Modern Solutions for the use of near Surface Geothermal Energy in Banat

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Abstract. The energy feed problem leads us in the future strongly to mix the energy of renewable energy and non-renewable energy. Geothermal energy stored in the form of heat under the ground surface is one of the most important renewable energy. The stored heat in the ground results from sunlight and heat flux inside the earth resulting among others from radioactive decay, therefore, deep geothermal energy will be used for generating electricity, and near-surface geothermal energy serves to produce heat, respectively cold and battery heat. One particular advantage of the geothermal energy is the independence from day periods and unfavorable conditions. The increase in sales on the geothermal heat pump market proves that evidently. Heat pumps are modern installations that are utilized as an alternative to the conventional power plants having greater yields from 50 – 70%, and maintenance costs up to 2, 3 times smaller. In the paper, we discuss the current solutions by using a near-to surface geothermal energy and its application possibility in Timiș County area. Following this mathematical modeling with the PMWIN program, it can be seen that our thermal pollutant spreads to the ground and the groundwater and influences both the ground around the wells and the adjacent terrain. Influences produced may have major effects on the thermal regime of adjacent lands. With the spread of heat, there is a warming/cooling (depending on the use case) of the ground and, implicitly, of the groundwater. On the adjacent terrain, there will be no heating or cooling installations with heat wells because that area is already used by existing wells. All these effects, which affect not only the proprietor of the good installation, can also attract lower sale price of the land because of a geothermal change. However, affected neighbors do not have the opportunity to instantly defend themselves because there is currently no adequate legislation regulating these issues.

1. Introduction
In the past 15 years, the growth of energy resources consumption has been out of the ordinary changes. The energy sector landscape has been revamped in the aftermath of high growth rates, investments and new capacities of the renewable markets. This can be observed in figure 1, where we can see the overall reduction in fossil fuel consumption and the growth of renewables. [1] Romania has at its disposal a diversified range of energy resources: crude oil, natural gas, coal, uranium ore, as well as a potentially exploitable important renewable resource. Natural gas, coal, lignite, uranium hydrocarbon stocks are declining and limited in terms of declining domestic production and not identifying potentially important deposits. Considering the increase in the share of
energy demand and the sustainable growth of energy supply, it is clear that, renewable energy should be emphasized in the future, thus reducing dependence on energy imports and at the same time fortifying the internal market. The use of geothermal energy is, due to the limit of fossil energy deposits, economically, ecologically and geopolitically of particular importance.

![Figure 1. Primary energy consumption over the past 15 years [1]](image)

Regional distribution of renewable sources potential is presented in figure 2. We can see that the West part of Romania is suitable for geothermal energy usage [2].

![Figure 2. Regional distribution of renewable energy sources, I, Danube Delta (solar energy), II Dobrogea (solar energy and wind), III, Moldova (plains and plateaus – mico hydro, wind and biomass), IV Carpathians (biomass, micro-hydro), V Transilvania plateaus (micro hydro), VI West Plains (geothermal energy) [2]](image)

Timis County has large amounts of resources for developing geothermal energy, alas only one commune is currently using it for home heating. In Timis, there are several wells at Sânnicolau Mare, Variaș, Periam, Tomnatic, Comloșu Mare, Grahaț, Lenuheim, Jimbolia, Cărpiniș, Beregsău, Gottlob, Timișoara, Beba Veche, Sânmihaiu German and Baile Calacea.
Lovrin is the only locality in the county where the thermal agent supplied to the population through public service is the geothermal water. The Communists made it in the 1980s, but only less than ten percent of the locals benefit from this system. There are more than 80 families living in block apartments, but also homes located on the main road.

2. Near to Surface Geothermal Energy

Near surface geothermal energy is the energy stored in the form of heat under the surface of the solid earth. The energy in the earth, under 10-20 meters, results largely from the debris of gravitational energy and the initial heat from the moment of earth formation, as well as from the absorption of the radiant energies released in the terrestrial bark at the time of the decomposition of radioactive elements. The 238U, 235U, 232TH, and 40K radioactive isotopes occurring in all mineral layers at varying concentrations are highly mobile and therefore enriched in the upper layers of the earth's crust. High heat recovery elements are, for example, granite (3.0 μW / m3), gneiss (2.4 μW / m3) or metamorphic shale (1.4 μW / m3).

![Figure 3. Variation of temperature in the ground, near the surface area of the earth's crust [3]](image)

Earth layers, up to about 20 meters, are influenced by air temperature and solar energy. After this depth, the temperature remains approximately constant (figure 3). It is known that the heat flow is vertically oriented, and this leads to continuous temperature rise, the thermal gradient having an average of about 3.3K / 100 m. However, there are exceptions to the rule, especially in the areas with volcanic, tectonic activity and high thermal conduction.

Geothermal surface energy requires special systems to raise the water temperature to acceptable levels. These systems are called heat pumps and work on the same principle as refrigeration machines. Heat pumps absorb heat from the ground if the following conditions are met: - the resource must be in sufficient quantity - Higher temperature - Capture in economic conditions - High enough regeneration capacity - Heat accumulation capacity as high as possible.

