The role of the renewable resources in local development: The case of geothermal water energy exploitation in Oradea, Romania

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Abstract

Economic development in the new century faces the challenge of declining geological resources. While there continues to be a direct link between the per capita energy use and the living standard, the concerm now is for enhanced consumer safety and environmental protection. In this process, alternative renewable energy sources such as geothermal energy, offer both an affordable and sustainable solution. This is because renewable energy technologies generate a small amount of pollutant emissions and waste, decreasing significantly the chemical and physical (thermal, radioactive) pollution. This paper analyses the exploitation of geothermal water in Oradea, Bihor County, Romania as a sustainable solution for a local development. Results of the analysis indicate that the advantages of using this type of energy include a clean and renewable resource, reduction of greenhouse gas emissions, saving of fossil fuels, prices below those of conventional sources, minimal risk of external market fluctuations, widespread usability, psychological comfort of the user, and, the possibility of improved health.

Keywords: environmental protection, fossil fuels; geothermal water, greenhouse gas emissions, renewable energy sources, thermal pollution

Introduction

Climate change is now a challenge and an important priority for the European Union. Experts have concluded that unless measures are taken immediately, the planet will soon be facing irreversible climate phenomena. The EU has already formulated a clear response in the form of an integrated policy on energy and a firm commitment to reduce emissions of greenhouse gases by at least 20% and to increase the same percentage share of renewable by 2020 (Nemes, 2010).

The targets set could be met only by significantly increasing the contribution of renewable energy to electricity transport, heating and cooling in all member states. The challenge is immense, but the objective can be achieved through determined and concerted efforts at all levels. Thus, it is indisputable that renewable energy is a key factor for a sustainable future.

Needless to say, the implementation of an ambitious energy policy for Europe will require a vigorous and persistent promotional campaign for renewable energy that will involve taking action at all levels of policy and decision making. Efforts should be adapted at all levels and in all Community policies and must be adequately coordinated.

The contribution of each member state to achieve the objective must, however, take into account different national circumstances. Member States should show flexibility and promote renewable energies of most suitable potential and to their specific priorities.

As a member of the European Union, Romania's principal aim is to increase the use of energy from renewable resources. The objective is to increase up to 33% production of energy from renewable resources by 2010. Increasing the share of renewable energy will not only have a positive impact on the environment in Romania but also in tangent with the fact that Romania has committed to and accepted the demands of the Kyoto Protocol under the Convention United

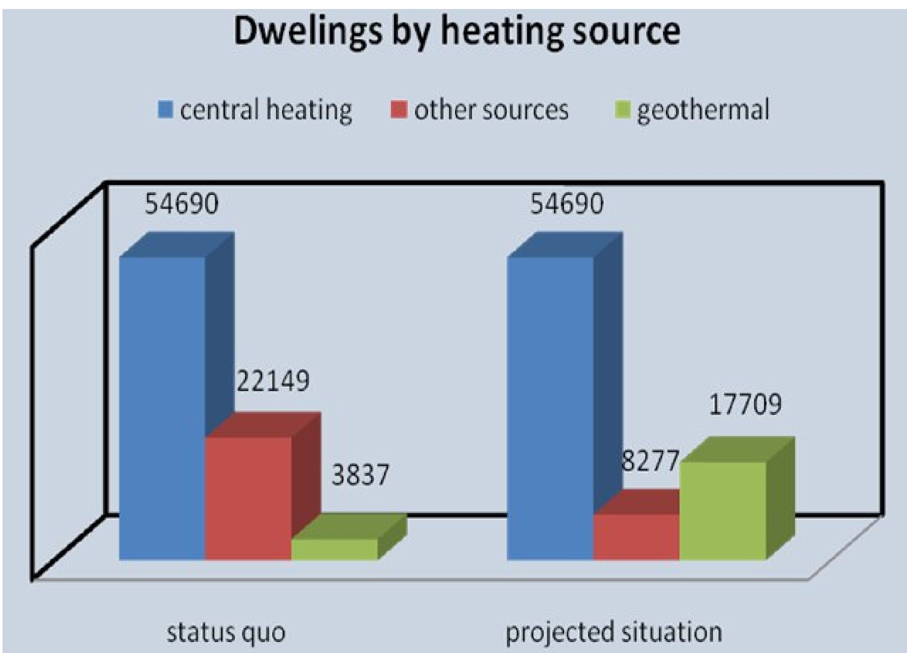
Nations Framework on Climate Change, adopted on 11th. December 1997 (Committee for Development Policy, 2007).

