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Country Update: Italy

Bruno DELLA VEDOVA[1], Maurizio CEI[2] and Paolo CONTI[3]*
UGI - Italian Geothermal Union[1]*, Enel Green Power[2], UGI - Italian Geothermal Union[3]
paolo.conti@unipi.it

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ABSTRACT

This paper examines the status of geothermal applications in Italy between 2021 and 2023, including both power generation, heating and cooling (H&C) sectors. Electricity data concerning 2024 are also presented in the supplementary materials and tables. Enel Green Power is currently the only producer of geothermal electricity in the country. By the end of 2023, installed geothermal capacity reached 915.8 MWe, distributed among 34 power plants and 37 generation units. In 2023, gross electricity production was approximately 5,700 GWh. All geothermal power plants are situated in the Tuscany Region without new generation units were added during the 2021–2023 period, maintaining the pattern of limited expansion observed over the past decade. The most recent data for 2024 indicates a stable trend in both values, with the same value of the installed capacity (915.8 MWe) and a modest decrease in the gross generation to approximately 5,600 GWh. In the H&C sector, total installed geothermal capacity is about 1,500 MWth, resulting in an annual energy use of around 10,550 TJ (~2,930 GWh). Compared to 2020, geothermal heat utilization in this sector increased by around 9%. Building heating represents the primary application, accounting for 59% of total geothermal energy use and 69% of installed capacity. The prominence of the building sector is associated with the growth of GSHPs, which have increased by roughly 16% per year in terms of installed capacity; besides, improvements in statistical monitoring systems have enhanced reporting figures for this sector. The geothermal sector in Italy has shown steady levels in both power generation and H&C sectors, with GSHPs as an exception. Therefore, the paper also addresses current challenges and possible strategies to encourage further development of geothermal energy in the country.

1 INTRODUCTION: GEOTHERMAL ENERGY IN THE ITALIAN ENERGY SYSTEM

Italy is one of the world's key countries for geothermal resources. Owing to its favorable geological setting, geothermal energy has been used since prehistoric times and was widely exploited during the Roman Ages (3rd century B.C. – 5th century A.D.) for thermal baths, cooking, heating spa facilities, and hydrothermal minerals. These uses declined between the 6th and 12th century A.D., but resumed from the 13th century and expanded significantly in the 19th–early 20th centuries with boron production (Ciardi and Cataldi, 2005). In the 20th century, geothermal development accelerated further. Italy hosted the world's first industrial geothermal power plant (250 kWe) in 1913 in Larderello, following the earlier experiment by Prince Ginori Conti. After World War II, installed capacity grew steadily for both power generation and heating & cooling (H&C), as illustrated in Figure 1 and Figure 2. Geothermal electricity production peaked at approximately 6.3 TWh/year in 2016 (Conti et al., 2016). The H&C sector expanded notably in the 2000s, particularly in district heating (DH) and ground-source heat pumps (GSHPs) (Bargiacchi et al., 2020). However, statistical data for H&C remain partly uncertain due to fragmented sources, methodological differences, and the absence of comprehensive catalogues, especially for small GSHP systems, fish farming, and balneology.

Since 2010, the Italian Geothermal Union (UGI), together with sectoral associations (AIRU, ANIGHP), has undertaken a systematic national survey to create a database of all direct geothermal uses (Conti et al., 2015; Bargiacchi et al., 2020; Manzella et al., 2019; Della Vedova et al., 2022; Della Vedova et al., 2025). Large-capacity systems are also monitored by national authorities such as the GSE, improving the quality of statistics. Nonetheless, data gaps persist, and Country Update authors still rely on informed estimates.

Italy currently ranks among the top 10 countries for geothermal electricity generation (Gutiérrez-Negrín, 2024*) and the top 20 for geothermal H&C (Lund and Toth, 2020*; IGA Dataset, 2025*). Despite this longstanding tradition (see Figure 1 and Figure 2), geothermal energy still provides a modest share of the national energy mix. In 2023, gross final energy consumption was 115.4 MTOE (≈4,900 PJ or 1,341 TWh), with renewables covering 19.6% (GSE, 2025), a share that has remained stable since 2015.

Italy's Integrated National Energy and Climate Plan (NECP) targets a 39.4% RES share by 2030, including 63.4% in electricity, 35.9% in H&C, and 34.2% in transport. Final consumption is expected to decline to about 100 MTOE by 2030 due to energy efficiency and electrification measures. In 2023, geothermal sources produced around 5.7 TWh of electricity (≈2% of domestic generation) and supplied limited amounts of renewable heat: 124 kTOE from GSHPs and 127 kTOE from DH and other applications—representing roughly 0.5% of national thermal energy consumption (GSE, 2025).

