Renewable and Sustainable Energy Reviews 59 (2016) 940–951

Contents lists available at ScienceDirect

Renewable and Sustainable Energy Reviews

journal homepage: www.elsevier.com/locate/rser

Analysis and possible geothermal energy utilization in a municipality of Panonian Basin of Serbia

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ARTICLE INFO

Article history:
Received 22 November 2014
Received in revised form
1 December 2015
Accepted 18 December 2015
Available online 27 January 2016

Keywords:
Geothermal energy potential
Geothermal drills
Hydrogeological characteristics
Physicochemical characteristics
Direct energy utilization

ABSTRACT

Energy goal of Serbia is to reach the share of 27% renewables in its final energy consumption by the year 2020. Geothermal energy is the source that can significantly contribute to the achievement of this goal, particularly in the domain of direct utilization. Indjija municipality is located in the northern part of Serbia and is a typical representative of a region in the Pannonian Basin.

In Indjija municipality two exploration boreholes are drilled. Conducted analysis has shown that one of them (Indj-3/H) did not achieve expected results and was labeled as negative. The second (Indj-1/H) was labeled valid for the evaluation of prospective use of geothermal fluid. The results have shown that around 1.25×10^6 m^3 of water can be obtained annually from the second drill. With complete effusion in the drill Indj-1/H, a total of 10.85 GWh can be expected annually.

The aim of this paper is to evaluate the geothermal energy potential of Indjija municipality based on two exploratory drill sites. Firstly, geomorphological, geological, geophysical, hydrogeological and hydrothermal characteristics of the area are determined. In addition to this, physicochemical characteristics of geothermal and mineral waters, as well as drill's capacity are analyzed. In accordance with the results, possible applications of the geothermal fluid are considered and recommendations for direct use are given. Feasibility study was conducted for a combined multifunctional system. Investment is profitable after 3–5 years depending of the scenarios. It is concluded that balneology, spas, sports and tourism activities, as well as sanitary hot water supply and space heating are the most appropriate forms for direct use.

Contents

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http://dx.doi.org/10.1016/j.rser.2015.12.337
1364-0321/

1. Introduction

Geothermal energy is the energy contained as heat in the Earth's interior [1]. It is the thermal energy contained in rocks and fluids (that fill the fractures and pores within the rock) in the earth's crust [2,3]. There are different definitions of geothermal energy, depending on the problem being researched. Heat stored in dry rock masses is called petrogeothermal energy and the heat in underground fluid-hydrogeothermal. At the present technology level, only hydrogeothermal energy has a practical use, while the use of petrogeothermal energy is still in the experimental stage [4,5].

In a world that is showing an increasing concern for the environment, there is a greater emphasis on the utilization of clean and sustainable energy sources such as geothermal [6,7]. Geothermal resources, among other renewable resources (wind, solar, biomass, tidal, etc.), can be used efficiently for clean energy production [8–10]. However, geothermal energy has been claimed to be one of the most environmental friendly energies [10,11]. Geothermal energy, by nature, has high availability because the source is not dependent on weather conditions, so it is among the most stable renewable energy sources [12–14].

The pallet of possible geothermal energy utilization is very wide and covers direct and indirect use of geothermal energy. Indirect use implies electricity production while direct use includes balneotherapy, recreation, tourism, gastronomy and application in different types of industry. Utilization of geothermal energy has significant advantages compared to the use of conventional energy sources, such as:

- renewable source of energy,
- clean energy,
- local resource,
- low maintenance costs of hydrothermal facilities,
- high security and reliability of use, etc. [4].

The first utilization of geothermal energy for energy purposes is related to electricity production in the countries that have this type of energy at their disposal, in the form of water vapor (Italy, USA, Japan, Iceland, etc.). The International Geothermal Association (IGA) has reported that 10,715 MW of the online geothermal power in 24 countries, are generating 67,246 GWh of electricity in 2010. This represented a 20% increase in geothermal power online capacity since 2005. IGA expects that this will grow to 18,500 MW by 2015, due to the large number of projects presently under consideration, often in areas previously assumed to have little exploitable resource [15,16].

Direct or non-electric utilization of geothermal energy refers to the immediate use of the heat energy rather than to its conversion to some other form such as electrical energy. Direct use of geothermal energy is one of the oldest, most versatile and also most common form of utilization of geothermal energy [17,18]. Although geothermal energy is categorized in international energy tables as one of the "new renewables", it is not a new energy source at all. People have used hot springs for bathing and washing clothes since the dawn of civilization in many parts of the world [19]. The primary forms of direct use include swimming, bathing and balneology (therapeutic use), space heating and cooling, including district heating, agriculture (mainly greenhouse heating and some animal husbandry), aquaculture (mainly fish pond and raceway heating), industrial processes, and heat pumps (for both heating and cooling), but is commonly used in balneology, agriculture and space heating, through heat exchangers and heat pumps [20]. Geothermal energy, in the form of thermal waters for bathing and medicinal purposes, has been known in the area since prehistoric times [21].

In general, the geothermal fluid temperatures required for direct heat use are lower than those needed for economic electric power generation. Most direct use applications use geothermal fluids in the low-to moderate-temperature range between 50 and 150 °C, and in general, the reservoirs can be exploited by conventional well drilling equipment. Low-temperature systems are also more widespread than high temperature systems (above 150 °C), so they are more likely to be located near potential users [22].

In order to successfully utilize geothermal energy at any given location, geomorphological, geological, geophysical, hydrogeological and hydrothermal characteristics of the area must be explored. Furthermore, for the accurate and detailed assessment of the potential uses of geothermal drills, it is essential to determine physicochemical characteristics of geothermal and mineral waters, as well as drill's capacity.

With the increase of energy crisis, the countries that have low-temperature geothermal resources and thermal and thermo-mineral waters have begun their utilization in a variety of low-temperature energy fields. It has been found that geothermal water under certain conditions can quite successfully replace the traditional fuels.

Geothermal energy sources in the Republic of Serbia (RS) mostly belong to low-to-moderate temperature range. RS consists of four geothermal regions: Autonomous Provice of Vojvodina (APV), Macva, Podunavlje and northern Pomoravlje. APV represents geologically the most important region. It is located at the southern edge of the Pannonian Basin.

The territory of APV is also a part of European geothermal zone that has favorable conditions for the exploration as well as utilization of geothermal energy [23]. With relatively little delay, APV started to utilize this type of energy. The most common applications