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Geothermal Energy Use – Country Update for Poland, 2022–2024

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ABSTRACT

The paper presents an update on the development of geothermal energy use in Poland between 2022 and 2024. It follows the previous report (2019–2021) prepared for the European Geothermal Congress 2022 (Kępińska & Hajto, 2022).

By the end of 2024, nine geothermal district heating (geoDH) plants were in operation, including three launched between 2022 and 2024. The 10th geoDH plant in Konin (8.1 MW_{th} geothermal capacity) was completed in 2024, but geothermal heat production and sales had not yet begun that year. Their total installed geothermal capacity reached 219.3 MW_{th}. That marked a significant increase of 59% compared to 2021 (six plants, a total of 137.5 MW_{th}). Total geothermal heat production was about 360 GWh (1297 TJ) in 2024, a 30% increase compared with 2021 production. Across various DH systems, the contribution of geothermal to total heat sales ranged from 4.3% to 99%, with an average share of 56% and a median of 60%.

The geothermal recreation sector continued to expand, with at least 19 facilities in operation by 2024. Simultaneously, geothermal water was applied for treatments in 15 localities (including 14 health resorts).

Geothermal energy was also applied in single cases in several other sectors, including fish farming, wood drying, heating the football pitch, walking pathways and parking, CO_2 and bath salt extraction, cosmetics production, and food processing.

The shallow geothermal sector in Poland experienced significant growth in 2022 but has seen a decline in sales volume over the following two years (2023–2024). The decrease also applied to ground-source heat pumps (GSHPs). Rough estimates of the total number of operational geothermal heat pumps (94'300 units) suggest that the overall installed capacity was approximately 965 MW_{th}, while the geothermal heat generated was around 1378 GWh (4960 TJ).

Between 2022 and 2024, 10 new geothermal wells were drilled, reaching depths of 1.1–3.0 km and encountering geothermal waters with temperatures ranging from approximately 30°C to 90°C, primarily for geoDH applications. Furthermore, drilling activities for additional boreholes and other geothermal investments commenced, supported e.g., by government funding programs for geothermal heating development entitled *Accessing Thermal Waters in Poland* (introduced in 2020 as the successor of the previous priority program *Recognition of the geological structure of the country;* launched in 2016 and *Geotermia Plus* program).

Consequently, an increase in the number of district heating systems incorporating geothermal energy is anticipated in Poland in the coming years.

1. INTRODUCTION

Geothermal uses in Poland focus on direct applications, primarily space heating, bathing, and swimming (recreation), with a few cases of other applications. In the period 2022–2024, nine geothermal district heating plants were in operation – as compared with six geoDHs reported at EGC2022. The construction of a 10th plant in Konin was completed in 2024, but no heat was produced or sold yet. Furthermore, two geothermal recreation centers were opened.

Despite these developments, geothermal uses remained limited. However, the number of drilling projects and investments aimed at integrating geothermal energy into district heating systems continued to grow. That progress was primarily driven by public support programs that were gradually introduced since 2016, some of which were available in 2022–2024. In 2023,

public grants were awarded to 30 municipalities to launch new projects for drilling a first geothermal well, while others received low-interest loans for infrastructure development. Additionally, drilling continued for about 15 wells that had secured funding in a previous round of the program, which concluded in 2020 (results announced in 2021, drillings started/continued in 2022–2024).

Between 2016 and the end of 2024, a total of at least 19 geothermal exploration wells have been drilled. Additionally, in 2022, the *Multi-year program for the development of the use of geothermal resources in Poland until 2040/2050* (2021) was announced. What concerns geothermal uses development, the focus was on district heating. Consequently, geothermal energy is expected to be incorporated into a few dozen new district heating systems across the country in the coming years.

2. GEOTHERMAL ENERGY POTENTIAL

Geothermal energy resources in Poland are primarily found in Mesozoic sedimentary formations within the Polish Lowlands and the Inner Carpathians. Additional potential exists in selected areas of the Outer Carpathians, the Carpathian Foredeep (sedimentary reservoirs), and the Sudetes region, where fractured crystalline and metamorphic formations may offer viable prospects.

The best hydrogeological conditions for geothermal waters occur at depths of approximately 1.0 to 4 km, and temperatures not exceeding 100°C in an outlet. Locally, hotter waters were found in deeper geological structures. So far, the highest water temperature with proven reserves has been found in the city of Konin (in the area of the Mogilno-Łódź Trough): the geothermal water from the Lower Jurassic reservoir, captured by the Konin GT-1 well (final depth of 2660 m) has a reservoir temperature of 97.5°C and an outlet temperature of 92°C.

On a regional scale, the aquifers in the Lower Jurassic and Lower Cretaceous formations are sandstone complexes with favorable reservoir parameters, which translates into significant geothermal water intake capacities (Górecki ed., Hajto et al. 2006).

Proven geothermal water reserves for single wells vary from several to a maximum of 550 m^3/h. The total mineralization of these waters ranges from 0.4 g/l to 140 g/l, reflecting significant variability.

The most promising areas for deep geothermal development are closely linked to the distribution of terrestrial heat flow, which varies across Poland's geological regions. The Polish Lowlands have moderate to low heat flow (40–70 mW/m^2. The Sudetes and Fore-Sudetic regions show higher values (60–90 mW/m^2). In the Carpathians, heat flow is variable (50–90 mW/m^2). The Lublin, Podlasie and Suwalki regions have lower heat flow (35–55 mW/m^2), influenced by the thermally stable East European Craton. Localized geothermal anomalies occur in fault zones and sedimentary basins, notably in Szczecin–Mogilno–Łódź Trough and parts of the Sudetes (Szewczyk and Gientka 2009, Majorowicz 2021).

Additionally, significant development potential exists in the shallow geothermal sector, particularly through the use of ground source heat pumps (GSHPs).

3. OVERVIEW OF GEOTHERMAL USES

This chapter provides an overview of geothermal energy applications in Poland as of the end of 2024, with their locations depicted in Figure 1. Key data on geothermal installations are presented in Tables A–G.



Figure 1. Poland geothermal direct uses, 2024: 1. district heating plants, 2. health resorts, 3. recreation centers, 4. wood drying, 5. fish farming, 6. individual heating systems.

