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Economic aspects of the use of deep geothermal heat in district heating in Poland

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ABSTRACT

The paper analyzes the economic aspects of geothermal heating plants in Poland—selected plant operating costs, prices of geothermal heat, and economic efficiency of geothermal heating plants. All six geothermal heating plants operating in Poland are analyzed including the oldest plant established in 1994 and the newest plant established in 2013. The cost structure of geothermal heating plants tends to significantly; however, amortization is the principal operating cost at close to 55% in some cases. Other key costs include use of materials and energy. A comparison of the net price of 1 GJ of heat produced by selected heating plants shows that heat produced by brown coal (lignite) plants is the least expensive, while that produced by black coal (anthracite) plants is more expensive. The prices of heat produced by geothermal heating plants are less competitive, but still more competitive than those of heat produced using natural gas, biomass, and fuel oil. An analysis of the economic efficiency of geothermal heating plants shows that this source of heat has significant potential for profitability, which is also shown by its positive EBITDA. A notable part of the revenue of geothermal heat companies comes from various types of subsidies and grants. A large number of difficulties of estimate risks and high start-up costs along with a low rate of return have thus far discouraged private entrepreneurs from pursuing this line of investment. As a result, virtually every geothermal heating plant in Poland is owned by the government at the local or national level.

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1. Introduction

The use of deep geothermal heat is gradually increasing around the world thanks to progress in heat exchange technology and drilling technology, increasing exploration for geothermal sources, and increasing documentation of reservoirs of geothermal heat [1]. The use of geothermal heat for home heating purposes in Poland began in the 1990s [2] and continues to increase every year. However, geothermal heat is still one of the least used sources of renewable energy in Poland. The largest contribution to renewable energy production in Poland in 2009 came from solid biomass energy, which constituted between 91 and 85% of the country's total renewable energy production in 2007–2011 [3,4]. The next six

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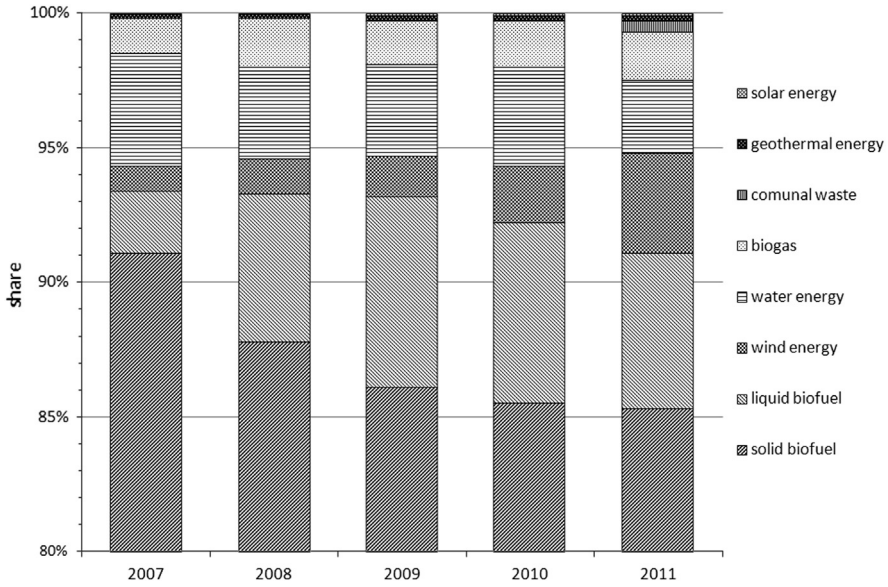

Fig. 1. The structure of renewable energy production in Poland in 2007–2011.

largest contributions to renewable energy production in Poland came from liquid biofuels, hydropower, biogas, wind, heat pumps, and geothermal energy (Fig. 1). It is noticable that in the scale of Poland, geothermal energy plays a marginal role within the structure of renewable energy resources use with the share of 0.2%.

Poland is one of the richest European countries in terms of low-temperature geothermal resources [5]. It features three geothermal regions consisting of large sedimentary basins with a total surface area of 250,000 square kilometers: (1) Polish Lowlands, (2) Carpathian Foothills, (3) Carpathian Mountains. The best geothermal conditions have been identified across the Polish Lowlands and in the small Podhale region in southern Poland. Potentially good geothermal conditions have also been identified in the Sudety Mountains in southwestern Poland. The region is already known as the capital of Polish balneotherapy, with geothermal water coming from fractured crystalline and metamorphic sectors of a number of landforms [6,7]. According to a number of experts [8–10], considering the current prices of most conventional fuels, financially viable geothermal facilities could provide heat for at least 40% of Poland's territory.

Eurostat data indicate that geothermal energy constituted 0.77% of primary electricity production in the European Union (27 countries) in 2011. In Poland, this value was forty times lower at 0.02%. What is also noteworthy is the rate of change in the use of geothermal energy. Poland increased its usage of geothermal energy by 237% in the period 2002–2011, while the European Union as a whole (27 countries) increased its usage by 154% during the same time period. While geothermal energy remains a marginal form of energy, its usage is rapidly increasing both in Poland and the European Union in general.

The three main direct uses of geothermal energy in Europe are space heating, balneology, and recreation, which account for close to 2/3 of all geothermal energy produced [11]. However, on the global scale, the proportions are different. In 1995 deep geothermal energy was mostly used for space heating – almost 40,000 TJ/year – which was 39.4% of total geothermal output. By 2005 the use of geothermal heat for space heating had decreased to 29.6%, while total usage of geothermal heat had increased to about 55,000 TJ/year [12]. This decrease can be attributed to a rapid increase in the use of geothermal energy to heat swimming pools and other recreational facilities. These new uses of geothermal energy consumed 44.6% of all geothermal energy produced in Europe in 2005, up from 16.2% in 1995. Swimming pools and other recreational facilities had become the primary users of geothermal energy by 2005 [12].

Table 1
Basic characteristics of geothermal heating districts in selected European countries.

Country	Capacity [MWth][a]	Annual energy [TJ/y][a]	Number of district heating[a]	Number of planned district heating 2013–2018[b]
Czech Republic	6.6	25.0	1	4
Denmark	33.0	289.0	3	18
France	316.2	1200.2	41	109
Germany	171.3	311.6	23	120
Hungary	83.1	1282.5	15	54
Italy	70.7	165.7	16	47
Netherlands	50.5	982.0	7	21
Poland	98.1	159.6	5	14
Romania	106.6	150.1	12	31
Slovakia	14.2	0.0	4	18
Slovenia	3.7	6.3	3	10
Sweden	33.0	270.0	1	1
United Kingdom	2.8	0.0	1	8

[a] According to http://geodh.eu/ (last access: 9.09.2014).
[b] According to http://geodh.eu/wp-content/uploads/2012/07/GeoDH-Brochure.pdf (last access: 9.09.2014).

As it was mentioned, district heating has the largest share in the global geothermal energy usage. According to the data published on Geothermal District Heating's website in the year 2012 there were more than 5000 heating systems installed in Europe which includes 212 geothermal plants [13]. In general, European countries can be divided into three groups according to their geothermal heating development potential, its advancement and prospects for the future. Western European countries, with France and Germany at the forefront, are the most advanced as far as the level of the geothermal heating development is concerned. The combined power of all geothermal plants, annual heat production as well as the number of existing and planned heating plants is the largest in those countries (Table 1). The second group is comprised of Central and Eastern European countries such as Poland but also Hungary, Slovakia, Slovenia, Czech Republic, Bulgaria and Romania where similar objects have been constructed recently and their number is