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Geothermal Energy Use, Country Update for the United Kingdom

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ABSTRACT

In the reporting period 2022–2025, there has been a sustained resurgence of interest in all aspects of geothermal energy in the United Kingdom (UK), including in the provision of decarbonised heat. Currently, the main area of exploitation are shallow geothermal resources using GSHP (Ground Source Heat Pump) systems. There has been increased activity in pre-feasibility and exploration stages of medium to deep geothermal resources, however exploitation continues to be slow.

Sales of shallow geothermal via GSHPs have remained stable or decreased for small-scale residential and commercial schemes (< 50 kW_{th}) due to the end of the Renewable Heat Incentive scheme. Only 3% of grants in the replacement domestic Boiler Upgrade Scheme were for GSHPs. Through the Public Sector Decarbonisation Scheme and Heat Network Funds and the predecessors, the number of larger-scale GSHP projects operational has increased.

The most significant developments in deep geothermal have been the construction of the power plant at the United Downs Deep Geothermal Project and production of deep geothermal heat at the Eden Geothermal Project, both in Cornwall. Both deep geothermal projects have encountered permeable structures at depth in radiogenic granites. Co-production of lithium from geothermal brines in these settings is changing the economics of these deep geothermal power or heat projects. A project in Cornwall and another in Weardale gained planning permission for lithium extraction plants, with utilisation of the heat a later consideration.

The UK has an increasing number of geothermal research and demonstration sites spanning shallow aquifers, mine water energy and repurposing of hydrocarbon wells. A number of geothermal groups and associations cover different geothermal technologies and sectors, with a corresponding number of conferences, webinars, research grants and publications.

1. INTRODUCTION

The exploitation of geothermal energy in the UK remains small and mainly restricted to the utilisation of ground source heat pumps. There has been a growth in larger capacity GSHP projects (>500 kW_{th}) supplying hospitals, campuses and district heating networks. Mine water geothermal has seen renewed interest with a 6 MW_{th} project newly operational, two research field sites active and several large grant-funded projects.

There is an increasing interest in the development of medium and deep geothermal resources. The last few years have seen the construction of a power plant at the United Downs Deep Geothermal Project (UDDGP) and heat utilisation at the Eden Geothermal Project (EGP) in Cornwall (SW England).

The comprehensive work by the British Geological Survey ('BGS'; reported by Downing and Gray, 1986) is still a definitive reference to the geothermal prospects of the UK. Over 60 legacy reports from that geothermal energy programme are now available in the BGS publications viewer, a digital geothermal catalogue has been released (Fellgett and Monaghan, 2024) and a UK digital geothermal platform is due to go live in summer 2025. Whilst some grant schemes require reporting on GSHPs installed and larger geothermal projects are presented at conferences and in the media, there is not a comprehensive database of UK geothermal projects. Material provided in this report builds on earlier updates reported at the GRC International Symposia on Geothermal Energy, the IGA World Geothermal Congresses, the European Geothermal Congresses and

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the IEA Geothermal UK Country Reports, dating back as far as the 1990s. The most recent summaries are provided in the World Geothermal Congress 2023 Country Update (Abesser et al., 2023c) and IEA Geothermal 2023 Country Report (Gonzalez Quiros et al. 2024).

Emerging trends in the UK geothermal sector include increased interest from the oil and gas sector, high temperature and industrial heat pumps, integration with underground thermal energy storage, deep geothermal closed loop and reservoir independent technologies.

2. POLICY AND INCENTIVES

Following on from a net zero and heat in buildings strategies in 2021, a UK energy strategy was released in 2022 to address the dual objectives of meeting CO_2 reduction targets whilst achieving national energy security (UK Government, 2021a,b, 2022). It includes mention of geothermal energy. A change in UK Government in 2024 resulted in 'economic growth, warm homes and clean power missions' that may include geothermal energy and for which detailed plans are awaited. GB Energy was set up by UK Government in 2024 with a focus on investment in and delivery of clean energy. The UK Climate Change Committee (CCC) continues to provide the targets that the UK is legally obliged to meet. The seventh carbon budget (CCC, 2025) pathways include ground source heat pumps (less than 1% of all heat pumps) and low carbon heat networks. However geothermal is mentioned only in the context of carbon capture and storage international case studies.

Policy recommendations towards exploiting geothermal energy at scale in the UK and unlocking investment have been covered by an Environmental Audit Committee inquiry (EAC 2022), a paper by an MP (Mullan, 2023) and a deep geothermal White Paper (Abesser et al. 2023a,b).

A significant policy change for geothermal energy during the reporting period was the closure of the renewable heat incentive (RHI) in March 2022. The scheme applied to domestic and non-domestic projects. A peak of domestic GSHP installations accompanied the end of the RHI (EA, 2024a).

For individual projects up to 45 kW_{th} or shared ground loops up to 300 kW_{th} in England and Wales, the Boiler Upgrade Scheme, launched in 2022, offers capital grants of £7500 towards a GSHP, £7500 for an air source heat pump (ASHP), or £5000 for a biomass boiler. The Home Energy Scotland Grant and Loan can provide similar in Scotland. Statistics from Ofgem (2024) show that 96 % of grants were for ASHP and 3% were GSHP. The level of subsidy is not perceived to be making a substantial contribution to the capital outlay for GSHP, in contrast to substantial fraction of ASHP cost (EA 2024a). UK and Scottish Government are reportedly changing plans to prohibit replacement of old gas boilers with new gas boilers from 2035, and the Future Homes Standards / New Build Heat Standard that effectively ban installation of gas boilers in new homes from 2025. However firm policy statements await the Warm Homes Plan (England and Wales) and Heat in Buildings bill (Scotland) later in 2025.