3.1 District heating

By the end of 2024, nine geothermal district heating plants were in operation (compared with six plants reported in 2021; Kępińska and Hajto 2022). Furthermore, the construction of a 10th plant in Konin was completed in 2024, but no heat was produced or sold yet.

The Podhale region. The geoDH system has been operational since 1993 and is constantly being expanded. The combined maximum artesian water flow rate from three wells is approximately 1070 m^3/h, with outflow water temperatures from 82°C to 86°C. By 2024 the system had an installed geothermal capacity of 94.8 MW_{th} (out of a total of approximately 140 MW_{th}), with geothermal heat sales reaching 512 TJ, accounting for around 99% of total sales (M. Pelczarska – pers. communication). In 2024, approximately 2000 buildings were connected to the geoDH system, primarily in Zakopane, the main city of the region. The system met about 40% of Zakopane's

heating demand. A portion of the spent geothermal water is reinjected through three wells, while the remainder is used to supply two recreation centers. The operator of that geoDH system is PEC Geotermia Podhalańska S.A.

In 2023, the company received public support for drilling the 4th production well and some surface infrastructure. This will increase capacity, heat sales, and enable new connections to the district heating network. The Podhale system is among the largest geoDHs in continental Europe, with ongoing optimization and expansion efforts.

In addition, the drilling of a deep (planned 7 km) research well began in Szaflary municipality (the Podhale region) in 2023. The project is supported by public funds and aims to widen the understanding of the geological structure and geothermal conditions of that region, potentially enhancing the effectiveness of geothermal heating investments in the region. The project is in the final phase of implementation.

Pyrzyce. The geoDH plant has been operational since 1996. The maximum water flow rate discharged by a production well is approximately 198 m³/h of 65°C water, highly mineralized (120 g/l). Spent water is injected back via four wells. In 2024, the plant's total installed capacity was 28 MW_{th}, including 12 MW_{th} of geothermal. It provided heat and domestic warm water to over 90% of the town's population (13'000 residents), meeting about 50% of the total heat demand. In 2024, geothermal heat sales decreased to 20.0 TJ, primarily due to maintenance works on the injection system (B. Zieliński – pers. communication). The operator of the plant is Geotermia Pyrzyce Sp. z o. o.

Mszczonów. The geoDH has been in operation since 2000. The maximum geothermal water flow rate is approximately 60 m³/h at 42.5°C with a mineralization of 0.5 g/l, produced by one well. In 2023, the second well was drilled, enabling the system to operate in a doublet configuration. In 2024, the geothermal capacity was 2.5 MW_{th}, while the total capacity 7.1 MW_{th} (including gas boilers, absorption heat pump, compressor heat pump). In 2024, geothermal heat sales were 15.2 TJ (ca. 38% of total heat sales, around 39.7 TJ) (M. Słowek – pers. communication). After cooling, water was used for drinking (via water supply system). Part of the geothermal water stream supplied the recreation center and, since 2021, a unique deep spot for free diving (approximately 45 meters deep). New projects aimed at improving geothermal energy efficiency and water management were in progress. The plants' operator is Geotermia Mazowiecka S.A.

Uniejów. The geothermal district heating (geoDH) plant has been in operation since 2001. The production well yielded a maximum discharge of 120 m³/h of 68°C water with a mineralization of 6–8 g/l. The total installed capacity was 7.4 MW_{th}, including 3.2 MW_{th} from geothermal, 1.8 MW_{th} from a biomass boiler, and 2.4 MW_{th} from fuel oil peak-load boilers. In 2024, approximately 80% of the town's buildings were supplied by the geoDH, with geothermal heat sales about 21 TJ, accounting for 60% of total heat sales (numbers assumed based on previous years). The expansion of heating network continues systematically, with new connections being added annually. The operator is Geotermia Uniejów Sp. z o.o. Beyond district heating, a substantial portion of the geothermal water was applied by spa and recreational facilities, also partially heated by geothermal. Additionally, the discharged water is repurposed for heating a football pitch and walking pathways. Uniejów has held the status of a health resort since 2012. In addition to the geoDH system and the aforementioned applications, various other geothermal applications have been implemented or are under development, further enhancing the town's sustainable energy infrastructure.

Poddębice. The geothermal heating plant began operation in 2013. As of 2024, the installed geothermal capacity reached 10 MW_{th}, with a total installed capacity of 18.6 MW_{th}. The plant uses water at 71°C, with a maximum flow rate of 252 m³/h and a mineralization of 0.4 g/l. It supplies heat to public buildings, schools, multi-family residential buildings, and a hospital (in a hospital – also geothermal water is applied for rehabilitation). The operator of the plant is Geotermia Poddębice Sp. z o.o. Part of the water stream supplied the *Hydrotherapy and Leisure Centre*, opened in 2022 (in site of the geothermal pools complex). In 2024, geothermal heat production was about 60 TJ, with 47 TJ sales, i.e. over 98.5% of total heat generation (A. Karska – pers. communication). The remaining demand was met by peak-load gas boilers distributed across multiple locations within the municipal heating network. Additionally, geothermal water was applied for potable purposes, albeit on a limited scale. Further applications of geothermal energy were in various stages of implementation and planning in 2024, expanding the scope of geothermal uses in that city.

Stargard. The geothermal heating plant has been in operation since 2012 (following a renovation). The owner of Geotermia Stargard is G-Term Energy Sp. z o.o. As of 2024, the plant was t based on two production and five injection wells, achieving a maximum production rate of 345 m³/h of 87–90°C water, with a mineralization level of 140 g/l. In 2024, the plant's geothermal capacity reached 44 MW_{th}, with annual heat sales amounting to 388.4 TJ, all of which was supplied to the municipal district heating system. The municipal heating network, primarily powered by a coal-fired plant with a total capacity of 120 MW_{th} (M. Stelmach – pers. communication), served approximately 75% of the city's population (75'000 residents). In 2024, geothermal energy accounted for 63% of the total heat sales to the city by that company. With further planned investments, those developments could enable geothermal energy to meet up to 90% of Stargard's heat demand in the future.

