ZURICH, SWITZERLAND
6 - 10 OCTOBER 2025

EUROPEAN GEOTHERMAL CONGRESS 2025

Geothermal Energy Use, Country Update for Slovakia 2022 – 2024

Branislav Fričovský [1], Katarína Benková [1], Daniel Marcin [1], Matej Hotovčin [2], Katarína Augustini[3] , Klement Fordinál [4], Radovan Černák [1]

[1] Dionýz Štúr State institute of Geology, Dept. of Hydrogeology and Geothermal energy; Mlynská dolina 1, 817 04 Bratislava, Slovakia

[2] Ministry of Investments, Regional Development and Informatization of the Slovak Republic, Pribinova 25, 811 09 Bratislava, Slovakia

[3] Ministry of Economy of the Slovak Republic, Mlynské nivy 44/A, 827 15 Bratislava, Slovakia

[4] Dionýz Štúr State institute of Geology, Dept. of Younger geological units; Mlynská dolina 1, 817 04 Bratislava, Slovakia

branislav.fricovsky@geology.sk

Keywords: geothermal energy, geothermal potential, direct use, Slovakia

ABSTRACT

As of 2023, there are 123 wells producing geothermal waters at 79 different sites. Similarly to previous reports, the recreation and balneotherapy prevails in both, the installed capacity and use. Only one site uses a single reinjection well under commercial production (Podhájska thermal resort). Compared to 2022 and 2023 reports, two new wells were completed: the GTK-1 supplies heat for the hybrid district heating system of the town of Kežmarok (geothermal share is up to 3% due to operation reasons only; the LM-1 well delivers heat supply for a fur-processing manufacture in the town of Liptovský Mikuláš. Two other wells obtained withdrawal approvals, the L-1 Lipany well (originally oil-and-gas prospection well, reconstructed) and M-2 Komárno well, both used in recreation (pool-heating). The Ďurkov – Svinica geothermal site was provided with funding and declared a project of national importance for centralized district heating system of the Košice town. Recently, existing wells are tested to monitor reservoir response in 1:2 produced / injector scheme. New wells are scheduled for drilling since October 2025; well completion is planned by Q2/2026. In 2024, a new geothermal catalog for Slovakia based on conditioned stochastic modelling was finalized.

1. INTRODUCTION

A systematic research and prospection on geothermal resources in Slovakia launched in the 1970s responded to global concerns on fossil fuels economics; yet utilization of geothermal energy is dated beyond Medievals, owing to numerous natural thermal springs available for treatment or food processing (Fendek et al. 1999). Recently, 331 wells are listed in the national geothermal database, proving geothermal resources in 30 out of 31 identified geothermal water bodies. A recent country update reports on actual state-of-art in utilization of geothermal resources as of 2023, developments in assessment of geothermal potential and incentives, both in action or planned.

2. GEOLOGY AND REGIONAL GEOTHERMICS

2.1 Regional geology review

The regional geological structure of Slovakia reflects its geotectonic evolution and recent position, forming the northern branch of the European Alpine mountain chain (Schmid et al. 2008, Plašienka 2018) as part of the Western Carpathians formed in Variscan to Alpine orogeny (Jurewicz 2005). The bedrock comprises crystalline thick-skinned and Mesozoic sedimentary thin-skinned nappe series formed during Jurassic to Cretaceous collision. Then, the Central Carpathian Paleogene Basin (siliciclastics) covers pre-Tertiary formations transgressively. The Miocene–Quaternary sediments of the Pannonian basin system reach particularly high thickness in the Vienna, Danube and East Slovak basins. Neovolcanites of Miocene – Pliocene age are substantial to Miocene extension, producing volcanoclastics and flow products as part of Neogene basin fill in the Inner Western Carpathians (IWC). The External Western Carpathians (EWC) consist of thin-skinned nappes, where Carpathian Flysch Belt prevail in volume, recording syn-orogenic mass transport deposits formations. The Pieniny Klippen Belt is a complex shear zone dividing the EWCs and IWCs, composed of Mesozoic carbonates-dominated “core” and Tertiary envelope of siliciclastics.

2.2 Geothermal waters

According to borehole measurements and monitoring, documented geothermal resource range in 20 – 135 °C temperature at the wellhead. In screens of tens to 3600 m depths, temperatures increase up to 150 °C (Černák et al. 2014). Models, typically for steady-state conditions, imply temperatures up to 270 °C at depths up to 6000 m (Fričovský et al. 2024).

Up to now, proven geothermal resource is typically a single-phase geothermal water, with saturated wet-steam documented only on Ďurkov and Čižatice sites.

Geothermal waters are principally petrogenic (originally meteoric waters with various degree of horizontal and vertical circulation and residence time), marinogene (originally seawater or degraded at different rate), or mixed / polygenetic in origin; TDS varies widely 0.4-90 g/l (Marcin et al. 2014, Bodiš et al. 2018).

2.3 Regional geothermics

The surface heat flow density varies 50-120 mW/m^2, with a mean of 82.1 ± 20 mW/m^2 (Bodiš et al. 2018). Highest geothermic activity is documented within Eastern Slovakian Neogene Basin (90-130 mW/m^2) and CDPP (> 90 mW/m^2), decreasing in tertiary intramountain depressions (40-70 mW/m^2), whilst minima (30-50 mW/m^2) are recorded from the Flysch Belt (Marcin et al. 2014, Majcin et al. 2017). As part of the Western Carpathians, the geothermic activity of Slovakia is outlined through (Fendek et al. 1999, Franko and Melioris 1999):

1) different structure and depths of neotectonic block with a manifest in overall crustal thickness;
2) non-uniform mantle propagation;
3) spatial distribution of Neogene – Quaternary volcanism;
4) local and regional hydrogeological conditions;
5) course and depth-seating of major crustal fault systems.

With a lack of some additional heat source, such is a volcanism or active geodynamics, occurrence of large-scale convection controlling the heat flux regime remains questionable due to a relationship between plausible reservoir temperature depths and expected loss in reservoir permeability (Fričovský et al. 2024).

