The effects of developing the geothermal energy in Uniejów town, Poland

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Abstract

There is a growing interest in the use of the geothermal energy in Poland. It is caused by the need of energy sources diversification as well as the necessity to meet the requirements of the European Community. The strategy of EC is based on the increase of the share of energy coming from renewable resources in the general energy balance. The development of the geothermal energy brings a lot of benefits for the heating industry. The report presents the conditions to be met by the geothermal district heating in Uniejów. The aim of the above mentioned analysis was examination of the influence of unconventional heating sources in a town of about 3 000 inhabitants, situated in the central Poland. The town was heated through small, dispersed and traditional boilers using conventional energy sources. The effects are grouped in 3 sections: social issues, ecological issues and economic ones. The results coming from the analysis have an essential impact on planning the future geothermal plants in the Polish Lowland. The advantageous, geological conditions typical of this region are not enough to guarantee the success of geothermal investments. The experience gained from Uniejów ought to be used at the first stage for planning geothermal district heating in such places as Koło, Poddębice, Czarnków, Stargard Szczeciński and others.

***Keywords**: geothermal utilization, district heating, ecology.*

1 Introduction

Poland is about to be incorporated in the EU structures; therefore Polish law needs to be adjusted to the EU standards. The most essential of Energy Legal Acts is Energetics Law. There were also other formulated and accepted documents: Policy of Ecology, The Second Policy of Ecology, The Strategy of Development of Renewable Energy and Foundation of Energy Policy upto the year 2002. Solid legal foundations and comprehensible tax policy are a basis for the development of a stable, renewable energy market in Poland. That is also connected with meeting EU obligations.

People have been interested in using heat accumulated in geothermal water in Poland for years. At the end of the 1980s the first such projects were attempted (Górecki, 1990). They resulted in making a few boreholes in the Podhale region and in Uniejów in order to substantiate and develop geothermal energy.

Three deep geothermal wells were drilled in Uniejów. Due to economic problems connected with political transformation at the beginning of 1990s, further works on two geothermal projects had to be abandoned. The essential research concentrated in the Podhale region because of the convenient geothermal conditions. As a consequence of these works, the Geothermal Research Institute, operating as a division of the Polish Academy of Sciences was founded, the first in Poland. Since that moment geothermal energy for heating purposes has been exploited by three district heating stations in Podhale, Pyrzyce and Mszczonów. An interest in heating plants projects in Uniejów was observed at the turn of the century.

Thanks to the efforts of Voivodship Fund for Environmental Protection and Water Management in Łódź, the fourth Polish station that runs exploitation of geothermal system was established in 1999.

The advantages of using geothermal water for heating purposes are the following:

- reduction of heat production costs,
- elimination or significant reduction of air pollution,
- decrease of charges connected with pollution emission,
- end user independence on price increase of conventional energy sources.

2 Geothermal conditions in Uniejów

Resources of geothermal water in the region of Uniejów occur in the lower Cretaceous sandstone at a depth of 2000 m. Temperature of water at the production well head reaches 70°C. Artesian flow rate reaches about 68 m^3/h. Water have been classified as sodium chloride, fluoride water, boron water with mineralization of approximately 6.8-8.8 g/dm^3 depending on well.

It was necessary to rebabilitate injection wells upon investing in geothermal heating systems. This was made at the end of 2000 thanks to the support of the National Fund for Environmental Protection and Water Management in Warsaw. The aim of the reconstruction was to obtain technological and economically advantageous conditions for water injection into the reservoir. As a result, positive parameters of geothermal water injection were obtained, a pressure of 7.1 bar at the flow rate corresponding to the self outlet productivity.

The exploitation of geothermal water for heating purposes circulates in a closed cycle. Geothermal water is produced from the well Uniejów PIG/AGH-2 and after going through heat exchanges and transferring heat to heat carrier, it is directed to the same water-bearing layer through the injection well Uniejów PIG/AGH-1. The hydraulic contact in the deposit was confirmed by hydrogeologic tests carried out in winter 2000/2001.

