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NEW PROJECTS OF GEOTHERMAL ENERGY UTILIZATION IN DISTRICT HEATING SYSTEM IN SLOVAKIA

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SUMMARY

Abundance of geothermal water reservoirs in Slovakia and existence of many district heating systems, where the geothermal energy can be utilized, presents ideal conditions for advancement of geothermal projects. Currently, several projects focused on geothermal energy utilization for the purpose of space heating in the towns are being developed intensively. These projects are in different state of art.

INTRODUCTION

Slovakia belongs within Europe among countries with above-average geothermal conditions. Most of the geothermal reservoirs in the country provide geothermal water with temperature lower than 100°C which insufficient for power generation but optimal for district heating purposes.

Mass housing development which took place in 70´s and 80´s of the last century was typical with centralized heating systems. Therefore there is a district heating system in almost each town in Slovakia. Nowadays the efficiency of many of the district heating system is on the edge of acceptance and it is necessary to start reparation and reconstruction. Within the framework of district heating reparation the local possibilities of renewable energy resources utilization must be taken into account. In selected areas, geothermal energy appears to be one of the most convenient alternative energy resources. Utilizing available geothermal energy in a district heating system represents obtaining of stable, economical and ecological renewable energy resource. Several projects with such objective located in well explored areas are in process. The aim of this paper is to give brief information about new geothermal district heating projects in towns of Velky Meder, Sered, Sala, Michalovce a Presov (Figure 1).

1. GEOTHERMAL PROJECT IN THE TOWN OF VELKY MEDER

Town of Velky Meder with population of almost 10 000 is situated in south part of Slovakia and is very popular due to the thermal spa, which is operated since 70´s of the last century. Two geothermal wells are used for the purposes of the spa. Existing wells represent

reliable and valuable source of geothermal water used in the pools and on the other hand source of geothermal heat for space heating, ventilation and hot tap water utilization in the spa area. Just the long lasting positive experiences with geothermal energy and possibility of wide public to be in touch with geothermal water creates good relation to further geothermal energy utilization.

Two district heating systems are currently present in the town, each with central heat plant with natural gas boilers (Stred I with installed heat output of 7,3 MW_t and annual heat production of 37 000 GJ; Stred II with 2,2 MW_t and 18 000 GJ). Both boiler plants supply heat and hot tap water to apartment houses (altogether 1 828 apartments) and further buildings. It is necessary to repair the district heating systems soon due to obsolete state. Within reconstruction, it is proposed to unite both systems and centralize the heat source into boiler plant Stred I. Simultaneously, whole district heating system will be transformed from four pipe system into two pipe system, i.e. central preparation of hot tap water will be replaced by local preparation in object heat exchanger stations placed in each supplied building.

