Geothermal Energy Use - Country Update for Poland, 2016-2018

Beata Kępińska

Mineral and Energy Economy Research Institute, Polish Academy of Sciences
Wybickiego 7A Str., 31-261 Kraków, Poland

bkepinska@interia.pl

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ABSTRACT

The paper updates the status of geothermal energy use development in Poland in 2016–2018. It follows similar report prepared for the European Geothermal Congress 2016 (Kępińska, 2016).

At the end of 2018 six geothermal district heating plants (geoDHs) were operating. Their total installed geothermal capacity was 74.6 MW and geothermal heat production 250.4 GWh (38-100% share of total heat production in particular geoDHs). A growing interest was continuing in recreation sector: total of 15 centres were operating in 2018. Ten health resorts applied geothermal water for curative treatments. Among other geothermal energy and water uses was a large atlantic salmon farming. Other single uses involved a semi-technical wood drying,heating up a football pitch and walking paths.

In case of shallow geothermal, its development was continuing. In 2017 a number of ground source heat pumps (GSHPs) can be evaluated for at least 56 000, capacity for 650 MW and heat production for 860 GWh. The progress of GSHPs was part of the progress of the whole heat pumps' sector.

In 2016–2018 about three new geothermal wells were drilled. They encountered ca. 40–65ºC waters for recreation or geoDH. In addition, drillings of several wells started in 2018. They were funded from state support program for geothermal heating development introduced in 2015 (the completion of bulk of them and hydrodynamic test results were expected in course of 2019). In 2018 several more drillings were granted the funds from the mentioned program and were planned for realization in 2019. In addition, some wells were planned to be done from other funding sources. Hence, in the coming years one may expect some next geoDHs in the country.

1. INTRODUCTION

The paper updates the status of geothermal energy use development in Poland in 2016–2018. It follows similar report submitted for the European Geothermal Congress 2016 (Kępińska, 2016).

The geothermal applications in the country involve space heating, recreation, balneotherapy and some other uses. At the end of 2018 six geothermal district heating plants were operating (same as reported in 2016). Their total installed geothermal capacity was 74.6 MW and heat production 250.4 GWh. Fifteen geothermal recreation centres and ten health resorts that used geothermal water for treatment were operating at the end of 2018. Geothermal applications involved also fish farming and some other minor uses.

The paper lists also ongoing geothermal investments and projects in various stages of advancement. However, comparing with several other countries, the level of geothermal uses in Poland in 2016–2018 was rather low. From the other hand – one shall note that in 2015 the state program was launched to support geothermal exploration drillings and other infrastructure dedicated to energetic uses (space heating as a priority, CHP, HDR) by the Ministry of Environment, Chief State Geologist. The program is operated by National Fund for Environment Protection & Water Management, NFEP&WM. That incentive has already resulted in granting funds for over 10 new wells (in 2018 drillings several of them were in progress or even finished) while next applications were awaiting the decisions for funding. It is expected that in the coming years these new wells will form the bases for introducing geothermal into some number of existing district heating systems in the country.

2. GEOTHERMAL ENERGY POTENTIAL

Geothermal energy resources in Poland are hosted mainly by Mesozoic sedimentary formations in the Polish Lowlands, and in the Inner Carpathians. Some prospects are connected with selected areas and locations in the Outer Carpathians, the Carpathian Foredeep and the Sudetes region (Fig. 1).

The recorded so far outflow water temperatures vary from about 20 to 97°C (depths of aquifers up to ca. 3.7 km). The proven geothermal water reserves amount from several L/s up to 150 L/s. Water mineralisation (TDS) vary from 0.4 to 156 g/L.

3. OVERVIEW OF GEOTHERMAL USES

The chapter gives an insight into geothermal energy applications in Poland at the end of 2018. Their location is shown on Figure 1. Main data on geothermal installations are given in Tables A–G.

3.1 District heating

In 2018, six geothermal district heating plants were operational: in the Podhale region and in the municipalities of Pyrzyce, Mszczonów, Poddębice, Uniejów, Stargard (same as reported in 2016).