The Contracts for Difference (CfD) scheme is the UK Government's main mechanism for supporting low carbon electricity generation across GB and provides power revenue guarantees and protection from market fluctuations for 15 years. Allocation Round 5 results were published in September 2023; it saw the first allocation of CfDs for geothermal. The CfDs were awarded for three projects to Geothermal Engineering Limited (GEL), together with its investors Kerogen Capital and Thrive Renewables.

2.1 England and Wales

The Energy Security Bill (2023) introduced a regulatory framework for heat networks and powers to enable heat network zoning in England. Heat network zoning provides an opportunity for geothermal to be considered as a heat source. Central and local government have been working with industry and local stakeholders to identify and designate heat network zones to offer the lowest cost solution for decarbonising heat. A number of maps and zoning pilot studies have been produced.

A number of support schemes are available for heat networks.

The Heat Networks Delivery Unit (HNDU) provides support for local authorities, NHS, universities and property developers by funding techno-economic feasibility studies and detailed project development in England and Wales. In September 2024, the last round (round 14) closed. The previous 13 funding rounds had awarded £37.8 million across 188 local authorities.

UK Government ran the Heat Network Investment Project (HNIP) and invested £320m up to April 2022 to support the construction of heat networks and accelerate the growth of the market across England and Wales. Although now closed, this fund provided grants to mine water geothermal schemes in north east England.

HNIP has been replaced by the £288m Green Heat Network Fund (GHNF) scheme in England, which started in March 2022. It is a capital grant fund that covers commercialization and construction costs of new low and zero carbon heat networks, as well as retrofitting and expansion of existing heat networks. GSHP projects have been awarded funding such as supplying blocks of apartments in London, as well as expansion of the Gateshead District Energy Scheme that includes mine water heat into the network.

The Public Sector Decarbonisation Scheme (PSDS) provides grants for public sector bodies to fund heat decarbonisation and energy efficiency measures. There have been several phases to the PSDS. Phase 3 of the PSDS will provide over £1.425 billion of grant funding between 2022–2026, through multiple application windows. In Phase 3b of the PSDS, 26 projects incorporating GHSPs were awarded funding and in Phase 3c, 13 projects.

2.2 Scotland

Under the Scotland Act, heat policy, energy efficiency and building standards are devolved. In October 2021, Scottish Government published its 'Heat in Buildings Strategy', including a £1.8 billion for heat decarbonisation and energy efficiency projects. The Heat Networks (Scotland) Act 2021 and Heat Network Delivery Plan (2022) introduce a regulatory system to provide certainty and with a target of increasing heat supplied from heat networks to 8% by 2030. A Heat Network Fund was allocated £300 million to support the development and rollout of zero emission heat networks across Scotland. £10 million has been awarded by March 2024, including GSHP projects in Glasgow, Motherwell, and Aberdeen. A Heat Network Support Unit has been established to support the public sector in pre-capital stages.

The predecessor of the Heat Network Fund was the Low Carbon Infrastructure Transition Programme, which supported several geothermal feasibility studies between 2015–2020, as well as completed GSHP projects in Edinburgh and Dundee. Scottish Enterprise has supported geothermal feasibility studies, pilot projects and research, including a feasibility study of a deep geothermal demonstrator at the Hill of Fare District Heat Network in Banchory, Aberdeenshire funded by the CAN DO Innovation Green Heat Feasibility Challenge call.

Local Authorities in Scotland are preparing Local Heat and Energy Efficiency Strategies (LHEES), several of which include mine water geothermal. Scottish Government (2024) provides regulatory guidance for geothermal energy.

2.3 Northern Ireland

The governance of energy in NI is almost entirely a devolved policy matter, but there are existing UK-wide agreements and legislation that influence energy policy in NI. The Department for the Economy (DfE) leads on energy policy and in December 2021 published the Northern Ireland Executive's Energy Strategy - the Path to Net Zero Energy. The strategy and accompanying action plan set out plans to develop opportunities for geothermal energy and assess potential solutions for decarbonisation of heat. As part of this DfE took forward trials and demonstrators, using a range of energy sources including geothermal energy as outlined in Point 16 of the Energy Strategy Action Plan 2022.

To support the Energy Strategy, DfE set up a Geothermal Advisory Committee (GAC) for Northern Ireland, chaired by the Geological Survey of Northern Ireland (GSNI). The GAC was established in July (2021) and brings together a group of experts from industry, academia, public sector and professional organisations based in UK and Ireland. This group provides independent advice to DfE aimed at informing, supporting and developing the geothermal energy sector in NI.

In Northern Ireland, interest in geothermal energy has seen a notable rise over the past few years. Following on from a successful international conference in December 2020 organised by GSNI and the Centre for Sustainability, Equality and Climate Action (SECA) at Queen's University Belfast (QUB), a series of monthly webinars have been organised by GSNI, QUB, Geothermal Association of Ireland (GAI) and Geological Survey Ireland (GSI) through 2021 and 2022. The GSNI produced a summary report on geothermal energy potential (Raine and Reay, 2021) and Queen's University Belfast produced two strategic reports commissioned by the Department for the Economy (see Section 6.2).