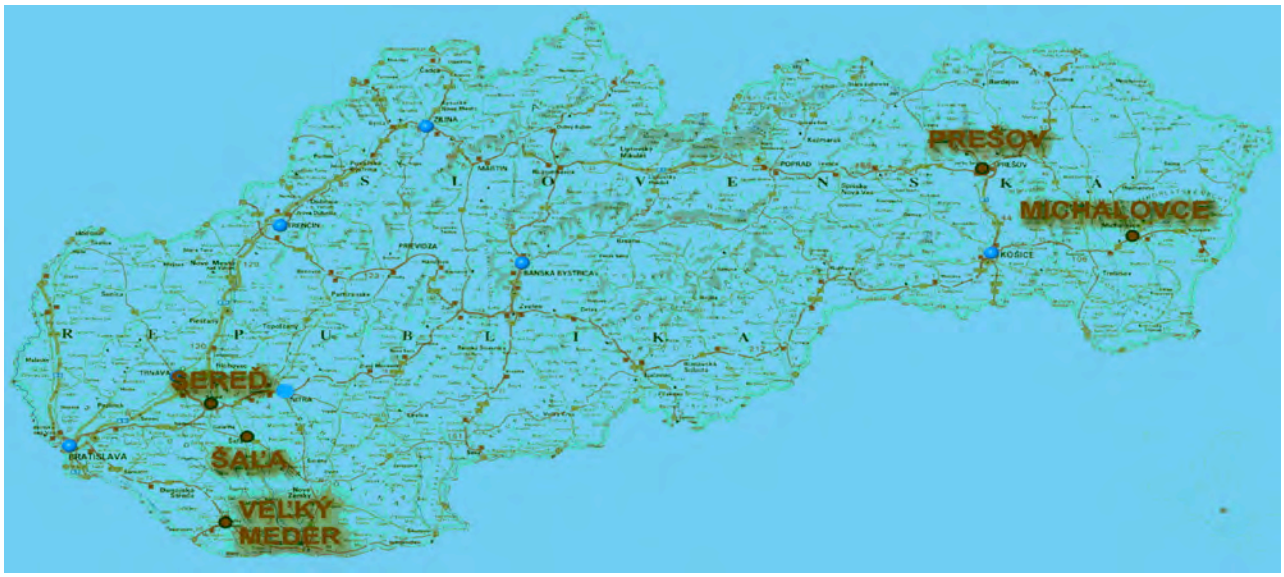

Figure. 1. Localization of new geothermal project on the map of Slovakia

According to favorable geological conditions in the area confirmed by more wells, it is proposed to to utilize geothermal energy for heat supply into united district heating system. Exploitation geothermal well with depth of 2 500 m is proposed, while expected parameters of geothermal water at the well head are following: temperature 85°C, free flow rate 10 l/s, TDS 5 – 6 g/l, theoretical heat output 2,9 MW_t. Geothermal water will be transported via preinsulated pipe placed in the ground from exploitation well into heat exchanger station built in central boiler plant. After utilizing in heat exchangers, discharge water will be led via pipe to reinjection well and reinjected back into reservoir. Installed heat output of the heat exchangers is 2,5 MW_t. Natural gas boilers with capacity of 11,5 MW_t will be used as a peak and backup heat source.

Out of total heat amount produced in central heat plant of 55 000 GJ, approximately **65% will be supplied by geothermal energy** (approx. 35 550 GJ). That will lead to annual natural gas savings of approx. 1,2 million m^3 and reducing of CO2 emissions of 2 200 ton per year.

Investment costs of described project including complete reconstruction of the systems are estimated to be **7,3 million €**. Complex project documentation for building permission was elaborated and process of building permission issuing is running.

2. GEOTHERMAL PROJECT IN THE TOWN OF SERED

Town of Sered lies in southwest part of Slovakia in Danube basin on the right bank of

Vah river. Population is approx 18 000. Surroundings of the town belong among the most fertile parts of the country. Six district heating systems with central heat plant and hot water distribution network are built in the town. Systems supply apartment buildings and other buildings. Presence of geothermal water was confirmed by hydrogeological study. Available geothermal water is suitable for utilization in one of the existing central boiler plant.

Most convenient for geothermal energy utilization is boiler plant K5 with four natural gas boilers altogether of 8,7 MW_t. Distribution system is two pipe system and contains object heat exchanger stations. Total 17 apartment buildings with 960 apartments and further objects are supplied by heat. Annual heat production reaches 39 000 GJ.

Exploitation geothermal well situated in south part of the town is proposed. Designed depth is 1 600 m with possibility of deepening to 1 800 m. Expected parameters of geothermal water at the well head are following: temperature 63°C, flow rate by pumping 10 l/s, TDS 3,5 - 5 g/l, theoretical heat output 2,0 MW_t. Geothermal water will be driven through preinsulated pipe into heat exchanger station in the boiler plant. Heat exchangers with heat output 1,63 MW_t and heat pumps with heat output 1,3 MW_t will be installed. Natural gas burning cogeneration unit will produce electricity for heat pumps driving. Existing gas boilers of total 8,7 MW_t will serve as a peak and backup heat source. Used geothermal water will be drained into Vah river.

Geothermal energy in combination with heat pumps will provide approx. 78% of total heat production (30 420 GJ), the rest will be covered by cogeneration unit (11% - 4 290 GJ) and gas boilers (11% - 4 290 GJ). That will lead to annual natural gas savings in comparison with current state of approx. 0,8 million m^3 and reducing of CO_2 emissions of 1 550 ton per year.

Investment costs of the project are estimated to be **3,3 million €**. Preparation of complex project documentation for building permission is in the process.

3. GEOTHERMAL PROJECT IN THE TOWN OF SALA

Town of Sala with approx. 25 000 inhabitants is situated 70 km east of Bratislava. Location of the town within geothermal active area enables utilization of geothermal energy for space heating purposes. Two district heating systems which distribute heat into apartment houses and other building are built in the town. Boiler plant CK31 situated in west part of the town is most suitable for geothermal heat exchanger station.