2.4 Regional geothermal play-typing

According to a global play-type classification (e.g. Moeck 2014), there are likely conduction-dominated intracratonic basin / foreland basin / and orogenic-belt type plays (Fričovský et al. 2022). On a local scale, yet not formalized, the concept of play-typing (Figure 1) has been finalized (Fričovský et al. 2024):

i) *Neogene sedimentary basins – CD1a* – local to large sedimentary basins formed during Neogene, typically Neogene or Mid Triassic reservoirs, one reservoir unit, semi-open to closed, low vulnerability, geothermal waters usually hydrosilicatogene to silicatogene, marinogene or variously degraded
ii) *sedimentary basin embayments – CD1b* – tectonic, typically elevated margins of large Neogene sedimentary basins, usually both, primary Mid Triassic and secondary (if any) Neogene reservoir units, questionable vertical evasion, reservoir open to closed depending on formation of structural traps; basin constriction, lateral evasion, bedrock elevated dynamic systems; geothermal waters usually carbonatogene, transient to sulphatogene, less mixed, polygenetic or hydrosilicatogene
iii) *buried passive margins volcanic centers and tephra aprons – CD1c* – remnants of volcanic centers and their margins in passive rifts and volcanosedimentary grabens; reservoir units in coarse-grained volcanoclastics and volcanic breccia, typically semi-closed to closed in regime; dome and tephra aprons dynamic systems; geothermal waters usually silicatogene, hydrosilicatogene, mixed and marinogene
iv) *foreland basins – CD2a* – specified for the Flysch Belt; reservoir units in Paleogene (breccia, conglomerates, sandstones); stratified reservoir systems, likely circulation-dominated; geothermal waters hydrosilicatogene or carbonatogene in chemistry
v) *intramountain depressions – CD2ba* – formed through Cenozoic tectonic development, typically one or two reservoir units in at least one tectonic unit; open to closed geothermal reservoirs; variable dynamic circulation to accumulation systems; reservoirs in Mid Triassic carbonates (primary) or Paleogene breccia and conglomerates (secondary if hydraulically connected); variable reservoir chemistry, typically carbonatogene to sulphatogene or mixed
vi) *hydrogeological massifs – CD2bb* – local circulation-dominated systems separated from adjacent basins in Klippen Belt; typical reservoirs in Mid Triassic or Jurassic carbonates; one or two reservoir units depending on regional geological structure; short residential time of geothermal waters; geothermal waters carbonatogene to silicatogene or mixed
vii) *neovolcanic footslopes and adjacent depressions* – CD2bc – basin-type systems at volcanic peripheries in non-active areas; geothermal reservoirs in Mid Triassic carbonates; volcanic formations form transition zones; possible secondary reservoirs in Neogene volcanosedimentary formations; typically semi-closed to closed reservoirs; accumulation systems with bedrock-high, basin-constriction or vertical evasion; carbonatogene, sulphatogene, transient to mixed type geothermal waters.

3. NATIONAL GEOTHERMAL RESOURCE CATALOG UPDATE

A first national geothermal catalog was published as the Atlas of geothermal energy of Slovakia (Franko et al. 1995), based on discrete approach. With more perspective geothermal areas explored and new installations since, a preceding stochastic catalog based on best-guess setting the PDFs and simulations was submitted to the WGC2020+1. Recently, a new national catalog was submitted towards Ministry of Environment of the Slovak Republic, under peer-review, that includes (Fričovský et al. 2024):

- conditioned stochastic simulations based on conceptual models (hydrogeological regime, dynamic systems, vertical structure, exploitation options) of reservoir formations; to control both, pre-processing, construction of PDFs and simulation post-processing
- regionalized stochastic models of recovery factors
- stochastic models of McKelvey scheme
- sustainable thermal capacity assessment
- models of developable potential per each reservoir unit
- classification of perspectivity and risk assessment
- stochastic models of exergetic potential per each reservoir unit
- classification of reservoir units by production sustainability aspects.

The catalog is, moreover, constructed for both, the 40-years long production period, and 100-years long, sustainable period according to Axelsson et al. (2001).

3.1 Proven reserves

By 2024, geothermal resources have been documented / proven by 331 wells in 30 out of 31 identified geothermal water bodies; with 2 new installations in Liptovský Mikuláš and Kežmarok since CU2022. A cumulative proven reserves count R_{pv} = 475 MW_{th}. It is, however, important to note that the proven reserves may, however, be less, as typically, geothermal wells have rarely been tested together at critical positions.

Cumulative thermal output (proven reserves) correspond then to proven deliverability of Q_{pv} = 3254 l/s. However, this may also differ, as not every well documenting geothermal resource was subjected to at least required 21-days long well tests.

3.2 McKelvey scheme – a stochastic model

The concept is derived of booking scheme of geothermal resources (Sanyal and Sarmiento 2005). Setting t = 100 years as desired period of production meeting the sustainability criteria, total geothermal resources are estimated with P < 5 % for RS_T = 7755 MW_{th}, while total geothermal reserves at P = 10 % count RE_T = 6030 MW_{th}. The cumulative model then assesses total inferred reserves for R_{inf} = 3825 MW_{th} at a probability scale of P = 10 – 50 %, while probable reserves R_{pb} = 1610 MW_{th} with P = 50 – 90 %.

A category of (probabilistic) total thermal potential TTP(p) was introduced to the catalog, reporting assessment of geothermal energy at P = 50 %. This corresponds to the lowermost tolerable risk of failure limit. Then, the $TTP_{(p)}$ = 2204 MW_{th} for t = 100 years, while the potential increases to $TTP_{(p)}$ = 5565 MW_{th} if considering t = 40 years long production.

3.3 Sustainable thermal capacity / potential

The category of sustainable thermal capacity has been introduced to the catalog to report part of energy available for exploitation under low risk of disruption in reservoir energy balance and energy depletion. A reserve capacity ratio (Bjarnadottir 2010) approach was used to correct the $TTP_{(p)}$ for 50 %, given by r_{cap} = 0.5 to determine a maximum rate of production not exceeding half of the estimated reservoir capacity (Fričovský et al. 2020, 2024). Then, the $P_{th(S)}$ = 1100 MW_{th} for t_{prod} = 100 years, while shortening the desired period of production rises reservoir sustainable capacity to $P_{th(S)}$ = 2745 MW_{th} for t = 40 years.

4. LEGISLATION CONTROLS

Research and prospection of geothermal resources follows the Act No. 569/2007 Coll. (Act on geology) with consequent amendments and Decree No. 51/2008 Coll on applying the Act on geology with consecutive amendments; applying criteria for exploration and prospection, claims and conditions in submission for provision on licensing withdrawals of (not only) geothermal waters. This sets obligation on approval by Ministry of Environment as based on long-term pumping well tests, including hydraulic properties, rock properties, geochemical properties of a resource and basic criteria on quantitative and qualitative resource monitoring. The obligation on withdrawals is later regulated through Act No. 364/2004 Coll. (Act on water) with consequent amendments, defining respective payments and other objectives. Geothermal resources with proven curative composition are regulated through Act No. 538/2005 Coll with onward amendments, generally forcing additional resource monitoring and restrictions on actions in a resource protection zone.

Most recently, there is an ongoing debate on legislative regulation of geothermal resources prospection and utilization. Likely, advanced geothermal systems will be regulated in terms of required modelling of reservoir thermal response on long-term production through amendments of Act No. 44/1988 Coll (Mine Act).

Qualitative and quantitative parameters of geothermal water bodies are still evaluated according to obligations set through the Water Framework Directive 2000/60/EC of the European Parliament and of the Council.

