APPLICATION OF GEOTHERMAL ENERGY FOR HOUSEHOLDS HEATING IN SERBIA

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ABSTRACT:
The paper offers an analysis of the possibility for households heating in Serbia with geothermal energy. The assessment of electric energy consumption for households heating and assessment of the geothermal potentials in Serbia is presented. Also, the comparative cost analyses for heating of a facility with different geothermal heating systems and electricity are presented.

INTRODUCTION

Heating of households in our country is not efficient regarding the primary energy consumption, mainly due to a poor thermal insulation of the buildings/facilities, increased losses in the district heating systems (DHS), as well as due to the use of electricity for heating. It is also known that there are geothermal energy sources in Serbia that have not been sufficiently exploited. With all these facts in mind, the aim of this paper is to present the possibilities of the use of geothermal energy for the heating of households in Serbia.

1. ASSESSMENT OF CONSUMPTION OF FUELS FOR THE HEATING OF HOUSEHOLDS IN SERBIA

Based on the analysis of statistical data on energy consumption for the heating of households in Serbia, as well as the structure of that consumption, it was as-

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sessed that the total energy consumption for the heating of households in Serbia in the last 5 years averages 22,5 TWh per year. In the same period, the electricity consumption for the heating of households in Serbia approximated 2,6 TWh per year or 11,6 % of the total energy consumption for the heating of households [1,2].

Table 1 shows data on the share of a specific fuel, i. e. systems for the heating of households in Serbia, obtained through earlier research.

Table 1. Share of specific types of fuel/systems in the heating of households in Serbia

Type of heating/ fuel	%	Urban households	Rural households
Wood, coal	62	40	90
District heating	20	38	—
Electricity	12	16	7
Gas	4	3	—
Other	2	3	3

2. POTENTIAL AND USE OF GEOTHERMAL ENERGY IN SERBIA

In Serbia, geothermal energy is mainly used in a traditional way, for balneology, sports and recreation purposes. Its use in agricultural production and for heating is very modest, compared to the potential and resources of the country. Total thermal power of the usable reserves of geothermal energy in Serbia is estimated at about 320 MW which is equivalent to an energy of about 360.000 toe (toe – ton of oil equivalent, where 1 toe=42 GJ), while the total installed thermal power of the presently exploited geothermal sources ranges about 86 MW_T [3]. The total power of the existing sources which are not in use, but could be commercially used, amounts to about 30 MW which is equivalent to 23.000 toe [4].

On the basis of the mentioned data on energy consumption for the heating of households in Serbia and the geothermal potential, the following can be concluded:

- If the geothermal reserves of Serbia (about 360.000 toe) would be used in total, that would provide for the substitution of approximately 19% of the total thermal energy used annually for heating of households in Serbia, which means that the electricity used for heating of households could be substituted in full (it amounts, as indicated, to about 11,6% or 2,6 TWh).
- – If the total power of the existing geothermal sources which are currently not in use could be exploited (and they are estimated at 30 MW), about 10% of electricity consumed annually by households in Serbia for heating, that is about 23.000 toe, could be substituted.

3. COMPARATIVE COST ANALYSIS

This chapter presents comparative analysis of costs of heating of a facility, for the version using electricity and the other one using geothermal energy by means of several different systems which could be applied in our country.

The first case covers the system for the heating of a facility with the heat losses of 500 kW which corresponds to a heating area of 5.000 m^2 or 80 apartments of an area of 62,5 m^2 each. Two cases are analyzed: one – when the geothermal source has a geothermal flow rate of 10 kg/h and the temperature of 60°C and geothermal heating system has a supplementary heat source with the heating oil-fired boiler, and the other – when the geothermal source has a geothermal flow rate of 10 kg/h and the temperature of 40° C and the geothermal heating system has a supplementary heat source with heat pump.

The fig. 1. shows results of the analysis of the first case, i. e. comparative costs of a heating system with the supplementary heat source with the heating oil-fired boiler with respect to a heating system using electricity. The presented analysis brings us to a conclusion that the geothermal system heating pays off after 4 heating seasons.

The fig. 2. shows the comparative analysis of the costs in the second case, comprising a geothermal heating system with the supplementary heat source with the

