Chapter 11

The History of Geothermal in the United Kingdom

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The United Kingdom has a long, proven record of geothermal exploration and deployment—from the 1977–1991 UK Geothermal Energy Programme to decades of reliable operation at the Southampton District Energy Scheme. Today, digitised national data sets; new screening and mapping tools; revitalised research funding; and a growing ecosystem of public, academic, and industry initiatives are translating that legacy into a practical pathway to scale geothermal heat, storage, and targeted electricity generation across the country.

In the wake of the 1973 oil crisis, concerns in the UK government about energy security drove a new interest in geothermal energy. The UK Geothermal Energy Programme (1977–1991)—led by the Department of Energy and the Institute of Geological Sciences (now British Geological Survey [BGS])—was the most comprehensive early national undertaking. It resulted in the drilling of seven deep geothermal boreholes, including three hot dry rock (HDR) wells at Rosemanowes,[1,2] near Cornwall, and four aquifer-targeted wells in Southampton and Marchwood (Hampshire), Cleethorpes (Lincolnshire), and Larne (Northern Ireland).[3,4,5] That work established a baseline understanding of the UK's heat flow and subsurface thermal gradients, but commercial uptake was constrained by low market interest, technical uncertainties, and the shift of national interest to the production of petroleum from the UK Continental Shelf.

A notable output of this period was the 1980s BGS *Catalogue of Geothermal Data for the Land Area of the United Kingdom*,[6] which recorded crucial information about subsurface temperatures, heat flow, and geochemical data. The first version was published

by the Department of Energy in 1978, and subsequent updates were made in 1982, 1984, and 1987. Although foundational, this catalogue has not been updated with any measurements since 1987. In 2024, BGS produced the first digitised version of the catalogue.[7]

Of the seven wells drilled on behalf of the UK government during the 1980s, the one in Southampton was developed for geothermal energy provision and heat distribution and forms the basis for the Southampton District Energy Scheme.[8] The three wells drilled into the granite at Rosemanowes Quarry, near Penryn, Cornwall, became research boreholes for testing geophysical equipment. They are now owned by Avalon Science Ltd and remain accessible.[9]

The Southampton District Energy Scheme uses a single-well abstraction system to produce water at around 75°C, delivering approximately 1.7 megawatts thermal from the Triassic Sherwood Sandstones as part of a combined heat and power network in central Southampton. The decision to retain and develop the well, rather than abandon it, was driven by Mike Smith, then an accountant with Southampton City Council who almost single-handedly championed and developed the scheme, which has been in operation since 1987.[10]

Despite the UK Geothermal Energy Programme and the publication of the BGS *Catalogue*, there was little interest from government, industry, or academia in the geothermal potential of the United Kingdom until the early 2000s. At that point, interest was reawakened by the late Paul Younger, who responded to a proposal from a regional development agency in the Northeast[11] to repurpose an abandoned quarry and cement works at Eastgate in Weardale County Durham as an eco-village. Younger suggested that heat could be provided to the proposed village using the proven geothermal resource of the area.[12] The village plan was not executed, but the Eastgate 1 well was drilled in 2003 through 2004 and designed to cross-cut the Slitt Vein, a major fault system within the Weardale Granite known from mining records to have substantial fracture-based porosity and permeability. The well was drilled to a terminal depth of 998 metres below rotary table and tested warm water at very high flow rates,[13] with solute ratios that suggested equilibration at temperatures well above 100°C.[14] A second well was drilled at Eastgate in 2010 by a partnership between Newcastle and Durham universities that was supported by the UK government's deep geothermal fund. The well was designed to confirm the fracture and fault permeability architecture in the Weardale Granite.[15]

Newcastle University partnered with Durham University and Newcastle City Council to drill the Newcastle Science Central Deep Geothermal Borehole in central Newcastle in 2011. It was planned to intersect the 90 Fathom Fault at the level of the Lower Carboniferous Fell Sandstone at a depth of around 1.8 kilometres. The well was executed on a very tight budget, resulting in few downhole data points being collected. The well reached the target as planned and demonstrated both high heat flow and a bottomhole temperature of 73°C at 1,740 metres, a little higher than projected. Heat flow was estimated at 88 milliwatts per square metre. However, the well failed to flow on test.[16,17]

This active geothermal exploration work led to the formation of BritGeothermal, a consortium including three universities (Newcastle, Durham, Glasgow) and the BGS with a mission to promote and develop geothermal energy in the UK. The two main outputs of BritGeothermal were the recognition of geothermal being distinct from shale-gas fracking in the UK Infrastructure Act and a revision to the UK geothermal resource base published by the BGS in the 1980s.[18]

