GEOTHERMAL ENERGY POTENTIAL IN PART OF PANNONIAN BASIN: HUNGARY, CROATIA, ROMANIA AND SERBIA- CURRENT SITUATION AND MUTUAL PERSPECTIVES

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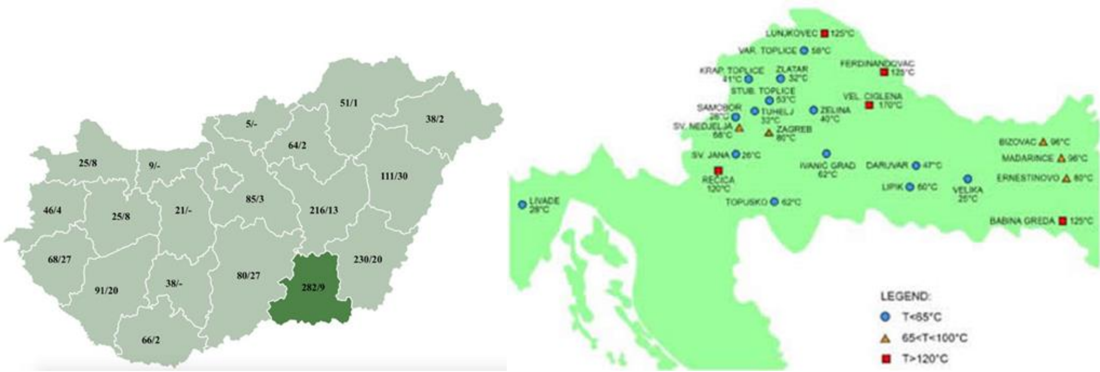
Abstract

Hungary, Romania, Croatia and Serbia have a various tradition and current situation in geothermal usage, although their potential can roughly be estimated as similar. The reasons for insufficient usage of geothermal energy are dominated by legal regulations related to the obligation of reinjection, concession, as well as feed-in tariffs. All the facts support the need for joint projects, or at least for a common approach to increasing the use of geothermal energy. According to the geothermal water characteristics, the most efficient way to use geothermal water in the most of the Panonian Basin is cascade use, two-stage or multistage, which is proposed as a model for usage.

Introduction

Pannonian Basin has been recognised long time ago as a positive geothermal field. Hungary, Romania, Croatia and Serbia are countries with significant part of their territory in the Panonian Basin and have a various tradition and current situation in geothermal usage, although their potential can roughly be estimated as similar. The Pannonian Basin has a heat-flow density ranging from 50 to 130 mW/m^2, with a mean value of 90-100 mW/m^2 and a geothermal gradient of about 45 °C/km [1,2]

Hungarian Office for Mining and Geology reported, there are 1622 registered geothermal wells in Hungary with production of about 25 million m^3 thermal water i.e. 2,509,519 GJ (data for year 2015.). The number, temperature and utilisation of geothermal wells vary greatly, as does the economic health of 19 provinces in which Hungary is administratively divided into (Figure 1(a)). As it has been previously published in [3], that from a geothermal point of view the most promising county is Csongrád, a province that has 282 geothermal wells and 9 abandoned hydrocarbon wells which are being evaluated for geothermal uses. The geothermal gradient is 37- 45 ^{o}C/km, with a county-wide heat flow of 90-106 mW/m^2 [1].



(a) (b)

Figure 1. (a) Counties with the number of existed geothermal wells and the prosperous hydrocarbon wells in Hungary [3] and (b) Geothermal wells in Croatia [5]

Csongrad produces 25–30 million m^3 of thermal water per year, or 1/6 of all Hungarian geothermal water production. Every town in the county has a geothermal heating system. The largest is in Hódmezővásárhely, with 8 producing and 2 injection wells. In addition to its highest geothermal potential in Hungary, it is important to emphasize here that Csongrad is a border country with Serbia and its position strongly encourages development of mutual bilateral and multilateral project.

