consumption by approximately 8 000 tons per year and avoids nearly 20 000 tons of CO_2 emissions. The total investment, estimated at 27 million euro, was financed through a mix of public subsidies, a concessional loan from the National Fund for Environmental Protection (NFOSiGW), and the operator's own funds.

The second project commissioned in Poland is the Sieradz plant. With a geothermal capacity of 9.3 MWth, the heating plant exploits geothermal heat via direct exchangers and two absorption heat pumps, supplemented by a biomass boiler and gas boilers. The total capacity of the installation is around 33 MWth. For the geothermal component, Geotermia Sieradz drilled two wells at depths of 1 500 and 1 990 meters, reaching a temperature of 53 °C and a flow rate of 70 l/s. The total investment amounted to 37 million euros, financed through co-funding, a NFOSiGW loan, and the operator municipal funds from PEC Sp. z o.o. of Sieradz.

In Konin, a geothermal doublet was drilled to 2 660 meters, exploiting a resource at 97.5 °C. The plant, with a capacity of about 8.1 MWth, covers nearly 10% of the city's district heating needs. Completed in October 2024 at a total cost of 67 million PLN (approximately 15.3 million euros), the project was financed through NFOSiGW grants and loans, supplemented by municipal contributions and the local operator MPEC Konin. This was the tenth geothermal district heating network in the country. An eleventh project, located in Turek (6.6 MWth), is under construction and expected to come online in 2026, covering roughly 40% of the city's heating demand.

Preliminary data provided to Eurostat indicate that geothermal energy production in Poland should increase by approximately 13.4% between 2023 and 2024, reaching 37.2 ktoe, with the figure to be consolidated at year-end.

In 2024, according to EurObserv'ER, only one small geothermal power plant was brought online in the European Union. Located in Bad Blumau, Styria, Austria, it was developed by Frutura, a fruit and vegetable producer. This modest facility makes use of surplus geothermal heat from its greenhouses. The unit generates around 625 MWh of electricity per year, with an average output of 70 kW (0.07 MW), avoiding 100 tonnes of CO_2 emissions each year.

THE NETHERLANDS PLANS TO DOUBLE GEOTHERMAL PRODUCTION BY 2030

In 2024, according to Statistics Netherlands, the 23 operating geothermal installations in the country collectively produced 178.6 ktoe of geothermal energy, an increase of 10% compared to 2023. This growth marks a recovery in annual geothermal production after a period of stability between 2022 and 2023, which was due to the temporary shutdown of several installations for maintenance. The significant increase in 2024 is mainly explained by a higher average number of operating hours per installation, as the new doublets commissioned during the year contributed only modestly to total production.

The Aardwarmte Maasdijk geothermal project, located in the Westland horticultural region, was the only project to be commissioned in 2024. The first geothermal doublet, with a capacity of 15 MWth, was officially inaugurated in March 2025 out of three planned on the site. All were drilled to approximately 2 900 meters, exploiting a resource at around 90 °C. According to TNO (Netherlands Organization for Applied Scientific Research), the first two doublets were actually put into service in 2024, before the official inauguration, with the first heat delivery on 21 October 2024. Production that year was limited due to a small fire on 2 November in the plant, caused by rock oil returning from the depths during geothermal extraction. The plant was shut down for cleaning and only resumed operations in March 2025. The system is designed to produce 50 MWth of heat, meeting the heating needs of approximately 54 000 households. The EGEC estimates the plant's geothermal capacity at 40 MWth. The project was developed by the Maasdijk Heat Cooperative (Warmtecoöperatie Maasdijk) and the public company HVC, with an investment of nearly 115 million euros financed by a banking consortium (BNG Bank, ING, Rabobank, Triodos Bank, and asr). The heat produced will eventually supply around 70 horticultural operations, covering approximately 500 hectares, with planned connections to residential and public buildings as well. This project contributes to the local energy transition by reducing dependence on natural gas. Other significant geothermal projects for greenhouse heating are under construction in the Netherlands, such as the Zoetermeer project, which reached a key milestone in 2024 with the completion of geothermal well drilling.

