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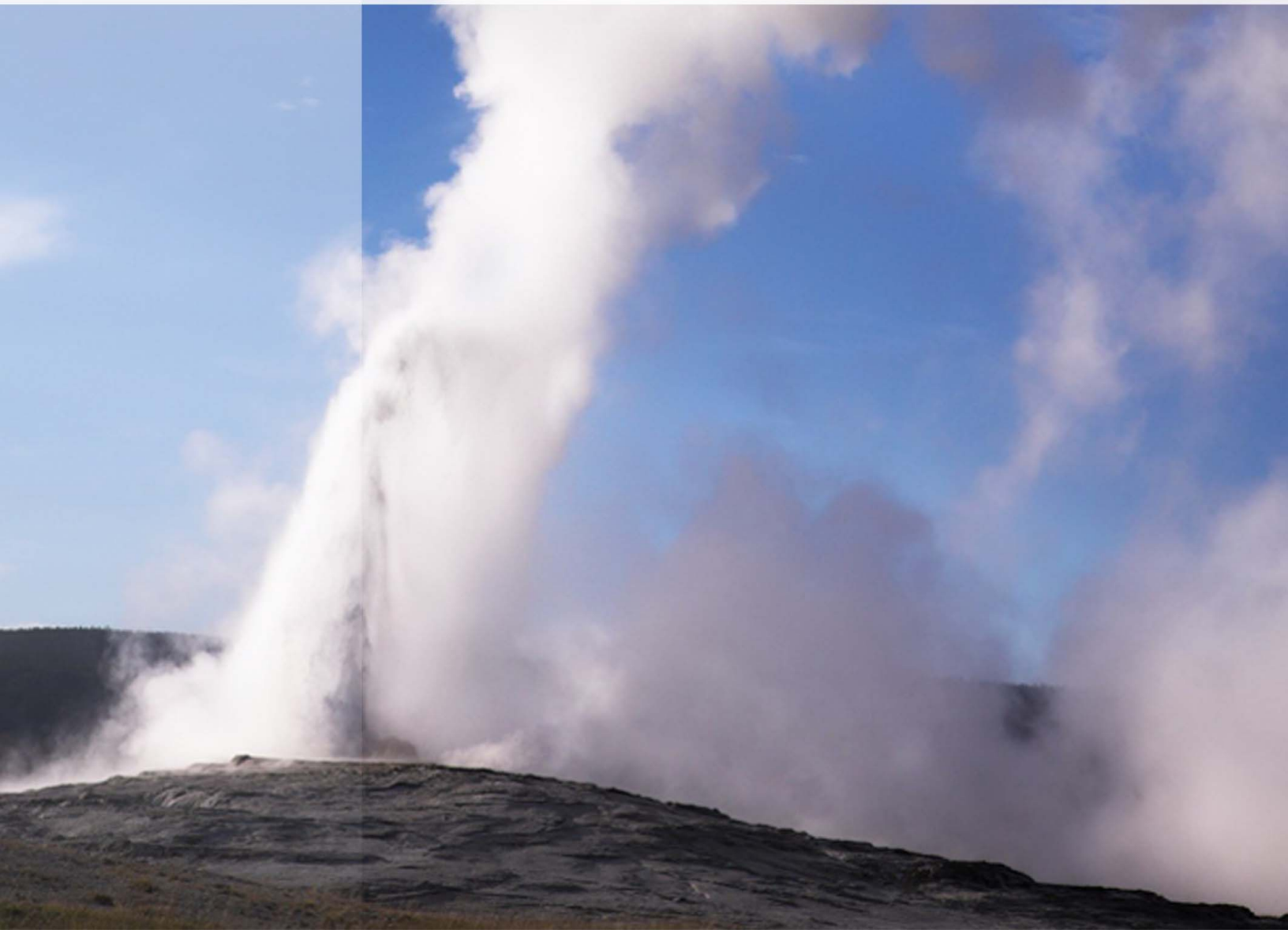
Geothermal energy: How to take advantage of hidden potential of Serbia



GEOTHERMAL ENERGY:

HOW TO TAKE ADVANTAGE OF HIDDEN POTENTIAL OF SERBIA

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ABSTRACT

This text aims to point out the insufficient utilization of geothermal energy resources in Serbia and propose measures to solve this problem. The current Serbian energy strategy does not deal with geothermal energy as an important and significant resource that is several times greater than the total coal reserves in Serbia and that is present at any place at any time.

