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The Role of Geothermal in Hungary's Energy and Domestic Heating Policy

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ABSTRACT

There are many compelling arguments for using geothermal energy in Hungary. One of the most important reasons is that the country would be able to profitably exploit its abundant, relatively untapped network of geothermal reservoirs. These reservoirs are considerably warmer and closer to the surface than in most of Europe, and therefore can be more easily developed. Both now and in the foreseeable future, Hungary's geothermal resources can satisfy the conditions required for efficient energy production. In the long term, the tremendous amount of energy stored in our geothermal reservoirs could potentially meet a major part of the country's energy demand.

Another very important consideration is Hungary's current dependence on fossil energy, more than 70% of which is imported. By contrast, geothermal energy is completely home-grown and could satisfy up to 435 PJ of our heating and cooling needs well into the future. Geothermal energy is therefore a powerful tool for reducing energy imports and achieving the national goal of energy independence.

In the long term, geothermal energy would be more affordable and less likely to undergo major price fluctuations. Unlike oil and gas imports, the market price for geothermal energy produced in Hungary cannot be easily manipulated by external factors. This could play an important role in establishing the stability of the Hungarian energy market.

1. INTRODUCTION

Hungary's excellent geothermal potential is well-known. Traditionally, most of the country's thermal water has been used for spas. The country's geothermal energy production is used as a direct heat supply to heat housing projects and businesses. As yet there is no operational geothermal power-plant in Hungary. Neither is the market for ground-source heat-pumps very strong, no doubt because of a depressed economy that has still not recovered from the global recession. Despite the weak economy, a few large-scale district heating projects are underway. Approximately 80% of the thermal energy currently sold by district heating suppliers are for heating and hot water consumption.

2. GEOTHERMAL ENERGY PRODUCTION AND UTILIZATION IN HUNGARY

Geothermal energy is produced by using the energy content of Hungary's thermal waters. This is done almost exclusively for the purpose of providing heat for direct utilization. Another source of direct utilization is that provided by heat pumps. These do not depend on warm-water sources, and harvest energy from depths of 200 meters or less.

There are currently about 1700 registered geothermal wells in Hungary. According to data from the Mining and Geological Survey of Hungary, 24.608 million m^3 of thermal water was extracted in 2015, for a total produced heat energy of 2509 TJ.

Geothermal is mostly used as direct-use applications, in district-heating and as thermal-water heating cascade systems. Currently, this is available in 23 towns representing about 223,36 MWth installed capacity and 635,66 GWhth/y annual production (Nador et al, 2019).

More than 40% of Hungary's roughly 600 thermal wells are used for balneological purposes (spas). They have a total estimated thermal capacity of about 352 MW_t, or about 3912 TJ/year. Unfortunately, this thermal capacity is not fully exploited, as Hungarian spas rarely take the opportunity to use thermal water for any purpose beyond that of offering warm water for their guests to bathe in (Toth, 2017).

Using geothermal for agriculture purposes has a long and notable history in Hungary.. About 500 wells produce nearly 11 million m^3 of thermal water for more than 70 hectares of greenhouses and 260 hectares of underfloor heating. More than fifty localities use thermal water to heat fish ponds, chicken/ turkey coops, pig pens and even snail farms. These agricultural applications use an estimated 3413 TJ.

3. IDENTIFICATION OF TARGET AND HEAT MARKETS FOR GEOTHERMAL ENERGY SUPPLY

Hungary's first geothermally-based power-generation plant was launched in Tura in 2017, as a pilot project. Unfortunately there is no significant, detailed information available regarding this project. The plant is located in a thoroughly explored former hydrocarbon block, and draws from a depth range of 1700-2200 m. The project originally aimed to achieve a 3.0 MWe capacity. Actual gross electricity production is only 2.3 MWe, of which nearly 1 MWe is used for the power plant's own electrical demands. This leaves the plant with a net usable capacity of 1.3 MWe.

Hungary's heating demand of Hungary is rather high, as houses have to be heated for about half the year. District heating systems have therefore become fairly widespread, with district heating companies supplying 94 municipalities, representing 656,000 residential customers and about twenty thousand industrial or institutional consumers.