Toruń. The geothermal heating plant in Toruń was commissioned in October 2022. It operates on a geothermal doublet system. The approved exploitable

reserves are approximately 320 m^3/h of 61°C water. The installed geothermal capacity is 18 MW_{th}. Owned by Geotermia Toruń Sp. z o. o., the plant supplies heat to the Academy of Social and Media Culture complex as well as to a part of the municipal district heating system (serving above 100'000 citizens), operated by PGE Toruń S.A. (total installed heat capacity about 358 MW_{th}; https://pgetorun.pl). The planned annual sales of geothermal heat are about 230 TJ. In 2024, the share of heat from geothermal water and absorption heat pumps in total heat supplied into PGE Toruń network was 4.4% (106.6 TJ). The main heat sources were gas-fired CHP plant and peak gas boilers (ca. 95.5%). Biogas facilities contributed less than 1%. The geothermal heat sales via a municipal network in 2024 were very roughly estimated by the authors for ca. 50 TJ (based on general information on https://pgetorun.pl/o-spolce/efektywny-system-cieplowniczy).

Koło. The Koło geothermal heating plant was officially inaugurated in March 2024. It operates on a basis of a doublet of wells drilled in 2018. Geothermal water is produced from Lower Cretaceous sandstones. As in 2024, the geothermal water flow rate was 311 m^3/h at a maximum outflow temperature of 90°C, with mineralization about 104 g/l. The installed geothermal capacity was 17.4 MW_{th}, contributing to a total installed thermal capacity of 55.9 MW_{th}. Annual geothermal heat sales in 2024 amounted to 16.4 TJ, supplying 70% of the district heating system's total demand (J. Szwast – pers. communication). By using geothermal resources, the plant reduces reliance on fossil fuels, contributing to low-emission heat supply for the city. The operator of the plant is Geotermia Koło Sp. z o. o.

Sieradz. The geothermal district heating plant was launched in 2024. It is a geothermal-biomass facility with a total installed capacity of approximately 31.5 MW_{th}, of which 9.3 MW_{th} is derived from geothermal. The system is designed to meet the city's heating demand for 8–9 months per year and operates on a basis of doublet of wells (completed in 2018 and 2022, depths 1505 m and 1990 m). The geothermal aquifer is situated in Lower Jurassic sandstones. The proven water reserves are 250 m^3/h, with a temperature of 53°C and mineralization 2.6 g/l. Geothermal water is applied in two ways. Firstly, it serves as a heat source for the district heating system (preheating return water via plate heat exchangers, thereby raising its temperature to 52°C while cooling the geothermal water to 49–50°C). Secondly, it acts as a low-temperature heat source for two absorption heat pumps, each with a thermal output of approximately 10 MW, significantly enhancing the system's overall efficiency. Sieradz, a mid-sized city (approximately 40'000 inhabitants), operates a 40-km-long district heating network, which was previously reliant on two outdated coal-fired heating plants with capacities of about 50 MW_{th} and 20 MW_{th}. The city's peak winter heating demand reaches 50–55 MW_{th}, underscoring the need for a modern and sustainable district heating solution. In its first incomplete operational year (2024), the sales reached 6.2 TJ of geothermal heat, contributing to about 22.3% of the total district heating demand. The operator of the plant is PEC Sieradz Sp. z o.o. The geoDH is a major step toward low-emission renewable urban heating by maximizing the use of local geothermal resources.

Konin. The construction of the geoDH was completed in 2024. The operator of the plant is Geotermia Konin Sp. z o. o. Its capacity is 8.1 MW_{th}. The annual production is planned to be about 159 TJ (no production has been recorded in 2024). The plant is based on a doublet of wells. The outlet temperature of water extracted from the production well is 92°C, whilst the flow rate of 156 m^3/h. The Konin GT-1 production well reaches a total depth of 2660 m and has the highest temperature among all geoDHs in Poland, with a reservoir temperature of 97.5°C in the Lower Jurassic sandstones. This will be the third ecological heat source in that city, along with already operating biomass boilers (Konin Power Plant, PAK-PCE Biopaliwa i Wodór Sp. z o. o.) and the Municipal Waste Thermal Treatment Plant. The geoDH is set to start producing and selling heat in 2025 (S. Lorek – pers. information).

To sum up: Poland's geothermal district heating sector saw significant growth in 2022–2024, expressed by four new plants (three of them were put into operation in 2024). The total installed geothermal capacity across ten geoDH systems reached 219.3 MW_{th}, marking an almost 60% increase from 2021. Geothermal heat sales (by nine geoDHs) amounted to 1077 TJ (299.2 GWh), while total heat production can be estimated at 1297 TJ (360 GWh), i.e. 30% increase compared with 2021 data. Geothermal heat prices remained more stable and competitive with those of fossil fuel-based sources, including natural gas and even coal.

In addition to geothermal district heating systems, several recreational centers use geothermal water for pool filling, spa treatments, and facility heating. Furthermore, some individual buildings used geothermal energy for heating (power and heat values are not provided here).

Furthermore, a moderate-scale geothermal cogeneration installation for the production of heat, electricity, and cooling, integrated with a PV power plant and an energy storage system was constructed in Chochołów (Podhale region) as a result of project co-funded by EEA FM and NMF[1].

3.2 Health resorts, recreation, and balneotherapy

This category includes both health resorts and geothermal recreation centers. Between 2022 and 2024, two new recreation centers were launched: in 2022 the *Hydrotherapy and Leisure Centre* in Poddębice (built on the site of the geothermal swimming pools); in 2023,

[1] https://eko.chocholowskietermy.pl/hydro-geo-solar-english/

in Kazimierza Wielka commune (Carpathian Foredeep region). It is an open-air pool with sulfur water. The investment was based on geothermal water discharged by a well drilled in 2015 in Cudzynowice village[2].

In 2024, geothermal waters were applied for curative treatments in 15 localities in the country (including 14 health resorts). Approved water reserves ranged from approximately 2 to 205 m³/h, with outflow temperatures between 20 and 90°C. In some cases, when outflow temperatures were around or below 20°C, additional heating was required to meet SPA treatment needs. At least 19 geothermal recreation centers were operating, some hosting several thousand visitors each day. These centers are spread across various regions, including seven in the Podhale region, several in the Polish Lowlands, the Carpathian Foredeep, and the Sudetes. Some of these facilities do not have their own wells but rely on portions of geothermal water extracted by other enterprises, mainly for heating purposes.