Even with its current limited deployment, geothermal energy is recognized as a strategic resource (Italian Law No. 134/2012). Italy holds significant potential in combined heat and power, district heating and cooling, low-enthalpy heat pumps, electricity generation, and strategic mineral recovery. As part of the country's long-term decarbonization strategy, geothermal energy is expected to play an increasing role, particularly in the heating and cooling sector.

This paper presents geothermal developments for 2021–2023 in both power generation and H&C. Electricity data were provided by Enel Green Power, while thermal application data are mainly derived from GSE statistics and UGI/AIRU datasets.

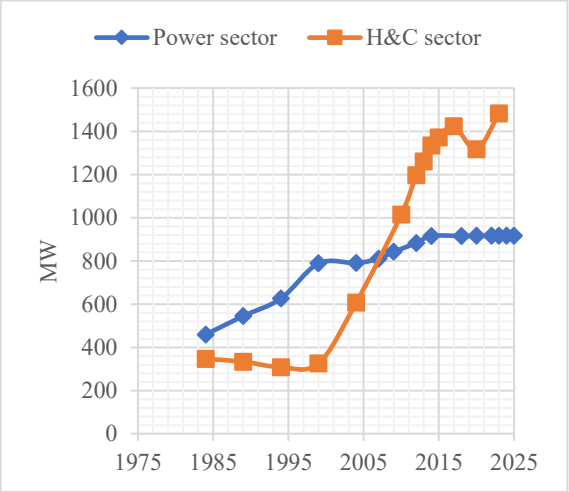

Figure 1. Evolution of geothermal capacity in Italy

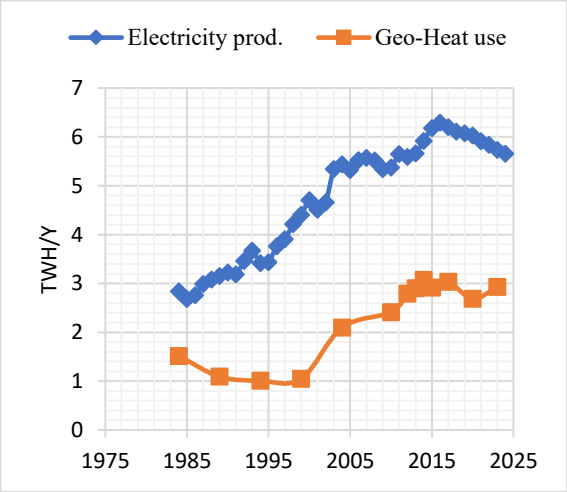

Figure 2. Evolution of geo-energy use in Italy.

2 GEOLOGY BACKGROUND

Italy is a tectonically active country, being located along the African-Eurasian plates convergent margin (Manzella et al. 2017 and ref. therein). The complex tectonic regime produced the two mountain chains characterizing the country, the Alps and Apennines, and an oceanic basin in the western margin, below the Tyrrhenian Sea (Figure 3, left). The tectonic complexity of the Italian territory results in a pronounced lateral variability of the surface Heat Flow (HF), which mimics the main structural features and magmatic domains (Figure 3, right). The western sector of the Apennine and the Tyrrhenian margin show the most favorable conditions for hosting geothermal resources. This area is characterized by a reduced crustal and lithosphere thickness, a widespread magmatic activity and a high geothermal heat flow. The presence of geothermal systems at relatively shallow depth has been verified in several areas from north to south of the Italian territory and in offshore zones, thanks to the numerous deep wells drilled for oil and gas or for geothermal exploration. High temperatures at relatively shallow depth, suitable for electricity production and district heating, have been recorded in numerous areas. Hydrothermal circulation has been recognized in volcanic, sedimentary and crystalline rocks, and local rise of warm waters from deep formations through faults or lateral discontinuities produces numerous natural hot springs.

The last national assessment of deep, hydrothermal resources in Italy was carried out at the end of the 1980s with the completion of the Inventory of the Italian Geothermal Resources (Cataldi et al., 1995). In the assessment, Italy was divided and ranked in seven categories on the basis of the presence of a regional aquifer of up to 3 km depth and on the fluid temperature range. More recently, geothermal potential was computed at local scale, especially for mining lease requests of power production projects, but the potential at a national scale has been only roughly estimated. On the basis of the temperature distribution, the Italian Geothermal Association (UGI) esteems a potential total production from geothermal resources within 5 km depth of 21

Exajoule (Buonasorte et al., 2011). Two thirds of them have temperatures below 150°C. Resources at temperatures >80-90°C at relatively shallow depth can be found in many areas, i.e. those showing a high surface heat flow. In particular, low temperature resources can be found almost everywhere in Italy, and they could be efficiently used for thermal applications, also in combination with by GHSP technologies.

Waiting for modern resource assessment at national level, various assessments have been carried out at regional level, using diversified methodologies. The most comprehensive assessment of geothermal resources has been carried out by the National Research Council in four regions of southern Italy. The provided maps show the location of geothermal resources that can be developed with the current technologies, including district heating, both in heating and heating/cooling (H&C) mode, and open- and closed-loop GSHP systems (Manzella et al., 2017 and ref. therein).

