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Supporting heat decarbonisation in the UK through national geothermal data and summary information

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ABSTRACT

Geothermal energy roadmaps, white papers and inquiry findings in the UK have frequently recommended improving data availability and accessibility, as one part of unlocking geothermal investment at scale. Between 2023-2025, the British Geological Survey (BGS) and collaborators have delivered a range of national scale initiatives around digital geothermal data, maps and tools. These include releasing over 11,800 data points in the UK Geothermal Catalogue and a newly developed digital UK Geothermal Platform containing over 90 layers of data, including summary layers for four geothermal technologies. A ground source heat pump screening tool has also been released for hospital sites in England.

Taken together, the data and information makes geothermal opportunities more visible and provides underpinning information for developers, Government policy makers and researchers to understand the options. As interest rises in shallow and deep geothermal technologies, data is now becoming more available and accessible to support heat decarbonisation in the UK.

1. GEOTHERMAL ENERGY FOR HEAT DECARBONISATION IN THE UK

In common with many countries, heat decarbonisation (including cooling and thermal storage) in the UK is a major challenge (UK Government, 2022; CCC, 2025). In recent years, there is increasing interest from industry, public sector and government in the role that shallow and deep geothermal energy technologies could play as part of heat decarbonisation to meet net zero targets (e.g. Northern Ireland Executive, 2021). Large investment and policy changes are being made around heat networks (UK Government, 2021, 2025; Scottish Government, 2025a,b). In addition, innovations in cross-sectoral integration of numerous heat/cool sources, low temperature heat networks and industrial scale heat pumps are particularly relevant for geothermal uptake.

1.1 Status of geothermal and potential in the UK

Currently, utilisation of shallow geothermal resources with GSHPs (Ground Source Heat Pumps) is the dominant type of geothermal exploitation. 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 1,430 GW_{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 (e.g. BSRIA, 2023). There is growth in larger capacity GSHP projects (>500 kW_{th}) supplying hospitals, campuses and district heating networks (EA, 2024). Mine water geothermal is a particularly active technology area in Great Britain, including a 6 MW_{th} heat network project operational at Gateshead since 2023 (Mining Remediation Authority, 2023), two research field sites and several large grant-funded research projects. There is a growing focus on low temperature geothermal and underground thermal storage; a shift from simply extracting heat to using the subsurface for balancing heating, cooling, and storage for better efficiency and sustainability (e.g. Jackson et al., 2024).

There is an increasing interest in the development of medium and deep geothermal resources in the UK. A hot sedimentary aquifer project has recently been awarded £35 million grant funding (University of York, 2025) and several others are in exploration stages. The last few years have seen the construction of a power plant at the United Downs Deep Geothermal Project (due to be operational Q2 2025; Olver and Law, 2025) and heat utilisation at the Eden Geothermal Project in Cornwall, England. The UK Country Report for EGC (Monaghan et al. 2025) provides more details.

Geothermal energy is feasible across most of the UK. It offers a range of possibilities, with shallow closed-loop

GSHPs suitable for nearly all locations, and shallow open-loop GSHPs also well-demonstrated across large regions. Deep geothermal projects are more favourable at certain locations across UK nations. Emerging deep, reservoir-independent technologies could be viable nationwide in future, particularly in areas with higher geothermal gradients (Cornwall, North Pennines). Geothermal technologies are available for different geologies, depths and scales, providing options for various project locations, sizes and economics, tailored to need. As demand grows and technology advances, geothermal energy could play a much larger role in the UK's energy mix.

1.2 Challenges for wider deployment of geothermal energy in the UK

Geothermal deployment in the UK is hampered by technical, economic, regulatory, policy and social challenges (EAC 2022; Abesser and Walker 2022; Abesser et al, 2023a,b). For example, high capital costs, long payback times, a complex regulatory regime and less than 3% of the heat market connected to heat networks.

One challenge for more widespread deployment is around lack of available and accessible geothermal data and information. For example, IEA policy recommendation 7 'Improve data quality and create open data repositories to facilitate geothermal resource assessments for investors' (IEA, 2024) and the deep geothermal White Paper (Abesser et al. 2023 a,b) recommendation 3 is:

- Short term: Review and share legacy data
- Medium term: Create data platform
- Long term: Government exploration programmes, data sharing obligations

Countries with larger installed geothermal capacities have geothermal data platforms and viewers (e.g. ThermoGIS, Netherlands, GeotIS Germany). The content and tools vary depending on the background data available and the policy and data sharing regime of each country. This paper describes some of the steps taken in the last few years to improve data availability and accessibility in the UK.