The Podhale region. The geoDH system has been operating since 1993 (on larger scale since 2001). The total maximum artesian water flow rate produced by 3 wells is ca. 297 L/s (since 2017; before was 267 L/s) of 82–86°C water. In 2018 the installed geothermal capacity was 38.8 MW (total 77.9 MW) while geothermal heat production amounted to 141.5 GWh (509.5 TJ), i.e. 89.3% of total production (W. Ignacok, M. Pelczarska – *pers. communication*). In 2018 ca. 1600 receivers were hooked to geoDH (mostly in Zakopane – the main city of that region and main heat market; geoDH met ca. 35% of its heat demand). Part of spent geothermal water is injected back by 2 wells while part supplies 2 recreation centres. The Podhale system is among the biggest geoDHs in continental Europe. In 2016-2018 further works on optimization and extension of that system were ongoing.

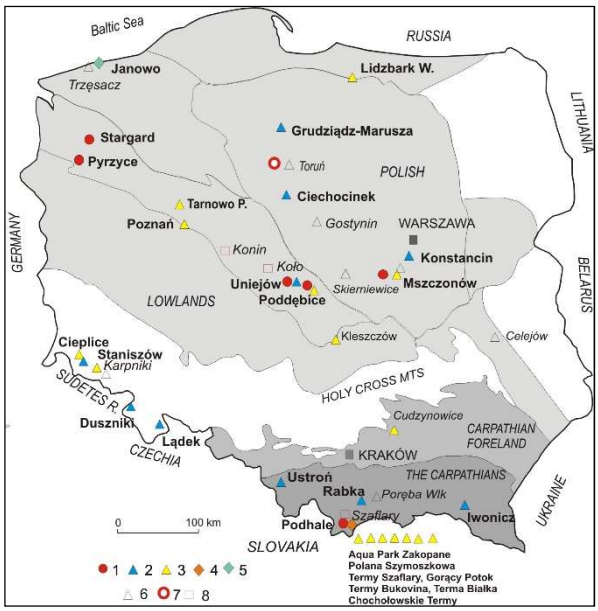

Figure 1. Poland: geothermal direct uses, end 2018: 1. district heating plants, 2. health resorts, 3. recreation centers, 4. wood drying, 5. fish farming, 6. recreation centers in realization, 7. heating system in realization, 8. planned CHP installations

Pyrzyce. The geoDH plant has been operating since 1996. By 2017 the maximum water flow rate from two production wells was ca. 100 L/s of 61°C water (spent water was injected back by two wells). In heating season 2017/2018 a new production well was included into the geoDH system (maximum water flow rate ca. 55 L/s, temperature 65°C) while all the-so-far 4 wells started to function as injection ones. The plant's maximum installed capacity is 22 MW including 6 MW geothermal. It supplies heat and domestic warm water to over 90% users of the whole town's population (13,000) and meets ca. 60% of total heat demand. In 2018 geothermal heat production was 19.5 GWh (70.2 TJ) and total 31.3 GWh (112.68 TJ) (B. Zieliński – *pers. communication*).

Mszczonów. The geoDH has been operating since 2000. Similar to earlier years, maximum geothermal water flow rate was ca. 16.6 L/s of 42.5°C, while TSD were 0.5 g/L. Water was discharged by a single well (no injection). In 2018 the total installed capacity was 8.3 MW (4.6 MW gas boilers, 2.7 MW absorption heat pump, 1 MW compressor heat pump). In 2018 geothermal heat production was 4.6 GWh (16.49 TJ), total 12 GWh (43.2 TJ) (M. Balcer, B. Dajek – *pers. communication*). After cooling water is used for drinking. Part of water flow rate is sent to recreation centre. Some new projects on more efficient geothermal energy management were ongoing.