The estimated power of all existing geothermal wells in Serbia is about 160 MW of which about 100 MW is currently used. Using heat pumps can take from the land as much completely clean energy as we need. For example, installation of 20 000 heat pumps of 20kW power for residential heating facilities can take from the land as much energy as we obtain from thermal power plants of 300 MW.

In Europe, very high objectives were set in terms of implementation of renewable energy sources and reducing emissions. Geothermal energy is most appropriate for achieving those goals and because of that it is the only one of all renewable energy sources in several European countries that entered the legal obligation to be used for heating new buildings. By joining the European Union, we will also face the commitment regarding the use of renewable energy sources and reducing greenhouse gas emissions. It is necessary for Serbia to begin as soon as possible the realization of its potential in this field which would result in multiple effects:

- *With minimum investment maximum installed capacity in a very short term is achieved*
- *The investment is conducted by citizens, not states*
- *Maximum energy efficiency is achieved, because only 25% electricity is invested*
- *There is no pollution or emissions*
- *Scientific and technological knowledge is increased, as well as employment*

In this article, programs that are aimed at greater use of geothermal power in Serbia are divided into three areas:

- ***More efficient use of existing geothermal springs and wells.***

When using geothermal water in spas, sanatoriums and leisure centres water energy is only partially used, while water temperature is at a sufficiently high level. The application of heat pumps can use the available energy up to the temperature level of 10°C. This means that at some places two to three times more the capacity of geothermal sources can be used than they are used now.

- ***Activation of sealed wells.***

By increasing the price of fossil fuels and electricity many sealed wells will become attractive and this will create the need for their activation. If the new owner of NIS offers its wells for sale, there will certainly be customers who will take advantage of the maximum of the existing capacity by the rationalization of its use.

- ***Intensive use of geothermal heat pumps***

State with its stimulatory measures should lead the project for the massive use of heat pumps for heating buildings, for calculation shows that it is a great profit for both the state and the user. The project can be implemented quickly with financial participation of future users and without any lengthy preparations. It is only necessary to run a campaign, and incentives will serve primarily to draw attention to the seriousness and significance of the project.

I. INTRODUCTION

The notion that the energy is extracted only in the form of coal, oil and gas and that it is produced in thermal power plants and hydro power plants is the main reason why the most available geothermal energy remains hidden and unused. The population of Serbia was in a long time held under a specific mistaken notion that geothermal energy sources include the water temperature higher than 45°C. However, geothermal energy means the energy that can be obtained from water, soil and rocks whose temperature exceeds 10°C.

Technological development enabled as early as in the seventies efficient use of low-temperature geothermal energy through heat pumps. In this period there were efforts in Yugoslavia to increase energy efficiency and lower heating costs in our spas, using domestic equipment of fairly large force.

Current, and also the old problem in Serbia is that its energy sector is led by people whose aim is only millions of tons of coal to dig. The concept of low-temperature energy does not exist in the current Serbian Energy Strategy. Geothermal energy in the classical sense (hot springs and wells) is mentioned in terms of declarative commitment to developing the potential of Serbia in this sector, but without concrete measures and solutions.

Contrary to this, a surprisingly large emphasis is placed on the use of wind energy in good locations where it is present more than half of the year, as well as solar energy, which is theoretically present a maximum of half a day. Biomass is also not universally available: it is necessary to be collected and stored where it is present, and when it is present.

However, in our conditions, over 50% of generated electrical energy is spent in buildings for housing, primarily for heating and sanitary water, for what geothermal energy can be effectively used. In this case, a great deal of our electric generating capacity can be directed to export electricity.

