

The Competitiveness of Geothermal Regard to Conventional Energy Carriers in the Selected Large Polish District Heating Systems

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ABSTRACT

The paper presents the current price of energy paid by final user. The estimation take into account various energy carriers used to cover the demand for heating (space heating and domestic hot water) in Poland. The hard coal is still the most common used energy carrier in Poland. About ¾ of heat in Poland is generated base on coal. Coal is still widely recognized as the cheapest energy carrier. In the case of good reservoir conditions, geothermal energy can compete with hard coal in the scope of energy price. If the temperature of geothermal resources allows use it without the use of heat pumps (more than 70°C), then the price of energy for the final consumer may be comparable to the price characterizing the energy produced by hard coal. The energy prices estimated in the article were determined based on the settlement tariffs applicable in 2018 for most installations using geothermal energy and selected conventional energy carriers. The calculations show that geothermal energy is not more expensive than energy from conventional energy carriers (hard coal, heating oil, natural gas). The use of geothermal resources characterized by lower temperature (40-60°C), requiring the use of heat pumps, locates geothermal energy in the price range characteristic for natural gas and heating oil.

1. INTRODUCTION

The article is basing on the billing tariffs approved by the President of the Energy Regulatory Office in Poland. Geothermal energy is compared with the other energy carriers most commonly used in heating, i.e. coal, natural gas and fuel oil. To determine the total energy price paid by the final user for all analysed media used the same. Methodology and assumptions are described in detail in the article (Pająk and Bujakowski 2016 and 2018). It is based on certain assumptions about the energy performance of a hypothetical object that uses district heating. The object is characterized by the demand for:

- heating power from 30 to 150 W/m²,
- heat demand between 0,26 to 0,9 GJ/(m² year),
- hot water consumption ~50 kg/(day person) with temperature on a tap 55°C.

The selection of non-geothermal energy suppliers has been made assuming that these companies, due to a large amount of energy sold, have correctly calculated billing tariffs (based on real data). As a result of the calculation, the total unitary price applicable to the final recipient is determined. It is a price that includes both a fixed tariffs component and a variable settlement tariff (including costs of generation and transmission and distribution of energy).

In the analyses Polish currency is being used, that is "zł". It might be assumed that 3,8 zł ≈ 1 \$ (USD).

1.1. Data source and methodology

Table 1 summarizes the billing tariffs of selected heating companies valid for September 2018. From among of six Polish geothermal heating installations, those that have established and commonly share current billing tariffs have been analysed. This applies to the approved settlement tariffs for 4 geothermal heating plants: PEC Geotermia Podhalańska S.A., Geotermia Mszczonów S.A., Geotermia Pyrzyce Sp. z o.o. and G-TERM Energy Sp. o.o. Geotermia Stargard. The Geotermia Poddębice Sp. z o. o. did not have established billing tariff in September 2018 and Geotermia Uniejów Sp. z o.o. which did not publish it.

Table 1: The billing tariffs for selected heating companies, net values valid for a final energy user in the September 2018 (Pająk and Bujakowski 2018).

no	Name (tariff group) \ type of the payment	The fixed fee for the ordered power c_{smz} [zł/(MW yr)]	Price for thermal energy c_{ec} [zł/GJ]	Price of the heat carrier [zł/m ³]	Fixed rate of transmission fee c_{sop} [zł/(MW yr)]	The variable transmission fee rate c_{zop} [zł/GJ]
1	Geotermia Pyrzyce (group of users A)	114997,20	37,84	22,11	43091,16	18,89
2	Geotermia Pyrzyce (group of users B)	114997,20	37,84	22,11	42225,96	15,26
3	Geotermia Pyrzyce (group of users B1)	114997,20	37,84	22,11	47481,24	18,03
4	Geotermia Pyrzyce (group of users B2)	114997,20	37,84	22,11	28144,20	11,30
5	Geotermia Mazowiecka (the group of users M1 80/60°C)	106379,08	47,04	13,40	29737,53	11,28
6	Geotermia Mazowiecka (the group of users M2 70/50°C)	106379,08	47,04	13,40	26458,39	12,00
7	Geotermia Podhalańska (M1 individual energy user)	72770,11	19,01	17,43	49662,53	15,33
8	Geotermia Podhalańska (M2 individual energy user PEC)	72770,11	19,01	17,43	54445,78	20,62
9	Geotermia Podhalańska (M4 the group of users PEC)	72770,11	19,01	17,43	61309,12	24,90
10	Geotermia Podhalańska (G direct connection)	52974,88	16,52	3,35	0,00	0,00
11	PEC Stargard (B1 PEC Stargard Szczeciński)	68472,69	26,38	44,95	20886,43	11,03
12	PEC Stargard (B2/1 PEC Stargard Szczeciński)	68472,69	26,38	44,95	43570,28	18,91
13	PEC Stargard (B2/2 PEC Stargard Szczeciński)	68472,69	26,38	44,95	30026,58	11,84
14	PEC Stargard (B3 PEC Stargard Szczeciński)	68472,69	26,38	44,95	39204,00	19,14
15	MPEC Kraków (KO based on heating oil)	154096,56	66,05	-	0,00	0,00
16	MPEC Kraków (KG based on natural gas)	123044,16	59,88	-	0,00	0,00
17	Veolia Energia Warszawa SA (A12B1C3 natural gas, adress Nurzynska 1)	96192,96	56,62	13,23	24774,72	9,00
18	Geotermia Mazowiecka (S1 coal and biomass)	125681,24	35,91	11,81	32424,42	10,40
19	Veolia Energia Warszawa SA (A15B1C1 coal)	68345,64	31,74	4,29	8578,92	3,17
20	Veolia Energia Warszawa SA (A3B1C221 district heating, MPO)	40469,04	27,10	7,26	38158,92	12,95
21	MPEC Kraków SA (S1 WGP the connection node belongs to the MPEC)	66228,36	25,00	16,60	42917,16	16,60