In Northern Ireland, GeoEnergy NI launched at the end of June 2023. It is a £3 million project designed to 'unearth the heat beneath our feet', aiming to support decarbonisation of the energy sector in pursuit of net zero carbon targets by 2050. The project is funded and delivered by the Department for the Economy with scientific support from the Geological Survey of Northern Ireland and a specialist contractor team led by Tetra Tech Europe. The project will inform the development of a policy and regulatory framework that supports and promotes opportunities to unearth Northern Ireland's geothermal potential and create a vibrant geothermal sector. More information is provided later in this report.

The 'Geothermal energy momentum on the island of Ireland' (GEMINI) project is a £17.3m investment announced in 2024 from the cross-border EU PEACEPLUS Programme. The project will install 3 shallow and 1 deep geothermal systems. Two of the shallow pilots will be in Belfast at the Northern Ireland Housing Executive Centre of Excellence and at Northern Ireland Water, Belfast. The project will build capacity, develop best practice for community engagement and inform new policies, guidelines and support for the sector.

3. GEOTHERMAL UTILISATION

3.1 GSHPs

In 2023, the UK was reported to have an estimated 55'210 GSHPs and a total installed capacity of 847 MW_{th}, representing an annual production of 1430 GWh_{th}/yr (Gonzalez Quiros et al. 2024). This is based on information from sales for domestic (< 6 kW) to light commercial (up to 50 kW) heat pumps (BSRIA, 2023). Data is not yet available for subsequent years.

An electrification of heat demonstration project that installed over 700 heat pump systems across a range of different housing types and monitored them for over 2 years has completed (Energy Systems Catapult, 2025). It has demonstrated large-scale rollout of heat pumps is possible within the UK, in all types of properties.

There is no register of larger scale GSHP installations for the UK. EA (2024a) used abstraction licence data to estimate 149 open loop projects from 12-2346 kW_{th} in size, as well as giving examples such as 237 closed loop borehole schemes >45 kW_{th} designed by one company. As summarised above, tens of larger scale GSHP schemes are mentioned in grant funding awards. Selected examples of larger scale GSHP projects include:

- The Queens Medical Centre, a hospital in Nottingham, is installing air and ground source heat pumps, with 64 boreholes up to 250 metres deep. The first phase is a 4 MW combined heat pump solution with a 2.88 MW cooling capacity.
- £1.7 million funding from the Public Sector Decarbonisation Scheme is being used for a GSHP project at BGS headquarters. It includes 28 closed loop boreholes drilled up to 225 m deep. The planned thermal capacity is 300 kW supplying 55°C heat.
- The Citigen project in London, managed by E.ON, was upgraded in 2022 with the addition of a heat pump and the drilling of three 200 m deep boreholes with capacity of around 4 MW heating and 2.8 MW cooling. The ground source heat pumps are integrated with a heat network, CHP and a thermal store.
- The Kensa 'Heat the Streets' project was completed in 2023. Over a two-year duration the project installed ground source heat pump technology in 98 new and existing homes in the village of Stithians, Cornwall. It connected the ground source heating systems to Shared Ground Loop Arrays.
- The Colchester Northern Gateway gained funding from the UK Government Heat Network Investment Project to install an 800 kW_{th} capacity open loop ground source heat pump system for a district heat grid to supply 300 new build houses and healthcare facilities. The scheme is using 5 boreholes sunk into the Chalk Group aquifer (Sezer et al. 2024).
- In Northern Ireland, one of the two GeoEnergy NI feasibility studies is at the Stormont Estate in Belfast. A drilling and testing programme of four 250m hydrogeology boreholes and a 500 m deep cored borehole has completed, to assess the potential of a shallow aquifer at around 15ºC for shallow geothermal energy and inform the design of a heat network to decarbonise several buildings on the Estate. The project has also been undertaking significant communications and engagement activity, and in 2023, launched the GeoEnergy Discovery Centre, a mobile visitor unit that aims to boost public awareness and understanding of the potential for geothermal energy in Northern Ireland.

The MCS have published a Specification for Ground Source Closed Loop Drilling and the Ground Source Heat Pump Association (GSHPA) have a Vertical Borehole Standard . CIBSE publish TM51, a Ground Source Heat Pump standard and a standard for heat pump installations in non-domestic buildings.

3.2 Underground Thermal Energy Storage

Aquifer Thermal Energy Storage (ATES) developments are very limited in the UK, with only 11 installations (9 of them in London targeting the Chalk aquifer, 1 in Manchester and 1 in Brighton; Jackson et al., 2024). The first ATES system deployed was in 2006, averaging at around one new system installed per year (Jackson et al., 2024).

In 2021, the Scottish Government Low Carbon Infrastructure Transition Programme (LCITP) supported the development of the BODYHEAT Programme through a Green-Recovery from Covid-19 Pandemic fund. The BODYHEAT system harnesses thermal energy produced by dancers and stores it in shallow geothermal boreholes. The first pilot project was built by TownRock Energy in the SWG3 Events Venue, Glasgow. The project started operations in September 2022 and has successfully been providing heating and cooling to the venue using 12 boreholes. This will enable SWG3 to achieve net-zero status on Scope 1 and 2 carbon emissions in 2025.

