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Analysis of Selected Boreholes in the Area of Szczecin Through for Their Use in Geothermal Power Generation

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ABSTRACT

The paper presents a preliminary analysis of 6 boreholes from among 28 selected boreholes located in the Stargard-Radęcin area of the Szczecin Through region. The analysis focuses mainly on the possibilities of the use of the area for the production of heat or for medical, therapeutic or balneotherapy purposes. The article also presents a detailed analysis of the geological, petro-physical and chemical analysis of groundwater from 2 boreholes, performed on the basis of archival information from the National Geological Archives (NGA). The most important factors influencing the ability to exploit groundwater for heating or for medical, therapeutic or balneotherapy purposes are pointed out. The paper also indicates the main factors affecting the profitability of geothermal investments in Poland.

1. INTRODUCTION

Geothermal energy is the energy coming from the interior of the Earth, accumulated both in hydrothermal systems and systems of hot dry rocks (Górecki et al., 2011). Geothermal reservoirs are characterized by high values of porosity and permeability allowing the accumulation of water and vapor (Górecki et al., 2011). Reservoirs, due to temperature, can be divided into two types; the reservoirs in which the high-temperature vapor exceeds 150°C and the low-temperature reservoirs of water temperature less than 150°C (Nicholson, 1933). In Poland, according to Geological and Mining Law (Journal. Laws of 2011, No. 163, item. 981 with amendments), thermal water is defined as underground water whose temperature at the outlet is not less than 20°C. Currently, in Poland there are six geothermal heating plants (Fig.1) operating (Kępińska, 2013). Five of them are located in the Polish Lowland, they are a geothermal heating plant Pyrzyce created in 1997, a geothermal heating plant in Mszczonów created in 1999, Uniejów in 2000, in 2005 - geothermal heating plant in Stargard Szczeciński (now G-Term Energy), and in 2013 also a heating plant in Poddębice (Kępińska, 2013). These heating plants mainly use new geothermal boreholes but also, to a lesser extent, reconstructed boreholes, drilled between the years 1958 - 1995 for research purposes. Today, they are operated successfully for exploitation or injection of groundwater as exemplified by the exploitation borehole in Mszczonów and one of the injection boreholes in Uniejów (Biernat et al., 2012). Reconstruction of archival boreholes sometimes becomes a beneficial (financially) alternative to investments related to the exploration and exploitation of groundwater. However, reconstruction is not always possible, and the cost of reconstructing old boreholes can exceed the cost of implementing new facilities (Biernat et al., 2012).

Taking into account the favorable thermal conditions prevailing in Szczecin Through, as well as the benefits of obtaining heat from groundwater, boreholes drilled in Stargard-Radęcin were analyzed in terms of their use to obtain geothermal energy, including recreational, balneothrapy or therapeutic purposes. Based on the conducted studies of Szczecin Through done in recent years in order to determine the geological structure and to determine the geothermal potential, 28 archival boreholes were selected (Table 1). These boreholes are located in one of the most prospective areas, which include the Stargard-Radęcin zone located in Szczecin Through. The analysis of the Lower Jurassic aquifer was mainly conducted based on archival data from the National Mine Geological Archives in Warsaw. Two of prospective boreholes were discussed in detail: Chociwel IG-1 and Choszczno-1. Issues related to the extraction of groundwater in the Polish Lowland, including the problems of injecting groundwater into the reservoir, with the example of operating geothermal heating plants in the areas Pyrzyce and Stargard Szczeciński, were also discussed. Finally, the most important legal and financial aspects of the geothermal project were presented.

