



POSSIBILITY OF APPLICATION OF GEOTHERMAL ENERGY IN SUSTAINABLE DEVELOPMENT OF SPA TOURISM IN SERBIA

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Abstract:

The issue of environmental protection and the use of renewable energy sources in order to achieve environmentally sustainable business, is becoming an unavoidable topic today. Geothermal energy is one of the most promising forms of renewable energy sources whose use dates back to the distant past. The existence of the possibility of using the mentioned renewable sources, especially within the framework of spa tourism, represents the basis of sustainable business. The Republic of Serbia has a huge potential for the use of geothermal energy, especially when it comes to the tourism sector. The Republic of Serbia has a large number of geothermal mineral springs, but they are insufficiently used. The largest consumers of geothermal sources are the industrial sector and agriculture, while in tourism these resources are barely used. In recent decades, health, wellness and spa tourism have become one of the fastest growing tourism sectors globally. Tourism based on the use of geothermal energy represents a development opportunity which is in line with the Tourism Development Strategy of the Republic of Serbia for the period 2016 - 2025. The aim of this paper is to explore the potential and current application of geothermal energy in spa tourism in the Republic of Serbia. For this purpose, the authors will consider two distinct locations the Jokin Grab Spa and Vranjska Banja.

Keywords:

spa tourism, geothermal energy, sustainable tourism, Jokin Grab Spa, Vranjska Banja.

INTRODUCTION

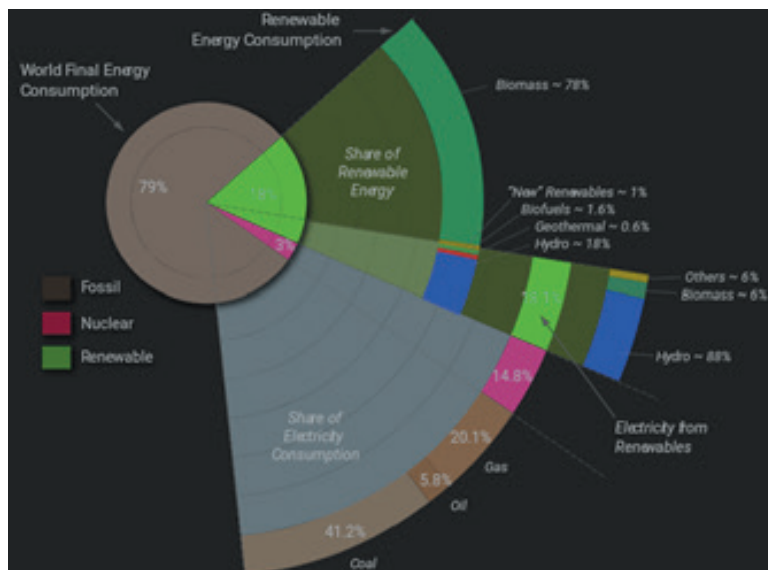
World population growth, modernization and application of high technologies in the everyday and business world, leads to increased demand for energy, which amounts to about 1.5% annually, with the prediction that by 2055 the process will accelerate 3 times (Dražić, 2020). Increased energy needs cause the irrational use of energy sources that are on the verge of extinction, directly endangering the planet Earth. One way to reduce the use of non-renewable energy sources is to gradually switch to the use of renewable “new” energy sources. The term renewable energy sources (RES) refers to the rate of their consumption that is less than or equal to the rate of recovery, so their reserves are estimated over a long period, and these types of energy include: solar energy, wind energy, water energy, biodegradable waste, geothermal energy and biomass. In contrast, traditional, non-renewable energy sources are found in limited quantities and are prone to complete depletion (Dražić, 2020).

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The use of RES represents a large financial investment in the process of formation and implementation, their use in production is significantly more expensive than fossil fuels, and this is one of the reasons why their application is at a very low level. Research has shown that only 18% of the world's energy comes from RES Figure 1.