3.3 Mine Water Geothermal Energy

There is a wide interest in the use of flooded abandoned coal and metal mines for geothermal purposes in different regions of the UK. Whilst a number of formerly active schemes have ceased (Shettleston, Lumphinnans, Crynant, Caphouse -Walls et al. 2021), there are three large operational commercial schemes. Two deliver 2.4 MW_{th} and 1.2 MW_{th} to the beverage warehouses of Lanchester Wines at Felling, Gateshead (Walls et al. 2021, Banks et al., 2022). TownRock Energy have taken on the operations & maintenance since 2021. The other 6 MW_{th} scheme feeds a district heating network run by Gateshead Energy Company.

The Gateshead mine water heating scheme (Mine water energy scheme at Gateshead - Coal Authority), located in Northeast England, started operations in March 2023. The project took about 3 years to deliver and was funded by the Heat Network Investment Project (HNIP) and Gateshead Council. The Gateshead Energy Company heat network supplies heat to a range of users, including offices, municipal buildings, 1,250 council owned homes, a large arts centre, and an industrial lubricants factory. The water is extracted from flooded mine workings about 150 m below the ground surface and, with 6 MW_{th} installed capacity, is one of the largest mine water heat schemes in Europe.

The mine water schemes at Lanchester Wines were drilled in 2015. The scheme has encountered some operational challenges, including iron ochre scaling, corrosion of the downhole water loggers and limits in the reinjection capacity due to suboptimal connectivity of the mine workings (Banks et al., 2022, TownRock Energy, 2023). Progress has now been made in resolving these issues.

The Mining Remediation Authority (MRA), who manage the effects of past coal mining and own the majority of coal mining infrastructure in Great Britain, have a mine water heat team that has completed numerous feasibility studies to potential users of mine water heat. The MRA have released mine water heat opportunity maps for the Welsh coalfield and ten English cities. The latter have been integrated within a series of 'Heat Network Zoning Reports' delivered by the Department of Energy Security and Net Zero.

Developing the heat resource from existing mine water treatment schemes is a lower risk approach than drilling new boreholes (Bailey et al. 2016; Walls et al. 2022). Construction of an energy centre has begun at the Dawdon mine water treatment scheme in North East England to supply heat to 750 homes in the adjacent Seaham Garden Village development with estimated 2.4 MW_{th} capacity. Also using a mine water treatment scheme, a closed loop heat exchanger will be installed to provide c. 45 kW_{th} of heat to an industrial unit in south Wales. Bolsover District Council in Derbyshire are due to construct a closed loop scheme using an abandoned, flooded coal mine shaft, with construction expected in 2025.

Feasibility studies are also being conducted for heat and thermal storage in flooded metal mines in Cornwall to manage seasonal demand. One study as part of the PUSH-IT project is examining sites close to the United Downs deep geothermal power project.

3.4 Medium / Low Enthalpy Hydrothermal Projects

The City of Southampton Energy Scheme (Smith 2000), the only deep aquifer geothermal energy system in the UK is believed to be operating again after being offline in 2020 to install a new borehole pump (Abesser et al. 2023c); no operational data is available. The scheme started in the 1980s when an aquifer in the Triassic Sandstone containing 76 °C fluid was identified at approximately 1800 m depth in the Wessex Basin. Construction of a district-heating scheme commenced in 1987 and this has since evolved and expanded to become a combined heat and power scheme for 3000 homes, 10 schools and numerous commercial buildings. While gas fired CHP now supplies most of the district energy scheme's low-carbon heat, it is reported that the geothermal well has saved 131'564 tonnes of CO_2 emissions since start of operation (Abesser et al. 2023c).

Hot springs continue to be used as hydrothermal resources in Bath and Matlock Bath. Where deeply buried the same early Carboniferous Limestone rocks have been estimated to contain a large theoretical potential resource (Jones et al. 2023).

A number of deep hydrothermal projects are in feasibility and exploration stages for heat supply to hospitals. GT / Star Energy are developing a project for a deep geothermal heat plant for the Salisbury District Hospital NHS Trust, for the full heat requirements of the hospital, currently >20 GWh_{th} per year. A seismic survey has been conducted. An assessment is also being made of the resource potential for a geothermal plant to supply heat to the Wythenshawe Hospital in Manchester.

In Northern Ireland, the second GeoEnergy NI feasibility study is at the College of Agriculture, Food and Rural Enterprise (CAFRE) Greenmount Campus near Antrim. It is investigating the potential of the Sherwood Sandstone Group aquifer at around 2 km deep. In summer 2023, a series of gravity, magnetotelluric and seismic geophysical surveys were undertaken.

