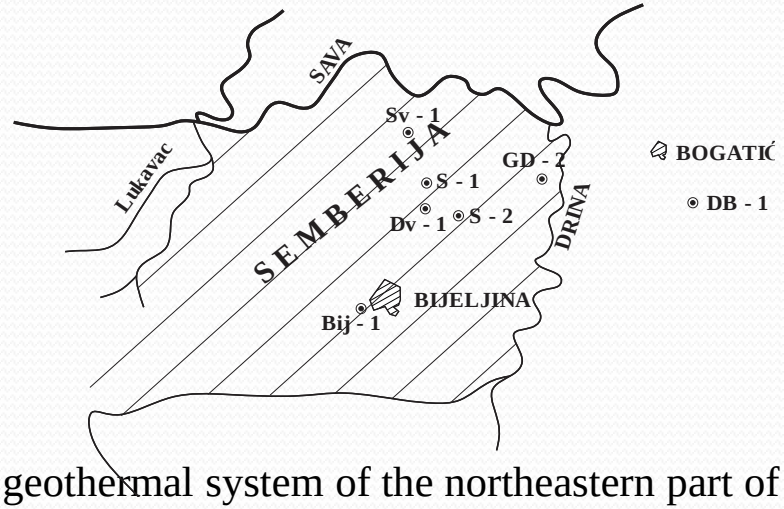
INTRODUCTION

As part of the research for oil in the fifties of the twentieth century, it was noted in several boreholes a presence of hot underground water temperature around 75 - 100°C at the mouth of the borehole. Three boreholes were drilled S – 1, S – 2 i Sv – 1, depth of 1250 – 1700 m, picture 1. All boreholes are closed at the surface and further interest for them stopped.



Picture 1. The geothermal system of the northeastern part of the Republic of Srpska

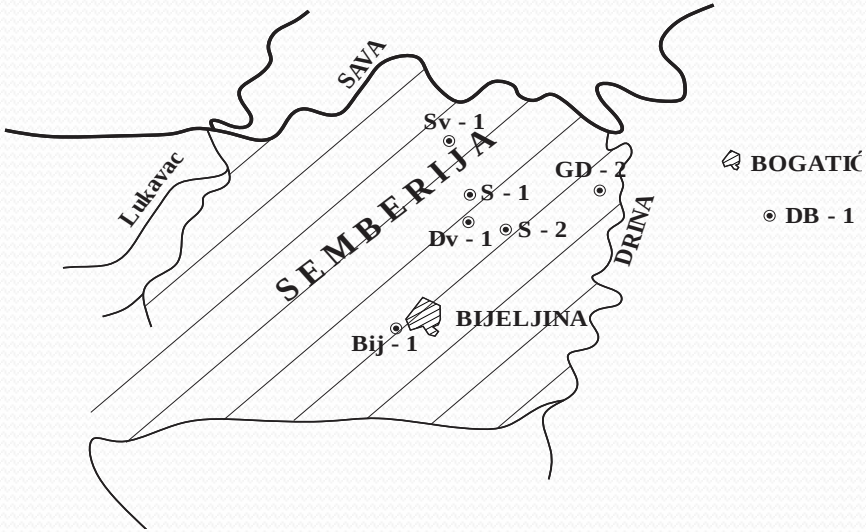
At the end of the sixties inhabitants of the village Dvorovi near Bijeljina opened a borehole S – 1, where the outburst of water with temperature around 75^0C was detected. After that the first open poll was built in this settlement, which was filled with the water from the borehole S – 1. For the first time in this area began the use of geothermal energy. Other boreholes stayed closed and it is not known in what conditions they are today.

In the seventies of the twentieth century, it was not talked about underground hot water, but about geothermal energy accumulated in the groundwater, which is located at a depth greater than 1200 m. Due to the high temperatures that occur on the surface, the energy of the hot water is used in sports and recreational purposes and Spa Dvorovi was built, picture 2.

Picture 2. Spa Dvorovi near Bijeljine

The amount of geothermal energy stored in the water and rocks is significant, that it has opened the first thoughts of the possibility of its use for heating the town of Bijeljina. Town then had about 30,000 inhabitants and an important industry in the area of food production and processing, as well as the mechanical industry.

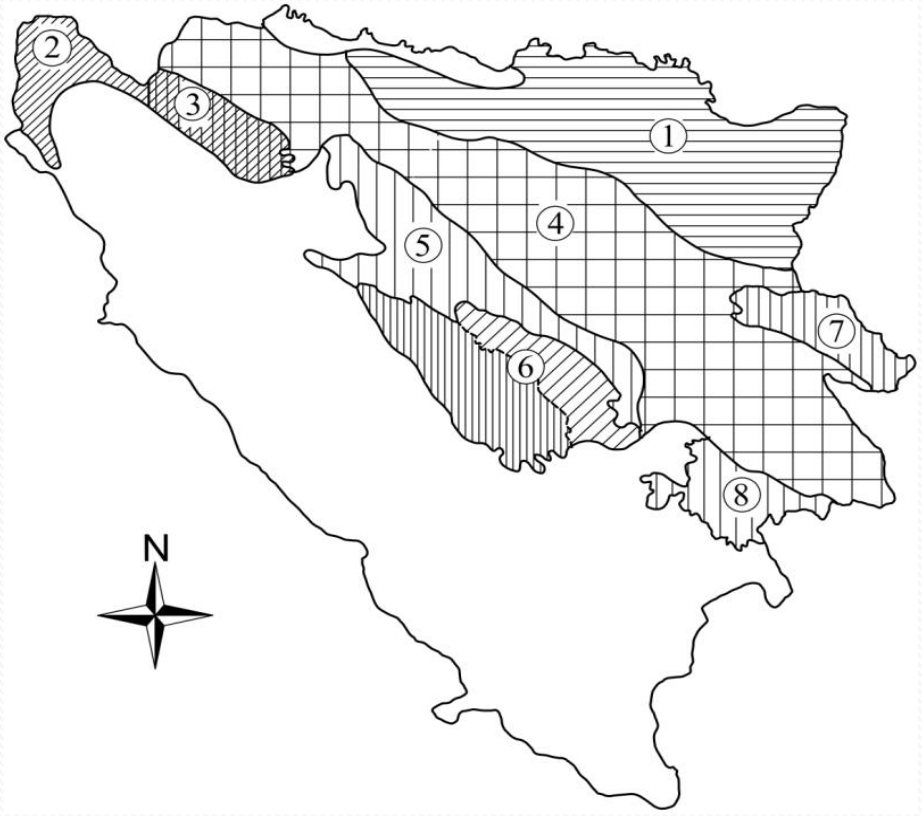
In the eighties of the XX century, it was renewed the oil exploration in the northern part of Bosnia and Herzegovina. In the area of Semberija, southwest of the town of Bijeljina, it was drilled a borehole Bij - 1, up to 2,479 m, where it was clearly obtained that in this area can be caught water of temperature higher than 100°C, picture 3.



Picture 3. Borehole Bij – 1

Besides Semberija, geothermal regions are characteristic also in other parts of the country. Several region is highlighted in which is accumulated hydrogeothermal energy, picture 4.

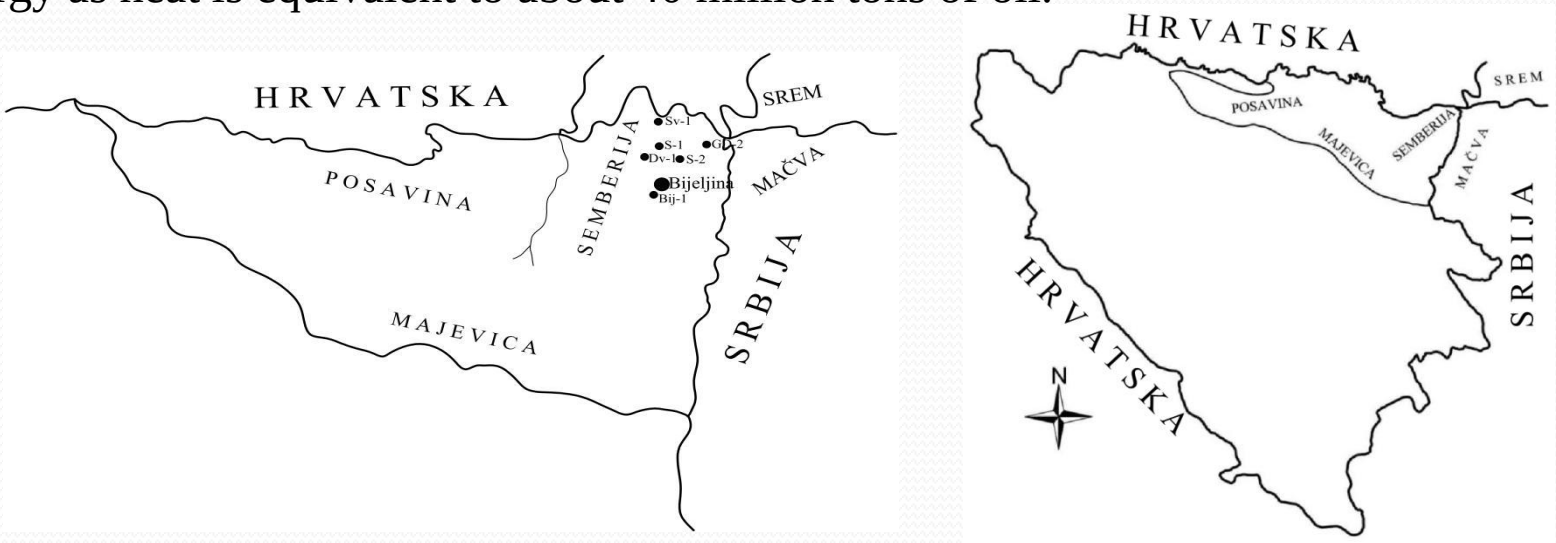
1. North Bosnia (Semberija, Mejevica and Posavina)
2. Bihac - Kladuse region
3. Una - Sana region
4. Central part of Bosnia NW – SE (ophiolitic zone)
5. Banja Luka - Sarajevo
6. Mid Bosnian region (divided in two parts)
7. Eastern part of Bosnia
8. Southeastern part of Bosnia