Figure 1. Global energy consumption by sources

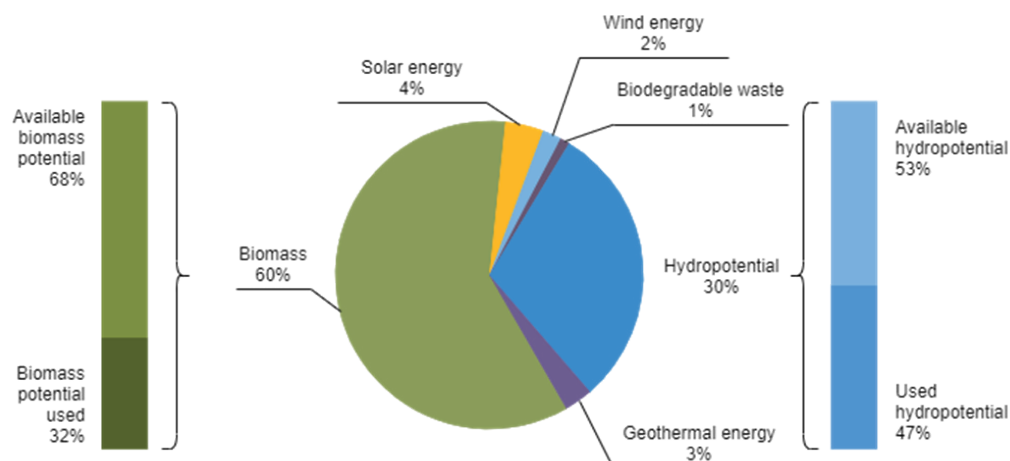


Source: https://greenrhinoenergy.com/renewable/context/uses_and_sources.php

The use of RES has numerous benefits, less negative effect of the "greenhouse" and it stimulates the development of local areas and the economy, which is directly related to the reduction of the unemployment rate (Riznić et al., 2013).

Valorisation of RES in Serbia is in the initial phase, although the estimated potential is significant. Until recently, the use of these sources was at a minimal level, but by participating in activities and projects designed and financed by the EU, ratification of numerous agreements, both internationally and nationally in this area, Serbia achieves a higher percentage of use of these types of energy.

Figure 2. Structure of the estimated RES potential in Serbia



Source - Adjusted according to: <http://indikator.sepa.gov.rs/pretrazivanje-indikatora/indikatorilat/allfindr/2edb a915e97b466aab3bb6581e2db228>



GEOTHERMAL ENERGY

Renewable energy sources (RES) in their various forms are all around us, and a very important source is geothermal energy. The term geothermal energy comes from the Greek words geo (earth) and therme (heat) and is most often defined in the literature as heat obtained from the Earth's core. It represents the natural energy accumulated in the fluids and rock masses in the Earth's crust (Nenković & Pucar, 2019). Below the Earth's surface there are a large number of thermal springs, hot rocks and magma. As the depth increases, the temperature rises and ranges from 17 °C to 30 °C (Andrić, 2015). The geothermal potential at the global level is very high, especially if we take into account that with a decrease in the temperature of the Earth's crust by only 0.1 °C, the heat of the Earth's crust would be enough to supply electricity for the next 15,000 years (Nenković & Pucar, 2019). Geysers are one of the most recognizable ways for hot water to come from the depths to the Earth's surface. For their formation, the so-called "storage" of water is needed, a heat source that turns water into steam and an opening on the earth's surface through which high-temperature water and water vapor come out under pressure. Rainfall in the form of rainwater penetrates through cracks in the earth's crust and accumulates there. Then, hot volcanic rocks heat that accumulated water and turn it into steam, which results in the eruption of steam or hot water through the opening of the geyser. Not to be overlooked is the fact that, after the eruption, the geyser calms down and shrinks, and after a certain period of time the eruption occurs again (Center for Energy Efficiency, 2021).