3.5 EGS Projects

3.5.1 United Downs Deep Geothermal Power project

The United Downs Deep Geothermal Power project, led by Geothermal Engineering Ltd. (GEL), is the first commercial project in the UK to develop deep geothermal for power generation. It develops some concepts tested by the Hot Dry Rocks project at Rosemanowes Quarry in the 1980s. The project utilises the natural permeability of the Porthtowan Fault, a deep Variscan NW-SE striking, steeply dipping, strike-slip fault zone in the Carnmenellis granite in Cornwall. Drilling of two deviated wells started in November 2018 and was completed in 2019. The wells intersect the fault at two different depths in order to create a closed loop circulation system vertically along the fault. The first well, UD-1, has a drilled length of 5275 m (5057 m total vertical depth), encountering temperatures of 180 °C, and is the production well. The second well, UD-2, has a drilled length of 2393 m (2214 m total vertical depth) and acts as the injection well (Farndale and Law, 2022; Olver and Law, 2025).

Limited hydrotesting of the wells took place in July 2021 on the basis of which a 5 MWe gross air-cooled binary power plant was ordered. There is a restriction on power export of ~3 MWe due to local grid constraints. Construction of the plant took place throughout 2024, and it is due to begin operation in Q2 2025. The project plans to supply 3 MWe electricity to the grid.

Testing at the United Downs geothermal wells revealed lithium concentrations of >300 ppm in the geothermal fluid, one of the highest in Europe for commercial geothermal lithium projects (Olver and Law, 2025). GEL has received funding for a 100 tonnes per annum demonstration lithium extraction plant. The plant will use Direct Lithium Extraction (DLE) technology to recover lithium from the geothermal fluids and is set to come online in Q2 2025.

3.5.2 Eden Geothermal Project

The second, operational deep geothermal project is at the Eden project in Cornwall. It is situated on the St Austell granite. The project is being developed by Eden Geothermal Ltd., which has shareholders comprising Eden Project Ltd., EGS Energy Ltd. and BESTEC (UK) Ltd. The project received funding of £16.2m from the European Regional Development Fund, £1.4m from

Cornwall Council and £6.5m from institutional investors. The project targeted a deep Variscan NNW-SSE striking, steeply dipping, strike-slip fault zone known as the Great Cross Course in the St Austell granite in Cornwall. Drilling of the well into the granite began in May 2021 and was completed in November 2021. The well, EG-1, has a vertical depth of 4871 m and its measured depth (drilled length) is 5277 m, making it the longest geothermal well in the UK.

It is a requirement of the funding of this project that the first well is initially used as a deep coaxial system to demonstrate its production capability. A coaxial circulation system was installed to 3850 m and since June 2023, 1.4 MW_{th} has been used to heat the biomes, greenhouses and other buildings at the adjacent Eden Project via a 3.8 km closed loop. The intention is to drill a second deep borehole in order to develop a doublet for power production. If this goes ahead, the coaxial installation will be decommissioned, and waste heat from the power plant will be used to supply the biomes instead.

3.5.3 Deep Geothermal projects in planning

GEL has announced plans to develop more projects in Cornwall. Two of the sites (Manhay, Penhallow) have received local planning approval at early 2025. The Tregath site is awaiting planning determination.

In Scotland, in addition to the study at Banchory described above, TownRock Energy are conducting a feasibility study for NHS Grampian sites across Aberdeen considering wells up to 5 km deep.

The co-production of critical minerals such as lithium is changing the economics of deep geothermal projects. In Cornwall, Cornish Lithium have drilled 8 exploration boreholes to 2 km depth to assess the potential for geothermal lithium production. In 2025, planning permission has been granted for a commercial lithium production facility at Cross Lanes near Chacewater. The production-scale wells will be used to assess the potential for harnessing heat from the same geothermal waters to provide heating for local homes and businesses.

In the North East of England, Weardale Lithium have also received planning permission in 2025 for a lithium extraction facility to produce battery grade lithium carbonate. Situated on a brownfield site at Eastgate, the geothermal brine will be extracted and re-injected from the existing deep wells (Manning et al. 2007).

3.6 Geothermal District Heating

District heating networks are not as common in the UK as in other European countries. There are policy developments and grant funding schemes for heat networks (section 2). An example additional to those summarised above is the Swaffham Prior heat network in Cambridgeshire. It heats 300 homes and public buildings using 108 ground source heat boreholes (1.7 MW_{th} capacity) integrated with solar and air source heat pumps.

The use of shared ground loop borehole arrays delivering to distributed heat pumps has gained significant traction in the social housing sector. A recent example of a retrofit of apartment blocks is at Sutton Dwellings in London, where Kensa and Clarion Group used 27 boreholes to 180 m to heat 81 flats.

4. GEOTHERMAL GROUPS AND ASSOCIATIONS

The Ground Source Heat Pump Association (GSHPA) is one of the main trade associations, representing designers, installers, drillers and consultants across domestic and commercial shallow geothermal projects.

The Renewable Energy Association (REA) provides the secretariat for the All Party Parliamentary Group (APPG) on Deep Geothermal. The APPG was launched in 2024 and is chaired by Dr Kieran Mullan MP. It brings together parliamentarians to share information and ideas on geothermal energy, and to work collaboratively with stakeholders with the long-term goal of deep geothermal to become a mainstream renewable energy source in the UK.

The National Geothermal Centre was launched in 2024 to advance geothermal research and delivery in the UK through collaboration. The centre founders are Durham University, the Net Zero Technology Centre and SHIFT Geothermal, with support from the Reece Foundation. From 2025, the National Geothermal Centre is running a knowledge sharing forum, the 'geothermal taskforce', with the North East Combined Authority, previously coordinated by the North East Local Enterprise Partnership and which initiated as a 'mine water energy taskforce'.