Picture 4. Geothermal regions in Bosnia and Herzegovina *(N. Miošić 1986, updated N. Đurić 1997)*

GEOTHERMAL POTENTIALITY OF SEMBERIJE

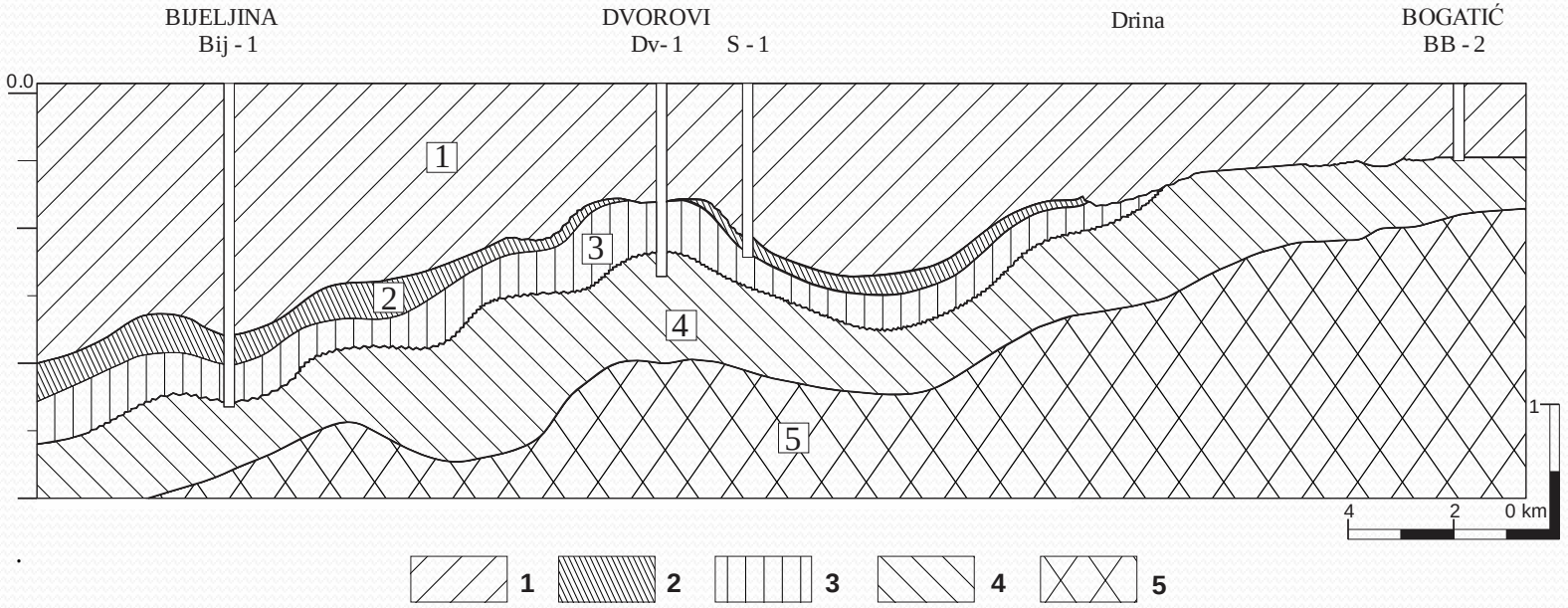
Geothermal potential of the area of Semberija, together with Macva, makes a great finding of thermal waters. This finding likely extends below Srem at the north and towards Posavina at the west, picture 5. Semberija and Posavina belongs to the northeastern and north part of Republic of Srpska – Bosnia and Herzegovina, and Macva and Srem belongs to Serbia. Area deposits of thermal waters in the area of Mačva and of Semberija is about 2,000 km^2, and geothermal potential in terms of energy as heat is equivalent to about 40 million tons of oil.



Picture 5. Geothermal findings of groundwater source

RS – BIH (Posavina – Semberija), Serbia (Macva – Srem)

The deposit extends with a gentle slope from Macva on the east, towards Semberija which is at the western part. The depth of the thermal waters in Bogatic (Macva) is about 450 m, while in the western part of Semberija depth is around 2500 m. There are also shallower horizons in the Cretaceous limestones, but Triassic limestones at greater depths are more significant., picture 6.



Picture 6. Geological terrain profile of Semberija

1. Tertiary sediments, 2. Upper Cretaceous limestones, 3. Upper Cretaceous marl and sandstone, 4. Triassic limestones and dolomites, 5. Underlying stratum sediments

The thickness of the earth's crust in the area of Semberija is from 25.0 to 27.0 km. Geothermal field consists of:

- thermal field, ie value of terrestrial heat of flow density
- temperature field, ie temperature values at different depths of the Earth's crust.

According to some researchers of this space density of terrestrial heat flow in Semberija should be around 100 mW/m^2. These values are about 50-80% higher than the average value of the density of terrestrial heat flow in continental Europe, which is about 60 mW/m^2.

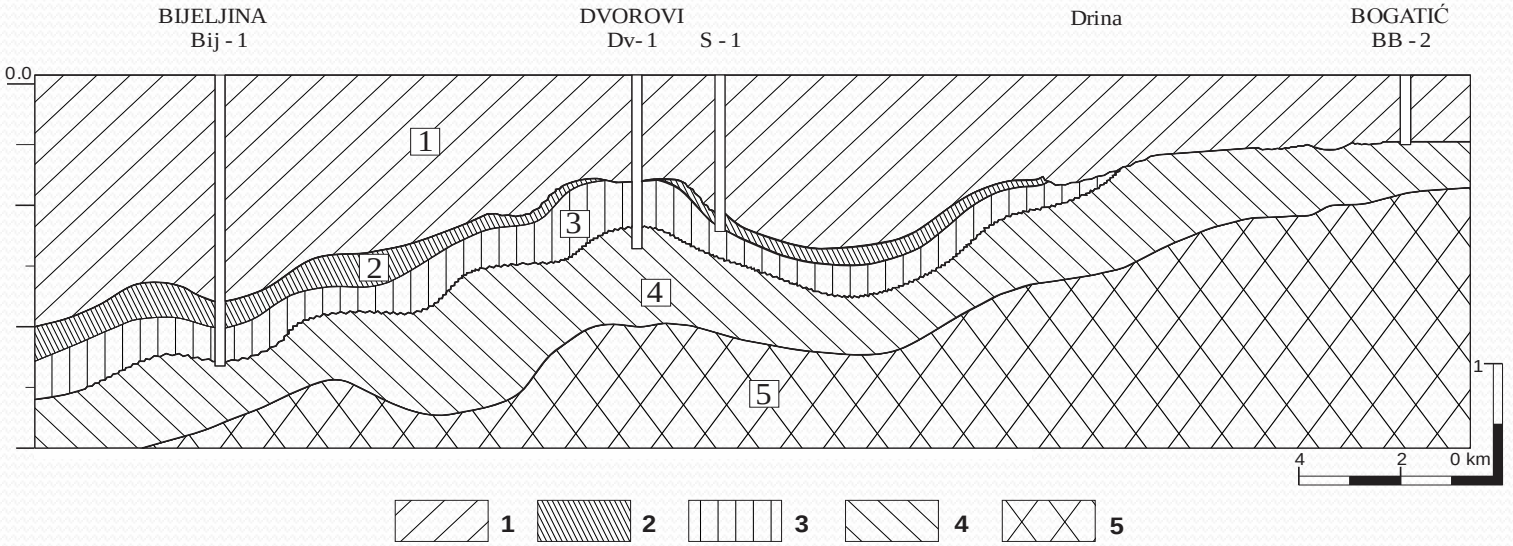
Temperature field is determined on the basis of model calculation where the temperature :

- at the depth of 5,0 km should be about 230 ^oC
- at the depth of 7,0 km about 300 ^oC
- at the depth of 10,0 km about 420 ^oC.

At the Mohorovicic discontinuity (the boundary between Earth's crust and layer, ranges from 25.0 to 27.0 km) value of temperature should be about 800°C.

Hydrogeothermal system in the area of Semberija is characterized by reservoir located in the Mesozoic sediments, picture 7, and it consists of:

- Upper Cretaceous limestones and
- Triassic limestones and dolomites.



