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1.
AN OVERVIEW OF SELECTED GEOTHERMAL SPACE HEATING PLANTS AND PROJECTS IN POLAND

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ABSTRACT

The paper presents the results of research – development works, that have been performed in Poland since 1989, when all-Polish programme devoted to exploration and utilization of geothermal energy was initiated. This programme assumed the recognition of geothermal resources occurrence conditions and start-up three space heating plants: first in the Podhale region, second in NW - Poland, and third in the central part of the country. As a result of such activity, the geothermal plant in Podhale region was started in 1994 but another two plants had to be put off because of financial problems in Poland in the eighties/nineties. Presently (2004), five geothermal plants are producing thermal energy from geothermal waters of the various temperatures. These installations were described in this paper, and introduction to this part consists chapters that outline the problems related to the classification of geothermal waters and to the assessment of the volume of geothermal energy.

1. PROPOSAL OF NEW CLASSIFICATION OF GEOTHERMAL WATERS

In accordance with the definition, geothermal energy is an Earth's interior energy, accumulated in rocks and underground waters. The heat in the Earth interior is partially primordial heat, which has originated from the period of our planet creation, and partially contemporary heat generated mainly from radioactive elements disintegration i.e. from uranium, actinium and thorium series as well as from radioactive potassium isotope. This definition does not determine a relevant temperature values. This is occasioned by the idea of geothermal energy pertaining practically to any temperature of subterranean waters or rocks from which it is possible to recover and utilize it. The medium carrying geothermal energy are natural reservoir fluids, usually waters but also crude oil, natural gas and steam. They occur in pores and fractures within the rocks forming the Earth crust Other medium are special liquids, such as glycol, used e.g. in vertical and horizontal systems of ground heat source for the heating pumps. Consequently, waters and other fluids should be classified as liquids and gasses, according to the temperature which determines the manner of their utilization. Such classification, based on the manner of geothermal energy utilization may be formulated as follows:

- Cold fluids: up to 25ºC (used as either water or glycol in compression heat pumps);
- Low – temperature fluids: from 25 to 60ºC (used e.g. in absorption heat pumps);
- Medium – temperature fluids: from 60 to 100ºC (used e.g. directly by the user);
- High – temperature fluids and gasses: from 100 to 140ºC (used e.g. in binary power plants producing electricity and thermal energy);
- Very high – temperature fluids and gasses: above 140^0C(used e.g. in conventional geothermal power plants).

2. ASSESSMENT OF GEOTHERMAL ENERGY RESOURCES IN THE ASPECT OF THEIR UTILIZATION

The resources of geothermal energy on a globe scale are practically beyond any estimation. This is caused mainly by the size and nature of the phenomena and processes occurring inside the Earth. The level of difficulty in assessing the size of geothermal energy resources can be exemplified by the discrepancies in the results achieved using various calculation methods. For example: Kleemann and Meliss (Sobanski et al. 2000) estimate that, by cooling the outer layer of the whole Earth crust (to the depth of 7 km) down to 80°C, one can achieve approximately 4.3 x10^{15}tpu (tpu – equivalent of solid fuel 1 tpu = 29.33GJ), while Sokolowski (1997) states that for 250,000 km^2 of Poland's area geothermal energy resources amount 13.0 x 10^{12}tpu, including the energy contained in rocks. This value is approximately only 300 times lower than the value assessed by Kleeman and Meliss for the whole globe.

In "Geothermal waters in Poland and the possibilities of their utilisation", Ney and Sokolowski (1987) proposed to divide the country into several geothermal districts. The volume of water filling various geological formations and the amounts of energy contained in them were calculated for each district. The total energy resources in these formations were estimated on approximately 34.7 billion tpu. As a comparison: documented resources of coal and hydrocarbons in Poland amount 17.5 billion tpu. According to Ney (1997), this figure (34.7 billion tpu) should be reduced by factor of 0.1, taking into account feasible possibilities of exploitation in various aspects (technical, economical and degree of development of various areas). So, estimated quantity of exploitable energy resources based on geothermal waters would be around 4 billion tpu.

The cited authors pointed out the necessity of conducting separate research works and tests for each new facility where utilization of geothermal energy is postulated. Such research should clearly determine the local potential of the aquifer. This potential will depend on a number of factors. The most important one is environmental safety of the water – bearing horizon, guaranteeing a long – term exploitation of the reservoir and its renewability.

A comparison of the potential energy resources (occurring up to the depth of 7,000 m and estimated on the basis of cooling them to 80°C) with the actually – harnessed quantity of energy indicates that less than a millionth fraction of one percent of these resources are currently in economic use.

According to the classification used in the European Union (Gorecki 1995), geothermal energy resources were divided depending on a degree of geological exploration and economic feasibility. They are classified as follows:

Accessible resources are the amount of thermal energy that is stored in the Earth crust up to the depth of 3 km, referred to the average annual temperature at the surface.

Static resources of geothermal water and energy are the volume of free (gravitational) geothermal water accumulated in pores, fractures etc. in the rocks of specific hydro–geothermal horizon, expressed either in m^3 or in km^3, and upon conversion also in [J].

Static recoverable resources of geothermal water and energy are only a part of static resources, reduced by recovery factor, which by simplification is approx. 0.33. They are expressed in [J].

Disposable resources of geothermal water and energy are the volume of free (gravitational) geothermal water which can be accessed and utilize under given environmental conditions, but without any indication as to the specific location and the technical/ economic conditions for setting up the water intake. They are expressed either in [m^3 per day] or in [m^3 per year] and upon conversion also in [J per year].

Exploitable resources of geothermal water and energy are the volume of gravitational geothermal water which can be produced under specific geological and environmental conditions from the intake of optimum technical/economical parameters. They are expressed in [m^3 per hour], [m^3 per day] and [J per year] (Gorecki 1995).

