Turning Problems into Potentials

CENTRAL EUROPE Project 1CE084P4 ReSOURCE

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Title:

Executive Summary

Feasibility study on Geothermal Energies from Minewater in Mansfeld-Südharz

No: 4.2.6

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1. Description of the starting point

One of the central objectives of the EU project “ReSource” is to study the possibility of recovering remaining specific mining resources from late mining regions in Central Europe (mining stockpiles materials, other mining residues, minewater, etc.)

BdU Sachsen-Anhalt e.V., as one of the project partners of ReSource, studied the former copper mining region of Mansfeld-Südharz under the above-mentioned aspects.

The district of Mansfeld-Südharz (MSH) was characterized for centuries by its variety of mining activities. In particular, copper mines (before its closure in 1990) determined for more than 800 years the economy and social development of the Mansfeld regions. Figure 1 shows an overview of the former copper mining areas in MSH.

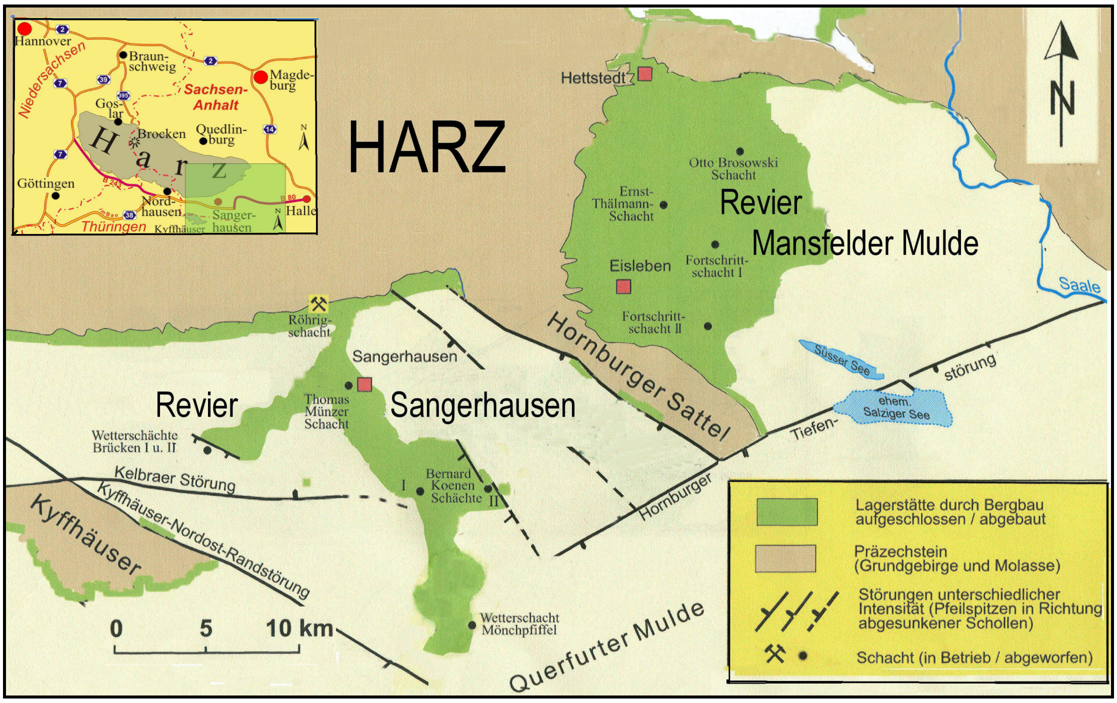


Figure 1

In the former mining districts of the region, drainage tunnels had to be done in order to conduct underground water flows (minewater) to the surface. Figure 2 shows the entrance and the inside of the drainage tunnel „Froschmühlen“.

Figure 2

Figure 3 shows the localization of the most important still existing minewater drainage tunnels in the Mansfeld region.

Figure 3

Until 2010, minewater had never been used with geothermal energy purposes in the district of Mansfeld-Südharz.

2. Objective of the study

The aim of the study was to evaluate the possibilities and limitations of the economic utilization of minewater with geothermal energy purposes in the rural district of Mansfeld-Südharz. Particularly, existing drainage tunnels of minewater were included in the study because of their relatively favorable conditions for geothermal.

