Geothermal energy from mining sources in the Zasavje region

Pre-investment study

SUMMARY

4.2.6

Partner: PP 9 – RCR

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Work Group: Natural potentials – Geothermal energy

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ABSTRACT

With grants of the European project ReSource (Central Europe Programme) a pre-investment study was prepared by the project partner RCR for future use of geothermal potential from mining groundwater in the Zasavje region, Slovenia.

Mining groundwater from the Zasavje coal mines presents a substantial geothermal potential in the region. We focused on this renewable energy source (RES) for future development projects as part of the general energy efficiency objective of the region.

Within our research, an overall survey on potential geothermal use of minewater in Zasavje region based on existing regional and national studies was completed. Measurements which include the water temperature, yield and eco-acceptable withdrawal have been provided. 7 minewater geothermal sources were identified. Derived from this analysis, 2 investment projects were investigated in more detail. The first investment aims at using minewater for provision of warm water and office heating to premises of the mining company Trbovlje-Hrastnik (RTH). The second investment is connected to the reconstruction of an elementary school in Zagorje ob Savi. Here, it is intended to heat the school gym as well as the swimming pool with minewater.

The results of the study are available for future investors, spatial planners and other target groups interested in the use of mine groundwater for different purposes.

1. STARTING POINT

Economic and social development of the Zasavje region largely depended on brown coal mining which started 250 years ago in mid 18th century. Until 1995 three coal mines operated in the Zasavje region (Hrastnik mine, Trbovlje mine and Zagorje mine). Today only the Trbovlje-Hrastnik Coal mine (RTH) operates and still employs 500 workers. Nowadays, brown coal from RTH is used exclusively for the production of electricity in Trbovlje thermal power plant. The coal mine in Zagorje ob Savi municipality was closed in 1995 and the company is in the process of liquidation. The production of brown coal in RTH will stop by the end of 2012 followed by its economical, social and ecological re-cultivation and reconstruction.

In Zasavje, geothermal sources of mine groundwater can be found in the cracked Triassic dolomite covered by clay deposits from the Oligocene[1].

At the beginning of our research, some investigations in the field of geothermal potentials in Zasavje region have already been available: Mining companies from the Zasavje region started to explore the geothermal potential of the mine groundwater in 1990. Further studies have been prepared in the years since then.

However, these studies have been prepared only as technical support for the brown coal production at RTH or the Zagorje mine in closure process. Our ReSource study focused on the pre-investment study which includes technical, economical and ecological aspect of mine groundwater for heating of sanitary and spatial heating hot water for the RTH premises in Hrastnik. The pre-investment study is a basic decision making document for further project investment implementation for the RTH as investor.

2. OBJECTIVE OF INVESTIGATION

The main objective of our investigation is to identify geothermal potentials from mine groundwater in the Zasavje region and to research the possible use, from the technological, economical and ecological aspect, of this geothermal potential in future projects.

The project activities will presents the first regional attempt in the Zasavje to gather all available information's from the field of mine ground water characteristics, possible technical solutions for further use of this energy source, Slovenian and European best practices of using geothermal energy, identification of possible locations for using the mine ground water. The study will include the legislative overview[2] of mine ground water use in Slovenia with steps to get the concession to use it. The study will include possibilities of using the geothermal potential from mine groundwater in the Zasavje region.

3. APPLIED APPROACH

To reach the purpose of the project's activities we chose several methods of investigation.

3.1 Good practise analysis

We analysed good practices of mine groundwater use as geothermal potential in Slovenia and the EU[3-5]. We checked the thematic studies and other literature which processes the mine groundwater as geothermal potential. An analysis of geothermal energy use for district heating in Lendava[6] (Slovenia) has been made. Together with the representatives of RTH we participated at a thematic seminar in Bad Schlema (Germany), organized within the ReSource project, and where good practices of mine groundwater use were presented by the Heerlen (The Nederland), Bad Schlema (Germany) and the Sachsen region.