First three kinds of resources are rather theoretical, and they are important mainly for preliminary analyses and regional large – scale evaluations. Last two kinds i.e. disposable and exploitable resources are of practical importance. Precise determination of the resources' amount has great signifycance at the stage of feasibility studies preparation for specific investment. The subsequent part of this paper describes reliable estimated, disposable and exploitable resources.

3. A REVIEW OF DISPOSABLE RESOURCES OF GEOTHERMAL WATER AND ENERGY IN POLAND

The existing resource assessments in Poland apply to waters whose temperatures exceed 20°C. Waters below this temperature have not been assessed in terms of energy potential in a regional scale. Considering their relatively low thermal capacity, they have been treated as marginal, also from commercial point of view. Such waters are very common and, what is the most important, they require considerably less capital expenditure to tap them. They are usually low mineralized or drinking waters, which makes them usable also in the water supply systems, while the facilities and installations that would recover heat from them would not have to meet the special anticorrosive requirements.

The latter aspect has a tremendous impact on the cost of producing and using such installations. New technologies that are becoming widespread in energy production and utilization allow for extending assessments to cover also those water resources which have not been assessed so far. This is the case with waters occurring in the Underground Water Reservoirs, which have been described in details and proved in numerous hydrogeological works (Table 1).

Underground water resources in Poland occur mainly in Quaternary water – bearing horizon, which takes up a large area of about 234 thousand km^2 (Table 1). Cretaceous, Jurassic and Triassic horizons with fissure and fissure - karst waters (mostly endangered by pollutions) are also of great importance. They include about 21% of resources. The water level of the first horizon of underground water often occurs shallowly on about 50% of the Poland's area – at the depth lower than 5 m. The average depth of the underground waters intakes from main reservoirs amounts from 25 to 50 m in Quaternary horizon (5 – 10 m in the Carpathian rivers' valleys), but often it is considerably lower. In Cretaceous horizon the water intakes are at the depth of 20 – 150 m, in Jurassic 100 – 150 (200) m, Triassic 100 (250) m.

Table 1. Main water – bearing horizons in Poland and underground water resources (modified after www.mos.gov.pl)

Water-bearing horizons	Area [thousand km^2]	Void characteristic	Share in total disposable resources (12,50 km^3) [%]	Share in disposable resources in GZWP (7,35 km^3) [%]
Quaternary (Q)	234	pores	65,0	51,3
Tertiary (Tr)	191	pores	11,0	5,5
Cretaceous (K)	70	fissures	13,0	23,1
Jurassic (J)	60	fissures + karst	5,0	11,7
Triassic (T)	15	fissures +karst	3,0	7,1
Older horizons(S)		fissures, fissures + karst	3,0	2,3

The underground water reservoirs are divided into local, exploitable, regional and principal (Popovski-lish: GZWP) reservoirs. Their extension is shown on Figure 1, while their characteristics are presented in Table 1 and Table 2.

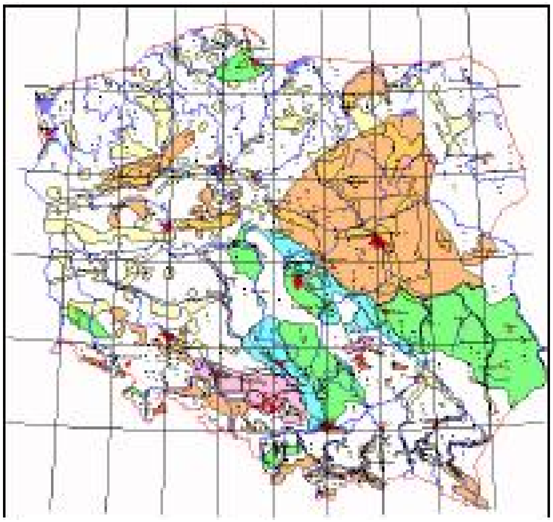

Figure 1. Principal reservoirs (GZWP) in Poland (www.pgi.gov.pl)

Principal Underground Water Reservoirs (GZWP) are defined as those where, among other factors, the potential flow rate from production well is above 70 m3/h of water. Due to the mostly small depths at which such waters occur, their temperatures range from 9 to 25 m3/h. GZWP are a fragment of the very common Exploitable Underground Water Levels (Polish: UPWP), for which the potential output of the well ranges from 5 to 10 m3/h. As GZWP have been examined to much larger extent, they have been assessed to estimate their energy production potential and the disposable energy resources. These assessments involved the use of the quantities of disposable resources of GZWP waters, i.e. ones that are disposable for 95% of time each year (Kleczkowski 1990). Table 3 presents results of these assessments. A total amount of energy resources accumulated in GZWP was estimated on

Geothermal aquifers that occur deeper, are located in the Polish Lowlands in Cretaceous, Jurassic and Triassic formations. Disposable resources of geothermal energy were assessed in all hydrothermal reservoirs in the region of the Polish Lowland (Sokolowski 1992, Gorecki et al. 2002).

104 210 TJ/year.