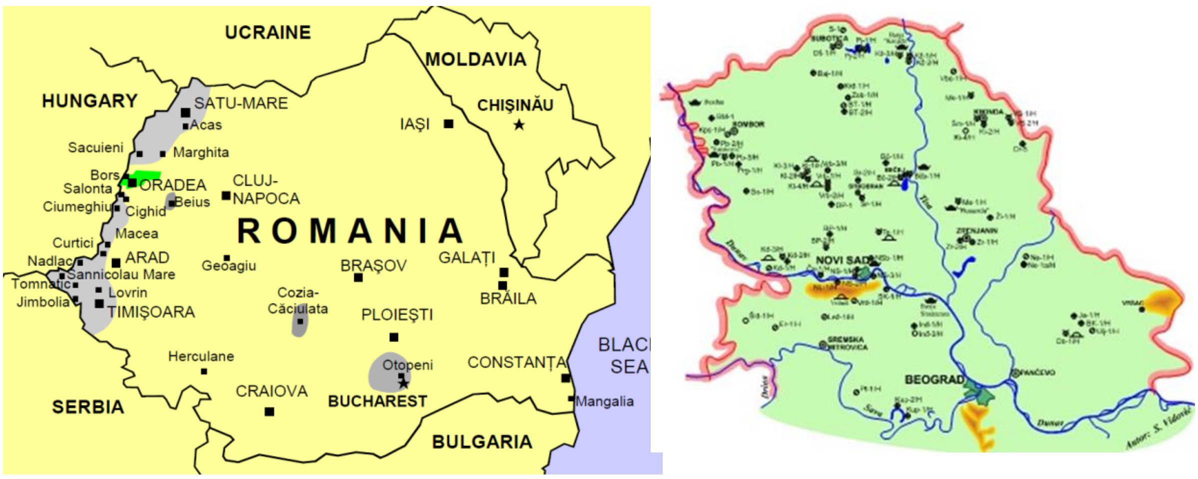
As stated in the Geothermal Energy Utilization Potential in Croatia, the Field and Study Visits Report, published in June 2017 [4] there are 28 geothermal sites in total, of which 18 are in use. Panonian basin in Republic of Croatia have great properties from the viewpoint of geothermal potentials: the temperature gradient is 0.04 ° C / m to 0.07 ° C / m. The terrestrial welding flux is also high and ranges from 60 to over 100 mW / m^2.

Geothermal energy is used in the Republic of Croatia for 18 spas and recreational centers, and various medical therapies (Figure 1(b)). In 23 locations, shown in Figure 1(b), the direct use of the geothermal energy is the same as in the total installed power of about 75 MWt [5]. The yearly consumption of the total energy of all geothermal locations, calculated from a new factor of 0.27, could reach 650 TJ / year.

The main geothermal project, which is currently in the final phase, is Velika Ciglena, which is expected to be a crochet of Croatia, but also the largest European ORC geothermal power plant. There are 15 MW in the full production process of 15 MW is expected to be put into operation this year, 2018.

The main geothermal areas in Romania (Figure 2 (a)) are: Satu Mare, Tasnad, Acas, Marghita, Sacuieni, Salonta, Curtići-Macea-Dorobanti, Nadlac, Lovrin, Tomnatic, Sannicolau Mare, Jimbolia and Timisoara. The main purposes are: heating 10 hectares of greenhouse; district heating for about 2,500 apartments, obtaining sanitary hot water for 2,200 apartments, health and recreational bathing and fishing [6].

The Pannonian geothermal aquifer in Romania extends over an approximate surface of 2,500 km^2 along the western border of Romania, from Satu Mare to the north to Timisoara and Jimbolia in the south. The aquifer layer is located at a depth of 800 to 2,400 m. More than 100 geothermal wells were tested, of which 33 are currently exploited. The heat gradient is 45-55 ° C / km. Boreholes are mainly used as artificial wells, and very few have installed pumps.



(a) (b)

Figure 3. (a) Locations of main geothermal reservoirs in Romania [6]; (b) Geothermal potentials in Panonian Basin in Serbia

The main direct uses of geothermal heat are: central heating and individual space heating, balneology and recreation. In several places geothermal energy is used for heating greenhouses (about 10 ha), fish farming (several farms), industrial processes and drying.
In Panonian Basin in Serbia (province of Vojvodina), thermal waters usageare: spa and baths 43.6%, heating 38.8%, Industry 11.5%, recreation (outdoor and indoor swimming pools) 6.1%. The best application of geothermal water was realized in Kanjiža where hot water is used by multipurpose, cascade system, then in Bečej, even in Junaković near Apatin.
In Figure 2 (b). all objects of exploration and use of hydrothermal waters (drilled well drilling, wells in production, places of use, spa, sports-recreation centers etc.) in Vojvodina are shown.
The total thermal energy of water and all drilled hydrothermal wells is about 55 [MW], and the power of all wells that were in production about 23 [MW]. The possible substitution of oil for drilling wells in production is about 10 000 [t per year].
The geothermal waters of the Pannonian Basin of Vojvodina, in terms of physical, chemical and geothermal characteristics, could be used in agriculture for heating greenhouses, livestock and horticulture for heating farms, industry as technical hot water, balneotherapy and sports and tourism centers, for heating of settlements and other facilities, supply of population with sanitary water, fishing, etc. It is important to mention that there is a low percentage of utilization (up to the 30%) of the potential of these hydrothermal wells is due to either unadjusted user installations or due to lower user needs compared to the potentials of the exploited well. In addition to the wells that are in operation, there are 11 hydrothermal wells on the territory of Vojvodina, with built hydrothermal systems, which are currently out of production and wells that have never been in production, which are promising both from the aspect of energy and the supply of drinking water to consumers.

