

Response provided by the British Geological Survey to the inquiry by the Welsh Affairs Committee on:

What progress has been made in addressing the environmental legacy of Wales' industrial past?

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Introduction

The British Geological Survey (BGS) is the national geological survey of the UK. We are a leading authority on geothermal energy, advising the Department for Energy Security and Net Zero (DESNZ) and representing the UK as a delegate to the International Energy Agency (IEA) Geothermal Technology Collaboration Programme, where we lead the International Mine Water Energy Expert Group. BGS plays a central role in advancing research and collaboration in this field, including acting as the lead organiser of the annual [IEA Mine Water Energy Symposium](#), which convenes experts from industry, academia, and government.

BGS is actively engaged in mine geothermal energy and thermal storage research, including the EU funded [PUSH-IT](#) (Piloting Underground Storage of Heat In Geothermal Reservoirs) project. We operate the UK Geoenergy Observatories (UKGEOS), including our site in Glasgow - a dedicated research facility providing real-world data on mine water energy systems. Additionally, we maintain strong links with operational mine water geothermal projects across the UK and Europe. The BGS works collaboratively with the Mining Remediation Authority (MRA - previously Coal Authority) on a number of these research projects.

Should the Committee be interested, BGS would be pleased to facilitate site visits to our research infrastructure or provide contacts to established operational projects to support its inquiries. Our experts are also available to provide oral evidence and any additional information required to assist the Committee in its investigation.

Background

Mine water geothermal technologies utilise water stored in disused mines as a renewable energy source for heating, cooling, and thermal energy storage. Many former mining areas have extensive underground networks filled with water, which maintains a relatively stable temperature throughout the year. This makes mine water a valuable resource for low-carbon energy applications while also providing an opportunity for remediating these former industrial sites.



Mine water heat can be accessed by drilling boreholes into the old mines, or by using existing mine water discharges or pumping schemes for water treatment for environmental protection. For heating, warm mine water (typically between 10–20°C) is pumped to the surface and passed through a heat exchanger, where a heat pump upgrades the temperature to a level suitable for district heating networks, homes, or industrial use. Once the heat is extracted, the cooler water is returned underground. For cooling applications, the process is reversed.

In addition, abandoned mine workings serve as vast underground reservoirs that can be used for storing excess heat, e.g. from industrial processes, waste heat from power generation, or surplus renewable energy (such as excess solar in summer). This stored energy can then be used later when demand rises, helping to balance the gap between energy supply and demand.

Thermal energy storage is particularly important because it addresses the mismatch between when energy is produced and when it is needed. By capturing and storing waste heat (or cold), mine water systems can provide a reliable heat source throughout the year, reducing reliance on fossil fuels and improving energy efficiency. In winter, stored heat can supply warmth to homes and businesses, while in summer, the system can shift to cooling applications. This flexibility supports grid stability, enhances energy security, and maximises the use of renewable and waste energy sources.

Re-use of abandoned, flooded coal mine workings as a shallow geothermal resource is a proven technology for heating buildings that has been used in the US, ([Jessop *et al.* 1995](#); [Korb 2021](#); [Gasperikova *et al.* 2024](#)), Spain ([Jardón *et al.* 2013](#)), the Netherlands ([Verhoeven *et al.* 2014](#)); the UK ([Athresh *et al.* 2015](#); [Walls *et al.* 2021](#)) and China ([Wang *et al.* 2024](#)) and increasingly also for storing excess heat ([Hahn *et al.* 2024](#)). With schemes already operational at larger scales in NE England (Lanchester Wines 2.4 and 3 MW_{th}, [Walls *et al.* 2021](#); [Banks *et al.* 2022](#); Gateshead heat network up to 6 MW_{th}, [Coal Authority 2023](#)), a significant opportunity exists in the UK to expand the use of low temperature mine water heating, cooling and thermal storage in the quest to reduce greenhouse gas emissions from fossil fuels and decarbonise heating and cooling of buildings. Such decentralised local energy also increases the resilience and security of energy supply.

How could the UK Government further support the remediation of former industrial sites in Wales?

The UK Government could support the remediation of former industrial sites in Wales by identifying and prioritising locations suitable for mine water geothermal energy. This would involve

- assessing and ranking mining sites, including shafts and mine water discharges, according to their potential for heat extraction and energy storage.
- aligning (mapping overlap of) these sites with potential heat users by identifying existing or planned heat demand, such as heat network zones, housing developments, or industries requiring low-temperature heat (*drying, agriculture, aquiculture*).

Some preliminary research and mapping has been carried out in some areas which could be extended to identify opportunities at the national scale, including in Wales. For example, BGS and the Mining Remediation Authority (MRA - previously Coal Authority) have undertaken



mapping of the temperature distribution in abandoned coal mines across the UK that could support such an assessment ([Farr et al. 2020](#)).

The Welsh Government commissioned the development of a '[Mine Water Heat Opportunity Map](#)' for Wales, which was published in August 2024. This map identifies former coal mining areas that could be suitable for mine water heat schemes.

A mine water tool kit has been developed for Local Authorities (<https://www.bridgend.gov.uk/residents/nature-climate-and-environment/energy-and-decarbonisation/caerau-heat-scheme/>), commissioned by Bridgend County Borough Council.

