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Promotion of Geothermal Energy in Serbia

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ABSTRACT

Mannvit participated in a geothermal project funded by EuropeAid in Serbia from 2011 to 2013.The project was implemented by the Serbian office of EPTISA (Servicios de Ingenieria S.L.) in a Consortium with Mannvit and the Energy Saving Group, Belgrade. This project was a part of The European Union's IPA 2010 Programme for the Republic of Serbia (EUROPEAID/129768/C/SER/RS) called Promotion of Renewable Energy Sources and Energy Efficiency. The objective of the project was to contribute to the sustainable energy sector development in Serbia by increasing the geothermal energy knowledge, providing a review of geothermal potentials in Serbia and identification of best options for their utilization.

The first part included gathering of available data on geothermal potential areas in Serbia, including a review of current policy toward usage of geothermal resources. A report was made on the potential utilization in Serbia with best options for the use of geothermal resources identified in different sectors with focus on district heating systems. A list of 12 potential locations for the use of geothermal energy was defined, sites were visited, additional data collected, a ranking methodology was developed and a priority list of these locations was prepared. The three most promising locations were identified and pre-feasibility studies with a clear indication of economic and financial feasibility of potential projects were prepared for these locations. Action Plan for increasing of the geothermal energy use in Serbia, which could be implemented in the official documents dealing with energy sector development and participation of renewable energy sources in the final energy consumption in Serbia was developed. There was further a training component included in the assignment. It consisted of a number of meetings with representatives of the beneficiary, four workshops dealing with findings related to the potential, best options, necessary feed-in tariffs, results of pre-feasibility studies and proposals for the action plan and a study tour in Iceland, which gave insights into the geothermal industry in Iceland in respect to policy and utilization.

1. INTRODUCTION

From a geological point of view the territory of Serbia encompasses four large geotectonic units that all belong to the Alpine Orogeny (e.g. Martinović and Milivojevic, 2010). The first geotectonic unit (Pannonian Basin, Figure 1) covers essentially Northern Serbia (Vojvodina Province) while the other three geotectonic units (Dinarides and Vardar Zone, Serbian-Macedonian Massif and Carpatho-Balkanides) split Central Serbia from west to east. These regions are however not equal in terms of data available for assessing their respective geothermal potential. The distribution of surface heat flow over Serbia shows that the westernmost and easternmost parts of Central Serbia are the least promising at first sight and can be partly ruled out. In comparison, the Vojvodina province as a whole and a region in Central Serbia, extending from Macva-Kolubara districts in the north to Pcinja district in the south, can be the focus of geothermal interest. This is already reflected in the regional coverage and quality of the database that was made available for this study. Results of earlier geothermal research are essentially reported or summarized for Northern Serbia (Vojvodina as a whole) and for only few areas of Central Serbia characterized by heat flow higher than 90 mW/m^2 on average (districts of Macva, Kolubara, Belgrade City, Pcinja).

An extensive geothermal research started in Serbia with different projects ongoing from the year 1974. A first geothermal Atlas was completed in 2010 for the northern part of Serbia, Vojvodina and a second was expected in 2013 for Central Serbia. Geothermal wells have been drilled in Serbia from 1969 to the latest known well, BT-1, drilled in 2009 to a depth of 770 m in Bogatic.

All public available data on geothermal resources and their development were gathered within this project by the Consortium. It was put together in both an excel database and, when possible, into a GIS (geographical information system) to facilitate the utilization of the data for estimating the geothermal potential and maps to illustrate the geothermal resource in Serbia. Data was gathered on numerous geothermal wells and projects and is believed to have exceeded the data gathering done for the World Geothermal Congress country update report presented in 2010 (Martinovic and Milivojevic). Still there is evidence of missing data within the database and therefore the question arises whether all geothermal data is publicly available. This shows that the database is not complete for Serbia even though it is based on all publicly available data as requested by this project. Data for 176 wells and springs was gathered.