My intention and desire is to point out in this article that geothermal energy is present everywhere, that there are technological conditions for it to be very effectively used and that the state can accomplish, by implementing the measures proposed in this paper, multiple uses:

- Only through information, it can point to the large cost-effectiveness of the *implementation of heat pumps.*
- *Appropriate measures to stimulate the use of heat pumps in the following year* would lead to a reduction in the share of electricity for heating dwellings, which would also enable the profitable export of electricity.

- The consumption of fossil fuels and emissions would be reduced, and this would lead to the amplification of other environmental effects.
- This would contribute to increasing scientific and technological knowledge on the use of heat pumps.
- Serbia would equally and readily enter the European integration in the field of increasing energy efficiency.

The article is organized as follows: after a brief summary of the characteristics of geothermal energy and the most common ways of its use, I will switch to the description of the current application of heat pumps in the European Union. Main article contains an overview of the situation and proposed measures to improve energy efficiency, activation of existing and new geothermal boreholes, as well as mass application of heat pumps in Serbia. The conclusion offers recommendations for general Serbian strategy in this field.

II. GEOTHERMAL ENERGY

Geothermal energy on Earth dates back to the creation of our planet 4.5 billion years ago. The temperature in the center of the Earth is about 6000°C and there thermonuclear reactions still take place. The heat from the heated core moves towards the surface of the Earth's crust. Only a small part of the energy in the surface area several kilometers deep is available to us.

Geothermal energy is contained in the Earth's crust, in its rocks, underground water, underground water-steam and magma. Depending on its environment geothermal energy is called hydrogeothermal, and petrogeothermal and magmogeothermal.

Hydrogeothermal energy is stored in underground thermal water whose temperature is higher than 10°C. Its extraction is done from the source or wells. Petrogeothermal energy is contained in dry rocks which do not contain free underground water. This year commercial production of electricity from power plants that use the energy of hot rocks has started. For this application rock temperature needs to be higher than 100°C. Magmogeothermal energy is accumulated in hot magma and experiments for its exploitation are successfully conducted.

The potential of geothermal energy in a particular area can be described as density of geothermal heat flow (the amount of geothermal heat that in each second through an area of $1m^2$ comes from the interior of the Earth to its surface). The average values in Europe are about $60mW/m^2$, while in Serbia these values are significantly greater: over $100mW/m^2$. Serbian terrains are built of hard rock and because of such favorable

hydrogeological and geothermal characteristics in Serbia there are about 160 sources of geothermal water with temperature higher than 15°C. The hottest sources are in Vranjska Spa, where the temperature is up to 96°C.

The estimated total amount of heat contained in geothermal water sites in Serbia is about two times higher than the equivalent amount of heat that would be obtained from burning all our coal reserves.

In Vojvodina, there are also 62 artificial geothermal sources (wells) of the total yield of 550l/s and thermal power of 50MW. In the part of Serbia south of the Sava and the Danube there are 48 more wells with an estimated power of 108MW. [1]

These data indicate a great potential for the exploitation of geothermal energy in our country, which is currently almost entirely unrealized.

III THE MOST COMMON WAYS OF USING GEOTHERMAL ENERGY

HOT SPRINGS

Hydrogeothermal potential is mostly used in the world and in Serbia. The reasons are simple: the natural resources were in the previous period brought to use and in further use funds are needed for the maintenance and refurbishment by adding new attractive content. Some countries of the world which take care of energy and tourism are continuously investing in health resorts, spas, sports and recreational and tourist centers. These are countries with private capital investments which are encouraged to be invested in energy efficient, ecologically justified and tourist attractive projects.

In Serbia, due to the lack of laws and documents geothermal sources (especially drills) are unavailable to new investors. Jurisdictions are not known, or if they are, they are so intertwined between the various state authorities that it is practically impossible to come into possession of a hot spring and start or improve its use. Vranjska Spa is a typical example where the entire river of warm water flows through the town and the population is heated with electricity, wood or coal.