As part of the energy transition, geothermal energy plays an important role in the Netherlands in providing sustainable heat supply for both greenhouse horticulture and the built environment. The Dutch government aims for an annual geothermal production of 15 PJ (358 ktoe) by 2030 and 80 PJ (1 911 ktoe) by 2050. According to TNO, which publishes an annual geothermal report (Aardwarmte in Nederland 2024: hernieuwde groei in warmteproductie, onzekerheid vraagt om aandacht), the 2030 target of 15 PJ is likely to be achieved. However, the 2050 goal of 80 PJ of geothermal energy appears difficult to reach.

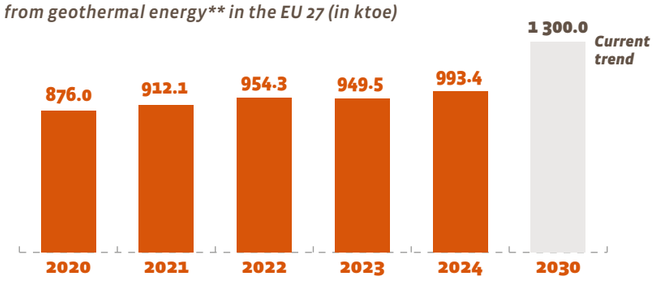
ELSEWHERE IN THE EUROPEAN UNION

In Greece, the Antheia geothermal plant was commissioned in 2024. It exploits the Aristinos-Antheia geothermal field, one of the largest in Eastern Macedonia and Thrace, using fluids with temperatures up to 90 °C to produce thermal energy at a depth slightly below 500 meters. The site's geothermal capacity is estimated by the EGEC at 7.5 MW. Most of this capacity is intended for agricultural use, while also benefiting municipal buildings. The system already covers the heating and hot water needs of Antheia's primary and secondary schools, as well as nine buildings of the SOS Children's Village, including seven residences and two administrative buildings. The EGEC also reports two small local geothermal district heating systems: the Alcaraz project in Spain, implemented by the engineering company Artecoin, and a small 1 MW geothermal heat pump system in Stei, Romania, developed by Termoline. These two installations are not classified as deep geothermal. In Romania, a more ambitious project, the Nufarul I plant in Oradea, was officially inaugurated on 29 May 2025, although technically completed in 2024. With a total cost of 25.6 million euros, partially funded by the European Union, the project is based on four wells drilled to 2 800 meters (two production and two reinjection wells) and develops a capacity of around 18 MWth. More than 270 mini-heating stations supply 6 000 apartments, equivalent to approximately 13 500 inhabitants. From the start, the installation covers around 15% of the city's district heating needs, with a medium-term target of 30%.

EurObserv'ER also identified a small project in Spain commissioned in 2024: the Pozo Fondón district heating network in Langreo, Asturias, developed by the public group Hunosa. The first phase, commissioned in 2024, relies on a 1.5 MW geothermal plant exploiting mine water from the Fondón shaft to supply several public and residential buildings, including a sports center, a health center, social housing, and a senior residence. The second phase, inaugurated in Octo-

Graph. n° 1

EurObserv'ER projection of heat consumption from geothermal energy** in the EU 27 (in ktoe)*



** Heat consumption is equivalent to Final energy consumption in «Industry» and «Others sectors» except transport and gross heat production in the transformation sector.* ***Source: EurObserv'ER 2025.***

THE NEW GENERATION OF GEOTHERMAL DISTRICT HEATING NETWORKS IN EUROPE

According to the EGEC, district heating and cooling (DHC) is entering a new era thanks to next-generation geothermal technologies. These future systems will feature high-capacity plants, reuse of existing wells, and exploitation of low-temperature resources.

Advanced geothermal systems (AGS) and enhanced geothermal systems (EGS) will no longer be limited to electricity production. They will allow for cogeneration installations (producing both heat and electricity) or even units solely dedicated to heating. A flagship example is the Eavor-Loop™ project in Geretsried, Germany, which is expected to supply 64 MW of thermal energy to the local heating network, in addition to 8.2 MW of electricity.

The reuse of existing wells is also beginning to develop. In Hungary, the first closed-loop geothermal plant was commissioned in 2021 in a former oil well, delivering 0.5 MW of thermal energy using MS Energy Solutions' WeHEAT technology. More recently, in 2023, the Eden geothermal plant in Cornwall (United Kingdom) inaugurated an innovative system: an insulated vacuum tube inserted into a 3 800-meter well, allowing hot water to be pumped and transferred via a heat exchanger to produce heat at 85 °C.