3.2 Civic participation

Civil society has been included through the participation of NGOs members as stakeholders in the project. The most helpful was the cooperation with the representatives of the RTH, Zasavje municipalities and Zasavje NGOs from the field of environment. Following the detailed analysis of best practice and project cross cooperation with potential stakeholders (RTH, municipality of Zagorje ob Savi) two future projects for the use of geothermal potential from mining ground water in the Zasavje region have been prepared. One is in the phase of project idea and the other is in the phase of pre-investment study.

Cooperation with the local communities helped us to get information's about the municipalities' spatial plans in connection to the use of geothermal sources in the Zasavje region. The cooperation with the NGOs initiated the need to promote the use

of renewable energy sources (RES), specially the mine groundwater in the Zasavje region.

3.3 Methodology

First of all the examination of literature and previous documents, whose contents include geothermal potential of the Zasavje region, had been finished. The results of the analysis helped us with the identification of Zasavje region geothermal sources locations, followed by analysis of some models of best practice using geothermal energy in Slovenia and Europe[7]. Best practice models have been monitored and evaluated with the scope of possible transfer of knowledge to the Zasavje region.

Detailed methodology steps:

- Identification of key regional actors for the geothermal sector,
- Analysis of current situation on the exploitation of geothermal energy in the Zasavje region,
- Analysis of hydrogeological situation in the Zasavje region for the exploitation of geothermal energy,
- Gathering info on similar projects successfully carried out in other regions, countries,
- Examination of administrative procedure for the use of geothermal energy from mining sources
- Analysis of environment impacts due to geothermal energy exploitation
- Good practice exchange (case Lendava, Slovenia)

3.4 Previous investigation

Previous studies results identified the micro locations of the mine ground water in the Zasavje region with their basic technical characteristics (temperature, depth, the flow, chemical characteristics)[8]. These studies have been prepared by RTH and Zagorje mine in closure after 1990.

4. RESULTS

The main result of the project is pre-investment study where geothermal sources in the Zasavje region have been identified. Mining groundwater from the Zasavje coal mines presents a geothermal potential, which use depends on its temperature and available quantity. Geothermal sources in the Zasavje region have been identified as low temperature sources. The available results, provided by technical and economical calculations, indicate that the most efficient use of these RES in the Zasavje region would be the use for direct and indirect heating of business premises, residential building and sport facilities. Direct use is appropriate and energy efficient for the floor heating in new constructed buildings. Indirect use defines the installation of water/water geothermal heat pumps[9, 10].

One of the main results is the elaborated pre-investment study of the use of mine groundwater for heating the industrial premises of RTH in Hrastnik.
Additional project idea derives from the project activity related to the use of geothermal potential from mine groundwater for heating the indoor swimming pool and school gym in Zagorje ob Savi.

Within the Zasavje region two main areas with geothermal potential have been located. The first is the RTH production area still connected to current brown coal production in Hrastnik and Trbovlje municipalities and the other is located in Zagorje ob Savi municipality.

Within the RTH production area five different locations for potential use of mine groundwater have been identified. All locations are linked to the groundwater drainage mine pit forwarded to the nearest stream or river.

4.1 Geothermal sources of mine groundwater from the area of RTH

The production area of Trbovlje – Hrastnik Mine (RTH) covers an area between Hrastnik municipality and Trbovlje municipality. The locations are connected to the areas where the ground water from the mines is being pumped to the surface and later to the local streams[11].

Technical characteristics

The results from previous research studies show great energy potential of this geothermal source. The results show the possibility to use 2,7 MW of potential energy at constant flow (Q) of mine groundwater Q = 9000 l/min with the average temperature of 13,8 °C [10].

Table: Potential areas of geothermal sources from mine groundwater within RTH

Location	**Potential users**
Trbovlje pit	Production building of RTH in Trbovlje
Trbovlje pit	Residential buildings near Gvido area
Trbovlje pit	Residential buildings near Frančiska plateau
Trbovlje pit	Production premises of the Trbovlje coal separation
Hrastnik pit	RTH premises in Hrastnik

Close cooperation with the RTH initiated the activities to prepare a pre-investment study where the mine groundwater from Hrastnik pit could be efficiently used for heating the water used for the spatial heating and bathing in the head office building of the RTH in Hrastnik municipality.