Since the wells were drilled in Weardale and Newcastle, geothermal exploration and development in the UK have grown substantially, much of it driven by the work of Charlotte Adams, who recognised the potential for exploiting the tepid water that now occupies almost all of the 23,000 abandoned mines in the UK.[19] In particular, Adams reasoned that while the temperature was low, the permeability of mined areas is exceptionally high. (This reasoning ran counter to the view of geothermal skeptics in the UK who often cited the risk of encountering low-permeability rock as a reason not to undertake a project.) Adams further reasoned that UK councils needing to reduce greenhouse gases could become developers of low-grade, low-carbon, mine-water heat systems in their areas, which did in fact happen. Gateshead Council's initial 6 megawatt scheme became operational in March 2023, shortly after the first industrial minewater geothermal scheme became operational in the same council area for Lanchester Wines.[20] At a national level, the North East Local Enterprise Partnership (NE LEP) commissioned a white paper that assessed minewater geothermal potential across the UK and highlighted key regulatory and economic constraints.[21]

Building on its success, NE LEP went on to oversee a UK-wide deep geothermal reevaluation for the Department of Business, Energy and Industrial Strategy, extending the work of Gluyas et al. (2018) with contributions from BGS and Arup.[22]

In 2024, the UK National Geothermal Centre (NGC) was created by a partnership between Durham University (Durham Energy Institute), the Net Zero Technology Centre, and Shift Geothermal Ltd, with financial support provided by the Reece Foundation. The centre aims to facilitate the development of the United Kingdom as a geothermal nation, with its work covering four areas of activity: (1) policy, regulation, and investment; (2) technology and innovation; (3) infrastructure; and (4) research and knowledge. The centre has been appointed to manage the Department for Energy Security and Net Zero's (Deep) Geothermal Task Force. The NGC announced in September 2025 that it had signed a memorandum of understanding with the Renewable Energy Association to promote geothermal energy in the United Kingdom.

In addition to the NGC, several other initiatives and organisations are contributing to the growth of the geothermal sector in the United Kingdom. The Geothermal UK Coalition, led by Anne Murrell, plays an important role in advocating for geothermal's strategic integration into the national energy mix and raising its profile across government and industry.[23] Industry associations such as Offshore Energies United Kingdom's Geothermal Energy Forum, the Heat Pump Association,[24] and the Renewable Energy Association's newly formed Geothermal Energy Advancement Association[25] are driving awareness, technical standards, and policy engagement across both shallow and deep geothermal applications. Regional collaborations such as the London Geothermal Consortium[26] further highlight the growing momentum behind geothermal deployment in specific urban and infrastructure contexts. Together, these initiatives reflect a diverse and complementary ecosystem that is helping position geothermal energy as a vital component of the United Kingdom's transition to secure energy.

In 2025, *UK Geothermal Energy Review and Cost Estimations*[27] was published alongside the launch of the UK Geothermal Platform,[28] a new BGS-developed hub showcasing geothermal potential across the United Kingdom. Commissioned by the Department for Energy Security and Net Zero and led by Arup, the report provides the most detailed assessment of UK geothermal costs to date, including the first levelised cost of heat and power estimates, while the department has also issued a cover note outlining the research's purpose, scope, and intended use.[29]

EVOLVING DATA INFRASTRUCTURE AND SCREENING TOOLS

Recent years have seen major improvements in digital data availability. The 2024 release of the UK Geothermal Catalogue in digital form represents a significant step forward in accessibility. Building on this catalogue, BGS is developing a new digital portal, the UK Geothermal Platform, to unify geothermal data sets and models. A precursor to this system includes a set of legacy geothermal models such as depth-to-top Sherwood Sandstone aquifer maps.[30]

For shallow systems, BGS maintains the Open-Loop GSHP Screening Tool, which supports preliminary assessments of groundwater suitability for heating and cooling across England and Wales.[31] This tool is critical for enabling developers and local authorities to identify viable sites for open-loop geothermal installations.

BGS has also played a leading role in synthesising strategic assessments, including the white paper *The Case for Deep Geothermal Energy*,[32] which provides an overview of resource potential, barriers, and recommendations.

CURRENT NATIONAL AND REGIONAL STUDIES

Heat-demand mapping conducted by the former Department for Business, Energy, and Industrial Strategy and the Department for Energy Security and Net Zero has informed spatial planning of low-carbon heating infrastructure. These maps focus on surface heat demand density rather than subsurface resource quality and thus must be interpreted in conjunction with geological models for geothermal targeting.

Multiple researchers have conducted deep geothermal resource assessments of the Lower Carboniferous limestones across central and southern Great Britain, providing updated estimates of temperature, reservoir thickness, and thermal capacity.[33,34,35] These studies are three of the most rigorous basin-scale assessments to date and underpin much of the recent planning for geothermal heat networks.

Gluyas and colleagues evaluated the capacity of the UK's deep saline aquifers for heat storage,[36] and Imperial College London is now leading two major geothermal research projects: (1) ATESHAC (Aquifer Thermal Energy Storage for the Decarbonisation of Heating and Cooling),[37] which further explores the role of aquifers in seasonal heat storage, and (2) SMARTRES (Smart Assessment, Management and Optimisation of Urban Geothermal Resources),[38] which addresses technical and regulatory challenges in subsurface thermal resource development.