Several closed-loop technologies are currently attracting interest, including Green Therma, GreenFire Energy's GreenLoop™, and Wells2Watts. Pilot projects are already underway in Denmark, Germany, Romania, and Switzerland, with the objective of producing both heat and electricity.

Regarding EGS, Switzerland is developing a large-scale project in Haute-Sorne, aiming to produce up to 5 MW of electricity and supply a heating network. In France, the Ecogi plant in Rittershoffen (Alsace) has illustrated the potential of these technologies since 2016: designed as a "heat-only" unit, it continuously supplies industrial steam to the agro-food group Roquette Frères.

ber 2024, added a 1.5 MW biomass unit and expanded the network to new buildings, bringing the total installed capacity to 3 MW. Two thermal storage tanks of 12 000 liters each ensure better supply regulation. The installation reduces users' energy costs by at least 10% and avoids the emission of 1 300 tons of CO_2 per year. Co-financed by the European Regional Development Fund, the project is part of the regional energy transition strategy. A third phase is already planned to extend the network to additional buildings, with an estimated investment exceeding 700 000 euros.

DRILL (FOR GEOTHERMAL), BABY, DRILL, AND DRILL NOW!

By 2030, prospects for geothermal heat remain very encouraging. According to the EGEC, 484 geothermal district heating and cooling projects were under development in 2024 across the European Union, with Germany (169), Poland (72), Hungary (47), France (41), and the Netherlands (39) accounting for the largest number of projects. This represents a sharp increase compared to the previous EGEC study, which identified only 333 district heating and cooling plants under development in the EU. These projects potentially represent 636 installations to be put into operation in the coming years—more than double the number of operational projects at the end of 2024. In summary, the European market for geothermal district heating and cooling networks is poised for substantial growth, driven by political support, technological advances, and the need to develop sustainable energy solutions. According to the EGEC, focusing on low-temperature systems and innovative business models will be crucial to overcoming current challenges and meeting the ambitious goals set for the future.

The European Commission, via a written response from European Commissioner for Energy Dan Jørgensen to a question from MEP Davor Ivo Stier, reaffirmed the importance of geothermal energy for decarbonizing the EU's energy system. It highlighted that the development of this sector is still hindered by obstacles related to permits, financing, skills, planning, and data availability. To address these issues, the Commission plans to publish a heating and cooling strategy in the first quarter of 2026, accompanied by an action plan dedicated to geothermal energy. In the meantime, the implementation of recent directives on renewable energy and energy efficiency is expected to already favor the development of this energy source.

ELECTRICITY PRODUCTION

Geothermal electricity production involves converting the heat from high-temperature aquifers (150 to 350 °C) using turbo-generators. When aquifer temperatures range from 100 to 150 °C, electricity can also be generated using binary cycle technology. In this process, a heat exchanger transfers the aquifer's heat to a working fluid such as isobutane, isopentane, or ammonia, which vaporizes at a temperature lower than that of the water. This principle is employed by plants in Germany, Austria, and mainland France, notably at Soultz. Overall, the EU's geothermal electrical capacity has remained nearly stable. According to EurObserv'ER, installed capacity reached 1 047.7 MW, with an estimated net exploitable capacity of 878 MW in 2024, close to the levels of 2022 and 2023.

In 2024, only a single small geothermal electricity plant was commissioned in the EU. It is located in Bad Blumau, Styria, Austria. Developed by Frutura, this modest installation valorizes excess geothermal heat from its greenhouses using an ORC module supplied by Orcan Energy. The unit produces approximately 625 MWh of electricity per year, with an average capacity of 70 kW (0.07 MW), avoiding 100 tons of CO_2 emissions annually. Additionally, in April 2024, the 50 kW pilot geothermal plant in Centiba, Lendava municipality, Slovenia, partially came online. Built in 2023 by Petrol Geo for Dravske Elektrarne Maribor (DEM), this experimental installation tests a patented gravity geothermal heat-pipe technology that allows the reuse of old gas wells for electricity production.