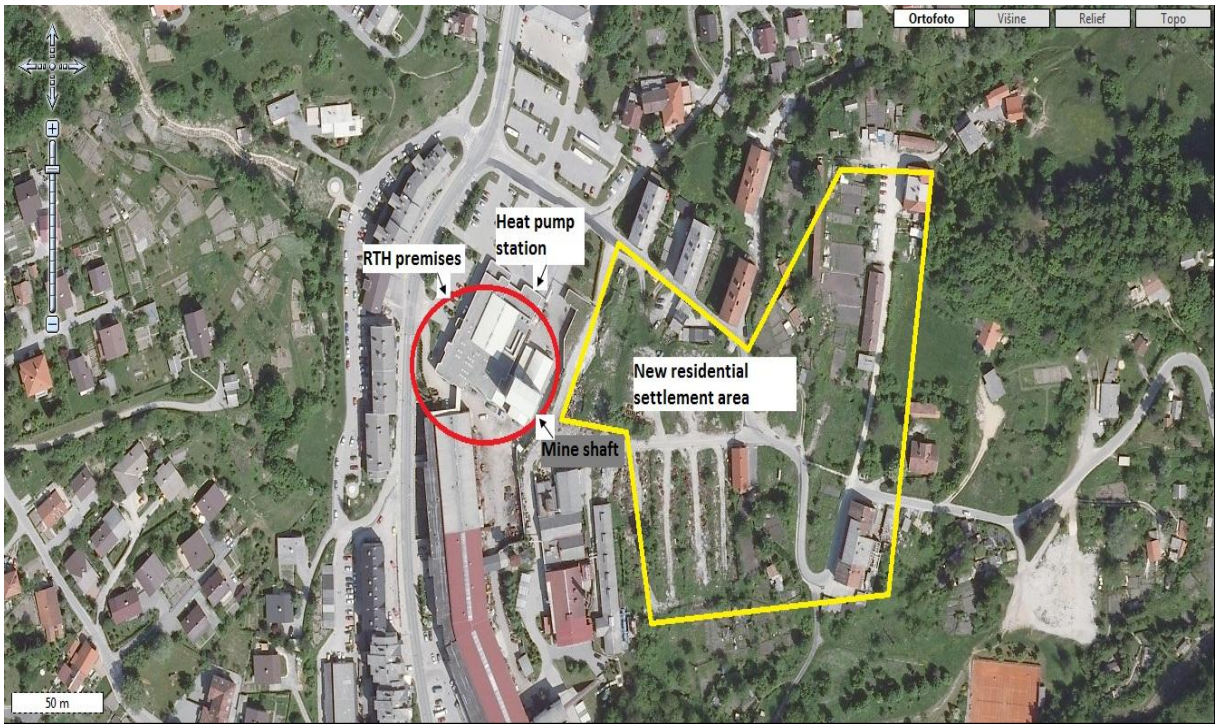
4.2 Project of mine groundwater use for water heating of Head-office building of RTH in Hrastnik

Background

Regarding the increasing heating costs during the last years RTH decided to find an alternative source of energy which would supply the heat for spatial heating and heating of sanitary water. The heating cost for their premises in Hrastnik reached 137.000 EUR in 2008. The pre-investment study is based on the project idea to use mine groundwater from Hrastnik pit for space heating and heating of water for bathing in Head-office building of RTH in Hrastnik municipality. The building is owned by RTH and it was built in 1997. It is located close to the Hrastnik pit and includes office premises and miners bathroom with total area of 1.300 m^2. Today the building heating station is connected to the Hrastnik local hot water grid, where gas is used as an energy source[12].

Several alternative project ideas have been prepared by the RTH in 2008, one of them referred to the use of mine groundwater for the production of heat. Since the geothermal activities within the ReSource project started in 2009, RTH has been participated as one of the stakeholders.

Picture 1: Investment project of RTH Head-office building in Hrastnik



The red line indicates the location of the RTH premises and the yellow line indicates an area where new residential area Resnica is being reconstructed. This area should be considered as potential user of energy produced by water/water heat pum.