In developed countries of Europe energy saving is especially prominent after last year's problems with Russian gas. There hydrogeothermal energy is maximally used for heating residential and business premises. Its larger application is in agriculture and animal husbandry because geothermal energy is then used at its source and does not need to be transported to towns. Exploitation of hydrogeothermal energy is so advanced that almost

every well or drill can be effectively used regardless of water quality and content of minerals and gases dissolved in it, with complying with environmental requirements.

BORES

Exploitation of geothermal energy from the borehole is slightly more expensive, but when taking into account the longevity of such energy sources, fossil fuel substitution and preservation of nature, then the benefit is great for investors, for the local community and country as a whole. It is important only that all three parties see their benefit and that they engage in the realization of any such projects.

HEAT PUMPS

Heat pumps are cooling machines that transfer heat from one space to another by cooling one space, and heating the other. In order to achieve the transfer of heat energy certain electric energy, mostly the energy for the compressor, must be invested. The main reason for the application of heat pumps lies in their effectiveness: to transfer heat energy only 20-30% of transferred energy is used. Namely, the heat pump uses 1kWh electricity for the transfer of heat energy of 3-4kWh. If the heat energy that is transferred is obtained free of charge, for example, using low-temperature geothermal energy (10-20°C), the price of the energy provided for the user is multiply reduced.

Climatic conditions in Serbia are perfect for the application of heat pumps. Pumps in winter work in the heating mode, and in summer in the cooling mode. This avoids investment in additional equipment for cooling. The application of heat pumps reduced heating costs 3 to 4 times. If heat pumps are used combined with floor and wall heating thermo-accumulative effect is achieved. In this way it is possible that a large part of the heating season uses electricity per night rate which additionally reduces the cost of heating 3 to 5 times. Heating with heat pumps is cheaper 9 to 16 times compared with equivalent heating with fossil fuels, wood or electric energy in conventional boilers. Using electricity during the night has multiple advantages: spending is carried out when there are surpluses of electricity and the peak load during the day is reduced, which makes better power system regulation.

HEAT PUMPS OBTAIN GEOTHERMAL ENERGY FROM THE GROUND IN THE THREE FOLLOWING WAYS:

1. The water from wells, which is usually at a temperature of 10 to 20°C, is brought to the heat pump and after its cooling it returns to another well or is poured into canals, waterways or sewers. This is in terms of energy the most efficient way, because the water temperature is constant throughout the year. From the standpoint of reliability and simplicity of the whole system, there are certain problems and costs of construction of the wells. Capacity restriction is defined by yield of the well. A common case is that the locations where it is necessary to carry out heating with heat pumps do not have available the required quantity of water or water is not present.
2. Using the probe eliminates problems with lack of well water. Longevity of this system is guaranteed, the possibility of defects or other problems is minimal, and the ease of handling is reduced to an absolute minimum. Depending on the geological characteristics in a particular location, with a probe depth of 200m it is possible to achieve heating power of up to 13kW. In economical terms probe application is a little more expensive investment compared to the wells, but its reliability, ease of handling and long-term solving the problem of space heating and cooling at any location imposes this solution as the most attractive and it should be maximally used in Serbia in the future, as it is now the case in the richer European countries.
3. Terrestrial collector is a solution very similar to probes with the difference that it does not require drilling the well where the probe is descended, but the plastic pipes are laid in the form of a network in the soil at a depth of about 1.5 m. The energy collected by this method is mostly solar energy accumulated in the surface of the land during the summer. This solution is much cheaper than the probe if the installation is done during construction of the facility and if there is a large enough area of land for setting up of collectors. A disadvantage of this method is that the energy from land is used in the winter, so at the end of the heating period the system efficiency is reduced.