The EU's net exploitable electrical capacity is distributed across seven countries: Italy (771.8 MW), Germany (48 MW), Portugal (29.1 MW), France (16.2 MW), Croatia (10 MW), Hungary (2.7 MW), and Austria (0.25 MW). This capacity is provided by approximately sixty active plants, distributed as follows: 36 in Italy, 11 in Germany, 3 in Portugal (Azores), 3 in France (Guadeloupe and Soultz), 3 in Austria, 2 in Romania, 1 in Croatia, and 1 in Hungary.

Italy is the EU's leading country for geothermal electricity production. It has two main production areas: Larderello-Travale/Radicondoli and Monte Amiata. According to Terna, the Italian grid operator, net capacity has not changed in recent years and remains at 771.8 MWe in 2024, for a nominal (motore primi)

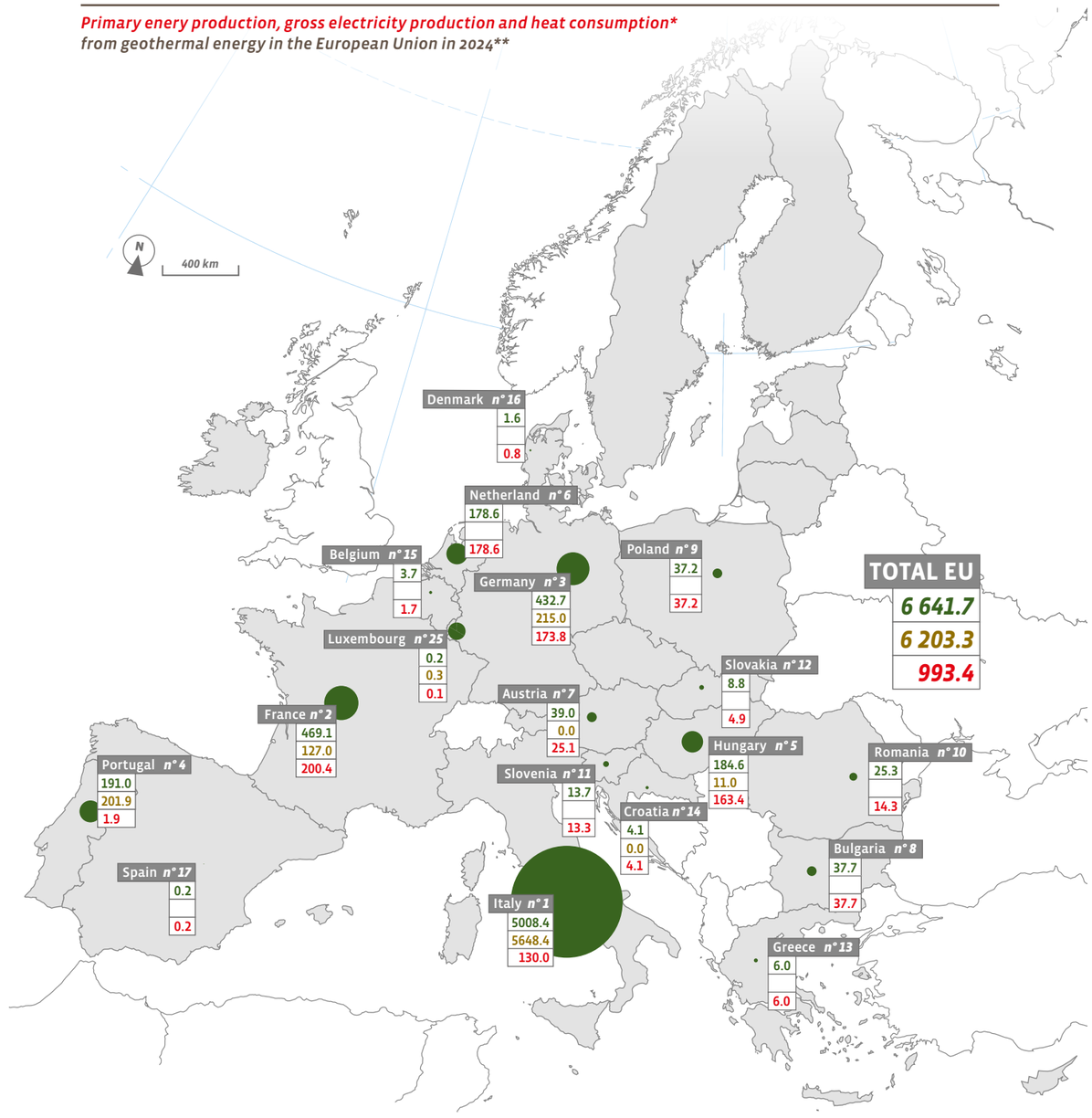
Tabl. n° 3

Capacity installed and net capacity* of geothermal electricity plants in the EU in 2023 and 2024** (in MWe)