Regional studies in Northern Ireland by Geological Survey of Northern Ireland (GSNI) have focused on the Lough Neagh Basin and northeast Antrim, identifying thermal gradients, aquifer potential, and resource confidence levels.[39] In 2022, Northern Ireland's Department for the Economy announced that it would make available £3 million in funding to deliver geothermal demonstrator projects as part of the GeoEnergy NI project in two separate locations in Northern Ireland to investigate both shallow and deep geothermal potential.[40]

Exploratory geothermal drilling and testing took place at the first of these two sites between 2024 and 2025 on the grounds of Stormont Estate in Belfast. The investigations at Stormont examined the shallow geothermal opportunities and their potential to provide sustainable, low-carbon, renewable heating and cooling to several pre-identified buildings on the estate. Investigations consisted of the drilling and testing of five boreholes, which ranged between approximately 100 metres and 300 metres deep and were used to examine open-loop and closed-loop potential and gather stratigraphic information about the local geology in the area using rotary coring. A series of downhole geophysical and pumping tests and analyses were carried out to ascertain the optimal numbers and depths of boreholes required to deliver low-carbon, renewable heat to the estate.

In parallel, the GeoEnergy NI project completed a feasibility study at the College of Agriculture, Food and Rural Enterprise (CAFRE) Greenmount Campus near Antrim to assess the viability and plan for the drilling of a deep geothermal borehole doublet. During summer 2023, the GeoEnergy NI team conducted detailed geophysical surveys (including of gravity, magnetotelluric, and seismic reflection) around CAFRE to assess deep geothermal potential. Data from this survey have been used to inform a 3D geological model to approximately 2 kilometres deep, evaluating the area's suitability for a geothermal district heating network. A planning application supported by an Environmental Impact Assessment was lodged in June 2025. The work was supported by local stakeholders and forms part of a wider project exploring geothermal demonstrators in both Antrim and Belfast, led by the Department for the Economy, with scientific support from GSNI.

Numerous organisations—including the Ministry of Defence, housing developers, industrial heat users, and leisure centres—have evaluated the use of shallow and deep geothermal, and many city and local councils across the UK have also commissioned feasibility studies (such as Newcastle City Council,[41] Durham County Council,[42] and Glasgow City Council[43]). Such studies are commonly integrated with decarbonisation planning and urban planning and housing development schemes. These studies may also assess the practicality of ground source heat pump (GSHP) deployment in residential and commercial zones. Other unique public sector partnerships have helped raise the profile of geothermal potential across the United Kingdom. For example, the Ministry of Defence has evaluated the feasibility of geothermal energy production at numerous sites since 2020; in 2022, in partnership with Newcastle University as a first-of-its-kind effort for the United Kingdom, the ministry acquired a high-density 3D seismic survey.[44] While less work has been done on the environmental impact of geothermal development,[45] one significant study was commissioned by the Environment Agency to evaluate the risks associated with repurposing petroleum industry infrastructure for geothermal energy (see the section on onshore activity).[46] This report followed an analysis of the potential for heat generation from the end-of-life Welton Oil Field in Lincolnshire, as well as the geothermal potential of the whole of the East Midlands Oil Province.[47,48,49]

INDUSTRIAL DEPLOYMENT AND DEMONSTRATION PROJECTS

The most recent deep geothermal developments are located in Cornwall and are the first developments since the Southampton District Energy Scheme in 1987. The Eden Geothermal Project, supported by multiple stakeholders (including the University of Exeter), has completed a well that is 4,871 metres deep (measured depth or total length of 5,277 metres) and is now supplying direct heat to the Eden Eco Park.[50] Geothermal Engineering Ltd. (GEL) operates the United Downs Deep Geothermal Project, with a production well drilled to 5,275 metres measured depth and a re-injection well to 2,393 metres measured depth, targeting the radiogenic Cornubian granite batholith.[51] GEL has the first-ever Contract for Difference issued in the United Kingdom for electricity generation from geothermal energy.[52] The United Downs project also aims to deliver a second revenue stream from lithium extraction of produced water.[53]

These projects mark the first commercial-scale demonstrations of deep geothermal in the United Kingdom. They have also yielded valuable thermal and geochemical data sets that support wider national geothermal assessments. The involvement of universities in Cornwall, notably the Camborne School of Mines at the University of Exeter, has been critical to the interpretation of subsurface data and fault system characterisation.[54]

ACTIVITY FOR REPURPOSING EXISTING OIL AND GAS WELLS

Onshore

The United Kingdom has a significant legacy of onshore oil and gas drilling, with 2,135 exploration, appraisal, and development wells recorded by the North Sea Transition Authority.[55] This extensive subsurface infrastructure has sparked growing interest in whether these wells could be repurposed for geothermal energy production unlocking access to deep, hot formations without the cost of drilling new wells, although not without risks.[56]

In the United Kingdom, the idea of repurposing onshore oil and gas wells for geothermal use was first proposed for heat storage applications by Westaway,[57] with several studies following suit. Globally, interest in this approach has accelerated,[58] and the UK is beginning to see tangible steps being taken.