The most complete dataset for evaluating the geothermal potential of an area in Serbia came from a reported or summarized geothermal research that includes not only basic data (temperature, capacity) from a single well or spring, as in the Excel database provided to the Consortium, but also a full set of interpreted information on surface and subsurface geology, tectonics, geochemistry and geothermometry, temperature gradient, etc. This useful data was however found to be documented partly and only in the Geothermal Atlas of Vojvodina (Martinović, et al., 2010) and in the report sections, scanned and translated for the project, of earlier geothermal investigations conducted in Central Serbia on behalf of the Mining and Geology Faculty and exploration companies (Geozavod, Naftagas, Gesonda). The unequal regional distribution of the reported results had direct influence in the listing of potential areas for geothermal development especially in Central Serbia. There is a large part of Serbia which has not yet been investigated despite its theoretical geothermal potential.

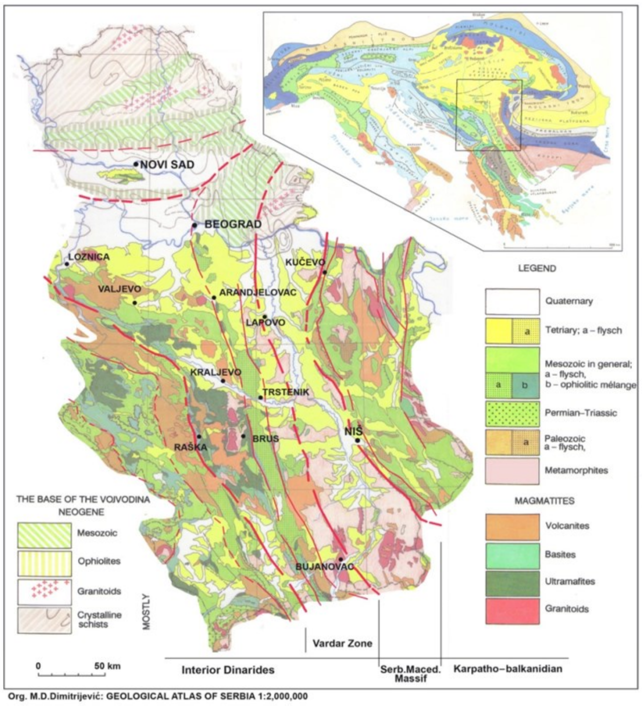

Figure 1. Geological map of Serbia (modified by Petrovic et al., 2010).

2. GEOTHERMAL POTENTIAL

Serbia has experience in utilizing geothermal energy. To date, geothermal energy has been utilized for balneology, swimming pools, space heating, on pig and poultry farms and for industrial processes. This shows that there is existing knowledge of how to utilize geothermal energy in Serbia. The challenge within geothermal utilization is therefore not a lack of experience within the country but instead how to find ways to expand utilization and to make it more efficient. The opportunity for geothermal heating in Serbia is in expanding applications beyond balneology/ recreation and space heating, which currently accounts for ~70% of geothermal energy use.

The reported geothermal potential has a wide range, ranging from 86 to 216 MW_{th}. In this project two approaches were applied to estimate the geothermal potential, the first included a volumetric method (Equation 1) and the second approach was based only upon information from existing wells. Neither approach gives an exact account of the actual geothermal potential in Serbia. Nevertheless by comparing the two approaches and presenting the available research on the geothermal resource of Serbia as a whole and in detail by areas of interest, the project came up with the best possible estimate of the theoretic geothermal potential based upon available data. The theoretic geothermal potential of Serbia was estimated to be about 180,000 MW_{th} by the volumetric method and 330 MW_{th} based on the theoretical potential of available information on existing wells (Equation 2) if the geothermal fluid was used by cascading solutions down to the average ambient temperature of Serbia (10.5°C). The difference between these two approaches gives an indication of how much untapped thermal potential lies in the unexplored basins of Serbia. In the existing well approach the potentials represent already located geothermal resources whereas in the volumetric method approach consideration is taken to future research of the total geothermal potential in Serbia.