Energy is captured through the intermediate circuits of the heat pump. These circuits consist of collectors, circulating pumps, expansion vessel, distribution system of the intermediate agent in the
collectors, ventilation devices. Geothermal collectors can be placed horizontally or vertically. They have a shape of the capillary pipe network.

Horizontal collectors (figure 4) are mounted at a depth of 1.2-1.5 m in an area free of construction and unsealed to be able to use as much solar radiation as possible. Heat exchanger pipes are positioned at about 0.3-0.8 m [3]. The specific capture capacity is 10 - 40 W / m² for, for 1 KW being 15 - 30 m².

![Figure 4. Horizontal and vertical collectors for ground heat capture [4]](image)

The vertical collectors, (figure 4) also called wells, are mounted by drilling at depths of up to 100 m (over these depths drilling authorization is difficult to obtain). Unlike horizontal collectors, using geothermal probes, we have a thermal capacity of 20 - 80 W / m², depending on geothermal conditions. In order to achieve these performances, double PE or double-ended PEHD pipes are introduced into the well bore, as well as absorption conductors, and a bentonite cement suspension isolates the remaining space [4].

The operating principle of the heat pumps is simple. A schematic is presented in figure 5. The pump tubes circulate a liquid that has a very low boiling point. This liquid takes up the heat from the environment and then goes through the stages: evaporation, compression, liquefaction (condensation) and decompression [4].

In the evaporator, the liquid is initially at reduced pressure and, implicitly, a temperature lower than its boiling point that is why it takes over the heat from the environment. Heating the liquid to boiling results in evaporation, the vapors are then absorbed into the compressor where the pressure is increased. Compression is the only step that produces energy, which can be electrical or burned. As the pressure increases, the temperature increases. The working fluid vapors pass into the condenser...
where, by transferring heat to a water circuit, it passes into the liquid state. The circuit closes when the liquid passes through the expansion valve again into the evaporator where it is decompressed and passed again to a low pressure. The heat can be up to 55 - 60°C. The efficiency of the heat pump is influenced by energy consumption and soil temperature. Heat pumps can work with different working fluids, they can be: organic substances: hydrocarbons with flora and hydrocarbons, inorganic substances: ammonia, carbon dioxide or water. Due to the physio-chemical characteristics of carbon dioxide, it has been used to perform geothermal wells called CO2 probes, which allow operation without the circulation pump.

![Figure 5. Schematic of operating principle of a heat pump [5]](image)

3. Results and discussions

The performance of the heat pumps depends basically on the temperature difference between heat source, and the heating system. Extracting/introducing heat into the ground leads to changes in the initial temperature.

The temperature changes are propagated in time and lead to changes in an area, more or less extended around probes. This change reached even 6 – 8°C and can have a negative influence on the system performance due to interference effects between the heat exchanger boreholes. The average temperature changes in an extended area of the GSHP system, which can move through, transported by groundwater and arise as a form of heat pollution. This can even lead, among others, to conflicts of legal nature with the owners of adjacent parcels. This new problem is mentioned in the recently specialized literature [6].

The model is designed to highlight the influences of the heat wells on the soil's thermal regime where the good network was installed but at the same time on the adjacent property. By working on the principle of heat exchange with the soil, the probes influence both the field in which it operates and the adjacent land [6]. It was considered a land of 11250 m2 divided into lots of 500 m2. In one of the lots, we have a group of 9 probes placed in a 3x3 network that occupies an area of 100 m2.

The installation is used for cooling, for this purpose circulating liquid CO2 through the tubes. It is believed that vertical collectors group heats the area around the boreholes by 6 °C. Model PMWIN 5.3 was used for modeling. The PMWIN software is generally used for modeling underground flows.
and for modeling the transport of pollutants. In our case, the pollutant is the temperature introduced into the soil by means of heat probes. The input data were: coefficient of conductivity $\lambda = 1.275 \text{ W/mK}$, environment porosity $n = 0.25$ (sandy soil). The aquifer is considered to be unconfined. The ground on which the heat sink installation has been applied has a 1% slope. For groundwater, a slope of 0.33% was considered.

In figure 6, we can clearly see that the effect could influence the adjacent land and bind the neighbor from using its land with this technology.

**Figure 6. Dispersion of heat in the underground**

### 4. Conclusions

Following this mathematical modeling with the PMWIN program, it can be seen that our thermal pollutant spreads to the ground and the groundwater and influences both the ground around the wells and the adjacent terrain. Influences produced may have major effects on the thermal regime of adjacent lands.

With the spread of heat, there is a warming/cooling (depending on the use case) of the ground and, implicitly, of the groundwater. On the adjacent terrain, there will be no heating or cooling installations with heat wells because that area is already used by existing wells. All these effects, which affect not only the proprietor of the good installation, can also attract lower sale price of the land because of a geothermal change. However, affected neighbors do not have the opportunity to instantly defend themselves because there is currently no adequate legislation regulating these issues.

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