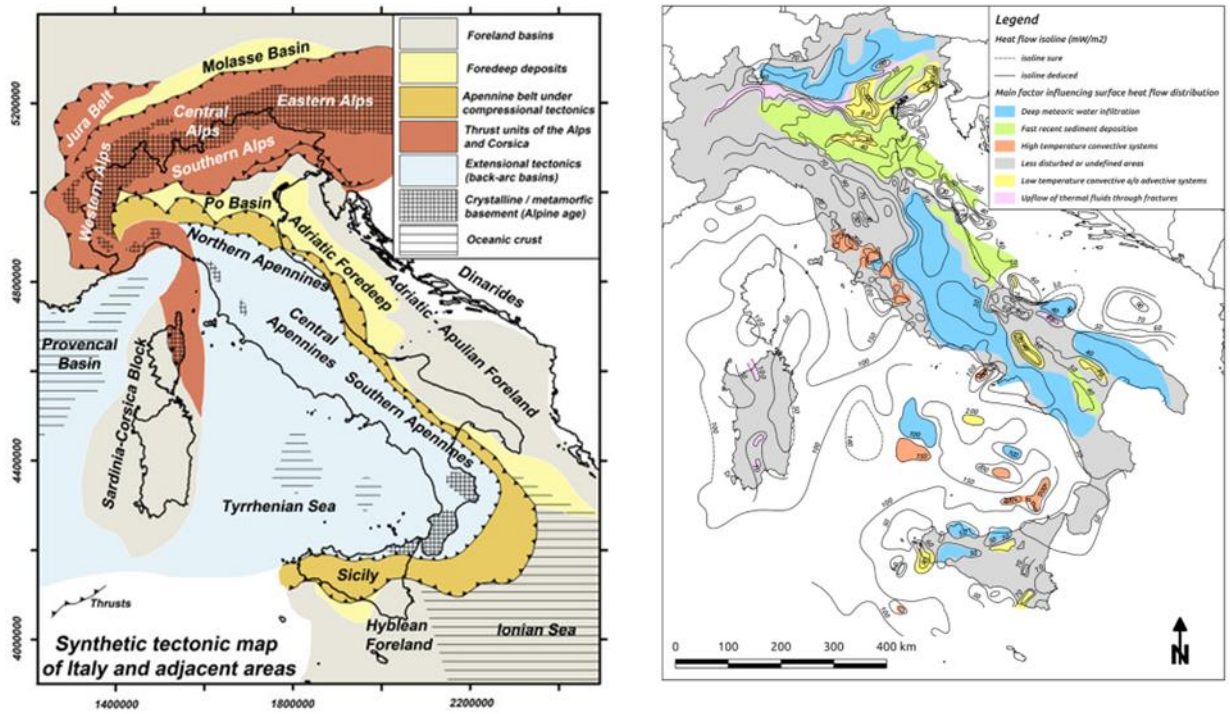

Figure 3. Left: tectonic and geothermal provinces, and temperature distribution at 3 km depth in Italy (modified from *Carminati et al. 2004). Right: Heat flow distribution and its relation to hydrogeological conditions (modified from *Della Vedova et al., 2001).

The hottest geothermal resources of Italy are located in what is called the "traditional" geothermal area of Italy, in the tectonically active regions of Southern Tuscany (Figure 4). These areas host all the national geothermal plants for electricity production and most of the geothermal district heating networks.

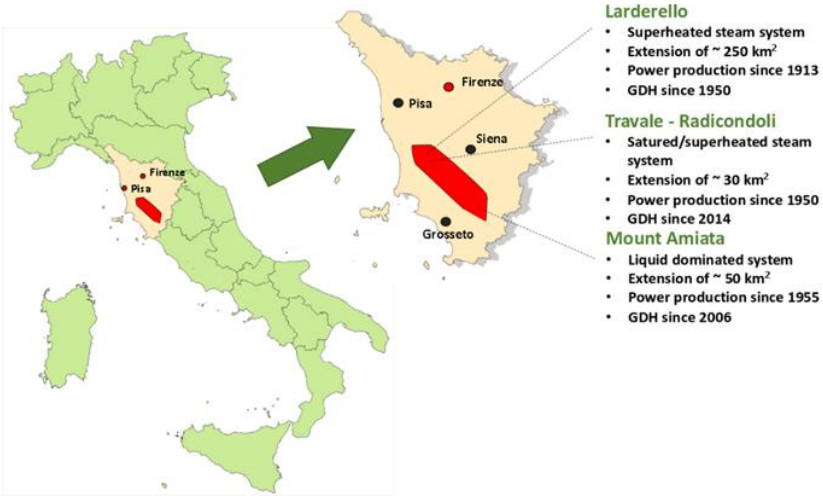

Figure 4. "Traditional" geothermal areas in Italy, where electricity is produced from geothermal high temperature resources, and the most productive geothermal district heating (GDH) networks are located.