To date, the only UK well actively undergoing repurposing for geothermal demonstration is Kirby Misperton-8 (KM-8) in North Yorkshire. Exploration for natural gas in this area began in the 1970s, resulting in three gas fields in the Vale of Pickering, Kirby Misperton, Marishes, and Pickering[59] all produced from the Upper Permian Zechstein dolomite reservoir. KM-8 also yielded gas from Namurian sandstones, sourced from Lower Carboniferous organic-rich shales, as identified in the original exploration well KM-1.

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In 2015, KM-8 was drilled to a total vertical depth of 3,068 metres to test a tight gas play within the Lower Carboniferous section.[60] At the time, operator Third Energy intended to hydraulically fracture the reservoir, but plans were halted due to local protests and, later, the withdrawal of financial backing. The well remained suspended for nearly a decade.

In 2023, CeraPhi Energy acquired the rights to KM-8 and announced plans to recomplete the well as a closed-loop, coaxial geothermal demonstrator.

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Research Projects

Since 2006, a range of geoscience and engineering research projects, totalling around £90 million, have been publicly funded, principally through UK Research and Innovation (UKRI) schemes. Of that, about £22 million has been provided by Innovate UK to support business-led innovation. These projects, awarded to more than 30 different research organisations, have supported developing knowledge, understanding, and capability despite the lack of commercial uptake, and they play a crucial role in UK geothermal research. Organisations including BGS, the University of Glasgow, Durham University, Newcastle University, Imperial College London, the University of Leeds, and the University of Manchester have all led multiple research projects on geothermal energy, such as thermo-physical properties (THERMOCAL[61]), assessment and management of geothermal resources (SmartRes[62]), the acquisition and processing of novel seismic data for exploration (Project VITAL),[63] integration of minewater geothermal into energy systems (GEMS[64]), and quantitative understanding of fluid flow in granitic rocks (GWatt[65]). A full list of funded projects can be found by searching on the UKRI website (gtr.ukri.org).

Uniquely, the UK has two subsurface observatories designed for shallow geoenergy studies, called the

UK Geoenergy Observatories. These facilities were funded in 2017 by the UK's Department for Business, Energy and Industrial Strategy, now the Department for Energy Security and Net Zero, and are owned by UKRI's Natural Environment Research Council. They are being operated by BGS. They were delivered through an initial £31 million investment from the 2014 UK government plan for the growth of science and innovation. Glasgow, Scotland, is home to one observatory, a fully instrumented minewater geothermal research site providing real-time temperature and fluid data from a network of boreholes.[66] A second site in Cheshire is home to a field-scale laboratory for research and innovation in aquifer underground thermal energy storage, rock volume characterisation, and subsurface process monitoring. The facilities can be used by research institutes and industry.

Industry, academia, and regional stakeholders are proposing a UK programme similar to the Frontier Observatory for Research in Geothermal Energy (FORGE) programme in the United States that could establish two next-generation geothermal test and demonstration hubs in the southwest and northeast parts of England. Building on the success of the U.S. FORGE programme, the initiative aims to unlock stalled projects, reduce drilling costs, and accelerate UK geothermal growth, delivering up to 300 gigawatt-hours per year of baseload power and 230 gigawatt-hours per year of heat per site. With a projected £250 million investment (70% public and 30% private), the programme would drive innovation, attract private capital, create high-value jobs, and enable the North Sea oil and gas transition while supporting the United Kingdom's clean energy goals.[67]

In addition, the University of York has secured a £35 million grant from the UK government's Public Sector Decarbonisation Scheme, delivered by Salix Finance, with an additional 12% matched funding from the university. Located on the university's Campus East site in York, the initiative is a deep geothermal energy project designed to tap into the geothermal heat beneath the campus to provide a low-carbon heating solution—and, in later phases, potentially generate electricity. The first phase, spanning approximately three years, will focus on supplying geothermal heat to most campus buildings, reducing fossil fuel consumption by an estimated 78%. Over a total project timeline of around six to seven years, subsequent phases will explore electricity generation and the potential to expand heat provision to the wider York community. The project is also envisioned as a "living laboratory," supporting research, education, and community engagement around renewable energy and decarbonisation.[68]

In September 2025, the United Kingdom's National Wealth Fund announced a £31 million commitment to geothermal developer Cornish Lithium to advance its projects to the next stage of development, following an earlier £24 million investment in 2023, when the fund operated as the UK Infrastructure Bank.[69] The new funding will support two key initiatives: the Trelavour Lithium Project, which focuses on hard-rock lithium extraction, and the Cross Lanes Geothermal Lithium Project, which uniquely combines geothermal drilling with lithium recovery. The latter is particularly significant because it integrates renewable energy and mineral extraction—using geothermal heat and fluids to extract lithium—thereby demonstrating a hybrid model that leverages shared subsurface infrastructure. This approach not only strengthens Cornwall's role in the United Kingdom's critical minerals supply chain but also positions the region as a dual-asset hub for both geothermal energy and lithium production.

Finally, Star Energy is applying its onshore oil and gas experience to the development of geothermal heat projects in the UK. Its Salisbury Geothermal Project in Wiltshire aims to provide heat to Salisbury District Hospital by drawing from deep aquifers, using adapted drilling techniques and existing supply chains.[70] The company has undertaken geological assessments, early stakeholder engagement, and risk-reduction measures to evaluate the project's feasibility.

