New geothermal installations for geothermal recreation and therapy in Poland

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ABSTRACT

Geothermal installations using geothermal water for recreation and therapy are operating in several locations in Poland.

In 2006 – 2013 nine new recreational and therapy centers (swimming pools, aqua parks, therapy centers), which use geothermal water were built. Five of the geothermal bathing centers are located in the Podhale region, S-Poland. The first commercial application of geothermal water for recreational purposes in Podhale region was *Aqua Park Zakopane* opened in 2006. The most recent balneorecreational center in the Podhale region is *Terma Bania*, opened in June 2011.

Other bathing centers are working in the Polish Lowlands (northern and central part of Poland). The first center in the region – *Geotermia Grudziadz* was opened in 2007. It is relatively small center, similarly to the *Termy Mszczonow* and *Termy Uniejow*. However, their development is intended in the near future. In Mszczonow and Uniejow geothermal water has been also used for district space heating. The most recent geothermal installation is located in Poddebice.

Further development of following existing centers is planned. Some of those investments have already started. Nowadays, there are five centers underway. At least twelve more are planned in the future. They will be located in different parts of Poland, mostly in the Polish Lowlands and Podhale region as well.

Also ten health resorts utilize geothermal water for balneotherapeutical purposes. They are located mostly in the southern Poland.

1. INTRODUCTION

The popularity of balneorecreational centers such as swimming pools, aqua parks and therapy centers which use geothermal waters has grown recently. There is an increasing interest in the geothermal balneorecreational and therapy sector in many countries. This kind of interest is growing also in Poland. In 2006 – 2013 there were nine new centers built.

Five of the bathing centers are located in the Podhale region, S-Poland. The quantity of balneorecreational centers in Podhale is not accidental. The Podhale Trough, if compared with other regions of the country, has the most favourable conditions for obtaining geothermal waters because of a geology, high temperature of waters, low TDS level and high water flow rates.

Other bathing centers are working in the Polish Lowlands (northern and central part of Poland, about 80% of the country's territory). Geothermal waters exploited in these centers come mostly from Lower Cretaceous and Lower Jurassic aquifers.

Recently, ten health resorts which use geothermal waters are operating in Poland. Polish formal health resorts Cieplice Slaskie Zdroj, Ladek Zdroj, Duszniki Zdroj, Uston, Iwonicz Zdroj (including Lubatowka), Rabka Zdroj, which are localized in the south of the country, use geothermal water. In the other parts of Poland are localized Ciechocinek, Konstancin, Marusza and Uniejow, which is the latest thermal health resort in Poland. Total thermal capacity of geothermal water use in health resorts amounts to less than 10% of direct geothermal heat use in Poland. In some cases the geothermal water is heated up for treatment because of its small outflow. The location of existing geothermal bathing and therapy centers is shown in Fig. 1.

2. NEW GEOTHERMAL RECREATIONAL AND THERAPHY CENTERS

2.1 Aqua Park Zakopane

Initial application of geothermal water in Zakopane was in outdoor baths using warm springs in 19th century. Among the commercial applications of geothermal water for recreational purposes in Podhale region the first was in *Aqua Park Zakopane*. The center was opened in 2006. It uses waters of 36 and 28°C, which capacity is ca. 130 m^3/h. The TDS of HCO3-Ca-Mg type water are 0.3 g/dm^3. Recreational-sporting outdoor swimming pool of 400 m^2 area is filled with 30.5°C geothermal water which comes from Zakopane IG-1 and Zakopane 2 wells (http://www.aquapark.zakopane.pl/). The center is also heated with geothermal energy.



Figure 1: Location of existing, underway and planned geothermal bathing, recreational and therapy centers in Poland.

2.2 Polana Szymoszkowa Zakopane

Geothermal water from well fills an outdoor swimming pool since summer season of year 2009. Previously, tap water in the swimming pool was only heated by geothermal energy. Currently, geothermal water in the swimming pool has temperature about 30°C (http://szymoszkowa.pl). The water is of HCO_3-Cl-Mg-Na type, while the TDS are 0.4 g/dm^3. Thermal capacity of geothermal water without installed heat pump is 0.3 MW_t (Kepinska 2011). Apart from the center attractions, the location and beautiful view of the Tatra Mountains from the swimming pool is essential.