The greatest potential of geothermal energy is in the areas that are geologically very active i.e. areas that have a large number of active volcanoes such as the Pacific Ocean (the so-called Pacific Fire Belt), New Zealand, the Philippines, Japan, the Alps and the Himalayas.

The basic ways of using geothermal energy listed in (Nenković & Pucar, 2019) are:

- ◆ Heating of buildings
- ◆ Spa tourism
- ◆ Greenhouse
- ◆ Application in aquaculture
- ◆ Industry and application in agriculture

The use of geothermal energy sources achieves numerous benefits, environmental, social, economic, both in individual application and for business purposes, which imply sustainable development and operations. When applying geothermal energy, it is important to:

1. achieve minimal pollution, as well as low emissions, therefore it is one of the cleanest energy sources;
2. to have facilities that use geothermal resources mainly located in rural areas where, in most cases, the unemployment rate is higher than in urban areas, and thus greatly affect the increase in the employment rate per megawatt in comparison to facilities that use natural gas (Kostić & Vukadinović, 2014);
3. by implementing and valorising geothermal energy, economic entities, as well as individual households, achieve significant savings in terms of costs, e.g. heating or cooling of hotel facilities, valorisation of hot water in spa centres, in processing facilities, in heating of households, greenhouses, etc.

GEOTHERMAL ENERGY IN SERBIA AND ITS APPLICATION IN SPA TOURISM

The European Union has defined the term geothermal energy in the RES Directive as "any type of energy stored in the form of heat below the surface of the terrain" (European Parliament & Council of the European Union, 2018). The geothermal potential of an area is estimated based on the geothermal flow density, which is the amount of geothermal heat that comes to the Earth's surface every second through an area of 1 m².

The use of geothermal energy in Serbia is at a very low level, despite the fact that our country has great potential, as well as the possibility for its use. Serbia could produce 55% of electricity when using geothermal energy, while unfortunately only 86 MW is used. It should be noted that the geothermal flow density in most parts of the Republic of Serbia is higher than the average value of the rest of Europe, which is 60 MW/m² (Andrić, 2015).



The use and application of thermo-mineral healing waters in health prevention dates back to the Roman period, as evidenced by numerous remains of Roman baths on the territory of our country (Vrnjačka Banja, Sokobanja, Sijarinska Banja, Niška Banja, Ribarska Banja). At the end of the 19th century, Baron Sigmund A. Herder analysed the water of the former spas and the degree of their healing properties. The existence of thermo-mineral springs and the development of mass tourism condition the appearance of the so-called spa tourism, which is becoming increasingly popular type of tourism in today's modern age. According to the definition of the International Spa Association, ISPA, a spa is "a place dedicated to improving overall well-being through a variety of professional services that encourage the renewal of body, mind and spirit." (Internacionalna Spa Asocijacija, 2021).

The Republic of Serbia has a great potential for the use of geothermal energy, which is mostly used for space heating, in spas (balneology) and in agriculture. Table 1 shows final consumption of geothermal energy by consumption sectors. Geothermal resources of the Republic of Serbia are quantified according to the following subgroups (Chamber of Commerce of Serbia, 2021):

- ◆ Subgeothermal resources with the temperature up to 30 °C (subhydrogeothermal and subpetrogeothermal resources),
- ◆ Geothermal resources in the narrow sense, with the temperatures from 30 °C to 100 °C,
- ◆ Geothermal resources with the temperature over 100 °C (hydrogeothermal resources and dry rock energy (hot dry rock systems - HDR))

The areas of Vojvodina, Mačva, Stiga, Pomoravlje, as well as the Toplica and Vranje areas are the richest in geothermal waters, which indicates the great exploitation potential of geothermal energy in our country.