Picture 7. Reservoir of warm water in the Mesozoic sediments (2 i 4)

It represents a huge unique karst aquifer, where is a small mineralization water with high content of individual components as a result of depth. Thereby the hot water can be rationally exploited in order to use the heat energy.

Geothermal reservoir of Upper Cretaceous limestone and its thermal water has the following characteristics:

- The total geothermal energy potential is about 230 x 106 tons of thermally equivalent oil
- Forecasting reserves of geothermal energy in the rock mass and thermal waters of the reservoir is estimated to 57 x 106 tons of thermally equivalent oil
- Reserves only in the thermal waters are about 2 x 106 tons of thermally equivalent oil

Outlet temperature of the thermal water from the Upper Cretaceous limestone to the entire area should be > 75^{o}C.

Geothermal energy in the Triassic limestones and dolomites, represent the main Hydrogeothermal reservoir from which will be made exploitation of hot water.

- Total geothermal energy potential reservoirs of Triassic limestones and dolomites is about 1170 x 106 tons of thermally equivalent oil.
- Forecast of total reserves of geothermal energy in it, including the rock and water, is around 315 x 106 tons of thermally equivalent oil.
- Reserves only in thermal water are about 20 x 106 tons of thermally equivalent oil.

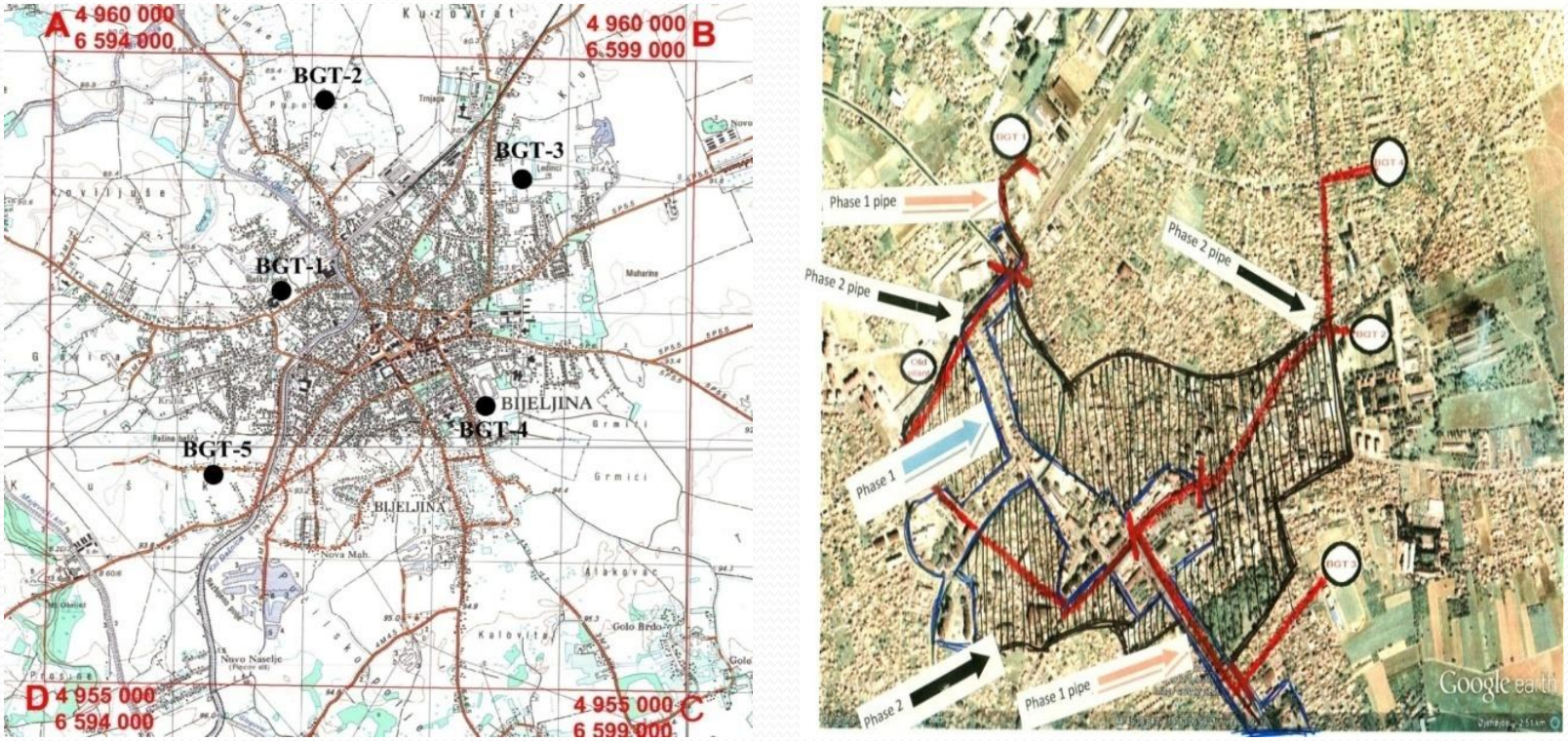
The temperature in the water collector is from 90 – 130^{0}C, and the outlet temperature will be slightly less, about 80 – 110^{0}C.

POSSIBLE USE OF GEOTHERMAL ENERGY

So far the use of geothermal energy if from the finding in Semberija in Spa Dvorovi for heating buildings, spa treatment, sports and recreational purposes, then in Slobomir city for heating buildings of Slobomir P. university and Aqua Park.

At the beginning of this century, it was expressed the interest in the exploration and exploitation of geothermal water in order to exploit the energy for heating of the city of Bijeljina, which has about 70,000 inhabitants. Energy exploitation would be in several stages, from 80°C to 16°C, when the cooled water through reinjection wells would return into the underground sewer.

Exploration and exploitation of geothermal water will be carried out in the town of Bijeljina. There will be five (5) exploration - exploitation boreholes and they will be distributed in the peripheral part of the urban area, picture 8.



Picture 8. Exploration area with the layout exploration and exploitation boreholes BGT and transportation pipelines

In addition to the exploration - exploitation boreholes, and several reinjection boreholes will be done for the return of exploited water in the first collector, after a certain amount of energy use. The number of boreholes and their appearance, whether they are vertical or sloping, will be defined during the implementation of the entire project.

Exploitation characteristics

The thermal energy that would be obtained by exploitation of hot water from the boreholes located in the peripheral part of the city, will be used primarily for heating of the town.

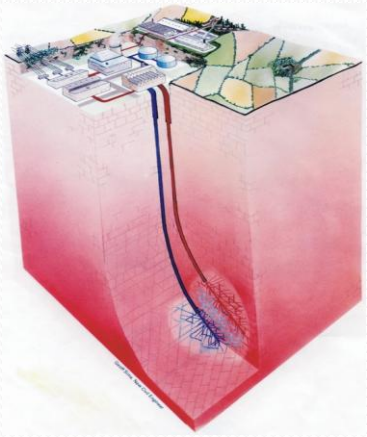
- Required temperature consumption is from 90 – 70^{o}C
- After that water can be used for the further use of heat energy to the 16^{0}C
- Then it will be return into the collector through reinjection wells, Figure 9

If the energy is not fully exploited in the initial phase, it would be returned at 60°C at the collector after the first stage of the use.

Thermal energy experts would more accurately expressed it:

Project documentation will resolve
a cascading use of geothermal energy :

- for the heating of objects from 90 to 70^{0}C,
- for agriculture from 70 to 50^{0}C,
- for technical water in industry from 70 – 30^{0}C
- for pools from 50 to 30^{0}C,