IV HEAT PUMPS APPLICATION IN THE EUROPEAN UNION

Since January 2009 the application of heat pumps has definitely been classified among renewable energy sources. This is important because the application of heat pumps now automatically fits the already established rules, regulations and financial structures that are used for renewable energy. Europe's energy dependence on imported energy proved in particular during the gas crisis in January 2009. The European Union does not have much choice, but directions are clear.

"As Johnson (Johnson, 2005: 257-62) states, this is consistent with two main strategies that the European Union has at its disposal to ensure energy security and reduce energy dependence. The first strategy means reducing consumption by introducing new, mainly renewable energy sources and finding new energy sources and energy suppliers. It's a long-term strategy, while the only short-term strategy is developing close relationships and partnerships with major energy suppliers of the European Union. "[4]

Over 40% of primary energy in the EU is used on heating and cooling. Therefore, it is a broad area to act and where it is necessary to achieve significant results.

High goals for reducing primary energy consumption by 20% by 2020 while reducing carbon dioxide emissions by 20% have resulted in the fact that renewable energy sources are treated as the backbone of cost savings. In these savings the application of heat pumps will have a significant share of 22%.

In the last 5 years several European countries have passed legislation and provisions of newly constructed buildings that each facility must have a heat pump for heating built-in. Additionally, most European countries provide significant incentives for the installation of heat pumps, from direct payments to manufacturers for each supplied heat pump to the tax incentives for users. The profit has been calculated from the application of heat pumps at the state level and on the basis of that certain incentives to achieve the intended effects have been determined.

	2003	2004	2005	2006	change 03/04	change 04/05	change 05/06
Austria	3.780	5.129	6.098	8.853	35,7%	18,9%	45,2%
Czech Rep.	1.200	2.400	4.000	4.000	100,0%	66,7%	0,0%
Denmark	0	0	4.000	4.000			0,0%
Estonia	510	750	1.095	2.333	47,1%	46,0%	113,1%
Finland	8.540	12.648	22.307	36.950	48,1%	76,4%	65,6%
Franc	13.700	17.300	25.200	61.510	26,3%	45,7%	144,1%
Germany	15.838	19.636	25.486	51.827	24,0%	29,8%	103,4%
Ireland	1.300	1.800	2.300	2.300	38,5%	27,8%	0,0%
Italy	0	12.131	13.000	13.000		7,2%	0,0%
Netherlands	1.557	1.800	1.891	2.767	15,6%	5,1%	46,3%
Norway	55.081	35.390	40.000	40.000	-35,7%	13,0%	0,0%
Poland	0	0	1.465	1.465			0,0%
Sweden	68.100	100.215	101.350	122.473	47,2%	1,1%	20,8%
Switzerland	8.695	9.796	12.008	15.806	12,7%	22,6%	31,6%
UK	0	0	750	750			0,0%
Total	178.301	218.995	260.950	368.034	22,8%	19,2%	41,0%

Table 1. Sales numbers for different EU countries. (Source: EHPA)

Number of installed heat pumps and annual changes [5]

The total number of newly installed heat pumps in eight European countries increased in 2008 by an average of 50%. For example, Sweden, where there is statutory requirement that every newly constructed object must have a heat pump, in 2007 there was a decrease in sales due to the saturated market, that is, due to reducing the number of newly constructed buildings.

There is a trend that in old facilities the replacement of existing heating systems should be performed, and due to stimulation measures already in 2008 sales rose from 93.000 to 128.000 heat pumps. There is also an increase in the installation in buildings with multiple dwellings, while in the first round a more massive use was in family homes.

The latest news is that the European Council adopted the decision that, starting from 2020, each newly constructed residential or business object must be energy independent. This means that each object will have to produce as much energy during the year as is spent in the building. Needless to say, heat pumps are in the focus of this decision and now incentives will follow for their even faster development.