2.3 Termy Szaflary

The center uses geothermal water from a nearby geothermal heating plant *PEC Geotermia Podhalanska*, where the temperature of 86°C of water is decreasing in heat exchangers. *Termy Szaflary* center has been working since 2008 (www.termyszaflary.com). Maximum capacity of 38°C geothermal water is 25m^3/h. Thermal capacity of the installation can be assessed on 0.14 MW_t (Kepinska 2011). There are indoor and outdoor year-round geothermal swimming pools and other attractions, including hotel and restaurant.

2.4 Terma Bukowina Tatrzanska

Recreational and spa center in Bukowina Tatrzanska was opened in 2008. The center has twelve indoor and outdoor swimming pools, saunas, spa&wellness rooms and a culinary part. A new hotel has been opened recently. Water in swimming pools has temperature of 28 – 36°C (www.termabukowina.pl). The center uses 64.5 ºC geothermal water coming from the well drilled at the 1990s. Maximum capacity of geothermal water is assumed on 40 m^3/h. Water of SO_4-Cl-Ca-Na type has the TDS of 1.5 g/dm^3. The center may host 2000 visitors per hour. Thermal capacity of the geothermal installation of the center is 0.35 MW_t (without heat pump installed) (Kepinska 2011).

2.5 Terma Bania Bialka Tatrzanska

The most recent bathing center in the Podhale region - *Terma Bania* was opened in June, 2011. It is located near a ski resort. A building body of *Terma Bania* can be considered as harmonious with terrain and ecological background, having green, hill-shaped roofs covered with special plants. The Tatra Mountains' panorama can be admired from inside. Further extending of infrastructure is intended. A new four-star hotel for 400 people with spa&wellness and swimming pool has been opened recently.

Geothermal water that fills swimming pools comes from well Bialka GT-1 drilled in 2009-2010. It is Na-Ca-SO_4-Cl type and has ca. 1.8 g/dm^3 of the TDS. Total capacity of geothermal water is 40 m^3/h. The aquifer is at the depth of ca. 2500 m while the water at the outflow has temperature 73°C.

On the area of 8 500 m^2 there are swimming pools and other attractions which are separated into zones: Loud Zone, Quiet Zone, sauna complex, spa&wellness institute and a culinary part (with regional cuisine). It can be visited by 3000 persons per hour.

Loud Zone offers five swimming pools filled with 34°C water. Besides, there are some water roundabouts, team games playground, ropes course, climbing wall, water cascades, indoor and outdoor water slides, an artificial wave and some attractions for the youngest. Quiet Zone is a relaxing area with jaccuzzi and pools filled with geothermal water that has a temperature 36 or 40°C. Sauna complex consists of six types of sauna, a relaxing cabin with infrared, UVB and UVC rays, a pool with geothermal water (36°C) and a pool with cooling water (24°C), benches for wetting feet, showers, etc. Clients could also have their service in eight spa&wellness rooms (www.termabania.pl).

2.6 Termy Mszczonow

Geothermal water in the town of Mszczonow is produced by a single well and it comes from Lower Cretaceous sandstones at depth of ca.1700 m. When discharged by the well it has a temperature of 42.5°C and flow rate of 55 m^3/h. It is a drinking water which TDS are 0.427 g/dm^3. The bulk of geothermal water is used for space heating – about 35% of the heat delivered to Mszczonow inhabitants comes from geothermal energy. Some amount of the geothermal water is used in *Termy Mszczonow*, which was established in 2008 (Kurek 2011).

Termy Mszczonow offers year-round outdoor geothermal pool connected with indoor pool filled with raw geothermal water of temperature 32–34°C, recreational pool with purified geothermal water of temperature 30–32°C, water slides, sporting swimming pool and children pool. The area of the center is ca. 2 ha. Additionally, there is possibility to use a seasonal ice rink or grassy beach with beach volleyball field and children playground (www.termy-mszczonow.eu/).

Currently, the second stage of development of *Termy Mszczonow* is in progress. The modernization of the geothermal installation was finished in 2011. However, in the area of 2 ha there are plans to broad the commercial offer with a hotel, conference and training area, restaurants, indoors bathing pools, spa center and bowling, squash, billiard rooms.