$$P(MW)=dT\{°C\} * [V_t\{km^3\} \; *(1-\Theta) \; *\rho_r\{kg/km^3\} * C_r\{kJ/kg°C\} + V_t\{km^3\} * \Theta *\rho_w\{kg/km^3\} * C_w\{kJ/kg°C\}] * r /(10^3 * t\{s\}) \quad (1)$$

where

- P = Potential {MW} over 50 years;
- dT = The difference between the inlet and outlet temperature {°C};
- V_t = Total Volume of rock hosting the geothermal reservoir {km^3};
- Θ = Porosity factor;
- ρ = Density {kg/km^3}; r = rock, w = water;
- C = Heat capacity {kJ/kg°C}; r = rock, w = water;
- t = time {s} (7000 hr/yr for 50 years);
- r = recovery factor telling how much of the stored energy is possible to harness.

There are big uncertainties in all the parameters.

$$Capacity\ (MW_{th}) = \frac{1}{10^6} \cdot \dot{v} \cdot \rho \cdot c_p \cdot (t_1 - t_2) \quad (2)$$

where:
Q [MW_{th}] thermal capacity of the geothermal fluid
$\dot{v}$ [l/s] fluid flow
ρ [kg/m^3] water density
c_p [kJ/kg·°C] specific heat
t_1 [°C] inlet temperature
t_2 [°C] outlet temperature

The outlet temperature was not known for all cases and thus estimated as 15-25°C dependent on inlet temperature and application.

2.1. Geothermal utilization

The Serbian country update was presented in an article written by Martinovic, M. and Milivojevic, M. for the World Geothermal Congress (WGC) 2010 since this update was made further collection of data regarding wells utilized for direct use in Serbia has been performed within this project. The result can be seen in Table 1 below.

Table 1. Utilization of geothermal energy 2011.

Utilization reviewed from collected data	Installed Thermal Power (MW_{th})
Space Heating	33.4
Bathing and Swimming	83.6
Agricultural Drying	0.6
Greenhouses	34
Fish and other Animal Farming	8
Industrial Process Heat	0.9
Subtotal	*160.5*
Heat Pumps	9.9
Total	**170.4**

The most common utilization of direct geothermal energy is in balneology and recreation in Serbia (Table 1). Geothermal direct energy has also been used within greenhouses, space heating, pig and poultry farms and industrial process. In Debrc wheat and other cereals are planned to be dried with geothermal direct use. For the time being, geothermal water is used for 4.5 hectares of greenhouse. These applications are not all active today, however the varied existing utilization methods already applied in Serbia show that the knowledge and potential to utilize the geothermal resource exists.

3. GEOTHERMAL AREAS AND SITE VISITS

Figure 2 shows the locations of wells and springs with known coordinates that were collected during the project. After the data collection, 12 areas were chosen for further data collection by site visits. The fundamental requirement for investigating geothermal projects is information regarding the resource. The amount and quality of information available affects directly the quality and risk in the geothermal project. It was therefore decided to select the areas where most information on the geothermal resource exists for further studies. This is the first and most important parameter for the selection of the areas. The main emphasis was on existence of well data, measured temperature at depth and flow rate for the wells.

3.1. List of Favorable Areas in Serbia for Geothermal Utilization

A total of 12 locations were chosen (Figure 3) for further data gathering taking into account the data gathered by the Consultant and the Ministry's knowledge on spa's ownerships, development plans and local authorities willingness to cooperate and continue with project implementation towards the prefeasibility stage of the project. The 12 areas chosen for further data collections were:

Vojvodina:

1. Prigrevica, northwestern Serbia, bordering Croatia (district of West Backa),
2. Kanjiža northeastern Serbia, bordering Hungary and/or Romania (district of North Banat),
3. Kula (district of South Bača),
4. Vrbas (district of South Bača),
5. Inđija.

The whole of Vojvodina is promising for geothermal utilization. First selection includes areas with existing wells measured temperature above 50°C and the published Geothermal Atlas of Vojvodina is used as confirmation material, i.e. the temperature gradient and temperature at 1000 m and 2000 m depths.