Technical characteristics

Based on the cooperation with the RTH project team pre-investment study has been elaborated which included all technical characteristics of mine ground water from Dolska track (temperature, quantity of water, discharge,...), needed technical equipment, assessment of economics and additional activities which have to be undertaken to start the project implementation. The project predicts the use of wasted mine groundwater from the Hrastnik pit area called "Dolska track" which is located 40 m below the surface. The constant mine groundwater flow is 685 l/min with constant temperature at 13,8 °C. Mine groundwater will be pumped under surface and later on drained through the pipeline to the heating pump on the surface. The additional installation system would use the heat pump system water/water and would be fitted to the current heating station which is located within the building. On the basis of mine groundwater characteristics, technical and economics assessment the installed system would use 2 x 15 kW heat pumps.

Prediction of investment costs for the RTH mine groundwater system heating

	Year 2011 (EUR, VAT exl.)
MECHANICAL EQUIPMENT	**184.000**
Total cost of constructions in the pumping area	*3.000*
Equipment costs in the pumping area	*11.000*
Costs for the pressure pipeline	*21.000*
Construction and equipment costs for heating station	*2.000*
Other costs (project documentation, project supervision, tests,...)	*9.000*
Total costs for the heating station	*138.000*
ELECTRO EQUIPMENT	**37.000**
TOTAL INVESTMENT COSTS	**221.000**

Table: Heating costs for the RTH premises in Hrastnik

	Year 2008 (EUR)	**Year 2009 (EUR)**	**Year 2010 (EUR)**	***Year 2012 (EUR)***
HEATING COSTS	**137.000**	**135.000**	***140.000***	***67.000***

The pre-investment study shows that predicted total investment cost for RTH mine groundwater heating system would be 221.000 EUR. According to the annual heating

costs which amounted to 137.000 EUR in the year 2008 the future investment in the reconstructed heating system is justified from the economical point of view.

The annual cost for heat supply of RTH premises in Hrastnik after 2012 will be reduced to 67.000 EUR including all operational costs and supplementary costs for current heating system, to cover the winter season energy demand.

According to the analysis of cost the investment payback period would be 4 years taking into account the current heating costs.

The reconstruction of heating system for RTH premises in Hrastnik is justified also from the environmental point of view, due to the fact that the Zasavje region is the most polluted region in Slovenia. The use of geothermal energy would have a positive impact on the environment. The reduced consumption of gas used as current energy source for Hrastnik heating grid will consecutively reduce the green-house gas emissions. The investment will be finished in 2011, thus first positive effects will be visible in 2012.

4.3 Geothermal sources of mine groundwater in the municipality Zagorje ob Savi

Within Zagorje of Savi municipality 2 geothermal sources from mining groundwater have been indicated. Both sources are connected to the past production of brown coal and have been established as mining underground water level monitoring bores after the coal production had been stopped. Both bores are located close to the residential area of Zagorje ob Savi centre, marked and were included in spatial planning documents of the Zagorje ob Savi municipality as Bore KT-1/97 and Bore Fk-1/97[13].

Bore KT-1/97

The bore is located in Zagorje ob Savi and has been built by The Zagorje Mine in 1997 due to the monitoring of mine groundwater rising to its natural level after the coal production had stopped. The bore is 424,50 meters deep and initial results show that the water temperature at constant flow/pumping (Q); (Q) = 10 l/s is still 30 - 32 °C. It is located near former miners' bathroom and Spar market centre. The bore is owned by Zagorje Mine in liquidation[13].

Picture 2: Bore Fk-1/97 in Zagorje ob Savi

Bore Fk-1/97

The bore has been built by The Zagorje Mine in 1997 due to the monitoring of mine groundwater rising to its natural level after the coal production had stopped. The bore is 180 meters deep. The test results show that the groundwater from the bore has a temperature nearly 13°C. The sustainable flow (Q) is Q = 11- 12 l/s. The bore is located in the surroundings of the residential area Farčnikova kolonija and the production premises of Bartec Varnost and Kumplast companies. The bore is owned by Zagorje Mine in liquidation.