The final price of thermal energy is estimated base on the equation:

$$c_c = \frac{(c_{mz} + c_{sop}) p 10^{-6}}{q} + c_{ec} + c_{zop} \quad (1)$$

Where c_c is net total price of thermal energy suitable for final heat user. Other marks in the equation above in accordance with table 1.

2. RESULTS AND DISCUSSION

The price of heat coming from geothermal energy in 2018 ranged from 48 to 83 zł/GJ (13 – 22 \$/GJ) net - Figure 1. It takes into account both the price of energy and the costs of its transmission and distribution. The price of energy from conventional carriers ranged from 44 to 92 zł/GJ (12-24 \$/GJ) (Figure 1). From conventional energy carriers, the cheapest price was characterized by energy coming from coal, it ranged from 44 to 60 zł/GJ (12-16 \$/GJ). Energy from natural gas was priced from 74 to 86 zł/GJ (20-23 \$/GJ), and derived from fuel oil from 84 to 92 zł/GJ (22-24 \$/GJ).

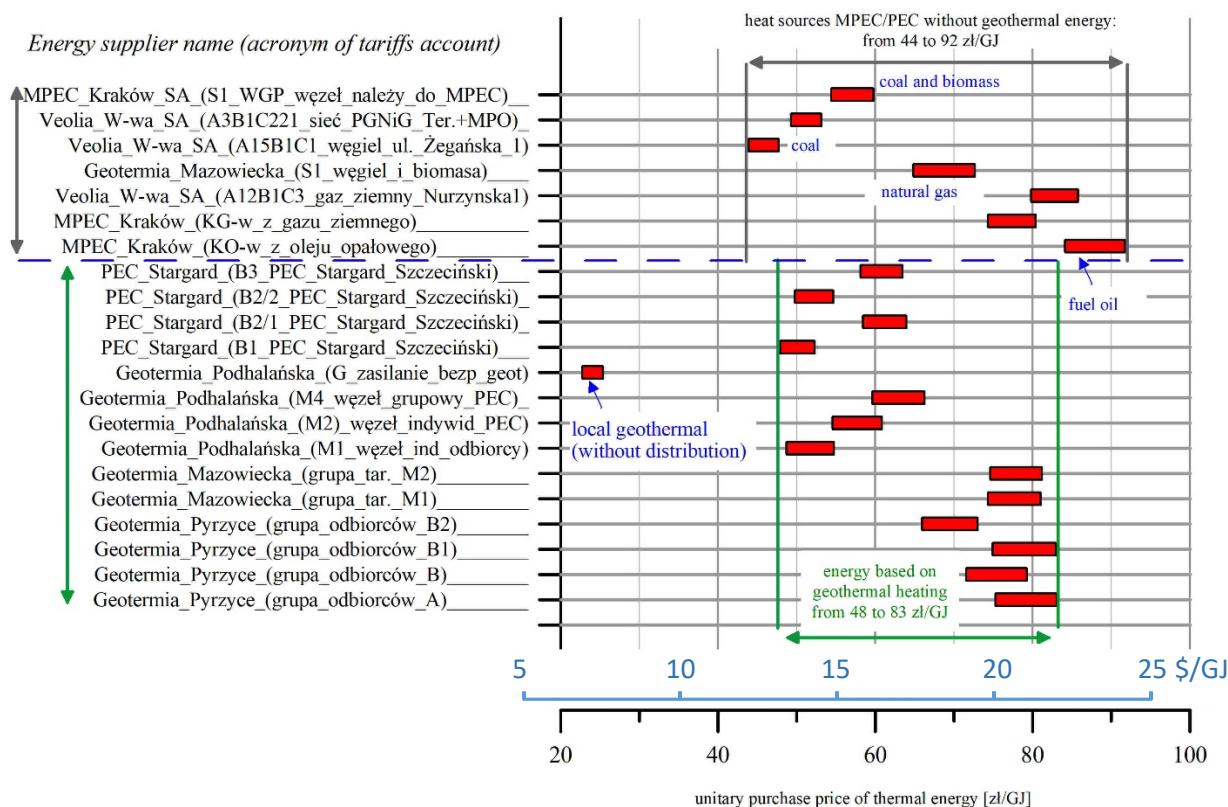


Figure 1: Statement of the unitary net price of purchase the heat valid for the final user, includes all charges for the selected companies in 2018 (Pająk and Bujakowski 2018).