Central Serbia:

1. Bogatic area (Macva District),

2. Valjevo area (Kolubara District),
3. Vranjska spa,
4. Mataruška spa (Raška District),
5. Jošanička spa,
6. Sijarinska spa,
7. Sokobanja.

The areas in Central Serbia were selected based on the availability of information mainly from reports gathered by the Consultant. The existence of data such as geological information and chemical data was a ruling factor besides the well data. The selection was made with aid of data compiled during the data gathering phase and the GIS database organized for this project.

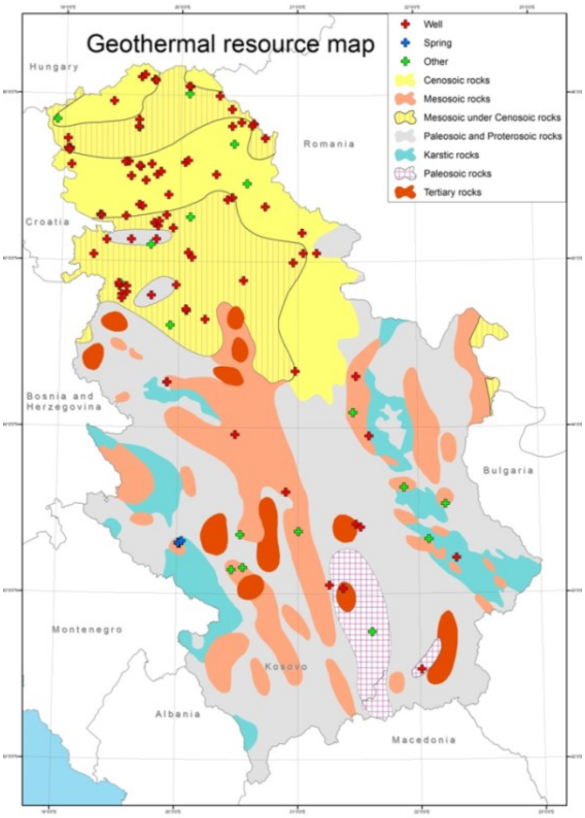

Figure 2. Locations of wells and springs with known coordinates.

4. RANKING AND PRE-FEASIBILITY STUDIES

The 12 areas visited during the project were ranked in order to choose 3 areas for pre-feasibility studies. Five of the sites are located in Vojvodina. Site visits were carried out during October 2011, starting from Vojvodina, while the sites in south of Serbia were visited at the end. Meetings with representatives of existing/potential users and/or local authorities were held, additional data collected and pictures taken. The purpose of the visits was to evaluate the sites on the basis of existing technical data, heat demand, access to the appropriate voltage level and the situation on the site regarding existing infrastructure (roads, district heating network, industrial facilities etc.) according to an evaluation methodology developed by the Consultant. In addition to above mentioned information the Consultant had to assess readiness/determination of appropriate counterparts to continue the implementation of the project after prefeasibility studies. Almost all counterparts showed high interest in this project with the exception of one site where a private investor has exploration license for geothermal energy and has already engaged two consulting companies for geothermal project implementation. Based on the findings from the site visits it could be concluded that utilization rate of geothermal energy is significantly less in comparison to assessment made at the beginning of the project implementation. Some wells are out of use (damaged, closed or submerged in water), whereas the level of energy efficiency of those that are in use is mainly very low. In other words there is lot of opportunities for improvement of geothermal energy usage in almost all visited sites.

After the site visits the ranking of these 12 areas was prepared. Information from the site visits was interpreted and used for the ranking procedure according to a ranking methodology defined by the Consultant. To choose the sites two ranking lists were generated to present the sites ranked according to utilization of only existing wells for smaller projects as well as utilization of the area with drilling of new wells for larger projects in mind. The two lists are:

Small projects (existing wells)	Large projects (new wells)
Bogatić	Bogatić

Mataruška spa Vrbas

Sokobanja Valjevo

Therefore, in cooperation with the Ministry of Infrastructure and Energy the areas chosen are Bogatić and Mataruška spa for the pre-feasibility study of smaller projects where existing wells are used, and Vrbas for a larger project with new wells.