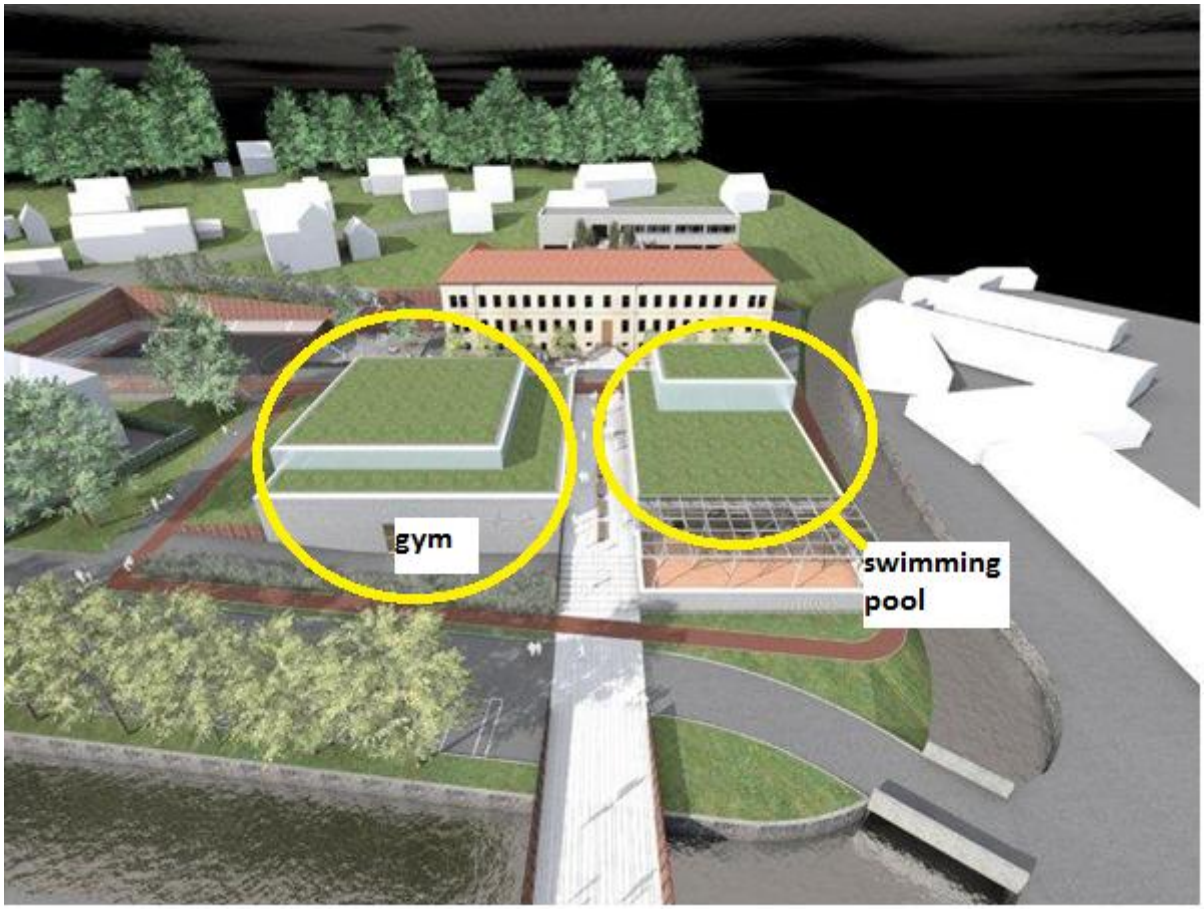
Picture 3: Bore KT-1/97 in Zagorje ob Savi

4.4 Project of restructuring the Elementary school in Zagorje ob Savi and construction of indoor swimming-pool and school gym

Cooperation with the Zagorje municipality encouraged the intentions to use the mine ground water from the Bore KT-1/97 for the spatial heating of the new indoor-swimming pool and school gym close to the Elementary School Tone Okrogar.