Promotion of RES into national PEM is legislatively regulated through amendments of Act No. 309/2009 Coll. (Act on promotion of renewable energy sources and high efficiency combined production (latest 377/2018 Coll.) that follows goals as set by the Directive 2009/28/EC of the European Parliament and the Council on the promotion of the use of energy from renewable sources.

5. LIST OF PREVIOUS COUNTRY UPDATES

- 1995: Remšík, A. and Fendek, M.: Geothermal Country Update for Slovakia, Proceedings World Geothermal Congress 1995, Florence, Italy, 1-5
- 2000: Fendek, M. and Franko, J.: Country Update for the Slovak Republic, Proceedings World Geothermal Congress 2000, Kyushu-Tohoku, Japan
- 2005: Fendek, M. and Fendeková, M.: Country Update of the Slovak Republic, Proceedings World Geothermal Congress 2005, Antalya, Turkey
- 2010: Fendek, M. and Fendeková, M.: Country Update of the Slovak Republic, Proceedings World Geothermal Congress 2010, Bali, Indonesia
- 2015: Fendek, M. and Fendeková, M.: Country Update of the Slovak Republic, Proceedings World Geothermal Congress 2015, Melbourne, Australia
- 2016: Fendek, M., Fendeková, M., Fričovský, B. and Blanárová, V.: Geothermal Energy Use, Country Update for Slovak Republic, Proceedings European Geothermal Congress 2016, Strasbourg, France
- 2019: Fričovský, B., Černák, R., Marcin, D., Blanárová, V., Benková, K., Pelech, O., Fendek, M.: Geothermal Energy Use, Country Update for Slovakia, Proceedings European Geothermal Congress 2019, Den Haag, Netherlands
- 2020: Fričovský, B., Černák R., Marcin, D., Blanárová, V., Benková, K., Pelech, O., Fordinál, K., Bodiš, D., Fendek, M.: Geothermal energy use – country update for Slovakia, Proceedings World geothermal Congress 2020+1, Reykjavik, Iceland
- 2022: Fričovský, B., Marcin, D., Benková, K., Černák, R., Fordinál, K., Pelech, O.: Geothermal Energy Use, Country Update for Slovakia, Proceedings European Geothermal Congress 2022; Berlin, Germany
- 2023: Fričovský, B., Černák, R., Fordinál, K., Benková, K., Pelech, O., Marcin, D.: Geothermal energy use – Country update for Slovakia (2019 – 2022), Proceedings World Geothermal Congress 2023, Beijing, China.

6. GEOTHERMAL ENERGY USE IN SLOVAKIA, QUALITATIVE UPDATE

6.1 General characteristics as of 2023

The reservoir media in conditions of the Western Carpathians is a geothermal water, associated mostly with Mesozoic – Mid Triassic carbonates (e.g. Liptov Basin, Žilina Basin, Piešťany Embayment) or Neogene sands, sandstones or conglomerates (e.g. CDDB). Only several wells hit thermal waters in Neogene volcanosedimentary complexes. Steam phase, likely as wet-steam (saturated steam) has only been documented in wells of the Košice Basin, i.e. at the (Svinica) Ďurkov and Čižatice localities.

A geothermal database operated at the Dionýz Štúr State institute of Geology, using own data and data submitted by individual operators to the Slovak Hydrometeorological Institute according to the Act on water, counts 123 wells online with at least some record on geothermal resource utilization as of 2023, plus two more wells online, but under testing, supplying heat to 79 geothermal sites. In general, a typical production scheme in Slovakia is 1 well – 1 site – 1 operator. Use of cascaded systems or by-passes is rather rare. In following segment-characteristics, we assign the purpose to the well according its highest energy demand.

Based on data provided of 2023, the general factsheet on geothermal utilization in Slovakia is as follows:

- cumulative geothermal waters production was $Q_{prod} = 16.8 \cdot 10^6$ m^3, that is $0.14 \cdot 10^6$ m^3 per online well
- a cumulative mean yearly productivity is Q_{prod} = 605 l/s, or 4.9 l/s per active well
- a mean production time counts 327 days per year
- 98 wells produced geothermal waters 365 days/yr
- a cumulative mean thermal output, if referenced to the T = 15 °C, counts P_{th} = 86 MW_{th} or P_{th} = 0.7 MW_{th} per well
- the total installed capacity of active geothermal wells is $P_{th,inst}$ = 231 MW_{th} or $P_{th,inst}$ = 1.9 MW_{th} mean per well
- total geothermal energy production reached E_{TH} = 758 GWh_{th} or E_{TH} = 6.2 GWh_{th} per well
- total geothermal heat production counts EQ = 2122 TJ or EQ = 17 TJ per well per year
- no geothermal steam was produced as of 2023.

General outline clearly shows a rapid difference to the data reported towards EGC 2022 and WGC 2023 (e.g. P_{th} = 58 MW_{th}, E_{TH} = 470 GWh_{th}, EQ = 1684 TJ), working with sets as of 2020 and 2021, respectively. The increase is obviously either due to no COVID-19 restrictions applied after 2022 in Slovakia, concerning opening of recreation centers and hotels, where geothermal water is used for space heating, and local climate conditions, with prolonged open-air season for thermal parks due to warmer autumn in 2023.

6.2 Developments compared to EGC 2022 status:

Since the last country update to the EGC (Fričovský et al. 2022), several updates took part:

- the M-2 Komárno well is already in operation and submitting withdrawals; i.e. included in geothermal utilization statistics (recreation)
- the Lipany-2 well yielded withdrawal approvals, now operated for local thermal resort and reporting withdrawals, i.e. included in statistics (recreation)
- the GVL-1 Veľká Lomnica well successfully claimed approvals, extending heat supply to housings and a hotel within a camp as well, i.e. included in statistics (individual space heating)
- the GTK-1 Kežmarok well has been completed and underwent a long-term well tests, currently in process of approvals, i.e. not reporting and not included in statistics (geothermal district heating)

- the new installation in Liptovský Mikuláš has already been completed, now under long-term pumping tests prior applying for approvals, i.e. not reporting, not included in statistics (industry).

6.3 Geothermal district heating systems

Compared to EGC 2022 and WGC 2023 reports, there are 5 sites with (hybrid) geothermal district heating systems in Slovakia – four launched between 1996 and 2017 (Galanta, Šaľa, Veľký Meder, Sereď) + new installation for the town of Kežmarok with a geothermal well GTK-1, however, production data were not officially available as approval on withdrawal provisions was in the process. As hybrid, local GDHSs operate for both, the base- and peak- demand in combination with natural gas. A share of geothermal energy production on total energy generation varies from 45% (Sered) to 99% (Galanta). Generally, wells operating in GDHS systems have both, the highest mean thermal output and mean thermal capacity out of the analyzed segments. This is because of highest energy demands. Although active sites are all located in the southern part of Slovakia, with a short heating period (roughly 210 days/yr.), geothermal resources are used for domestic hot water out of season, too. Production data as of 2023 summarize that:

- number of sites: 5
- number of online wells: 7
- cumulative geothermal water production: $Q_{prod} = 1.1 \cdot 10^6$ m^3
- cumulative productivity: Q_{prod} = 37 l/s
- cumulative thermal output: P_{th} = 9 MW~~th~~
- cumulative installed capacity: $P_{th,ins}$t = 21 MW_{th}
- cumulative energy production: E_{TH} = 78 GWh_{th}
- cumulative heat production: EQ = 226 TJ
- mean operation time: t_{prod} = 340 days/yr.