Uniejów. The geoDH has been operating since 2001. The maximum discharge from one production well is 33.4 L/s of 68ºC water and the TDS are ca. 6–8 g/L. The total installed capacity is 7.4 MW (3.2 MW from geothermal, 1.8 MW from biomass boiler and reserve 2.4 MW fuel oil peak boilers). In 2018, 80% of all buildings in that town were supplied by the geoDH. Geothermal heat production was 3.3 GWh (12 TJ), 60% of total production. Some new connections to geoDH were done in 2017–2018 (eg. new housing estate supplied with geothermal heat, warm tap water and geothermal water (J. Kurpik – *pers. communication*). Part of geothermal water flow has been used for health spa and recreation centre (ca. 8.4 L/s of 42°C water; ca. 1 MW, 2.1 GWh) which is also heated by geothermal energy. Some amount of spent water (ca. 5.6 L/s, 28°C) is used to heat up a football pitch (ca. 1 MW, 8.7 TJ) and walking paths. Uniejów has a status of health resort (since 2012). Besides geoDH some other geothermal uses were at various stages of project realization and preparation.

Poddębice. The geoDH has been operating since 2013. It has a 10 MW geothermal capacity based on 68ºC water (average flow rate 32.2 L/s, mineralization 0.4 g/L). The plant supplies several public buildings, school, hospital (and submits water to its rehabilitation part), multi-family houses. In 2018 geothermal heat production was 17.6 GWh (63.36 TJ), i.e. 96.5% of total production. Some part of water stream is sent to swimming pools. Nest types of geothermal uses were at various stages of project realization and planning (A. Karska, A. Peraj – *pers. communication*). Among them was a project of using geothermal for rehabilitation and removing barriers for disable persons.

Stargard. The geothermal plant has been operating since 2012 (after renovation). It is based on a doublet of production and injection wells. In 2018 maximum

water production was ca. 50 L/s of 87°C water. The geothermal capacity was 12.6 MW and heat production 63.9 GWh (230 TJ), entirely sold to the municipal district heating plant (A. Biedulski – *pers. communication*). That municipal district heating system is supplied by coal-fired plant (total capacity 116 MW serving 75% of local population (75,000)). In 2018 geothermal met ca. 27% of total heat demand of that municipality. The operator of geothermal plant planned to drill 4 new wells to double geothermal capacity and heat sales to municipal DH.

In addition to geoDHs, in several recreation centers geothermal waters were used both for filling the pools, spa treatments and for heating their objects. Some single buildings started to be heated by geothermal energy.

To sum up the geothermal district heating in Poland: in 2018 the installed geothermal capacity of six geoDHs was 74.6 MW and geothermal heat production was 250.4 GWh, while total production amounted to 289.5 GWh. In individual cases geothermal share in total heat production was from 38 to 100%.

3.2. Health resorts

In 2016-2018 geothermal waters were used for healing treatments in ten health resorts. Their approved reserves varied from ca. 0.5 to 56 L/s while maximum outflow water temperatures from ca 20 to 80°C.

For installations in health resorts using geothermal water for treatment, capacities and heat uses were roughly estimated taking into account the average annual water flow rates and temperatures at inlet and outlet from curative pools and other facilities. In some cases geothermal water was also used for heating the centers' objects and warm water preparation.

3.3. Recreation, balneotherapy (balneology)

At the end of 2018, 15 geothermal recreation and balneotherapeutical centres were operating. That number included one new centre opened in reported years 2016–2018 (the Podhale Region – 7th such centre there). Some of them apply geothermal water both for the pools and other facilities, as well as for heating their objects and warm water preparation. In 2018 next investments oriented for recreation were at various stages of realization or under projects' elaboration (chapter 5).

3.4. Aquaculture

Since 2015 the atlantic salmon's farm using geothermal water has been operating (Janowo at the Baltic coast). Water is applied both for culturing and for heating the farm's facility. In 2018 an experimental algae cultivation using geothermal water was initiated in Poddębice (A. Karska – *pers. communication*).

3.5. Other uses

In addition to the-above-listed, one shall mention a semi-technical wood drying (MEERI PAS, Podhale region), and heating up of a football pitch and walking paths in Uniejów. In several localities the iodine-bromine, cosmetic salts, and CO_2 are extracted from the waters. Some new types of uses were considered and initiated like organic food processing and production of cosmetics based on geothermal waters.