Based on available data and previous reports, the total geothermal capacity in the bathing and recreation sector in 2024 could be roughly estimated at a minimum of 50 MW_{th}, with a total annual heat production of at least 200– 300 TJ. However, obtaining precise figures remains challenging due to limited access to technical data, complex system configurations, and incomplete facility records. The statistics shall be updated following the development of this sector.

Geothermal bathing and recreation continued to be a highly attractive sector, offering both health benefits and contributions to local economic development. Its further expansion is expected in the coming years.

3.3. Aquaculture and other uses

In addition to their conventional use for residential heating, recreation, and therapy, geothermal waters in Poland have been applied in various areas, usually on a small scale or in individual cases. These included:

- Aquaculture.
- Wood drying.
- Heating of football pitch, walking paths.
- Snow melting (e.g., parking areas).
- Cosmetics production.
- Agri-food processing.
- Drinking water supply.
- Bath salt extraction.
- CO_2 recovery.
- Algae cultivation.

Since 2022, no new geothermal installations have been launched in the above sectors, with all previously reported applications dating back to earlier years.

From the listed applications, the large commercial scale (although a single one) represents an Atlantic salmon farm, which has been operating since 2015 (http://www.lososjurajski.pl). It applies geothermal water and heat (in former years, its capacity was estimated for about 2 MW_{th} and an annual heat use for about 18 TJ; Kępińska and Hajto 2022).

According to the official annual statistics of the Polish Geological Survey, published in *The Balance of Mineral Resources in Poland*[3] as of December 31, 2023, 36 geothermal water deposits had been identified in the country, 25 of which were covered by exploitation licenses. The total proven reserves of those deposits were estimated at ca. 6000 m³/h, while the total geothermal water extraction amounted to over 13 M m³ in 2023. Details can be found in Szuflicki et al. (2024).

3.4. Shallow geothermal use with heat pumps

After several years of dynamic development of the whole heat pumps sector in Poland, in 2024, heat pump sales fell by more than 35% year-on-year on average, continuing a significant sales decline (around 40%) that began in 2023. The demand for heat pumps in 2024 was also lower than in 2021, the last year in over a decade that saw stable sales growth before market disruptions caused by the war in Ukraine. According to estimates by the Polish Organization for Heat Pump Technology Development (PORT PC), sell-in sales (to wholesalers and distributors) for different device categories were as follows[4]:

- Air-to-water heat pumps for central heating (and domestic hot water): approximately 70,000 units – a 37% decline compared to 2023.
- Ground-source heat pumps (brine-to-water) for space heating (and domestic hot water): approximately 6,000 units – over 25% decline.
- Air-to-water heat pumps for domestic hot water: approximately 4,600 units – a 16% decline.

The drop in sales was mainly due to unfavorable political and administrative decisions. PORT PC identified three key issues that negatively impacted the sector and restricted fair competition:

- Uncontrolled subsidies in the third beneficiary group of the *Clean Air*[5] subsidy program.
- Rising electricity prices affected most heat pumps' users, while natural gas prices remained frozen, and fossil fuels were supported.
- Non-recognition of European heat pump quality labels in the priority building retrofit support program, *Clean Air*.

GSHPs are installed for individual heating as well as for heating large-capacity facilities. They are also installed in some geothermal heating plants and

[2] https://wkielcach.info/aktualnosci/w-kazimierzy-wielkiej-otwarto-caloroczny-basen-termalny-z-woda-siarczkowa-zdjecia/
[3] https://www.pgi.gov.pl/oferta-inst/wydawnictwa/serie-wydawnicze/bilans-zasobow-kopalin.html
[4] https://portpc.pl/trzy-bledy-polityczne-oslabily-rynek-pomp-ciepla-w-2024-roku-czas-na-korekte-kursu
[5] https://czystepowietrze.gov.pl/

recreation centers. Increasingly, they work in both heating and cooling modes.

Despite a downturn in recent years, industry institutions and analysts expect the heat pump market in Poland will start to recover in 2025 and the forthcoming years. This will be possible after corrections of subsidy programs and improvements in the technology's public perception.

Market development forecast scenarios based on the PORT PC Market Report statistics for ground-source heat pumps until 2030 – depending on the scenario – may amount to 1.9–5.3 GW_{th} of installed thermal capacity (Ryżyński, 2022). These values fit nicely in the panorama of renewable energy sources that should be implemented in Poland to increase the share of RES in the national energy mix according to the *Polish Energy Policy until 2040*[6].

Rough estimates of the total number of operational geothermal heat pumps (primarily GSHPs) indicate an installed capacity of approximately 965 MW, with geothermal heat generation reaching around 4960 TJ. Trends in the development of the geothermal heat pumps' market (sales) in Poland from 2020 to 2024 are illustrated in Figure 2.

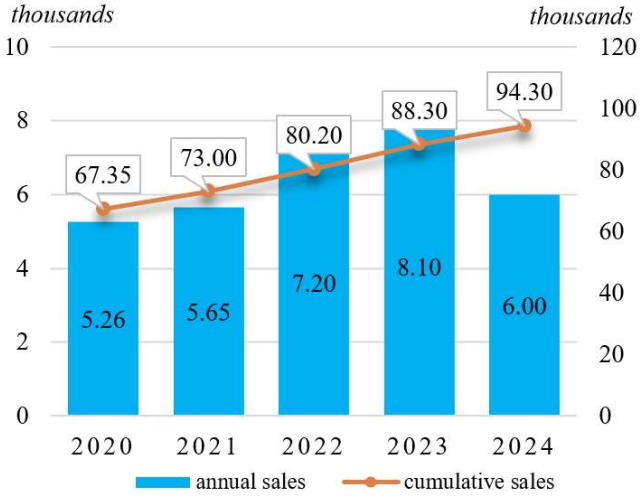


Figure 2. GSHPs' sales in Poland in the period 2020–2024 (based on data from PORT PC).