	2023		2024**	
	Capacity installed	Net capacity	Capacity installed	Net capacity
Italy	918.8	771.8	918.8	771.8
Germany	57.0	52.0	57.0	48
Portugal	34.0	29.1	34.0	29.1
Croatia	16.5	10.0	16.5	10.0
France	17.2	16.2	17.2	16.2
Hungary	3.0	2.7	3.0	2.7
Austria	1.2	0.3	1.2	0.3
Total EU 27	1 047.7	882.0	1 047.7	878.0

** Net maximum electrical capacity. ** Estimation.* ***Source: EurObserv'ER 2025.***

Primary enery production, gross electricity production and heat consumption* from geothermal energy in the European Union in 2024**



Key

6 641.7 Primary energy production of geothermal energy in the European Union in 2024** (in ktoe)

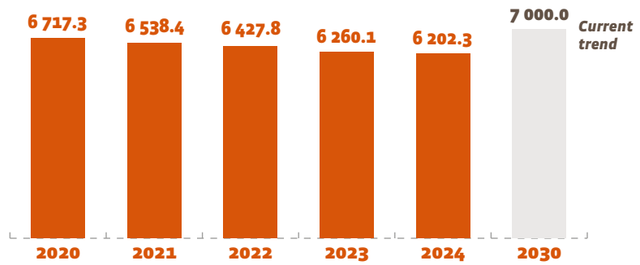
6 203.3 Gross electricity production from geothermal energy in the European Union in 2024** (in GWh).

993.4 Heat consumption* from geothermal energy in the European Union in 2024** (in ktoe).

**Gross heat production in the transformation sector and final energy consumption in Industry and «other sectors» (excluding transport) ** Estimation*
Source : EurObserv'ER 2025.

Graph. n° 2

EurObserv'ER projection of geothermal electricity production in the EU 27 (in GWh)



Source: EurObserv'ER 2025.

capacity of 918.8 MW. Electricity production slightly decreased by 0.8% between 2023 and 2024, reaching 5 648.4 GWh.

In Portugal, geothermal electricity production is concentrated in the volcanic Azores archipelago, specifically on São Miguel Island. According to the DGGE (Direcção Geral de Energia e Geologia), net exploitable capacity is around 29.1 MWe, with a nominal capacity of 34 MW. Portuguese geothermal electricity production slightly decreased from 207.5 GWh in 2023 to 201.9 GWh in 2024.

In France, two geothermal power plants are currently operational: Bouillante (Guadeloupe), consisting of two units—Bouillante 1 (B1) and Bouillante 2 (B2)—with a total installed capacity of 15.5 MW, and Soultz-sous-Forêts (Alsace), with a capacity of 1.7 MW. Together, these facilities produced 127 GWh in 2024, a level similar to 2023. At Bouillante, an extension project is underway with the construction of a new unit, B1 bis, which will add approximately 11 MW, financed by 22 million euros from the French Development Agency and several partners. Work began in March 2024, with commissioning planned for mid-2026. The new plant will adopt an innovative process: instead of directly using the steam from geothermal fluid separation, the heat will be transferred via a heat exchanger to vaporize a refrigerant. Eventually, the Bouillante plant could cover nearly 12% of Guadeloupe's electricity production.