GEOTHERMAL RESOURCE REPORTING

Historically, the geothermal sector (both globally and in the United Kingdom) has suffered from ambiguity in the terminology and approaches used to report quantities of geothermal energy, which has left too much latitude in geothermal assessment, thereby leading to less confidence in development. In addition, with no bespoke regulation of the geothermal industry in the UK currently in place,[71] no single organisation has the remit to manage the reporting of geothermal energy resources.

With a diverse range of geothermal opportunities, a major challenge is the inherent difficulty in defining what the appropriate metric actually is when assessing geothermal energy resources. Should it be the primary resource, the reservoir, fluids, stored heat, recoverable volume, recoverable heat, recoverable power, or net profit? This challenge is further complicated by changing environmental, policy, and regulatory constraints nationally and around the globe.

The amount of energy that can be dynamically extracted over a project's lifetime (for example, 30 years) ultimately depends on the specific technologies and system designs employed. Rybach already highlighted the progression needed to go from theoretical to developable geothermal potential.[72]

As shown in Chapter 3, "Where Is the Heat? Exploring the United Kingdom's Subsurface Geology," Heat-in-Place figures can be further converted into estimates of recoverable quantities. For electric power generation projects, for example, the latter are a function of the thermal energy stored in the reservoir, the rate of thermal energy recovery at the wellhead, and the efficiency with which the latter can be converted into electric power. Electric power generation can be estimated from a stored heat estimate through the application of a recovery factor, an energy conversion factor, a power plant capacity factor, and power plant life. (See Chapter 3, Appendix B, for more detail.)

A consistent assessment framework for geothermal energy resources is needed by investors, regulators, insurers, governments, and consumers as a foundation for a comprehensive overview of current and future energy sustainability scenarios at the project, company, country, region, or world levels and to offer greater confidence in development.

CHAPTER REFERENCES

1 Parker, R. (1999). The Rosemanowes HDR project 1983–1991. *Geothermics, 28*(4–5), 603–615. https://doi.org/10.1016/S0375-6505(99)00031-0

2 Parker, R. H. (Ed.). (1989). *Hot dry rock geothermal energy: Phase 2B final report of the Camborne School of Mines Project*. Pergamon Press. https://openlibrary.org/books/OL2190432M/Hot_dry_rock_geothermal_energy#overview

3 Downing, R. A., & Gray, D. A. (Eds.). (1986). *Geothermal energy: The potential in the United Kingdom*. HMSO. https://nora.nerc.ac.uk/id/eprint/537257

4 Downing, R. A., & Gray, D. A. (1986). Geothermal resources of the United Kingdom. *Journal of the Geological Society, 143*(3), 499–507. https://doi.org/10.1144/gsjgs.143.3.0499

5 Barker, J. A., Downing, R. A., Gray, D. A., Findlay, J., Kellaway, G. A., Parker, R. H., & Rollin, K. E. (2000). Hydrogeothermal studies in the United Kingdom. *Quarterly Journal of Engineering Geology and Hydrogeology, 33*(1), 41–58. https://doi.org/10.1144/qjegh.33.1.41

6 Rollin, K. E. (1987). *Catalogue of geothermal data for the land area of the United Kingdom: Third revision, April 1987*. British Geological Survey. Unpublished. https://nora.nerc.ac.uk/id/eprint/537114

7 British Geological Survey (BGS). (2024). *UK digital geothermal catalogue, version 1* [Data set]. BGS. https://www2.bgs.ac.uk/nationalgeosciencedatacentre/citedData/catalogue/05569ed5-db0e-4587-807c-58e39ee240fa.html

8 Gearty, M. (2008). *Southampton District Energy Scheme: A story of collaboration and steady ambition*. University of Bath. https://people.bath.ac.uk/mnspwr/doc_theses_links/pdf/dt_mg_APPDXGSouthampton_case_issue_vws_A5.pdf

9 Avalon Sciences Ltd. (n.d.). *Avalon borehole test facility*. https://avalonsciences.com/services/avalon-borehole-test-facility/

10 Gluyas, J. G., et al. (2018). Keeping warm: A review of deep geothermal potential of the UK. *Proceedings of the Institution of Mechanical Engineers, Part A: Journal of Power and Energy, 232*(1), 115–126. https://doi.org/10.1177/0957650917749693

11 Government of the United Kingdom. (n.d.). *One North East*. https://www.gov.uk/government/organisations/one-north-east

12 Dunham, K. C., Johnson, G. A. L., Bott, M. H. P., & Hodge, B. L. (1961). Granite beneath the Northern Pennines. *Nature, 190*(4782), 899–900. https://doi.org/10.1038/190899a0

13 Younger, P. L., & Manning, D. A. C. (2010). Hyper-permeable granite: Lessons from test-pumping in the Eastgate Geothermal Borehole, Weardale, UK. *Quarterly Journal of Engineering Geology and Hydrogeology, 43*(1), 5–10. https://doi.org/10.1144/1470-9236/08-085