Table 1. Final consumption of geothermal energy by consumption sectors

Final consumption of geothermal energy by consumption sectors	2019.	2018.	2017.	2016.	2015.	2014.
Industry	0	0	0	0	0	0
Traffic	0	0	0	0	0	0
Households	0	0	0	0	0	0
Agriculture	132	131	132	132	167	149
Public commercial activities	88	87	82	82	89	85
TOTAL:	220	218	214	214	256	234

Source: Republički zavod za statistiku, 2021

CASE STUDY OF HYPERTHERMAL SPA - "JOKIN GRAB" SPA IN BOGATIĆ AND VRANJSKA BANJA

Jokin grab spa is located in Bogatić, in the Mačva district, occupying the area between the rivers Drina and Sava. Hydrogeothermal exploration of Mačva began in 1982 after the discovery of a large conductive geothermal anomaly in Neogene sediments in Dublje. Based on the chemical analysis of the thermal waters of Mačva, it is concluded that these are waters of good quality and chemical composition. The density of terrestrial heat flow in the area of Mačva is very high and in the well in Bogatić it is 120 mW/m² (Matić, 2018). The temperature of water in the pool is 39°C. The potential of the spa water has been fully used for balneological purposes. It helps in the treatment of many diseases and together with its chemical composition it has a significant hydrothermal, hydro-chemical and hydromechanical effect on visitors. "Termalna Rivijera" aqua park with healing thermal waters and its own wells with a temperature of 70 °C offers various types of services, outdoor and indoor pools, hydro-massage pools, pool bars, restaurants and many other facilities making it an ideal place for couples and families with children.



Given the geothermal potential, good transport infrastructure, proximity to neighbouring countries (Bosnia and Herzegovina, Croatia) in the coming period more intensive development of spa tourism in this part of Serbia can be expected, as well as the expansion of the existing tourist offer. The use and utilization of thermo-mineral resources is a safe, guaranteed and inexpensive source that is not subject to numerous economic and environmental accidents.

Vranjska Banja encompasses the Vranjska valley, and tectonically it belongs to the Serbian-Macedonian mass, being located at an altitude of 380 m. One of the greatest potentials of the Vranjska valley are geothermal springs whose use dates back to ancient times. Numerous archaeological excavations as well as archaeological artefacts found there, testify to the existence of Roman baths in this area. Thermo-mineral water was used for healing purposes in the Middle Ages, but only after the liberation from the Turks did it gain importance as a health and tourist centre.

According to the richness of geothermal resources, Vranjska Banja is one of the warmest spas in Europe with a water temperature of 96 °C, while in some places the water temperature is 111 °C, recording a capacity of 140 litres per second. On account of the water temperature, Vranjska Banja together with Jošanička Banja belongs to the group of hyper thermal sources. The importance of this water, in addition to temperature, is also reflected in its noticeable healing properties: the water is mineral, has a large amount of sulphur, it is slightly alkaline. The water temperature at the iron spring is 61 °C, while at the sulphur spring it is higher and reaches 84 °C (Predlog programa razvoja gradske opštine Vranjska Banja 2012-2017, 2021). It is used in the treatment of a large number of diseases such as: various forms of rheumatism, post-traumatic conditions, gynaecological and skin diseases, diseases of the digestive organs and many others. It has a wide range of medical services: kinesitherapy, massage, sonotherapy, laser therapy, hydrotherapy and many others. The healing power of water is influenced by the healing gas sulphur-hydrogen, which records a quantity of 1.9 mg/l, which is twice as much as the defined 1 mg/l required for the healing properties. The water temperature at the sulphur spring averages 90 °C and has a great balneotherapeutic value in combination with various possibilities of therapy, exercises and the like. In addition to the mentioned minerals, the water is rich in fluoride (8-8.5 mg/l), which is another benefit of water in Vranjska Banja compared to spas in the rest of the Republic of Serbia. (<https://vranjska-banja.rs/>). According to the latest available data, 10 springs have been recorded in the spa, the most significant of which are shown in Table 2.