Distribution network of boiler plant SK31 contains 82 object heat exchanger stations. Installed four natural gas boilers are of total heat output of 20,7 MWt. Annual heat production fo CK31 is approx. 87 000 GJ.

It is proposed to drill exploitation geothermal well of depth 2 100 m with following geothermal water parameters: temperature 73°C, flow rate by pumping 15 l/s, TDS 3,5 - 5 g/l, theoretical heat output 3,8 MW_t. Geothermal water will be driven through preinsulated pipe into heat exchanger station in the boiler plant CK31. Heat exchangers with heat output 3,5 MW_t and heat pumps with heat output 3,0 MW_t will be installed. Natural gas burning cogeneration unit will produce electricity for heat pumps driving. Existing gas boilers will serve as a peak and backup heat source. Used geothermal water will be drained into Vah river.

Geothermal energy in combination with heat pumps will provide approx. 73% of total heat production (63 510 GJ), the rest will be covered by cogeneration unit (15% - 12 717 GJ) and gas boilers (12% - 10 715 GJ). That will lead to annual natural gas savings in comparison with current state of approx. 1,4 million m^3 and reducing of CO_2 emissions of 2 900 ton per year.

Investment costs of the project are estimated to be **4,5 million €**. Preparation of complex project documentation for building permission is in the process.

4. GEOTHERMAL PROJECT IN THE TOWN OF MICHALOVCE

Town of Michalovce with almost 40 000 inhabitants is situated in north part of Eastslovakian lowland. Elaborated hydrogeological study has confirmed presence of geothermal resources convenient for utilization for space heating purposes. Several district heating systems are built in the town, while supplied with heat are mainly apartment houses.

Boiler plants PL-1, PK-2 and PK-3 were chosen for geothermal energy utilization. Those are plants with natural gas boilers and with central hot tap water preparation. Altogether 126 apartment buildings are connected and annual heat production reaches 100 000 GJ.

Exploitation geothermal well with depth of 1 900 m is proposed (with possibility of deepening to 2 200 m). Expected geothermal water parameters are following: temperature 85°C, flow rate by pumping 15 l/s, theoretical heat output 4,7 MW_t. Several modifications must be done in the plant in order to enable geothermal energy utilization. Main modification consists of centralizing the heat source into plant PK-1 and connecting of the distribution networks. Boilers will be removed from the plants PK-2 and PK-3 and the plants will be turned into heat exchanger stations. Installed heat output of gas boilers in modified heat plant PK-1 will be 16,12 MW_t. Geothermal water will be used for heating water preparation in the first stage and for the the hot water preparation in the second stage. Used geothermal water will be drained into Laborec river which flows through the town.

Out of total heat amount produced in central heat plant of 100 000 GJ, approximately **43% will be supplied by geothermal energy** (approx. 43 000 GJ). The rest will be covered by gas boilers. Geothermal energy utilization will lead to annual natural gas savings of approx. 1,3 million m^3 and reducing of CO_2 emissions of 2 500 ton per year.

Investment costs of the project are estimated to be **10,2 million €**. Pre-project feasibility study was elaborated and potential investor is being searched now.

5. GEOTHERMAL PROJECT IN THE TOWN OF PRESOV

Town of Presov with population of more than 91 000 is the third largest town in Slovakia. Important international rail and road communications lead through the town. Historical centre of the town is national culture sight. Presov is situated near very prospective area from point of geothermal energy utilization. According to hydrogeological study results, geothermal water with convenient parameters for energetic purposes is present. Expected geothermal water temperature enables also power generation by binary plants. Many district heating systems supplying mainly apartment houses are built in the town.

Prospective geothermal locality is situated east of the town. Temperature conditions are rising with the distance from the town, therefore geothermal wells must be situated further from the town. It is planned to drill one or two exploitation geothermal wells 3 250 – 3 500 m deep. Expected geothermal well parameters are stated in table 1.

Table.1. Parameters of geothermal wells

Number fo exploitation wells	Temperature of the water	Total free flow rate	Design reference temperature	Theoretical heat output
[pc]	[°C]	[l/s]	[°C]	[MW]
1	125	40	15	18,4
2	125	80	15	36,8

Expected TDS of the water is on the level of 30 g/l, therefore liquidation of used geothermal water is possible only via reinjection. It is

supposed that reinjection well will be assigned to each exploitation well.