V APPLICATION OF GEOTHERMAL ENERGY IN SERBIA: CURRENT SITUATION, PROBLEMS AND RECOMMENDATIONS

In the period from 1974 to 1992, 113 wells were drilled in Serbia [1] which tested the capacity and quality of water. It was a period in which a good basis was set for greater exploitation of hydro-geothermal potential in Serbia. Geothermal wells were made in the process of searching for deposits of gas and oil and often they were built outside residential areas and roads. This is the reason for their little use in the previous period. There was no interest in state for the activation of these wells. Also, low prices of other energy sources, especially electricity, were not the stimulus for the use of geothermal water, even in agriculture, although a larger number of wells are located in cultivated land. Also, agricultural production in the protected and heated area such as greenhouses has been here in its infancy for decades, so that in the whole of Serbia only a few agricultural buildings are heated with hot water from wells.

5.1 ENERGY EFFICIENCY

Serbia has a very distinct problem of insufficient energy efficiency and irrational use of existing sources or wells that are under exploitation.

In thermal spas almost no attention is paid to energy efficacy and large amounts of hot water are discharged as useless, but from them by using heat pumps enough energy to heat

the area or the pool can be extracted. At the same time the space is heated by coal, oil or electricity. If they carried out the rationalization of using thermal energy from hot springs in the spas, then from the same sources of energy new attractive facilities could be provided.

Also, the future users of currently sealed wells have to become familiar in time with the ways of rational use of the maximum energy potential, which will show better financial analysis results.

Example [2]

- Drill Bečejski Bč-2/H is one of the most energy appropriate in the territory of Vojvodina. The designed outburst has a thermal power of 4.153kW if it is calculated from water cooling to 25°C. However, the installation of heat pumps can increase this GTV to 5.192kW. Power that can be achieved with standard combustion of separated gas should be added, making about 1.425kW with about 90% efficiency in the process of combustion.
- Unfortunately, for a long time only (25-40)% of the capacity has been used, depending on which GTV flow is accounted. A total of current consumers is of too small strength and duration of its use for such a powerful drill. This example clearly shows the other side of the issue of geothermal resources use in general. In fact, the more difficult part of the problem is forming proper consumers, than opening and fully equipping the wells. This is the main reason why a large number of successful wells are out of use, regardless of the geothermal water being above 45°C already competitive to conventional energy sources.
- Our calculation shows that on this drill, with adequate consumers, a powerful thermal power plant with over 7MW base power can be built, with an additional feature of warming the consumers such as swimming pools and similar pools for raising fish. Modern plant scheme with heat pump also provides summer cooling, in addition to the maximum utilization of geothermal water in the heating season.
- Therefore, the following activities regarding the architectural draft, in the vicinity of the current production well, should focus on the composition of a strong and long-lasting heat energy consumer, which will remain economically viable even after the perhaps necessary construction of the return well. We should not forget either the existence of something weaker, but still acceptable well Bč-1/H, which can easily be joined to the thoroughly analyzed Bč-2/H and significantly increase this resource.
- Investment in the construction of this powerful energy source is not small, and it would be about 2.237.000€ if started with a bare land. However, it is actually lower for the value of the existing production wells (about 360.000€) and for another 200.000€ which could be used from other existing equipment. Therefore the price would be around 1.677.000€ together for the consumers and owners of the wells. It is

still not small, but it would be repaid in about 3.5 to 4 years, if it achieved an annual profit of 600.000€, and under the quite difficult credit conditions, with an annual effective interest rate of 10%.

- At a minimum, present consumers should improve the plant with the installation of a heat pump and a relatively small thermal boiler which would ensure the current consumption in a better way, and introduce additional summer cooling function. It is an investment below 125.000€

At other locations the situation is similar. Thus, for example, the entire rehabilitation center in Vrdnik is heated with oil in addition to the geothermal resources of large capacity which is sufficient to heat the entire center. In this center two years ago a geothermal heat pump for heating sanitary water was installed and this reduced by 75% the consumption of the energy which was previously used for these purposes.