According to data from the Hungarian Central Statistical Office, there were 2809 townships in Hungary as of 2016. Urban agglomerations represent a concentrated market, with heat demand directly proportional to population size. Urban population density varies widely between the different regions. The largest market by far is in Budapest, the country's capital. Budapest has 1.7 million habitants, and several different district heating systems.

Only 27 Hungarian towns utilize thermal water for heating purposes. These towns are: Barcs, Bóly, Budapest, Cserkeszőlő, Csongrád, Debrecen, Gárdony, Győr, Hódmezővásárhely, Jászkisér, Kistelek, Makó, Mezőberény, Miskolc, Mórahalom, Mosonmagyaróvár, Nagyatád, Szarvas, Szeged, Szentes, Szentlőrinc, Szigetvár, Szolnok, Tamási, Törökszentmiklós, Vasvár, and Veresegyház. Of these, only 21 towns have actual district heating systems: Barcs, Bóly, Cserkeszőlő, Csongrád, Gárdony, Győr, Hódmezővásárhely, Kistelek, Makó, Miskolc, Mórahalom, Nagyatád, Orosháza, Szarvas, Szeged, Szentes. Szentlőrinc, Szigetvár, Szolnok, Vasvár, and Veresegyház. Fig. 1 shows where there are geothermal district heating systems in Hungary. The figures enclosed in brackets indicate produced energy (TJ) for 2017. Although most district heating systems are only for residential supply, the district heating system in Győr also supplies an industrial consumer. Fig. 1 shows the amount of heat output provided for district heating.

Of the 6740 MW used for heating buildings in 2016, only 186 MW came from geothermal heat (HEA, 2016). We estimate that about 6500 MW (about 95%) could be provided from geothermal sources, but a more practical goal would be to replace 50 to 70 percent (about 3,370 to 4,720 MW) of current conventional heating with geothermal.

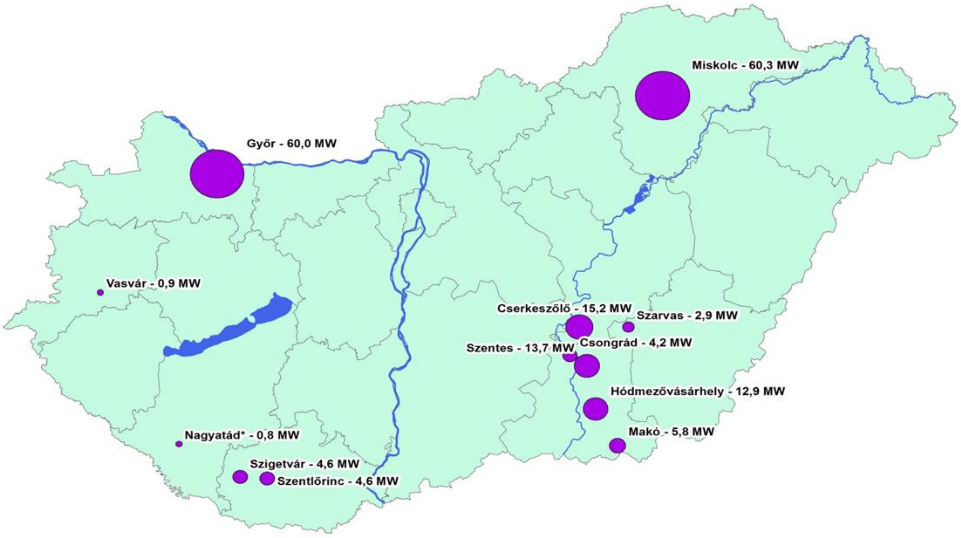

Figure 1: Geothermal district heat capacity by township in Hungary

4. MAJOR CHALLENGES FOR THE FUTURE DEVELOPMENT OF GEOTHERMAL ENERGY

World renewable energy consumption is constantly growing, as shown in Fig. 2 (Smil, 2017). Nonetheless, the future of geothermal energy is highly dependent on the extent to which deployment of geothermal power stations can be accelerated, as there is also a rapid worldwide development currently in the use of other renewable energy sources (solar, wind, water, biofuels, etc.). To cite a few examples, the utilization of wind energy is increasing annually by 25 GWe and solar energy by 6 GWe. Meanwhile, the growth of geothermal power generation remains below 2 GWe/year. Some however would argue that an increase in geothermal capacity makes it all the more important to accelerate geothermal power generation (Rybach, 2017).