Results and discussion

On a number of geothermal sources of interest there is a mixture of water and gas. This gas, by degassing process, should be separated and used in an environmentally friendly way, through cogeneration (coupled production of heat and electricity). After use, directly or indirectly, geothermal water should be returned to the wall mass, through geothermal sink. Those sinks are operated at an average distance of up to 300-500 m from the geothermal source. Figure 3 shows the use of water from the geothermal spring.
Thermal water from a geothermal source is pumped through a pump into a degasser where water and gas separation is carried out. The degassed water is gravitationally flowed into the underground tank of water tank while the gas goes into the above-ground gas tank. Degassed water is pumped through the pump line into the water line from which the consumers are supplied and the gas is transported by the compressor into the gas line from which the cogeneration plant is supplied. According to this scheme, the water will be return to the geothermal sink is relatively high temperature, about 28°C.
Panonian Basin geothermal sources are more suitable for integrated use of the geothermal resource in multiple applications under the concept called cascade utilization for power generation and sequential use of geothermal heat for various direct uses, or by use of thermally activated technologies (Figure 4). In the first instance, through the heat exchanger, geothermal water would be used for underfloor heating, water treatment for swimming pools, etc. After that the geothermal water would go to second degree, again through a heat exchanger, into a heat pump. After that, the geothermal water would be returned to the geothermal sink.