14 Manning, D. A. C., Younger, P. L., Smith, F. W., Jones, J. M., Dufton, D. J., & Diskin, S. (2007). A deep geothermal exploration well at Eastgate, Weardale, UK: A novel exploration concept for low-enthalpy resources. *Journal of the Geological Society, 164*(2), 371–382. https://doi.org/10.1144/0016-76492006-015

15 Gluyas, J. G., Adams, C. A., Narayan, N. S., & Hirst, C. M. (2020). The geothermal potential of the fractured Weardale granite and associated aquifers of County Durham and adjacent areas, northern England. In *Proceedings of the World Geothermal Congress 2020*. Reykjavik, Iceland. https://www.worldgeothermal.org/pdf/IGAstandard/WGC/2020/16046.pdf

16 Younger, P. L., Manning, D. A. C., Millward, D., Busby, J. P., Jones, C. R. C., & Gluyas, J. G. (2016). Geothermal exploration in the Fell Sandstone Formation (Mississippian) beneath the city centre of Newcastle upon Tyne, UK: The Newcastle Science Central deep geothermal borehole. *Quarterly Journal of Engineering Geology and Hydrogeology, 49*(4), 350–363. https://doi.org/10.1144/qjegh2016-053

17 Sutton, R. (2022). *Assessing the geothermal potential of the Lower Carboniferous Fell Sandstone* [Doctoral dissertation, Durham University]. Durham E-Theses Online. http://etheses.dur.ac.uk/14692

18 Gluyas et al., 2018.

19 Adams, C. A., Monaghan, A. A., & Gluyas, J. G. (2019). Mining for heat. *Geoscientist, 29*(4), 10–15. https://nora.nerc.ac.uk/id/eprint/523186/
20 Adams, C., Gordon, J., & Parker, K. (2022). *The Gateshead mine water heat scheme: Coal mining in Great Britain*. Coal Authority. https://www.spe-aberdeen.org/uploads/1115-SPE-Aberdeen-Feb23-Adams.pdf
21 Kirkup, W., Cavey, A., Lawrence, D., Crane, M., Gluyas, J. G., & Handley, W. (2021). *The case for mine energy—unlocking deployment at scale in the UK*. North East Local Enterprise Partnership. https://www.midlandsnetzerohub.co.uk/media/cw0hj5q1/mine-energy-white-paper_final.pdf
22 Abesser, C., Gonzalez Quiros, A., & Boddy, J. (2023). *Evidence report supporting the deep geothermal energy white paper:* The case for deep geothermal energy—unlocking investment at scale in the UK. British Geological Survey. https://nora.nerc.ac.uk/id/eprint/535567
23 Geothermal UK. (n.d.). *Geothermal UK*. https://www.geothermaluk.org
24 Heat Pump Association. (n.d.). *Heat Pump Association*. https://hpauk.org.uk/
25 Renewable Energy Association. (2025, October 17). *Renewable Energy Association and the Geothermal Energy Advancement Association come together to drive forward the growth of geothermal energy in the UK*. https://www.r-e-a.net/renewable-energy-association-and-the-geothermal-energy-advancement-association-come-together-to-drive-forward-the-growth-of-geothermal-energy-in-the-uk
26 London Geothermal. (n.d.). *London Geothermal Consortium*. https://londongeothermal.com/
27 Department for Energy Security and Net Zero. (2025). *UK geothermal energy review and cost estimations*. Government of the United Kingdom. https://www.gov.uk/government/publications/uk-geothermal-energy-review-and-cost-estimations
28 British Geological Survey. (2025). *UK geothermal platform*. https://ukgeothermalplatform.org/

29 Department for Energy Security and Net Zero. (2025). *Cover note: UK geothermal energy review and cost estimations*. Government of the United Kingdom. https://assets.publishing.service.gov.uk/media/6891e217e8ba9507fc1b0a20/geothermal-energy-review-cover-note.pdf

30 British Geological Survey. (n.d.). *Legacy BGS geothermal models: Depth to the top Sherwood Sandstone Group in the Permo-Triassic Cheshire, Worcester, Wessex and East Yorkshire-Lincolnshire basins* [Vector contour data set]. Derived from Rollin, K. E., Kirby, G. A., & Rowley, W. J. (1995). *Atlas of geothermal resources in Europe: UK revision* (British Geological Survey Technical Report WK/95/7, Regional Geophysics Group) and the European Geothermal Atlas. https://hosted-metadata.bgs.ac.uk/geonetwork/srv/api/records/0ba977bd-62a5-4e3b-8fac-d568f413fe9e

31 British Geological Survey. (n.d.). *Open-loop GSHP screening tool (England and Wales)*. https://www.bgs.ac.uk/geology-projects/geothermal-energy/geothermal-technologies/open-loop-gshp-screening-tool/

32 Abesser, C., Gonzalez Quiros, A., & Boddy, J. (2023). *The case for deep geothermal energy—unlocking investment at scale in the UK*. North East Local Enterprise Partnership & British Geological Survey.

