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Geothermal Energy Use, Country Update for Serbia

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ABSTRACT

The territory of Serbia has favourable geothermal characteristics. There are more than eighty hydrogeothermal systems within four geothermal provinces. According to the recent data in Serbia in 2021 **539.68 GW$_{th}$** was produced from geothermal sources with a total capacity of **156.52 MW$_{th}$**, where **422.77 GW$_{th}$** was in geothermal direct use with a thermal capacity of **103.93 MW$_{th}$**, and **116.91 GW$_{th}$** from shallow geothermal systems using heat pumps of total capacity **52.59 MW$_{th}$**. The commonest use of geothermal energy in Serbia is the traditional ones: balneology and recreation. The use of the geothermal energy from shallow systems is in expansion, since the number of residential and office buildings using heat pumps for heating, air-conditioning and cooling and sanitary hot water, is rising on monthly basis. However, Serbia did not meet its 2020 renewable energy target of 27% of gross final energy consumption set by EU, yet it is intensively working on new regulations and projects to attract investors and provide funds to increase the total share of all renewable energy sources in gross final energy consumption.

1. INTRODUCTION

Serbia is situated in the central part of the Balkan Peninsula (Fig 1) and covers the surface of 88361 km^2. Systematic geothermal investigations in Serbia began in 1974, after the first world oil crises. Until 1990 numerous deep geothermal drill holes had been constructed and put into operation. In Pannonian basin, as the most prospective region, 24 hydrogeothermal systems had been constructed and put in operation before 1990, when the highest production was reached of about 1.6 million m^3 of thermal water, that was used for heating, balneology, agriculture and industrial processes.

Nowadays, situation is different, hydrogeothermal systems in use are mainly those constructed before 1990, and most of them are not fully operational. However, Serbia is experiencing an expansion of energy production from shallow geothermal systems using heat pumps. Almost every state-of-the-art residential or business building is using heat pumps for heating, air-conditioning and cooling and sanitary hot water.

Figure 1: Geographical location of Serbia.

2. GEOLOGY BACKGROUND

In the territory of Serbia rocks of different age outcrop, from Precambrian to Quaternary age, and of all lithological types. There are five major geotectonic units (Fig 2): Dinarides, Serbian-Macedonian massif, Carpatho-Balkanides and Pannonian Basin, and a very small part at far east of the country that belongs to Mesian Platform (Grubic, 1980).

Dinarides occupy large part of Serbia and they are made of Mesozoic rocks, mainly limestones and dolomite of Triassic age, then of ophiolite melange of Jurassic age and Cretaceous flysch.

The Serbian-Macedonian massif occupies the central part of Serbia and it is made of Proterozoic metamorphic rocks: gneisses, various schists, marbles, quartzites, as well as magmatic, or intrusive-granitoide and volcanic rocks of Tertiary age.

Carpatho-Balkanides extend over the eastern part of Serbia and the unit is mainly made of limestones of Triassic, Jurassic, and Cretaceous ages. At north, Serbia belongs to the large unit that extends far beyond the Serbian borders, known as the Pannonian basin that consists of Palaeogene, Neogene and Quaternary sediments with a total maximum thickness of about 4000 meters.

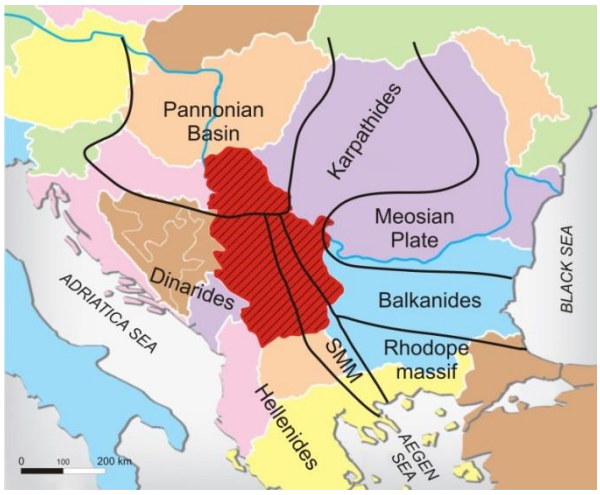


Figure 2: Tectonic map of Balkan Peninsula (Martinovic and Milivojevic, 2010)

3. GEOTHERMAL RESOURCES AND POTENTIAL

The territory of Serbia is featured with a geothermal potential higher than what is in use nowadays. According to M. Milivojevic (1989), there are four geothermal provinces within the four main geotectonic units.

