Geothermal Energy Use, Country Update for Czech Republic

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ABSTRACT

The geothermal energy use in the Czech Republic has been constantly increasing despite the financial demand, especially in the initial investment phases. Besides heat extraction from hydrothermal resources, the importance of geothermal drilling using different technological approaches begins to grow. Numerous research studies show that sufficient temperature to produce electricity can be encountered in depth of about 5 km. The existing natural and geologic conditions, as well as market conditions in energy supply, explain the current status in development of geothermal electricity utilization in the Czech Republic. Although first efforts for deep geothermal projects development are currently being undertaken, the most exploitable resources are those of low temperatures used for geothermal heating. Typical cases of geothermal heating are summarized by the presented article.

1. GEOTHERMAL POTENTIAL IN THE CZECH REPUBLIC

The territory of the Czech Republic is formed by granite bed rock of Bohemian Massif. Considering that 4 km thick massif is cooled by 1ºC down, the theoretical potential equals 500 000 PJ while the annual consumption of primary energy resources in the Czech Republic is 1 800 PJ (Motlik, 2007). More than 60 sites potentially favourable for geothermal energy exploitation might be identified within the Czech territory (in total estimated 250 MW for geothermal electricity and 2 000 MW for heating) (Myslil et al., 2006). Geothermal potential of the Czech Republic was also summarized in Atlas of Geothermal Resources in Europe (Myslil et al., 2002) and was subject of the research project described in Jirakova et al., 2013.

Several cities in the Czech Republic consider seriously the use of geothermal energy not only for space heating but also for electricity production. However, only one cogeneration geothermal project – in Litomerice – has been already under development (as described later on in section 2.2).

Other geothermal projects focusing on district heating and electricity generation as the second product are under investigation in two more cities in northern Bohemia - Semily and Liberec.

2. GEOTHERMAL DISTRICT HEATING

Although there are several sites favourable for development of geothermal district heating systems in the Czech Republic, only the area around the municipality of Decin is a typical example of such type of geothermal resource exploitation in the country.

2.1 Geothermal resource in Decin

Central heating resource for the right river side of the municipality of Decin represent unique project in the Czech Republic. Experimental borehole was drilled in 1998 and put in operation in 2002 (TERMO Decin Co.). The project is partially financed by State Environmental Fund of the Czech Republic. The geothermal borehole reaches 550 m below surface. As the temperature of spontaneous water outflow is rather low (30ºC), heat pumps cool water down to 10ºC and is consequently used for drinking purposes. Acquired heat is treated in municipality Heating Plant with other heat sources – cogeneration gas engines and gas kettles. Installed capacity of individual facilities is given in Table 1.

Table 1: Installed capacity of Heat Plant in Decin.

Heat pumps	2x 3,28 MWt
Cogeneration gas engine	0,8 MWe/1,01 MWt
Cogeneration gas engine	1,94 MWe/2,09 MWt
Gas kettles	2x 16,5 MWt

So far, Decin project is the only District Heating Plant project in the Czech Republic.

2.2 Litomerice geothermal project

The geothermal research project focusing on deep geothermal energy use for both heat and electricity production via Hot Dry Rock technology was realized in Litomerice city, situated in the Czech Central Mountains, in the years 2006 - 2007. The research well PVGT-LT1 was constructed with the financial support of Ministry of Industry and Trade and the city budget became a first deep exploratory geothermal borehole in the territory of the Czech Republic.

Extensive geological and geophysical tests have been performed on the well PVGT-LT1.

The exploratory well of 2 111m total depth became a subject of investigation in order to evaluate geothermal potential for the geothermal power plant construction and the heat exploitation from the depth up to 5 000m. Archive information together with new geophysical measurements suggest promising conditions for these purposes which lies in its favorable geological position on the crush zone in metamorphic rocks with high thermal conductivity values.

In 2111 m temperature reaches 63.5°C (Figure 1). Then, extrapolation to 5000m provides temperatures 178 – 207.5°C which is rather challenging for both heating and electricity production (Stibitz et al., 2011).

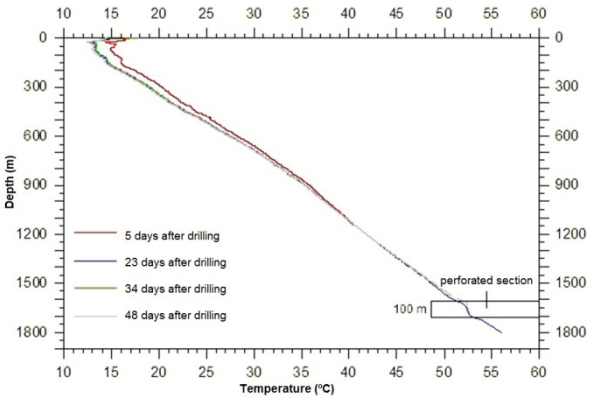

Figure 1: Temperature record in Litomerice geothermal borehole PVGT-LT1, (Safanda et al., 2007).