At present, chilling water is injected into the injection well Uniejów PIG/AGH-1 at the appropriate economical and pressure parameters of injection. However, taking into account the chemical composition of brine as well as the planned growth in the use of Uniejów geothermal water for the needs of balneotherapy sanatorium, the third borehole should be considered as an additional injection well, e.g. well Uniejów IG-1. Its location is advantageous and due to a relatively small distance from the present well injection site.

There were also conducted researches on geothermal water for therapeutic purposes. They proved to have a beneficial influence on health. Besides, they can be used for recreation and balneotherapy purposes. The geothermal water in Uniejów is recommended for curing the following illnesses:

- rheumatic illnesses,
- orthopedist and traumatic illnesses,
- nerve system (neuralgia, neurosis),
- illnesses of vessels of lower limps.

The research study contributed to starting water therapy and making Uniejów a spa center. This is especially important as no health resorts can be found in that region of Poland. These plans may succeed not only because of the Uniejów's location (in the Warta river valley) but also because of geothermal heating systems and clean air.

3 Development of geothermal energy

Works on the geothermal system heating started at the beginning of 2000 and lasted to the end of 2001. In the framework of the geothermal investment, ten kilometers long heating pipelines have been lied out and addition installments have been made. Geothermal district heating extends from public buildings, e.g. school, teacher's house, kindergarten, church, presbytery, health center, chemists, block of flats and two detached house estates. About 170 new customers were linked to the system.

A heating central using geothermal water energy of 3.2 MW was constructed, and heating plant and oil boilers of 2.4 MW were installed as a peak-load heating source.

The geothermal energy coming from water is presently used for central heating and heating of tap water. Tap water that is used for private and public residential buildings is produced in the heating plants. The maximum production of tap water is determined by total heating power of heat exchangers. It reaches up to 0.4 MW (Sapińska, 2000).

The percentage share of thermal energy production for the individual heating sources in the period of October 2001 to September 2002 is shown in the Figure 1.

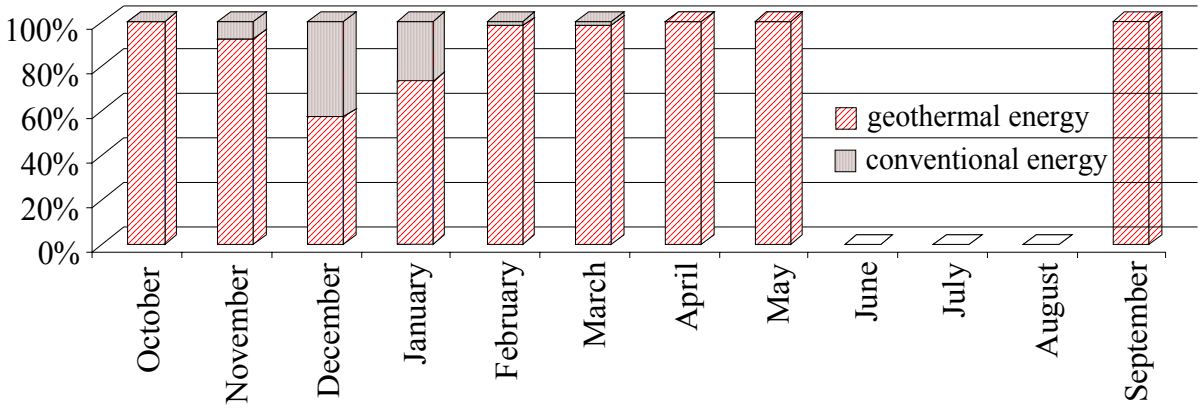

Figure 1: The percentage share of heating energy production in the period of October 2001-September 2002.

Plans are made to use the chilling geothermal water for recreation and balneotherapy purposes. It will be directly used for bathing in small swimming pools with brine. In the open and covered swimming pools, low temperature heating waste included in the water leaving heat exchangers in the geothermal heating plant is utilized for bathing purposes.

Cascaded receipt of heat as the most advantageous way of development of geothermal water enables a better use of heat and improvement of economic efficiency of the investment. At present, there is a need to look for an investor who would be able to build an injection well on the ground belonging to the Geothermal Company. An aquapark is planned there. There are arguments for a recreation center in Uniejów with its geothermal waters, i.e. a short distance to the urban area of Łódź (over 800 000 of inhabitants) and clean environment.