Underground water reservoir (water level)	Well output [m^3/h]	Intake output [thousand m^3/twenty-four hours]	Number of consumers who could be supplied [thousand]
Local reservoir	below 5-10	below 0.3	below 2.0
Exploitable level	over 5-10	0.3-1.0	2.0-6.6
Regional reservoir	10-70	1-10	6.6-66
Principal reservoir (GZWP)	over 70	over 10	over 66

Table 2. Classification of underground water reservoirs (www.mos.gov.pl)

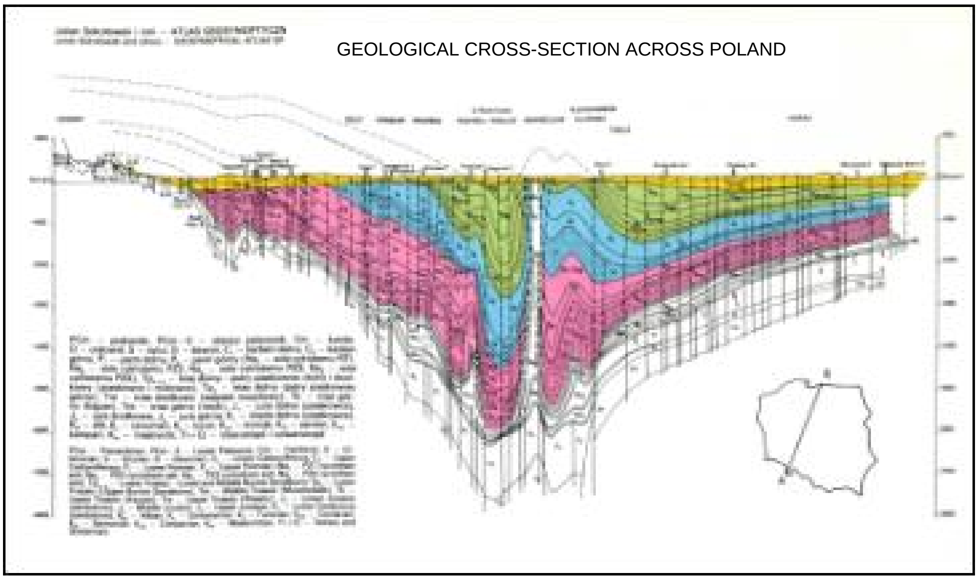

Figure 2. Geological cross-section across the Poland (Sokolowski 1992)

The temperatures of these water range from 40°C to about 100°C, and even up to 160^{0}C in the Triassic reservoir. Figure 3 shows an exemplary map of temperatures within the Low Jurassic water horizon (according to Gorecki, www.mos.gov.pl).

Disposable resources of geothermal energy accumulated in water reservoirs of the Polish Lowland are presented in Table 3. A total amount of energy resources was estimated on 6.682.000 TJ/year. Energy assessment of disposable resources of waters in the Podhale Basin based on the tests performed in several hydrothermal wells located in Podhale region (Dlugosz 2001, 2002), and is presented in Table 3.

The figures presented in Table 3 illustrate the disposable resources of geothermal energy and these figures are inconceivably large. In order to assess the actual amount that is reasonably harnesssable, i.e. exploitable resources, one would have to adjust these figures using a relevant ratio. Assuming that about 1.5% of the disposable resources will be used, the amount of exploitable resources would be about 100.000 TJ/year. This amount is an equivalent to the energy resources of about 130 geothermal plants, and each of them covers the receivers' thermal needs at about 800 TJ/year. As a comparison, such an amount of energy output was planned by the Geothermal Plant in the Podhale region in order to cover the needs of Zakopane, Nowy Targ towns and other receivers in small towns and villages in this region (Dlugosz 2002).

4. A REVIEW OF GEOTHERMAL PLANTS IN POLAND

The review of Polish achievements in the use of geothermal energy includes examples of currently ope-rating geothermal plants that use reservoir waters of various temperature values (from 90ºC to below 20ºC).

The descriptions highlight the innovative and scientific aspect of each plant. It is noteworthy that it was exactly this aspect of all projects that formed the base for applying for support and funding from a number of institutions. The leading role in this respect is played by the State Committee for Scientific Research co – financing all of the projects. Due to the financial poten-tial, the largest share in funding was always contributed by the National and Voievodeship Funds for Environmental Protection and Water Management. However, without the own funds contributed by the local stakeholders, none of the projects would have been launched.

The initial impulse usually came from borough executive offices. Geothermal research and exploitation efforts in Poland, underway since mid – nineteen – eighties, have resulted in launching of five geothermal plants operating as direct – use systems. The fluids used at these plants are geothermal waters which temperature, according to the classification described above, qualify them as: cold fluids (up to 250C), low – temperature fluids (25 – 60ºC) and medium – temperature fluids (60 – 100ºC) (Fig. 4).

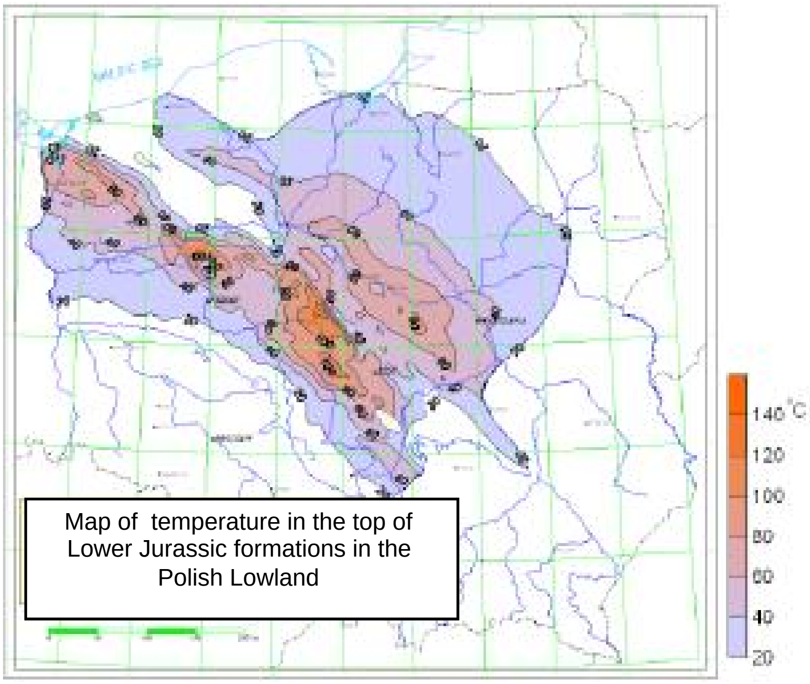

Figure 3. Map of temperature in the top of Lower Jurassic formations in the Polish Lowland (www.mos.gov.pl)