3.6. Shallow geothermal – heat pumps

In 2016–2018 a progress in shallow geothermal development was continuing (www.portpc.pl). According to Heat pumps barometer (EurObserv'ER 2018; https://www.eurobserver.org/online-database/), by third quarter of 2018 the GSHPs' sales amounted 5660 units what situated Poland on the fourth place in the sales ranking of GSHPs in EU-countries (Table 1). Comparing to 2016 the annual growth was ca. 5%. (Total numbers for 2018 were not available during preparation of this article).

One may estimate that at the end of 2017 the number of GSHP reached ca. 56 000 units, while their total capacity was at least 650 MW and heat production 860 GWh / 3100 TJ.

Table 1. Ground source heat pumps sales' top ranking in the EU-countries by third quarter of 2018 and position of Poland (Heat pump barometer; EurObserv'ER 2018)

Country	Number of GSHPs' sales
Sweden	22 641
Germany	20 170
Finland	7 986
Poland	5 660
Austria	5 230
The Netherlands	4 806
France	3 100
Great Britain	2 358
Denmark	2 143

4. GEOTHERMAL DRILLINGS

As regards geothermal drillings, in 2016-2018 a positive change occurred compared to the years 2013-2015 (marked by stagnation in geothermal heating due to the closure of public support program in 2012). In 2015 it was launched a new governmental program to support research drillings (grants: up to 100 % costs for local governments; loans) and other infrastructure targeted at the geothermal energy uses for geoDH and CHP (the latter feasible in some cases). The allocation of first part of that support (Ministry for Environment, operated by National Fund for Environment Protection and Water Management) was ca. PLN 200 million for drillings and PLN 500 million for other infrastructure. Next support programs were expected in 2019.

In 2017–2018 ten positive decisions on financing new research drillings were issued. If positive they will serve for geothermal energy production for already existing district heating grids in several municipalities. In 2018 drilling one of those was completed, four other were in progress. Realization of next boreholes began

in 2019 while the next group of drilling projects was awaiting the decisions for public funding.

Apart from exploration geothermal drillings funded by the state program, in 2016-2018 at least one well was made from private funds, and one from public loans. There were also preparations for drilling four new wells aimed at extension of geoDH in Stargard.

To sum up: in 2019–2020 and beyond about 10 new geothermal wells can be expected. They should allow to introduce geothermal energy into already existing district heating systems in a few – a dozen or so cities (mainly in the Polish Lowlands), an to increase geothermal heat production by existing geoDHs.

5. WORKS IN PROGRESS AND PLANNED

In addition to drilling activities in 2016–2018 several geothermal investment projects were ongoing. They were oriented for space heating, as well as recreation. They were accompanied by feasibility studies, pre-investment works, as well as research and R+D+I activities. Their summary is given below.

- Investments aimed at increasing geothermal capacities, heat extraction and hooking new consumers were conducted in all operating geoDHs. In one case a new production well was drilled and optimised configuration of exploited wells was done (Pyrzyce plant). As already mentioned, the operator of Stargard plant was making preparations for drilling four new wells to double geothermal capacity and heat production. In city of Toruń the construction of a geothermal heating plant (based on the doublet drilled several years ago) was initiated. In the Podhale region the works were ongoing to install large heat pump to extract more heat from geothermal water supplying geoDH system. In addition that plant was in progress of project to add an ORC unit to the system. The activities to introduce geothermal to Nowy Targ (one of main city in that region), and some other localities were in progress – geothermal water will come from new deep well (supported by the state) the drilling of which was planned for 2019. However, it was no progress in CHP project concept for Konin town (case given by Kępińska, 2016);
- Further investments oriented for recreation and balneotherapy: among them was the construction of a huge center in Wręcza, central Poland. New well was drilled in recent years to supply it with water and heat. Another large balneotherapy / recreation project was ongoing in Poddębice town;
- Several pre-investment works and feasibility studies related to various sites in the country meeting the interest shown by local authorities and private investors;
- Research, R+D+I on various topics, eg.: geothermal water desalination, geothermal use in agriculture, ATES, etc.;
- First geothermal projects funded by the EEA financial mechanism performed jointly by teams from Poland, Iceland, Norway (and EGEC in one case) in 2016–2018 for Poddębice town:
  GeoHeatPol (www.eeagrants.agh.edu.pl),
  Geothermal4Pl (www.pgi.gov.pl/geothermal4pl.html).
- Polish teams have been participating also in some EU projects, eg.:
  GeoPlasma-CE (https:// portal.geoplasma-ce.eu),
  GEORISK (www.egec.eu).