The IEA Geothermal Mine Water Energy Expert Group, coordinated by BGS has grown between 2022-2025, as part of the IEA Technology Collaboration Programme. The UK section of WING (Women in Geothermal) is active and has organised a series of online webinars. Geothermal and lithium projects in Cornwall are represented by a number of initiatives and groupings, including the Southwest Geothermal Alliance, Deep Digital Cornwall, Cornwall mining and geo-resources alliance.

5. RESEARCH AND INNOVATION

5.1 Research Projects

Overall, funding for geothermal research and innovation remains limited compared to other renewable technologies. Much research is undertaken within the Higher Education sector, where there has been a notable increase in postgraduate MSc and PhD projects. There is a trend towards projects investigating integrated heating, cooling and underground thermal energy storage applications, as well as projects that integrate social science and economics.

Table 1: Summary of large geothermal research projects 2022-2025 with UK lead or partner.

Name, description	Lead UK researchers	Funding
GWATT Geothermal Power Generated from UK Granites	Exeter, Heriot Watt Univ. BGS	NERC
CRM-Geothermal Raw materials from geothermal fluids	BGS, GEL, Cornish Lithium	Horizon Europe
NetZero GeoRDIE Net Zero Geothermal Research for District Infrastructure Engineering	Newcastle, Glasgow Univ.	EPSRC
ATESHAC, Aquifer thermal energy storage for decarbonisation of heating and cooling: Overcoming technical, economic and societal barriers to UK deployment	Imperial, Manchester Univ., BGS	EPSRC, NERC
Hypogene karst: genesis and implications to optimisation of low enthalpy energy resources	Manchester, Bristol Univ., BGS	NERC
GEMS Geothermal Energy from Mines and Solar Geothermal Heat	Durham Univ., BGS	EPSRC
STEAM GigaWattHour Subsurface Thermal Energy storAge: Engineered structures and legacy Mine shafts.	Strathclyde, Edinburgh Univ.	EPSRC
SMARTRES Smart assessment, management and optimisation of urban geothermal resources	Imperial, Manchester, Leeds Univ., BGS	NERC
Galleries to Calories Legacy mine workings as recycled heat storage and transport networks.	Edinburgh, Strathclyde Univ. TownRock Energy	Geothermica, SES
GoForward Geothermal Exploration and Optimization through Forward Modeling and Resource Development	BGS	Horizon Europe
NHSE GSHP screening tool	Energy Systems Catapult, BGS	Innovate UK
PUSH-IT Piloting Underground Storage of Heat In geoThermal reservoirs	GEL, BGS, Exeter, Anglia Ruskin Univ.	Horizon Europe
GeoGrid Long term geothermal energy storage	Leeds Univ. Northern Powergrid and 5 others	Ofgem
GeoEnergy NI	DfE, GSNI, Tetra Tech	NI DfE
GEMINI Geothermal energy momentum on the island of Ireland	Codema, DfE, GSNI and 11 partners	EU Peace-plus

EPSRC = Engineering and Physical Sciences Research Council,
NERC = Natural Environment Research Council

5.2 Research Infrastructure

The UK Geoenergy Observatory in Glasgow for research and innovation in mine water geothermal and thermal energy storage includes boreholes drilled and screened in two levels of flooded, disused mine workings. Heat abstraction or storage research is enabled by a ~200kW heat pump/chiller, together with extensive hydrogeological, geophysical and environmental time-series monitoring equipment (Monaghan et al. 2022a,b, 2024; Monaghan and Spence, 2023; Gonzalez Quiros et al. 2024).

The UK Geoenergy Observatory in Cheshire comprises 21 boreholes for research and innovation infrastructure into shallow geothermal energy and thermal energy storage in a sandstone aquifer. The facilities include borehole heat exchangers for heating and cooling of the subsurface (closed loop), boreholes for open loop investigations, advanced sensors (electrical resistivity and fibre optics) for 3D imaging of subsurface processes in real time and a network of boreholes for multilevel groundwater monitoring and hydraulic control. The UK Geoenergy Observatories are open for use and provide a wide range of open data.

The Cardiff Urban Geo-Observatory is investigating shallow geothermal heat recovery and storage. The project aims to improve the understanding of the way groundwater and heat moves around in a complex geological environment changed by industrialisation and urban growth. At the BGS Keyworth ground source heat pump project that will heat two buildings on the campus, additional temperature and geophysical monitoring equipment is being added to create a Living Lab.

The Mining Remediation Authority started the construction of the Gateshead Mine Water Heat Living Lab in 2023 and completed in 2024. Comprising of 4 boreholes drilled into worked coal seams, it is located between the operational mine water heat schemes operated by Gateshead Energy Company and Lanchester Wines. Designed to monitor any impacts or interactions between multiple mine heat schemes, it is producing open access data (Coal Authority, 2024) and evidence to support licensing, regulation and other stakeholders.

CeraPhi Energy have established a demonstration site, repurposing of the legacy Kirby Misperton KM8 well in Yorkshire to a coaxial closed-loop geothermal technology. A study to assess the viability of a geothermal heat network in the town of Pickering using redundant gas wells and new boreholes was announced in 2024.