6.3 Individual space heating

The individual space heating refers to sites, where wells are used to heat individual buildings regardless their function, such is administration, hotels, storages etc. There are 11 wells supplying 11 sites as both, individual, or cascaded projects, combining the space heating with recreation (Bešeňová, Liptovský Trnovec, Poprad) or agriculture (Podhájska). In Vrbov, the space heating is, however, lower in energy demand compared to recreation / agriculture, i.e. adjusted respectively. Geothermal wells for individual space heating have the highest mean yearly productivity. High productivity index (average is 360 / 365 days per year) is rather due to cascading or use of geothermal waters for domestic hot water. The segment statistics as of 2023 are:

- number of sites: 11
- number of online wells: 11
- cumulative geothermal waters production: $Q_{prod} = 2.9 \cdot 10^6$ m^3
- cumulative productivity: Q_{prod} = 97 l/s
- cumulative thermal output: P_{th} = 17 MW_{th}
- cumulative installed capacity: $P_{th,ins}$t = 42 MW_{th}
- cumulative energy production: E_{TH} = 146 GWh_{th}
- cumulative heat production: EQ = 402 TJ
- mean operation time: t_{prod} = 360 days/yr.

6.4 Agriculture

Agriculture covers both, greenhousing / planting (e.g. Topoľníky, Bruty, Nesvady) or fish-farming (Turčianske Teplice, Vrbov). Geothermal waters are utilized in primary agriculture only, not for food / plant processing. Lower productivity index with mean production period of 325 days/yr. is due to variation in site operation, i.e. seasonal (e.g. Topoľníky) or full-time (e.g. Tvrdošovce). Moreover, in Nováky – Laskár, the geothermal heat is used for fish-farming and planting together. A typical scheme is 1 well per 1 site, except the Horná Potôň site. Statistics as of 2023 are then as follows:

- number of sites: 12
- number of online wells: 13
- cumulative geothermal waters production: $Q_{prod} = 2.2 \cdot 10^6$ m^3
- cumulative productivity: Q_{prod} = 73 l/s
- cumulative thermal output: P_{th} = 14 MW_{th}
- cumulative installed capacity: $P_{th,ins}$t = 44 MW_{th}
- cumulative energy production: E_{TH} = 122 GWh_{th}
- cumulative heat production: EQ = 343 TJ
- mean operation time: t_{prod} = 325 days/yr.

6.5 Recreation

Recreation, in terms of heating outdoor (e.g. Rimavské Janovce – Kurinec, Chalmová, Bešeňová) and/or indoor (e.g. Poprad, Patince) pools in both, direct and indirect systems largely prevails in geothermal energy utilization in Slovakia. Following statistics are, however, based on sites where recreation is a primary purpose, not part of cascades. Although a scheme of 1 well – 1 site prevails, few sites operate two (Poľný Kesov, Štúrovo, Chalmová, Dolná Strehová, Kaličiakovo) to three (Vyhne, Virt) boreholes. Lowest productivity index, i.e. average of 286/365 operation days per year is due to variation in seasonal / year-round opening hours for respective thermal parks, where 18 out of 50 wells are online seasonally only. For those, operation days vary from 28 (Čilistov) to 334 (Diakovce). Further statistics as of 2023 include:

- number of sites: 41
- number of online wells: 50
- cumulative geothermal waters production: $Q_{prod} = 7.4 \cdot 10^6$ m^3
- cumulative productivity: Q_{prod} = 297 l/s
- cumulative thermal output: P_{th} = 34 MW_{th}
- cumulative installed capacity: $P_{th,ins}$t = 97 MW_{th}
- cumulative energy production: E_{TH} = 301 GWh_{th}
- cumulative heat production: EQ = 798 TJ
- mean operation time: t_{prod} = 286 days/yr.

6.6 Balneotherapy

The segment of balneotherapy refers to use of geothermal waters with already proven curative effects on human health. Besides targeting for temperature, location and extension of balneotherapeutical use is limited by geology and chemistry of geothermal waters to have their curative effects proven. Moreover, mineral-thermal waters withdrawal is subjected to specific objections framed by the Ministry of Health and national Inspectorate of Spas and Springs, including setting not only technical limits for abstraction, but extension of protective zones for a resource. Use of geothermal waters in balneotherapy is also limited by strict limits on water quality and monitoring, under provision of the Spa Act. There are 11 spas in Slovakia, i.e. Bojnice, Trenčianska Teplice, Vyšné Ružbachy, Lúčky, Piešťany, Turčianske Teplice, Kováčová, Sliač, Sklené Teplice, Dudince, Rajec, that differ in specific health indications, generally according to different water chemistry and temperature. Under balneotherapy, only wells providing the resource for direct or indirect therapies are enlisted. The segment does not include wells providing heat supply for pools or space heating within spas, if not used for medical purposes. Referring to thermal waters, there are usually more than one well per site, except the Vyšné Ružbachy, Sliač and Dudince, where spas are supplied rather by "cold" healing springs. Respective characteristics as of 2023 then are:

- number of sites: 11
- number of online wells: 44
- cumulative geothermal waters production: $Q_{prod} = 3.2 \cdot 10^6$ m^3
- cumulative productivity: Q_{prod} = 102 l/s
- cumulative thermal output: P_{th} = 13 MW_{th}
- cumulative installed capacity: $P_{th,ins}t$ = 27 MW_{th}
- cumulative energy production: E_{TH} = 112 GWh_{th}
- cumulative heat production: EQ = 354 TJ
- mean operation time: t_{prod} = 364 days/yr.

6.7 Shallow geothermal energy use

Quantifying the use of shallow geothermal energy remains difficult. Some data are available for large-scale installations in Podhájska, Bojnice, Vyšné Ružbachy, Gbelany, Rajecké Teplice, Piešťany, Senec, Čilistov, Rabča and Borša; with installed capacity likely unchanged at 1.6 MW_{th} cumulative (Fendek et al. 2016) and assumed heat production of 14 TJ per year.

The situation is more difficult for small installations, both ground source (horizontal loops or BHE) or water-water systems. According to Slovak Association for Cooling, Air Conditioning and Heat Pumps, there are at least small 530 installations in the country, including 287 for GSHP and 243 for water-water designs. Data on individual installed capacities and energy production are not available.