5.2 ACTIVATING CURRENT GEOTHERMAL BOREHOLES

Putting into operation wells that are sealed have great importance for Serbia. In the process the procedure which was established for the purpose needs to be implemented. On many holes a complete examination of the water composition and quality has not been performed and therefore it must not be allowed to discharge such water uncontrolled into waterways. It is possible that damage should be greater than the benefits. State should then take an active part and determine the water that can be discharged to the surface, and which must be returned underground after taking heat. This means that prospective customer must have an existing certificate on technical receiving of the wells or receive a new certificate after the performed analysis.

5.3 NEW GEOTHERMAL BOREHOLES

Drilling new wells will likely be left to the private sector, because the state has no plans to conduct further research of geothermal potential. It is so far best covered by the law with specified jurisdictions, obligations and procedures. The drilling cost, the degree of uncertainty in the outcome of drilling and instability in economic terms are the reasons for not accessing massive drilling of new wells. Also, the quality of the obtained hot water can require that, after its use (withdrawal of heat energy), it must be returned underground, which causes double-cost because another exact hole would need to be drilled.

5.4 MASS DEPLOYMENT OF THE HEAT PUMPS

As part of the Energy Development Strategy of the Republic of Serbia until 2015 direct use of heat pumps is not mentioned, but one of the priorities is renewable energy sources.

"Third-specific priority of use of NRES (new renewable energy sources) and new energy-efficient and environmentally acceptable energy technology and devices/equipment for the use of energy. "[3]

"Priorities of the selective use of new and renewable sources of energy and energy-efficient technologies and devices, which include measures and activities for a more intensive use of biomass, use of the remaining hydropower, especially for the construction of small hydropower and multipurpose hydropower facilities, along with more organized research and use of geothermal resources, as well as a greater use of solar energy for decentralized use of heat."[3]

"The energy potential of the existing geothermal resources in Serbia is close to 0.2Mt.en in the territory of Vojvodina, Posavina, Mačva, Danube region and the wider area of Central Serbia and the existing spas.

An unsystematic approach to the research and preparatory work for the use of geothermal resources and lack of incentives for organized use of the energy are the main reason for the symbolic energy efficiency of hot water from hundreds of existing wells, of relatively low temperatures (often over 60°C) and thermal power below 160MJ / s, although previous research indicates that the actual potential of geothermal resources is at least five times higher than the used one. "[3]

From these positions of the Energy Development Strategy of the Republic of Serbia it can be seen that there is no serious intention to take significant steps in the field of geothermal energy even though the geothermal potential is several times greater than all our coal reserves.

In Serbia, great confusion is also caused by the term "geothermal energy", which implies hydro-geothermal energy, i.e. hot water sources or wells with warm water whose temperatures exceed 40°C. It is generally assumed that colder waters are not geothermal, and that therefore they are not suitable for use for heating. There is an impression that the Strategy of Energy Development in Serbia until 2015 considers geothermal energy only as natural and artificial sources of warm water.

Using low-temperature geothermal energy by using heat pumps for heating and cooling of residential and office space has become imperative now when the reduction of energy dependence and reduction of carbon dioxide emissions are being planned. In the near future with approaching the European Union the application of heat pumps will become a liability.

The estimated power of all the wells in Serbia is about 160 MW [1], and the installation of only 20.000 heat pumps of 20kW capacity can take 300MW from the land, which, with

the necessary electricity, makes 400MW of installed capacity for heating with an investment of about 100 million euros.

A town such as Jagodina has about 4.000 gas connections and as many individual gas boilers. In Subotica, there are about 10.000 gas connections and dozens of large consumers. There is a similar situation in other cities. Serbia has a total of about 100.000 gas connections. This comparison is necessary to indicate that it is quite reasonable and possible in the next period of 5 years in Serbia to install about 50.000 heat pumps. With so many heat pumps the installed capacity of 1GW would be achieved, out of which about 750MW would be coming from the land. This is significantly higher than the installed capacity of the future co-generative gas plant in Novi Sad.