3 GEOTHERMAL UTILIZATION

3.1 Geothermal electricity generation

In 2023, Italy's electricity demand reached 305.62 billion kWh, about 3% lower than in 2022 due to efficiency measures. Domestic production covered 83.2% of demand, with 16.8% met through imports (Terna, 2023). Of the 264.7 TWh of gross domestic generation, 61.4% came from thermal sources and 38.6% from renewables, mainly wind, solar, and geothermal (Terna, 2023). Geothermal energy represents only 2.1% of national electricity production but supplies over 30% of Tuscany's needs.

In 2023, the average electricity market price was €0.12596/kWh, over 50% lower than in 2022 (ARERA, 2024). Plants qualifying for the GRIN tariff received 10.9 eurocents/kWh plus the market price, subject to reduction coefficients. The 2016 FER Decree introduced a "Base Incentive Fee": 13.4 eurocents/kWh for units <1 MWe, 9.8 eurocents/kWh for 1–5 MWe, and 8.4 eurocents/kWh for >5 MWe, including the market price (D.M. 23/06/2016). The Decree also offered up to 230 €/MWh for new full-reinjection plants, though none were realized due to authorization issues.

3.1.1 Geothermal power generation: current status and developments

Figure 2 depicts the historical evolution of geothermal electricity in Italy, showing two main development phases: (i) from the 1930s to mid-1970s, focused on shallow carbonate reservoirs (depths up to ~1,000 m); (ii) from the early 1980s onward, marked by deep drilling, higher productivity, and artificial reservoir recharge through reinjection (Cei et al., 2020a).

In Italy, geothermal power is produced only in Tuscany by 34 plants operated by Enel Green Power (EGP). The company's long-term management has enabled record outputs, peaking at ~6.3 TWh in 2016. In 2023, installed capacity totaled 915.8 MWe, yielding 5,736 GWh of gross production—slightly below 2022. All plants are equipped with AMIS abatement systems. In 2021, average availability exceeded 90% in Larderello and Travale-Radicondoli and reached ~95% in Mount Amiata. AMIS systems remove mercury and H_2S from non-condensable gases through catalytic oxidation and sorbents (Sabatelli et al., 2009). Most recent available data for 2024 confirms a constant trend of the installed capacity (915.8 MW) and a slightly reduction of the gross production (5,654 GWh).

3.1.2 Geothermal fields

Italy's four geothermal fields used for electricity—Larderello, Travale-Radicondoli, Bagnore and Piancastagnaio—are all in Tuscany (see Figure 4). All plants are remotely operated from a central control room in Larderello, where parameters are continuously monitored to allow rapid shutdowns and restarts. Advanced modelling tools support steam pipeline management and optimization of well operations (Cei et al., 2020b).

Larderello: covering ~250 km^2, it hosted 594.8 MWe of installed capacity in December 2023 across 22 units. Sustainability relies on reinjection and deep drilling. Since the late 1970s, reinjection has increased pressure and production in depleted zones (Cappetti et al., 1995). Deep exploration has identified permeable zones in the Metamorphic Basement (3,000–4,000 m), with pressures up to 7 MPa and temperatures of ~350 °C (Barelli et al., 1995, 2000; Bertini et al., 1995; Cameli et al., 2000; Bertani et al., 2005). EGP has obtained permits for the 5 MW Monterotondo-2 total-reinjection project.

Travale-Radicondoli: this ~50 km^2 area comprises 200 MWe across eight units. Deep drilling has revealed permeable layers similar to Larderello and productive zones in the underlying Granite at ~4,000 m. Results show that shallow Larderello and Travale-Radicondoli systems belong to a single deeper geothermal system extending across ~400 km^2, with consistent temperatures and pressures at ~3,000 m (Bertani et al., 2005).

Mount Amiata: the Bagnore and Piancastagnaio fields were discovered in the late 1950s–1960s. Initial production came from a shallow carbonate reservoir; later deep exploration identified a fractured Metamorphic Basement at 2,500–4,000 m, liquid-dominated with ~200 bar and 300–350 °C at 3,000 m (Bertini et al., 1995). By the end of 2021, installed capacity totaled 121 MWe across seven units.

3.2 Geothermal energy in the Heating and Cooling sector

Heating and cooling (H&C) applications are widespread across Italy, with major uses in agriculture and food processing, industrial heat, balneology, recreation, tourism, and space heating/cooling. Technologies include individual GSHPs, DH networks, and direct-use geothermal wells (spas, pools, cascades). Cooling applications continue to expand thanks to reversible GSHPs and adsorption systems. However, updated data remain limited and will be included in future reports.