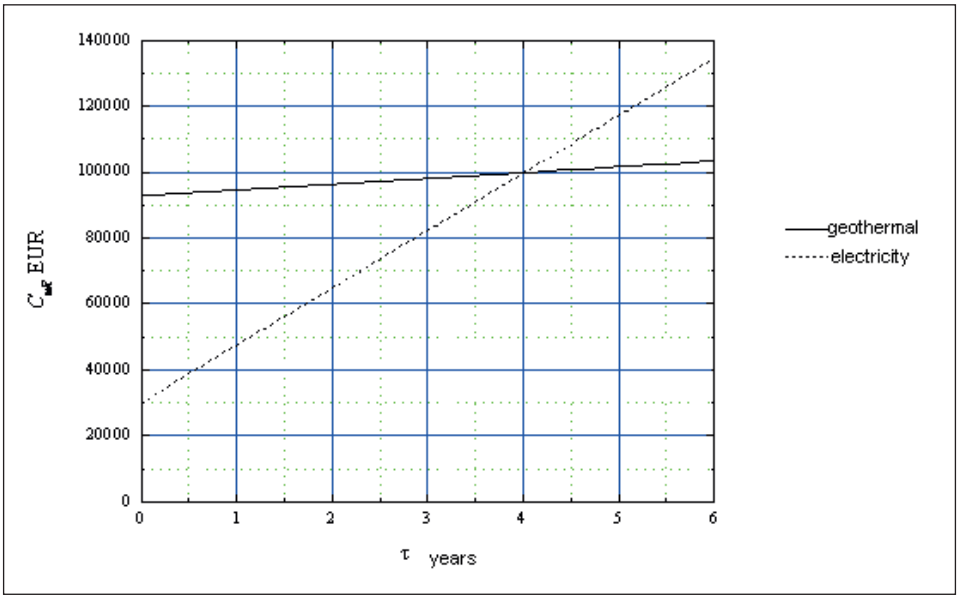

Figure 1. Comparative analysis of the costs of heating using geothermal system versus the electricity-based heating

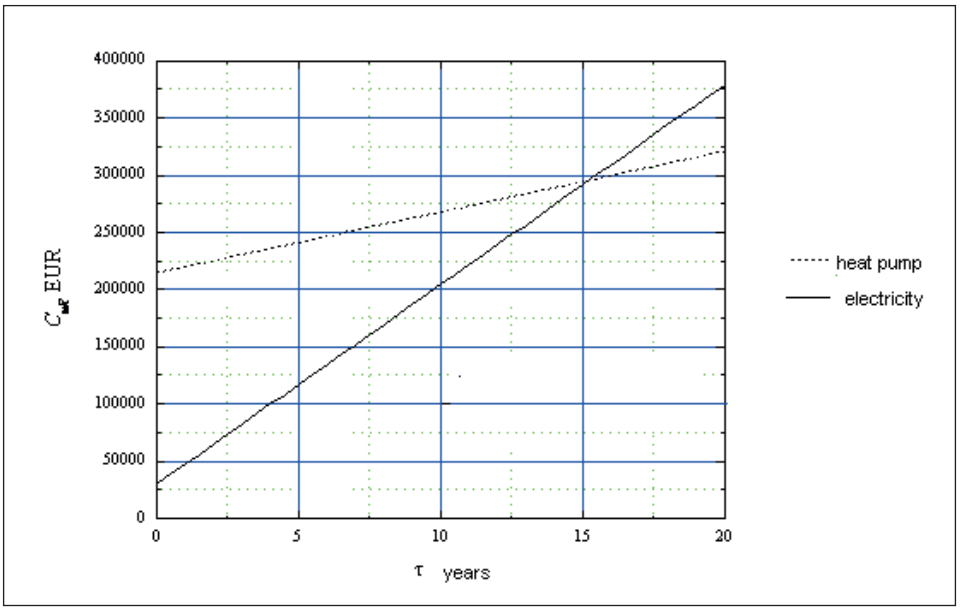

Figure 2. Comparative analysis of the costs of heating by means of a geothermal system with the heat pump and the use of electricity

heat pump. It can be concluded on the basis of this analysis that the heating based on this system will pay off after 15 heating seasons.

Analysis also comprised the comparative case of the heating of an individual facility of an area of 150 m^2 by means of a Ground Source Heat Pump – GSHP and electricity. The following data were adopted for the GSHP system:

- Borehole heat exchanger, type: PE – Xa 32 mm (supplied by REHAU) price: 9,5 EUR/ m
- Heat power of the heat exchanger PE–Xa 32 mm: 50 W/m for the soil of normal hardness $\lambda \leq 0{,}3$ W/mK.
- Price of the hole boring: 20 EUR/m
- Price of internal heating installation (equipment plus assembly): 25 EUR/m^2
- Price of the heat pump (heating coefficient $\varepsilon = 3$): 200 EUR/kW
- Heat losses of the heated facility: 80 W/m

It can be derived from the above data that the total investment costs amount to approx.: 12.500 EUR, while the exploitation costs amount to approx.: 40 EUR/ month.

If the same facility is heated with electricity, the investment costs will amount to about 6.000 EUR, while the exploitation costs will amount to approx.: 120 EUR/ month.

The said data indicate that the heating of a facility by means of GSHP system would pay off after 90 months of operation, i. e. in about 15 years.

CONCLUSION

In Serbia, geothermal energy is mainly used in a traditional way, for balneology, sports and recreation purposes. Its use for heating and other energy-related purposes is very modest, compared to the potential and resources of the country.

Based on the comparative analysis of the costs of household heating with electricity and the systems using geothermal energy, the following was concluded: heating by the systems using geothermal energy and a supplementary heat source pays off in 4 years, while the geothermal systems with the heat pump pay off after 15 years of operation, i. e. heating seasons. Longer ROI (return of investments) period of the system with the heat pump results from the high price of the heat pumps. However, return of investments would be much higher if these equipments would be also used for the cooling of facility in the summer months.

LITERATURE

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KORIŠĆENJE GEOTERMALNE ENERGIJE ZA GREJANJE DOMAĆINSTAVA U SRBIJI

SAŽETAK:
U radu je analizirana mogućnost grejanja domaćinstava u Srbiji sa geotermalnom energijom. Data je procena o potrošnji električne energije za grejanje, kao i procena o geotermalnim potencijalima u Srbiji. Prikazana je takođe i uporedna analiza troškova za grejanje objekta sa različitim geotermalnim sistemima i električnom energijom.