6.8 Projects in preparation or stand-by

The Svinica – Ďurkov geothermal center, the largest geothermal project in Slovakia, reported several times in previous CUs, is at a kick-off point as of March 2025. Three geothermal wells with installed thermal output of 15 MW_{th} (1 producer, 2 injectors) will be subjected to long-term pumping tests expected to take part between May – September. Another three geothermal wells are scheduled for drilling from autumn 2025 on. Both triplets are expected to operate 7200 h/y and 4800 h/y, respectively, producing 180'000 MWh_{th} of geothermal energy yearly in average. The project is designed as GDHS for Košice, likely to supply 25 % of total heating demand of the city. The importance of the project is accented with providing its status of National Project. A support of Just Transition Fund counts 56.2 mil. €; plus private investment costs. The costs include not only drilling and associated actions, but infrastructure construction, land purchase etc. Overall duration of the project is scheduled for 43 months.

There were two projects on binary geothermal power plants at Lovča and Teriakovce reported in previous CUs. Recently, both obtained EIA evaluation. Recently, both projects are active, however, no drilling takes place, due to funding issues.

The Čižatice geothermal project remains on stand-by. After well completion, there was no well test carried out. The project is recently applying for funds to continue with the reinjection well and EIA evaluation. Preliminary results show geothermal water temperature at the wellhead is 96 - 98 °C; measured deliverability was 14 l/s after spontaneous phase-separation (reservoir conditions imply saturated wet-steam)

Other projects subjected to EIA evaluation, yet not in a drilling stage as of 2025 are:

- GOP-1 Oravská Poruba – Geceľ – planned to a TVD = 2800 m + 100 m optionally (individual space heating for local appartments + cascaded recreation)
- GTK-1 Kaličiakovo – opting for heating pools in existing resort (recreation) with planned total depth of 1000 m ± 200 m.

7. FUNDING

Recently, state budget funds are provided for research of geothermal resources on a regular scale. Typically, this is allocated to the Dionýz Štúr State institute of Geology, supplying national geological survey services. While in the past funds were also allocated for exploration wells, at least for a decade the support is oriented rather on hydrogeothermal evaluation or modelling activities.

There are two schemes scheduled Q2 and Q3 as of 2025. The Slovak Innovation and Energy Agency (SIEA), a departmental organization of the Ministry of Economy of the Slovak Republic, finalizes a call to support exploration and prospection of geothermal resources towards its energetic use under the European Regional Development Fund, ready to allocate almost 13.1 mil. €. A second call is supported by the Just Transition Fund supervised by the Ministry of Investments, Regional Development and Informatization of the Slovak Republic. The funding is to allocate 10.5 mil. € research, exploration and prospection on geothermal resources activities, including borehole reclamation, borehole logging etc.

To trigger geothermal energy use and production, a REpowerEU scheme funds mapping and evaluating (existing) geothermal wells in Slovakia recently not used in public (governmental, municipal) ownership. A goal is to provide a database and fact sheets of geothermal wells towards public authorities and private sector, including geological profile, hydraulic parameters, geothermal water chemistry, thermodynamic parameters, exergetic potential analysis, thermal output maps etc; as well as actions required for a borehole reclamation.

8. CONCLUSIONS

According to 2023 data, there are 123 geothermal wells online, producing the resource both, year-round or seasonally, at 79 different sites / projects. Overall geothermal water production reached $Q_{prod} = 16.8 \cdot 10^6$ m^3 with cumulative yearly productivity of $Q_{prod} = 605$ l/s. This is equal to a yearly mean cumulative thermal output of all online geothermal wells of $P_{th} = 86$ MW_{th}, whereas a total installed capacity is roughly $P_{th,inst} = 231$ MW_{th}. A cumulative geothermal heat production counts EQ = 2122 TJ, i.e. geothermal energy produced $E_{TH} = 758$ GWh_{th}.

When compared to geothermal development outlooks as of CU 2022 and CU 2023, reported geothermal wells in Kežmarok – GTK-1 (geothermal district heating systems) and Liptovský Mikuláš (industry) were completed, wells in Lipany (L-2) and Komárno (M-2), both for recreation, are in a regular operation. Recently, the Ďurkov – Svinica geothermal project, largest in the country, with installed capacity of 60 MW_{th} for GDHS of the city of Košice, is ready for kick-off in April 2025, scheduled for 43 months to the completion.

Analogously with previous CUs, there is only direct use of geothermal resources in the country. Although recreation is a dominant segment, it is also likely to be replaced with GDHS soon, as long as the Ďurkov project will be completed. Numerous concerns occur on binary geothermal power production. Nowadays, both planned sites, i.e. Lovča and Teriakovce obtained EIA and now are applying for fundings.

REFERENCES

Axelsson, G., Gudmundsson, A., Steingrímsson, B., Palmasson, G., Armansson, H., Tilinius, H., Flovenz, O.G., Bjornsson, S., and Stefansson, V.: Sustainable production of geothermal energy: suggested definition. *International Geothermal Association News Quaterly*, **43**, (2001), 1-2.

Bjarnadottir, R.: *Sustainability evaluation of geothermal systems in Iceland. Indicators for sustainable production* [manuskript – Master's Thesis], Reykjavik Energy Graduate School of Sustainable Systems, Reykjavik, (2010).

Bodiš, D., Remšík, A., Černák, R., Marcin, D., Ženišová, Z. and Fľaková, R.: Geothermal and hydrogeological conditions, geochemical properties and uses of geothermal waters in Slovakia. In: Bundschuh J. – Tomaszewska B. (Eds.), Geothermal Water Management, 41-69, *Taylor & Francis*, (2018).

Černák, R., Remšík A. and Nador A.: Geothermal energy research in Slovakia and cooperation on geothermal transboundarz project Transenergy, *Slovak Geological Magazine*, **14 (2)**, (2014), 5-16.

Fendek, M., Rebro, A. and Fendeková, M.: A spell cast: historical aspects of thermal springs use in the Western Carpathian region. In: Cataldi, R. (Ed.): Stories from a heated Earth: Our Geothermal Heritage. *Geothermal Resource Council Transactions*, **Special Issue 19**, (1999), 251-265.

Fendek, M., Remšík, A. and Král, M.: The nature of geothermal resources in Slovak Republic, *Slovak Geological Magazine*, **5 (1-2)**, (1999), 121-130.

Fendek, M., Fendeková, M., Fričovský, B. and Blanárová, V.: Geothermal Energy Use, Country Update for Slovak Republic, Proceedings European Geothermal Congress 2016, Strasbourg, France (2016).

Franko, O. and Melioris, L.: Condition for formation and extension of mineral and thermal waters in the Western Carpathians, *Slovak Geological Magazine*, **5 (1-2)**, (1999), 93-107.

Fričovský, B., Marcin, D., Benková, K., Černák, R., Fordinál, K. and Pelech, O.: Geothermal Energy Use, Country Update for Slovakia. *Proceedings European Geothermal Congress 2022*; Berlin, Germany, (2022).