Leeds University have established a ‘Living Lab’ on campus as they work to create a geothermal heated campus. Eleven boreholes have been drilled to 150-250 m depth into sandstones with the Coal Measures. Two boreholes will be utilised as a fully reversable open loop ground source doublet to supply geothermal heat to buildings via heat pumps in a new energy centre.

6. MEETINGS AND PUBLICATIONS

6.1 Meetings and webinars

The growing interest in geothermal energy and thermal utilisation of the subsurface in the UK is reflected in an increasing number of regular and specialist meetings.

The Geological Society of London UK geothermal symposium runs annually in November. It was extended to 3 days in 2023 and 2024 in response to increased activity and interest. The first Energy Geoscience Conference 'Powering the energy transition through subsurface collaboration' ran in May 2023 with geothermal sessions and a resultant conference volume.

The GSHPA continues to hold an annual meeting and an annual conference, topics covered include exemplar projects, all forms of ground source heat utilisation, innovation and policy. A geothermal session has been regularly convened at the annual All Energy renewable energy exhibition and conference in Glasgow, along with talks and posters within the heat decarbonisation theme,. A newly established Society Of Petroleum Engineers (SPE) Geothermal Seminar ran online in 2022-2024 with a hybrid event in 2025, including talks from geothermal well and market specialists.

In June 2024, GSNI and Ulster University co-hosted a "Heat Pumps: Knowledge X-Change and Networking Event", bringing together over 120 experts, policymakers, and industry leaders.

The IEA Geothermal Mine Water Energy Symposium ran online in 2022, 2023, 2025 and as a hybrid event in 2024. It has attracted a global audience and presentations are available online https://www.iea-gia.org/workshops-and-symposium.

An increasing number of organisations feature webinars and lectures on geothermal energy topics. GSNI has hosted a Northern Ireland Geothermal Webinar series with Queen's University Belfast, the Geothermal Association of Ireland and Geological Survey Ireland since 2021. From 2022 to present, there has been a total of 31 webinars on various geothermal energy topics, all of which are available on the GSNI YouTube channel. In total, the webinars attracted over 4400 registrants from 100 countries. Others include Scottish Enterprise, BGS, Mining Remediation Authority, university departments and local geological societies.

6.2 Publications

Papers and reports from UK authors between 2022–2025 have spanned a wide range of topics. Publications covering the geothermal potential of the UK, unlocking investment and policy have included Palmer et al. (2021a,b), Arup and BGS (2022), EAC (2022), Abesser and Walker (2022), Abesser et al. (2023a,b) and Mullan (2023). Regulation and management have been covered by Abesser et al. (2023d), IEA Geothermal (2023), McLean and Pedersen (2023), Environment Agency (2024 a,b,c), Monaghan et al. (2024). On costs and economics, the value of geothermal heat was discussed by Banks (2023) and a levelised cost study commissioned by UK Government is awaited in 2025.

Shallow geothermal projects and modelling methods are covered in Receveur et al. (2024), Sezer et al. (2024). Mine water geothermal and MTES has been a particular focus with papers spanning from the hydrogeology and hydrogeochemistry (Walls et al. 2023b; Monaghan et al. 2024, Gonzalez Quiros et al. 2024,), modelling (Mouli-Castillo et al. 2024; Todd et al. 2024), the resource (Fraser Harris et al. 2022; Walls et al. 2022, 2024), drilling and specific projects (Walls et al. 2021, 2023a, Banks et al. 2022; Monaghan et al. 2022a,b; Whittington et al. 2023). Social aspects have been investigated by Roberts et al. (2023) and Deeming et al. (2024). The role of field research sites, monitoring and open data are described by Monaghan and Spence (2023), Coal Authority (2024) and in a major release of legacy geothermal temperature and thermal conductivity data (Fellgett and Monaghan, 2024).

The UK potential of ATES, BTES has been evaluated and modelled by Regnier et al. (2022), Jackson et al. (2024) and Brown et al. (2024). Papers on deep borehole heat exchanger modelling and demonstration include Brown and Howell (2023), Brown et al. (2023), Banks et al. (2024), Kolo et al. (2024).

Deep geothermal hot sedimentary aquifer potential and de-risking has been evaluated by Bremaud et al. (2023), Brown (2023), Jones et al. (2023), Kearsey et al. (2024). Deep geothermal EGS projects (Farndale and Law, 2022; Olver and Law, 2025), resources (Brown, 2022) and allied research (Yeomans et al. 2023) have also been documented.

7. CONCLUSION

There is currently increasing interest in all forms of geothermal energy utilisation in the UK across industry, Government and research organisations. The first geothermal power from the UK is due from the United Downs project in 2025 and the first deep geothermal heat for 30 years was supplied to the biomes of the Eden Project in 2023. With major investments in lithium extraction making positive impact to the business case for geothermal, several other projects are in planning in that region.

The numbers of larger scale mine water heat and GSHP projects have increased during the 2022-2025 reporting period. Notable examples include a 6 MW_{th} mine water heat project supplying the Gateshead Energy Company heat networks and examples in London and other cities of retrofit of blocks of flats using closed loop arrays.

Though challenges remain in the policy, regulation, incentives and investment for geothermal energy projects, the uptick in interest is a positive direction towards future geothermal energy contributions to UK heating, cooling, storage and power.

