New Geothermal District Heating Systems in Slovakia

Oto Halás

SLOVGEOTERM a.s., Palisády 39, 811 06 Bratislava, Slovakia

oto.halas@slovgeoterm.sk

Keywords: Geothermal district heating, direct use of geothermal energy, natural gas saving, CO_2 emission reduction.

ABSTRACT

Abundance of geothermal water reservoirs in Slovakia and existence of many district heating systems where the geothermal energy can be utilized present optimal conditions for advancement of geothermal projects. During the last three years, two new geothermal district heating systems were implemented in Slovakia. The projects are located in the towns of Sala and Sered in Danube basin and are very similar to each other. Old natural gas burned central boiler plants with wide distribution network were present in the towns. New production geothermal wells were drilled in both locations, piping and heat exchanger stations were built and connected to the existing boiler plants circuits. Heating water and hot tap water is being prepared by geothermal energy now and significant natural gas saving and CO_2 emission reduction have been achieved. Good project design and conception is confirmed after several months of operation and geothermal energy is proven to be optimal RES in particular localities.

1. INTRODUCTION

Slovakia belongs within Europe among the countries with above-average geothermal conditions. There is a high degree of knowledge and survey of geothermal structures and areas due to many hydrogeologic and also hydrocarbon exploration wells completed within the survey works driven by the state. This knowledge and effort resulted into completion of the Geothermal Atlas of Slovakia where the prospective areas are selected and described. Most of the geothermal reservoirs in the country are low-enthalpy reservoirs and provide geothermal water with temperature lower than 100°C. This is insufficient for efficient power generation but optimal for district heating purposes (Halás, 2009).

Mass housing development which took place in the 70´s and the 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 of available geothermal energy in a district heating system represents obtaining of stable, economical and ecological renewable energy resource. The aim of this paper is to give information about the newly implemented geothermal district heating projects in the towns of Sala and Sered.

2. LOCAL CONDITIONS

Towns of Sala and Sered are both located in southwest part of Slovakia (Figure 1), in the warmest and the most fertile area with the longest sunshine during the year. Locality belongs to central depression of Danube basin from the geological point of view. The Vah river, largest Slovak river, flows through both of the towns. Population of Sala and Sered in 2012 was 23,440 and 16,214 inhabitants respectively. Several district heating systems owned and operated by the municipalities are built in the towns. Heating period takes approximately 210 days.



Figure 1: Map of Slovakia with places of interest marked.

3. GEOTHERMAL WATER PROPERTIES

New 1,800 m deep geothermal production wells were drilled in both towns. Collectors of the geothermal brine are created by sandstones. Reservoirs are semi-open, i.e. recovery of the reservoir is provided by natural water inflow. Submersible electric pumps are installed in order to provide sufficient pressure of the brine in the whole geothermal system. Basic parameters of the wells are stated in Table 1.

Table 1: Parameters of the geothermal wells. TDS = total dissolved solids.

Town	Well name	Temperature on well head	Flow rate by pumping	TDS
		[°C]	[m^3/h] ([l/s])	[g/m^3]
Sala	GTS-1	73	54.0 (15)	5,200
Sered	SEG-1	66	28.8 (8)	5,100

Withdrawn geothermal brine has corrosive properties while a scaling effect does not appear under conditions maintained in the systems. The whole geothermal systems in both towns are made of corrosion resistant materials (piping and valves of stainless steel and plastic, heat exchangers of titanium) in order to avoid corrosion problems.

4. TECHNICAL CONDITIONS

In the town of Sala, geothermal energy is being utilized in large boiler plant CK31, where four natural gas boilers of 20.7 MW total thermal output are installed. The installed capacity is strongly overdesigned in relation to recent heat consumption (massive installation of external thermal insulation on apartment houses takes place) and significantly lower heat outputs are needed even in extremely cold period. Designed temperature gradient of heating water is 100/50°C but most of the year lower return heating water temperature is being achieved. Distribution network supplies by heat 82 pressure independent heat exchanger stations situated in apartment and public service buildings. Annual heat production of CK31 boiler plant averages 75,000 GJ (20,833 MWh). The geothermal well GTS-1 is located approximately 200 m west of boiler plant. Geothermal brine is transported via preinsulated pipeline to heat exchanger station placed in boiler plant site. Two stages of direct geothermal water utilization are implemented: in the first stage return heating water is being warmed up; in the second stage water of heat pump evaporator loop is being warmed up while the heat pump warms up the return heating water. Parameters of the mentioned devices are stated in Table 2. Geothermal energy combined with heat pump presents base load heat source, while natural gas boilers are used as a peak load source or back up source. Thermally used geothermal brine is drained via 800 m long plastic pipeline into the Vah river.