33 Narayan, N. S., Adams, C. A., & Gluyas, J. G. (2021). Karstified and fractured Lower Carboniferous (Mississippian) limestones of the UK: A cryptic geothermal reservoir. *Zeitschrift der Deutschen Gesellschaft für Geowissenschaften (Journal of Applied Regional Geology)*, *172*(3), 251–265.

34 Jones, D. J. R., Randles, T., Kearsey, T., Pharaoh, T. C., & Newell, A. (2023). Deep geothermal resource assessment of early carboniferous limestones for Central and Southern Great Britain. *Geothermics*, *109*, 102649. https://doi.org/10.1016/j.geothermics.2023.102649

35 Johnstone, D. J. (2024). *A subsurface geological model to assess geothermal energy and hydrogen storage potential in North West England* [Doctoral thesis]. University of Manchester. https://pure.manchester.ac.uk/ws/portalfiles/portal/1424700273/FULL_TEXT.PDF

36 Gluyas, J. G., Adams, C. A., & Wilson, I. A. G. (2020). The theoretical potential for large-scale underground thermal energy storage (UTES) within the UK. *Energy Reports*, *6*(Suppl. 7), 229–237. https://doi.org/10.1016/j.egyr.2020.12.006

37 Department of Earth Science and Engineering. (n.d.). *Project: ATESHAC*. Imperial College London. https://www.imperial.ac.uk/earth-science/research/research-projects/ateshac

38 Department of Earth Science and Engineering (n.d.). *Project: SMARTRES*. Imperial College London. https://www.imperial.ac.uk/earth-science/research/research-projects/smartres

39 Raine, R. J., & Reay, D. M. (2021). *Geothermal energy potential in Northern Ireland: Summary and recommendations for the Geothermal Advisory Committee* (GSNI Technical Report 2021/EM/01). Geological Survey of Northern Ireland. https://nora.nerc.ac.uk/id/eprint/531393/33/GSNI-%20NI%20Geothermal%20Energy%20Summary%20for%20GAC%202021_report.pdf

40 GeoEnergy NI. (n.d.). *The demonstrator projects*. Department for the Economy. https://geoenergyni.org/demonstrator-projects

41 Newcastle City Council. (2022). *Net zero Newcastle: Priority actions update April 2021-August 2022*. Newcastle City Council.

42 City Science. (n.d.). *Unlocking heat network potential in County Durham*. https://cityscience.com/case-study/unlocking-heat-network-potential-in-county-durham

43 Hilley, S. (2022 August 12). Glasgow energy crisis could get lifeline with 6km geothermal well in Clyde. *Glasgow News*. https://www.glasgowlive.co.uk/news/glasgow-news/glasgow-energy-crisis-could-lifeline-24741071

44 https://geoscientist.online/sections/unearthed/seismic-for-geothermal/

45 Environment Agency. (2024). *Environmental impacts of teperature changes from ground source heating and cooling systems: Summary*. Government of the United Kingdom. https://www.gov.uk/government/publications/environmental-impacts-of-temperature-changes-from-ground-source-heating-and-cooling-systems/environmental-impacts-of-temperature-changes-from-ground-source-heating-and-cooling-systems-summary