Enabling the deployment of geothermal technologies at scale involves a wide range of different stakeholders and users. A workshop held for the UK Geothermal Platform focused on better understanding stakeholder needs around geothermal data and information. Very simply, policy makers, local and regional planners needs were for summary maps of geothermal potential, whereas developers and researchers needs were around detailed data and information (Figure 1).

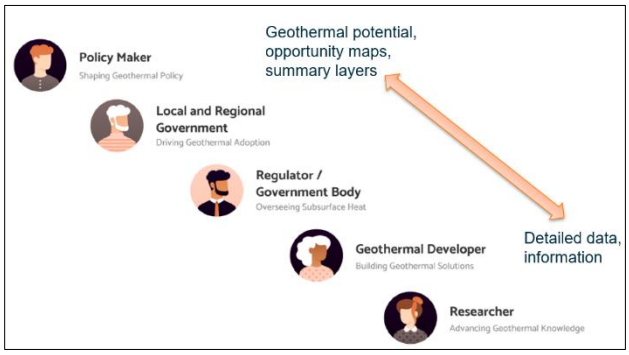

Figure 1: Summary of stakeholder types and needs for geothermal data and information in the UK BGS©UKRI 2025.

2. NATIONAL DATASETS AND MAPS

The British Geological Survey (BGS) is the national geological survey for Great Britain established in 1835, and hosts the National Geoscience Data Centre (NGDC). The Geological Survey of Northern Ireland completes coverage of the UK and some datasets such as the legacy heat flow map and the geothermal catalogue cover Northern Ireland.

The comprehensive work of the Geothermal Energy Programme in the 1980s, led by the British Geological Survey (Downing and Gray, 1986) is still a definitive reference to the geothermal prospects of the UK. Sections 2.1 and 2.2 describe how that legacy information has been made more available and accessible.

There is not currently a comprehensive database of UK geothermal projects, partly because geothermal energy is not licensed in the UK. Some project information is available from regulators through groundwater permitting and licensing (e.g. EA, 2024). Some grant schemes require reporting on GSHPs installed and larger geothermal projects are presented at conferences and in the media. Geothermal projects are summarised in IEA and EGC Country reports (Gonzalez Quiros et al. 2024; Monaghan et al. 2025).

2.1 Geothermal catalogue of temperature, thermal conductivity and heat flow

The UK geothermal catalogue of temperature, heat flow and thermal conductivity was published in four reports between 1978-1987 (Burley and Edmunds, 1978; Burley and Gale 1982, Burley et al. 1982, Rollin, 1987) as part of the geothermal energy programme.

The first digital version of the catalogue was released under Open Government Licence in 2024, comprising around 77% of the original catalogue following a basic set of validation, verification and intellectual property rights checks (BGS, 2024a; Fellgett and Monaghan, 2024). The release comprises spreadsheets of measured temperature, measured thermal conductivity and calculated heat flow linked to the national 'single onshore borehole index' identifier and original data

source. An accompanying user guide describes the variable quality and limitations of the dataset.

The release comprises 11,821 data points derived from 743 sites (Figure 2). Some measures of data quality (e.g. equilibrated temperatures vs bottomhole temperatures) and error were included in the legacy dataset and have been included in the digital release. A limitation is that heat flow values are reproduced from the legacy data without paleoclimatic and topographic corrections documented subsequently. This leads to an underestimation of temperatures and heat flows for UK deep geothermal resource potential models.

A second open release is planned in 2025 that includes legacy data with more complex copyright data that has been resolved since the first release, as well as data newer than 1987.

These data support developers and researchers to estimate technical geothermal potential, for example to estimate a geothermal gradient within an area of interest. Work is ongoing to collect new datasets and gather information from data deposits into the NGDC, as well as to update national-scale heat flow, temperature and thermal properties map data products.

