# Feasibility Study for Geothermal Mine Water Usage at the Mine Water Drainage Site Haus Aden, Bergkamen, Germany

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**Abstract**

This study evaluates the geothermal potential of mine water at the Haus Aden drainage site in Bergkamen, Germany. Technical assessments, system configurations, and integration into the district heating network were analysed in collaboration with key stakeholders. Results show that mine water can provide a reliable base-load heat supply, complemented by biomass for peak demand. A phased system development reduces economic risks and improves feasibility. The project has the potential to become one of the largest mine-water geothermal systems in Europe. The study also highlights the importance of stakeholder coordination and provides transferable concepts for future mine-water-based energy systems.

**Keywords:** IMWA 2026, mine water, geothermal energy, district heating, heat pump, Ruhr area, coal mining

## Introduction

As part of the European transition towards greenhouse gas-neutral heat supply, a transformation study was conducted for the existing district heating network in Bergkamen, Germany, to identify and evaluate potential climate-neutral supply concepts. Within this context, the assessment of locally available renewable energy sources revealed that the city and its heating infrastructure are situated above a considerable geothermal resource associated with mine water. The Ruhr area, including the city of Bergkamen, is characterised by a long history of hard coal mining, which has substantially shaped both the regional infrastructure and subsurface conditions. Following the ending of mining activities, continuous mine water management remains necessary to control groundwater levels and prevent uncontrolled discharge. Central mine water pumping sites provide long-term and reliable access to subsurface thermal energy. Despite this favourable starting point, the integration of mine water into large-scale district heating systems is still limited and requires comprehensive technical, economic, and organisational evaluation. In particular, the utilisation of centralised pumping sites offers a relevant potential for scalable and continuous heat supply but remains insufficiently explored in practice.

This study investigates the feasibility of using mine water from the Haus Aden pumping site in Bergkamen as a key component of a future climate-neutral heat supply system. The aim is to develop and evaluate technical concepts, assess their integration into the existing heating network, and identify pathways for a phased system implementation. In addition, the study considers the role of stakeholder coordination as a critical factor for successful project development.

## Regional and Technical Background

### *Mining legacy and mine water management in the Ruhr area*

Hard coal mining in Bergkamen was primarily carried out at the collieries Haus Aden and Grimberg. The first shaft at Haus Aden was sunk in 1938, followed by a second shaft in 1939. Mining activities continued at this site until 2001 and were later integrated into the colliery Ost, where operations persisted until 2010. Within the municipal area, shaft Grimberg 3 reaches a depth of 1638 m and is therefore among the deepest shafts in the Ruhr area as well as one of the deepest hard coal shafts overall (Huske J, 2006). After the ending of mining activities, the mine water management strategy in the Ruhr area was fundamentally restructured. A centralised mine water management system was established to maintain controlled mine water levels across the entire Ruhr coalfield. Today, mine water is pumped at six central locations to ensure that defined water levels are maintained throughout the system (Figure 1). The objective of this centralised approach is to prevent uncontrolled mine water rise into overlying groundwater horizons. At the same time, the concentration of pumping activities at selected sites increases operational efficiency and enables a more controlled discharge of mine water into larger receiving waters.

The central mine water pumping sites include Lohberg, Walsum, Robert Müser, Heinrich, Friedlicher Nachbar and Haus Aden. The present study focuses on the Haus Aden site, which represents one of these key locations within the regional mine water management system (RAG Aktiengesellschaft 2024).

### *Mine water provinces and centralised management system*

Mine water provinces describe hydraulically connected mining areas that have been linked over decades of mining activities through underground connections. Within the framework of the so-called box model, created by the German company DMT by order of the RAG AG, these connections were systematically documented, including