The main sub-objectives of the study were:

1. An overall collection and presentation of all potential sites for geothermal utilization of minewater in the rural district of Mansfeld-Südharz.
2. Pre-selection of relevant sites according to an evaluation of advantages and risks under mining and infrastructure aspects.
3. Evaluation and classification of the pre-selected sites according to their potential taking into account geological, mining law and economic aspects.
4. Elaboration of a transferable guidance to evaluate the utilization of minewater with geothermal energy purposes of other comparable mining regions, based on the findings of this potential analysis.
5. Creation of a first draft presentation of how to build a geothermal energy pilot plant taking as example the shaft of "Seegen-Gottes-Stollen" in Wettelrode.

3. Approach applied

For the realization of this study, not only drainage tunnels from the former copper mining were analysed, also minewater from mining activities of potash, lignite and gangue were involved. The only minewater source excluded from the beginning of the study was the water used to flood the former copper mines; this due to a potential threat to the geological balance in the highly karstic Mansfeld region.
Basic information from:

- Archives of former regional mining companies
- Mining experts
- Data of companies (ROMONTA GmbH, etc.)
- GVV Sondershausen and the regional mining office

- Regional approaches to county government (Nature and Environment)

as well as present scientific knowledge from the University of Applied Sciences of Zwickau, partnership experience (PP1, PP4, PP7, PP8, and PP9) and knowledge of users from geothermal energy plants in the federal state of Saxony (Ehrenfriedersdorf Schlema), were necessary and taken into account consequently for the realization of this study.

The following steps describe the procedure taken to develop this feasibility study:

1. Collection of all flowing minewaters (surface and underground) in the study area of Mansfeld-Südharz.
2. Pre-selection of the collected mine water sites based on exclusion criteria and an analysis of advantages and risks for each site.

   Exclusion criteria:

   - a minimum water flow rate of > 0.1 m³ / min.
   - a maximum depth of 150m
   - a maximum distance between the user location, and the geothermal heat source of 500 m.
   - Minimum temperature of the minewater of > 8 ° C

   An example of the above mentioned analysis of advantages and risks is shown in the **Annex 1**.
3. Elaboration of a potential analysis of the pre-selected minewater sites based on the criteria specified below:

   a. Physical condition of the potential site e.g.:
      - Accessibility to the minewater location (shaft)
      - Depth of the minewater site
      - Security of the location of the heat source

   b. Hydrogeological aspects e.g.:
      - Water quality

- Water flow rate m³/min.
- Water temperatur

c. Infrastructure aspects e.g.:

- Ownership structure of the user of the site and the heat source
- Natural protection and environmental restrictions
- Communal allocation
- Distance between heat source and potential users

As a result of the analysis, all pre-selected minewater sites were divided into 3 classes:

Class 1: Mining sites - without potential

Class 2: Mining site with potential - Preliminary study is recommended

Class 3: Mining sites with potential and preliminary study available - Potential use is recommended.

4. Regional and transnational references and guides for the utilization of minewater with geothermal energy purposes were developed based on the results of the point 1-3.
5. Elaboration of a concept to build a geothermal energy demonstration plant in 2012 at a mining site of class 3 (Mining museum Wettelrode).
6. Transfer and dissemination of the results of the study within and outside the partnership.

The above proposed procedure can be applied in similar minewater sites of former mining areas in the countries of the EU.