Picture 9. Reinjection”dubl” system of well

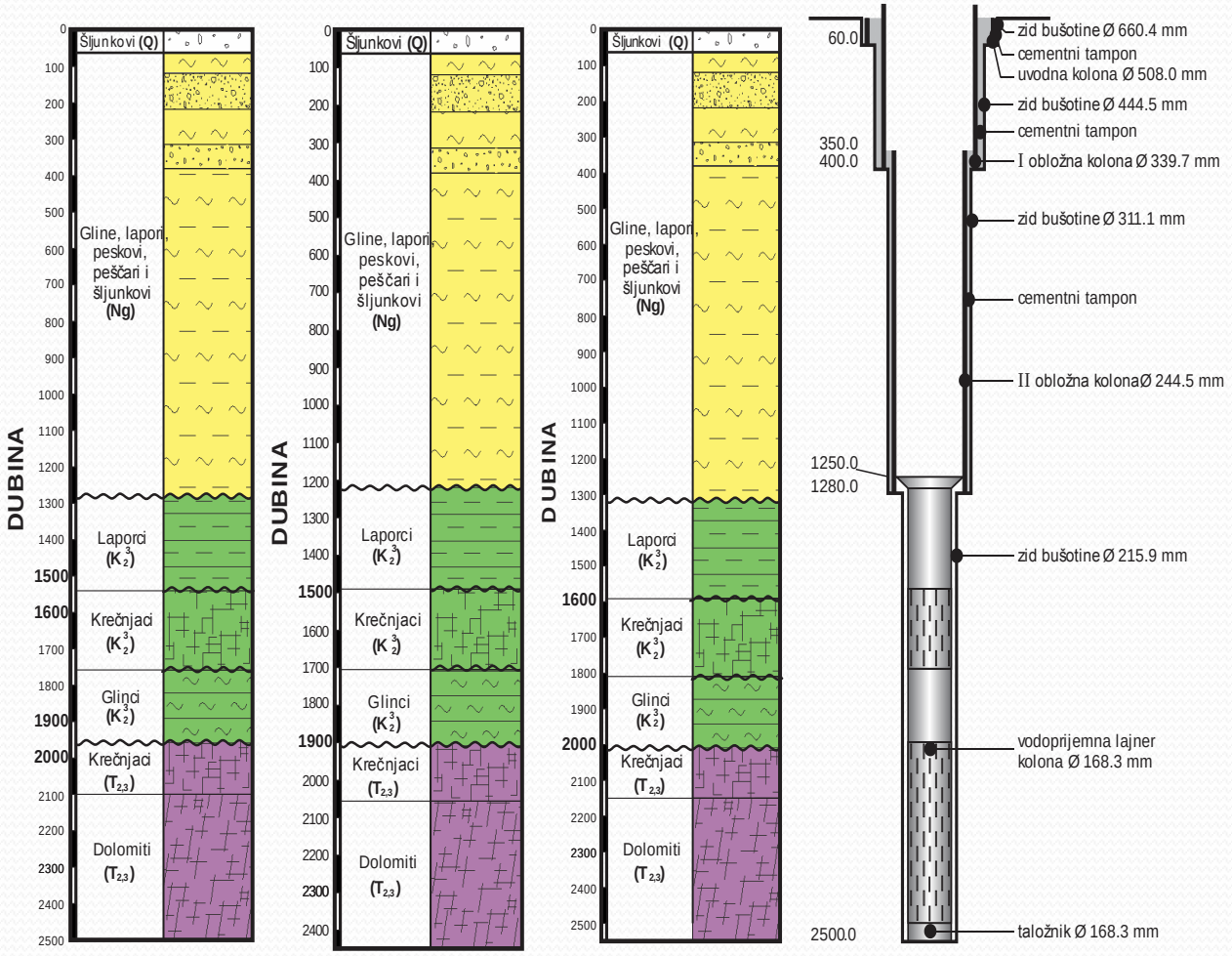
The construction of a borehole with associated pipe network represents one stage of the project implementation. These may perform several steps at the same time, if permitted by finance.

Given that geothermal energy is a domestic resource, ecologically clean and economically beneficial, the heat energy will be used in the lower temperature range. It would consists of various economic programs, for which the thermal energy is the main energy, and also related programs for recreational purposes. Experience from countries that use geothermal energy, as well as interested business entities are sufficient to guarantee that the project of exploitation of geothermal water in order to exploit the thermal energy will be successfully implemented.

The main mining - technical project will define the method of exploitation and the use of energy.

Since the collector with hot water is at great depth, it is necessary to carry out exploration drilling to a depth of approximately 2,500.0 m, Picture 10. After the completion of drilling and consideration of all the data from the borehole, it will serve as exploitation.

Depending on the characteristics of the first borehole, it will be defined a location for the other borehole, and the total number of boreholes. Previously planned five (5) boreholes may be sufficient or the number could change, depending on the capacity of the use and the need for heating energy.



Picture 10. Geological profiles and construction of geothermal exploration and exploitation boreholes

Intensive exploitation of geothermal energy from these reservoirs, ie from thermal water and rock mass can be effected only by reinjection "dubl" systems. They consist of an exploitation borehole and one injection borehole. Injection borehole, ie well serves for completely or partially energy used thermal water to returns into its primary reservoir for additional heating by geothermal energy accumulated in the rock mass. Quite often, one injection borehole can hold more water than it is the yield of the exploitation well, and it can serve for two to three exploitation borehole.

The choice of location of injection borehole should meet the requirements, that there would be no impacts of cold water on exploitation borehole in the period of its planned life of exploitation. Temperature drop of the part or the reservoir between the exploitation and injection borehole can not be higher than 50°C after 30 years of exploitation.

Impacts interaction between the exploitation and injection well would be predict on hydrogeothermal simulation model at the micro level, and will also determine the duration of exploitation of reservoirs and its findings. Thereafter, the optimization work of making proper facilities for the use of geothermal energy will be done.

The exploitation parameters for the conditions of outburst and pumping water from boreholes are given in table 1.

Table 1. The exploitation parameters for the specific exploitation conditions of thermal waters

Method of exploitation	Capacity l/sec	T (^{0}C)	T of the use ΔT (^{0}C)		Power of the t MW		Thermally equivalent kWh/god. x 10^6		thermally equivalent fuel oil (t)	
			65	20	65	20	65	20	65	20
outburst	20-25	80-90	85-20	85-65	25	7	210	60	15.000	6.000
pumping	50	80-90	85-20	85-65	95	29	840	225	56.000	17.000

Realistically it is to be expected at each borehole an outburst of 20 - 25 l / sec of thermal water with the push at the head of closed borehole about 3 bars.

Economic evaluation of the profitability of exploitation

For the economic analysis in the financial investment in the exploitation of geothermal water for heating of the town of Bijeljina are included

- Includes all potential users of geothermal heating in the next ten (10) years.
- As part of the economic-financially analysis, it is given the invoice of required investments in basic and working capital as well as sources of funding and obligations according to the sources.
- Results of operations and balance sheet and financial, economic and social flow project.

The economic evaluation of the action in addition to the above factors includes the need for the rational use of natural wealth. This assessment is provided through static and dynamic analysis of the project.

For the stated investment is necessary to provide a loan at an interest rate of 4.5%. Investments are one-off, as after payback remains a cheap energy that will next to use for heating of the city, find their interests in other industries.

The current method of heating the town of Bijeljina, is related to coal, oil, present energy and wood. Use of geothermal energy as alternative energy source for heating the city of Bijeljina, improve air quality in the city and the environment, especially in the winter.

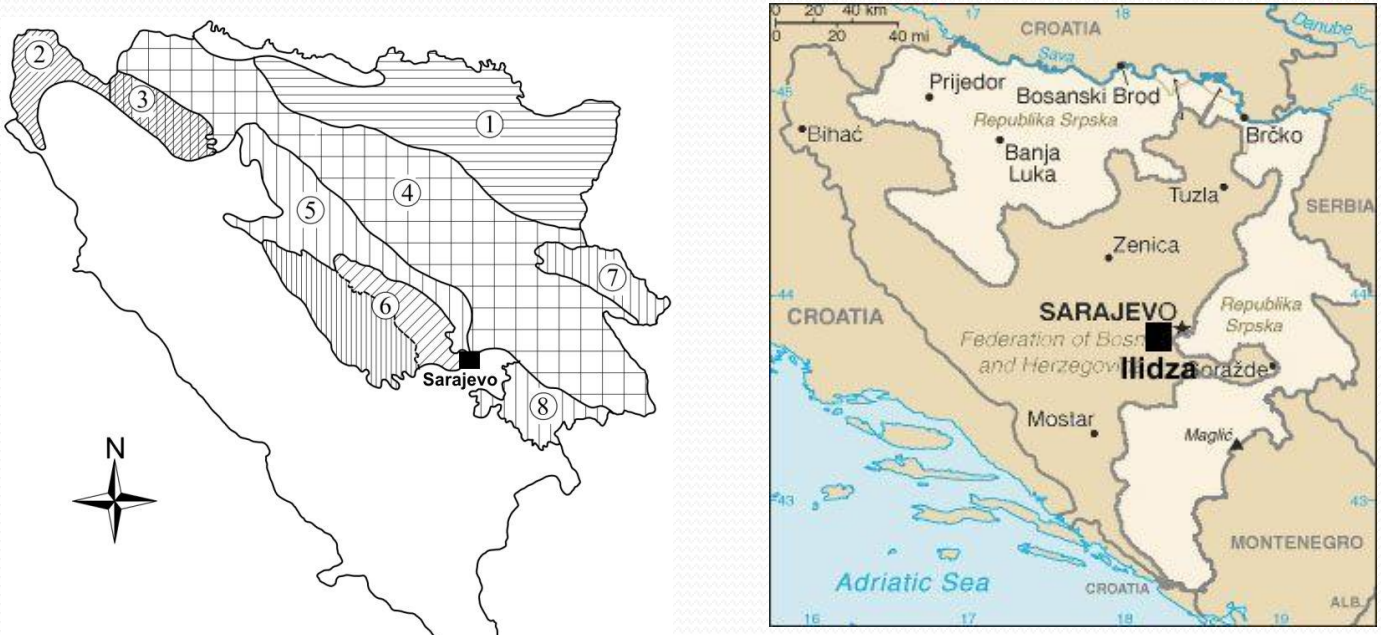
Environmental quality in the area is monitored for a dozen of years. The results show that the air quality is worse in the winter during the low temperatures, due to the use of coal with high sulfur content. The rest of the year shows the results, that quality of air, water and soil is within the required limits.

The advantages of using geothermal energy in Semberija are multiple. It is a domestic resource, then the resource that is renewable and represents a clean energy that does not pollute the environment when it is used, and it is a much cheaper energy source. This energy in the highest percentage may be a replacement energy to the existing energy sources.

Semberija is an agricultural area which requires a completely clean environment throughout the whole year, so that it’s products would be acceptable on European market. Also it is foreseen the use of geothermal energy at lower temperatures consumers for agricultural production, especially in periods when there is no open manufacture during the year.

