Current geothermal activities and prospects in Poland – an overview

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Abstract

Poland is a country with good conditions for the occurrence of geothermal water aquifers and their exploitation in many regions. Geothermal energy should be treated as one of the main renewable energy sources. On the other hand, there are several factors influencing the low official prognoses for the geothermal use which are briefly characterized.

Among the most important fields for geothermal development in the country, the space heating forms a sector with very good prospects for its wide application as it will result in a considerable reduction in the use of traditional fuels and in the emissions generated in many regions.

The paper presents the main aspects of current geothermal development in Poland, including the plants on-line, under construction and some further plans. Some experiences gained from the operation of existing plants will be given. Particular prospects for the development of geothermal energy in the country will be introduced (i.e. the adaptation of abandoned wells; cascaded, integrated and distributed systems; heat extraction not only from large depths but also from shallow water horizons and rock formations). Such solutions will result in the lowering of investment costs, increasing their effectiveness, extending the market and making geothermal energy competitive both for traditional energy sources and other renewables.

Key words: geothermal energy, direct uses, update, Poland

1. INTRODUCTION

The last decade was marked by the beginning of geothermal energy use for heating purposes in Poland. The first experimental geothermal plant in the Podhale region was opened in 1992 [17]. It was followed by commissioning four other plants and initiating the realization of two new projects. The Podhale geothermal project is regarded to be the most important achievement so far. It will be one of the largest in Europe for its capacity and heat production.

The paper presents the state of geothermal uses and activities in the country as of early 2003, since the presentation of the update reports at EGC Basel 1999 [9] and WGC Japan 2000 [10]. In 1999 – 2003 some projects mentioned at these events were finished and some others were underway. There is also a constant increase of scientific and practical experience gained during the operation of existing plants as well as the number of new studies and projects.

Over the last several years, the circumstances accompanying geothermal development remained more or less the same. Some general documents related to the long – term energy policy of the country were introduced. The most important of them, involving renewables, is the Strategy for Renewable Energy Resources Development [18]. However, it does not meet

the expectations of geothermal community in Poland. A new law concerning the sector of renewables is expected to be introduced soon. It is hoped to create better conditions also for geothermal development, adequate to the reservoir potential, ecological and social needs.

2. GEOTHERMAL POTENTIAL

Poland has one of the richest low-enthalpy geothermal resources in Europe. Three geothermal provinces built of extensive (total ca. 250,000 km^2) sedimentary basins were distinquished (Fig. 1): the Polish Lowland, the Fore-Carpathians and the Carpathians. They contain numerous geothermal aquifers [6,14-16]. Reservoir temperatures vary from 30 to 130°C (depths of 1 - 4 km). The TDS of waters change from 1 to 300 g/l. The proven geothermal water reserves, evidenced on the basis of flow tests from the wells, amount from several l/s up to 150 l/s. The best conditions are found in the Polish Lowland province and in the Podhale region (the Carpathians). Prospective conditions also exist in the Sudetes region (historical cradle for geothermal balneotherapy in the country) where geothermal water can be found in fractured crystalline and metamorphic sectors of several formations [4,5]. Different but basically positive opinions are expressed by the professionals regarding the possible scale of geothermal use. Considering the current prices of traditional energy carriers, economically viable geothermal facilities could be built on an area equal to some 40% of Poland's territory [13]. This area could be even biggest if another approach is adopted [15,16].