Germany continues, in 2024, to operate 11 geothermal electricity plants: 9 in cogeneration and 2 producing electricity only (Dürrnhaar and Insheim). According to AGEE-Stat, nominal capacity was 57 MW in 2024, unchanged from 2023, or 2 MW higher than the German Geothermal Association's estimate. Net exploitable capacity was estimated at 48 MW, with electricity production of 215 GWh in 2024 (up from 195 GWh in 2023). Capacity is expected to expand in 2026 with the commissioning of the commercial EavorLoop™ project in Geretsried, Bavaria. This innovative, fully closed, fracking-free system uses four loops (eight wells) drilled up to 4 500 meters. The unit is expected to enter service at the end of 2026, with 64 MW thermal and 8.2 MW electrical output, avoiding 4 ,000 tons of CO_2 annually. The project received substantial financial support: 91.6 million euros from the European Innovation Fund and 45 million euros from the European Investment Bank. Other projects are underway, including the Deutsche ErdWärme geothermal plant in Graben-Neudorf (Baden-Württemberg). Drilled in 2022, the first well revealed water at 200 °C at 4 000 meters—a record for Germany at this depth. Tests conducted in 2024 confirmed injectivity above expectations. A multi-week injection test is planned for Q4 2025 to validate reservoir sustainability and test operational procedures, while drilling of a second well is already in preparation. A new platform has been installed, and planning for the future plant is progressing. The plant's end-use—whether cogeneration or heat-only—will depend on additional tests and infrastructure planning. Supplying heat to neighboring municipalities—Bruchsal, Dettenheim, and Bretten—remains a priority.

Tabl. n° 4

Gross electricity generation from geothermal energy in the European Union countries in 2023 and 2024 (in GWh)*

	2023	2024*
Italy	5 692.2	5 648.4
Germany	195.0	215.0
Portugal	207.5	201.9
France	128.8	127.0
Croatia	20.6	0.0
Hungary	16.0	11.0
Austria	0.005	0.000
Total EU 27	6 260.1	6 203.3

** Estimation.* ***Source: EurObserv'ER 2025.***

SLIGHT DECLINE IN ELECTRICITY PRODUCTION IN 2024

Gross geothermal electricity production in the European Union reached approximately 6.2 TWh in 2024, representing a slight decline of 0.9% compared to 2023. However, this overall figure masks disparities between countries: production fell in Italy, Portugal, Hungary, and Croatia, while increasing in Germany. These variations are mainly explained by maintenance operations. It is worth noting that the Croatian plant at Velika Ciglena (16.5 MW), located near Bjelovar, has been offline since June 2023. Due to disputes over ownership, the energy market operator (HROTE) suspended state subsidies, and a bankruptcy procedure was initiated in September 2025 at the Zagreb court, the outcome of which remains uncertain.

The geothermal project in the Pleyel district of Saint-Denis, in the Paris region, involves drilling 11 shallow geothermal wells equipped with reversible heat pumps and extending the existing heating network by 10 kilometres. The system will provide an annual heat supply of up to 30 MWh and a cooling supply of up to 10 MWh to the new urban district created from the conversion of the Olympic and Paralympic Village, the future Pleyel ZAC, as well as the Pleyel Tower, now converted into a hotel.

Many projects to be completed by 2030

The stagnation of the geothermal power plant market between 2020 and 2023 can be attributed to an unfavorable context: lack of regulatory support, political uncertainties, effects of the COVID-19 pandemic, the war in Ukraine, rising interest rates, and a stagnant electricity market. Since the development of a geothermal plant typically takes 5 to 7 years, few commissions are expected in the short term.

However, EGEC remains optimistic. According to the association, the market is entering a new phase, with numerous plants expected by 2030. In 2023, it recorded 34 projects under development and 145 projects under preliminary study in the European Union. Germany is expected to remain the most active country, with 17 projects underway and 18 others in preliminary investigation.

According to the EGEC, recent projects reflect a dual evolution of the geothermal sector. On the one hand, the growing maturity of binary cycle technologies allows the development of larger-scale installations. On the other hand, there is renewed interest in smaller plants, particularly those designed for cogeneration. This trend is accompanied by a strategic orientation toward project portfolio models: developers increasingly favor grouping projects, either within the same geological basin or across multiple regions, to distribute risk and streamline development. □

Sources : AGEE-Stat (Germany), Terna (Italy), SDES (France), Ministry of Industry and Trade (Czech Rep.), Danish Energy Agency, Statistics Netherlands, Ministry for the Ecological Transition and the Demographical Challenge (Spain), Statistics Austria, SPF Economie (Belgium), Statistics Finland, DGEG (Portugal), Croatian Bureau of statistics, Hungarian Central Statistical Office, EurObserv'ER, Eurostat.

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