Excluding Pannonian basin, there are 159 natural springs of thermal water with temperature above 15ºC. The thermal springs with the highest temperature are in Vranjska spa (96ºC), then Josanicka Spa (78ºC), Sijarinska Spa (76ºC), Kursumlijska Spa (68ºC) and Novopazarska Spa (54ºC). The total flow of all natural springs is about 4000 l/s. The thermal springs with highest flow are draining the karstified limestones of Triassic age, and the next are those from Tertiary granitoides and volcanic rocks. The most of thermal springs occur in the Dinarides then in the Carpatho-Macedonian Massif.

In Pannonian basin there are 83 hydrogeothermal drill holes with total average flow of about 700 l/s, and water temperature that ranges from 21ºC to 82ºC.

There are 60 convective hydrogeothermal systems in Serbia. Of this number, 25 are in the Dinarides, 20 in the Carpatho-Balkanides, five in the Serbian-Macedonian Massif, and five in the Pannonian Basin under Tertiary sediments (Fig 3). Conductive hydrogeothermal systems are developed in basins filled with Paleogene and Neogene sediments and as such they mainly occur in the Pannonian Basin in Vojvodina, northern Serbia (Martinovic and Milivojevic, 2010).

3. GEOTHERMAL UTILIZATION

At over 50 locations in Serbia, thermal water is being currently used for balneology, sport and recreation. Geothermal energy utilization for heating, as well as in agriculture and industrial processes, is present but only in a few locations. Geothermal energy utilization for heating is usually connected with systems used for spas and balneology, while district heating systems based on geothermal energy are rather rare. The latter are old systems, working only partially. However, there is a growing interest in using geothermal energy from shallow systems through heat pumps for individual commercial and residential buildings heating, air-conditioning and cooling and sanitary hot water.

Total energy production from geothermal sources in Serbia in 2021 was **539.68 GW_{th},** where **116.91 GW_{th}** was from shallow geothermal systems using heat pumps.

There are 130 hydrogeothermal drill holes, of which 83 are in the Pannonian basin and 47 in other provinces. The total heat capacity of all hydrogeothermal drill holes in Serbia is about 200 MW_{th}, where 82.5 MW_{th} is in the Pannonian basin. In 2021, 20 hydrogeothermal drill holes in the Pannonian basin were in operation with a total thermal capacity of 25.4 MW_{th}.

In other geothermal provinces in Serbia, Macva region is considered one of the highest prospects for multipurpose use of geothermal energy. The total heat capacity of hydrogeothermal drill holes in Mačva is over 30 MW_{th} while in 2021 16.35 MW_{th} were in use.

The use of heat pumps in Serbia became popular in the last several years, along with the use of solar panels. There are about **2900** heat pumps installed throughout Serbia with a total capacity of **52.59 MW_{th}** that produced **116.91 GW_{th}** in 2021. Most are used for heating commercial and residential buildings in cities in Serbia, like Belgrade, Novi Sad and Nis. In the last four years over 10 projects of geothermal energy use for heating have been started in mountain resorts and commercial and residential buildings in cities. The latest of these projects was started in Belgrade in 2021, with 180 probes of 2.15 MW_{th} thermal capacity for heating and 2.1 MW_{th} for cooling.

We must emphasize that it is difficult to quantify the exact number of geothermal energy applications, especially from shallow geothermal installations, for small greenhouses and individual buildings. But it is evident that those applications are growing very quickly, and that some users are not always following the procedures proscribed by Serbian regulations.

4. DISCUSSION

The highest geothermal interest in Serbia is in resources to be used for aqua parks and wellness centres, where investors recognize the benefits of using thermal water not only for recreational purposes but for heating the premises and sanitary hot water as well.

The government, for its part, is trying to help investors with incentives, but still, when it comes to deep systems, projects stop after the hydrogeothermal drill holes are completed, mainly due to the high cost of constructing the new heating systems or adapting the existing ones.

In the last decade, six hydrogeothermal drill holes were constructed in Vojvodina (Pannonian basin) and all were planned to be used for heating and recreational and wellness centres, yet only one was put into operation. Projected hydrothermal systems planned to be operational by 2022 are still on hold. This was only partially due to the pandemic of COVID-19, and more due to a lack of funds and serious investors.