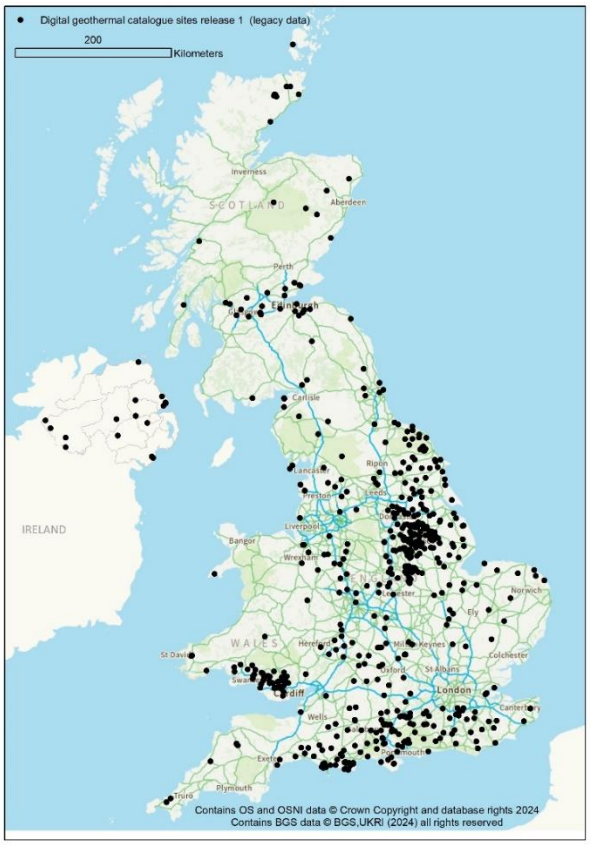

Figure 2: Map showing the distribution of data points in the first digital release, legacy data of the UK Geothermal Catalogue BGS©UKRI 2024.

2.2 Legacy maps and models

Extent maps of geothermal potential and the depth, modelled temperature of target geology, along with regional models of theoretical or technically recoverable heat are important in making visible deep geothermal opportunities and estimating their potential. As a first step, legacy maps and models are being made available to view for deep geothermal, hot sedimentary aquifer targets within the open UK Geothermal Platform (see section 3). This includes:

- Triassic Sandstone (Sherwood Sandstone Group) in the Cheshire, Wessex, East Yorkshire and Lincolnshire and Worcester basins (Rollin et al. 1995)
- Permian Sandstone (Bridgnorth Sandstone, Collyhurst Sandstone formations) in the Cheshire and Worcester Basins (Rollin et al. 1995)
- Carboniferous sandstone (Fell Sandstone Formation, Mid Border Group) Northumberland-Solway Basin
- Early Carboniferous Limestones across central and southern England (Jones et al. 2023)
- Upper Devonian Sandstone (Kinnesswood Formation and Stratheden Group) in the Midland Valley of Scotland (Kearsey et al. 2024)

This follows a release in 2024 of deep geothermal areas (v2) including the extent of deep sedimentary basins and radiogenic granites via an Open Government Licence (BGS, 2024b).

National scale heat flow (Busby et al. 2009), temperature maps (Busby et al. 2009; Busby and Terrington, 2017) and a thermal properties map are also being made available as viewable 1km-sided hex-cells.

2.3 Reports

Digital copies of the 65 plus reports from the 1980's geothermal energy programme have been made available. Five were released on an open access repository in 2024 and earlier, including the versions of the geothermal catalogue described above. Subsequently, there was a major release of original reports on BGS publications viewer (https://webapps.bgs.ac.uk/data/Publications/series.html?code=WJ/GE). The reports cover regional studies of geophysics, temperature measurements, heat production data for granites, geochemistry, initial maps and older theoretical potential resource estimates, as well as the results of drilling seven deep geothermal test wells across the UK.

2.4 Time-series and sensor monitoring data

In contrast to the legacy datasets, up-to-date and extremely well characterised research and demonstration sites are providing multi-disciplinary time series data streams to characterise and monitor geothermal processes. The UK has geothermal research

and demonstration sites ('Living Labs') spanning shallow aquifers, mine water energy and repurposing of hydrocarbon wells.

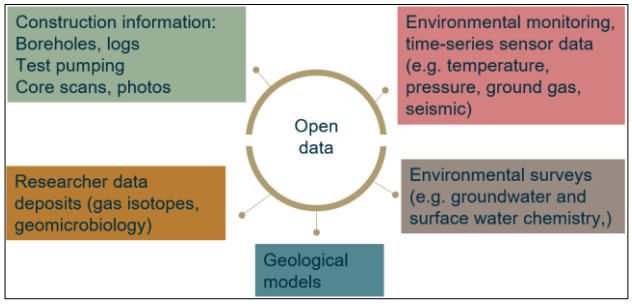

Figure 3: Range of open data, including time series data available from the UK Geoenergy Observatory in Glasgow (mine water geothermal) BGS©UKRI 2025.