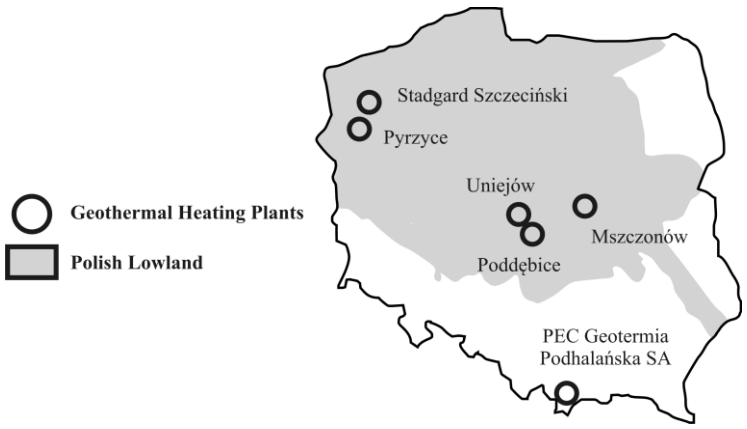

Figure 1: Location of geothermal plants in Poland based on Kępińska (2013).

2. ANALYSIS OF STARGARD-RADĘCIN AREA

The most prospective of the aquifers in the Polish Lowlands include the Lower Jurassic geological formations, whose reserves are estimated at 1,88x1018 J/rok (Górecki et al., 2010). The Lower Jurassic aquifer in this area is mainly built of Lias complex (sand and sandy - mudstones), characterized by good thermal parameters like porosity between 14-19%, and permeability whose values are up to 10000 mD (Biernat et al., 2009). In the case of geothermal investments the most important of the reservoir parameters, which mainly determine the profitability of this kind of investments, are: temperature, efficiency, and mineralization of groundwater (Sowiżdżał A., 2010). In the case of the Szczecin Through, previously performed research indicates that the area is characterized by temperature in the range of 20 - 90°C (maximum value in the axial parts of the Through), the yield in the range of 80 - 300 m^3/h (maximum values in fall and central parts) and mineralization between 20 – 150 g/dm^3 (Sowiżdżał A., 2010). Equally important for the cost of implementation of the borehole is the depth of the top surface of the aquifers (Górecki et al., 2010). For the analyzed boreholes depths are from the range of 826.6 m in the Drawno Geo 1 to more than 5000 m in Stargard-1. Analyzed boreholes were primarily made for research purposes (oil and gas exploration), or for the purpose of geological recognition of the Szczecin Trough, made between the years 1957-1998.

Table 1: Analyzed boreholes located in the area of Stargard-Radęcin (based on data from the National Geological Archives in Warsaw).

Name	Depth [m]	Stratigraphy on the bottom	Year	Name	Depth [m]	Stratigraphy on the bottom	Year
BANIE 1	4090.00	Permian	1975	HUTA SZKLANA 2	2200.00	Carnian	1969
CHOCIWEL 2	3750.00	Lower Triassic	1998	KUŹNICA ŻELICHOWSKA-1	1910.00	Noryk	1966
CHOCIWEL 3	3361.00	Lower Triassic	1987	MARIANOWO-1	2917.00	Triassic	1990
CHOCIWEL IG-1	2906.70	Upper Synemur	1963	MARIANOWO-2	2100.00	Triassic	1989
CHOSZCZNO IG-1	1500.50	Upper Synemur	1960	MARIANOWO-3	2045.00	Triassic	1991
DOBRZANY 1	2261.90	Upper Triassic	1961	MASZEWO 1	1724.10	Rhaetian [Alpine]	1961
DOLICE GEO-1	1179.50	Jurassic	1960	MĄKOWARY 1	2670.00	Carnian	1969
DRAWINY 1	1904.80	Carnian	1966	MYŚLIBÓRZ GN-1	3893.00	Carboniferous	1961
DRAWNO 1	3228.20	Upper Permian	1957	PŁAWNO 1	2886.10	Permian	1971
DRAWNO GEO 4	1603.00	Rhaetian [Alpine]	1968	RADĘCIN 1	2767.00	Upper Permian	1971
DRAWNO GEO 1	826.60	Jurassic	1958	STARGARD 1	5444.00	Permian	1976
DRAWNO GEO 2	1529.90	Carnian	1959	STRZELCE KRAJEŃSKIE IG-1	4700.00	Permian	1988
DRAWNO GEO-3	1002.90	Lower Jurassic	1959	SULISZEWO 1	1726.00	Noryk	1961
HUTA SZKLANA 1	3129.00	Permian	1969	ŻABICKO GEO-1	1030.40	Lower Toarcian	1960