Taking into account that the cities of Europe sustain 80% of the population and are the main source of industrial pollution , most cities are confronted with the common environmental problems associated with urbanisation and urbanism such as traffic congestion. Indeed, urban living requires a sustained interest in the principle of sustainable development. All forms of urban planning, spatial development plans and environmental legislation power of local authorities should abide by the tenets of sustainable development.

The city of Oradea is in the same situation of having to deal with environmental problems pertaining mainly to air quality. The main source of thermal pollution of the city is in the large amounts of sulfur dioxide and nitrogen dioxide in the emitted air. This paper analyses the exploitation of geothermal water in Oradea, Bihor County, Romania as a sustainable solution for a local development.

Oradea's energy needs and sources

About 900,000 Gcal is needed to provide heating and hot water based on the number of households which have a central heating system. In 2010, a total volume of 900,000 Gcal was delivered to the population by the two local providers. While some 58,527 dwellings were connected to the two local providers, there still was a total of 22,149 homes that are not linked to the central heating system (Figure 1). These houses have their own heating system consisting mainly of boilers or stoves powered by firewood or natural gas.



Source: DJS Bihor, 2010.

Figure 1. *Dwellings by heating source*

The first and the biggest of Oradea's two local providers for heating and hot water is the old electro-thermal plant which is intended to create electricity and heating for the city. In order to provide good quality services, and because there was a large area to cover, there were two plants constructed in Oradea, one for the main industries and the western part of the city (CET 1), and one for the east (CET 2). After 1989, with the closedown of most of the local energy consumption industries, the political actors decided to shut down the eastern plant (CET 2). This decision had led the other provider to come up with the development of other heating methods.

The plant produces electricity which is sent into the national electricity system, and thermal energy, which is called the primary agent – meaning hot water or technological steam which is sent to the consumers through 5 main pipelines. For the public heating, the consumers are the 196 neighborhood plants, which receive the primary agent, and circulate it through heat exchangers that will finally heat the secondary agent which will turn into a closed circuit through radiators in each house. In order to provide the hot water, they follow the same procedure, but instead of using a closed circuit they could use water from the public water network.

This central heating system covers mainly the blocks of flats which were built up during the '60s and the '90s. It is very difficult to supply the heating and the hot water to the family houses the secondary pipeline network is only 545 km long which allow it to provide heat for 70% of the city which is equivalent to 54,690 apartments and about 145 000 inhabitants.

After the eastern plant was shut down, there was a breech in the central heating system. To cover that hole, the municipality allowed a private company to take over a part of the eastern secondary heating network, along with the neighborhood plants. The raw material used to heat the secondary agent was modern, clean and renewable. The company utilised geothermal water from 10 wells within the perimeter of Oradea, which was then sent to 12 neighborhood plants to provide heating and hot water to 3837 apartments. At this scale of operation the plant was only using 21% of the total geothermal potential. It was believed that exploiting the full potential of the plant power generating capacity would allow geothermal heat to serve all the houses which were not connected to the central heating system and forced to resort to using other sources of energy such as fire wood, coal, oil and gas for their boilers. At present, geothermal water is used to heat up 3837 dwellings or only 21% of its potential. The main goal is to exploit 100% of the potential, which would allow heating for about 17,709 dwellings.

The geothermal system of Oradea

The geothermal potential of Oradea is estimated at 250000 – 300000 Gcal of which only 65 000Gcal is used. The Oradea geothermal potential is exploited by 12 wells located in the following 5 areas around the city:

1. Probe area I 4797 (Nufarul) provides hot water current for the inhabitants of Nufarul neighborhood.
2. Probe area II 4767 (Iosia) provides the primary energy for heating PT 511, 512, 513 for the residential district of Iosia.
3. Probe area III 4795 (Route Aradului) provides primary heating for the thermal PT 911, 912, 913.
4. Probe area IV 4004 (Dacia) provides primary heating for the hotel Dacia, Elit hotel and Expoflora.
5. Probe area V 1709 (Episcopal) provide heat for the primary⎱ termice104, 105107 (Hospital for Children).

Respectively, Probe 4796 provides the primary agent for the University of Oradea geothermal and Probe 1715 the primary geothermal SICOOP, Strand Municipal, Mănăstire and Electrometal.

Around Oradea town, and especially the nearby Felix and 1 Mai spas, geothermal wells have been excavated and then used for therapeutic purposes for over the past 100 years. In the last 25 years, initiatives have been taken to discover and analyse geothermal wells. Thus it has been discovered that in the Western Plain, in which Oradea is situated, all geological formations contain aquifer layers of various capacities and thermal properties. The waters here surface in a gushing fashion due to the high amount of gases dissolved in the water.