BGS operates the UK Geoenergy Observatories for people to come and use. A facility in Cheshire is focused on aquifer thermal energy storage and ground source heat, and the Glasgow Observatory is focused on mine water geothermal. Tens of 'static' data packs have been released covering the construction of the observatories, groundwater, surface water, soil gas and soil chemistry surveys (https://www.ukgeos.ac.uk/data-downloads; Figure 3). A range of time-series data is also being produced, covering both ongoing environmental monitoring and around periods of geothermal or thermal storage investigations (sensors-gui.bgs.ac.uk). Sensors include downhole distributed temperature sensing from fibre-optic cables and downhole electrical resistivity tomography. Hydrogeological pressure and temperature monitoring is deployed downhole and across heat exchangers and heat pump/chiller. Small thermal changes induced by geothermal investigations can be observed (e.g. https://www.ukgeos.ac.uk/glasgow/observatory-infrastructure/dts; Boon et al. 2025; Monaghan et al. 2024; Receveur et al. 2025).

A multi-year thermogeological record of city scale monitoring is also available for boreholes penetrating a shallow, glacial gravel aquifer in Cardiff, Wales (Farr et al. 2019; Boon et al. 2022)

3. UK GEOTHERMAL PLATFORM

The UK Government Department for Energy Security & Net Zero (DESNZ) have funded development of the UK Geothermal Platform. This is a freely (openly) available geothermal energy national information hub, due to go live in Summer 2025. Two phases of stakeholder engagement and user testing have been undertaken to understand how the platform can make geothermal data more accessible and what the priorities are for this first version. Within the geothermal platform map explorer, summary layers use multicriteria calculations and analysis to provide a map overview of geothermal energy potential for four technology options. The results are presented in 1 km sided hex-cells (Figure 4). The technologies covered are:

- closed loop GSHP array
- open loop GSHP array
- deep geothermal - hot sedimentary aquifer (hydrothermal) for direct use heat
- Deep geothermal, petrothermal/EGS – granites (qualitative only)

The summary layers include information in each hex-cell on:

- Type of geothermal technology
- Thermal output (kW)
- Annual Thermal Output (kWh)
- Supply Water Temperature (ºC)
- Descriptive geothermal technical feasibility
- Geology of target
- Confidence descriptor
- Levelized cost information from a separate DESNZ-Arup study

The summary layers are for those interested in using geothermal energy who need an overview of the geothermal potential of a location. For example, a set of public sector buildings or university campus site. The summary information is not for detailed planning of projects. The summary layer fields were specified with the aim of feeding into the UK Government heat networks national zoning model, and to make geothermal energy options more visible to clean heat and heat policy decision makers.