Lessons from other countries show that additional supporting measures will be needed to encourage uptake of geothermal technologies and attract private investment, including policy measures (e.g fossil fuel bans for new builds) and financial support through grants, risk insurance, or long-term heat purchase agreements. Streamlining regulatory processes and including geothermal technologies in the UK and Welsh governments' energy and decarbonisation strategies could further facilitate deployment (see further details below).

Challenges encountered by geothermal developments in the UK, and mine water geothermal in particular, have been investigated by white papers commissioned by DESNZ through the [North East Local Enterprise Partnership](#) and also an Environmental Audit Committee inquiry on [Deep Geothermal Systems and Mine Water Energy Systems](#).

Can former industrial sites contribute to the green transition in Wales, and how could the UK Government help to maximise opportunities?

Yes, there is opportunity to repurpose industrial sites within the coalfields in Wales, most obviously those associated with former coal mines. Mine workings with potential resource for heat extraction can also extend significant distances from the footprint of former surface pit head building so could contribute to low-carbon energy source through the development of mine water geothermal schemes over wider areas. These schemes present a decentralised energy solution that enhances local energy security by reducing dependence on external energy supplies. Additionally, disused mine workings often coincide with areas of high heat demand and socio-economic deprivation, making them well-suited for targeted regeneration efforts. This technology is proven and has been successfully deployed both in the UK and internationally (see examples in the Background section).

In England, mine water geothermal is already in commercial use, such as at Lanchester Wines ([Walls et al. 2021](#); [Banks et al. 2022](#)), where it provides low-carbon heat for industrial processes, and in Gateshead ([Coal Authority 2023](#)), where it supplies a district heat network.

In Wales, a test scheme in Bridgend explored the feasibility of using mine water for heating. The scheme was initiated in 2016 with the aim of harnessing geothermal energy from the flooded former Caerau Colliery to provide heating for approximately 300 homes, as well as community buildings and a primary school. However, development was discontinued due to significant technical and commercial uncertainties encountered during the design and development phase – this project highlights some of the complexities and challenges of implementing mine water heating schemes in the UK.

Each potential site considered for mine water geothermal will have its own characteristic mine workings and hydrogeology. The amount of heat that can be sustainably and economically



extracted from mines for 10's years will depend on many factors including the extent of mine workings, water level, temperature, connection with other mines and groundwater aquifers and the water chemistry.

Whilst there is no operational scheme in Wales at present, the coal mine workings of South Wales have commonalities with other mine workings across the UK and in other countries, suggesting that there may be similar potential in Wales for using this technology. The potential is illustrated in Taff's Well, where the natural flow of warm water from Wales' only thermal spring is providing heating to the nearby park pavilion and the local primary school.

There are also opportunities for mine thermal energy storage, and some research and innovation projects in the UK are looking at using mines as a [geobattery, storing curtailed wind energy](#) or excess geothermal heat (e.g. [PUSH-IT](#) pilot site at United Downs). In Heerlen, Netherlands, mine water energy is used as the baseload of low temperature heat networks balancing heating and cooling demands.

Mine water geothermal has environmental benefits as well as potential environmental hazards. Besides CO₂ emissions savings, operating a mine geothermal scheme would enhance groundwater and mine water management in the area. Potential hazards relate to water quality, water levels, gas and ground motion. The regulatory regime for groundwater (administered by the Natural Resources Wales) and drilling into mines (regulated by the Mining Remediation Authority) will assess the associated risks before permits and licenses are awarded.

UK Government help

The role of geothermal technologies, including mine water geothermal, in supporting the UK's Net Zero efforts—particularly in the decarbonisation of heating—remains largely underrepresented in the country's energy and decarbonisation plans and strategies.

To encourage industry investment and broader adoption—thereby also contributing to the ongoing efforts to manage the environmental legacy of Wales' industrial past—the UK and Welsh Governments could introduce clear targets and policies for geothermal technologies. Further support for the sector could include clarifying and streamlining regulations (e.g. geothermal energy is not currently recognised as a natural resource in UK legislation) and strengthening skills development in drilling, installation, and maintenance of ground source heat pumps and shallow geothermal systems. Additionally, establishing expert multi-disciplinary groups and fostering knowledge-sharing and professional development for developers, installers, and officials in planning and regulatory roles would further help build the expertise necessary for effective geothermal deployment.

The recently published International Energy Agency's (IEA) report, "[The Future of Geothermal Energy](#)" highlights that with appropriate policy support and technological advancements, geothermal energy can play a crucial role in decarbonising energy systems.

Recent reports commissioned by the DESNZ arrived at similar recommendation for the UK ([Geothermal evidence report](#), [Geothermal White Paper](#)). Drawing on evidence from a wide range of European countries, these reports highlight the potential for job creation and economic benefits linked to the deployment of geothermal technologies, and identify key measures for supporting businesses and building up the sector. These include targeted financial incentives such as grants and low-interest loans, investment in R&D to improve



drilling and heat exchange technologies, and infrastructure development to integrate mine water heating into district energy networks. Streamlining regulatory frameworks, raising public awareness, and engaging local communities are also crucial to ensuring successful implementation.

The Environmental Audit Committee (EAC) inquiry (<https://committees.parliament.uk/call-for-evidence/2669/>) in 2022 highlighted that geothermal energy could potentially fulfil a significant portion of the UK's heating and power needs without the harmful emissions associated with oil and gas. The Committee emphasised the importance of government support in realising this potential.