Geothermal installations will be developed in the future. It is intended to build the geothermal heating installation for sporting field and making available geothermal water for investors in agriculture and food production (Kurek 2011).

2.7 Termy Uniejow

Termy Uniejow was opened in 2008. It is located in Mogilno-Lodz Trough in the central part of the Polish Lowlands. Geothermal water in Uniejow comes from Lower Cretaceous sandstones aquifer and is of Na-Cl type (Sapinska-Sliwa and Kurpik 2011). Temperature of water in three swimming pools fluctuates between 25 and 36°C depending on the season. There are also some saunas in the center.

Furthermore, a development of other geothermal installations in Uniejow has been accomplished. There are located some new outdoor and indoor swimming pools as well as spa area with saunas, cool and hot pools and outdoor terrace for sunbathing, culinary part, bowling, etc. The connection between outdoor and indoor pools allows a year-round work of the whole center. Hotel spa&wellnes, a modern rehabilitation and recreational complex have also been established (www.termyuniejow.pl/).

70% of buildings in Uniejow and a lawn of football playground are heated by geothermal energy. In the future, a hybrid thermal-electric power station that uses geothermal energy and biomass for electricity production in Organic Rankine Cycle will be provided (Sapinska-Sliwa and Kurpik 2011).

The town of Uniejow received an official status of health resort in 2012 due to ordinance of Council of Ministers on 27th of June, 2012, No. 782. The health resort offers treatment in followed medical specializations:

- orthopedic and traumatic diseases;
- nervous system diseases;
- rheumatologic diseases;
- peripheral arterial diseases;
- skin diseases.

At present, treatment is provided in 2 entities. One of them is *Termy Uniejow* with separated medical center. In the health resort area there are localized also spa park and fitness trail.

2.8 Geotermia Grudziadz

Geotermia Grudziadz which was opened in 2007 offers geothermal pools, pyramid-shape graduation tower, balneotheraphy, cryotheraphy, massage rooms and sauna. There are four swimming pools filled with geothermal water, which temperature is 32–36°C. Cl-Na,I,Fe type therapeutic geothermal water is a 7.9% brine and has reservoir temperature of 38°C (Krawiec 2009). Swimming pools were opened in 2007. In a previous year a “brine cave” had been established, where an initial possibility of bathing and gymnastics was provided.

Development of the swimming pools and the whole center apart from creating a site for Camper cars are intended (http://www.geotermiagrudziadz.pl/).

2.9 Poddebice

Geothermal water application in Poddebice will involve space heating, balneotheraphy and recreation. Geothermal heating of municipal utilities and a lawn of football playground are finalizing. Furthermore the Balneological Rehabilitation and Recreation Center as well as hotel with a catering department and fitness center will be established. The Center will provide rehabilitation and medical service in thermal swimming pools, water strings, individual hydotherapeutic treatment points, kinesiotherapy and physiotherapy complex. Balneotherapeutic treatment could be provided in the district hospital, which has a special department adapted for balneotheraphy. Additionally, proximity of peloid deposit is an asset.

Geothermal water is HCO_3-Na-Ca type. It has a temperature of 72°C and flow rate of 115 m^3/h. Water has the low TDS – 0.455 g/dm^3, therefore it can be used as a drinking water (Karska and Hajto 2009).

In July, 2011 the first outdoor swimming pool filled with 28–35°C geothermal water was opened. Providing of geothermal space heating began in 2013, which makes the installation in Poddebice the most recent in Poland.

3. GEOTHERMAL RECREATION AND THERAPY CENTERS UNDERWAY

Some next bathing and therapy geothermal centers are underway in Poland meeting the growing demand for such kind of services. The works to initiate new centers have been started in the Polish Lowlands in several locations. The planned centers are pointed out in Fig. 1.

3.1 Termy Maltanskie Poznan

Termy Maltanskie is one of the new bathing centers. The center was opened in October, 2011. *Termy Maltanskie* center and hotel complex was listed as one of the most important projects accompanying the 2012 UEFA European Football Championship, which took place in Poland.

In this sporting and recreational center customers can benefit from two sporting swimming pools, eleven recreational swimming pools, saunas, hammams, graduation tower, snow cave and six water slides (http://www.termymaltanskie.com.pl/).