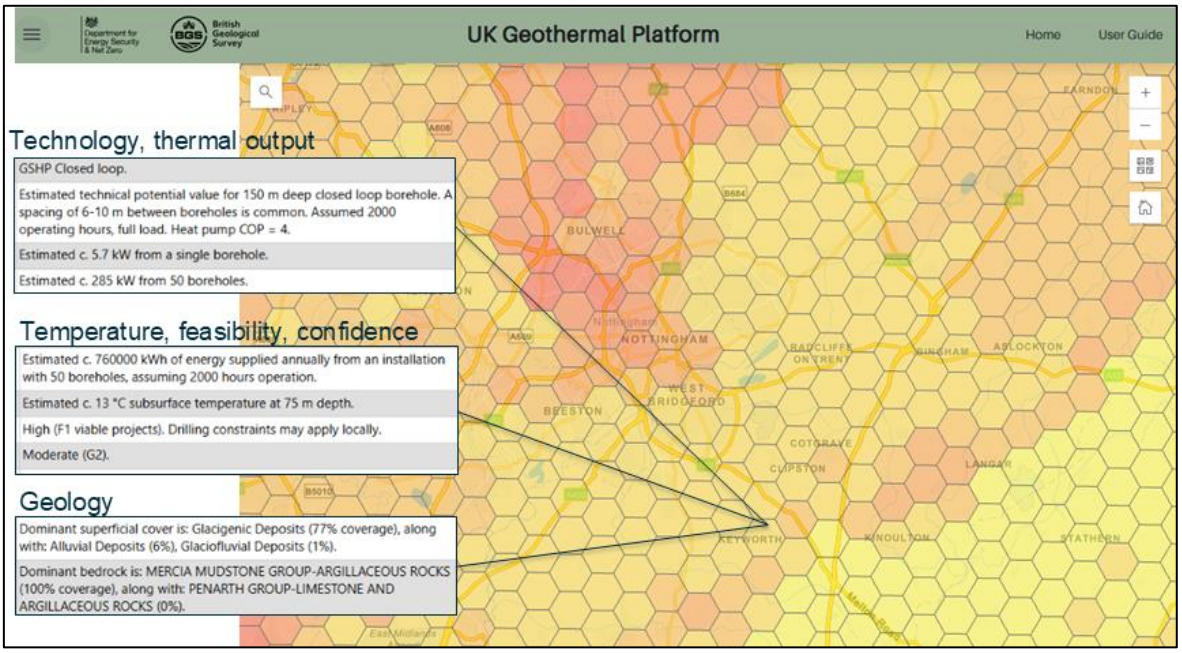

Figure 4: Example of the closed loop GSHP summary layer in the UK Geothermal Platform BGS©UKRI 2025. Contains DESNZ Summary layer data and Ordnance Survey data © Crown copyright and database rights 2025.

Specialists can also use the UK Geothermal Platform to access a range of geothermal and geoscientific information (Figure 5) for site-specific feasibility studies or regional assessments. The platform has a map explorer, a metadata catalogue for data search, access and download, as well as links to reports, tools and regulatory guidance. Examples include the ability to query the legacy maps and models described in section 2.2, reports and download selected datasets such as the UK Geothermal Catalogue (section 2.1).

This first release of the UK Geothermal Platform makes information from seven organisations accessible in around 90 layers. It includes geothermal data and models such as mine water heat opportunity maps from the Mining Remediation Authority, hydrogeology information from environmental regulators and borehole, well and seismic data from the UK Onshore Geophysical Library. The platform makes locating and viewing datasets from these different organisations easier. It is hoped to include more sources of information in future.

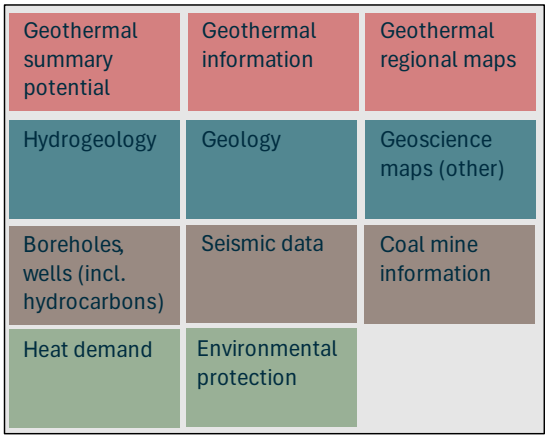

Figure 5: Types of data and information included in the UK Geothermal Platform map explorer BGS©UKRI 2025

4. GSHP TOOL FOR HOSPITALS

In 2023-2024, a collaborative project between the Energy Systems Catapult, BGS and NHS England developed a screening tool for England to guide initial feasibility studies for using closed loop ground source heat pump technology (GSHP), as an option for low carbon heating for individual NHS trust buildings and heat networks.

The tool includes input data of building type, heat demand and land available for drilling an area of boreholes. It estimates heat outputs for closed loop boreholes based on the BGS heat flow and thermal

properties maps, the ground elevation and local geology, along with a choice of full load equivalent operating hours and building load inputs. It produces a screening level output (Figure 6), geology description, planning prognosis, drilling prognosis, thermal output prognosis and ancillary information including indicative CAPEX and OPEX. User feedback and outcomes are being used to inform future improvements of the tool, including comparisons with air source heat pumps and additional building types to cover a wider range of public sector buildings.

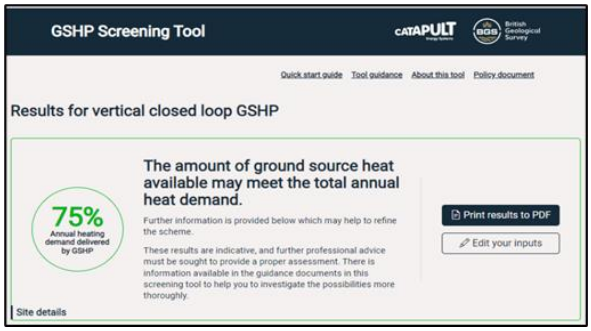

Figure 6: Image of the summary screen from the GSHP tool for hospitals, available at https://gshpscreeningtool.co.uk/

5. GEOLOGICAL SERVICE FOR EUROPE (GSEU) GEOTHERMAL ENERGY RESOURCES

The GSEU project (https://www.geologicalservice.eu/) aims to develop pan-European harmonised data and information services across Europe. One of the focus areas is geothermal energy resources. BGS has supplied national scale deep geothermal data, using the data and information described in section 2 for the online atlas of sustainable geoenergy capacities.