Taking into account the parameters of the reservoir and the depth of the bottom of the Lower Jurassic formations, initially six boreholes, which could be used to obtain geothermal energy, were chosen. These boreholes were: Drawno Geo 1, Drawno Geo-3, Chociwel IG-1, Chociwel 3, Choszczno IG-1 and Dobrzany 1. The depths of Lower Jurassic formation in the selected boreholes were at the level from 403 m in borehole Drawno Geo-3 to 2345.5 m in hole Chociwel IG-1 (Fig. 2). The conducted research shows that the temperature of the Lower Jurassic ranges from 45°C in the Choszczno area to 55°C in the Drawno region and to 80°C in the area of Chociwel (Sowiżdżał A., 2010). Those values can be confirmed with measurements of temperatures in the Lower Jurassic formations for the selected boreholes. Also, high performance values in the range of 200 m^3/h in Choszczno region up to 300 m^3/h in Chociwel region provide the possibility of using the study area in order to obtain energy from groundwater (Sowiżdżał A., 2010). The results of the research allowed for establishing the size of the mineralization of groundwater in the area which is at the level of 100 g/dm^3 (Drawno and Choszczno regions) to 150 g/dm^3 in the Chociwel region (Sowiżdżał A., 2010). It should be noted that large values of mineralization may have a negative impact on the exploitation of groundwater by reducing both efficiency and absorption of the geothermal system. Other parameters affecting the absorption of injection boreholes are: the aquifer thickness, porosity, permeability coefficient, the formation pressure, and the presence of impermeable upper geological formations which provide no migration of water, and thus provide security for the utilized water aquifers (Lewkiewicz-Małysa A. and Winid B., 2011).

2.1 The Analysis of the Borehole Choszczno IG-1

The basis for the drilling of Choszczno IG-1 borehole was the design of geological work on seismic profile No. 2 in the Drawno - Gorzów Wielkopolski region, made in 1958 in the first stage of geological exploration of the Polish Lowlands (Jaskowiak-Schoeneichowa ed., 1977). The borehole was primarily made to determine the formation and identify possible gaps in the stratigraphic formations of Jurassic and Cretaceous formations. While drilling Choszczno IG-1, comprehensive geophysical measurements in the quantitative interpretation of reservoir layers in the depth range 1130-1496 m were performed (Jaskowiak-

Schoeneichowa ed., 1977). Based on the electromagnetic charts, the mineralization of water from the Lower Jurassic formations ranges between 110-220 g/dm^3, and the value of porosity between 22-35% - providing very good reservoir properties of the Lower Jurassic aquifer (Jaskowiak-Schoeneichowa ed., 1977). In addition, temperature profiling (TPU) on the section with a depth of 126-1394 m (made after an eight-day stand-up) was conducted. The results of thermal measurements for the Lower Jurassic formation are shown in Table 2. Based on the results, the sizes of the geothermal degree and geothermal gradient (Table 2) were estimated; the average values reached 52.4 m/^{o}C and 1.91^{o}C/100 m (Jaskowiak-Schoeneichowa ed., 1977).