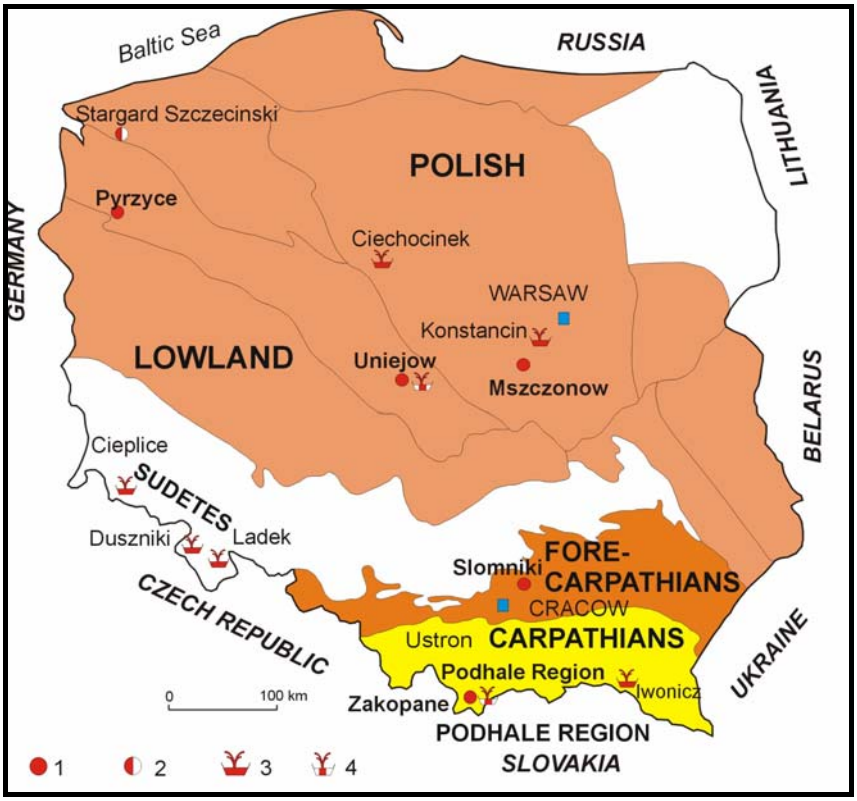

***Figure 1**: Poland, 2003 – geothermal plants in operation (1), underway (2), spas using geothermal waters (3) and balneotherapeutical facilities under construction (4) shown against geothermal provinces distinquished within the country (geothermal division after [15]).*

3. GEOTHERMAL DIRECT USES – AN OVERVIEW

3.1 General remarks

A key area for developing geothermal energy use in Poland is space heating. Wide-ranging use that would be adequate for the reservoir potential would permit to significantly limit reliance on fossil fuels and mitigate the negative effects of such fuels being burnt [13-16]. However, as is the case of other renewables, the country is still at the beginning of geothermal implementation for heating and other types of direct uses.

Similar to the periods reported previously [9-10], during 1999 – 2000 geothermal has been used on a limited scale mainly for heating, balneotherapy and bathing, (Fig. 1, Table 1). For other purposes it was still implemented on a semi-industrial scale (this same cascaded system as reported before; [10]). As compared to the data from 1999 – 2000 [9-10], the installed geothermal capacity and amount of heat produced increased significantly in 2001 – 2002 (by 38 MW_t and 150 TJ/y) after the extension of the Podhale project by connecting large number of receivers in Zakopane, main town of the region.

***Table 1**: Poland – summary of geothermal direct uses (early 2003)*

	Type of use	Installed thermal power (MW_t)	Energy use (TJ/yr)
a	Space heating and warm water supply (heat pumps excluded)	54.8	260.0
b	Space heating and warm water supply (heat pumps' contribution)	23.4	76.0
c	Space heating and warm water supply (a + b)	78.2	336.0
d	Balneotherapy and bathing	18.7	34.5
e	Greenhouses, fish farming, drying	1.0	4.0
f	Other – extraction of CO_2, salts	0.3	1.0
g	SUBTOTAL (c+d +e+f)	98.2	425.5
h	Heat pumps (estimated)	10.0	80.0
i	TOTAL (g+h)	108.2	455.5

3.2 Balneotherapy/ bathing and other uses

Geothermal waters produced by natural springs or boreholes, with temperatures ranging from 20°C to 62°C, are currently used for medical treatments in seven spas. In several cases, some by-products, like iodine-bromine medical and cosmetic salts, and CO_2 are extracted from geothermal waters. In one locality a production of cosmetics based on geothermal water has been started recently. Moreover, the realization of two new projects was initiated in 2001 - 2002 in Uniejow and Zakopane. In Duszniki Spa the amount of geothermal water available for healing treatments was increased significantly after a new well was drilled (chapter 4).

3.3 Geothermal space heating

Five geothermal space heating plants are currently in operation. Two older existing plants, one in the Podhale region (since 1992) and the other one in Pyrzyce (since 1996) were joined by a plant in Mszczonów (since late 1999), Uniejów (since 2001) and a small one in Slomniki (since late 2002). As each of them uses geothermal waters of different exploitation parameters, they operate on the basis of different layouts and vary considerably as far as geothermal capacity and heat production are considered. Among them are plants with slight gas peaking only (Podhale), integrated plants with considerable gas contribution (Pyrzyce, Mszczonow, Uniejow) and plant integrating geothermal heat pumps with gas and fuel oil boilers (Slomniki). For 1999 – 2003 the considerable extension of the Podhale geothermal district heating project should be regarded as the main acitivity. Among the new investments initiated in the reported years is the plant in Stargard Szczecinski (chapter 4).

3.3.1 Podhale region

In the Podhale region (the Carpathians), the main geothermal aquifer is situated within the Triassic and Eocene carbonates at the depths of 1 – 3.5 km. Reservoir temperatures reach up to 80 - 90°C and the water flowrates vary from 50 to 150 l/s. The TDS are at the level of 0.1 – 2.5 g/l. The aquifer is under artesian conditions [8].