Despite broad deployment, comprehensive statistical coverage is difficult. Reliable figures are generally available only for large systems such as DH networks, major greenhouses, and industrial plants, based on owner data analyzed by AIRU, UGI, and EGP. Small-scale systems, balneology, and aquaculture rely on aggregated GSE (2025) and EUROSTAT (2025) data. All collected information has been processed following previous Country Update methodologies (Conti et al., 2015; Conti et al. 2016; Manzella et al., 2019; Bargiacchi et al., 2020, Della Vedova et al., 2022; Della Vedova et al., 2025) and presented in Table 1 and attached supplementary materials (Excel tables). Where source data were missing, estimates were derived using energy engineering assumptions, sector-specific capacity factors (CFs), and/or equivalent operating hours (EOHs), consistent with values used in earlier Updates and global averages (Lund and Boyd, 2021). For GSHPs, reference EOHs and SCOPs follow Directive 2013/114/EU.

3.2.1 Heating and cooling energy statistics

The reference year for all H&C data is 2023. Installed geothermal thermal capacity reached ~1,500 MWth, with ~10,500 TJ/yr of energy use (Figure 5 and Figure 6; Table 1). Space heating is the dominant sector, with 59% of capacity and 69% of annual use. Health, recreation, and tourism represent 23% of capacity and 25% of use. Agriculture, aquaculture, and food processing account for 16% of geothermal heat use (1,739 TJ/yr) and ~8% of capacity (120 MWth). Industrial heat remains marginal (15 MWth; 64 TJ/yr). The average CF across all H&C applications is 0.23, influenced by progressively lower operating hours in space heating, linked to rising outdoor temperatures and stricter building insulation requirements.

Table 1. Summary of installed geothermal capacity, energy use and capacity factor in the H&C sector in Italy at the end of 2023 (values in MWth)1.

	Capacity			Energy			Capacity Factor		
APPLICATION	TOTAL	GSHP	DH	TOTAL	GSHP	DH	TOTAL	GSHP	DH
Aquaculture	68			1,047			0.49		
Heating for buildings	1,022	850	169	6,207	5218	966	0.19	0.19	0.18
Agriculture and Food Processing:	37			628			0.54		
Industrial process heat	18		3	64		20	0.13		0.23
Health, Recreation & Tourism	340			2,599			0.24		
TOTAL	1,482	850	172	10,545	5,218	986	0.23	0.19	0.18

Regarding GSHPs, they account for 57% of the total installed capacity and up to 49% in terms of energy (see Figure 8 and Table 1). For this report, the primary data source is EUROSTAT (2025), which has recently revised its aggregation scheme for heat pump statistics by redistributing the "GEO" category between "hydrothermal" and "others". In this CU, all data under "GEO" and "hydrothermal" have been included, as the latter encompasses open-loop GSHPs. The "others" category includes undefined types, which have been proportionally reallocated to GEO and hydrothermal based on their relative share compared with air-source heat pump technologies. It is also important to note that in this report we refer to "Capacity" and "Energy" values as the power/energy delivered by the ground source (namely, to the evaporator section) as this represents the actual geothermal contribution in heating mode. This approach aligns with the EU-level definition of “ambient heat” used to quantify the renewable contribution of heat pumps. Other reports may refer to GSHP statistics based on condenser output, focusing instead on the contribution of the technology to the heating service provided to the end-user system. In any case, caution is advised when comparing GSHP data across different sources, as definitions and reference points may vary. To avoid ambiguity, in *Della Vedova et. al (2025) we reported values at both the

1 Terminology: "Capacity" is the maximum instantaneous geothermal output under declared conditions; "Energy" is the geothermal heat delivered to end users (losses included); "Capacity factor" is ratio of delivered energy to full-load theoretical output.

evaporator and condenser levels (see *Conti et al., 2015 and *Conti et al., 2016 for further details on statistical methodology).

Geothermal DH systems contribute 9% of total geothermal heat use (986 TJ/yr) with ~172 MWth installed (see Figure 8 and Table 1). Tuscany hosts most systems, using geothermal cascade heat from power plants. Additional notable DH systems include Ferrara (14 MWth, two 2-km wells, full reinjection), Vicenza (68 °C, 100 m^3/h), and GSHP-based networks in Milan (18 MWth and 15 MWth). Recent additions include Lodi (~2 MWth) and Osimo (~150 kWth).