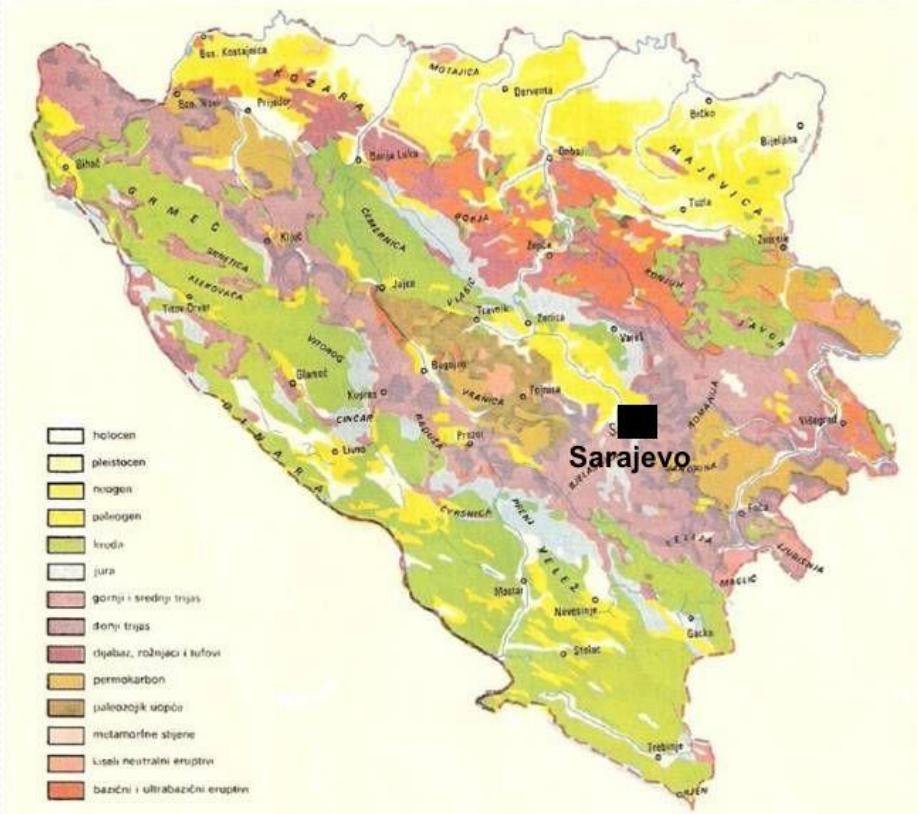
GEOTHERMAL POTENTIALITY OF ILIDZA

At the area of Ilidza near Sarajeva in the valley of the river Zeljeznica exist thermomineral waters, which are used from the Roman times, through the Turkish period till today, picture 11. Intensive use begins before the end of IXX century, in the Austro-Hungarian Empire, when they observed the area with favorable natural resources, where they can build a spa and other facilities for relaxation. So it arised Spa Ilidza, where it was soon built hotels with spa content, which are also present today. In time complex Spa Ilidza developes and becomes the most famous and most widely used treatment center in Bosnia and Herzegovina.



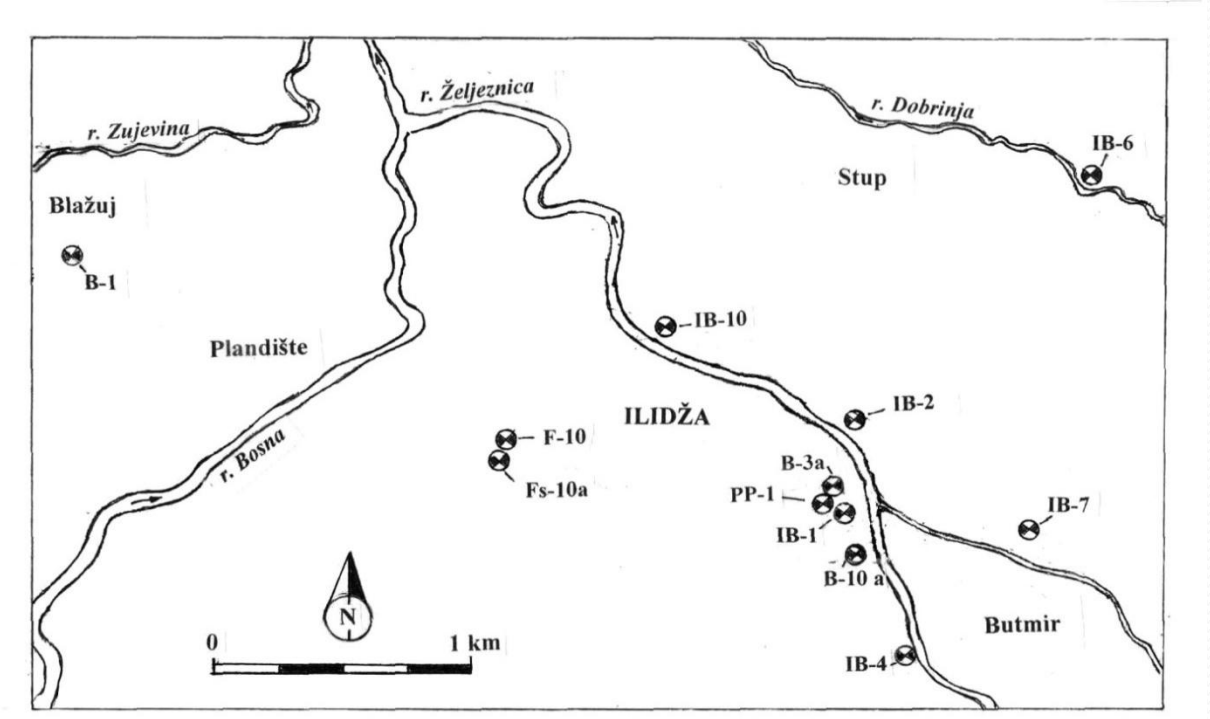
Picture11. Geographic location of the Spa Ilidza

Ground of Spa Ilidza surrouds towards west slopes of Mount Igman, built of limestones and dolomites of Middle and Upper Triassic. South of Ilidza in the structure of Igman are involved older - anisian carbonates represented with limestones and dolomites, and many other varieties of these rocks. These rocks make up the terrain up to Trnovo, and prevail in the structure of the western slopes of Trebevic, which makes the eastern and south-western rim of of Sarajevo field.



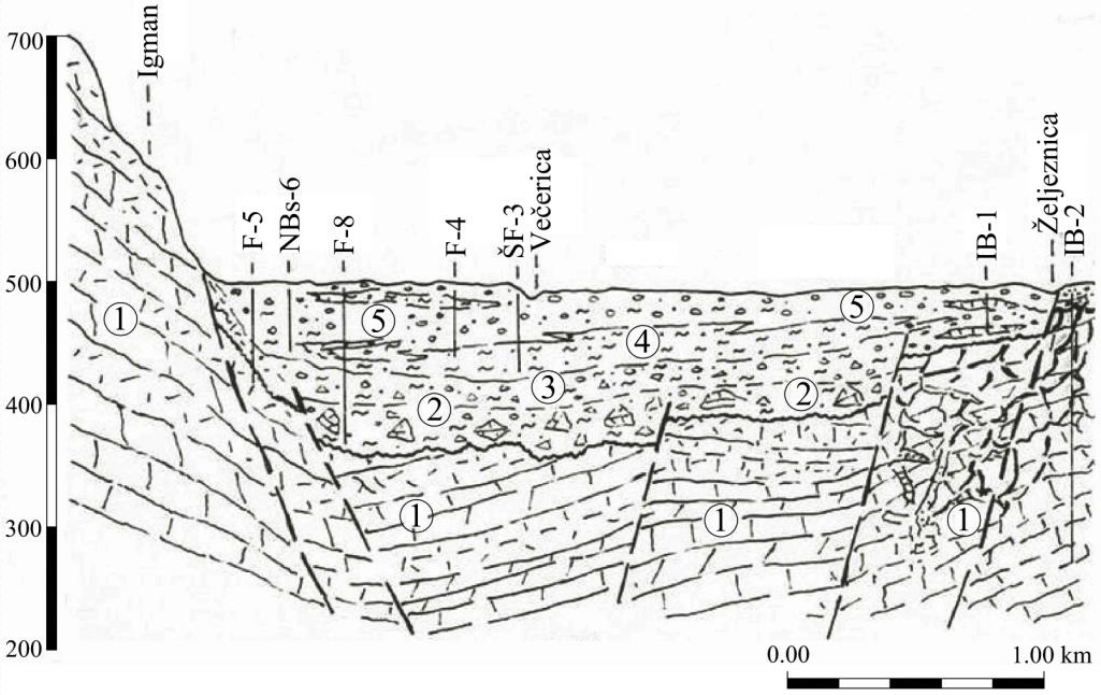
Picture12. Geological map of Bosnia i Herzegovine

The region of Ilidza is geologically extensively studied and investigated in the late IXX and throughout the XX century, picture 13. The works were carried out in order for better knowledge of the resources of drinking water contained in intergranular Quaternary sediments and thermal mineral water stationed in the deep horizons of the Triassic. A number of boreholes and wells to depths of about 100 m and five exploration wells (IB-1, IB-2, FS10, IB-6 and IB-7) from 180 to over 600 m were performed.