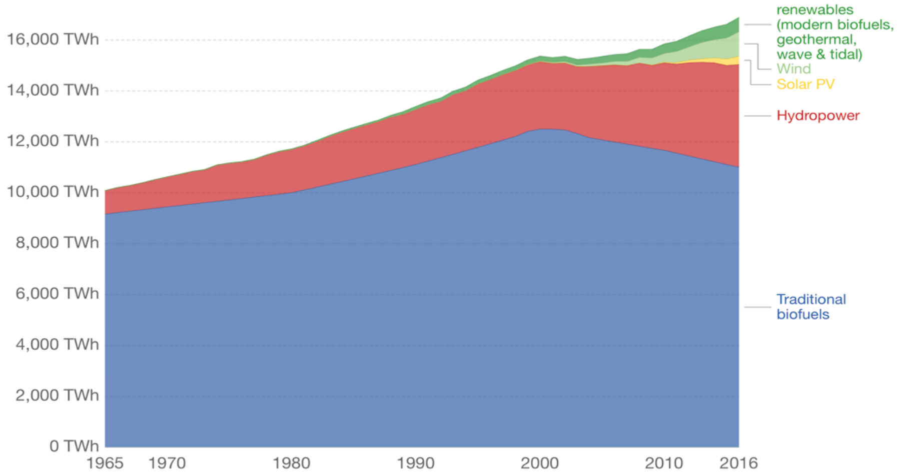

Figure 2: Global renewable energy consumption in the world

16 geothermal concession areas have been officially designated. In these areas there is a higher potential for geothermal electricity generation. These concession areas were evaluated with the help of the Hungarian Mining and Geological Survey (MBFSz), along with several associated institutions and administrative bodies, and in accordance with Hungarian Government decree No. 103/2011(VI. 29.). This decree addresses the vulnerability and capacity assessment of areas where mineral resources and geothermal energy may be located.

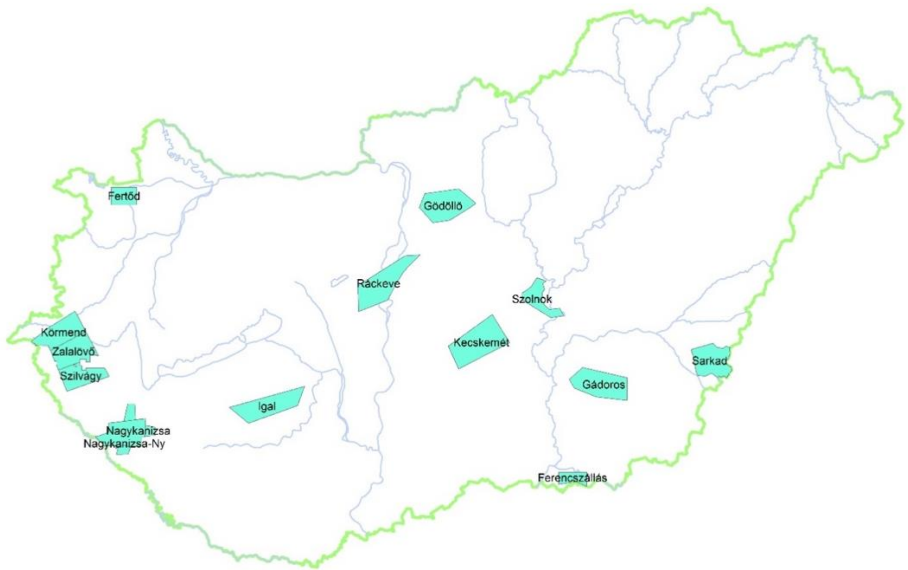

Figure 3: Geothermal concession areas in Hungary

In comparing the various electricity generation methods, including geothermal, we use Levelized Cost of Electricity (LCOE) and Levelized Avoided Cost of Electricity (LACE) over the lifetime of the project. The LCOE measure shows the cost of generating electricity per kWh over the lifetime of the power plant, including all construction, maintenance, operational and decommissioning costs, capital and cost of investment, fuel price and power plant utilization rate. (Tester et al., 2006).