4. Results of the study

1. Collection, description, pre-selection and classification of minewater sites in the rural district of Mansfeld-Südharz under terms of future geothermal energy use. As result, the study has confirmed that for 3 of the pre-selected sites, the utilization of minewater for geothermal energy production is possible. For further 11 sites the production of geothermal energy is basically also possible but specific feasibility studies are recommended. On the other side, for 4 of the investigated sites, no geothermal potential could be detected (See **Annex 2**).
2. Based on the findings of this potential analysis, a transferable guidance to evaluate the utilization of minewater with geothermal energy purposes of other comparable mining regions was developed and presented (See **Annex 3**).
3. Development of a synopsis to build a pilot plant for extraction of geothermal energy from minewater at the site of Wettelrode (effective in 2011-2012). The most important statements of the synopsis are:
   - The geothermal utilization of the minewater is technically and technologically feasible.
   - The production of geothermal energy from minewater covers the heating needs of the mining museum in Wettelrode (after its renovation).
   - The investments for the construction of the geothermal energy pilot plant in Wettelrode amount to 120.000 €
   - Through the construction of a geothermal energy pilot plant the heating costs of the mining museum in Wettelrode will be reduced in about 6,0 - 8,0 thousand Euros per year. Moreover the CO_2 Emissions will be greatly reduced
4. As part of the project work, funds for the construction of the pilot plant were secured involving the funding Programme LEADER.

5. Transnational usefulness and dissemination

1. Involvement of the partnership in the preparation of the study

PP3 received its first valuable advices on the content and objectives for this feasibility study at the international conference "Geothermal Energies" in Schlema on February 2010. Furthermore the presentation and discussion of the results during the 2nd and 3rd Progress Workshop in Salgotarjan and Eisleben respectively were very helpful and constructive for the development and conclusion of the study. In addition to that, PP3 tried always to involved members of the work group geothermal energies in the preparation of this study. Two bilateral visits at the premises of PP7 in Czech Republic supported also the preparation of this study.

Important information on the geothermal utilization of minewater at the site of Wettelrode were also given by Prof. Hoffmann (University of Applied Sciences of Zwickau) and mining experts from late mining companies of the region.

2. Transnational usefulness of the study

The main objective of the study was to evaluate the possibilities and limitations of the economic utilization of minewater with geothermal energy purposes in the rural district of Mansfeld-Südharz. Nevertheless, the evaluation method and the whole approach developed in this study are transferable and can be used in any mining region. Appendix 3 shows for example general benchmarks for the evaluation of the capacity of flowing minewater for the production of geothermal energy.

3. Dissemination of the study results

The results of the study as well as proposals for transnational utilization will be presented as planned in the 4th Progress Workshop ReSource in Austria in May 2011.

The following activities are planned for the dissemination outside the partnership:

- Presentation of the study results at the international conference “Geothermal Energies” in April 2011 in Eisleben.
- Presentation of the results under:
  www.bdu-international.de
  www.resource-ce.eu
- Presentation of the study results to the Economic Committee of the county in the rural district of Mansfeld-Südharz and the Steering Committee of the LAG- Mansfeld-Südharz.
- Presentation of the study results to the partnership Min-Novation during the Kick-Off Workshop in Cracow in January 2011.
- Presentation of the study results to the network of knowledge transfer “Wirthschaft-Wissenfschaft” (Economy-Science);in which small and medium sized companies work together with Universities of from federal state of Saxony-Anhalt (April 2011).

6. Internal evaluation of the results – further work

The main objectives of the study were achieved. Regarding to further work, PP3 will be concentrated in cooperation with regional partners in the development of the following activities:

1. Development of the geothermal energy pilot plant at the mining museum in Wettelrode (Class 3)
2. Development of implementation plans for the future utilization of the minewater site of Wiederstedt and the Museum of Hettstedt (both Class 3)
3. Further investigation of universal and transferable decision patterns to assess the economic efficiency of geothermal energy from minewater
4. Propagation of the feasibility study on geothermal energy from minewater to other mining areas in Saxony-Anhalt in the framework of the project Min-Novation.

7. Annexes

Annex 1: Analysis of risks and advantages for the utilization of minewater at the "Gonnaer-Stollen" (minewater drainage tunnel)

Deficits / Risks	Advantages
Determination and evaluation (e. g. Water supply, hydro-chemistry and hydro-physic, temperature, corrosion behaviour) of the water in the drainage tunnel of Gonnaer-Stollen is not available.	Stable mine water source, approx. 1,5-2,0 m^3/min
Ownership and use conditions as well as mining and environmental situation are unclear.	Located direct near to potential and possible users.
Height of the mining costs for maintenance and inspection work during the whole operating time is unclear.	Utilization of the minewater through the mouth hole of the tunnel and /or low depth drillings. In recent years, restoration works were carried out to the drainage tunnel.
Heat recovery system has to be adapted to the existing mining conditions (e.g. size and geometry of the tunnel and the shaft drainage pipe lines.	
Preparation of a prelimiary study is recommended.	