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Tables A-G

Table A: Present and planned geothermal power plants, total numbers

	Geothermal Power Plants		Total Electric Power in the country		Share of geothermal in total electric power generation	
	Capacity (MW_e)	Production (GWh_e/yr)	Capacity (MW_e)	Production (GWh_e/yr)	Capacity (%)	Production (%)
In operation end of 2024 *	0	0	74’800	292’700	0	0
Under construction end of 2024	3	0				
Total projected by 2028	10					
Total expected by 2032						
Number of licenses in force in 2024 (indicate exploration/exploitation if applicable):					Under development: n/a	
					Under investigation: n/a	

Table B: Existing geothermal power plants, individual sites

Locality	Plant Name	Year commis-sioned	No of units	Status	Type	Total capacity installed (MW_e)	Total capacity running (MW_e)	2024 pro-duction * (GWh_e/y)
Redruth, Cornwall	United Downs	2025	1 (RI)	Final constru ction	B-ORC	3		0
total								

Key for status:		Key for type: B Binary			
O	Operating	D	Dry Steam	B-ORC	Binary (ORC)
N	Not operating (temporarily)	1F	Single Flash	B-Kal	Binary (Kalina)
R	Retired / decommissioned	2F	Double Flash	O	Other

Table C: Present and planned deep geothermal district heating (DH) plants and other uses for heating and cooling, total numbers.

	Geothermal DH plants		Geothermal heat in agriculture and industry		Geothermal heat for buildings		Geothermal heat in balneology and other	
	Capacity (MW_{th})	Production (GWh_{th}/yr)	Capacity (MW_{th})	Production (GWh_{th}/yr)	Capacity (MW_{th})	Production (GWh_{th}/yr)	Capacity (MW_{th})	Production (GWh_{th}/yr)
In operation end of 2024 *			1.4				~1	
Under constru-ction end 2024								
Total projected by 2028								
Total expected by 2032								

Table D1: Existing geothermal district heating (DH) plants, individual sites

Locality	Plant Name	Year commis-sioned	CHP	Cooling	Geoth. capacity installed (MW_{th})	Total capacity installed (MW_{th})	2024 produc-tion (GWh_{th}/y)	Geoth. share in total prod. (%)
Total No UK data for >500 kW and > 25°C. Southampton currently no data.								

Table D2: Existing geothermal large systems for heating and cooling uses other than DH, individual sites

Locality	Plant Name	Year commis-sioned	Cooling	Geoth. capacity installed (MW_{th})	Total capacity installed (MW_{th})	2024 produc-tion (GWh_{th}/y)	Geoth. share in total prod. (%)	Operator
St Austell, Cornwall	Eden Project	2023	N	1.4	1.4		100	Eden Geothermal
Bath	Thermae Spa	2006	N	1	1		100	Bath & Somerset Council, YTL Hotels
total				2.4	2.4			

Table E1: Shallow geothermal energy, geothermal pumps (GSHP)

	Geothermal Heat Pumps (GSHP), total			New (additional) GSHP in the year 2024		
	Number	Capacity (MW_{th})	Production (GWh_{th}/yr)	Number	Capacity (MW_{th})	Share in new constr. (%)
In operation end of 2024	55’210 est.*	861 est. *	1430 est. *	not available	not available	
Of which networks	>2	> 7.7				
Projected total by 2028						

* 2023 numbers estimated

Table E2: Shallow geothermal energy, Underground Thermal Energy Storage (UTES)

	Aquifer Thermal Energy Storage (ATES)			Borehole Thermal Energy Storage (BTES)		
	Number	Capacity (MW_{th}) Heat / Cold	Production (GWh_{th}/yr) Heat / Cold	Number	Capacity (MW_{th}) Heat / Cold	Production (GWh_{th}/yr) Heat / Cold
In operation end of 2024	11	H: 6.61* C: 8.01*	H: C:	1	H: C:	H: C:
New (additional) in the year 2024		H: C:	H: C:		H: C:	H: C:
Projected total by 2028		H: C:	H: C:		H: C:	H: C:

* From Jackson et al. (2024)

Table F: Investment and Employment in geothermal energy

	in 2024 *		Expected in 2028	
	Expenditures ** (million €)	Personnel *** (number)	Expenditures ** (million €)	Personnel *** (number)
Geothermal electric power				
Geothermal direct uses				
Shallow geothermal				
total				

Information not compiled for the UK

Table G: Incentives, Information, Education

	Geothermal electricity	Deep Geothermal for heating and cooling	Shallow geothermal
Financial Incentives – R&D			
Financial Incentives – Investment			O- Public Sector Decarbonisation Scheme, Green Heat Network Fund can include geothermal
Financial Incentives – Operation/Production	O -Contracts for Difference		O – Boiler upgrade scheme (small scale installations)
Information activities – promotion for the public	Yes	Yes	Yes
Information activities – geological information	Yes	Yes	Yes
Education/Training – Academic	Yes	Yes	Yes
Education/Training – Vocational	No	No	Yes

Key for financial incentives:

DIS	Direct investment support	FIT	Feed-in tariff	-A	Add to FIT or FIP on case the amount is determined by auctioning
LIL	Low-interest loans	FIP	Feed-in premium		
RC	Risk coverage	REQ	Renewable Energy Quota		
TC	Tax credits	O	Other (please explain)		