The Oradea aquifer was identified in 1963-1964, the first three wells having been excavated in1964. Between 1965 and 1988, geological and hydro-dynamic studies of the aquifer were conducted. The Oradea aquifer has a very favourable siting, that is, under a thin crust of around 30 km, which provides better heat propagation. The aquifer covers an area of approximately 75 km^2 being located almost entirely under the Oradea municipality. The aquifer is located in the complex network of fissures which are part of Triassic limestones and dolomites at the depth of 2500 m and is part of an extensive hydro-geothermal system with natural recharge and outflow in the perimeter of the Felix and 1 Mai spas.

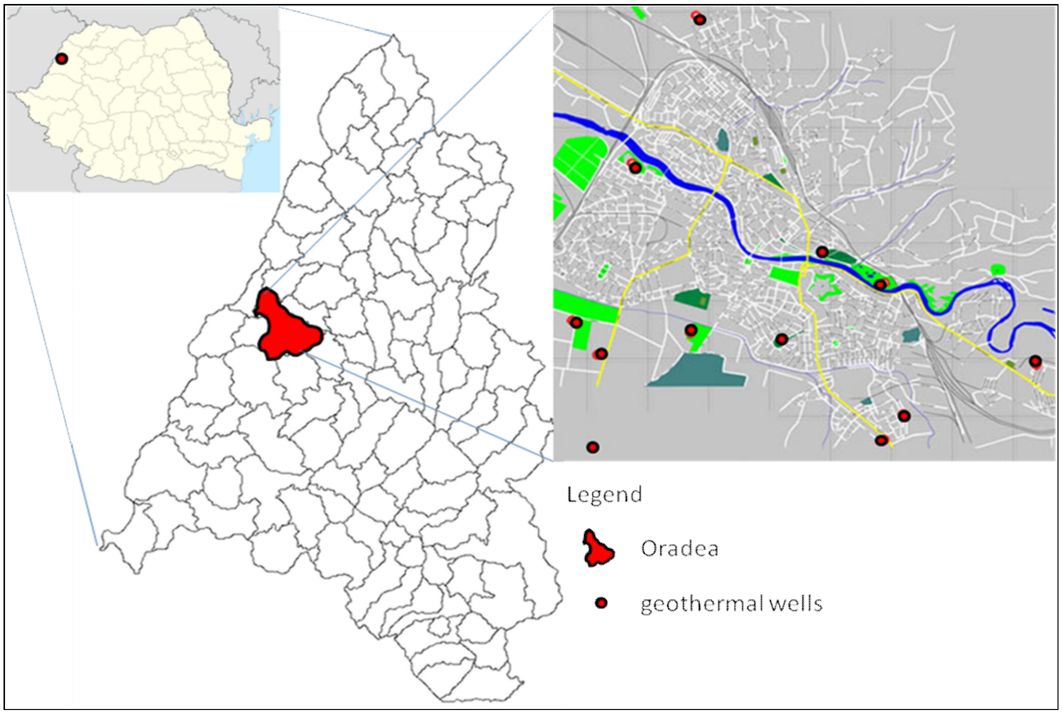


Figure 2. *Location of the geothermal wells in Oradea*

Oradea has 12 wells, 11 for production and one for injection (Figure 2). These wells can produce, through gushing, potential flows of about 150 l/s. In the early days of exploitation, the flows measured around 10 l/s, being afterwards increased substantially through water acidification and later on, some wells were equipped with submersible pumps at depths between 120 and 150 m.

Presently, 10 wells are being exploited by a single company that owns exploitation rights. About 2,5 million m^3 are being extracted. From this amount, 100000 Gcal are produced for domestic use, supplying about 30000 people. One well can supply 7 heating distribution points, which provide heat to 15000 people.

The potential of Oradea's geothermal deposit is estimated at 250000 – 300000 Gcal/year, while the total consumption of the town in the year 2005 has been cca. 900000 Gcal, which means that a third of the city's need could be met. The current thermal power is cca. 15MW, of which about 35% are being utilised. According to the license owner, the current geothermal resources could provide 300000 Gcal/year. From the present amount of water exploited, the yearly amount used for the urban heating system is 44000 Gcal/year (Panu et al., 1996) (Table 1).