Table 2. The most important geothermal springs in Vranjska Banja

No.	Source name	Quantity of water (l/s)	Depth (m)	Temperature (°C)
1.	Upper source	1,2 l/s		78 °C
2.	Source B1	2,0 l/s	26m	92 °C
3.	Source A1	0,5 l/s	25m	91 °C
4.	VG-2	27,0 l/s	1063m	111 °C
5.	Source A3	2,1 l/s	20m	91 °C
6.	Source B2	1,0 l/s	7m	96 °C
7.	Source B1	1,5 l/s	12m	87 °C
8.	Collection channel	50-70 l/s		84 °C
9.	Source A2	1,0 l/s	25m	84 °C
10.	VG-3	21,5 l/s	1600m	120 °C

Source: Gradska opština Vranjska Banja, 2021



Geothermal energy is used to heat accommodation facilities, kindergartens, schools and the “Železničar” hotel. The amount of energy in thermal water is directly correlated with the water temperature at the beginning of the process and with the leaving water temperature. Growing and production of flowers in Simpo-cveće and Rasadnici is based on the use of geothermal springs (Kostić & Vukadinović, 2014). Geothermal waters in Vranjska Banja have sufficient temperature for installation and application in the industrial process and greater application in the tourism sector in the future.

CONCLUSION

The use of geothermal energy has long-term benefits that are reflected in the saving of energy, capital and natural resources. In addition to the economic benefits due to the reduced need to import fossil fuels, geothermal energy has environmental benefits by contributing to the reduction of carbon dioxide emissions into the atmosphere. The introduction of green, cleaner technologies reduces the greenhouse effect and increases care and awareness of environmental protection. RES in Serbia are underused despite their great potential. The Municipality of Bogatić is a good example of the use of geothermal energy for balneological, tourist and agricultural purposes, and the Jokin Grab Spa near Bogatić, as one of the warmest spas, uses natural resources at its disposal and whose more intensive use is planned in the coming period.

Thanks to its unique capacity of hyperthermal water in this part of Europe, Vranjska Banja represents the greatest potential for the development of the abovementioned segment of tourism. The company Millennium Resorts in cooperation with the American company Marriott International is in the process of realizing the project in Vranjska Banja, construction of two hotels of different categorization, Westin hotel and Autograph Collection hotel. The project represents the largest investment in Serbian tourism, especially when it comes to the Pčinjski district. It is planned that the Westin hotel is categorized with 4*, that it has a congress centre, a spa centre of 4000m², as well as a special area for children, fitness and business centre. Autograph Collection hotel should be categorized with 5*, and located where the former special hospital for rehabilitation was. It should be noted that both hotels will be a part of the hotel complex, which will include the Sofka Medical Centre as well as numerous bungalows and apartments. With an investment of 90 million euros, Vranjska Banja gets the most modern medical centre and the opportunity to position itself on the tourist market as a destination of high international quality standards when it comes to spa & wellness tourism.

In 2014, the Assembly of the Republic of Serbia adopted the “Energy Development Strategy of the Republic of Serbia until 2025 with projections until 2030”. Based on the mentioned Strategy, it is noticed that the estimated amount of geothermal energy is higher than the total amount of natural resources, which indicates the importance of the application of the mentioned energy. Also, the Strategy defines and analyses the key elements in the goal of developing the energy sectors of the Republic of Serbia by 2025. One of the key goals of the issued document is more intensive use of RES in all economic activities, with special reference to the tourism sector, and that can certainly improve Serbia’s positioning on the tourism market, with a larger number of tourists and revenue growth. Hopefully this strategy will also boost research in the field of RES making available additional data on the geothermal potential of the Republic of Serbia which were at the time of writing of this paper sparsely available.

Due to the sparsity of the data about the geothermal potential of the Republic of Serbia this paper focuses on two polar examples of utilization of geothermal resources in the Republic of Serbia for which the data is available. In future research the authors plan to extend their analysis to all of the geothermal resources on the territory of the Republic of Serbia as well as to the region of Southeastern Europe with inclusion of countries such as Slovenia and Hungary which have a highly developed utilization of their geothermal resources.



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