For an organized introduction of heat pumps for heating and cooling residential and business premises there are the following reasons:

- The investment, which is about 3 times higher than in the case of heating with gas, it pays back within 3 to 4 years.
- Price of electricity consumed during operation is 4 to 16 times lower than in the case of heating with gas, electricity or fossil fuels.
- The quality and comfort of heating is on the highest possible level.
- During the entire heating season no intervention is needed.
- The same heat pump is in cooling mode during summer, thus avoiding procurement of equipment for cooling.
- There is a wide range of heat pump power (from 10kW to 2MW), which ensures good requirement coverage.
- It is possible to establish several manufacturers of heat pumps in order not to repeat the situation that all gas boilers in Serbia are imported.
- It would improve employment in manufacturing and assembling the equipment.
- To build co-generative 400MW gas power plant a minimum of 3 years is necessary. The installation of 10.000 heat pumps in each heating season would activate about 200MW of thermal capacity with the electricity being involved with installed power of 50MW.

The problem of inadequate use of heat pumps in heating in Serbia can be solved by different incentive programs or their combination:

1. The activities to increase the use of heat pumps for residential and office building heating should begin with the education of the population through press, radio, television and the Internet about the methods, advantages and benefits from using low temperature geothermal energy.
2. The population of Serbia currently has foreign exchange savings of about 6 billion euros. The owners of these resources often use fossil fuels for heating and they will

not invest their money in the electricity system of Serbia, or in the construction of the city co-generative gas thermal plants. The state, therefore, only through the action of information should activate a small fraction of that money.

3. The population will finance the new way of heating their homes by themselves, but it is necessary to clearly and accurately explain that heating with heat pumps is the most economical way in existence and that the cost of heating will not drastically change depending on fluctuations in energy prices on the world market. Electricity prices are everywhere in the world most stable compared to other energy and it can be expected to remain the same in the future. Most of our citizens are skeptical toward new solutions, especially as in the preceding thirty years' period they have changed the heating system several times. Therefore, the reasons for re-change should be clear and give long-term results.
4. The State should determine incentives for the application of heat pumps by a similar model as was done for the Fiat Punto car. Each buyer of the heat pump should be subsidized with the amount of 500 euros, which for 20.000 heat pumps equals 10 million euros. In this way, the same effect is achieved as that for the same money new 50MW power plants were made.
5. The state should encourage two or three manufacturers to produce heat pumps power of 10kW to 50kW. Design and preparation for the production can be done in a period of one year. There are experts who can design and development high-quality thermal pumps. Currently there are two manufacturers who produce annually up to 80 heat pumps. There are also several major manufacturers of cooling equipment that produce large cold storage and could very easily supplement its product range with heat pumps for heating and cooling buildings.

VI CONCLUSION

The current situation with the implementation of geothermal energy in Serbia is such that in the last fifteen years almost nothing has been done. On private initiative several shallow holes (up to 500m and 40°C) have been drilled and two to three existing wells have been activated.

Energy efficiency in the spa and sport and leisure centers, where geothermal resources are used, is not increased, because these centers have no financial incentives and are unable to invest in existing or new capacities adapted to new requirements.

The whole of Europe seeks to reduce energy dependence and tries to increase its energy production, and the only possibility is a substantial increase in the share of renewable energy sources in the total energy balance. Serbia is in a similar dependency on imported energy and therefore it is very important to start with an increased use of geothermal energy. In the next period of ten years using geothermal energy can provide over 10% of the needs for heat with the lowest investment compared to other energy sources. The cost of this investment can be completely covered by the population without additional government borrowing. The increasing unpredictability of the prices of energy derived from fossil fuels, environmental pollution, as well as harmonization with the European Union legislation urges establishing a coherent state policy in this field and integrating measures to stimulate the use of geothermal energy in the energy strategy and its implementation.

During the first half of 2010 a media campaign should begin to inform the population about the benefits of using heat pumps for heating residential and business premises.

At the same time, a center for the application of heat pumps should be established where several models and types of heat pumps would be continuously available to the general public for a direct and practical way of getting to know their work and their results.

The state should, through special competitions, encourage research and development that would soon lead to the possibility of domestic production of heat pumps.

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