Table 1. The geothermal system of Oradea

Estimated Surface	No. of wells	Excavation depth	Exploitable flow	Theoretically potential energy
75 km^2	12	2800 m	151l/s 545,4 m^3/h	34,1 MW_t (considering that geothermal water cools until 30^0C)

Source: Nemes, 2010

The exploitation and subsequent experimentation of the Oradea aquifer in the last 17 years has revealed the following water primary characteristics:

(i) It is a naturally recharging system, the water being part of the active hydrologic circuit (the waters age being about 18.000-20.000 years); the extraction of 57 million m^3 has not affected the aquifer's pressure;
(ii) The geothermal water can have a corrosive and encrusting character according to certain specialists. Chemically, the water does not represent a pollution risk;
(iii) Water temperature varies from 70^0C to 105^0C, decreasing from W to E, the medium temperature of the 12 wells from Oradea's perimeter being 90^0C;
(iv) The gushing flows of the wells vary between 5 and 30 l/s depending on the geological conditions, and the flows obtainable through submersible pumping are 20-50 l/s;
(v) The collector allows the reinjection of the used thermal water at pressures bellow 10 bars, even at flows of 25-40 l/s; the working geothermal heating doublet in one of Oradea's neighborhoods confirms that the injection solution is optimal for utilization; and
(vi) After the geothermal water has been used, it has a medium flow of 65 l/s and an evacuation temperature of 30^0 to 45^0C.

Supplying hot water is by far the best current use for the geothermal resource as the utilisation is constant throughout the year, while in the case of heating, a complementary provider is required. Without it, the potential of a geothermal well would be fully utilised only in short periods in the course of a year, when average temperatures drop below nominal value while for the six spring and summer months it would not be used at all. Geothermal energy is used for heating and domestic hot water preparation, which benefits about 8,000 apartments, institutions, hotels, etc. It is also used in various processes, for greenhouses and recreation.

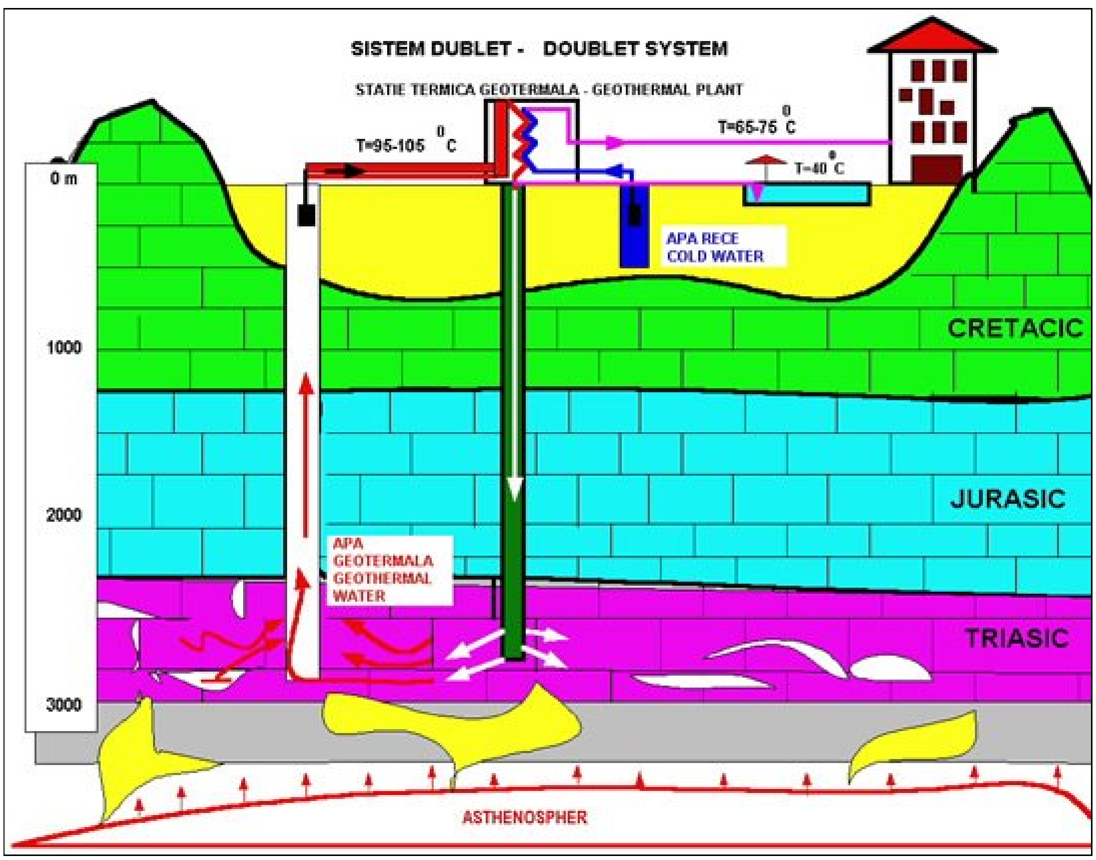


Figure 3. *The doublet system used in exploiting the geothermal water in Oradea*

In 1992 the first geothermal doublet was put into production in Romania, which consists of a well for extracting geothermal water, a geothermal power station equipped with a heat transformer and an injection well for used thermal water. The results were remarkable, investments having been made to increase production capacity for supplying a larger number of users (Panu, 1995; Lund, 1997).