3.5. The RES technology demonstration activities

It is also worth mentioning the project *The Heating Plant of the Future* in Lidzbark Warmiński, completed in 2023 with the launch of the Technology Demonstrator. The plant operates entirely on renewable energy sources. Its main heat source consists of heat pumps (2.6 MW_{th}) integrated with three heat sources: air heat exchangers, a low-temperature ground storage system (300 boreholes, 100 m deep, temperature 5–15°C), and a high-temperature water storage system (15'000 m^3, temperature 10–60°C). The energy supply comes from photovoltaics (1.26 MW_{el}) and PVT panels (190 kWp). The system uses energy from solar collectors and, if needed, draws electricity from the National Power Grid, purchased with a guarantee of origin from RES under PPA contracts. The investment cost was PLN 49 million, financed by European Funds[7].

4. GEOTHERMAL SHARE IN RES MIX

According to the Polish Central Statistical Office (GUS), renewable energy production in the country has seen a steady increase from 19.4% in 2019 to 24.5% in 2023 (GUS, 2024; detailed data for 2024 were not available at the beginning of 2025). The primary sources of renewable energy were solid biofuels (60.1%), wind energy (15%), solar energy (7.5%), liquid biofuels (7.7%), ambient heat/heat pumps (4.5%), biogas (2.7%), hydro energy (1.5%), renewable municipal waste (0.8%), and finally geothermal (0.2%). In 2023, total renewable energy production reached 580.4 PJ. In comparison, the share of geothermal among renewable energy sources in the EU-27 was 2.8% in 2022.

Between 2019 and 2023, the national consumption of renewable energy grew by 10.7%, from 531.8 PJ to 588.9 PJ. Gross final consumption also rose by 2.8%, from 493.3 PJ to 507.3 PJ. Renewable energy was primarily consumed by end users (52.6%), with the remainder used for energy transformations in industrial settings. In 2023, renewables accounted for 16.5% of gross final energy consumption. This share was broken down into 25.7% in electricity, 20.3% in heating and cooling, and 6.0% in transport (GUS, 2024).

Solar energy has experienced significant growth from 2019 to 2023. Solar power capacity surged from 1539 MW_{el} to 16'428 MW_{el}, with electricity production increasing from 710.7 GWh to 11'107.1 GWh. Compared to 2022, capacity and production grew by 4321 MW_{el} and 2797.4 GWh, respectively.

In the coming years, the share of geothermal energy within the RES mix, including heat, is expected to increase. This growth will be driven by a rise in geothermal heat production and sales, supported by both existing and upcoming district heating systems with geothermal components, which are currently at various stages of development.

5. GEOTHERMAL DRILLINGS

From 2022 to 2024, at least ten prospection and production geothermal wells were drilled (total depths 1130–2930 m); see Figure 3. Most of those wells resulted from the first call of the priority program "*Accessing Thermal Waters in Poland*", which selected 15 municipalities to receive 100% grants. Further projects were initiated, with new wells expected to be drilled.

[6] https://www.gov.pl/web/climate/energy-policy-of-poland-until-2040-epp2040

[7] https://cieplowniaprzyszlosci.pl/en/demonstrator/

Additionally, in 2023, positive funding decisions were issued for the next 30 geothermal exploration wells in the second call of that priority program (https://www.gov.pl/web/nfosigw/wyniki-konkursu3). In 2024 and spring 2025, the negotiations were ongoing to sign agreements between the NFEP&WM (the operator of the subsidy program) and beneficiaries (municipalities). This process paves the way for the start of drilling, which will hopefully commence soon. These subsidized wells are part of larger investment projects designed to integrate geothermal energy into existing district heating systems, modernize infrastructure, and enhance energy efficiency.

Furthermore, it is worth mentioning the drilling of the ultra-deep well (planned 7 km) in the Podhale region (Szaflary municipality), which began in 2023. It is supported by the public funds and priority program *Recognition of the geological structure of the country* (the decision on funding was issued before 2022) and aims to widen the knowledge of the geological structure and geothermal conditions of that region. It is also expected that geothermal waters found in this well will form a basis to extend geothermal district heating in the Podhale (during the preparation of this paper in spring 2025, drilling and research works in that well had not yet been completed).

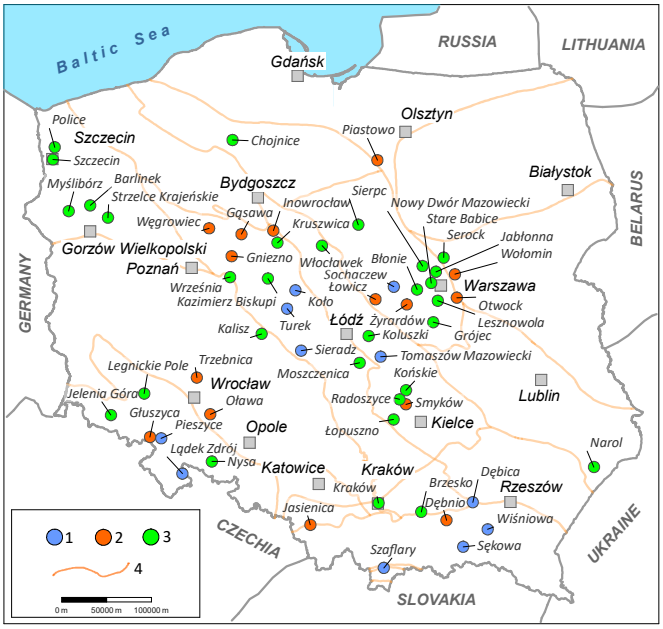


Figure 3. Municipalities that received public funding for drilling the first exploration /production well in 2016–2023: 1. Subsidized until 2018, 2. The first call in 2021, 3. The second call in 2023, 4. The extent of the main geological units in Poland.

6. INVESTMENT WORKS IN PROGRESS AND PLANNED

Between 2022 and 2024, alongside with drillings, investments to connect geothermal into several district heating systems and in relevant surface infrastructure were at various stages of development. They also focused on technological enhancements, improving the overall energy efficiency of geothermal uses, etc.

7. RESEARCH, EDUCATION, OTHER PROJECTS

During 2022–2024, alongside investment projects (supported by governmental programs), various studies, research, R+D+I work, awareness-raising activities were conducted (some will continue beyond 2024), dealing with a wide range of geothermal topics and co-funded by national, EU, EEA FM and NFM, other funds. Some main examples follow.