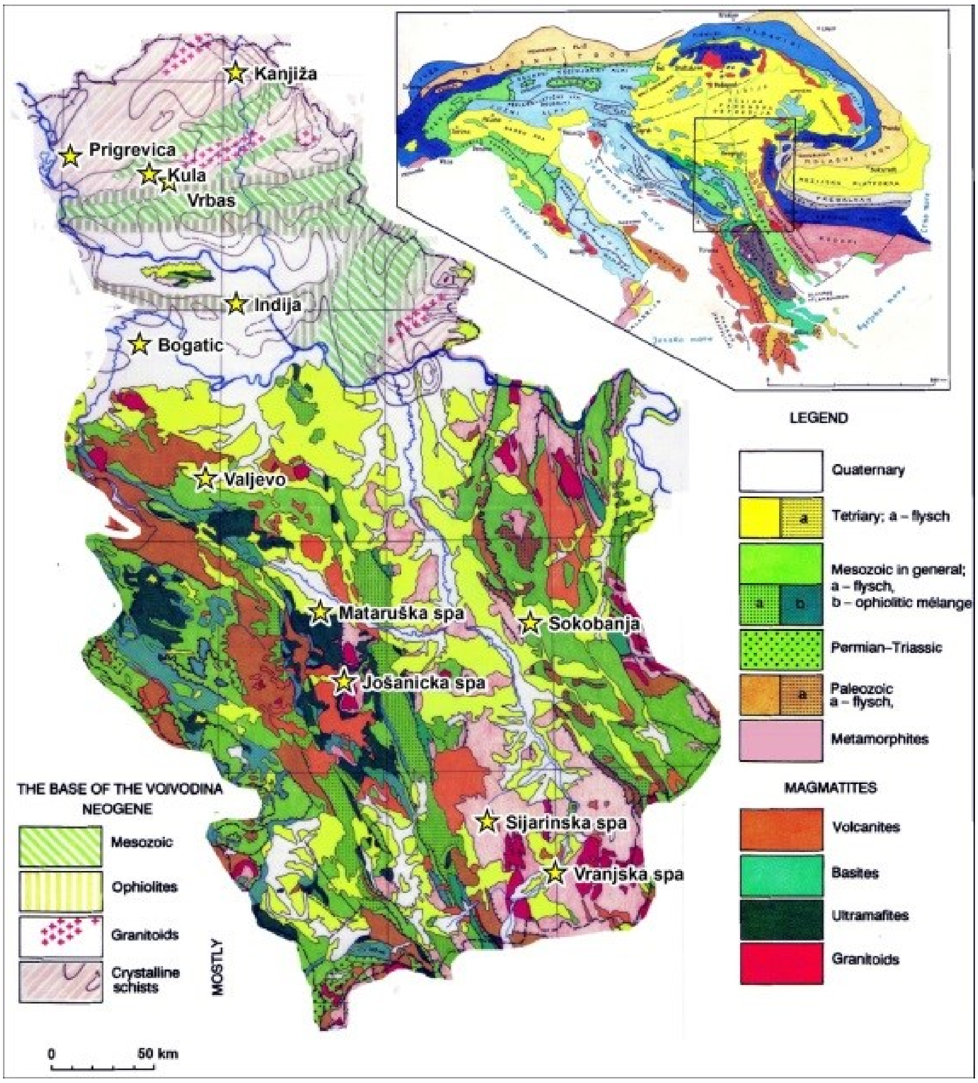

Figure 3. Geological map of Serbia with the location of the 12 selected areas (yellow stars).