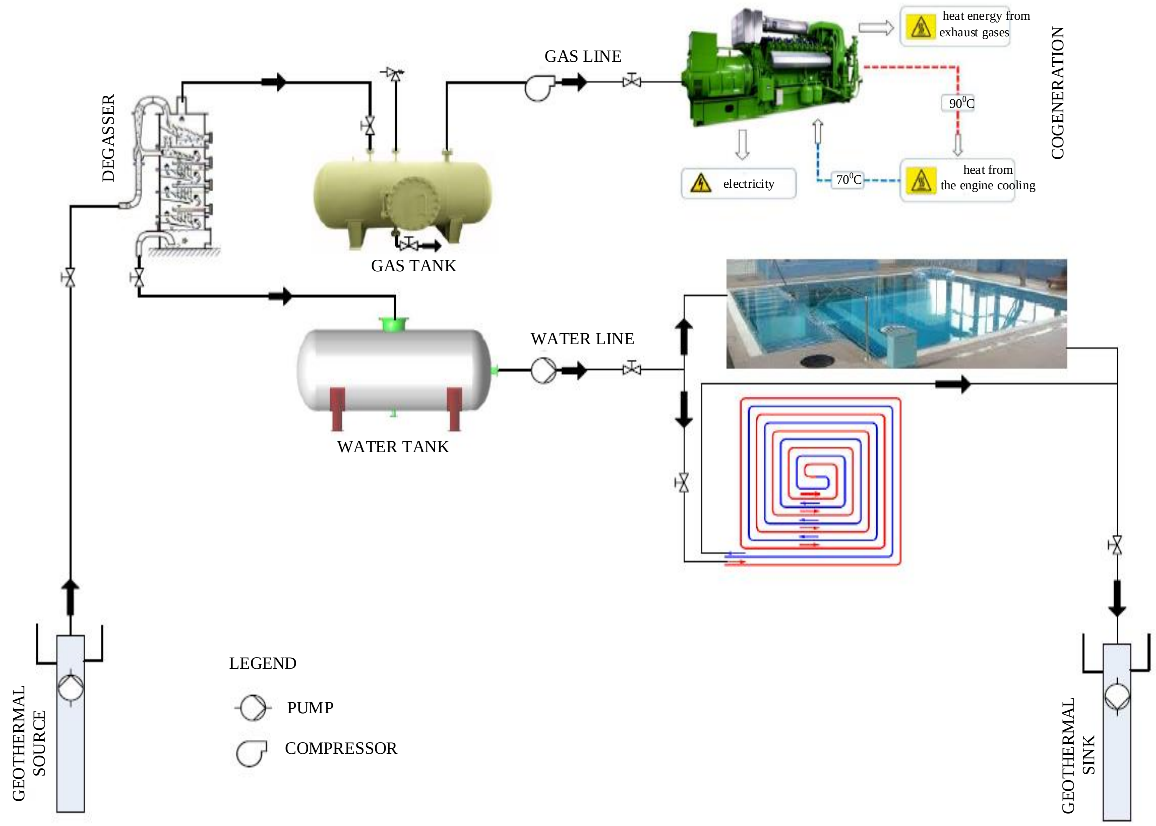


Figure 3. Scheme of usual geothermal energy utilisation

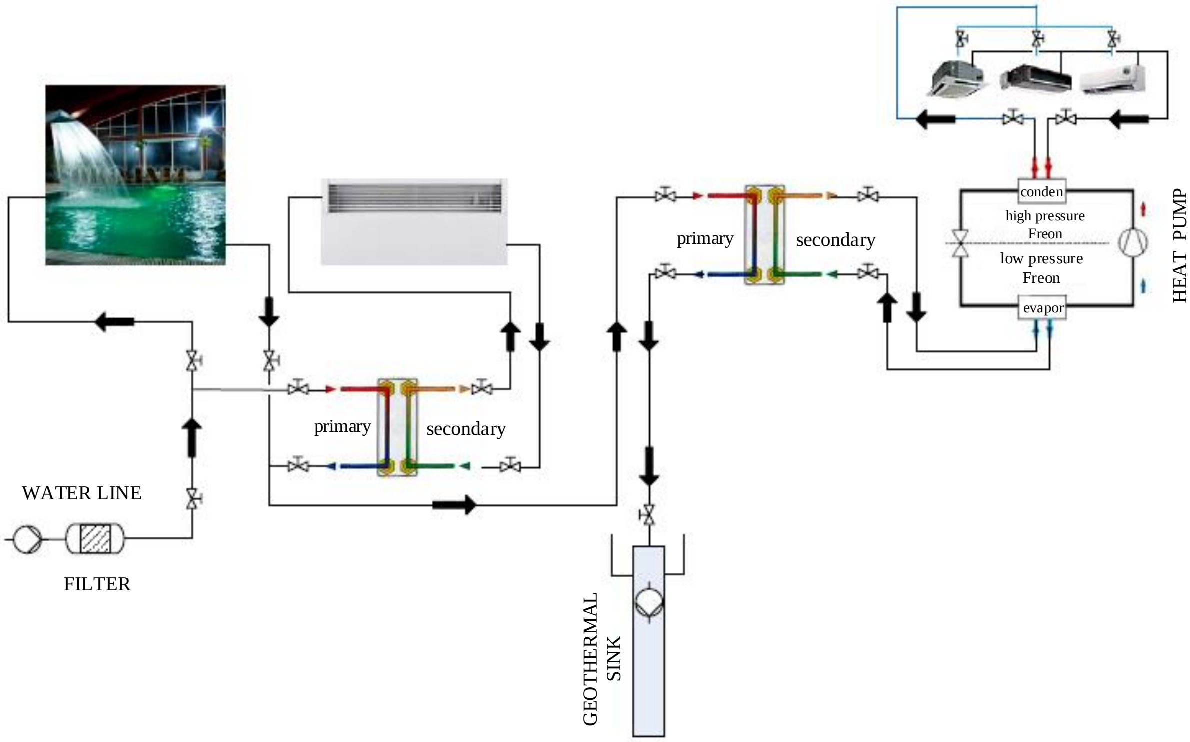


Figure 4. Cascade utilisation of geothermal energy

When using water from geothermal sources, special attention must be paid to the effect of temperature, as well as the quality of water on the equipment. The impact of corrosion on the heat exchanger has been thoroughly examined by the Oregon Institute and such experiences have led to the emergence of heat exchanger manufacturers specializing in geothermal water, or those who take into account the chemical composition of the fluid and determine, on the basis of it, materials that will be used in production.
In addition of the cascading use of geothermal energy mentioned above, cascade utilisation is also applied in agriculture (greenhouses, fishponds, etc.)

Conclusions

Geothermal resources in the Panonian part of Hungary, Croatia, Romania and Serbia are resources of medium and low enthalpy and therefore are suitable for cascade utilization. This is the integrated use of the geothermal resource in multiple applications for power generation and sequential use of geothermal heat for various direct uses. Cascading from power production provides water for direct uses, district heating, fishponds, greenhouses etc. Further projects (bilateral or multilateral) should be focused on investigation of the technical and economic feasibility to replace conventional boilers in the district heating network. The replacement should consider the direct utilization of geothermal heat in cascade to different temperature levels and the incorporation of a heat pumps.

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