3.2.2 Discussion on the evolution of the geothermal heating and cooling sector in the 2021-2023 period compared to the end of 2020

Table 2 compares 2023 and 2020 data to show developments over the past three years. Figure 7 and Figure 8 illustrate the longer-term evolution of Italy's geothermal H&C sector. After a previous downturn, in the last three years both capacity and heat use increased (+13% and +9%). Building heating remains the leading sector, driven by GSHPs: the installed capacity for space heating grew from 779 to 1,022 MWth (+31%), and energy use from 4,725 to 6,207 TJ/yr (+31%), with CAGR ≈ +10%. GSHP expansion contributed +278 MWth and +1,814 TJ/yr; DH capacity increased by 8 MWth. Other application sectors exhibit a general reduction in both installed capacity and energy use. However, it is worth stressing that the reported percentage variations (even when large) are often attributable to statistical uncertainty, changes in data aggregation methods adopted by the source, or the limited availability of data (and/or operating plants), which can result in amplified percentage fluctuations. Overall, it can be concluded that in Italy the main sector for geothermal thermal uses remains associated with GSHPs for space conditioning of buildings, and thermal balneology, although the latter has experienced a contraction in activity in the post-COVID-19 period.

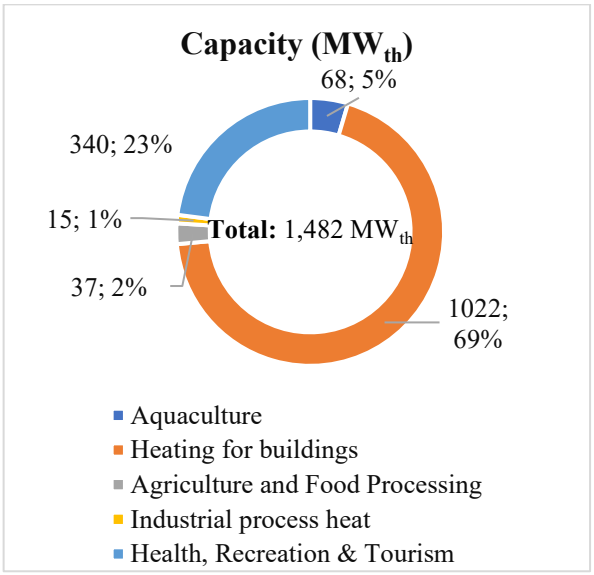

Figure 5. Share of geothermal installed capacity of H&C sector in Italy in 2023.

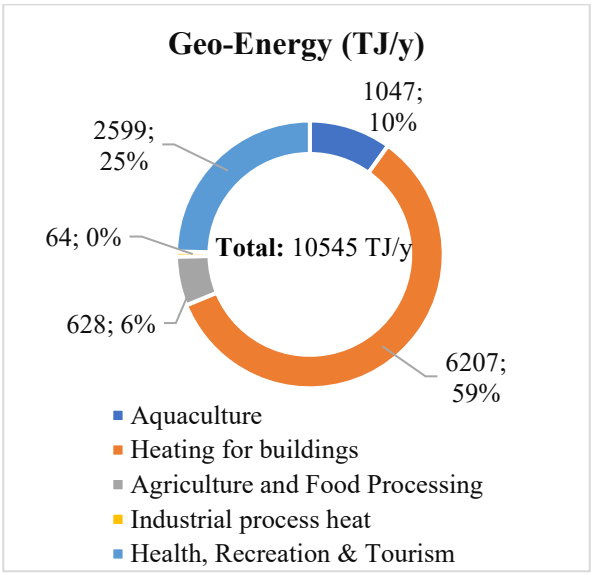

Figure 6. Share of geothermal geo-energy use of H&C sector in Italy in 2023.

Table 2. Development of geothermal direct uses in Italy from the end of 2020 to the end 2023.

	Capacity			Energy			Capacity Factor		
APPLICATION	TOTAL	GSHP	DH	TOTAL	GSHP	DH	TOTAL	GSHP	DH
Aquaculture	-13%	-	-	-13%	-	-	-	-	-
Heating for buildings	31%	53%	5%	31%	53%	14%	-	-	9%
Agriculture and Food Processing:	-33%	-	-	-10%	-	-	34%	-	-
Industrial process heat	-16%	-	-	-40%	-	83%	-28%	-	-

Health, Recreation & Tourism	-12%	-	-	-11%	-	-	1%	-	-
TOTAL	13%	49%	5%	9%	49%	15%	-3%	-	10%