4.1 Geothermal plant in the Podhale region: an example of utilization of middle – temperature water (60 – 100ºC) in an integrated system including gas and oil boilers as well as gas co-generation unit (Figs 5, 6)

In 1993, in the Podhale region, Mineral and Energy Economy Research Institute of the Polish Academy of Sciences (PAS MEERI) built and put into operation the first geothermal plant in Poland. It was based on artesian outflow of 78-80ºC water of the static wellhead pressure of about 2.7 MPa. At that time, water was produced by a single well named Banska IG-1 and injected through another well – Bia_y Dunajec PAN-1. Upon activation, it heated several buildings in the Banska Nizna village as well as a wood – dryer and a greenhouse. The plant was called the Experimental Geothermal Plant, and this name derived from the scientific programme funded by the State Committee for Scientific Research (KBN). The objective of that programme was to build and run the first installation in the country which would use geothermal energy. When the construction work was completed and the installation activated, in 1994 the name of the plant was changed to the PAS MEERI Geothermal Laboratory. The Laboratory built several more facilities (using funds granted by KBN for scientific research purposes) for experimental uses of geothermal energy: a stenothermal fish farming facility, foil tunnels for growing vegetables on a heated soil, and an educational/research building.

All the facilities, the new ones and those built previously, are currently in operation, recovering heat from geothermal water within the so-called cascaded system of geothermal energy utilization.

Over the years, the system has been consistently extended by a commercial company “PEC Geotermia Podhalanska SA” established particularly for this purpose in 1994.

Table 3. Disposable resources of energy in Poland’s Principal Underground Water Reservoirs (GZWP), in the main hydro – geothermal horizons of the Polish Lowland and the Podhale Basin

Reservoir	Area		Reservoir temperature [ºC]	Disposable resources of energy [TJ per year]
	of reservoir [km²]	Percentage of country’s total area [%]		
Principal Underground Water Reservoirs (GZWP)				
GZWP – Q /117 reservoirs/	45 468	14,7	10ºC	38 700
GZWP – Tr /14 reservoirs/	64 718	20,3	14ºC	7 192
GZWP – Tr – C /1 reservoir/				
GZWP – Tr – J /1 reservoir/	74	0,03	14ºC	92
GZWP – Tr – T /1 reservoir/	145	0,07	28ºC	188
GZWP – Carpathian flysch Tr, Tr – C, C /1 reservoir/	3 468	1,1	11ºC	431
GZWP – C /13 reservoirs/	32 263	10,5	14ºC	31 355
GZWP – J /11 reservoirs/	10 057	3,2	14ºC	15 839
GZWP – T /9 reservoirs/	6 650	2,1	14ºC	9 616
GZWP – D & older /6 reservoirs/	593	0,2	11ºC	797
GZWP TOTAL /180 reservoirs/		52,2		104 210
Principal hydrothermal reservoirs of the Polish Lowland				
Lower Cretaceous C1	115 521	36,9	40 – 100ºC	382 000
Upper Jurassic J3	198 975	63,6	40 – 100ºC	224 000
Middle Jurassic J2	202 225	64,7	40 – 100ºC	999 000
Lower Jurassic J1	158 600	50,7	40 – 100ºC	1 731 000
Upper Triassic T3	175 900	56,3	40 – 100ºC	761 000
Lower Triassic T1	229 525	73,4	40 – 160ºC	2 585 000
TOTAL				6 682 000
Hydrothermal reservoir in the Podhale Basin				
Triassic & Tertiary	475	0,15	20 – 100ºC	1 490
TOTAL IN RESERVOIRS: GZWP, POLISH LOWLAND, PODHALE BASIN				6 787 700

Figure 4. Location of operating and planned geothermal plants in Poland (background of regional geothermal division of the country according to Ney and Sokolowski 1987)

At present (2004) the system uses two production wells, with a total output is 670m3/h, and two wells for injection the water back into the aquifer.The installed thermal capacity of the geo-thermal system is ca. 38 MW (Geothermal Base Load Plant) while the total installed capacity is 67 MW (geothermal plus thermal capacity of the gas/oil boilers and co-generation units in Peak Load Plant). In order supply the heat from these sources to the users, a transmission pipeline has been built covering a distance ca. 14 kilometers to Zakopane town and several dozen kilometers of distribution network supplying heat mostly to Zakopane, Bialy Dunajec and Banska Nizna. Plans for the sub-sequent stages include geothermal heat delivery to Nowy Targ town and distribution to other localities along the transmission pipeline. The target output of the whole system is planned to reach around 80 MW, of which approximately 60 MW will be generated from geothermal (Dlugosz 2001, 2003).