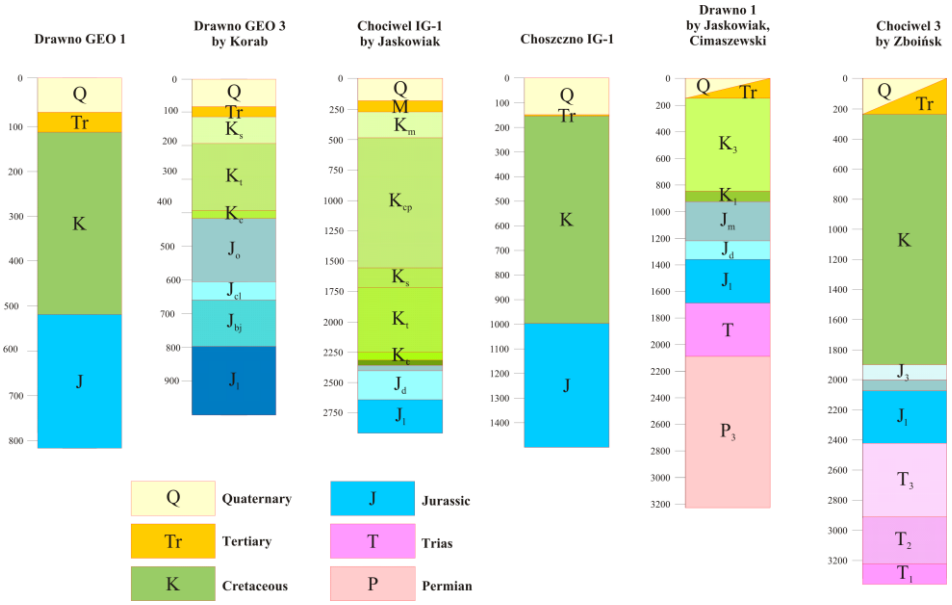

Figure 2: Stratigraphic profiles of selected boreholes (based on archival data from the National Mine Geological Archives in Warsaw).

Table 2: The results of temperature profiling for the level of the Lower Jurassic (Jaskowiak-Schoeneichowa ed., 1977).

Stratigraphy	Depth [m]	TEMP[^{O}C]	Degree of geothermal [m/^{O}C]	Geothermal gradient [^{O}C/100 m]
Lower Jurassic	1164.5-1187.0	40.8-41.4	28.2	3.54
	1187.0-1254.0	41.4-43.1	66.3	1.51
	1254.0-1394.0	43.1-45.5	58.8	1.70

2.2 The Analysis of the Borehole Chociwel IG-1

The Chociwel IG-1 borehole is located in the province of Szczecin and was made in 1961 in the first stage of general basic research in the Polish Lowland, conducted by the Department of Geology, Institute of Geology Lowlands (Jaskowiak-Schoeneichowa ed., 1977). Implementation of the borehole was connected with determination of the sedimentation and thickness within the Jurassic and Cretaceous formations. While drilling, detailed measurements of porosity and density of geological formations were performed. On the basis of estimated average effective porosity in the Lower Jurassic formations of more than 20% were calculated (Jaskowiak-Schoeneichowa ed., 1977). Additionally, based on the analysis of water from a depth of 1707-1755 m, the chemical composition of the brine acquired was established (Jaskowiak-Schoeneichowa ed., 1977). The chemical composition is shown in Table 3. Water analysis allowed the determination of the nature of the tested water as a brine chloride - calcium with mineralization of 63900 mg/dm^3, density of the order of 1.0466 g/dm^3, pH volume of 8 and carbonate hardness of 14.6 mval/dm^3 (Jaskowiak-Schoeneichowa ed., 1977).

Table 3: The results of temperature profiling for the depth 1707-1755 m bsl (Jaskowiak-Schoeneichowa ed., 1977).

CATIONS	mg/dm^3	ANIONS	mg/dm^3
Ca^{2+}	1880	Cl^-	38340
Mg^{2+}	10	SO_4^{2-}	491
Fe^{3+}	The trace amounts	HCO^{3-}	317
Na^+ oraz K^+	-	Br^-	76
Na^+	22769	J^-	0
Sum of cations	**24659**	**Sum of anions**	**39224**

3. GEOTHERMAL HEATING PLANTS LOCATED IN SZCZECIN THROUGH

For the majority of geothermal heating plants located in the Polish Lowlands using the waters of high mineralization, the installation needs to deal with many problems. One of them is the inlay zone triggered by chemical compounds in highly mineralized waters as a result of changes in physical-chemical conditions caused by the exploitation of the water (Biernat et al.,