- *KeyGeothermal – Capacity Building of Key Stakeholders in the Area of Geothermal Energy* (keygeothermal.pl), the largest training project to date conducted by MEERI PAS, Poland and NEA, Iceland (http://www.keygeothermal.pl);
  GeoModel – Optimal Management of Low-Temperature Geothermal Reservoirs – Polish-Icelandic Cooperation on Reservoir Modeling, conducted by MEERI PAS and ISOR, Iceland (https://geomodel.pl);
  Geothermal Synergy: Iceland – Poland Knowledge Exchange, by MEERI PAS and NEA (http://www.keygeothermal.pl/geosynergy);
  User4GeoEnergy – Improving the Energy Efficiency of Geothermal Energy Utilisation by Adjusting the User Characteristics (http://user4geoenergy.net/).
  Co-funding: the EEA FM Environment, Energy and Climate Change program, 2014–2021, and Nordic Financial Mechanism, 2014–2021 in some cases. Another project (investment one) funded by the mentioned programs is listed in another chapter.
- *EnerGizerS – CO_2-Enhanced Geothermal Systems for Climate Neutral Energy Supply,* the project led by AGH University of Kraków (http://www.energizers.agh.edu.pl/). Financing: POLNOR 2019 Polish-Norwegian research projects financed under EEA and Norway Grants.
- *SAPHEA – Developing A Single Access Point for the Market Uptake of Geothermal Energy Use in Multivalent Heating and Cooling Networks Across Europe* with participation of AGH University of Kraków (https://www.saphea.eu/) as a project partner. Co-funded by Horizon Europe.
- Two pioneering projects on underground thermal energy storage (UTES): *Preliminary Assessment of the Feasibility of Implementing Aquifer Thermal Energy Storage (ATES) Systems in Poland* (https://www.pgi.gov.pl/srodowiskowa/bloki-tematyczne/ates.html); *Assessment of the Potential for Underground Thermal Energy Storage Using Closed Loop Systems (BTES, PTES/TTES, EF) in Selected Locations in Poland* (https://www.pgi.gov.pl/inzynierska/1-geologia-inzynierska/gi-projekty/15623-btes.html). The projects were commissioned by the Ministry of Climate and Environment, funded by the National Fund for Environmental Protection and Water

Management, and led by PGI–NRI in Warsaw, with significant contributions from AGH University of Kraków, MEERI PAS, and others serving as subcontractors.

- *The Heating Plant of the Future – Discover Geothermal Energy* – a series of workshops addressed to municipalities, investors, etc. Funding: the National Fund for Environmental Protection and Water Management (https://geotermiapolska.pl).

8. PROFESSIONAL PERSONNEL ALLOCATION

The number of professional full-time (and part-time) personnel employed in various geothermal activities (including scientific and research institutions, geoDHs, other installations, service, consulting companies, and geological surveys) is estimated to be around 250 people as of the end of 2024. Furthermore, a significant number of technical staff (in services, maintenance, management, etc.) has been employed at recreation centers (depending on their size) and health resorts, though these are not included in the total estimate here.

9. PROGRAMS TO SUPPORT GEOTHERMAL INVESTMENTS

9.1. Deep geothermal

In 2022–2024, several public priority programs were available to support (as grants or loans) the geothermal heating development (energy sector). Those programs have been gradually introduced since 2015/2016 (relevant information was given in a former report; Kępińska and Hajto 2022), some extended or updated. Thanks to them, in 2019–2024, at least 26 geothermal wells were drilled (including about ten in the period 2022–2024), and decisions were issued regarding the financing of a dozen of the next wells. The first programs concerned exploration/research wells, while the next ones focused on the energy use extracted from the identified geothermal resources, development of the necessary infrastructure, etc. In 2022–2024 these were the following priority programs initiated and operated by the Ministry of Climate and Environment and the National Fund for Environment Protection & Water Management; more details, e.g.: https://www.gov.pl/web/klimat ; https://www.gov.pl/web/nfosigw/

- *Accessing Thermal Waters in Poland* (2020–2028) – carrying out geological works and operations (including drillings) related to the search for and identification of geothermal water reservoirs with the aim to make them accessible for heating. The beneficiaries are local governments or their associations. The program provides 100 percent subsidies (and, to a small extent, loans). In total, it is planned to allocate approximately PLN 700 M in the years 2020–2028. In the period 2022–2024, funds were awarded for 45 projects (as mentioned in another chapter). If the borehole indicates the potential for economic use, heating companies can apply for co-financing for the construction of a geothermal heating plant from other programs or foreign funds[8].

- *Polska Geotermia Plus* (2019–2025) – the program aims to increase the use of geothermal resources in the country (support is in the form of grants and loans). The program is addressed to entrepreneurs. It indicates three obligatory tasks, the fulfillment of which determines the possibility of obtaining support. In 2022–2023, agreements were already concluded for the co-financing of several projects (including drilling), several wells, and other investments were finished or have been in progress[9].

- *County Heating* (2019-2025) – a program aimed at local governments and towns below 100’000 residents (returnable and non-returnable support) to co-finance modernization projects, heating networks’ expansion, and, among others, energetic use of geothermal resources[10, 11].

- *The EEA FM Environment, Energy and Climate Change program, Energy area, 2014–2021* – in 2020–2024 (https://www.eog.gov.pl/en): co-financing was provided to four projects, including one investment: “Constructing a geothermal cogeneration installation for the production of heat, electricity, and cooling, integrated with a photovoltaic power plant and an energy storage system” (HYDRO-GEO-SOLAR[12]). Three other non-investment projects are mentioned in another chapter. The next funding period of EEA FM and NMF was under negotiation at the beginning of 2025.

9.2. Shallow geothermal

In supporting the development and utilization of shallow geothermal resources, the nationwide subsidy program *Clean Air* plays a key role. Its primary objective is to improve air quality in Poland. The program has provided support for various heat pump technologies, including geothermal systems (GSHP, WSHP), contributing to their growth in the country – as a result, interest in that sector has increased. Additionally, other programs, along with thermal modernization relief, have further facilitated this development.