The project idea derived within the ReSource project and intends the reconstruction of the Elementary School in Zagorje ob Savi. The reconstruction includes investment in school gym and indoor swimming pool. Both, the swimming pool and the gym will use a geothermal minewater from the Bore KT-1/97 for spatial heating. The project has already been incorporated into the municipality's spatial plan and is in the phase of further evaluation process. The projects' activities include the installation of a minewater pipeline grid wich will connect the KT-1/97 with gym and swimming-pool. The pipeline grid will be co-financed by ReMining LOWEX project funds. The investment will start in 2014.

Picture 4: Project idea for the use of mining water for heating of swimming pool and gym in Zagorje ob Savi



A spin-off project is envisaged for creating a European network of minewater expertise: Together with the related CONCERTO project ReMining LOWEX, a joint application for funds from the IEE programme is in realization.

5. TRANSNATIONAL VALUE OF STUDY RESULTS

Our pre-investment study has been built-up on regional and national studies and document's which result from the field of geothermal potentials in the Zasavje region. The participation of RTH's representatives in Bad Schlema symposium encouraged the preparation of pre-investment study for geothermal heating system from the mine groundwater. The system will be implemented in 2011.

The second project idea is connected to the reconstruction of the elementary school in Zagorje ob Savi. Here, it is intended to heat the school gym as well as the swimming pool with minewater. The project has already been incorporated into the municipality's spatial plan. In the next two years, first laboratorial installations are going to be set up, co-financed by the EU project ReMining LOWEX. The municipality foresees budget for the major investment from 2014 onwards.

The project ReSource will elaborate complementary pre-investment studies of geothermal energy use from mining sources from four different Central Europe regions (Zasavje, Mansfeld, Sokolov-East and Aue). The comparison of different approaches, technologies, minewater characteristics will be available to future investors and help better the future projects.

Our results will be delivered in a Slovenian document and also in an English version of the document summary. Both will be accessible on the project's webpage. Within the ReSource final conference which will be held in the Zasavje region, participants will attend a tour where good practices of minewater use in the Zasavje region will be presented.

6. EVALUATION

Collected data of current geothermal sources from mine ground water in the Zasavje region are available. The geothermal potential is owned by the state since both mines are 100% state owned. The results of the project can be used by potential investors, local communities and owners for the future use of these RES.

There are few unsolved problems regarding the exploitation of geothermal potential from mine groundwater. One of potential obstacles is the fact that the mining is in decline and by the end of 2012 the RTH will be closed. That should not be the reason to stop the pioneer steps in a process of using geothermal potentials of the Zasavje region. In the future some additional research should be done regarding the geothermal potentials of the region. According to the results of the pre-investment study, the geothermal potential from mine groundwater is big enough to be considered as one of directions in future energetic/municipal/regional plans.

In the future more public awareness campaigns should be started, which would promote the use of geothermal energy for heating. In Zagorje ob Savi municipality concession for the use of geothermal energy sources should be transferred from the state to municipality.

In the future some more investigations should be done to search for new potential geothermal energy locations within the region and wider.

7. ANNEXES

TIMETABLE OF ACTIVITIES AND IMPLEMENTATION FOR GEOTHERMAL PRE-INVESTMENT STUDY

	2009	2010	2011
Identification of key regional actors in the geothermal sector			
Analysis of current situation on the exploitation of geothermal energy in the Zasavje region			
Analysis of hydrogeological situation in the Zasavje region for the exploitation of geothermal energy			
Case to case comparison with the situation in the Zasavje region - gathering info on similar projects successfully carried out in other regions, countries			
Examination of administrative procedures for the use of geothermal energy from mining sources			
Analysis of environment impacts due to geothermal energy exploitation			
Good practice exchange (case Lendava, Slovenia)			
Minewater geothermal energy utilisation (Bad Schlema, Germany) – best practice exchange			
The use of geothermal energy for spatial heating and hot water for the RTH premises in Hrastnik – pre-investment study			
Geothermal energy from mining sources in the Zasavje region - pre-investment study			
Geothermal energy from mining sources in the Zasavje region - pre-investment study - summary			
The use of geothermal energy for spatial heating and hot water for the RTH premises in Hrastnik – investment			

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