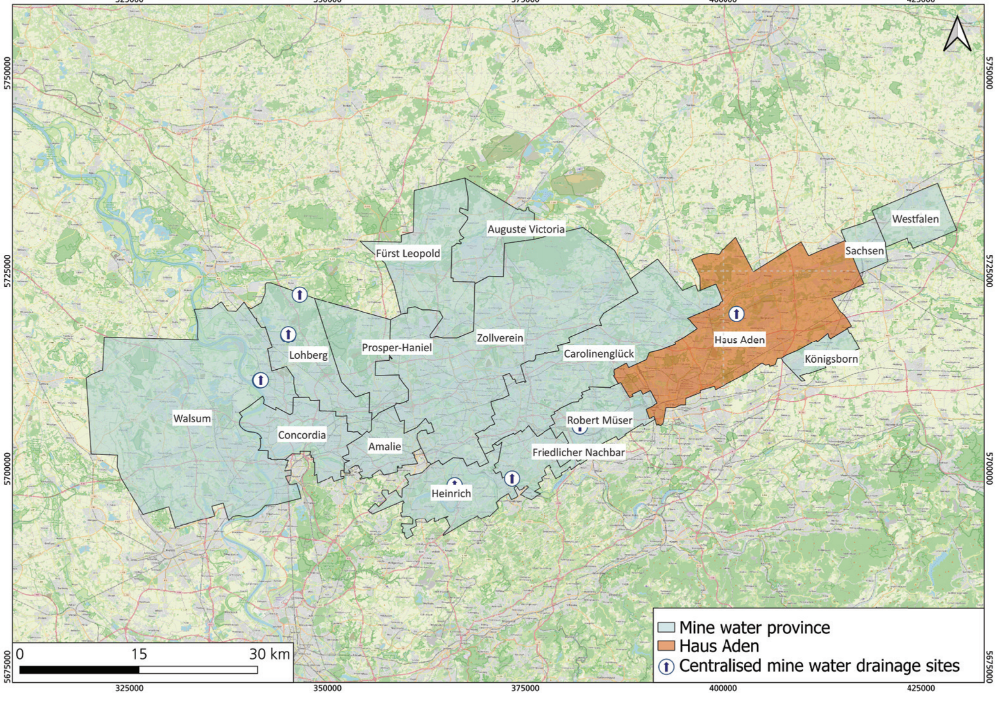


*Figure 1* *Mine water provinces of the Ruhr area and centralised pumping sites (Data provided by RAG AG).*

transfer points between individual mine workings and their respective depth levels. Based on this information, water flow between the different provinces can be modelled and hydraulic interactions can be analysed. In addition, the model allows the identification of hydraulic separations between individual mine systems.

Within this system, the Haus Aden site plays a key role for the eastern part of the Ruhr area. It is responsible for pumping mine water originating not only from Bergkamen but also from adjacent areas such as Kamen, Hamm and Dortmund. To prevent a continuous rise of mine water levels within the connected provinces, a long-term balance between inflowing and extracted water volumes must be achieved. This requires that, beyond a certain point, the pumped discharge corresponds to the inflow from surrounding mine workings.

Figure 1 illustrates the spatial distribution of the mine water provinces as well as the centralised pumping sites. The investigated shaft Haus Aden 2 is highlighted, showing the area that is primarily influenced by its operation. The extracted mine water is planned to be treated and subsequently discharged into the River Lippe, located north of the site, from where it is transported further towards the Rhine.

### *Utilisation of mine water*

For centralised pumping sites, the utilisation of the thermal energy contained in the extracted mine water represents the most relevant application pathway. At the Haus Aden site, mine water is planned to be pumped from a depth of approximately 600 m below surface level. Based on the geothermal gradient, mine water temperatures of around 20 to 22 °C are expected. The extracted mine water therefore provides continuous access to geothermal energy from depth. As mine water pumping is required as a permanent task, this resource represents a long-term and reliable energy source.

From an economic perspective, systems based on existing pumping infrastructure offer clear advantages compared to concepts requiring dedicated extraction wells. No additional investment for subsurface development is required, while large and continuously replenished water volumes are available. As a result, thermal regeneration of the underground system is not necessary.

In addition, the centralisation of pumping activities leads to substantially higher extraction rates at individual sites compared to decentralised systems. This allows for the utilisation of substantially larger thermal potentials at centralised pumping locations such as Haus Aden.

## Heat demand and system integration

### *Heat demand and network development*

The existing district heating network is located in the eastern part of Bergkamen. It has a total length of 22.7 km and a maximum peak generation capacity of 42.1 MW. Currently, approximately 600 residential and commercial units are supplied, resulting in a total annual heat demand of about 40 GWh. For the further development of the system, the heat demand of the remaining urban area was assessed. In cooperation with the local utility (GSW Gemeinschaftsstadtwerke GmbH Kamen, Bönen, Bergkamen), priority areas for network expansion as well as areas for future decentralised, non-network-based supply were identified. Based on this, a phased network expansion pathway was developed, including planned pipeline routes and a timeline for the connection of individual districts. The heat demand was determined using the spatial heating demand model of North Rhine-Westphalia (LANUV, 2024), provided by the Landesamt für Natur, Umwelt und Verbraucherschutz Nordrhein-Westfalen. The model is based on a GIS-based dataset of building-specific heat demand values derived from building characteristics, typologies, and statistical assumptions. To improve the reliability of the calculated demand, the model results were validated and refined using gas consumption data from the supply area. For the development of supply scenarios, the different energy sources available within the project area were analysed. Based on this assessment, several system configurations were defined and subsequently compared with regard to their economic performance. A key objective of this planning process was the connection of the existing network in the eastern part of the city with the mine water pumping site at Haus Aden in order to enable the integration of a sustainable and renewable heat source. In the final expansion stage, the total heat demand of the network is expected to increase to approximately 83 GWh/a, representing nearly a doubling of the current system. Figure 2 shows the potential expansion options for the district heating grid.

The existing biomass combined heat and power plant will continue to provide renewable heat. However, its role is planned to shift from base-load supply towards peak-load coverage, while mine water is intended to gradually assume an increasing share of the base load. As an initial step, the installation of a mine water heat pump with a capacity of 2.5 MW is planned. This system is intended to cover a first share of the base load of the district heating network.