[8] https://www.gov.pl/web/nfosigw/udostepnianie-wod-termalnych-w-polsce-2021
[9] https://www.gov.pl/web/nfosigw/nowy-program-nfosigw-dla-przedsiebiorcow-polska-geotermia-plus-z-budzetem-600-mln-zl
[10] https://www.cire.pl/artykuly/serwis-informacyjny-cire-24/155698-nfosigw-chce-teraz-rozwijac-programy-wsparcia-geotermii,-biogazowni-i-przydomowych-magazynow-energii
[11] https://nfosigw.abmstudio.pl/oferta-finansowania/srodki-krajowe/programy-2022-2024/dobra-jakosc-powietrza/cieplo-powiatowe
[12] https://eko.chocholowskietermy.pl/hydro-geo-solar-english/

The *Clean Air* Program statistics indicate that, as of the end of October 2024, 2.8% of the 836'409 applications for co-financing the replacement of a heat source were GSHPs, totaling approximately 23'500 units since 2018. However, since the peak in 2023, when heat pumps (of all types) accounted for as much as 64% of subsidy applications, there has been a drastic decline in interest in these devices. By October 2024, heat pumps (all types) represented only 23% of the applications[13]. The topic was discussed earlier in the text.

10. INVESTMENTS IN GEOTHERMAL SECTOR (HEATING)

The investments in the geothermal district heating sector (taking into account the subsidies and loans from several public programs in 2022–2024) can be very roughly estimated at least 250 M € (completed drillings, related works and equipment; construction of three geoDHs plants launched in 2024, etc.). Part of those investments would be continued in 2025 and beyond, using the sources granted in 2022–2024. This is an approximate amount, probably underestimated. These numbers are given on a basis of publicly available information provided by programs' operators (National Fund for Environment Protection and Water Management, Ministry of Climate and Environment). Other investments in the district heating sector, investments in recreation, and other areas (funded by various sources, both public and private) are not given here (they could be quite significant due to extension, modernization etc. in some facilities).

11. LEGAL BACKGROUND, STRATEGIC DOCUMENTS

The references and provisions related to geothermal energy can be found in various national legal acts and other documents. Among key strategic documents in force in 2022-2024 were:

- *National Energy and Climate Plan, 2021–2030*: submitted to the EU in 2019; its update was presented for public consultation in October 2024. Geothermal energy is mentioned in the context of the modernization and transformation of district heating systems; as a contribution to energy efficiency and an example of primary energy definition; the development of technologies for energy production from geothermal sources, job creation, and economic growth.
- *Poland's Energy Policy Until 2040*: sets the framework for Poland's energy transition. The document was adopted in 2021. Defines the selection of technologies for building a low-emission energy system. Focuses on increasing the use of renewable energy technologies in heat production. Geothermal energy is considered in the context of district heating, hybrid systems, and energy security.
- *The Multi-year Program for the Development of the Use of Geothermal Resources in Poland until 2040 with a perspective until 2050*: announced in 2022. It is based on three pillars: 1. Research; 2. Execution and implementation of pilot installations; 3. Implementation, education, and promotion[14]. The document contains nine groups of main topics and activities, i.e.: Utilization of geothermal resources in ranges up to 45°C, above 45°C; utilization of high-temperature geothermal resources above 100°C (binary systems, HDR/EGS); use of groundwater and wastewater; development of deep borehole heat exchanger technology; innovative heat storage technologies in rock formations; insurance program for risk mitigation in geothermal projects; legislative support.

12. CLOSING REMARKS

Over the years 2022–2024, significant efforts have been made to develop geothermal energy use in Poland, primarily in low-emission heating. Those included drillings of over a dozen new wells, other related investments, and the commencement of operation of the next three geoDHs. Much of that advancement was possible through substantial public support programs. The geothermal recreation sector has also seen some growth. Furthermore, several other individual geothermal applications have been implemented. Next, drilling and investment works were in progress during the reported period.

For the current and future geothermal development in the country, an important fact took place in 2021/2022, when the *Multi-annual program for the development for the use of geothermal resources in Poland* was announced. A key driver for the increase of geothermal energy use is the need to decarbonize the heating sector, increase the share of locally sourced energy, and ensure both affordability and security of supply. Geothermal energy has the potential to address these challenges. Poland is expected to see further growth in geothermal-based installations in the coming years, particularly in the heating sector.

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[13] https://czystepowietrze.gov.pl/efekty-programu/zrodla-ciepla

[14] https://www.gov.pl/web/klimat/mapa-drogowa-rozwoju-geotermii-w-polsce

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Tables A-G

Table A: Present and planned geothermal power plants, total numbers

	Geothermal Power Plants		Total Electric Power in the country		Share of geothermal in total electric power generation	
	Capacity (MW_e)	Production (GWh_e/yr)	Capacity (MW_e)	Production (GWh_e/yr)	Capacity (%)	Production (%)
In operation end of 2024	0	0	-	-	-	-
Under construction end of 2024	0	0	-	-	-	-
Total projected by 2028	0	0	-	-	-	-
Total expected by 2032	0	0	-	-	-	-
In case information on geothermal licenses is available in your country, please specify here the number of licenses in force in 2024 (indicate exploration/exploitation if applicable):					Under development:	
					Under investigation:	

Note: Geothermal power plants of commercial scale may occur in future in single cases (capacity and production difficult to estimate at present, most likely up to 0.5-2 MW_{el}, CHP).

Table B: Existing geothermal power plants, individual sites

No geothermal power plants exist in Poland at present.