6. CONCLUSIONS AND FUTURE DEVELOPMENTS

Compared to some European countries with similar geology, the UK has a smaller number of geothermal and ground source heat projects. However, there is increasing interest in geothermal heating, cooling and underground thermal energy storage for heat decarbonisation, with particular interest in heat networks, and integration with data centres, solar and intermittent renewables.

The availability and accessibility of geothermal data and information has been documented as a barrier to wider deployment of geothermal technologies. Specialists found it difficult to access raw data and summary geothermal potential resource information was not available to policy makers and planners, to feed into heat network planning and modelling.

From 2023-2025, BGS has undertaken a programme of work to make legacy geothermal data more available and accessible (Figure 7). These data have known limitations and improved local studies should be incorporated in future. At the same time, working with UK Government, NHS England and the Energy Systems Catapult, BGS has also derived summary information and tools (Figure 7) for heat policy, heat networks and hospital estate managers, to include geothermal energy in pre-feasibility stages of heat decarbonisation planning.

Taken together, these data and summary information support developers, Government and researchers in the UK in a high level understanding of shallow to deep geothermal options, ahead of engaging specialists for site specific work.

Future work will consider feedback from users to further improve accessibility. It will aim to fill data gaps. For example, a register of operational geothermal schemes and inclusion of resource estimations updated with operational data to move from theoretical to technical and developable potential for deep geothermal energy. Government-backed projects and supporting research are one avenue to generate and publish the data and information that could provide the confidence required to overcome investment hesitation and drive sector growth.

Cost relative to other renewable heating alternatives, such as air source heat pumps, is a key factor influencing the inclusion of geothermal energy in government policy, as well as for investors. The first version of the UK Geothermal Platform includes summarised levelized cost information from a DESNZ-Arup study to be published in 2025. Future work could include the comparative levelized costs and outputs of other technologies. Global experience shows that costs decline significantly as deep geothermal projects scale up, benefiting from improved drilling efficiency, innovation and technical knowledge of the geological target. In future, it will be important to incorporate these ‘nth’ of a kind costs.

Other future ambitions for UK geothermal data and information are to improve mechanisms for data sharing, and for new regional geothermal exploration programmes in areas of data gaps or high geothermal potential.

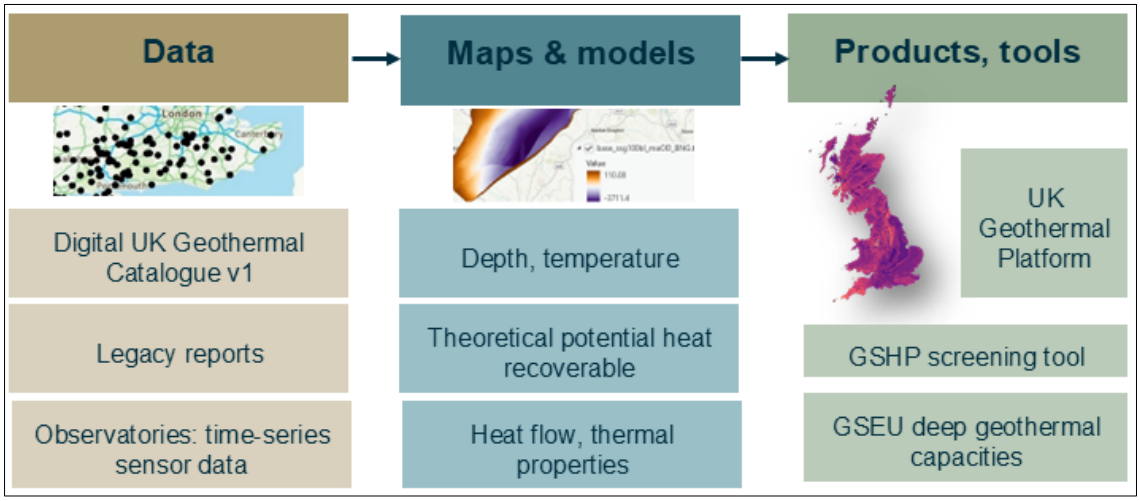

Figure 7: Summary of progress made on geothermal data and information sharing between 2023-2025 BGS©UKRI. Contain Ordnance Survey data © Crown Copyright and database rights 2025.

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