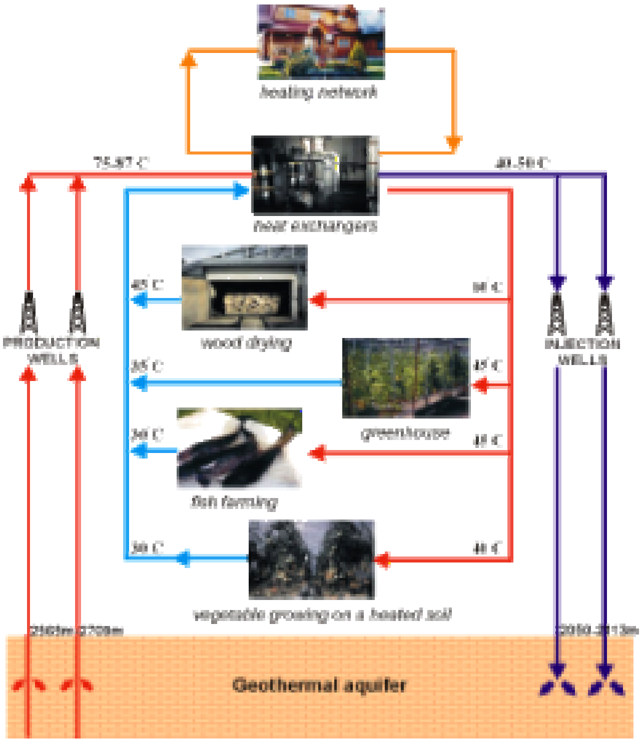

Figure 5. Geothermal cascaded uses system in the PAS MEERI Geothermal Laboratory, the Podhale region (Kepinska 2003a)

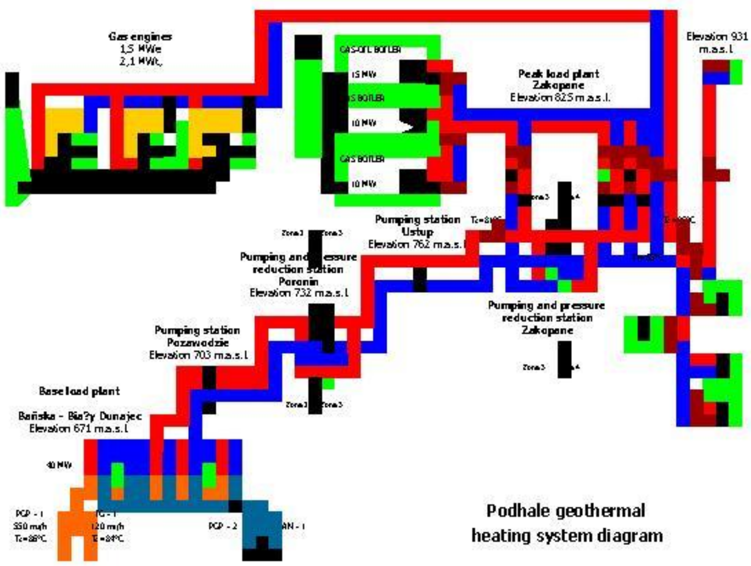

Figure 6. The Podhale geothermal heating system diagram (Dlugosz 2003)

4.2 Geothermal Plant in Pyrzyce: an example of geothermal water utilization at a temperature of about 60ºC in an absorption heat pump (AHP) integrated with natural – gas boilers (Figs 10, 11)

The second geothermal plant, built between 1992 – 1996, is located in Pyrzyce, West – Pomeranian Voivodeship. This plant uses about 64ºC water and supplies heat to a town with a population of 14 thousand. The installed capacity amounts to approximately 50 MW, of which about 17 MW comes from geothermal water discharged by two production and returned to the ground through two reinjection wells.

In operation since February 1996, this plant is a fully – fledged industrial facility designed to replace 68 coal - fuelled boiler houses in which about 20,000 t of coal used to be burnt annually (Sobanski et al. 2000, Kulik and Grabiec 2002, www.inet.pl/geotermia/) (Fig. 7).

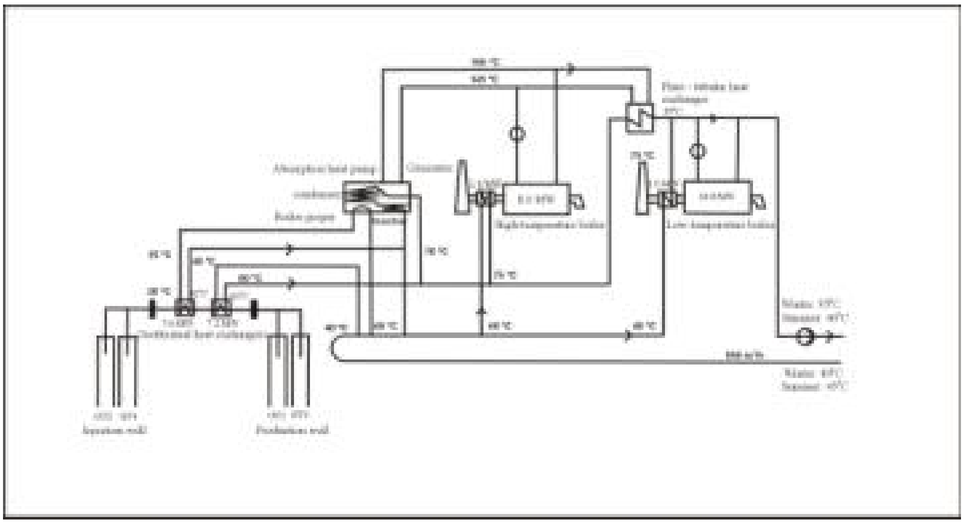

Figure 7. The scheme of Pyrzyce geothermal heating plant (www.inet.pl/geotermia/)

Brief characteristics of geothermal water intake in Pyrzyce can be given as follows:

- Reservoir rock formation - Liassic
- Reservoir depth - top - 1,489 m
- Total reservoir thickness - 147 m
- Reservoir temperature - 64^{o0}C
- Water mineralization - 121 g/dm^3
- Number of production wells - 2
- Number of injection wells - 2
- Max. geothermal water flowrate - 340 m^3/h
- Thermal output from geothermal water - 14.8 MW
- Distance between the wells - 1.5 km