Since the end of 1980s the construction of one of the largest geothermal heating network in Europe has been under realisation (target capacity ca. 80 MW_t, heat production ca. 600 TJ/y; [3]). After the success of the pilot phase done by the PAS MEERI [17], the work on deploying and operating the network has been conducted since 1994 by PEC Geotermia Podhalanska S.A. By autumn 2001, the network was based on one wells' doublet and supplied geothermal heat to over 220 buildings [10]. In late 2001 it was extended significantly by two new wells, other surface facilities (including, among others, 14 km - long main transmission pipeline) and linking considerable part of receivers in Zakopane – the main city of the region (population 30,000, over 3 million tourists/y). By 2005 geothermal will have supplied prevailing number of buildings in this city and the whole region. Heat supply will be based on geothermal, with gas being used at peak load. In 2002 the installed geothermal capacity was 38 MW_t and heat production ca. 150 TJ (total ca. 190 TJ).

Along with the construction of a regional heating network, the PAS MEERI Geothermal Laboratory has conducted the R&D works on cascaded uses covering a wide range of temperatures. The system comprises the same installations as described in former papers [10], i.e. wood drying unit, greenhouse, fish farming and foil tunnels with a heated soil for vegetable growing. The Laboratory is involved in the research and monitoring of geothermal system and also serves demonstration and education purposes.

3.3.2 Pyrzyce

The space heating plant in Pyrzyce (the Polish Lowland) has been in operation since 1996. The aquifer is situated within the Jurassic sandstones at the depths of 1.5 – 1.6 km. It is exploited by two production and two injection wells. The maximum flowrate is 103 l/s of 61°C water. The TDS are 120 g/l. The plant's maximum installed capacity is 50 MW_t including 13 MW_t from geothermal water and 37 MW_t from heat pumps and gas boilers. The plant supplies district heating and warm water to 12,000 users out of the town's total population of 13,000 [14]. In 2002 geothermal heat production was 95 TJ/year. Basically, the exploitation and technical parameters of the plant remain these same as during the past years.

However, both the thermal capacity and heating network were oversized while project planning at the beginning of the 1990s. The current maximum capacity is ca. 27 MW_t. So big decrease of thermal demand after the plant had been launched was caused by closing several industrial factories, thermomodernisation of buildings, installation of thermostatic valves and water-meters by individual heat receivers and, last but not least, by higher outside temperatures in last several years Relatively high costs of produced heat and its price are the result of partial utilisation of installed capacity and large share of gas [12].

3.3.3 Mszczonów

The heating plant in Mszczonów (the Polish Lowland) was launched in autumm 1999. Water with a temperature of approx. 40°C is exploited from the Cretaceous sandstones through a single well drilled in the 1970s and reconstructed for geothermal water production in 1996 – 1997. It is worth noticing that the adaptation of this abandoned well (instead of drilling a new one) significantly reduced investment costs. The plant of a total capacity of 10.2 MW_t uses geothermal water both for heating and drinking. The heating part of the plant operates on the basis of an integrated system: the district heating water is heated to the required temperature by the heat extracted from geothermal water and gas boilers fitted with 2.7 MW_t absorption heat pump and 0.6 MW_t cooler. When cooled down in heat exchangers, geothermal water can be used for drinking (TDS 0.5 g/l) and is supplied to the water works [1]. In the heating season, ca. 35% of a total heat supply comes from geothermal water.

3.3.4 Uniejów

Uniejów (the Polish Lowland) is a town (population 3,000) situated in the Central Poland. The integrated space heating plant was put into operation in 2001. Geothermal aquifer is situated within the Cretaceous sandstones at the depth of ca. 2000 m. The wellhead temperature is about 60^{o}C and the TDS are 5 g/l. Water is exploited in one doublet system. The installed capacity of the plant is 5.6 MW_t, including 3.2 MW_t from geothermal and 2.4 MW_t from peak oil boilers. In 2002 ca. 40% of heat consumers in the town were supplied by this plant, while the number of connected clients amounted ca. 60%. The total heat production was ca. 20 TJ, with ca. 15 TJ from geothermal water. In the coming years the works on connecting new consumers are planned. Because of valuable curative features, geothermal water will be also used for recreation and balneotherapy (chapter 4).