Recent activity in the city of Litomerice is a follow-up to geothermal research well construction enabling further steps towards the realization of adequate geothermal project aiming at heat and electricity generation from renewable resources and therefore contributing to development of local economy and new strategic industrial branch in the Czech Republic.

In 2011 a SPV (special purpose vehicle) was founded with the name of 1. Geothermal Litomerice, a joint-stock company, which is 100% owned by the town of Litomerice and is dedicated solely to the implementation of the geothermal project and related activities. Since then, numerous expert opinions and analytical studies are being gathered (feasibility studies, geological project, financial and economic analysis, technical project, seismicity monitoring plan). Currently, the Litomerice project also explores possibilities to further extent research and development activities on-site.

3. GEOTHERMAL HEAT IN BALNEOLOGY

Balneology has a long history in the Czech Republic. Thermal water is used in spas, wellness centres and swimming pools. Examples of thermal swimming pools are Usti nad Labem, Velke Losiny, Pasohlavky and Chrastava. Outside swimming pool in Velke Losiny was closed in 2012 and new thermal complex is going to be built. In Chrastava, thermal swimming pool was opened recently in December 2012. Although heat pumps are currently used for mineral water heating, drilling of 2 km deep geothermal well is in consideration for further development.

The most successful project using thermal groundwater for balneological purposes is located at **Pasohlavky / Musov** in east-southern part or the Czech Republic, geologically in Northern Vienna Basin.

Investigation of two geothermal boreholes – Musov-3G and Pasohlavky-2G – confirmed in 1 450m temperature 49,7 ºC and average temperature gradient 26,1ºC. The heat flux value calculated for Musov-3G from a complex of Jurassic sediments was 48,4 mW/m^2. Maximal outflow during natural overflow reached 7 L/s, maximal outflow considering a drawdown of 47,8 m was 17,2 L/s. Water temperature reached 48ºC on the surface. As revealed, the entire Jurassic complex represents a large reservoir of thermal groundwater (KEA, 2003).

Currently, thermal water is used in wellness Hotel Thermal Musov where the outside swimming pool is filled with mineral sulphureous water having 34 - 37ºC. In 2012, association “Moravia Thermal” and the investor ZS REAL, Co. started the construction of aquapark including pools with geothermal water (3 L/s, 46ºC).

Spa project “Thermal Pasohlavky” developed in municipality of Pasohlavky in south Moravia (southeast of the Czech Republic) is obviously the largest project financed from European funds supporting the balneology development in the Czech Republic.

4. GEOTHERMAL HEAT IN ZOOS

Geothermal heat is currently used in two zoological gardens: ZOO in Usti nad Labem (northwest of the Czech Republic) and ZOO in Prague.

4.1 Geothermal Heat in ZOO Usti nad Labem

District heating system in ZOO Usti nad Labem belongs with its unconventional technical solution to the most interesting installation using heat pumps in the Czech Republic. Geological and hydrogeological conditions are very favorable. Production geothermal well is 515 m deep. The well has artesian character, the thermal water inflow was registered between 400 – 470 m while the main inflow is between 409 – 414 m. Water of 32°C is pumped from 65 m depth. The overflow capacity is up to 5,6 L/s. The total well capacity is 12 L/s (ZOO Usti nad Labem, 2007). This technology provides heat for all ZOO buildings.

4.2 Geothermal Heat in ZOO Prague

In Prague, the primary energy source is groundwater of approximately 8 to 10°C with the output temperature of the medium is 50°C. Only four pavilions are heated in such a way. The project

originates from 1996, the realization was carried out 1997 until 2001. Total annual energy consumption of the four pavilions without the use of heat pumps is 768 MWh/year. The operation of installed heat pumps saves 526 MWh / year. The total installed capacity of all heat pumps is 187,4 kW. Considering above mentioned numbers, the annual saving exceeds 28 000,- EUR.

5. HEAT PUMPS – LOW TEMPERATURE HEAT

The most widespread technology of geothermal energy use in the Czech Republic is linked to installation of various types of heat pumps.

Despite high initial investments, the interest for such type of geothermal heating is growing. The investment recoverability is estimated up to 10 years. Moreover, increase of initial investment and extension of recoverability period may be caused by worse accessibility to geothermal resource.

5.1 Development of heat pumps installations and financial support

First extensive heat pump installation started in 80th of 20th century and a significant expansion has been observed since 90th. From 2005 a regular statistical observation is annually recorded in final reports of Ministry of Industry and Trade of the Czech Republic (Bufka, 2012).

According to the most recent finding and based on number of announced installations and data from financial support of State Environmental Fund of the Czech Republic, in 2011 was installed about 7015 heat pumps in total.

Estimation of total heat pump supply in 2011 is given in Table 2 while Figure 2 displays the evolution of heat pump supply since 2005.

Table 2: Estimation of heat pump supply in the Czech Republic in 2011 (Bufka, 2012).

	Number	Heat Capacity (kW)
Air-air	105	719
Air-water	4 525	57 753
Ground-air	2 296	26 055
Water-water	65	1 533
Others	24	41
Total	**7 015**	**86 100**

In 2011, the installation of heat pumps are financially supported from public and structural funds resources. Most of the heat pump installations have been supported by State Environmental Fund of the Czech Republic.