Picture 13. Schedule of boreholes of thermal mineral water of Ilidza
(F. Skopljak 2004.)

Structure of Ilidza's part of Sarajevo's field is related to the sediments of the Triassic, Jurassic-Cretaceous flysch, Miocene and Quaternary, picture14.



Picture 14. Geological profile of source of Bosna to Ilidza

(N. Čičić, F. Skoplak 2001, ažurirao N. Đurić 2014)

1. limestones and dolomites of the Middle Triassic, 2. roughly weak - bound limestone rocks, 3. gravel with less rounded grains of limestone, dolomite and subordinate sandstone with variable share of sand and clay, 4. clay with varying participation of gravel and sand, 5. gravel and sand, partly with increased participation of clay

Thermomineral water at Ilidza naturally izbijaju emerge at the surface near the hotel neposrednoj "Terma". Main characteristics of these waters are given in the table 2.

Table 2. Main thermal characteristics of thermal mineral water at Ilidza

The average revenue yield (l/sec)	Average temperature (^{0}C)	Usable temperature (^{0}C)	Power MWh
> 100	57,5	45,5	> 19,11

Around the main source of thermal mineral water of Ilidza were made borehole B-10a, IB-1, IB-2, PP-1 and B-3a, which are active, picture 13, however, only the borehole IB-2 is exploitation facility, because it is properly equipped. It is completed in Triassic limestones($T_{2,3}$?).

Thermo-mineral waters of Ilidza are of mixed descent. Water from deeper horizons are mixed with cold water from the alluvium. It was thought that greater depths may contain water of higher temperature, for which more detailed researches are needed. The warmest collectors are Anisian limestones where forecast temperatures of thermal mineral waters of 80°C or more, total mineralization of 3.29 g / l.

POSSIBILITIES FOR USING THERMO MINERAL WATER

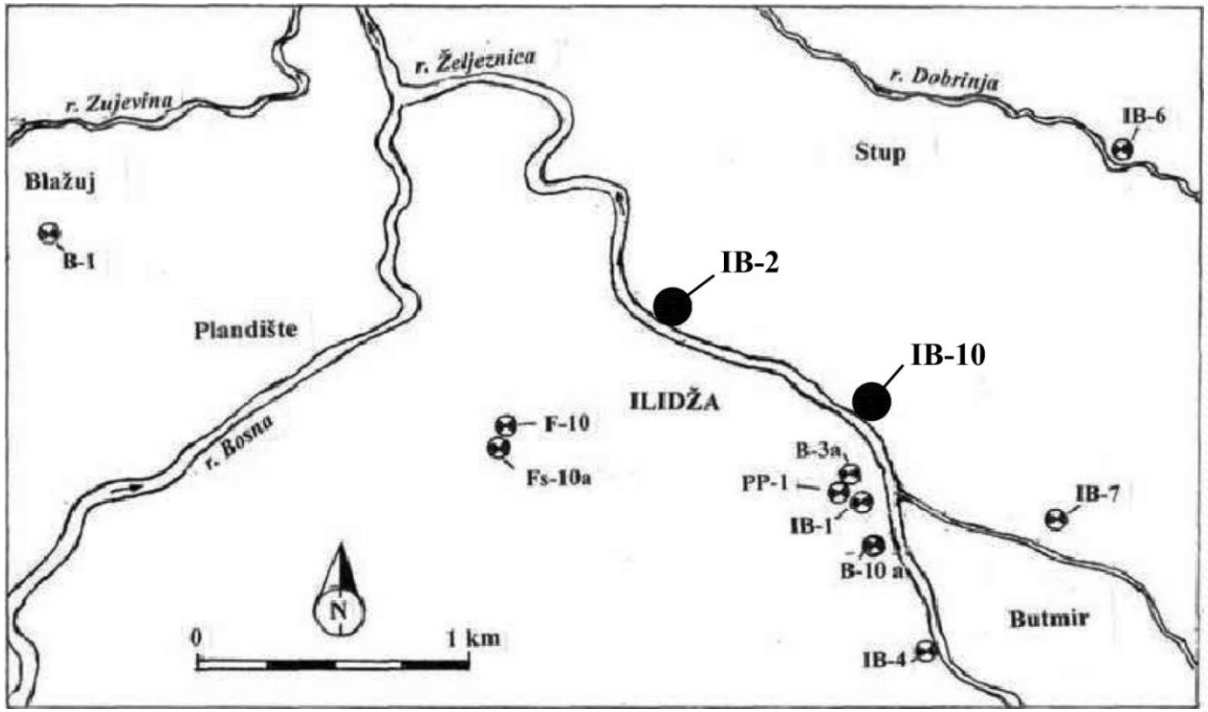
Current use of mineral waters is very modest compared to its potential. Total water yield of boreholes is approximately 260 l/s of water temperature from 24 to 58°C, and currently it is used about 10 l/s of these highly medicinal waters for the heating systems of the hotel. Water with a lower temperature of about 24°C is packaged in bottles and sold in the market under the name "Ilidza's diamond."

Sarajevo with its surroundings has about one million inhabitants and an area of Ilidza is suitable for agricultural production, which opens the possibility of using water in food production.

Spatial organization of Ilidza has a feature of Garden City. In Europe over 100 years is present an ideal of forming garden cities, whose roots stem from the late 19th century in England. This ideal is present in Sarajevo and Ilidza, and natural resources are in favor of this area.

Using the energy of hot water for heating in the settlement of Ilidza, would reduce the consumption of imported gas, and the environment would be fully harmonized with the current legislation, which creates and environmental requirements for the production of healthy food.

It is planned a construction of the swimming pool complex and related facilities with the use of thermal mineral water from borehole IB-2, picture 15 The project is intended to become one of the largest facilities of its kind in the former Yugoslavia. Taking into consideration these plans related to the characteristics of mineral waters, it is projected a borehole IB-10 at Ilidza, depth to 1250 m, with a capacity of about 100 l/s and a temperature of 58 - 80°C, picture 15.



Picture15. Position of boreholes IB-2 and IB-10

Economic and financial analysis of profitability

When evaluating the investments needed for the geothermal plant IB-10 at the site Ilidza direct, indirect and associated investment costs are taken into account .

Direct costs included the development of a complete borehole with associated studies, and development of energy facilities and the solving of property - legal rights.

Indirect costs of investments include the construction of access roads, supporting facilities, as well as producing of documentation for the same.

Following investment costs are the costs of building balneological complex of greenhouses for agriculture and horticulture, fisheries, and associated costs related to this type of investment.

Analysing the total cost of the investment and its economic feasibility, it was stated that the goal of economic justification of investment is achived if it is used a wider temperature consumption. It is necessary to fully enable the use of thermal energy from the heating of objects, until its complete utilization, up to a temperature from 20°C, where it returns through the injection well into the interior of earth.

DISCUSSION

Exploratory borehole IB-10 was carried out according to the project, but showed significantly different results than expected. Because of that is was stopped at the depth of 1 100 m, picture 16. Temperature instead of increasing with depth, it reduced because there is a mixing of hot and cold water. The presence of tectonics in this area is not yet fully clarified, so that the borehole obtained unexpected results. The temperature of water at the depth of 812-853 m was 40°C, and the depth of 1000 m was 21°C, table 3, picture 16.

Starost	*Litološki opis*	Interval (m)	Debljina sloja (m)	Profil bušenja (mm)	Grafički prikaz
Q	šljunak, pijesak i glina	0,0-40,0	40,0		
Pl,O	pijesak, glina	40,0 – 80,0	40,0	600,0	
M	laporovite gline, gline šljunkovite i pjeskovite, lapori, proslojci uglja i pješčara.	80,0 – 355,0	275,0	444,5 244,5 216,0	
T	*brečasti krečnjaci pigmentirani oksidima* željeza, ispucali i karstificirani sa ispunom od crvenice	355,0 – 1100,0	745,0	149,2	

Picture 16. Profile of the borehole IB-10 Ilidza (F. Skopljak 2004.)

Table 3. Mail characteristics of wates in IB-10 Ilidza

Interval (m)	Outburst (l/s)	Temperature (^{0}C)	Electrical conductivity (μS/cm)
812 – 853	40	30,3	1750
888 – 902	30 – 40	31	1560
1000 – 1005	22	21 – 22	920

The borehole is completed, properly closed and now does not have its significance. Will later be used for bottling of drinking water or any other purpose will depend on the new economic analysis of the possibility of using these waters.

Geothermal potential of thermomineral waters of Ilidza is important, so one negative result on a borehole will not stop further investigation. The results of the IB-10 shows that detailed hydrogeological research in planning such investments are necessary .