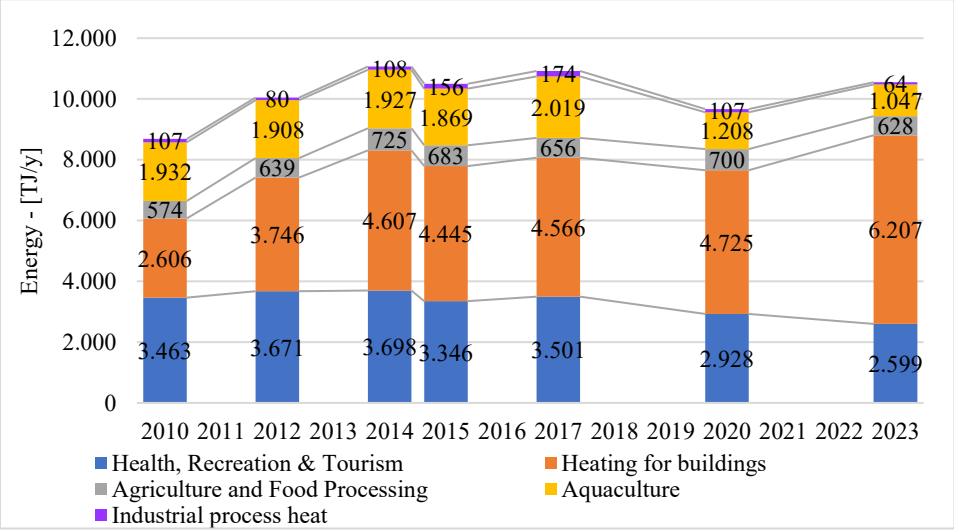

Figure 7. Development of the different sectors of direct uses in Italy.

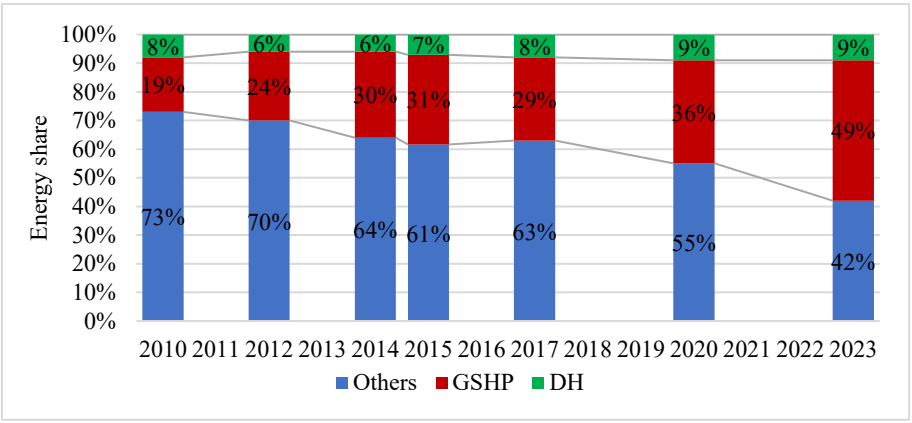

Figure 8. Development of geothermal DHs and GSHPs for space H&C concerning the total geo-heat delivered in Italy.

4 REGULATORY FRAMEWORK AND PROPOSALS FOR SUPPORT MEASURES AND A NATIONAL GOTHERMAL DEVELOPMENT PLAN

In February 2022, 26 national and international operators in the geothermal power and DH sectors launched the Italian Geothermal Technical Table (IGTT), coordinated by UGI and AIRU. The IGTT represents the full geothermal value chain at institutional level and is working on a medium- to long-term strategy covering power generation, district heating and cooling, shallow geothermal with heat pumps, heat storage, and raw material extraction from geothermal brines, in support of the energy transition. In May 2023, it submitted a proposal for a national geothermal action plan to the Ministry for inclusion in the Italian NECP.

After almost a decade of stagnation, the geothermal power sector is preparing to restart following the FER-2 decree (June 2024) and the 20-year renewal of Tuscany's concessions to Enel Green Power (February 2025). FER-2 promotes innovative RES plants with high costs and low environmental impact (including wind, solar PV, hydro, biomass, and sewage gas). For geothermal, it foresees support for 100 MWel of traditional plants with innovative features, 60 MWel of new "zero-emission" plants, and the renovation of 150 MWel of existing capacity; the related auction has been granted but not yet issued. The renewed concessions include a significant investment plan with three new geothermal plants in Tuscany (total 65 MWel).

The DH legislative framework remains incomplete, with delayed regulatory instruments hindering deployment of systems based on local renewables and waste heat. The "Energy Decree 2024" introduces measures on

renewables, energy security, and support to energy-intensive industries, promoting self-production and new high-tech plants. The forthcoming FER-T decree will support large thermal projects from renewables (>2 MWth) via competitive procedures, while the OIERT decree will define rules for selling heat and cold to third parties, ensuring a renewable share.

The newly launched "Conto Termico 3.0" incentive program will provide benefits for small-scale renewable heating projects (less than 2 MWth) and energy-efficiency upgrades in both public and private buildings, including geothermal systems. A regulation on closed-loop geothermal probes has been in force since 30 September 2022, simplifying requirements for building H&C systems, while a similar framework for open-loop systems is still pending.

5 R&D ACTIVITY IN GEOTHERMAL ENERGY TOPICS

Accelerating access to deep geothermal resources and lowering costs for low-carbon heat and power requires coordinated R&D in Earth Sciences and Engineering. In this context, drilling innovation is crucial. The EU-funded DeepU Project investigates non-mechanical drilling for deep systems, aiming to enable geothermal deployment "anywhere" as a stable baseload source. DeepU targets a deep (>4 km) closed-loop heat exchanger by integrating laser and cryogenic gas in a single drilling technology. Laboratory tests on different rocks assess its ability to liquefy/vitrify materials and prepare boreholes for immediate heat exchange, while generating data to evaluate technological, environmental, and economic feasibility and commercial potential.