Currently, the three brine pools are filled with water, which chemical composition is suitable modified. The pools will be soon filled with geothermal water from a well located near to the center. Geothermal water from the well is 2% brine and its temperature is 38°C. The water comes from 1300 m depth (Biernat et al. 2011).

3.2 Kleszczow

Kleszczow Municipality is situated in a rural area in Lodz Voivodeship, in central Poland with total population of ca. 4 500 inhabitants. Kleszczow is located close to a brown coal mine – the biggest open-pit mine in Poland and one of the biggest in Europe and the Belchatow Power Plant, the largest thermal power plant in Europe and one of the largest fossil fuel power stations in the world, (it produces almost 20% of total power generation in Poland). Kleszczow Municipality initiated the project of geothermal water use for space heating and recreation, some geothermal swimming pools are planned in Kleszczow. The Solpark – sporting and teaching complex will be heated with geothermal energy as well as school, students dormitory, gym, sport complex and hotel. Next to the Solpark complex there are planned geothermal swimming pools - a part of a recreational center and park, parkways, hotels and restaurants. An artificial hill with a ski tow and minigolf will be some of attractions for children.

Water will be discharged by two wells completed in 2010-2011 from the depth of ca. 1500 m. Its reservoir temperature is 52°C and the TDS are 6.08 g/dm^3 (Biernat et al. 2011).

3.3 Lidzbark Warminski

Lidzbark Warminski is located in the NE-Poland. *Termy Warminskie* will use geothermal water from Lidzbark Warminski GT-1 well, which comes from Lower Cretaceous aquifer. The TDS in water are ca. 20 g/dm^3 (Biernat et al. 2011). Because of rather low temperature of 20°C heat pumps for heating up the geothermal water are taken into accounts. The installation shall be finished in 2013. *Termy Warminskie* will consist of pools with warm brine water (27–36°C), saunas, the health and beauty center, hotels and restaurants, recreational infrastructure.

3.4 Gostynin

Termy Gostyninskie – the huge, modern center which combines recreational, leisure, rehabilitation, balneotherapeutical and medical function will be located on the area of 17 ha in Gostynin city. A hotel divided into a commercial part and a recreational part with water-recreation, balneotheraphy, rehabilitation and beauty salons will be build. The Crossregional Tourism, Balneology, Leisure, Entertainment and Recreation Center will be set up there. The geothermal water before using in balneotheraphy and balneorecreation will be used for space heating.

An 82°C geothermal water from newly drilled well is a Cl-Na type. It has a certificate of its curative properties (Biernat et al. 2011).

3.5 Piaseczno

In Piaseczno a newly drilled well is going to supply in geothermal water the recreation facilities of Geotermia Warszawska. Geothermal water will be used for balneotherapeutic and bathing purposes. The geothermal space heating of buildings in bathing center and some other residential buildings in the neighbourhood will be provided. Since the center will be the only one located so close to Warsaw, the capital and the most important metropolis of Poland, it is expected to be very attractive spa and recreational center.

3. FUTURE PLANS FOR BATHING AND THERAPHY CENTERS

Besides above mentioned projects, some next centers are planned in different parts of Poland. Progress of their implementation is diverse. In example, in Podhale region four new centers (in Szaflary, Poronin, Chocholow and *Termy Witowskie*) are considered. The center in Szaflary will be the second that kind of service localized very close to existing center, and similarly to it, will use the water cooled down in heat exchangers of nearby geothermal heating plant. The following centers are intended in Tarnowo Podgorne, Torun, Trzesacz in NW part of Poland (Biernat 2011). Termy Cieplice in Sudets Mts. will use curative water with high outflow temperature (ca. 90°C) from existing wells. New installations for bathing and balneotheraphy are planned also in Jaworze, Olsztyn, Celejow and Poreba Wielka. The feasibility studies of geothermal installations are done for some locations, like for example in Gorlice. Locations of each planned centers are shown in Fig. 1.

4. CONCLUSIONS

Visiting geothermal bathing centers becomes a strong trend in the way of recreation for Polish people. Activities on the field of geothermal recreation, bathing and therapy have risen in recent years, which can be clearly visible in increasing number of investments and plans. For investors wider range of application of geothermal water influences on faster reimbursement of the capital costs. The geothermal bathing and therapy market has growing number of clients interested.

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