Depending on the deposit parameters characterizing the geothermal installations analysed, the final price of energy was similar to:

- energy prices based on hard coal - wherever the temperature of geothermal water is high (above 70°C) and it is possible to use it without the use of heat pumps. This group includes the installations of Geotermia Podhalańska and PEC Stargard,
- energy prices from natural gas - where it was necessary to use heat pumps (40-60°C). This group includes: Geotermia Mazowiecka and Geotermia Pyrzyce.

In the time period from 2013 to 2018, one can observe a general trend of the decrease or stabilization of energy prices, which applies to all analysed carriers (Figure 2). The price drop for heating oil is particularly significant. It is associated with a reduction in the price of the fuel. A slight decrease in the price of energy can also be observed in the case of hard coal. Price stabilization applies to natural gas and geothermal energy, in the case of these carriers the price change since 2013 is negligible (Figure 2).

Regarding the comparison of the position and changes in geothermal heat prices compared to the currently cheapest carrier, i.e. hard coal, it is worth noting that the curve of the lowest geothermal prices is well below the curve of maximum coal prices and only slightly above the minimal price of coal energy. The image of these dependencies is likely to change in the coming year and next years which is connected with the introduction of fees for CO₂ emissions. As a result of these regulations, the current prices of coal will increase by about 20%, which will undoubtedly affect the final price of the final recipient.

A comparison of prices obtained from geothermal energy with natural gas prices unambiguously shows that geothermal energy is fully competitive to natural gas. The year 2012 was a breakthrough since we have recorded a clear trend of maintaining higher values of maximum gas prices than the maximum geothermal prices. When comparing these two energy carriers, two extremely important advantages of geothermal energy over gas should be recalled. One is that geothermal energy is a local, Polish resource while Poland's dependence on natural gas imports is over 70%. The second advantage is the lack of any emissions of pollutants to the atmosphere during the conversion of geothermal energy into usable heat, while the CO₂ emission produced during the combustion of natural gas when producing 1 GJ of energy is about 60 kgCO₂/GJ.

Geothermal energy is thus a more ecological source of energy than natural gas and has the value of 100% of the national resource.

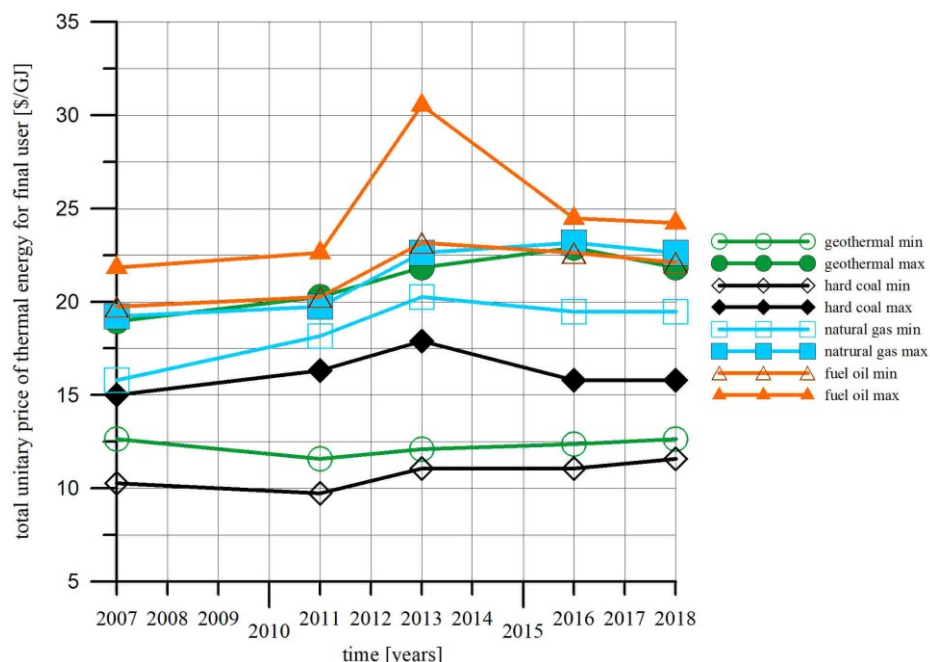


Figure 2: Comparison of the net unitary heat price for the end-user in the time interval from 2007 to 2018 (on the basis of: Pająk and Bujakowski, 2007, 2011, 2016 and 2018) (Pająk and Bujakowski 2018).

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