Annex 2:

1. Mining sites – without potential (oP)

Site	Name on map	Essential criteria for decision		
		Physical condition	Hydro-geological aspects	Infrastructure and usage situation
Mundloch Alteröder Stollen	**G 3/oP**	Restoration and maintenance works required	Low water quantity	Isolated site without utilization approaches
Mundloch Erdeborner Stollen	**H 1/oP**			Isolated site without utilization approaches
Mundloch Zabenstedter Stollen	**K 2/oP**		Utilization of water in tunnel LL20 Z in Gerbstedt possible	Without utilization approaches
Mundloch Jacob-Adolph-Stollen in Hettstedt	**J 1/Ve**		Geringe Wassermenge	Without utilization approaches
Mundloch Schlüssel-Stollen bei Friedburg	**K-1/Ve**			Isolated site without utilization approaches

2. Mining sites with potential – Preliminary study recommended (Ve)

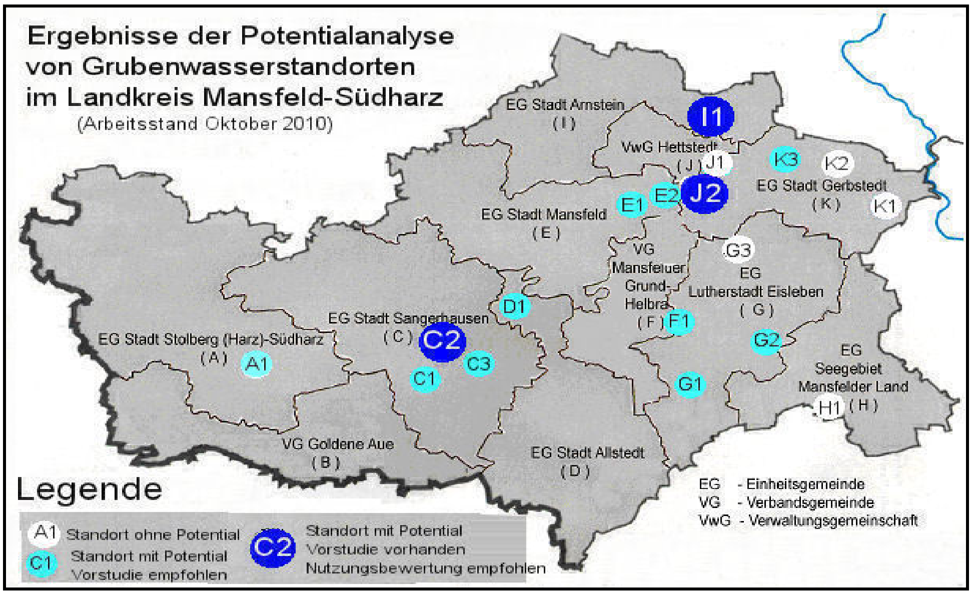
Site	Name on map	Essential criteria for decision		
		Physical condition	Hydro-geological aspects	Infrastructure and usage situation
Flußspatgrube Rottleberode	A 1/oP	Constant control and security is carried out	Sufficient water quality	Owner interested in the utilization
Mundloch S.-Gottes-Stollen in Sangerhausen	C 1/Ve	Constant control and security is carried out	Sufficient water quantity and quality	Water is currently being used. Proximity to the industrial park in Sangerhausen
Bereich Mundloch Gonnaer Stollen in Gonna	**C 3/Ve**	Restoration works carried out in recent years	Sufficient water quantity and quality	Residential development expected
Barbara-Schacht bei Pölsfeld	**D 1/Ve**	Open shaft	Sufficient water quantity and quality	Commercial use of the shaft area
Freiesleben-Schacht bei Großörner	**E 1/Ve**	Powered shaft with mechanical support	Sufficient water quantity and quality	Proximity to a village, industrial park and commercial areas
LL 26 Schlüssel-Stollen bei Großörner	**E 2/Ve**	Powered shaft with mechanical support	Sufficient water quantity and quality	Proximity to commercial areas and industrial facilities
Mundloch Mönch-Stollen und Meta Schacht in Sittichenbach	**G 1/Ve**	Restoration works carried out in recent years	Sufficient water quantity and quality	Development of facilities with tourism purposes
Mundloch Froschmühlen-Stollen bei Eisleben-Helfta	**G 2/Ve**	Constant control and security is carried out	Sufficient water quantity and quality	Nearby to commercial site in Eisleben-