2010). Equally undesirable effects are corrosion and clogging, which significantly affect the cost of obtaining energy (Tomaszewska, 2008). These problems affect both exploitation and injection boreholes although, for the injection boreholes, this issue is more problematic and results in reduction of absorption and causes reduced capacity of thermal power plant (Biernat et.al., 2010). Clogging phenomenon is mainly related to the precipitation of inorganic chemicals from the brine which include sparingly soluble salts, in the case of its oxygenation and hydroxyoxides, oxides of iron and manganese (Noga et al., 2013). Problems related to the physical-chemical properties of water in the region of Stargard-Radęcin were discussed with the example of geothermal heating plants located in Szczecin Trough.

3.1 Geothermal Heating Plant in Pyrzyce

The problem of encrustation occurs in the geothermal heating plant in Pyrzyce. The heating system is based on four boreholes: two exploitation (Pyrzyce GT-1 and Pyrzyce GT-3) and two injection boreholes (Pyrzyce GT-GT Pyrzyce 2-4). The system utilizes the Lower Jurassic aquifer, composed mainly of fine-grained, weakly cohesive sandstone of Miechow layers, deposited at a depth of 1429 to 1600 m. Obtained waters are highly mineralized brine, with a temperature of 64°C and 61°C at the outlet (Biernat i et al., 2010; 2011a,b). Based on the analysis of water, covering the chemical composition and physical properties (received directly from geothermal heating plant Pyrzyce) of water used in the heating plant, it can be classified as 11.56% water hyper chloride - sodium, bromide, iodide, ferrous, manganese, boron.

Another aspect of the use of groundwater in the geothermal systems is their aggressive nature and tendency to precipitate minerals in the form of deposits (Kleszcz and Tomaszewska, 2013), which may ultimately lead to the phenomenon of corrosion - it refers to borehole's structural elements, as well as the system equipment. It is also connected with the aggressiveness of the water, the presence of dissolved gases in the acidic water (CO_2 and H_2S), chloride ions, which affect the pH value of the water, and the presence of microorganisms. These conditions can contribute not only to the corrosion of steel elements themselves, but also corrosion of the cement stone outside the casing pipes and other system components (Dubiel et al., 2012; Banaś et al., 2007). The most aggressive water consists of substantial quantities of sulfates, chlorides, ammonium ions, aggressive CO_2 – that is water with a low pH and various salines (Macioszczyk and Dobrzyński, 2007).

From the water in the Pyrzyce, obtained on the basis of physical-chemical analyses directly derived from the heating plant, it shows that the highly mineralized brine in Pyrzyce is characterized by strong aggressiveness of sulfate (1200 mg SO_4/dm^3), poor aggressiveness of ammonium (NH_4^+ 21.7 mg/dm^3) and poor (average) aggressiveness of acidic (pH = 6), detailed classification is presented in Table 4 (Wachowicz-Pyzik, Mazurkiewicz, Królikowski, 2014, in press). Another negative factor is the tendency of water to precipitate extracted sediments, whose main ingredients are: oxides (Fe_2O_3), halides (NaCl), sulfides, sulfates, and others. These deposits can lead to clogging phenomena that may cause difficulty associated with the injection of thermal water into the aquifer (Biernat et al., 2011b). For geothermal installations in Pyrzyce, based on analyses carried out by Biernat et al. (2011a; b), it is shown that the main causes of performance degradation of injection waters are:

- temperature fluctuations during operation of thermal waters, which can lead to precipitation of sediments,
- changes in pH, the increase of which causes a decrease in the solubility of the iron salts and oxides,
- pressure fluctuations during operation can lead to the release of part of the dissolved CO_2 and pH increase (pressure drop)
- changes in CO_2 concentrations which cause changes in the pH of water,
- changes in redox potential, which causes an increase in the precipitation of iron oxides.