6. PROFESSIONAL PERSONNEL ALLOCATION

A number of professional full-time personnel employed at various geothermal activities (scientific and research entities, geoDHs, some other installations, consulting companies) can be estimated for ca. 200–250 persons as for the end 2018. In addition, significant number of technical personnel (services, treatment, management, etc.) has been working in recreation centres (ca. 10–100 prs/centre, depending on its size) and in health resorts (not included into total estimation above).

7. INVESTMENTS IN GEOTHERMAL SECTOR

The investments in geothermal sector in 2016–2018 can be roughly estimated for at least 80 million Euro. This contains drillings, related works and equipment, surface infrastructure (district heating grids, recreation centers, other). Investments in shallow geothermal in given years were evaluated for ca. 75 million Euro.

8. LEGAL AND ECONOMIC ASPECTS

In 2016–2018 geothermal development had relatively good legal background thanks to several provisions of Geological and Mining Law (2017). However, another document – i.e. the RES Law (2018; updated, initial text 2014) is oriented for electricity and does not sufficiently deal with H&C. In 2018 the works begun on the development strategy for heating sector. It will take RES into account so as also geothermal energy.

Regarding economic conditions of geothermal sector's development – in contrary to previous reported years, in 2015 a positive change took place. It was expressed by introducing a state program to support research drillings and other investment activities (as given in chapter 4). It acted as breaking of slow down in geothermal heating sector that had been lasting since 2012 (when former support program was closed).

In the group of state policy and strategy documents dedicated to energy and raw materials which have been introduced in recent years or are under preparation – some refer also to geothermal energy (as a part of RES or directly), eg.:

- the Strategy for Responsible Development (www.miir.gov.pl/strony/ strategia-na-rzecz-odpowiedzialnego-rozwoju/);
- the State Raw Materials' Policy (in preparation) (www.psp.mos.gov.pl). One of its basic pillars is related to Earths' heat. An executive program of its

development has been under elaboration (with the input of Polish Geothermal Society and cooperating entities).

Geothermal heating shall be facilitated also by the programs dedicated to thermal retrofitting and improving air quality.

In the view of above-mentioned facts, in coming years one may expect more geothermal installations in Poland, specially as far as heating sector is concerned.

9. GEOTHERMAL SHARE IN CURRENT RES MIX AND IN OFFICIAL PROGNOSES

According to the Central Statistical Office (Berent-Kowalska et al., 2018) in 2017 the RES share in total primary energy acquisition was 14.10% (383 168 TJ). The contribution of particular renewables was as follows: solid biofuels 67.9%, wind 14.0%, liquid biofuels 10.0%, hydro 2.4%, municipal wastes 1.01%, geothermal 0.25%, heat pumps (all types) 0.62%. For a whole H&C sector, RES input was 14.68% in 2017 (2018 data were not yet available while preparation of this article). According to EU- and state documents (Directive 2009/28/EC; NREAP, 2010), the RES' share in final gross energy consumption in Poland shall reach 15% by 2020 while in 2017 it was 10.97%. Furthermore: NREAP (2010) prognosed the share of geothermal in H&C as 3% by 2020. So in 2017 and 2018 the geothermal share in RES sector was far below that prognosis. For the coming years there are some premises that the geothermal share in RES heat's production and consumption will increase somehow – thanks to already existing as well as expected several next geoDHs. One may also expect an increased share of shallow geothermal in H&C.

10. CLOSING REMARKS

In 2016–2018 some progress was observed in geothermal sector in Poland as compared with former period 2013–2015. It was connected with increased heat production and sales by six geoDHs. All geoDHs contributed to low-emission heating, in all of them works were ongoing or planned to enlarge the grids and connect new consumers. The development of geothermal recreation sector was continuing. Further progress in shallow geothermal was observed.