3.3.5 Słomniki

Slomniki (the Fore-Carpathians province) is a small town situated in the southern Poland. In late 2002, a moderate – scale heating system was launched as an outcome of a target project prepared and supervised by the PAS MEERI Geothermal Laboratory. Currently, the plant is in a starting phase. The system works as an integrated one: a 17°C water produced by a shallow (ca. 300 m) well from the Cretaceous sandstones and sandy limestones – heat pumps – gas and fuel oil boilers. The total installed capacity amounts to 2.3 MWt, including 0.3 MW_t from geotermal water being a low source for heat pumps, while the rest comes from gas and fuel oil boilers. Currently the system supplies the school building and two blocks of flats. When the outside temperature is above - 5°C, the heat delivery is based on geothermal heat pumps and if it is lower than this value the system is switched into gas and oil boilers. After cooling down in heat pumps, geothermal water is sent to the water works as a drinking one (TDS 0.4 g/l). In the future several other public buildings and a residential housing estate will

be connected to the system [2]. The case of Slomniki is a good example of moderate – scale installation integrating low-temperature geothermal energy source and traditional fossil fuels. It is characterised with relatively low investment costs therefore is possible to be followed by other localities within the country.

3.4 Geothermal heat pumps

Interest in using heat pumps in geothermal sector has been slowly but gradually rising in the country, although the progress can not yet be compared with the leading European countries. Heat pumps have been working in three geothermal space heating plants (Table 1) in Pyrzyce (two pumps of 20.4 MW_t total capacity), Mszczonow (2.7 MWt) and in Slomniki (0.32 MW_t). The first heat pump, using as a low heat source a ventilation air from a coal-mine with a temperature of 16 - 19°C, was installed in 1997 in the Upper Silesia Coal Basin [10]. Currently, it is not in operation after the mine was closed. Besides, medium- and small capacity heat pumps based on ground or groundwater are installed for the individual consumers and office buildings. The survey to estimate the number of units and capacities installed is a very difficult task, but very roughly one can suppose a number of at least 700 – 1000 such pumps within the country (installed capacity ca. 10 MW_t and heat production ca.80 TJ/yr). The interest in using heat pumps should increase especially when the home-made devices which are cheaper than the imported ones will become available on the market.

4. GEOTHERMAL PROJECTS UNDERWAY AND PLANNED

Different stages of four geothermal investment projects are currently underway (Fig. 1):

– The Podhale region (the Carpathians): the construction of a regionaldistrict heating system is underway (described in chapter 3). In Zakopane – main city of the region, a large geothermal bathing and recreation centre has been in construction since 2001. It will be supplied with geothermal heat from the regional network and will use 26 - 36°C water from two existing wells situated at the site of a centre;

– Uniejów (the Polish Lowland): works on connecting new heat consumers are underway. Geothermal swimming pool is expected to start in 2003. The R&D on curative features of geothermal water are being conducted, which will be followed by the construction of balneotherapeutical centre;

– Stargard Szczeciński (the Polish Lowland): a deep (2672 m) well was drilled in 2001 – 2002. The aquifer is situated within the Jurassic sandstones. During the flow tests, the outflow of 87°C water was obtained. Geothermal heat is planned to be extracted by heat exchangers (total capacity 14 MW_t) and than it will be sold to the existing municipal district heating plant (coal-based, total capacity 95 MW_t) which will distribute it to the heat consumers in the town. While project preparation, special attention was paid to economical aspects in order to obtain low production costs of geothermal heat unit and its price, therefore making it competitive with the heat received by burning coal – the most popular and the cheapest energy source. After the drilling and some well tests had been completed, the project was stopped because of lack of funds. It is hoped that this obstacle will be positively solved in the near future;

– Duszniki (the Sudetes region): so far, ca. 19°C water discharged by one geothermal spring and cold mineral water were used for medical purposes. Recently, a deep (1695 m) well was

drilled and over 30°C water was obtained. Because of highly curative features, it will be implemented for healing treatments and thermal pool, thus increasing the curative capabilities and scope of services offered in this very popular spa [5].

Apart from the investments under realization, many assessments and projects on geothermal use have been prepared over the last decade for many regions, towns and facilities in Poland. They concentrate on geothermal heating, mainly in the Polish Lowland province, which is characterised by very good geothermal parameters suitable for such type of use [6-7, 13-16]. When new projects are prepared the experience of the existing operations is taken into account to minimise the investment costs and to make the projects profitable in specific circumstances also with the traditional fossil fuels and other local renewables in mind.