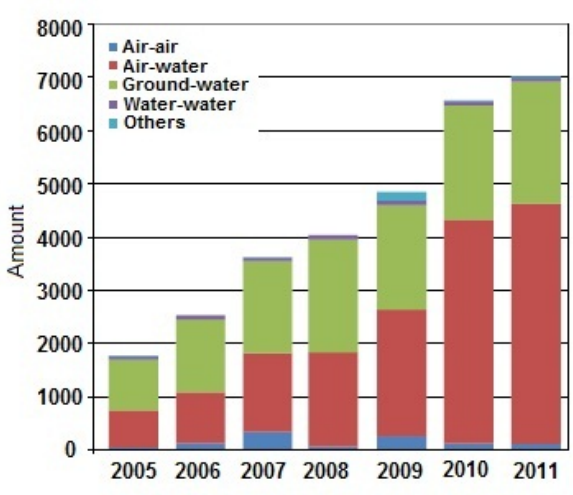

Figure 2: Evolution of heat pump supply in the Czech Republic 2005-2011 (modified from Bufka, 2012).

5.2 Heating of buildings

Interesting findigs have been observed from statistics of heating in new constructions approved in 2010 and 2011. While in 2010 about 1 540 heat pumps were installed, in 2011 the number increased up to 1 927. Heat pump as principal heat source has been registered in 8,4% family houses and in 4,8% flats. Based on registered distirbution, it might be concluded that 30% of heat pumps is being installed in new constructions.

6. CONCLUSIONS

Geothermal energy is very perspective renewable resource. Degree of its utilization will be primarily driven by economic development.

In the Czech Republic, the need for geothermal energy education and expanded resource exploration has been recognized and numerous geothermal projects including all types of technologies are either under development or under investigation.

In line with development worldwide, multiple Czech geothermal projects aim at extensions into research and development activities to further enhance the available geothermal resources.

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Tables A-G

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

	Geothermal Power Plants		Total Electric Power in the country		Share of geothermal in total	
	Capacity (MW_e)	Production (GWh_e/yr)	Capacity (MW_e)	Production (GWh_e/yr)	Capacity (%)	Production (%)
In operation end of 2012	-	-	20 250*	87 560**	-	-
Under construction end of 2012	-	-	-	-	-	-
Total projected by 2015	<5	<40	-	-	< 0.1%	< 0.1%

*data from 2011 (referred to31.12.2011), **data from 2011 (referred to period 1.-.12.2011), Resource: ERU, 2012

Table B: Existing geothermal power plants, individual sites*

*Geothermal power plants are not available in the country.

Table C: Present and planned geothermal district heating (DH) plants and other direct uses, total numbers

	Geothermal DH Plants		Geothermal heat in agriculture and industry		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)
In operation end of 2012	6.56*	25*	-	-	2.12**	-
Under construction end of 2012	-	-	-	-	-	-
Total projected by 2015	6.56	25	-	-	4	-

*Decin, **Pasohlavky (balneology)+ ZOO (Usti nad Labem)

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

Locality	Plant Name	Year commiss.	Is the heat from geo-thermal CHP?	Is cooling provided from geo-thermal?	Installed geotherm. capacity (MW_{th})	Total installed capacity (MW_{th})	2012 geo-thermal heat prod. (GWh_{th}/y)	Geother. share in total prod. (%)
Decin	Decin Geothermal Resource	2002	no	no	6.56	33	25	-
total					**6.56**	**33**	**25**	**-**

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

	Geothermal Heat Pumps (GSHP), total			New GSHP in 2011		
	Number	Capacity (MW_{th})	Production (GWh_{th}/yr)	Number	Capacity (MW_{th})	Share in new constr. (%)
In operation end of 2011*	11783	169	328	1771	21	
Projected by 2015	18000	350	680			

*data refer to ground heat pumps in 2011 (Resource: Bufka, 2012),

Table F: Investment and Employment in geothermal energy

	in 2012		Expected in 2015	
	Investment (million €)	Personnel (number)	Investment (million €)	Personnel (number)
Geothermal electric power	-	10*	-	30*
Geothermal direct uses	-	-	-	-
Shallow geothermal	-	-	-	-
total				

*estimate of personnel involved in research, development and innovation in geothermal energy

Table G: Incentives, Information, Education

	Geothermal el. power	Geothermal direct uses	Shallow geothermal
Financial Incentives – R&D	yes	no	no
Financial Incentives – Investment	no	yes	yes
Financial Incentives – Operation/Production	no	no	no
Information activities – promotion for the public	yes	yes	yes
Information activities – geological information	yes	yes	yes
Education/Training – Academic	yes	yes	yes
Education/Training – Vocational	yes	yes	yes

Key for financial incentives:					
DIS	Direct investment support	RC	Risc coverage	FIP	Feed-in premium
LIL	Low-interest loans	FIT	Feed-in tariff	REQ	Renewable Energy Quota

REFERENCES FOR TABLES A-G

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