Fričovský, B., Černák, R., Fordinál, K., Benková, K., Pelech, O. and Marcin, D.: Geothermal energy use – Country update for Slovakia (2019 – 2022), *Proceedings World Geothermal Congress 2023*, Beijing, China (2023).

Fričovský, B., Vizi, L., Marcin, D., Benková, K., Černák, R., Fordinál, K., Bottlík, F. and Bahnová, N.: Analýza možností trvalo udržateľného využitia a využívania zdrojov geotermálnej energie na Slovensku – I. časť. [manuskript - záverečná správa]. Štátny geologický ústav Dionýza Štúra, Bratislava, (2024) [in Slovak].

Jurewicz, E.: Geodynamic evolution of the Tatra Mts. and the Pieniny Klippen Belt (Western Carpathians): problems and comments, *Acta Geologica Polonica*, **55 (3)**, (2005), 295-338.

Majcin, D., Král, M., Bilčík, D., Šujan, M. and Vranovská, A.: Deep geothermal sources for electricity production in Slovakia: thermal conditions. *Contributions to Geophysics and Geodesy*, ***47 (1)***, (2017), 1-22.

Marcin, D., Remšík, A. and Benková, K.: Geothermal water utilization in Slovakia, *Slovak Geological Magazine*, **14 (2)**, (2014), 69-79.

Moeck, I.S.: Catalog of geothermal play types based on geologic controls, *Geothermics*, **37**, (2014), 867-882.

Plašienka, D.: Continuity and episodicity in the early Alpine tectonic evolution of the Western Carpathians: How large-scale processes are expressed by the orogenic architecture and rock record data, *Tectonics*, **37 (1)**, (2018), 1-51.

Sanyal, S.K. and Sarmiento, Z.: Booking geothermal renergy reserves. *Geothermal Resource Council Transactions*, **29**, (2005), 467-474.

Schmid, S. M., Bernoulli, D., Fügenschuh, B., Matenco, L., Schefer, S., Schuster, R., Tischler, M. and Ustaszewski, K.: The Alpine-Carpathian-Dinaridic orogenic system: correlation and evolution of tectonic units. *Swiss Journal of Geosciences*, **101 (1)**, (2008), 139-183.

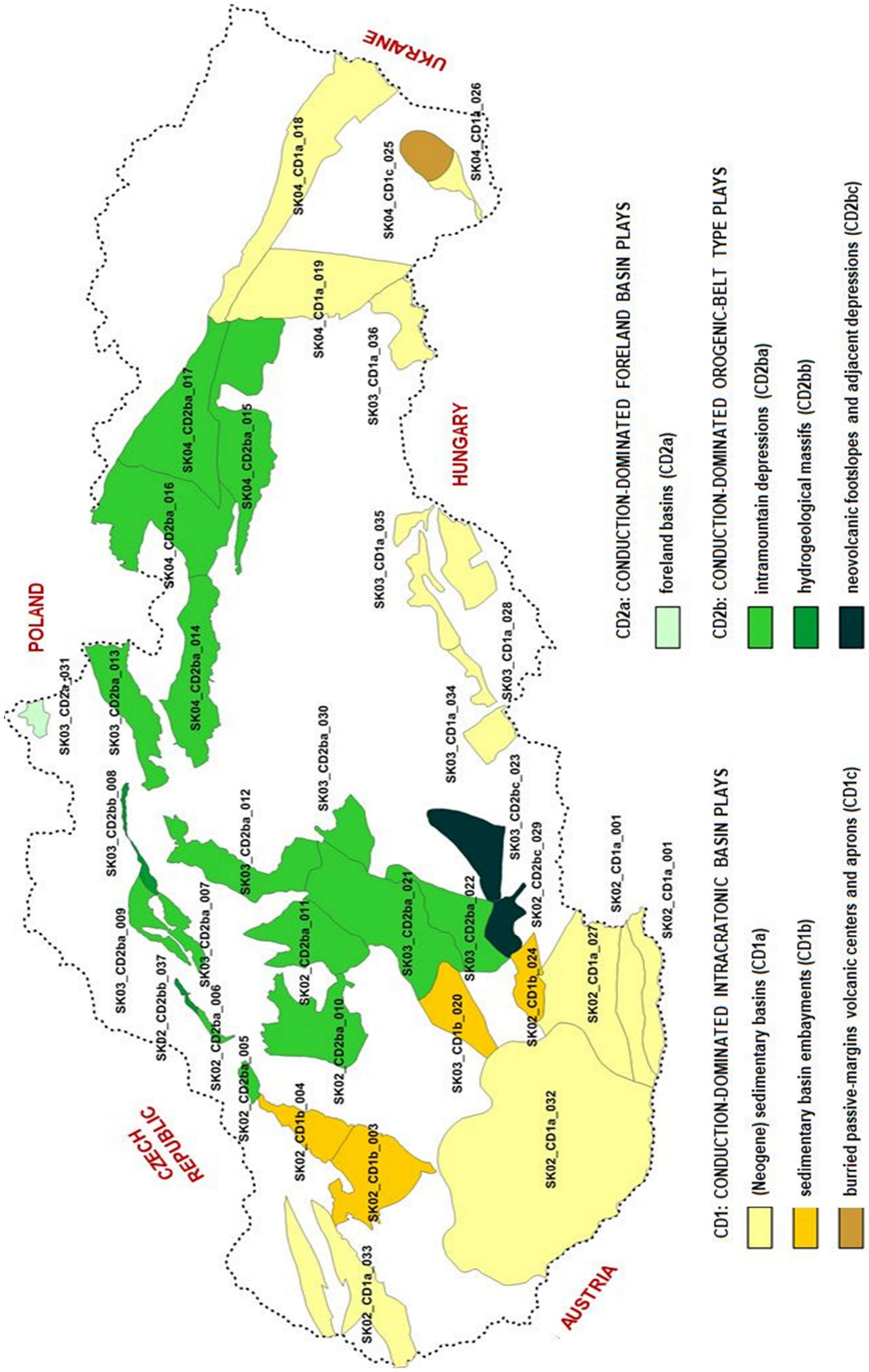

Figure 1: Recent delineation of geothermal plays in Slovakia (see explanation on next page).