The completed projects and activities planned include different layouts and solutions: the adaptation of abandoned wells; heat pumps; integrated and distributed energy systems. The area which shows great promise for development is balneotherapy and recreation, especially if new facilities will be constructed as a part of the multipurposed or space heating-oriented projects. These solutions provide a particular chance for geothermal development in Poland by reducing investment costs, increasing the effectiveness of investments and expanding the market. Another interesting idea still awaiting practical realization is the recovering of geothermal heat from underground mines. Some research and project studies are continued on this subject [11]. Recently the possibility of power and heat cogeneration has been considered. It is based on over 90°C waters which were tapped in some deep wells (over 3 – 4 km) or are expected to occur especially within the Polish Lowland province.

However, the level and conditions of financing of many innovative and feasible projects are insufficient, particularly from the Polish sources, which is the main obstacle to a wider geothermal use in the country. One should also mention insufficient support by the governmental policy, which could encourage and promote such activities.

5. GEOTHERMAL ENERGY IN THE COUNTRY'S ENERGY POLICY

The main document related to the whole sector of renewables in Poland is the Strategy of Renewable Energy Resources Development [18]. According to it, the share of all renewable energy sources (RES), including geothermal, in energy production will oscillate around 7.5% in 2010 and 14% in 2020. These figures seem to be significant as compared to the current share of all RES in energy generation (2.5%) but inadequate for the country's potential and situation in many other European countries. Among the main factors behind these unfavourable forecasts are the competitive prices of traditional fuels, insufficient financing and weak institutional and law regulations. Within the sector of renewables itself, geothermal is still unappreciated since other RES are much stronger promoted and lobbied. Relatively high investment costs (especially when deep geothermal wells are needed to be drilled) are indicated as the main reason for such a situation. Moreover, the other cheaper solutions, both working and planned are often neglected and not mentioned even by the oponents.

As one of the main RES accessible in Poland, geothermal should also be promoted in view of the conditions the country has to meet as a prerequisite for its accession to the European Union. One such condition is the increase in the use of renewables. Considering that geothermal is used in many locations chiefly for heating, it could contribute to a significant reduction of of emissions caused by the burning of fossil fuels. In the case of RES there still exists no leading organization whose fundamental aim would be to support and coordinate all the activities. This is also one of the important obstacles to increase the share of renewables in

the production of primary energy in Poland. The same applies to geothermal: all the research and projects have so far been carried out thanks to the initiative and efforts of scientists, specialists and other entities concerned. On the other hand there is a strong subsidiary system supporting the development of traditional power industry.

Progress in the developement of geothermal as well as other renewables is expected due to the amended Energy Law binding power companies to purchase electricity and thermal energy obtained from renewable sources. This law also makes local administrations responsible for managing the heating market, including the use of local energy sources. In Poland, it is geothermal which can fulfil these conditions offering in many localities good reservoir conditions as well as several technical solutions, reliable supplies and multiple options.

Neverthless, the few legal acts introduced to date to facilitate the development of RES sector, specially geothermal, are too general and insufficient. The appropriate economical and supporting instruments are still missing. It is expected that the new fundamental law concerning the renewables' management and development to be introduced soon will create more conducive conditions to wider geothermal development in the country.

6. FINAL REMARKS

Poland has a favourable basis for the wide geothermal use as one of the environmentally friendly and sustainable renewable energy sources. However, not given sufficient attention in official documents, geothermal looks set to gain a significant share particularly in the local heating market in many regions, which will mitigate the level of emissions from the burning of fossil fuels both at a local and global scale. A high potential for geothermal energy use also exists in the agricultural and food sector, aquaculture, balneotherapy and recreation.

The lack of adequate economical and legal promotion has not facilitated further development so far. It is expected that the The Strategy for Renewable Energy Development will soon be supported by a new law on these kinds of energy, including geothermal.

In the 1990s five geothermal space heating plants were open, the three of which (Mszczonow, Uniejow, Slomniki) during the period of 1999-2003 which is presented in this paper. The final stage of the realisation of the Podhale geothermal project is under way (one of the biggest in Europe). Much more could have been done. Nevertheless, a step forward was made in spite of numerous financial difficulties and the lack of sufficient government support.

For further successful progress in geothermal energy implementation, it is necessary to limit investment costs so as to make geothermal energy more competitive and marketable than the heat obtained from other sources. With this in mind, emphasis is placed on the construction and planning not only of large facilities based on deep wells, but also of smaller installations which make use of the existing wells, ground and shallow aquifers and working as cascaded and/or integrated systems. Better financial conditions for geothermal projects realisation will be created if they are conducted in the framework of the EU- and other international initiatives and sources.

Geothermal facilities in use or under construction will surely provide further arguments for the feasibility and profitability of geothermal energy, thus facilitating the raising of funds for research and project delivery and helping to elevate geothermal energy to the more important role in the renewable energy sector and in Poland's sustainable development, which it undoubtedly deserves.

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