Many of district heating systems are present in the town. With consideration to locality of geothermal reservoir, analyzed were the systems in the districts Sekcov, Solivar and Svaby. 8 boiler plants can be taken into consideration whose installed output and annual heat production is stated in table 2.

Table.2. Installed heat output and annual heat production of selected heat sources

Dwelling	Name	Installed heat output	Expected heat production	
		[MW]	[GJ]	[MWh]
Sek□ov	Sek□ov K-3	8,32	35 935	9 982
	Sek□ov K-4	9,2	27 054	7 515
	Sek□ov K-5	9,9	41 720	11 589
	Sek□ov K-6	8,7	20 120	5 589
	Sek□ov K-7	5,1	21 602	6 001
	Sek□ov K-8	9,65	32 484	9 023
	Sek□ov K-9	9,65	46 818	13 005
	PZT	46,8	118 130	32 814
Total:		107,32	343 863	95 518

Significant heat consumption is concentrated in the eastern part of the town. That is convenient from for the possibility of geothermal district heating system application which would serve heat into existing heat sources.

7 alternatives of geothermal energy utilization for were elaborated. Proposed solutions comprise individual heat production, individual power generation and their combinations. One or two doublets are assumed to be a source of geothermal energy. Two presented alternatives seem to be most convenient form nowadays point of view.

○ Utilization of geothermal energy for heat supply into existing boiler plants

This solution counts with one doublet. Geothermal heat will be supplied into existing boiler plants. It is necessary to built geothermal station with exploitation and reinjection wells and heat exchangers. Secondary water wit temperature approx 122°C will be circulated via 7,1 km long preinsulated pipeline into boiler plants where will be used for heating water warming. Pumping station must be built in order to drive the secondary water. No significant modifications in existing district heating systems are required, only heat exchanger station must be built in each boiler plant. Geothermal energy will represent base load heat source, existing natural gas boilers will take the role of peak and backup heat source. Possibility of new boilers installation with consideration to current heat consumption should be assessed.

Out of total heat amount produced in boiler plants of 343 863 GJ, approximately **76% will be supplied by geothermal energy** (approx. 261 086 GJ). The rest will be covered by gas boilers. Geothermal energy utilization will lead to annual natural gas savings of approx. 8,28 million m^3 and reducing of CO_2 emissions of 16 300 ton per year.

Investment costs of the project are estimated to be **15,2 million €**.

○ Utilization of geothermal energy for power generation and heat supply into existing boiler plants

This alternative counts with two doublets. Geothermal energy will be used for power generation and heat supply into boiler plants K-3 to K-9. It is necessary to built geothermal

station with two exploitation and two reinjection wells, binary power plant and heat exchangers. Geothermal water will be used for power generation in the first stage. Classic ORC unit with power of **1,76 MW_e** is proposed. Geothermal water escaping the power plant will be used for heat supply. Secondary water wit temperature approx 80°C will be circulated via 5,8 km long preinsulated pipeline into boiler plants where will be used for heating water warming. Pumping station must be built in order to drive the secondary water. No significant modifications in existing district heating systems are required, only heat exchanger station must be built in each boiler plant. Geothermal energy will represent base load heat source, existing natural gas boilers will take the role of peak and backup heat source. Possibility of new boilers installation with consideration to current heat consumption should be assessed.

It is possible to produce approx **15 437 MW_e** of electricity annually by geothermal energy. Out of total heat amount produced in boiler plants of 225 733 GJ, approximately **85% will be supplied by geothermal energy** (approx. 190 797 GJ). The rest will be covered by gas boilers. Geothermal energy utilization will lead to annual natural gas savings of approx. 6,05 million m^3 and reducing of CO_2 emissions of 11 900 ton per year.

Investment costs of the project are estimated to be **30,7 million €**. Pre-project feasibility study was elaborated and potential investor is being searched now.

CONCLUSIONS

Above-average occurrence of geothermal resources in Slovakia, their good exploration and existence of many extensive district heating systems represents excellent conditions for implementation of new geothermal projects focused on space heating in the towns. Geothermal energy is environmentally friendly, local and stable renewable energy resource which is independent on climatic and market conditions. Rising prices of natural gas and recent uncertainty related to its supply reliability is a strong motivation for heat producers and for the municipalities to support and develop geothermal energy utilization projects.