Table C: Present and planned deep geothermal district heating (DH) plants and other uses for heating and cooling, total numbers

	Geothermal DH plants		Geothermal heat in agriculture and industry		Geothermal heat for buildings		Geothermal heat in balneology and other	
	Capacity (MW_{th})	Production GWh_{th}/yr)	Capacity (MW_{th})	Production (GWh_{th}/yr)	Capacity (MW_{th})	Production (GWh_{th}/yr)	Capacity (MW_{th})	Production (GWh_{th}/yr)
In operation end of 2024	219.3	360.2						
Under construction end 2024	*~ 20*	*~ 40*						
Total projected by 2028	*~ 300*	*~ 460*						
Total expected by 2032	*~ 380*	*~ 580*						

Table D1: Existing geothermal district heating (DH) plants, individual sites

Locality	Plant Name	Year commis-sioned	CHP *	Cooling **	Geoth. capacity installed (MW_{th})	Total capacity installed (MW_{th})	2024 production (GWh_{th}/y)	Geoth. share in total prod. (%)
Podhale Region	PEC Geotermia Podhalańska	1993	-	Y	94.8	133.9	170.0	99.0
Pyrzyce	Geotermia Pyrzyce	1996	-	-	12.0	28.0	6.5	50.0
Mszczonów	Geotermia Mazowiecka	2000	-	-	2.5	7.1	4.6	38.2
Uniejów	Geotermia Uniejów	2006	-	-	3.2	7.4	8.0	60.0
Poddębice	Geotermia Podddębice	2013	-	-	10.0	18.6	16.6	98.5
Stargard	Geotermia Stargard	2005/2020[1)]	-	-	44.0	120.0	130.0	63.0
Toruń	Geotermia Toruń	2022	-	-	18.0	28.0	17.0	4.3
Koło	Geotermia Koło	2024	-	-	17.4	55.9	5.5	70.0
Sieradz	PEC Sieradz	2024	-	-	9.3	31.5	2.0	22.3
Konin	Geotermia Konin	2024			8.1	111.2	0.0	-
Total					**219.3**	**541.6**	**360.2**	**56.1** (aver.)

* If the geothermal heat used in the DH plant is also used for power production (either in parallel or as a first step with DH using the residual heat in the brine/water), please mark with Y (for yes) or N (for no) in this column.

** If cold for space cooling in buildings or process cooling is provided from geothermal heat (e.g. by absorption chillers), please mark with Y (for yes) or N (for no) in this column. In case the plant applies re-injection, please indicate with (RI) in this column after Y or N

1) Project renewal in 2020

Note: For 2024, the heat sales were given for individual sites (not production). Both sales and production are given as total numbers

Table D2: Existing geothermal large systems for heating and cooling uses other than DH, individual sites

Locality	Plant Name	Year commis-sioned	Cooling *	Geoth. capacity installed (MW_{th})	Total capacity installed (MW_{th})	2024 produc-tion (GWh_{th}/y)	Geoth. share in total prod. (%)	Operator
-	-	-	-	-	-	-	-	-
total				-	-	-	-	-

* If cold for space cooling in buildings or process cooling is provided from geothermal heat (e.g. by absorption chillers), please mark with Y (for yes) or N (for no) in this column. In case the plant applies re-injection, please indicate with (RI) in this column after Y or N.

Note: Several heating systems other than DH were operating in 2024 (individual buildings and H&C systems in recreation centres). No detailed data were collected.

Table E1: Shallow geothermal energy, geothermal pumps (GSHP)

	Geothermal Heat Pumps (GSHP), total			New (additional) GSHP in 2024 *		
	Number [1)]	Capacity[1)] (MW_{th})	Production[1)] (GWh_{th}/yr)	Number	Capacity (MW_{th})	Share in new constr. (%)
In operation end of 2024	94'300	965	1378	6000	61	10%
Of which networks **	-	-	-	-	-	-
Projected total by 2028	111'000	1150	1650			

* Distribution networks from shallow geothermal sources supplying low-temperature water to heat pumps in individual buildings ("cold" DH, Geothermal DH 5.0 etc.)

1) raw estimation

Table E2: Shallow geothermal energy, Underground Thermal Energy Storage (UTES)

	Aquifer Thermal Energy Storage (ATES)			Borehole Thermal Energy Storage (BTES)		
	Number	Capacity (MW_{th}) Heat / Cold	Production (GWh_{th}/yr) Heat / Cold	Number	Capacity (MW_{th}) Heat / Cold	Production (GWh_{th}/yr) Heat / Cold
In operation end of 2024	0	H: C:	H: C:	0	H: C:	H: C:
New (additional) in 2024	0	H: C:	H: C:	0	H: C:	H: C:
Projected total by 2028	1–2 (R&D stage)	H: C:	H: C:	1 (R&D stage)	H: C:	H: C:

Table F: Investment and Employment in geothermal energy

	in 2024		Expected in 2028	
	Expenditures * (million €)	Personnel ** (number)	Expenditures * (million €)	Personnel ** (number)
Geothermal electric power	0	0	0	0
Geothermal direct uses	~ 250	~ 250	~ 300	~ 300
Shallow geothermal	Probably less than 75	Data not available	?	?
total	**~ 325**	**?**	**?**	**?**

* Expenditures in installation, operation and maintenance, decommissioning

** Personnel, only direct jobs: Direct jobs – associated with core activities of the geothermal industry – include "jobs created in the manufacturing, delivery, construction, installation, project management and operation and maintenance of the different components of the technology, or power plant, under consideration". For instance, in the geothermal sector, employment created to manufacture or operate turbines is measured as direct jobs.

Note: the numbers given are very tentative (see the text). Expenditures refer to completed drillings, related works and equipment; construction of three geoDHs plants launched in 2024, etc.

Table G: Incentives, Information, Education

	Geothermal electricity	Deep Geothermal for heating and cooling (more: chapters in the main text)	Shallow geothermal
Financial Incentives – R&D	Yes	Yes	Yes
Financial Incentives – Investment	Yes	Yes	Yes
Financial Incentives – Operation/Production	No	No	Yes (for electricity)
Information activities – promotion for the public	No	Occasionally	Occasionally
Information activities – geological information	Yes – as for deep geothermal H&C	Yes	Gradually – yes
Education/Training – Academic	Yes (CHP), at some universities – part of education/training on deep geothermal	Yes, at some universities	Yes, at some universities
Education/Training – Vocational	Yes – but occasionally (limited scale) – along with deep geothermal for H&C, not regular	Yes – but occasionally (limited scale), not regular	Yes – but occasionally (limited scale), not regular

Key for financial incentives:					
DIS	Direct investment support	FIT	Feed-in tariff	-A	Add to FIT or FIP on case the amount is determined by auctioning
LIL	Low-interest loans	FIP	Feed-in premium		
RC	Risk coverage	REQ	Renewable Energy Quota		
TC	Tax credits	O	Other (please explain)		