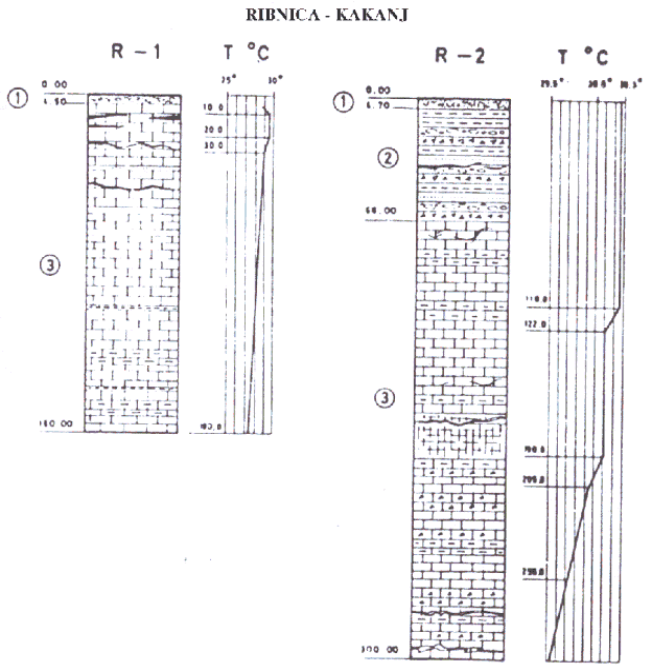
GEOTHERMAL POTENTIALITY OF KAKANJ

In the municipality of Kakanj, located in central Bosnia IT IS investigated the source of thermal mineral water Ribnica and Ticici, in terms of quality and quantity, and economic justification of the use, picture 17. Depending on the characteristics of water, it is planned the construction of the spa and / or sports and recreation center that follow this site.

Picture 17. Geographical location of Ribnica and Ticici

Appearance of thermal waters in Ribnica and Ticici of temperature around 30°C, is registered in the seventies of the twentieth century. Water are related to the Jurassic-Cretaceous limestones and Turonian-senionsk flysch on the NE edge of the Sarajevo-Zenica basin. Thermomineral water in Ribnica and thermomineral water in Ticici in the beginning of the eighties of the twentieth century, were limited to known sources of hot water with the name "Spa" for the locals to use.

At the beginning of the eighties of the XX century the tray of groundwater Ribnica operated in two exploration boreholes R-1 (182 m) and R-2 (300 m), which were completed in the Upper Cretaceous flysch presented with marl, sand and limestone breccias, picture 18. The boreholes were converted into exploitation wells with characteristics given u tabeli 4.



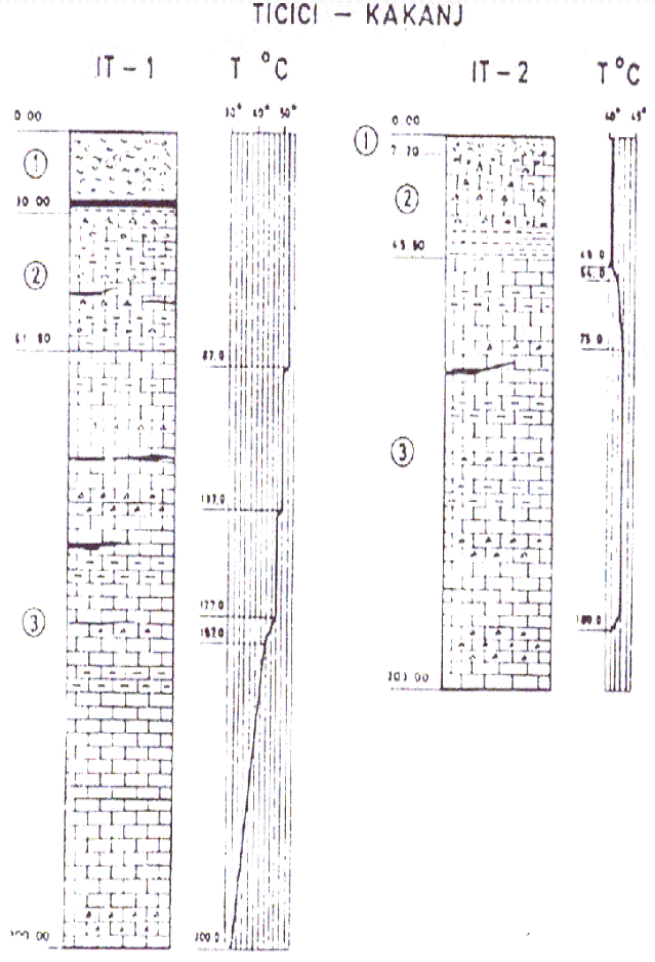
Picture 18. Geological profiles of exploratory boreholes and wells Ribnica near Kakanj

Table 4. Characteristics of exploitation wells RB-1 and RB-2

Well No.	Depth (m)	Yield (l/sec)	Temperaturae (^{0}C)	Pressure (bar)
RB – 1	80,0	40	28	-
RB – 2	180	80	30	0,04

Obtained results were a solid basis for building the spa tourism facilities in the area Ribnice, municipalities Kakanj. However, the development of surface exploitation substantial coal reserves in Vrtlište, is followed by space coerced solution to tailings from this mine to be deposited in an extended valley Ribnice. New facts on the ground, requested the conversion of river water Ribnice through a tunnel into the river Bosna. Afterwards, it was accessed to the study of thermal water at the site of Banja, near the village Ticici, west of Ribnice.

On the site called Spa-Tičići two exploration boreholes were made IT-1 (300 m) and IT-2 (203 m), at a distance of 350 m, picture 19. It was drilled through the same layers as in the Ribnica and it did not reached the footwall insulators. Some researchers believe that the underlying stratum insulators are much deeper, about 1500-2500 m. It is estimated that the Anisian limestone (Middle Triassic T2) as the real source of hot water, are at depths of two kilometers, and hot water erupt to the surface through faults.



Picture 19. Geological profiles of exploratory boreholes of thermomineral waters Banja-Ticici
1. Alluvium, 2. sandy calcareous marl with layers of coal and clay marl,
3. Cracked limestones in amending with layers of marl and brecciated limestone - hydrogeological collector of hot and cold water

The boreholes are of various depths, insufficient to reach the footwall insulators, and sufficient to gain insight into the basic characteristics of registered water table 5. It is typical that the temperature increases with the depth. On the IT-1 borehole, the water was under strong pressure (1.1 bar), erupted and threatened surrounding buildings.

Table 5. Characteristics of water in the exploration boreholes

Borehole No.	Q (l/sec)	t ^{0}C	pH	Firmness (^{0}dH) / mg ekv/l)	CO_2 (mgr/l)	H_2S (mgr/l)	O_2 (mgr/l)
IT – 1	30	54	6,9	25 / 13,9	190	0,07	9.8
IT - 2	22	39	6,5	29 / 14,73	147	0.07	6,7

According to the balneologic classification these waters belong to the thermals and hyperthermia, and have a wide range of therapeutic effects. Can be compared with Švajsersik spa in Austria and some famous spas in the former Yugoslavia.

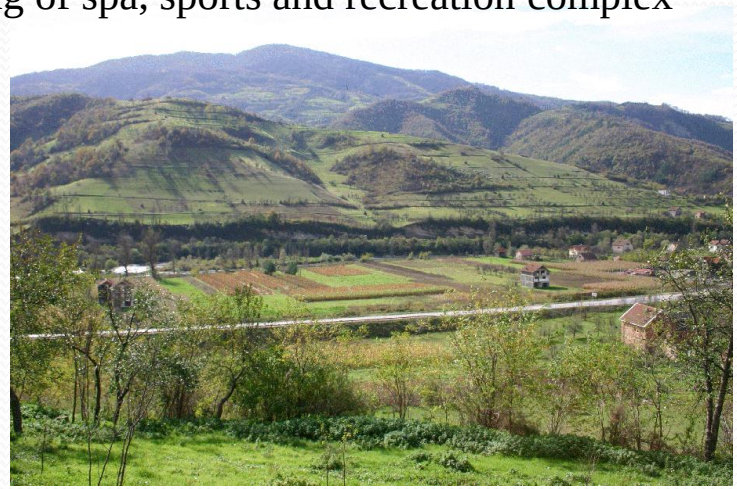
Today we use only natural water sources in Banja Tičić, mostly for swimming and recreation of the local population. Thermal mineral potential of the water resources Tičići is not significantly used, and the boreholes were closed from uncontrolled emphasis.

In order to increase hydro-geothermal potential, is is planned to develop a boreholes to a depth of 300-400 m. The influx of thermo mineral waters can be expected within the first 100 m, except that predicts an increase in flow with depth and the optimum water temperature around 50 ° C, in the carbonate massif. In addition to these sources in the municipality Kakanj, there are several smaller sources of thermal and termo mineralner water.

THE POSSIBILITY OF USING THERMAL AND THERMO MINERAL WATER

The central part of Bosnia and Herzegovina through the centuries, is characterized natural beauties, the presence of cultural and historical values and favorable climatic conditions which occur during the year clearly distinguish the four seasons. In this area, are crossed different cultures, religions, traditions, and in the range of 100 km can be seen largely the history of Bosnia and Herzegovina in the past years. Some of these events have had a significant influence on the development of European society.

Characteristics of the area over time has left a tradition agricultural production. Today we still can not find local products, which are market in Europe. Also possible is the development of organic farming in all aspects of food production, picture 20. Therefore this is an attractive destination for tourism development, where it is planned a building of spa, sports and recreation complex



Picture 20. Panorama of immediate surroundings of springs Ticici

Economic and financial analysis

The analysis was performed for the conditions of construction of a spa, sports and recreational tourism, and food in the open space and greenhouses.