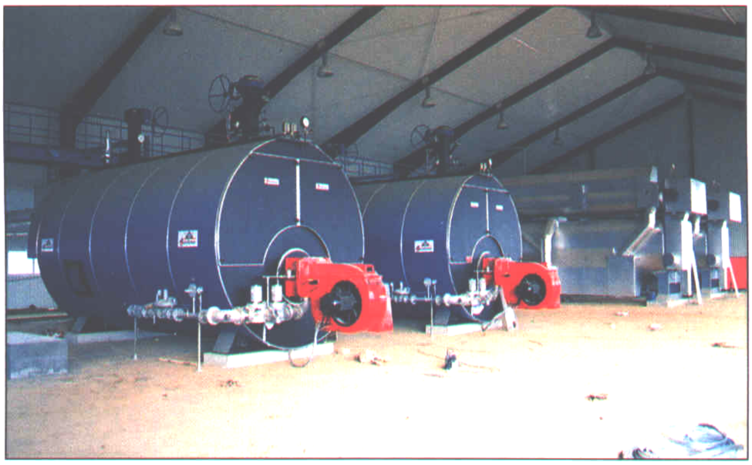

Figure 8. Pyrzyce geothermal plant: natural–gas low–temperature boilers (2 x 10.0 MW) and absorption heat pumps (2 x 8 MW)

Basic parameters of the heating plant and network are as follows :

- Two natural–gas low–temperature boilers - 20.0 MW
- Two exhaust gas chillers (condensing stream) -2.2 MW
- Two natural–gas boilers (about 160^{0}C) - 16.0 MW
- Two exhaust gas chillers (condensing stream) - 1.8 MW
- Two absorption heat pumps (AHP) - 16.0 MW
- Direct exchanger – first grade - 7.2 MW
- Exchanger integrated with an AHP– second grade - 7.6 MW
- Heating medium: water - 95/40ºC
- Heating water stream - 340 t/h
- Heating network length - 15 km
- Pipeline diameters - 450 mm

4.3 Geothermal plant in Mszczonow - an example of geothermal water utilization at a temperature of about 40ºC in an absorption heat pump (AHP) integrated with natural–gas boilers and also as drinking water (Figs 9, 10, 11)

The third plant was opened in 2000 in Mszczonow. The town is located near the Katowice–Warsaw road, about 50 km SW of Warsaw. The population is over 6 thousand.

The plant uses water of the temperature of 42^{0}C, produced by the Mszczonow IG-1 well, which was made and closed in 1976. After 20 years since its closure, it was reconstructed by MEERI PAS, and as a result a water– bearing level has been accessed of the following characteristics (Bujakowski 2000; Fig. 9):

- Formation - Lower Cretaceous sandstones
- Top/bottom depth - 1602/1714 m
- Total thickness - 112 m
- Temperature - 40°C
- Water flowrate - 60 m^3/h
- Static water level - 49 m
- Depression - 24.6 m
- Water mineralization - 0.5 g/l (drinking water)