As a milestone for wider geothermal development in the country one may treat the state support program introduced in 2015. By the end of 2018 it has resulted in granting funds for drilling about ten research wells (some were already completed, some were in drillings or close to this stage). If successful, they will serve as suppliers of heat to some existing municipal DHs. Several further drilling applications were awaiting decisions for funding. Therefore, it is hoped that at the next European Geothermal Congress some more geoDHs in the country will be presented.

In case of legal and regulatory conditions for geothermal deployment, important was the launch of the Strategy for Responsible Development. It refers, among others, to energy issues and RES. All the more, geothermal energy (Earth's heat) was included into basic pillars of the State Raw Materials Policy and forms a subject of the Executive geothermal development program (in preparation). Some other programs oriented at energy efficiency and low-emission shall also facilitate geothermal development.

Better economic conditions for geothermal introduced in recent years shall result in more dynamic development in the years to come. This is envisaged specially in heating sector – geothermal means low or zero emission. This is of utmost importance for Poland, the country where heating sector has been based on fossil fuels.

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Tables A-G

Table A: Present and planned geothermal power plants, total numbers[1]

	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 2018	-	-	44 298	170 100	0	0
Under construction end of 2018	-	-	1 675	~ 6432	0	0
Total projected by 2020	~ 1 – 2 MW_e (B, CHP)	~ 2 – 3	~ 47 048	~180 660	<0.001	<0.001
Total expected by 2025	~ 2 – 4 MW_e (B, CHP)	~ 3 – 6	~ 49 548	~189 930	<0.001	<0.001

In case information on geothermal licenses is available in your country, please specify here the number of licenses in force in 2018 (indicate exploration/exploitation, if applicable):	Under development
	Under investigation: 3 (research/exploration drillings)

* Data on electric power and production acc. to: Informacja Statystyczna o Energii Elektrycznej. 12/2018. ARE (http://www.are.waw.pl) and www.cire.pl

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 2018*	74.6	250.4	4	6	> 10	> 25	> 12	> 35
Under construction end 2018	~10	n.a.	-	-	> 5	> 15	> 2	> 10
Total projected by 2020 ***	~100–120	~ 330-400	~ 6 ?	~ 8 ?	?	?	?	?
Total expected by 2025 ***	~130–150	~ 430-500	~ 9 ?	~ 12 ?	?	?	?	?

* Estimation "in operation end of 2018" includes heating and warm water for several recreation centres (given also in Table D2) and minor share of some individual buildings. Rough estimation "Under construction end 2018" concerns estimation for large recreation centre

** Estimations based on Kępińska, 2015, slightly updated

*** In case of "Total projected by 2020" and "Total expected by 2025" exact or tentative numbers for "Geothermal heat for buildings" and "Geothermal heat in balneology and other" are difficult to assume. However, in all types of uses some progress is projected and expected. Concrete numbers will strongly depend on the level and accessibility of financial sources (including public ones, specially for geoDH and other heat uses) and other factors on investors' side

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})	2018 produc-tion (GWth/y)	Geoth. share in total prod. (%)
Podhale Region	PEC Geotermia Podhalańska SA	1993	-	Y (RI)	38.8	77.9	141.5	89
Mszczonów	Geotermia Mazowiecka SA	2000	-	N	3.7	8.3	4.6	38
Poddębice	Geotermia Poddębice Sp. z o.o.	2014	-	N	10	10	17.6	96.5
Uniejów	Geotermia Uniejów Sp. z o.o.	2006		N (RI)	3.2	7.4	3.30	60
Pyrzyce	Geotermia Pyrzyce Sp. z o.o.	1994	-	N (RI)	6	22	19.5	63
Stargard	Geotermia Stargard Sp. z o.o.	2012 (re-open)	-	N (RI)	12.6	12.6	63.9	100
total					74.6	138.2	250.4	

* 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})	2018 produc-tion (GWh_{th}/y)	Geoth. share in total prod. (%)	Operator
Białka Tatrzańska, Bukowina Tatrz., Witów *	Large recreation centres	2008-2016	Y	~ 9	n.a.	n.a.	n.a.	Operators of the centres
total				~ 9	n.a.	n.a.	n.a.	