Reducing emissions from geothermal plants via capture and reuse or storage is another priority. The EU-funded GECO Project builds on the CARBFIX results, which demonstrated a water-dissolution scrubbing method for CO_2 and sulfur gases. Industrial tests showed this approach can cut costs, reduce environmental impact, and improve long-term system performance by enhancing injection-well permeability. GECO aims to standardize this solution and related reuse schemes for the global geothermal industry through applications at three additional European sites. Detailed monitoring and reactive-transport modelling at four GECO sites with different geologies are used to generalize subsurface behavior and develop predictive tools to reduce project risks and costs.

Further advances are needed in characterizing crustal thermal conditions. The International Heat Flow Commission (IHFC) defines standards and methods for key geothermal parameters (heat-flow density, thermal properties, subsurface temperatures, and resource quantification) and oversees the Global Heat Flow Database, currently under comprehensive review and quality assessment.

6 EXPECTED DEVELOPMENTS

Since 2014, no new geothermal power plants have been commissioned due to permitting hurdles and limited public acceptance. Significant potential exists in Tuscany, Latium, Campania, and parts of Sicily and Sardinia, as well as Tyrrhenian coastal areas and islands suitable for zero-emission binary plants, possibly coupled with desalination. Several projects in Tuscany, Emilia-Romagna, Lombardy, and Lazio could add about 900 MWel by 2038, doubling today's ~916 MWel and increasing production from 6 to ~13 TWh/year. These perspectives, included in the national geothermal action plan proposal (May 2023), were presented by IGTT to MEES in the NECP context. Main barriers identified are high upfront costs, complex and lengthy permitting, insufficient incentives and derisking tools. Although difficult to quantify, geothermal can also support transport decarbonization via extraction of strategic raw materials (e.g., lithium) and the production of e-fuels from geothermal CO_2 and green hydrogen, as shown by Icelandic methanol projects.

Geothermal heat for buildings, cooling, and sanitary hot water is slowly growing but still marginal in national demand. Italian DH systems supply about 10 TWh/yr of heat, with an estimated potential of ~53 TWh by 2030, of which roughly one-third could come from geothermal sources (Politecnico di Milano for AIRU). The Ferrara integrated geothermal DH system, in operation since 1990, will double its geothermal contribution through new wells and network expansion.

The spread of seasonal underground storage with heat exchangers and heat pumps could eliminate gas use for winter heating and reduce electricity consumption for summer cooling. Closed-loop borehole systems can be combined with open-loop solutions using surface water, groundwater, or seawater in multivalent DHC networks. These solutions are promoted by the Horizon Europe SAPHEA Project, which supports GeoDHC uptake via a Digital Market Uptake hub. GeoDHC networks can share waste heat, provide baseload supply, and enable storage. Across Europe, nearly 20,000 DH networks serve over 77 million people, while DC systems remain limited and usually exploit sea or river water. In Italy, especially in the South, DHC is absent despite high potential to replace inefficient air conditioners and mitigate urban heat islands.

A larger contribution from geothermal and other renewables in electricity, thermal, and transport sectors is essential to improve competitiveness and stabilize energy prices by shifting costs from volatile fuels to relatively fixed capital and O&M. IGTT has stressed that geothermal DH is constrained by legislative inconsistencies, the lack of stable rules, and insufficient national-level planning.

7 CONCLUSIONS

This paper examines Italy's geothermal developments between end of 2020 and end of 2023, covering research and development initiatives, regulatory updates, and current or anticipated support measures. Geothermal power remained essentially stable, with 916 MWe installed and around 6 TWh of annual production. Geothermal heat still represents a small share of Italy's thermal mix but is growing steadily. At the end of 2023, installed capacity reached ~1,500 MWth, with a CAGR of 4% since 2020; geothermal heat supply rose to ~10,500 TJ/yr (CAGR 3%). Growth is mainly driven by GSHPs (CAGR 9% since 2020), with a smaller contribution from DH networks. Space heating is the dominant use, while agriculture and industry remain minor. Cooling applications are expected to expand, also underpinned by Commission Delegated Regulation (EU) 2022/759 on calculating renewable shares for cooling and district cooling. To meet EU targets (RePowerEU, Green Deal, "Fit for 55", etc.), several barriers must be overcome: fragmented legislation between national and regional levels, unstable regulatory frameworks, complex and lengthy permitting, and limited incentives. With adequate support and clearer planning, geothermal energy could significantly contribute to Italy's 2050 decarbonization goals while supporting economic development and job creation.

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