4.1 Ranking Methodology

The criteria for ranking were chosen with both technical and economical project viability in mind. Grades were calculated for each area based on data at hand. Only direct use of geothermal energy was considered. The areas were ranked in two ways. Firstly, the potential of each area in terms of utilizing existing wells was evaluated and a ranking created. Secondly, the potential of each area in terms of sustaining a new geothermal project was assessed and another ranking created. For each area and each criterion, a coefficient C_i was calculated or decided subjectively as appropriate. To create the final grade of the area the coefficients of the criteria were multiplied together while a weighted sum was created with the rest of the coefficients. The reason why some coefficients are multiplied together is to increase the effects of those criteria on the final ranking order. The equation used to calculate the grade is shown in Equation 3.

$$Grade = \prod_{i=1}^{N}(C_i) \times \sum_{i=N+1}^{M}(C_i \times W_i) \quad (3)$$

Some criteria were exclusively used for the first ranking when existing wells are assessed and omitted for the second ranking when considering a future geothermal project with new wells. Similarly, some criteria were exclusively used for the second ranking. Numbers N and M were therefore distinct depending on which ranking was calculated.

It should be noted that several other characteristics of the areas were considered in this study but were not reflected in the selection criteria. The reason why these characteristics were not used to rank the areas was that no distinction was found between the areas, or in some cases, data was not conclusive to make a distinction between areas. These were for example land planning issues, distance to roads, distance to power lines, distance to power stations and diameter of existing wells. Data was inconclusive to use chemical indication of reservoir temperature as a grading criterion. The manner in which each criterion coefficient was obtained was presented in the final report (Tulinius et al., 2012).

5. PRE FEASIBILITY STUDIES

When the three areas were chosen for pre-feasibility study other factors for example existing technical data, heat demand, access to power network, existing infrastructure, proximity and availability of biomass and restricted areas were taken into account and approved by the Ministry of Energy. Separate reports were made for the individual places as a final geothermal part of the project (Tulinius et al., 2012a, b, and c).

5.1 Bogatic

The potential market in Bogatic consists of public and residential off-takers. In total public off-takers have an annual heat demand of approximately 2,751 MWh/yr. Existing boilers

The cost estimation is on pre-feasibility stage and is based upon parametric models and have a total installed capacity of approximately 4.2 MWth for the peak load demand. As indicated by the annual heat demands this is rather high installed capacity for this market. Estimated total peak load for the geothermal heating system is 1.9 MW_{th} for the potential presented public off-takers. Additionally residential off-takers are estimated at an approximately 1,065 MWh/yr market with a peak demand of 0.9 MW_{th}.

This project focuses only on the utilization of well BB-1. The land around well BB-1 is owned by the state and utilisation rights belong to the Municipality of Bogatic. The well BB-1 is owned by the state and utilisation rights need to be applied for. The temperature of the geothermal fluid in well BB-1 is hot enough for space heating purposes, i.e. it is not necessary to heat it up further. Operating well BB-1 is not considered having a significant impact on the resource which is expected to sustain an even bigger utilisation.

judgment based on previous experience and projects. The total cost of the project is estimated to be 2.6 million EUR. The main findings of the financial analysis are that the optimum selling price, utilising maximum EU Grant amount, is approximately 0.115 EUR/kWh. Current average market price of fuel provided by the client is 0.022 EUR/kWh and estimate based upon recommendation from local experts gives a comparison price of 0.044 EUR/kWh. The fuel price does not include labour, maintenance etc. The biggest economic benefit identified is the CO_2 savings which results from replacing the fuel for the plant. Three alternative cases were also investigated that lowered the capital cost and thereby the optimum selling price to 0.091 EUR/kWh for no heat plant option, 0.075 EUR/kWh for the new well and larger market option, and 0.072 EUR/kWh for the added heat pump and larger market option. For present comparison price of 0.044 EUR/kWh this concept is therefore not feasible. The main capital cost lies in the long pipe necessary from the existing well to the available market.

The project will result in reduction of ambient air pollution from individual coal-fired and heavy fuel fired heating boilers. The primary social impact of the Project is expected to result in improved quality of heating leading to better quality of life for inhabitants. The project will introduce the utilization of clean energy resources such as geothermal heat. The project proposes the system where the geothermal fluid is supplied to heat exchangers and then discharged into the open channel after use. The cooled geothermal fluid would then flow into the improvised “Jokin grab” spa as it does today. Reinjection is proposed to be implemented in the later stage of the project operation. Extraction of geothermal fluid and its discharge present the main environmental concern in respect to this project. Other potential negative impacts are limited and related mostly to the temporary inconveniences associated with construction process. No resettlement is required under the Project.