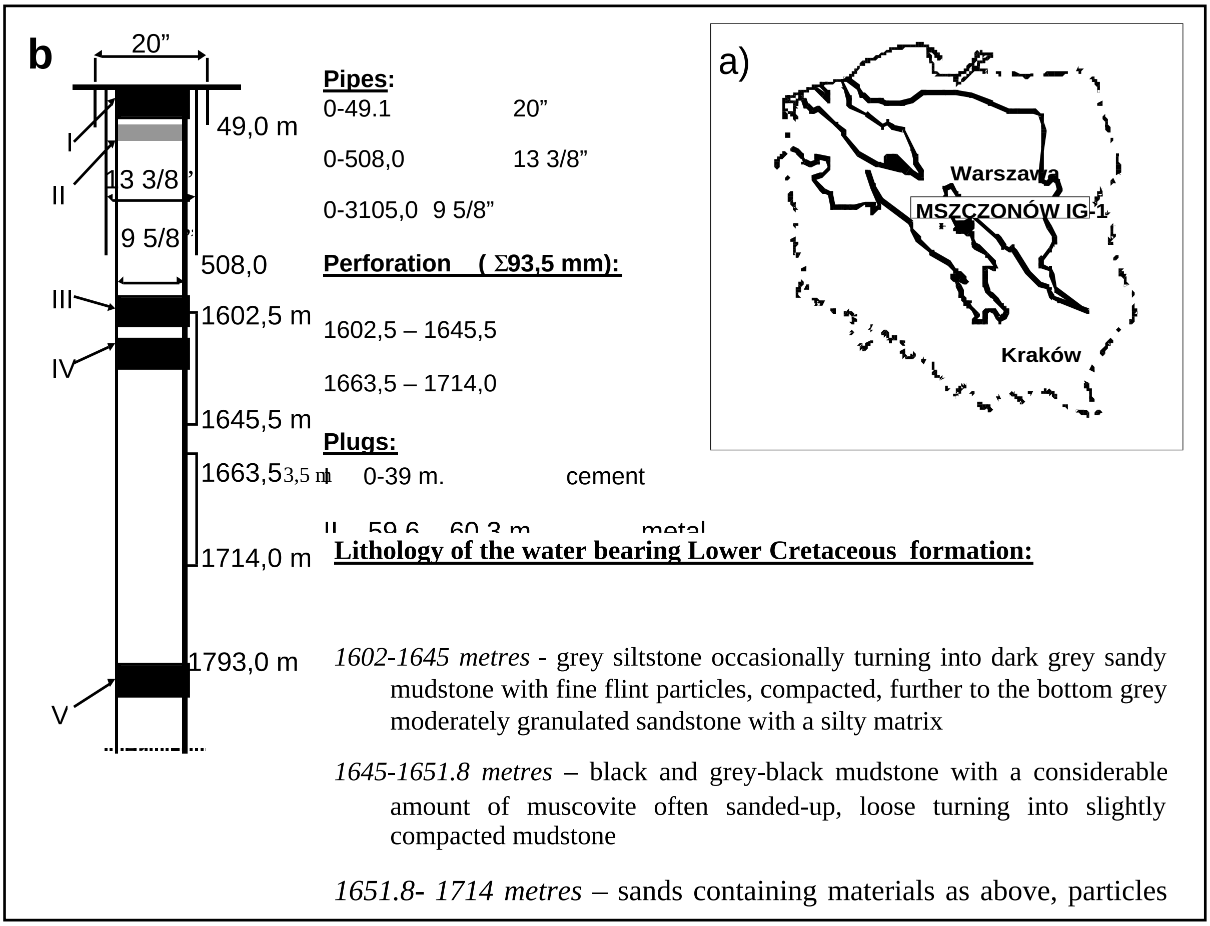

Figure 9. a. Location of the Mszczonow IG-1 well set against the range of the Lower Cretaceous formation; b. Technical diagram of the Mszczonow IG-1 well and lithological profile of Lower Cretaceous formations

Geothermal Plant in Mszczonow is one of the most original geothermal heating plants. It was built as a part of a Target Project co-funded by the State Committee for Scientific Research (KBN). The entity that applied for and actually carried out the project was the Executive Municipal Office of

Mszczonow while the scientific supervisor was MEERI PAS. Innovations in this project included primarily:

- Reconstruction of Mszczonow IG-1 well, which had been closed 20 years before (in 1976) and achieving such technical condition of it, which would ensure a safe long – term production,
- Accessing a water – bearing horizon, activation of the flow and stabilization of the chemical parameters of geothermal water,
- Creation of the modern source of thermal energy based on the absorption heat pump (using thermal water at about 400C),
- Optimal – two-way utilization of reservoir water: as a heat medium for heating systems as well as drinking water.

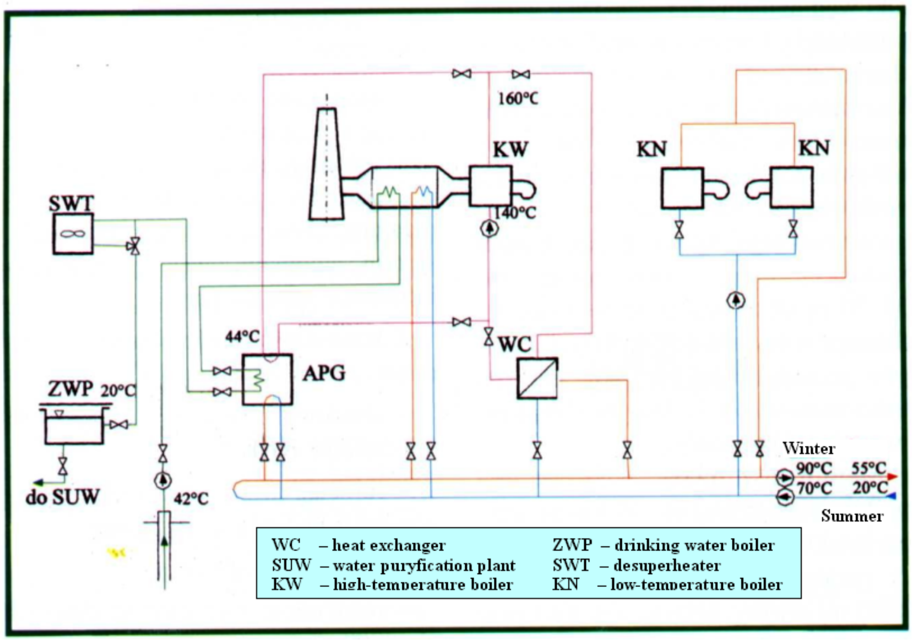

Figure 10. The scheme of Mszczonow geothermal heating plant (Balcer 1997)

Figure 11. Mszczonow geothermal plant - absorption heat pump (2.7 MW)

The Mszczonow plant replaced three estate heating plants located in the town center. Until then, those heating plants had burnt coal dust, which was a considerable burden on the environment. The launch of geothermal plant made it possible to eliminate the combustion of approx. 4,500 tonnes of coal annually. It reduced harmful atmospheric emissions by the following percentages:

- Sulphur dioxide by 100%
- Nitrogen monoxides by 82.9%
- Carbon monoxide by 98.5%
- Carbon dioxide by 74.8%
- Soot and dust 100%.

The use of geothermal water within an absorption heat pump system resulted in reduction of the natural gas use, down to 30% of a typical gas – propelled plant. The company Geotermia Mazowiecka S.A. performed a comparative analysis of three different heating installations which it either owns or operates. The analysis covered the heat unit production costs in a modern natural – gas heating plant, an old type coal boiler house and geothermal/gas boiler house described above. As a result of this analysis it was ascertained that, assuming identical work and economic conditions, the cost of producing 1 GJ in the gas boiler plant and coal boiler plant was similar (gas being slighty more expensive), while in geothermal boiler plant it was lower by nearly 25%.

4.4 Geothermal Plant in Uniejow - an example of geothermal water utilization at a temperature of 67°C, integrated with oil boilers

The fourth plant was opened in Uniejow. The total thermal capacity of this heating plant is 5.6 MW, of which 3.2 MW is obtained from peak oil boilers. The heat distribution system includes a pipeline network made of pre- insulated steel pipes, of the total length of 10 km, with individual meters and valves.

Geothermal water is used by the limited – liability company Geotermia Uniejow Sp. z o.o. which was established particularly for the purpose of town heating. Combined with the peak oil boiler house, geothermal heating plant is intended to eventually supply heat to 50% of buildings in Uniejow. The new system replaced 10 local coal boiler houses and 160 boiler units in single family houses. The boiler house installation is divided into two segments. The first one is a geothermal block consisting of production and injection wells, heat exchangers, filters and pumping system between the wells. The second one is an oil block comprising two low – temperature boilers using light furnace oil. It heats domestic water up to the required temperatures in the periods of peak demand for heating (www.uniejow.pl/geotermia.html).