Explanations to Figure 1

Code	Geothermal play-type by Moeck (2014)	Geothermal play	Code	Geothermal play-type by Moeck (2014)	Geothermal play
SK02_CD1a_001	CD1	Komárno High block	SK02_CD1b_020	CD1	Komjatice depression
SK02_CD1a_002	CD1	Komárno Magin block	SK03_CD2ba_021	CD2b	Žiar Basin
SK02_CD1b_003	CD1	Trnava embayment	SK03_CD2ba_022	CD2b	Bátovce depression
SK02_CD1b_004	CD1	Piešťany embayment	SK03_CD2bc_023	CD2b	Rykynčice depression
SK02_CD2ba_005	CD2b	Trenčín Basin	SK02_CD1b_024	CD1	Levice Block
SK02_CD2ba_006	CD2b	Ilava Basin, southern part	SK04_CD1c_025	CD1	Trebišov Basin, northern part
SK03_CD2ba_007	CD2b	Rajec valley	SK04_CD1a_026	CD1	Trebišov Basin, southern part
SK03_CD2bb_008	CD2b	Varín valley	SK02_CD1a_027	CD1	Dubník depression
SK03_CD2ba_009	CD2b	Žilina Basin	SK03_CD1a_028	CD1	Lučenec Basin
SK02_CD2ba_010	CD2b	Bánovce Basin	SK02_CD2bc_029	CD2b	Turovce-Levice horst
SK02_CD2ba_011	CD2b	Horná Nitra Basin	SK03_CD2ba_030	CD2b	Zvolen Basin
SK03_CD2ba_012	CD2b	Turiec Basin	SK03_CD2a_031	CD2a	Podbeskydy Furrow
SK03_CD2ba_013	CD2b	Skorušiná Basin	SK03_CD1a_032	CD1	Danube Basin central depression
SK03_CD2ba_014	CD2b	Liptov Basin	SK02_CD1a_033	CD1	Vienna Basin
SK04_CD2ba_015	CD2b	Hornád Basin	SK03_CD1a_034	CD1	Horné Strháre – Trenč graben
SK04_CD2ba_016	CD2b	Poprad Basin	SK03_CD1a_035	CD1	Rimava Basin
SK04_CD2ba_017	CD2b	Levoča Basin, NE part	SK03_CD1a_036	CD1	Moldava Basin
SK04_CD1a_018	CD1a	Humenné ridge	SK02_CD2bb_037	CD2b	Ilava Basin, northern part
SK04_CD1a_019	CD1	Košice Basin			

Tables A-G

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

<table>
<tr><th rowspan="2"></th><th colspan="2">Geothermal Power Plants</th><th colspan="2">Total Electric Power in the country</th><th colspan="2">Share of geothermal in total electric power generation</th></tr>
<tr><th>Capacity (MW_e)</th><th>Production (GWh_e/yr)</th><th>Capacity (MW_e)</th><th>Production (GWh_e/yr)</th><th>Capacity (%)</th><th>Production (%)</th></tr>
<tr><td>In operation end of 2024</td><td>-</td><td>-</td><td>3829</td><td>17’413</td><td>-</td><td>-</td></tr>
<tr><td>Under construction end of 2024</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>Total projected by 2028</td><td>N/A</td><td>N/A</td><td>N/A</td><td>N/A</td><td>N/A</td><td>N/A</td></tr>
<tr><td>Total expected by 2032</td><td>N/A</td><td>N/A</td><td>N/A</td><td>N/A</td><td>N/A</td><td>N/A</td></tr>
<tr><td colspan="5" rowspan="2">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):</td><td colspan="2">Under development:</td></tr>
<tr><td colspan="2">Under investigation:</td></tr>
</table>

Table B: Existing geothermal power plants, individual sites

No geothermal power plants are operational in Slovakia 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 *	21*	78*	86*	268*	42*	146*	124*	413*
Under construction end 2024	30	258	N/A	N/A	N/A	N/A	N/A	N/A
Total projected by 2028	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total expected by 2032	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

* If 2023 numbers need to be used, please identify such numbers using an asterisk

** Note: spas and pools are difficult to estimate and are often over-estimated. For calculations of energy use in the pools, be sure to use the inflow and outflow temperature and not the spring or well temperature (unless it is the same as the inflow temperature) for calculating the energy parameters, as some pool need to have the geothermal water cooled before using it in the pools.

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

Locality	Plant Name	Year commissioned	CHP **	Cooling ***	Geoth. capacity installed (MW_{th})	Total capacity installed (MW_{th})	2024 production * (GWh_{th}/y)	Geoth. share in total prod. (%)
Galanta	Galantaterm Ltd.	1996	N	N	12.47	13.1	33*	99
Šaľa	MeT Šaľa Ltd.	2011	N	N	3.4	20.7	25*	35
Veľký Meder	Veľký Meder	2017	N	N	3.16	15	17*	98
Sereď	Energetika Sereď Ltd.	2012	N	N	1.81	8.7	3*	45
total					20.64	57.5	78	-

* If 2023 numbers need to be used, please identify such numbers using an asterisk

** 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.

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. (%)
Bánovce n. Bebravou	Kúpalisko Bánovce n. Bebravou	N/A	N	1.7	1.7	3.77	100
Bešeňová	Vodný park Bešeňová	N/A	N	6.46	6.46	39.42	100
Bešeňová	Vodný park Bešeňová	N/A	N	5.03	5.03	48.09	100
Bojnice	Kúpele Bojnice	N/A	N	3.61	3.61	19.1	100
Bojnice	Kúpele Bojnice	N/A	N	0.4	0.4	3.59	100
Bruty	Bruty	N/A	N	3.54	3.54	15.51	100
Čilistov	Kúpalisko Čilistov	N/A	N	2.21	2.21	0.96	100
Diakovce	Termálne kúpalisko Diakovce	N/A	N	0.37	0.37	3.24	100
Dolná Strehová	Hotel Aquathermal	N/A	N	0.64	0.64	4.29	100
Dudince	Kúpele Dudince	N/A	N	0.8	0.8	2.19	100
Dunajská Streda	Top Toma	N/A	N	4.5	4.5	10.77	100
Dunajská Streda	Dunajská Streda	N/A	N	3.66	3.66	4.03	100
Galanta	Galanta	N/A	N	12.47	12.47	33.2	100
Galanta - Sládkovičovo	Termálne kúpalisko Vincov Les	N/A	N	2.01	2.01	9.37	100
Gánovce	Kúpalisko Gánovce	N/A	N	0.09	0.09	0.35	100
Horná Potôň	Prima Fruit	N/A	N	8.86	8.86	13.67	100
Horné Saliby	Termálne kúpalisko Horné Saliby	N/A	N	2.51	2.51	12.88	100
Chalmová	Termálne kúpalisko Chalmová	N/A	N	1.45	1.45	3.33	100
Kaličiakovo	Kúpalisko Margina - Ilona	N/A	N	0.97	0.97	4.12	100
Kaluža	Thermal Šírava	N/A	N	0.4	0.4	1.93	100
Kolárovo	Termál Kolárovo	N/A	N	5.15	5.15	17.52	100
Komárno	Thermal Komarno	N/A	N	0.49	0.49	3.77	100
Koplotovce	Kúpalisko Koplotovce	N/A	N	0.51	0.51	1.31	100
Kováčová	Kúpele Kováčová	N/A	N	3.29	3.29	5.96	100

* 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.