5.2 Mataruska Banja

The project owner and beneficiary are the DP Mataruska and Bogutovacka Banja. The district heating system (DHS) in Mataruska Banja is now heated by a heavy fuel boiler which can produce up to 3.2 MW_{th}. The heating demand for the last two heating seasons has been 6 968 MWh/year however due to high heating prices from heavy fuel oil and lack of finance, electricity has been used for half of the heating. The heating period in Mataruska Banja is for approximately 3 100 hours, from the beginning of October to the end of April. The cost of fuel for heating the existing DHS is now 0.037 EUR/kWh, which is according to the opinion of local experts not realistic. Namely, according to actual price of heavy fuel oil (VAT excluded) in Serbia and estimated energy efficiency of heavy fuel oil boiler, price for the heat at the exit of the boiler house should be at least 0.063 EUR/kWh.

The possibility of exploiting at least 10 MW_{th} derived from the fractured reservoir has been estimated for this area. This estimate includes drilling of new wells and indicates that there is a potential for exploitation beyond the scope of this report if the market grows. The thickness of the reservoir is estimated to be 300 m and the reservoir temperature about 45°C. The study area belongs to the Ibar ultramafite complex and partially to the Kraljevo depression and monocline of Radočelo, reflecting the complex tectonic history of this area.

The project concept of this report is to utilise five existing wells MB-1, MB-2, MB-3, S-7 and S-10 for the DHS in Mataruska Banja. The only well under operation today is well MB-2, which is used for balneology and physiotherapeutic purposes of a spa bath and a rehabilitation center. Wells MB-1, MB-2, S-7 and S-10 will then be used as production wells but well MB-3 as a re-injection well. The production wells can give 40 l/s of geothermal fluid with the temperature of 48°C. The geothermal fluid from the wells will go through an industrial heat pump where the water for the DHS will be heated and can produce up to 4.2 MW_{th}. With 2.85 MW_{th} it is possible to provide heat to the entire existing DHS. The capacity of the system thus allows further off-takers to be added to the system at a later stage.

The cost estimation is on a pre-feasibility stage and is based upon parametric models and judgment based on previous experience and projects. The total cost of the project is estimated to be 2.5 million EUR where the largest cost factor of the heat plant is the heat pump. The main findings of the financial analysis are that the optimum selling price, with utilisation of maximum EU Grant amount, is approximately 0.029 EUR/kWh. Current average market price of fuel provided by the client is 0.037 EUR/kWh which as explained above is not considered realistic. Price for the heat at the exit of a boiler house utilising heavy fuel oil should be at least 0.063 EUR/kWh. Comparing the optimum selling price to the comparison price this is a feasible project concept.

Figure 4. One of the wells in Mataruska.

No resettlement is required under the Project. The primary social impact of the Project is expected to result in improved quality of heating, leading to better quality of life for inhabitants and guests of the spa. Project will result in reduction of ambient air pollution from local coal-fired and heavy fuel fired heating boilers. Replacement of polluting fuels will better the quality of ambient air, resulting in greater comfort for the inhabitants. Improved environmental quality is expected to make Mataruska Banja more attractive for tourism and encourages future tourism and business investment

5.3 Vrbas

Market information was supplied by representative of the Municipality Vrbas. The present heat sources that can be replaced with geothermal energy are the five (5) boiler houses within DH system of Vrbas that use heavy fuel oil and one gas burner. Capacity of the individual boilers is in the range of 0.8 MW_{th} to 3.5 MW_{th} with 2 graded burners and boiler houses is in the range of 2.3 MW_{th} to 5.2 MW_{th}. The installed total capacity of existing boiler houses for heavy fuel oil is 18.7 MW_{th} (including boiler house in CFK Vrbas which is not part of DHS) and 1.12 MW_{th} for the gas boiler. The supply temperature is 90°C and the return temperature is 70°C for the heat source. The supply temperature for the houses is 90°C with a return temperature of 60-50°C. Peak load for the geothermal system as estimated in **Error! Reference source not found.** is 9.5 MW_{th}. There have not been done precise projections of future heat prices in Vrbas. It is though expected that it will increase since it is dependent upon fuel price. Actual average price in Vrbas is 5.5 RSD/kWh for residential space and 8.2 RSD/kWh for entrepreneurs.