3.1 Economic effects

The geothermal heating plant in Uniejów supplied heat to 104 buildings during the period of 01/10/2001 until 30/09/2002. There were 15 institutions and 75 individual recipients among the 90 heat recipients. The heating plant has sold almost 20.000 GJ heating energy and about 2 650 m^3 of hot tap water.

During the heating season 2002/2003, about 64 buildings will be heated by geothermal energy. In comparison with the last season, the number of individual recipients dropped down. That was connected with the change of heat charging systems in accordance with the rates set by Energetic Control Office. It follows from the Energetics Law of 01/10/02 that there were introduced charges for the actual consumed heat and also regular payments for ordering heat power, transferring the energy, and addition to the heating system. In spite of the dropping number of heat recipients, the heat sale seems to increase. Geothermal Company gained two new customers, therefore sale indexes increased.

Figure 2 presents the structure of incomes of energetic plant. The increase of incomes obtained from regular costs of heat supplies increases the reliability of incomes forecasts. At the same time it has a negative impact on the decisions of individual customers. The increase of constant heat price causes that the cost of energy for individual recipients depends to a smaller degree on real consumption of heating. It may tempting to look for other energy sources, the cost of which will depend solely on the quantity of consumed energy. The right rates always should be an element of economic calculation but on the other hand the psychological aspect is also important. The monopolistic heat energy supplies are a specific of Uniejów. However, that monopoly is limited; most of the recipients have had the possibility to use individual coal heating.

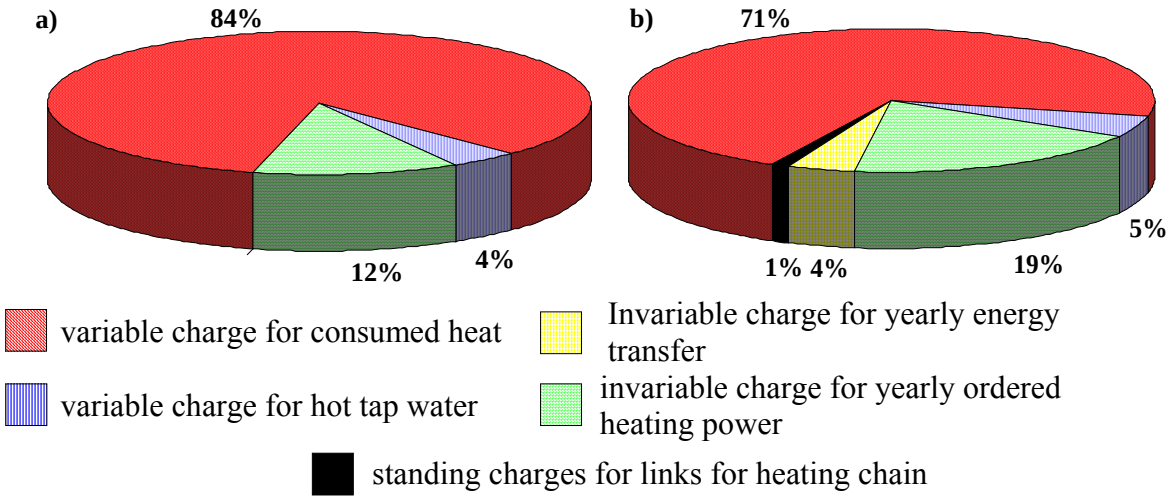

Figure 2: The structure of incomes of energetic plant. a) during heating season 2001/02, b) during heating season 2002/03 (forecast).

Polish heating company used to charge separately for heat and warm tap water, because they use separate pipe systems for both purposes.

Unfortunately, the income coming from the sale of heat and warm tap water did not cover the operating costs of the Company, inevitably leading to losses in the first season of its activity. Even with a loan granted to the Company, it will not be easy to generate net profit very quickly.

Total costs consist of the costs of repairs and conservation of the installation. Their share increases with the growing salinity of geothermal water. The salinity of geothermal water necessitates frequent cleaning of heat exchangers, shortens the life of the pipelines and casing.

Therefore, it is necessary to increase heat sales. There is an essential technical reserve. It seems sensible to use the heating in agriculture (Dziubiński and Sapińska, 1999). The big potential is connected with the recreation center where the low

temperature geothermal water (before the injection) can be used. As a big recipient of waste heat, the acquapark can get preferential energy price. The idea seems to be much more reasonable as there is no such a recreation center.