Serbia did not meet the goal of having 27% of renewable energy sources in the gross final energy consumption by the end of 2020, set in the Directive 2009/28/EC. In 2019 its share was 21.4% (Report on the Implementation of the National Renewable Energy Action Plan of the Republic of Serbia for 2018 and 2019).

Based on the current trend, it can be concluded that it takes time for the new system of incentives to come to life, and then to gain investors' confidence in the functioning of the system, as well as to prepare appropriate projects, especially projects for the construction of large power plants.

To improve investors' interest in renewable energy sources, in 2021 Serbian Government has come up with three improved laws about energy, mining and renewable energy sources that intend to shorten the procedure for obtaining licences and encourage investors to choose renewable energy sources.

At the time when this paper was finalised (autumn 2022), the ongoing war in Ukraine caused an energy crisis, particularly in Europa. This in turn triggered the question about household heating and electric energy availability in Serbia. Many individual households were searching for renewable energy options (solar panels and heat pumps in particular). Unfortunately, the facts about the expenses of building and maintaining these systems caused majority to give up. In our opinion, we need in Serbia wide plans of education and outreach on renewable resources and their benefits, along with government programmes, investments and help, as replacing the traditional energy sources with renewable sources is quite expensive.

5. FUTURE DEVELOPMENT AND INSTALLATIONS

For now, geothermal energy in Serbia is used in the amount of **103.93 MW_{th}** and additional **52.59 MW_{th}** of shallow systems. This can be considered a very low use compared to its potential.

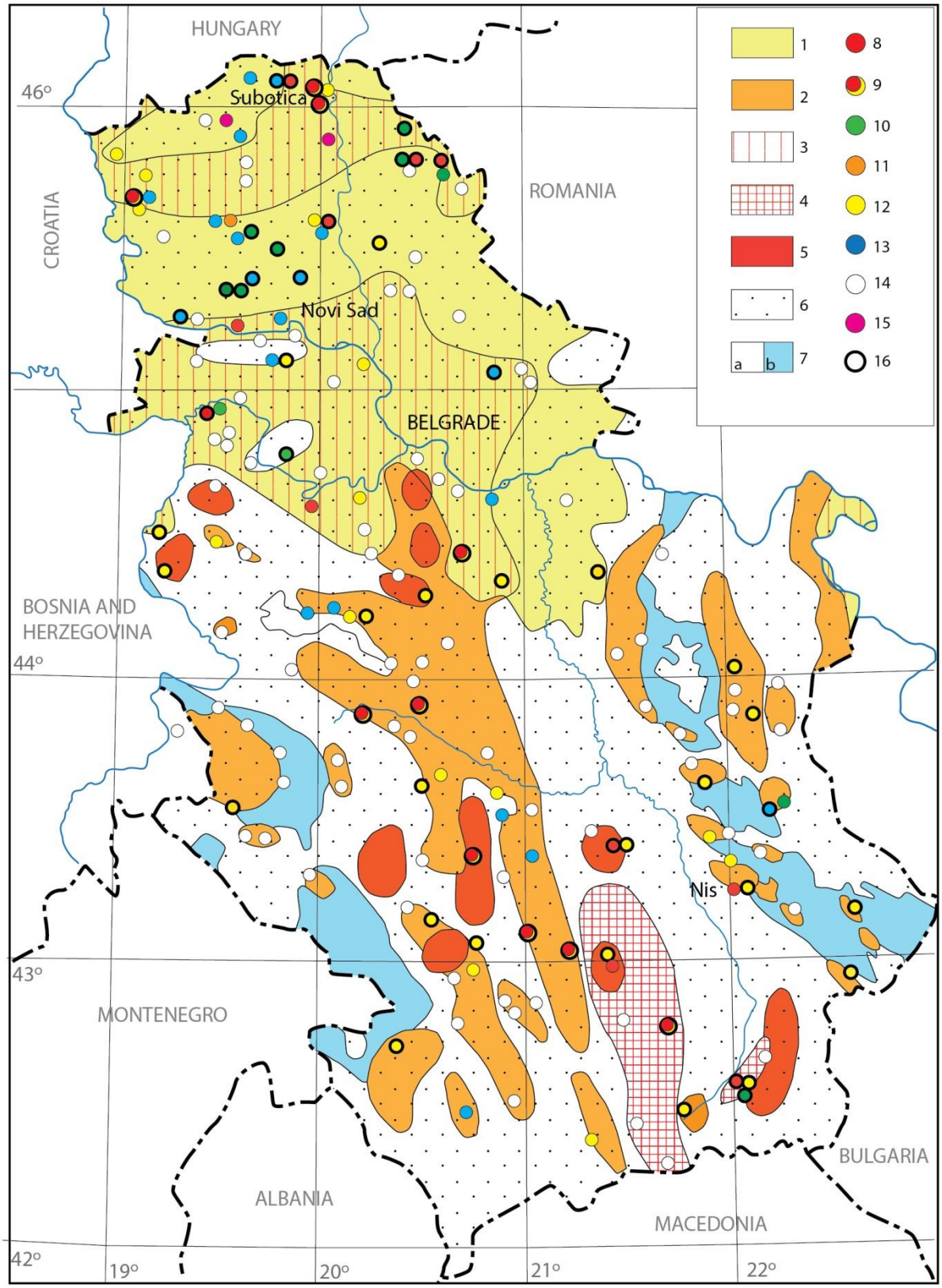
The most significant use of geothermal energy in Serbia could be for district heating of settlements and agriculture development, more precisely food production following the ecological standards and in near future for electric power production.