4.5 Heating plant in Slomniki - an example of cold water utilization at a temperature of 17°C in an absorption heat pumps integrated with natural – gas and oil boilers and also as drinking water (Fig. 12)

In 2002, a geothermal installation was opened in the town of Slomniki, near Krakow (Bujakowski and Barbacki 2004).

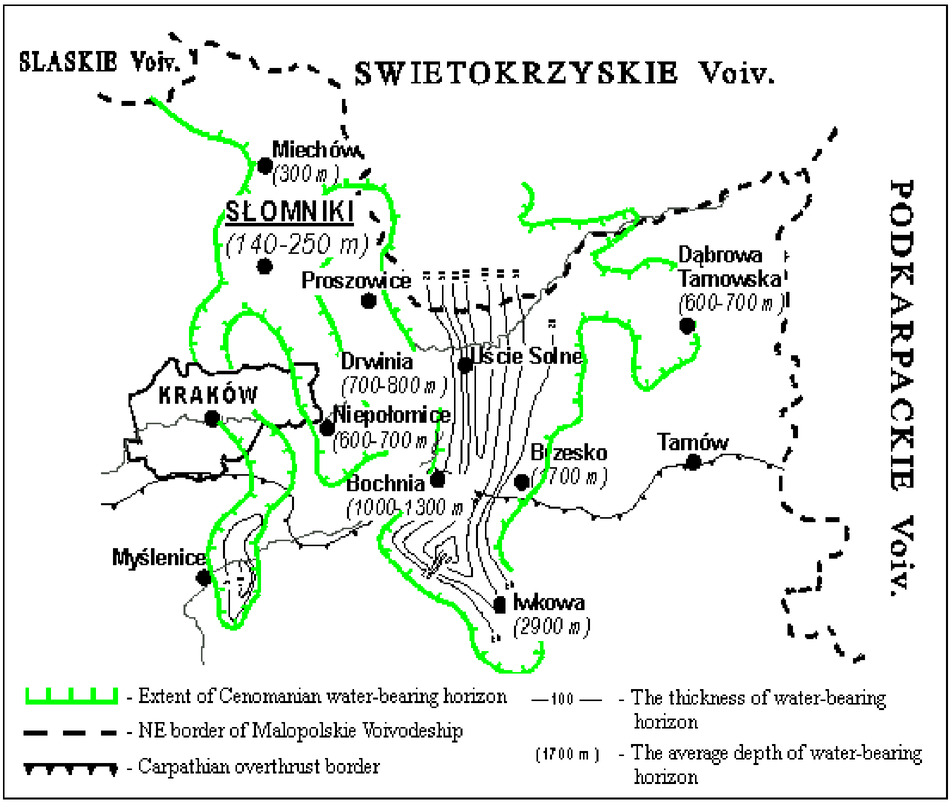

Figure 12. Assumed extension of the Cenomanian formations within the Malopolska Voievodeship area and location of Slomniki geothermal plant

The installation uses a water – bearing horizon located at shallow depth of 150 – 300 m below surface, which is characterized in this area by the outflow of drinking water at the temperature of 17ºC and pressure of 0.4 MPa with the flowrate of 50 m^3/h. The plant uses water as the low heat source for heat pumps operating in school, individual buildings and after cooling - as drinking water in the municipal water supply system (Fig.12) (Bujakowski, Barbacki 2000).

The project is a part of a Target Project co-funded by the State Committee for Scientific Research, conducted by MEERI PAS (Bujakowski and Barbacki 2000). Slomniki is a small town with typical solutions applied to the heating of small estates of blocks and private houses. The town is located in the area with shallow occurrence of underground water reservoirs and thus it has hydrogeothermal conditions that are actually typical for the considerable part of Poland. This project may lead to a widespread use of the solution in other region of Poland, and probably also in other countries.

A number of other sites in Poland are scheduled for utilization of geothermal energy for heating and farming purposes (Kepinska 2003b). At final stage execution is geothermal project in Stargard Szczecinski, while several other are awaiting for realization (e.g. Skierniewice, Kolo, Zyrardow). Building of geothermal plants is still debated in several other towns (see Fig. 4). The ongoing analytical efforts are aimed at reducing capital expenditures needed to utilize waters oscillating around the temperature of 20°C, which can be used economically if heat pumps are applied. In Poland, such waters occur at depths of 200 m, usually as drinking waters or very low mineralized. Another line of research is the assessment of thermal potential and technical possibilities of exploiting existing drinking water intakes.

Separate analyses are undertaken for existing old boreholes to assess the possibility of using them. This research is conducted along two major lines: (i). to assess the possibility of reconstructing of borehole and adapting it to the needs of either production or injection of geothermal waters, and (ii). to assess the possibility of using the boreholes as downhole heat exchangers.

5. SUMMARY

The rate of development of new technologies keeps extending the range of opportunities for using renewable sources of energy. This statement is valid for new sources of heat and new categories of energy consumers. New technologies allow to use reservoir waters of any temperature. The prerequisite for implementing a technology at any particular location is completion of a feasibility study with a positive effect. In order to achieve this, the existing energy resources should be examined in detail as far as the level of exploitable resources are concerned and correlated with the energy needs of the existing energy consumers.

Experience indicates that not every geothermal project is commercially feasible at any location. As before any venture, it is worthwhile to study and assess several scenarios, including the time factor and the anticipated changes of the analysed parameters projected over time, to select the most advantageous solution.

In this light, the use of geothermal energy is often one of the most favourable solutions securing man's needs and minimizing the negative impact on natural environment.

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