Table D2 (continued): 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. (%)
Kremnica	Kremnica	N/A	N	2.97	2.97	17.08	100
Lipany	Aquapark Lipany	N/A	N	2.74	2.74	6.22	100
Liptovský Ján	Kúpalisko Liptovský Ján	N/A	N	1.21	1.21	7.01	100
Liptovský Trnovec	Aqualandia	N/A	N	5.54	5.54	26.81	100
Lúčky	Kúpele Lúčky	N/A	N	3.83	3.83	4.39	100
Malé Bielice	Kúpalisko Malé Bielice	N/A	N	0.85	0.85	1.75	100
Mošovce - Drienok	Kúpalisko Mošovce	N/A	N	0.16	0.16	0.53	100
Ňárad - Baloň	Blumen Bt	N/A	N	3.39	3.39	8.32	100
Nesvady	PD Nesvady	N/A	N	0.48	0.48	6.04	100
Nováky - Laskár	HBP	N/A	N	3.84	3.84	17.34	100
Nové Zámky	Kúpalisko Štrand Emilia	N/A	N	0.79	0.79	6.39	100
Oravice	Meander Oravice	N/A	N	11.09	11.09	0.96	100
Oravice - Vitanová	Kúpalisko Vitanová	N/A	N	5.22	5.22	0.88	100
Partizánske	Kúpalisko Dúha	N/A	N	0.26	0.26	0.09	100
Patince	Kúpalisko Patince	N/A	N	2.18	2.18	0.53	100
Piešťany	Kúpele Piešťany	N/A	N	5.68	5.68	29.8	100
Piešťany	Kúpele Piešťany	N/A	N	4.75	4.75	9.99	100
Piešťany	Kúpele Piešťany	N/A	N	4.69	4.69	5.87	100
Podhájska	Termálne kúpalisko Podhájska	N/A	N	13.52	13.52	32.94	100
Poľný Kesov	Thermal park Nitrava	N/A	N	0.54	0.54	4.2	100
Poľný Kesov	Thermal park Nitrava	N/A	N	2.49	2.49	13	100
Poprad	Aqualand Poprad	N/A	N	8.07	8.07	32.67	100
Rajec	Aphrodita	N/A	N	0.98	0.98	0.74	100
Rajecké Teplice	Kúpele Rajecké Teplice	N/A	N	1.12	1.12	5.87	100
Rajecké Teplice	Kúpele Rajecké Teplice	N/A	N	0.37	0.37	1.66	100

* 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.

Table D2 (continued): 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. (%)
Rapovce	Thermal Park Novolandia	N/A	N	1.03	1.03	2.19	100
Rimavské Janovce	Kúpalisko Kurinec	N/A	N	1.44	1.44	8.76	100
Santovka	Santovka Wellness	N/A	N	2.97	2.97	5.69	100
Senec	Aquapark Senec	N/A	N	1.63	1.63	9.29	100
Sereď	Sereď	N/A	N	1.81	1.81	2.98	100
Sielnica	Kaskády Spa Resort	N/A	N	0.22	0.22	0.11	100
Sklené Teplice	Kúpele Sklené Teplice	N/A	N	3.9	3.9	22.43	100
Sklené Teplice	Relax Thermal hotel	N/A	N	0.36	0.36	2.1	100
Sliač	Kúpele Sliač	N/A	N	0.8	0.8	1.75	100
Stráňavy	Termálne kúpalisko Stráňavy	N/A	N	0.8	0.8	3.5	100
Šaľa	Šaľa	N/A	N	3.2	3.2	24.88	100
Štúrovo	Vadas Thermal Resort	N/A	N	7.52	7.52	14.8	100
Topoľníky	PD Topoľníky	N/A	N	5.34	5.34	2.1	100
Tornaľa	Plážové kúpalisko Tornaľa	N/A	N	1.44	1.44	1.75	100
Trenčianske Teplice	Kúpele Trenčianske Teplice	N/A	N	0.95	0.95	6.72	100
Turčianske Teplice	Kúpele Turčianske Teplice	N/A	N	0.17	0.17	1.05	100
Turčianske Teplice	Kúpele Turčianske Teplice	N/A	N	1.54	1.54	4.33	100
Tvrdošovce	Termálne kúpalisko Tvrdošovce	N/A	N	4.34	4.34	4.82	100
Veľká Lomnica	unkown	N/A	N	6.52	6.52	2.1	100
Veľký Meder	Veľký Meder	N/A	N	3.15	3.15	17.34	100
Veľký Meder	Veľký Meder	N/A	N	3.04	3.04	14.72	100
Veľký Meder - Čalovo	Veľký Meder	N/A	N	2.51	2.51	9.2	100
Vinica	Kúpalisko Vinica	N/A	N	0.24	0.24	2.63	100

* 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.

Table D2 (continued): 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. (%)
Virt	Virt	N/A	N	1.4	1.4	15.24	100
Vrbov	Kúpalisko Vrbov	N/A	N	5.76	5.76	31.62	100
Vrbov	Kúpalisko Vrbov	N/A	N	4.61	4.61	20.15	100
Vyhne	Hotel Termál Vyhne	N/A	N	0.94	0.94	3.42	100
Vyšné Ružbachy	Kúpele Vyšné Ružbachy	N/A	N	0.42	0.42	0.26	100
Zemné	PD Zemné	N/A	N	2.39	2.39	2.54	100
Zlatná na Ostrove	PD Zlatná n. Ostrove	N/A	N	1.08	1.08	7.8	100
total				229.4	229.4	749.72	

* 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.

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

	Geothermal Heat Pumps (GSHP), total			New (additional) GSHP in the year 2024		
	Number	Capacity (MW_{th})	Production (GWh_{th}/yr)	Number	Capacity (MW_{th})	Share in new constr. (%)
In operation end of 2024	N/A	N/A	N/A	N/A	N/A	N/A
Of which networks *	N/A	N/A	N/A	N/A	N/A	N/A
Projected total by 2028	N/A	N/A	N/A			

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

Table F: Investment and Employment in geothermal energy

	in 2024		Expected in 2028	
	Expenditures * (million €)	Personnel ** (number)	Expenditures * (million €)	Personnel ** (number)
Geothermal electric power	N/A	N/A	N/A	N/A
Geothermal direct uses	N/A	N/A	N/A	N/A
Shallow geothermal	N/A	N/A	N/A	N/A
total	N/A	N/A	N/A	N/A

* 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.

Table G: Incentives, Information, Education

	Geothermal electricity	Deep Geothermal for heating and cooling	Shallow geothermal
Financial Incentives – R&D	N/A	N/A	N/A
Financial Incentives – Investment	N/A	N/A	N/A
Financial Incentives – Operation/Production	N/A	N/A	N/A
Information activities – promotion for the public	N/A	N/A	N/A
Information activities – geological information	N/A	N/A	N/A
Education/Training – Academic	N/A	N/A	N/A
Education/Training – Vocational	N/A	N/A	N/A

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)		