The next possibility for improving the economical aspect of the investment is balneology services. The Geothermal Company Uniejów has started its activity in this field in September 2002. It gained considerable profits during the first three months. The development of operation base, as well as the rehabilitation and health care based on balneology could have a profitable influence on the investment in Uniejów.

3.2 Ecological effects

Before setup of the geothermal heating chain, the town of Uniejów did not have a centralized heating system. The heat was supplied from a few small boiler houses. Most of detached houses were heated using individual heat coming from stoves for charcoal or coal dust.

The annual coal consumption in 10 local boiler houses and 160 stoves in detached houses amounted to about 3 000 tons. Most of all generation stoves in the public buildings were over-measured. They were low efficiency stoves from 45 to 67%. The average temperature of supply and return in the central heating installation in the heating season was about 75/70^{o}C. None of the considered boiler houses was equipped with dust-filter appliances.

Building of geothermal heating plant contributed to the decreasing amount of dusts and pollutions emitted to the atmosphere in Uniejów. After activating the geothermal center, the main emission come from burning fuel oil in the peak boiler house, operating during cold weather outside. The ecological effect will be in proportion with the number of recipients who will be using the geothermal heat during the season. The quantity of emission to the atmosphere before and after activation of the heating plant in Uniejów may be found in the Table 1. Reference is made to the number of replaced traditional boiler houses and heat sold during the year.

Table 1: The quantity of emission to the atmosphere before and after replacing traditional coal boiler houses with the geothermal heating plant in Uniejów.

The element of emission	CO_2	SO_2	NO_x	CO	Dust	Benzapiren
Unit	Mg/year	kg/year				
The distracting coal boiler houses	5500	38240	3000	300000	135000	60
The centralized heating system based on geothermal heating plant with peak energy source	180	135	500	50	275	1

3.3 Social effects

Uniejów is a small town with about 3000 inhabitants situated in the central Poland. It is located nearby Łódź (800 000 of inhabitants), Poddębice and Koło – potential geothermal energy users. The analysis of social phenomena in Uniejów may contribute to the acceptance of a more advantageous policy in towns where geothermal plants will be built.

This is the first geothermal plant in Poland in a small urban area. Only 30% of all Uniejów's inhabitants leave in the blocks of flats. The rest of the buildings are detached houses. A significant number of heating recipients are individual ones. This causes that the investment costs of making a geothermal plant will increase.

The company makes efforts to gain every individual recipient because of the excess of power in the heating plant. The individual recipients are very demanding.

It is expected that the development of balneotherapy and building of the acquapark should increase the attractiveness of the town for tourists to the benefit of the inhabitants.

It follows from the analysis of geothermal investments in other towns, that social aspect must be taken into account along with geological, technical and economical analyses. Social aspects should be taken into consideration in the project. A program should be created to help prepare people to such an investment.

4 Conclusions

- The Geotermia Uniejów Ltd. is the first heating plant that supplies energy to the recipients in a small town. The experience gained at the investment and exploitation stages should be properly used. This is connected with additional costs resulting form the innovation character of such investments in the Polish conditions.
- The condition of effective consumption of geothermal heat is taking away the biggest quantity of energy from geothermal water. The project should point to the cascaded use of heat. Therefore, at the beginning of the project one should consider using energy for heating buildings than for other purposes required lower temperatures like balneotherapy, swimming pools, glass houses or acquaparks (that are still not very popular now.)
- To make efficient investments means to carefully analyze the market for the energy gained from geothermal heating systems. The starting point for any further analyses should concentrate on the technical availability of geological energy sources. Among its more important elements are sociological and marketing issues.
- Because of their localization, big cities are more advantageous for geological investments. A significant majority of recipients could be public and group recipients. In order to work out a reliable study of real profits coming from the heat sale, only public and individual recipients who declared their wish to be connected to a new chain should be analyzed at the beginning of preparing the project.
- The ecological aspect is very important in small towns, where geothermal energy covers a considerable percentage of heat demand in the whole town. Unfortunately, the benefits resulting from the reduction of pollution emission cannot be included in the economical calculation of investment.

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