Table 4: Categories and types of the aggressiveness of source water Pyrzyce (Wachowicz-Pyzik, Mazurkiewicz, Królikówski, 2014, in press).

	Nature and type of the aggressiveness of water					
	sulphate		**ammonium**		**acid**	
	content					
	Limits of sulphates [mg/l SO_4^{2-}]	The concentrations of sulphates of Pyrzyce [mg/l SO_4^{2-}]	Limits ammonium nitrogen [mg/l NH_4^+]	The concentrations of ammonia nitrogen of Pyrzyce [mg/l NH_4^+]	Limits pH	The concentrations pH of Pyrzyce
POORLY AGGRESSIVE	250 – 500		**15 – 30**		**7 – 6**	
MEDIUM AGGRESSIVE	500 – 800	**1200***	30 – 60	**21,7****	6 – 5	**6,0***
STRONGLY AGGRESSIVE	**800 – 1200**		60 – 100		5 – 4	

* analysis carried out by the company MARCORAM the object Geothermal Energy, ** laboratory analysis carried out in the laboratory VIEP in Szczecin

3.2 Geothermal Heating Plant in Stargard Szczeciński

In Stargard Szczeciński, geothermal energy is characterized by relatively high water temperature, compared to other systems located in the Polish Lowlands, which at the outlet reaches 87°C. A heating system is composed of a geothermal doublet, consisting

of exploitation (Stargard GT-1) borehole and (directional) injection (Stargard GT-2) borehole. Geothermal heat is transmitted to the heat network using a heat exchanger, and then the water is cooled to a temperature of 45-55°C. Finally, water is again injected into the aquifer from which it was obtained. Geothermal energy uses water from the aquifer of the Lower Jurassic sandstone of Radów and Miechów layers (Biernat, Noga, Kosma, 2012). For Stargard Szczeciński heating plants, evaluation of corrosion of thermal waters and the degree of the aggressiveness was performed for boreholes Stargard GT-1 and Stargard GT-2, based on data received from the geothermal heating plant. The characteristics of the obtained results are presented in Table 5. The analysis was conducted on the basis of the most important indicators of water quality, which determine the water's corrosive nature, i.e. pH, Ca_2^+, HCO_3^-, conductivity and appropriate temperature. Based on indexes widely used to evaluate the corrosive nature of water like Langelier (LSI) and Ryznar (RSI) index, which take into account the actual pH value, the pH of the water was analyzed in equilibrium with solid calcium carbonate (PHS) (Kotowski, 2010; Tomaszewska, 2011). The classification of the thermal water was analyzed based on the average temperature of the water generated from the GT-1 borehole and the average temperature of the injected water in the year 2012. The results are shown in the Table 5. For water from the Stargard GT-1 an average annual temperature of 78°C is assumed, while assumed average annual temperature for the GT-2 is 45°C (information from geothermal heating plant Stargard). Based on the analysis, ratios were estimated at level of: LSI = -5.9 for GT-1 i -3,5 dla GT-2 (at tolerance –0,5<LSI<0,5) and RSI = 15 for GT-2 i 18 for GT-1 which indicate high corrosiveness of the analyzed waters.

Table 5: Classification of thermal waters from wells GT-1 and GT-2 in terms of indexes Langeliera (LSI - Langelier Saturation Index) and Ryznara (RSI - Ryznar Stability Index). Own calculations based on Carrier (1965), Rafferty K., (1999).