There are six geothermal systems awaiting development, five in the Pannonian basin for heating and recreational purposes with a total capacity of **14.68 MW_{th}**, and one from reservoirs in karstified limestone beneath the Neogene sediments in Macva province, for use in agriculture, with a thermal capacity of **8.49 MW_{th}**.

The more interesting use in Belgrade is heat pumps for heating the large state-of-the-art residential buildings, hotels and shopping centres, where reservoirs of interest are in the alluvial sediments of Sava and Danube, and the Neogene sediments below. In addition, are significant prospects for using heat pumps on pumped groundwater from alluvial deposits along all major rivers.

At the very end of 2021, a new project commenced. The United Nations Development Programme in partnership with the Ministry of Mining and Energy of the Republic of Serbia and the Council of Europe Development Bank in close cooperation with the Administration for Joint Services of the Republic Bodies, will implement this project intended for preparatory activities for the Programme of Energy Efficiency in Central Government Buildings.

The envisaged multiannual programme is aimed at energy efficiency renovation of central government buildings as per Article 5 of the Energy Efficiency Directive (2012/27/EU). The Programme should result in 30% of primary energy consumption reduction, 20% of CO_2 reduction and 29% savings in operational cost for energy, within the 27 specified buildings. The first step shall be determining the locally available hydrogeothermal, and petrogeothermal potential from which it is possible to generate the required energy for building sustainable and acceptable systems, regarding the status and significance of the buildings.



Legend: 1-Hydrogeothermal aquifer in Cenosoic rocks; 2-Hydrogeothermal aquifer in Mesosoic rocks; 3-Hydrogeothermal aquifer in Mesosoic rocks bellow Cenosoic rocks; 4-Hydrogeothermal aquifer in Paleosoic rocks; 5-Petrogeothermal resources in Tertiary granitoide rocks; 6-Hydro-petrogeothermal resources to 200 m deep for exploitation of geothermal energy with heat pumps; 7-Areas without significant geothermal resources: a) terrains with rocks of Paleosoic and Proterosoic age, b) karstic terrains;
UTILIZATION OF RESOURCES: 8-heating; 9-heating, balneotherapy and recreation, 10-Food production; 11-industry; 12-Balneotherapy; 13-Recreation and sport; 14-Occurences not used; 15-Under construction in 2018; 16-In operation in 2018.

Figure 3: Map of geothermal resources of Serbia (background: Geothermal resources map, Milivojevic, 2001).

6. CONCLUSIONS

It is certain that Serbia has a great potential in hydrogeothermal energy for direct use, and that the current use is very small. Recent explorations show that many sources were closed and out of operation, and that many data are outdated. The past high interest in geothermal energy utilization has been decreased, and unfortunately lost after facing many obstacles.

On the other hand, the share of low enthalpy systems in total energy production from geothermal resources is 20% and rising. Due to the world energy crisis, we expect this percentage to be much higher in the next years. We hope that the new laws, passed in 2021 that move Serbia to a market-based scheme, would speed up geothermal energy utilization projects.

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