The geothermal resource of Vrbas is a hydrothermal system in a sedimentary basin located in the Vrbas graben, in the district of South Bačka. The resource capacity at Vrbas is estimated to amount up to 126 MW_{th}. The first recommended development activity is the exploration of the geothermal resource. The first step in the exploration phase is the proper siting of the first well based on all available drilling and seismic data. The drilling should target a fractured part of the pre-Tertiary crystalline basement (gneisse or micaschist) along the fault between the Middle Backa ridge and the Vrbas trough. The second step of the exploration phase is the drilling and testing of this new well. If the testing results are favourable the design and building of surface equipment and utilities will be the next phase in line. The last phase is their operation and maintenance. If the testing results show that the resource has a limited recharge capacity, or if a pressure decline appears in the reservoir during operation, the re-injection of the geothermal fluid should be seriously considered.

The conclusion from this pre-study of the geothermal resource is that each well will deliver 20-35 l/s at a temperature of 90-100 C from a depth of 1700-2300 m. This translates into wells delivering a range of 2.1-5.2 MW_{th}. This project therefore requires 2-5 production wells. Re-injection of the fluid is envisioned and the project is estimated to require same amount of injection wells as there will be production wells. The DH system is designed to produce up to 9.5 MW_{th} with full capacity. Then the well(s) are providing the system with 67-87 l/s of 90-100°C geothermal fluid. Required mass flow depends on achieved temperature of the geothermal fluid and heat exchanger size.

The cost estimate is on pre-feasibility stage and is based upon parametric models and judgment based on previous experience and projects. The total cost of the project is estimated to be 22.1 million EUR. The main findings of the financial analysis are that the selling price, with utilisation of maximum EU Grant amount, is approximately 0.078 EUR/kWh. Current average market price of fuel provided by the client is 0.063 EUR/kWh. The fuel price does not include labor, maintenance etc. The biggest economic benefit identified is the CO_2 savings which results from replacing the fuel for the plant. A scenario analysis was made including pessimistic case, optimistic case, case with a heat pump and a case without heat plant in case the chemistry would allow that. The main findings of the financial analysis for the alternative cases are that the optimum selling price, with utilisation of maximum EU Grant amount, ranges between 0.058 - 0.118 EUR/kWh. Thus the Base case, Optimistic case, the No Heat plant case and the Added Heat Pump case are all favourable cases while the Pessimistic case cannot be recommended. The cases are all built upon the optimistic and pessimistic estimation of parameters from the geothermal wells. This emphasizes the importance of a comprehensive exploration resulting in a drilling plan and careful study of the results of the first drilling.

No resettlement is required under the Project. There is no designated nature conservation areas present in the project site surroundings. The primary social impact of the Project is expected to result in improved quality of heating, sanitation and recreational opportunities leading to better quality of life for the town population.

6. CONCLUSIONS

During the project a great amount of data on geothermal research and utilization in Serbia was collected. The data collection included extensive internet search, cooperation with the University of Belgrade, companies involved in energy production and distribution, other stakeholders and the Ministries responsible for geothermal energy. Twelve promising areas for further geothermal utilization were chosen for further data gathering by contacting local owners and the sites were visited to complete the data collection. The 12 areas were then ranked and the ranking used to select three projects for pre-feasibility studies. All the data collected and the outcome of the pre-feasibility studies were published in reports available for further use to those interested in promoting the use of geothermal energy in Serbia. Two of the three pre-feasibility reports resulted in feasible project concepts that could be realized. In the third project concept the distance between the resource and the market proved too great. The Consortium believes that this project was successful and sincerely hopes that it will aid further geothermal utilization in Serbia.

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