Boreholes	Ca [mg/l]	HCO_3 [mg/l]	Conductivity in TDS [mS/cm]	pH	Ryznar Stability Index [RI]	Results Ryznar Stability Index	Langerier Saturation Index[LSI]	Results Langerier Saturation Index
Stargard GT-1	2,56	0,22	135,8	7,1	**18**	1. Water is very aggressive (based on Ryznar 1942)	**-5,9**	1. Water is under saturated with respect to calcium carbonate. Under saturated water has a tendency to remove existing calcium carbonate protective coatings in pipelines and equipment (based on Langerier 1936). 2. Serious corrosion (based on improved Langelier by Carrier (1965)
Stargard GT-2	2,52	0,22	135,8	7,9	**15**	2. Corrosion intolerable (based on improved Ryznar index by Carrier 1965)	**-3,5**	

4. STATE OF THE USE OF GEOTHERMAL ENERGY IN POLAND

In the renewable sector in Poland, the biomass sector has for years played the most important role, but solar, hydro and wind powers have also increasingly contributed to the growth of renewable energy sources (RES) in the country. Despite the increasing popularity of geothermal plants, as well as of recreation or therapeutic centers, which use thermal waters, geothermal occupies a marginal position in comparison with other renewable energy sources. This can be proved with results from the Central Statistical Office, which show that the share of geothermal energy has not reached even 1% so far, while solid biofuels sector is currently around 82% of total RES utilization in Poland (Berent-Kowalska i in., 2013). Poor utilization of geothermal energy is affected by many factors. One of them is the legal acts which provide guidance relating both to the recognition process and the heat acquisition, as well as the possibility of using groundwater, they include:

- Geological and Mining Law (Journal. Laws of 2011, No. 163, item. 981, with amendments), which defines the thermal water as underground water, which has a temperature not less than 20°C at the outlet.
- Water Law (Journal. Laws of 2005 No. 239, item. 2019, with amendments). However, it does not apply in the case of exploration groundwater including brines, medical and thermal waters and water coming from the drainage of mines.
- Environmental Law (Journal. Laws of 2008 No. 25, item. 150, with amendments). In the case of a system for the exploitation of groundwater which yield exceeds 10 m^3/h - such investment may have a negative impact on the environment.
- Act of 2 July 2004 about freedom of economic activity (i.e. Acts. U, of 2010 No. 220, item. 1447, with amendments), in accordance with the law Geological-Mining, define geothermal water as basic minerals, which requires obtaining a license for the purpose of identification and extraction.

Considering the legal aspects of the investments related to the acquisition of energy from groundwater, potential investors must face a number of legal procedures. Complicated procedures are also associated with additional charges and can significantly increase the costs of the investment, as well as realization time of installation. The current legal situation related to obtaining permissions from the relevant state authorities has significantly improved in recent years. This is evidenced by the introduction of a single-stage licensing process, exemption from fees for geological information used in project (in the case of extraction price is reduced to 1% of total costs), as well as the maintenance of a zero rate for the extraction of thermal waters and no license fee and a contract for the use of mining (Przybycin, 2011). There are still no decisive actions for geothermal investments such as reducing the geological risks which the potential investor must takes, introducing green certificates for geothermal energy, reducing VAT value, or introducing separate systems of support for geothermal projects (Kępińska and Tomaszewska, 2010).

Taking into account the requirements of the European Union (EU), mainly due to the increasing pollution of the environment, member states are obliged under the Directive of the European Parliament and Council Directive 2009/28/EC of 23 April 2009 (Official Journal of the EU. L. 140/16.5.6.2009) to reduce greenhouse gas emissions, reduce energy consumption and increase the

share of renewable energy sources in the total gross energy consumption. In response to the EU requirements, each of the member states has developed in recent years their own systems of support for investments related to alternative energy sources. Financial sources in Poland generally can be divided into two groups: internal (domestic) and external (foreign) sources (Fig. 3).