### *Technical integration and system concept*

The extraction of mine water is planned to be implemented in a phased approach in order to control and gradually slow down the rise of mine water levels. The objective is to progressively reach the targeted long-term mine water level. In parallel, the capacity of the heat pump system can be expanded step by step. For geothermal utilisation, a partial flow of the pumped mine water is diverted from the main discharge line. The thermal energy is transferred via a heat exchanger to a secondary circuit and subsequently supplied to the heat pump system. After heat extraction, the mine water is returned to the main flow. The heat pump uses the extracted thermal energy in combination with electrical energy to provide heat at the required network temperature level. In the final expansion stage, a pumping rate of up to 24 $m^3$/min is expected at the Haus Aden

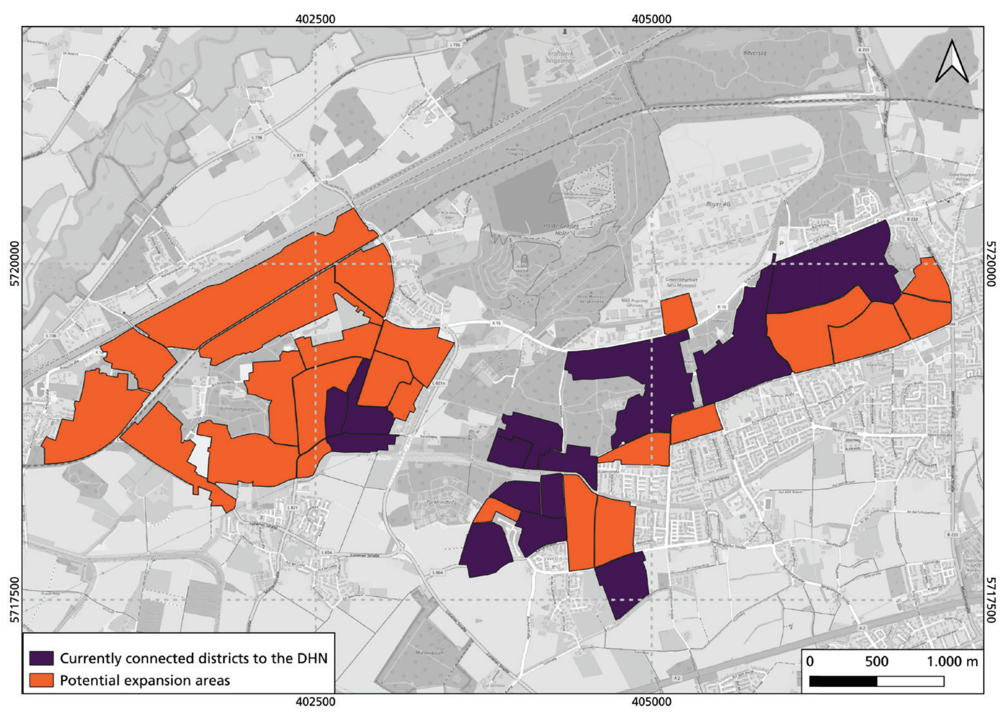


***Figure 2*** *Display of districts which are connected to the DHN at the moment of the study, and potential areas where the heating grid can be expanded to in the future (Expansion plan developed by Fraunhofer IEG and GSW).*

site. With a temperature difference of up to 15 K, this corresponds to a thermal output of approximately 25 MW based on the mine water alone. The use of electrical energy within the heat pump system allows for a further increase in the usable heat output. Overall, the results indicate that a large share of the urban heat demand can be covered by mine water under the described system configuration.

## Discussion

During the feasibility study, the importance of close coordination between the local energy supplier and the operator responsible for mine water pumping became evident. The development of a mine-water-based heat supply system involves a number of legal and organisational aspects that require careful consideration. In particular, interface points within the system, such as heat exchangers and heat pump installations, represent critical boundaries. These points are essential for clearly defining responsibilities between the involved stakeholders and for structuring ownership and operational frameworks. Early involvement of all relevant parties proved to be a key factor for project progress. It enabled the identification of potential challenges at an early stage and allowed for the development of appropriate solutions before they could hinder further planning. If successfully implemented, the project has the potential to serve as a reference case for future mine water geothermal systems at centralised pumping sites. In this context, it may provide a transferable approach for the utilisation of mine water as a renewable heat source.

## Conclusions

The results of the feasibility study demonstrate that the mine water drainage site at Haus Aden in Bergkamen has considerable potential for the expansion of its existing district heating network. This expansion is intended to be realised using renewable heat sources. Due to its specific location and its function as a centralised mine water pumping site, the Haus Aden site plays a key role in this context. The utilisation of mine water offers the possibility to provide a substantial share of the required heat and to support the transition towards a sustainable heat supply system.

The study further shows that close coordination between the mine water operator and the local energy supplier remains essential. The utilisation of mine water has to always be aligned with the existing mine water management concept in order to ensure both technical feasibility and long-term operational stability and having no negative influence on the mine water drainage concept. If successfully implemented, the project has the potential to become a reference for mine-water-based heat supply systems and to demonstrate the role of centralised pumping sites in future energy systems.

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