When estimating the investments in the development of the city two groups of investment costswere analyzed .

- costs of building the center with infrastructure ..... 6 000 000 €
- production costs of the exploitation wells and water exploitation ... 2 000 000 €

The starting point for the evaluation of investment is energy quality of the geothermal energy resources.

Previous research indicates that the temperature reached 50°C and energetic potential of about 6.5 MW. According to the previous experiences and economic analyzes compliant with current legislation and credit terms of domestic and foreign banks, investments in projects of geothermal resources with the resource of given quality are justified.

DISCUSSION

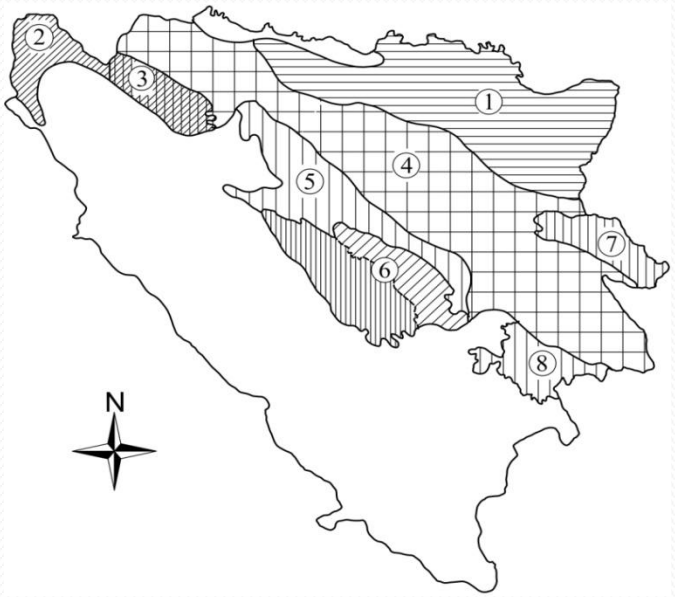
Previous studies of thermo mineral waters have shown justification for further research with the possibility of development of appropriate economic programs. Advantage in further research and investment originates in Ticici because of favorable geographical features. Besides two exploration wells for which is subsequently shown that are not of sufficient depth, it is planned a development of one more borehole depth of about 400 m, temperature 50°C.

Characteristics of the area both in geographical and historical terms, provide justification for investment in development primarily of spa, sports and recreational tourism. Together with other spas in Bosnia and Herzegovina, as well as important historical events, it would close a circle of service activities in the above areas.

The quality of the geothermal resource in the part of its use, justifies planned investments. Analysis of environmental and social factors in an area that is undeveloped, also confirmed the justification of the investment.

OTHER THERMAL AND THERMO MINERAL RESOURSES IN BIH

According to data from the end of the twentieth century, the total thermal energy potential of the springs and boreholes analyzed at 74 sites is 166 MW, without additional research. Sources are at varying degrees of exploration and with different thermal energy capacity. However, there is a sufficient number of resources that are in use today, and can be used to a greater extent with an increase in level of exploration. Renewable energy potential of hydrogeological thermal systems, calculated by various methods, to a depth of 3000 m is 125 x 106TJ in all nine (9) regions are separated in picture 21.



Picture 21. Geothermal regions in Bosnia and Herzegovina

Past exploitation of thermal and thermomineral waters is related to the known sources. Mainly by the spring of emerged spas, whose capacity increased over time. In areas with a high temperature, thermal energy is used mainly to heat the spa facilities. Overview of the use of thermal and thermomineral waters in Bosnia and Herzegovina and its entities Federation of Bosnia and Herzegovina and the Republic of Serbska are given in picture 22.

Picture 22. Spatial distribution of spas Bosni and Hercegovini

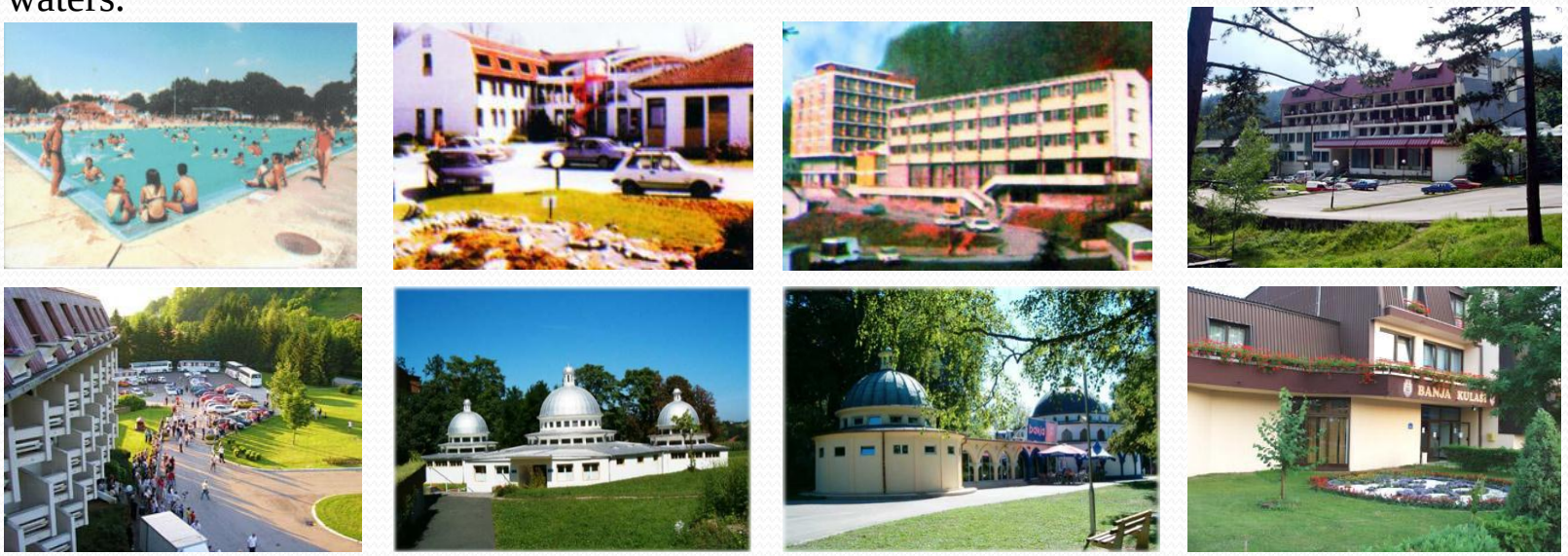
In the Federation of Bosnia and Herzegovina geothermal energy is used mainly for geothermal spa and recreational purposes. It is built five (5) spas, which have a longer tradition of its existence. Temperatures are around 50°C, although in some locations are registered lower or higher temperatures. They are divided into five major spas, picture 23.





Picture 23. Spas in Federation of Bosnia and Herzegovina
Ilidza Gradacac, Akvaterm Olovo, Ilidza Sarajevo, Reumal Fojnica, Kiseljak

Today, on the territory of the Republic of Serbska it is used exclusively hydrogeothermal energy of temperature lower than 75°C, on previously constructed facilities, picture 24. Degree of exploration is significantly higher compared to the use of thermal and thermo mineral waters.



Picture 24. Spas in Republic of Serbska
Dvorovi, Kozarska Dubica, Guber Srebrenica, Vilina Vlas Visegrad,
Vrucica Teslic, Slatina Banja Luka, Laktasi, Kulasi

For heating or warming mainly spa facilities with the use of heat exchangers, water inDvorovi, Slatina, Kulasi and Visegrad are used.

For recreational purposes, thermal mineral water are applied in Spas - Seher, Laktasi, Sockovac and Dvorovi.

Thermo mineral waters in the area Sockovac used for separation and a production of CO_2 gas .

FINAL COMMENT

Geothermal energy in the area of Semberija and northeastern part Reublic Serbska - Bosnia and Herzegovina, is an important energy resource. The current level of exploration is sufficient that it can be planned its usage, primarily for the purpose of warming of buildings in the winter. Remains insufficient exploration in terms of maximum temperatures of water on the surface, which can be obtained from a depth of 2500 m. After making the first geothermal borehole BGT-1 we will get data on temperature and capacity borehole, ie how much energy can we get from one borehole. Existing economic analyzes were performed for the maximum temperature on the surface of about 90°C.

If the temperature has reached the value of 110°C, then it would be considered the possibility of using geothermal energy for energy purposes, ie construction of appropriate geothermal power plants. In doing so, the economic justification for its use would be subsequently analyzed.

The use of geothermal energy in Semberia a justification, especially as this is an agricultural area, so that energy can be used in food production and processing, and the lower the temperature consume for sports and recreational purposes. Replace fossil fuels with geothermal energy, would reduce the concentration of pollutant particles in the air, that will improve the quality of the environment. Given that Sermberija is an agricultural area, by improving the environment, opens up the possibility of producing organic products.

Other parts of Bosnia and Herzegovina are characterized with the presence of warm waters from which you can get a certain amount of energy. In these areas, water temperatures are lower, but enough that itcan find the appropriate application.

Isolated areas of Ilidza near Sarajevo and Kakanj in central Bosnia are just some of the areas where it is used geothermal energy with a clear perspective for the future.

Thank you for your attention !