5. HUNGARIAN NATIONAL ENERGY STRATEGY

The LACE metric shows the cost of generating electricity in the network (in an existing or in another new infrastructure) where an investment in that electricity infrastructure is planned. If the LACE for a given investment is larger than the LCOE, the investment is considered economically viable. In this area, even for reference pricing, it is worth keeping up to date with the U.S. Annual Information Outlook of Energy Information Administration, which presents LCOE and LACE data for most of the world's natural energy market.

By applying this calculation method to geothermal energy, we can obtain very favorable values in terms of the cost-effectiveness of the investment. On this basis, and thanks to Hungary's favorable geothermal properties, geothermal energy could play an important role in the National Energy Strategy for 2050. The Hungarian geothermal potential can be treated as a national treasure and a strategic resource. Geothermal energy is used primarily for direct heat production purposes domestically, of course, but the long-term goal is to not to have it restricted exclusively to that purpose. The best solution for energy efficiency is to combine heat and power (CHP) and geothermal district heating systems. It is also important to note that, in some cases, the current high costs may decrease rapidly as technology advances.

The Renewable Energy Action Plan (NCsT) also takes into account geothermal energy. By 2020, the use of geothermal energy for heating purposes will more than triple compared to 2010 levels. According to the NCsT, geothermal will also generate electricity generation by 2020, with an estimated installed capacity of about 57 MWe (note: geothermally generated electricity is not yet currently available to any significant degree anywhere in the country). In 2020, geothermal energy could account for 19% of our gross final energy consumption from renewable sources for heating and cooling. The goal is to utilize about 18 PJ of this energy source to meet our heating, cooling and power generation goals.

The National Environmental Technology Innovation Strategy for 2011-2020 also contains proposals for geothermal innovation. It is worth thinking about pilot projects to develop the technical issues of paired geothermal wells. Other possibilities include using integrated (cascade) heat recovery systems to increase energy efficiency and utilize waste heat, if certain technological and hydraulic issues regarding thermal water injection can be resolved.

The current Hungarian domestic situation shows that several methods can continue to be used and developed for the utilization of geothermal energy: district heating; combined heat and power generation; domestic hot water production; and geothermal heat pumps, which can be used for either heating or cooling. At present, domestic use of geothermal energy is still low as a percentage of total renewable energy produced, as it less than 10 PJ/yr. Based on the government's 2020 targets, however, this will likely change.

It is worth mentioning the Danube Region Leading Geothermal Energy (DARLINGE) project, led by the Hungarian Mining and Geological Survey (MBFSZ). This project is aimed at promoting the sustainable use of geothermal resources in the Danube region. The project involves 15 partners from six countries, with the goal of promoting geothermal energy use in the heating sector throughout the southern Pannonian basin. The project posits a complex study and development plan for cross-border geothermal reservoirs.

SUMMARY

From the point of view of geothermal energy, Hungarian natural abilities are favorable and the conditions for efficient geothermal energy production are an asset not only now and will be well in the distant future. At the same time, we have to take into account the factors that hinder the widespread use of geothermal energy, so as to create a more realistic picture.

The spread of geothermal energy has the potential to lift up the economically disadvantaged populations who inhabit areas rich in natural geothermal resources. Exploitation of geothermal energy has a special role to play in employment, generating new jobs and positions in the sectors of education, vocational training, engineering and in-service training. But increasing of geothermal energy utilization cannot be achieved by mere technical research and development -- thoughtful, forward-looking policy decisions are also needed to achieve this goal.

Based on all this, it can be safely stated that geothermal energy -- as a new, environmentally friendly and economical energy source-- could soon become one of the driving forces of the Hungarian economy.

REFERENCES

Nador, A., Kujbus, A. and Toth, A.: Country Update for Hungary *Proceedings* of European Geothermal Congress, Haag, Netherland, (2019)

Smil, V.: Energy Transitions: Global and National Perspectives. & BP Statistical Review of World Energy, *Praeger;* 2. Edition (2016),

Toth, A.: Creating a Geothermal Atlas of Hungary, *Proceedings,* 42nd Workshop on Geothermal Reservoir Engineering, Stanford University, Stanford, CA (2017).

HEA: Data of the Hungarian District Heating Sector 2016,