Plans have been made to extend the "doublet" system in several areas of the town of Oradea (Figure 3). The Oradea deposits have a good potential and if injection operation is used to expand the geothermal energy distribution of domestic hot water in all municipal areas, water flow can increase by 50%. The caloric absorption capacity of a vertical captor is of about 50W per exploited meter, which means multiple heat capture points are needed, each within at least 10m distance. Two 50m geothermal wells are enough to heat a 120m^2 house (Figure 4). Vertical captors are harder to install, needing a company specialized in exploitation, and upholding the laws related to soil protection (Rosca, 1993; Rosca et al., 2005).

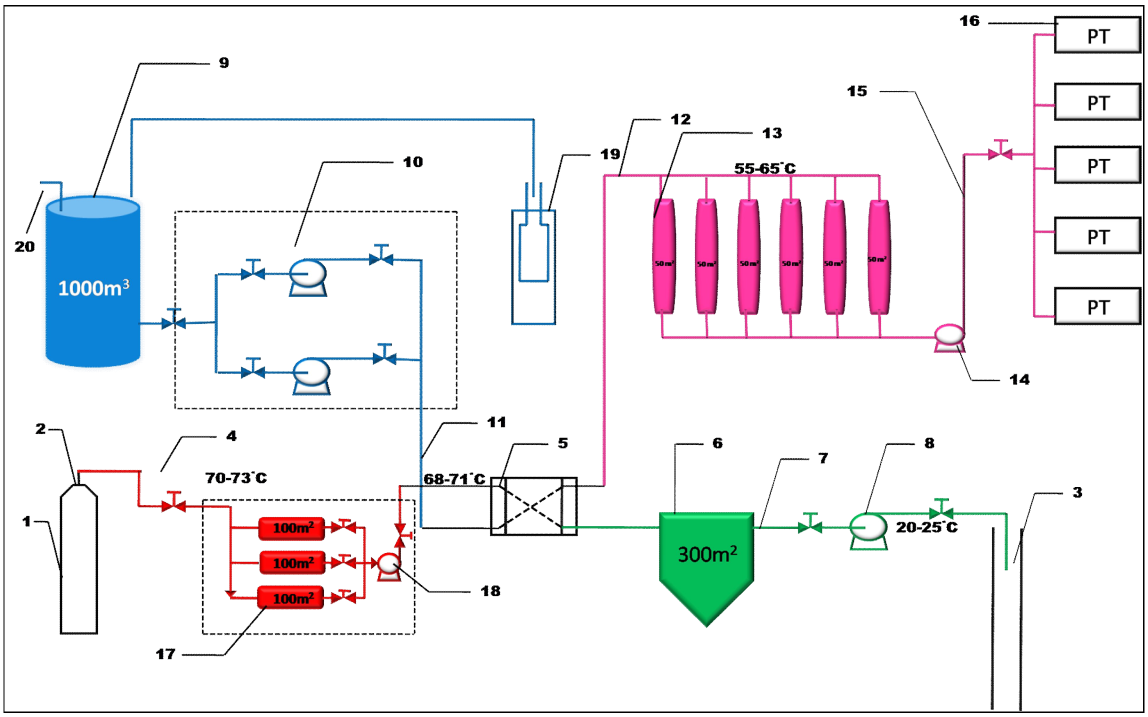


Figure 4. *Oradea geothermal doublet operating diagram*

1.Production probe
2.Exploitation head
3.Injection probe
4.Thermal water transport pipe
5.Heat exchanger
6.Injection tank
7.Used thermal water transport pipe
8.Centrifugal pump for thermal water injection
9.Cold water store tank
10.Cold water pumping system
11.Pipe for cold water transport to the heat exchanger
12.Pipe for warm water transport to the store tank
13. Warm water store tank
14. Pumping system for warm water.
15.Transport pipe for warm water to thermal points
16. Thermal points
17.Thermal water store tank
18.Thermal water pumping system
19.Cold water probe
20.Cold water entrance from the Water and sewage administration

Conclusion

Results of the analysis indicate that there were several advantages of using geothermal energy. These include clean and renewable source, reduction of greenhouse gas emissions, saving of fossil fuels, prices below those of conventional sources, minimal risks of external market fluctuations, widespread usability, psychological comfort of the user, and the possibility of improved health as it may be associated with wellness tourism.

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