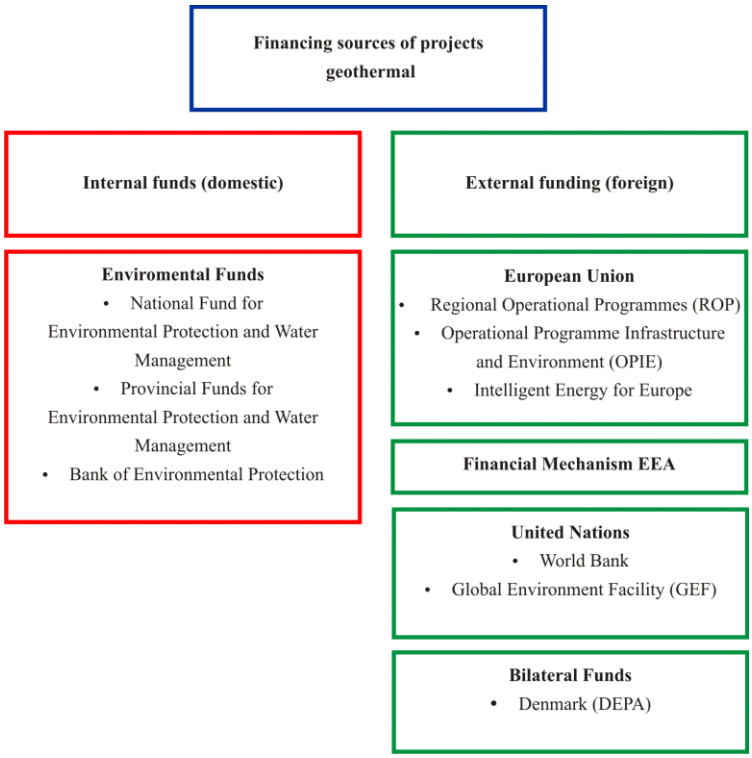

Figure 3: Distribution of available sources of financing projects of geothermal in Poland based on Górecki et al. (2013).

The majority of available forms of support include investments related to the deep geothermal energy; these include funds from the National Fund for Environmental Protection and Water Management in Warsaw (NFOŚiGW). Grants or loans originating from internal sources can also be expected from the Provincial Funds for Environmental Protection and Water Management (WFOŚiGW), and Bank of Environmental Protection (BOŚ), offering preferential loans for investments of geothermal energy - including the installation of heat pumps. Foreign funds are generally supported by the European Union, the Financial Mechanism of the European Economic Area (EEA), the United Nations (UN); detailed information is shown in Figure 3 (Górecki et al., 2013). The undoubted reason of the situation of poor utilization of geothermal energy in Poland (despite good thermal conditions) is the high cost associated with the implementation of geothermal installations and its accompanying infrastructure. The high geological risk, which the potential investor takes, as well as the costs associated with the implementation of boreholes, most often both the production and injection boreholes, is not constructive to the development the geothermal investment. High initial costs of systems will further affect the high costs of energy which will be sold to the consumers. The lack of competitive prices of alternative fuels in comparison with conventional sources does not attract great interest of consumers.

5. CONCLUSION

Based on the presented research and analyses, it can be concluded that the area of Szczecin Through has favorable conditions for geothermal energy production, which can be provided by many operating geothermal heating plants. Taking into account the favorable thermal conditions of Szczecin Through and the possibilities of reconstruction of existing boreholes to be use to obtain thermal energy and in spite of two operating heating plants in this area, the region still seems to be prospective in terms of new geothermal investments - or extension of existing facilities. Particularly, the Stargard-Radęcin area and boreholes located on its territory seem to be one of the most prospective regions. Chemical analyses carried out for this paper were based on data obtained directly from the geothermal plants Pyrzyce and Stargard Szczeciński. On the basis of these analyses, it can be concluded that high mineralization occurring in both of the heating plants can be a significant problem for new investments. It should be noted that the results of the analyses only give a general idea of the type of waters used for the acquisition of geothermal heat in the area of the research. In order to accurately assess the risks associated with high mineralization of the geothermal water, detailed chemical analyses of both waters extracted and injected into existing geothermal heating plant need to be performed. Those analyses could allow for reduction of errors related to the mean values of the individual chemical components adopted for the calculation. They also could have a significant impact on the proper selection of the optimum parameters of a new geothermal plant and reduce problems associated with adverse corrosion or clogging of boreholes which currently present the biggest problem in most of geothermal heating plants in the Polish Lowland.

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