* Rough estimation (acc. to available data); the recreation centres given here in Table D2 are also included in Table C, column "Geothermal heat for buildings".

n.a. – exact 2018 data not available

Table E: Shallow geothermal energy, ground source heat pumps (GSHP)

	Geothermal Heat Pumps (GSHP), total			New (additional) GSHP in 2018 **		
	Number	Capacity (MW_{th})	Production (GWh_{th}/yr)	Number	Capacity (MW_{th})	Share in new constr. (%)
In operation end of 2017 *	~ 56 000	~ 650	~ 860	~5 660	~ 75	~ 8 (average - all HPs' types) ***
Projected total by 2020	~74 000	~ 860	~ 1140			

* State in 2017: Numbers given and estimations made on a basis of data taken from: Heat pump barometer (EurObserv'ER 2018; https://www.eurobserv-er.org/online-database); www.portpc.pl (access January 2019) and data by Kępińska (2016)

** Heat sales in 2018 by end of third quarter (data source: Heat pump barometer (EurObserv'ER 2018))

*** Difficult to evaluate exact share of GSHPs. The given share (12.5%) is for all HPs types (www.portpc.pl)

Table F: Investment and Employment in geothermal energy [1]

	in 2018		Expected in 2020	
	Expenditures (million €)	Personnel (number)	Expenditures (million €)	Personnel (number)
Geothermal electric power	0	0	10	15
Geothermal direct uses	*est.* 80 – 90	~ 200 – 250	*est.* 80-90	ca. 300 – 400
Shallow geothermal	est. 75	?	est. 60 - 65	? [2]
total	**> 155– 165**	**> 200 – 250**	**> 150 – 165**	**> 300 – 400**

The Table gives mainly the number of personnel with academic degrees, employees in geoDHs, health and recreation centres (without technical and service staff in recreation centres, health resorts, etc.); for shallow geothermal the number of personnel is difficult to estimate.

Table G: Incentives, Information, Education

	Geothermal el. power	Deep geothermal for heating and cooling	Shallow geothermal
Financial Incentives – R&D	O: Public support for R&D projects	O: Public support for R&D projects	O: Public funds for R&D projects
Financial Incentives – Investment	DIS (since 2015): Public support for drilling first geothermal exploration well oriented for geoDH + CHP (details – column on the right) O: as for deep geothermal for H&C (see column on the right)	DIS (since 2015): Public support for drilling first geothermal exploration well oriented for geoDH and for above-surface geothermal heating infrastructure (up to 100% for local government units), loans (up to 50% for other investors) O: No fee for geological information used for the needs of exploration project	DIS LIL: Lower interest loans from some funding agencies (for surface heating infra-structure like for other RES) DIS: Some subsidies /grants for the-above-surface parts of installations (in general support schemes as for other RES)
Financial Incentives – Operation/Production	FIT	O: Reduced fee for geological information used for geothermal water exploitation (1% of its value by 2020, 5% after 2020) - No fee for geothermal water exploitation	No (introduction of cheaper electricity price to run the heat pumps is expected)
Information activities – promotion for the public	Yes, as part of promotion activities focussing on geothermal heating (because conditions for geothermal power production in Poland are moderate)	Yes, but occasional not regular No regular all-country activities so far, some occasional information in mass media, at events for some professionals, local authorities, etc.	Yes, but occasional not regular; no regular all-country activities so far, some occasional information in mass media, at events for some professionals, local authorities, etc.
Information activities – geological information	Yes, as for deep geothermal for H&C (see column on the right)	Yes, geological information is available (basic information: National Geological Archives /NAG data base; some other data bases), furthermore geothermal atlases, several other published sources	Yes, geological information is available, but more detailed recognition of conditions/ parameters of underground as low heat source for GSHPs in particular areas/localities is needed
Education/Training – Academic	Yes, included as part of education on deep geothermal: see column on the right	Yes, in several cases some series of lectures, but regular courses only at one university (all HP types)	Yes, in several cases some series of lectures, but regular courses only at some universities (all HP types)
Education/Training – Vocational	Yes, limited – as part of activities focussing on deep geothermal for heating (see column on the right)	Yes, in single cases; geothermal is among several subjects taught but not as individual subject of specialisation	Yes, but 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	O	Other (please explain)