In the town of Sered, the advantage of geothermal energy is taken in medium size boiler plant K5, where four natural gas boilers of 8.7 MW total thermal output are installed. The installed capacity is similarly as in Sala overdesigned and substantially lower heat outputs are needed throughout whole year. Designed temperature gradient of heating water is 65/45°C. Distribution network supplies by heat 20 pressure dependent heat exchanger stations situated in apartment and public service buildings with more than 960 apartments. Annual heat production of K5 boiler plant averages 25,000 GJ (6,944 MWh). The geothermal well SEG-1 is located approximately 300 m south of boiler plant. Geothermal brine is transported via preinsulated pipeline to heat exchanger station placed in boiler plant site. Two stages of direct geothermal water utilization are implemented: in the first stage return heating water is being warmed up; in the second stage water of heat pump evaporator loop is being warmed up while the heat pump warms up the return heating water. In addition, natural gas fired cogeneration unit producing heat for the network and electricity mainly for own consumption is installed. Parameters of the mentioned devices are stated in Table 2. Altogether four types of heat source are installed while geothermal and heat pump presents base load heat source, while natural gas boilers are used as a peak load source or back up source. Thermally used geothermal brine is drained via 400 m long plastic pipeline into the Vah river.

Table 2: Thermal outputs of installed devices. HX = heat exchanger.

Device/Locality	Sala – CK31	Sered – K5
I. stage geothermal HX [MW]	1.3	0.6
II. stage geothermal HX [MW]	0.5	0.5
Heat pump [MW]	0.6	0.6
Cogeneration unit [MW]	-	0.25

5. ENERGY BALANCE

Overall thermal energy production in Sala and Sered plants for the year 2012 including the contributions of newly installed devices is stated in Table 3. Graph with relative contributions expressed in percents is shown on Figure 2.

Table 3: Overall thermal energy production in Sala and Sered plants for the year 2012.

Locality	Sala - CK31		Sered - K5	
	[GJ]	[MWh]	[GJ]	[MWh]
Geothermal	21,810	6,058	10,177	2,827
Heat Pump	5,876	1,632	6,736	1,871
Boiler	46,102	12,806	7,294	2,026
Total	**73,788**	**20,497**	**24,207**	**6,724**

With respect to the parameters of given district heating systems and geothermal conditions of the localities, it is unfeasible to replace natural gas boilers by geothermal energy completely. But above described rate of geothermal energy utilization led to natural gas saving of 860,000 m^3 in Sala and 530,000 m^3 in Sered per year 2012. These figures present interesting asset from technical, economical and also ecological point of view.

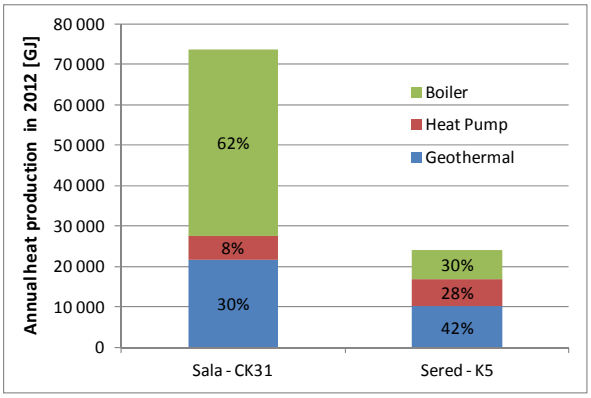

Figure 2: Overall thermal energy production in Sala and Sered boiler plants for the year 2012. Contribution of each heat source installed is depicted.

6. ENVIRONMENTAL ASPECTS

Replacing of natural gas consumption by geothermal energy as a green renewable energy resource led to reduction of CO_2 emission by 1,837 tons in Sala and 1,122 tons in Sered in the year 2012.

7. ECONOMICAL ASPECTS

One of the very few weak sides of geothermal energy utilization is relatively high initial investment costs in comparison with the other renewables. This inconvenience was also faced in the described projects. With high effort of all related parties, commercial loan covering 90% of investment costs was obtained for both projects after long lasting negotiations. Structural funds or other non-refundable subsidy was unreachable due to several mainly administrative obstructions in the subsidy system. Pay-back period of the projects was calculated to be approximately 10 years.

The heat price for the final customers after implementation of geothermal projects does not change in the initial years. This is because the savings of natural gas approximately cover loan repayments and interests. But as soon as the loan is paid, the heat price will decrease significantly. Reduction of dependence on natural gas also results to higher stability of the heat price.

8. CONCLUSIONS

Above-average occurrence of geothermal resources in Slovakia, their good exploration and existence of many extensive district heating systems represents good 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 is a strong motivation for heat producers and for the municipalities to support and develop geothermal projects. Moreover, newly built geothermal projects in Sala and Sered confirm, that well designed and implemented projects are economically feasible without any subsidy. Recently, preparation of further geothermal projects of similar scale and intention are in different state of art in Slovakia. Hopefully, after good experience with the presented projects, some of them will be implemented soon.

REFERENCES

Halás, O.: New Projects of Geothermal Energy Utilization in District Heating Systems in Slovakia, Proceedings of the International Geothermal Days, Slovakia, (2009), paper #II.4, 1-6