46 Daniels, S. E., Gluyas, J. G., Hartgill, D., & Jones, R. (2022). *Specific environmental risks from repurposing oil and gas wells*. Environment Agency. https://www.gov.uk/government/publications/specific-environmental-risks-from-repurposing-oil-and-gas-wells
47 Hirst, C. M., & Gluyas, J. G. (2015). The geothermal potential held within Carboniferous sediments of the East Midlands: A new estimation based on oilfield data. In *Proceedings of the World Geothermal Congress 2015*. Melbourne, Australia.
48 Hirst, C. M., Gluyas, J. G., & Mathias, S. M. (2015). The late field life of the Midlands Petroleum Province: A new geothermal prospect? *Quarterly Journal of Engineering Geology and Hydrogeology, 48*(1), 104–114. https://doi.org/10.1144/qjegh2014-072
49 Hirst, C. M. (2017). *The geothermal potential of low enthalpy deep sedimentary basins in the UK* [Doctoral dissertation, Durham University]. Durham E-Theses Online. http://etheses.dur.ac.uk/11979
50 Eden Geothermal. (n.d.). *About the Eden Geothermal Project*. https://www.edengeothermal.com/the-project/phase-1
51 Farndale, H., & Law, R. (2022). An update on the United Downs Geothermal Power Project, Cornwall, UK. In *Proceedings of the 47th Workshop on Geothermal Reservoir Engineering*. Stanford, CA, United States. https://pangea.stanford.edu/ERE/db/GeoConf/papers/SGW/2022/Farndale.pdf
52 Cariaga, C. (2023, September 8). *GEL awarded the first-ever Contracts for Difference for geothermal*. ThinkGeoEnergy. https://www.thinkgeoenergy.com/gel-awarded-the-first-ever-contracts-for-difference-for-geothermal
53 Olver, T., & Law, R. (2025). The United Downs Geothermal Power Plant, Cornwall, UK: Combining the generation of geothermal electricity and heat, with the extraction of critical raw materials. In *Proceedings of the 50th Workshop on Geothermal Reservoir Engineering*. Stanford, CA, United States. https://pangea.stanford.edu/ERE/db/GeoConf/papers/SGW/2025/Olver.pdf
54 University of Exeter. (n.d.). *Geothermal power generated from UK granites (GWatt)*. UK Research and Innovation. https://gtr.ukri.org/project/4EA2E71D-D45A-4ABC-8F22-3D6B05B0BDBA
55 Watson, S. M., Falcone, G., & Westaway, R. (2020). Repurposing hydrocarbon wells for geothermal use in the UK: The onshore fields with the greatest potential. *Energies, 13*(14), 3541. https://doi.org/10.3390/en13143541
56 Daniels et al., 2022.
57 Westaway, R. (2016). Repurposing of disused shale gas wells for subsurface heat storage: Preliminary analysis concerning UK issues. *Quarterly Journal of Engineering Geology and Hydrogeology, 49*, 213–227. https://doi.org/10.1144/qjegh2016-016
58 Santos, L., Dahi Taleghani, A., & Elsworth, D. (2022). Repurposing abandoned wells for geothermal energy: Current status and future prospects. *Renewable Energy, 194*, 1288–1302. https://doi.org/10.1016/j.renene.2022.05.138
59 Harrison, D., Haarhoff, M., Heath-Clarke, M., Hodgson, W., Hughes, F., Ware, D., & Mortimer, A. (2020). The Vale of Pickering gas fields: Kirby Misperton, Malton, Marishes and Pickering, North Yorkshire, UK onshore. In G. Goffey & J. G. Gluyas (Eds.), *Geological Society, London, Memoirs* (vol. 52, pp. 82–93). Geological Society of London.
60 Hughes, F., Harrison, D., Haarhoff, M., Howlett, P., Pearson, A., Ware, D., Taylor, C., Emms, G., & Mortimer, A. (2019). The unconventional Carboniferous reservoirs of the Greater Kirby Misperton gas field and their potential: North Yorkshire's sleeping giant. In M. Bowman & B. Levell (Eds.), *Petroleum geology of NW Europe: 50 years of learning–Proceedings of the 8th Petroleum Geology Conference*. Geological Society of London. https://doi.org/10.1144/PGC8.5
61 University of Glasgow. (n.d.). *THERMOphysical properties of CALedonian rock materials to de-risk geothermal development (THERMOCAL)*. UK Research and Innovation. https://gtr.ukri.org/projects?ref=EP%2FU536878%2F1

62 Imperial College London. (n.d.). *Smart assessment, management and optimisation of urban geothermal resources (SmartRes)*. UK Research and Innovation. https://gtr.ukri.org/projects?ref=NE%2FX005607%2F1
63 Ireland, M., Dunham, C., & Gluyas, J. (2023, September 4). *Seismic for geothermal*. Geoscientist. https://geoscientist.online/sections/unearthed/seismic-for-geothermal
64 Durham University. (n.d.). *Geothermal Energy from Mines and Solar-Geothermal Heat (GEMS)*. UK Research and Innovation. https://gtr.ukri.org/projects?ref=EP%2FV042564%2F1
65 University of Exeter, n.d.
66 Monaghan, A. A., Starcher, V., Barron, H. F., Shorter, K., Walker-Verkuil, K., Elsome, J., Kearsey, T., Arkley, S., Hannis, S., & Callaghan, E. (2022). Drilling into mines for heat: Geological synthesis of the UK Geoenergy Observatory in Glasgow and implications for mine water heat resources. *Quarterly Journal of Engineering Geology and Hydrogeology, 55*(1), qjegh2021-033. https://doi.org/10.1144/qjegh2021-033
67 Caroline Carroll, personal communication, August 2025
68 University of York. (n.d.). *Deep geothermal energy project*. https://www.york.ac.uk/about/sustainability/campus-operations/climate-action/geothermal-energy
69 National Wealth Fund. (2025, September 23). *National Wealth Fund announces a £31m commitment to Cornish Lithium to advance projects to next stage of development*. https://www.nationalwealthfund.org.uk/news/national-wealth-fund-announces-ps31m-commitment-cornish-lithium-advance-projects-next-stage
70 IGas Energy PLC. (2023, June 12). *IGas selected as preferred contractor for Salisbury NHS Trust geothermal scheme*. Investegate. https://www.investegate.co.uk/index.php/announcement/rns/star-energy-group-plc—star/igas-preferred-contractor-for-geothermal-scheme-/7569259
71 McClean, A., & Pedersen, O. W. (2023). The role of regulation in geothermal energy in the UK. *Energy Policy, 173*, 113378. https://doi.org/10.1016/j.enpol.2022.113378
72 Rybach, L. (2010). The future of geothermal energy and its challenges. *In Proceedings of the World Geothermal Congress 2010*. Bali, Indonesia. Classification of geothermal potentials—from theoretical through technical and economic to developable—is described therein.

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