				Strohügel
W-Schacht in Wimmelburg	**F 1/Ve**	Powered shaft with mechanical support	Sufficient water quantity and quality	In the city centre of Wimmelburg
LL 20 Zabenstedter Stollen in Gerbstedt	**K-3/Ve**	Powered shaft with mechanical support	Sufficient water quantity and quality	In the city centre of Gerbstedt

3. Mining sites with potential and preliminary study available - Potential use is recommended - (BNe)

Site	Name on map	Essential criteria for decision		
		Physical condition	Hydro-geological aspects	Infrastructure and usage situation
Röhrig-Schacht In Wettelrode	**C 2/BNe**	Powered shaft with mechanical support	Sufficient water quantity and quality	Reconstruction and restoration planned at the mining museum
Mundloch Wiederstedter Stollen in Wiederstedt	**I-1/BNe**	Absolutely necessary restoration works planned	-	Proximity to the Novalis museum and to the Kloster Wiederstedt (restoration planned)
LL 20 Schlüssel-Stollen in Hettstedt-Burgörner	**J 2/BNe**	Constant control and security is carried out	Sufficient water quantity and quality	Proximity to the Mansfeld museum and Industrial facilities

The following figure shows the localization of all sites investigated in the rural district of Mansfeld Southern Harz:



Annex 3: Guidance and benchmarks for the recovery of geothermal energy from minewater

Besides the physical condition of the minewater source and the proximity of potential users, quality and quantity aspects of the minewater crucially determine the viability of geothermal energy extraction:

1. Chemical and physical composition of the minewater
2. Temperature of the minewater and its development over a calendar year
3. Flow rate / unit of time of the minewater

1. Chemical and physical composition of the minewater

The chemical and physical quality of minewater essentially determines the technical implementation of the heat recovery from minewater.

The producers of water heat pumps recommend the fulfilment of the following conditions for an effective use (almost free of maintenance) of the heat exchangers:

Tab.: Consideration of the chemical properties

Property	Producer's parameter
	mg/l
deductible substances	-
Chloride	>300
electrical conductivity	<10 µS/cm | >500 µS/cm
PH value	<7,5 | >9
hydro carbonate	<70 | >300
sulphate	<70 | >300

If these parameters are exceeded, other technical-technological solutions such as the separation of the primary circle of the minewater and the utilization of heat exchangers with capillary tubes would have to be incorporated.

The chemical and physical composition of the minewater in all potential sites allows the utilization of existing water heat pumps.

2. Temperature of the minewater and its development over a calendar year

The economically optimal, technical and technological solution for generating energy from minewater is the utilization of water heat pumps.

The use of this technology requires a minimum temperature for the minewater of > = + 8°C.

With an assumed water flow of 1,0 m^3 / min (60 m^3 / h), a minimum temperature of + 8 ° C and the utilization of a water heat pump, it is possible to generate geothermal energy of approx. 60-80 kW = heat outcome (Heat extraction 1Kelvin).

Decisive for the recoverable geothermal energy amount is the compliance of the mentioned water temperature of +8°C and the water flow rate.

3. Flow rate / unit of time of the minewater

The outcome of utilizing water heat pumps to extract geothermal energy from minewater with a temperature of +8°C can be influenced by the water flow rate.

The following table shows approximately how much geothermal energy can be produced extracting 1 Kelvin from minewater at a respective water flow rate:

Minewater flow rate (m^3 / min)	Heat recovery (KW)
0,3 – 0,5	21,0 – 35
1 – 2	70 – 140
3 – 5	210 – 350
10 – 15	700 – 1050
20 – 25	1400 – 1750