Geothermal Technologies - Analysis of written evidence from the Environmental Audit Committee inquiry

Decarbonisation and Resource Management Programme

Open Report OR/23/058

BRITISH GEOLOGICAL SURVEY

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1 Introduction

In July 2022, The UK Parliament's Environmental Audit Commission (EAC) launched an inquiry on geothermal technologies as part of their Technological Innovations and Climate Change inquiry (https://committees.parliament.uk/work/6777/technological-innovations-and-climate-change-geothermal-technologies/publications/). The inquiry focussed on Enhanced Geothermal Systems and Mine Water Energy Systems. It investigated the potential scale of their deployment in the UK to provide heat and power; the role geothermal technologies could have in the UK's Energy Strategy and what barriers there are to the deployment, economic impact, and environmental impact of these technologies. As part of the inquiry, the EAC issued a call for the submission of written evidence to provide answers to one or more of the following questions:

1. What role can geothermal technologies take in the transition to net zero in the UK?
2. What barriers (technological, regulatory, or otherwise) are there to deploying operational geothermal technologies in the UK?
3. What is the scale of the potential market for geothermal energy sources and which geographic or other geological types are most suitable for exploitation of this natural resource?
4. Are current government support schemes sufficient to grow geothermal energy deployment in the UK?
5. What environmental concerns are associated with geothermal technologies, and are they appropriately accounted for in regulations?
6. What risks are there to investors, operators, and consumers of geothermal energy? How can these be mitigated?
7. How does the density of mine water systems affect their efficiency? Could widespread uptake of geothermal systems in dense population centres lead to a reduction in their ability to provide heat?
8. What economic impact could the deployment of mine water geothermal systems have on the areas in which they are deployed?

The written evidence received by the EAC for this inquiry is published on the UK Parliament website at https://committees.parliament.uk/work/6777/technological-innovations-and-climate-change-geothermal-technologies/publications/written-evidence/.

This report captures a qualitative analysis of this evidence. It specifically investigates what opportunities, challenges and barriers are identified by the submissions as well as the support measures that are suggested for developing a geothermal industry in the UK.

2 Methodology

2.1 DATA SUBMISSIONS

The committee received written evidence from 34 stakeholders. All of these were initially considered for analysis but after an initial review of these reports, three were discarded. Two of those submissions were discarded on the basis of being in an academic paper form describing specific geothermal technologies that did not address the questions. From the remaining submissions, one did not provide a direct response to any of the questions posed by the inquiry. The remaining 31 submission were grouped according to a stakeholder type. Figure 1 shows the types of stakeholders whose written evidence is included in this analysis.

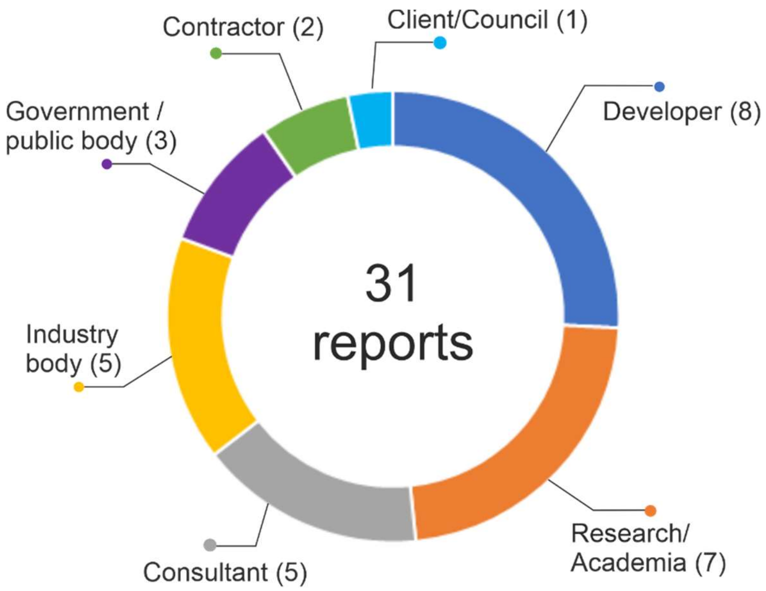

Figure 1 Grouping of submissions by a stakeholder type.

2.2 DATA ANALYSIS

After the validation process, a qualitative analysis was carried out by using an iterative, inductive method (Braun and Clarke, 2006). This method involved a close examination of the reports as a first step to manually develop initial codes (as opposed to using computer software such as NVivo), and to collate the text into general themes. These themes were then checked against the dataset, refined, and then ordered to create a narrative.

After the inductive data assessment, the following common themes were identified:

- geothermal potential in the UK
- benefits for the UK
- the current barriers
- support measures required.

These themes are described more in detail in the following chapters and a summary is provided at the end of this report.

Table 1 shows the themes and subthemes identified from the written evidence, categorised by stakeholder type. It also shows the overall percentage of stakeholders who mention the subthemes in their submission.

		Clients/ Councils	Consultant	Contractors/ Service Industry	Developer	Government/ public body	Industry body	Research/ Academia	TOTAL (%)
Government support	Yes	0	0	0	0	0	0	0	0
	No	1	1	0	3	0	2	1	26
	Insufficient/limited	0	1	0	3	2	2	0	26
	Not specified	0	0	0	1	1	0	1	10
Opportunities	Heating	1	3	0	6	3	4	4	68
	Cooling	1	3	0	1	1	2	2	32
	Power	0	1	0	5	2	3	2	42
	Agriculture/ agrifood/horticulture/ aquaculture/ industrial processes	1	1	0	2	1	1	0	19
	Repuprosing O&G	1	1	0	4	0	4	2	39
	Thermal storage	1	1	0	0	1	1	0	13
Barriers	Recognition/ Awareness/ Public acceptance	1	4	0	4	3	2	3	55
	Lack of financial support / incentives	0	4	1	4	2	4	2	55
	Regulation	0	5	0	5	1	4	3	58
	Lack of data / wells/ tools	0	4	1	4	3	2	2	52
	Expertise/ skills	0	1	0	0	2	0	1	13
	Supply chain	0	0	0	1	2	1	0	13
	Risks	0	2	0	3	1	1	2	29
	High upfront costs	1	2	1	7	2	0	1	45
	Lack of investment into sector	0	2	0	2	1	1	1	23
	Competion with other technologies	1	2	0	1	0	1	2	23
Support measures	Government support	1	4	1	7	2	2	3	65
	Regulation	1	3	0	4	1	2	3	45
	Stakeholder engagement/ education/ awareness rising	1	1	0	0	0	0	3	16
	Data acquisition (incl Seismic, exploratory drilling) & tools	0	0	0	3	0	0	0	10
	Demonstrators (data around costs etc.)	0	1	0	0	2	0	1	13
	Industry task force	1	0	0	0	0	2	1	13
	Reform of / support for spatial planning	0	0	0	0	0	1	0	3

Table 1 Identified themes and subthemes and percentage of mention categorised by stakeholder type.

3 Results

3.1 GEOTHERMAL POTENTIAL OF THE UK

There was a general agreement that the UK has potential for deep geothermal exploitation. The areas highlighted to have geothermal potential include the Southwest (Dorset, Cornwall), the Northeast (Tyne and Wear) and the Northwest (Cumbria, Cheshire, Greater Manchester) of England, Northeast Scotland and Northern Ireland.

The following geological formations were mentioned in the submissions as potential targets for deep geothermal: Mesozoic basins (Triassic / Sherwood Sandstone, Dogger Formation), Upper Palaeozoic sedimentary basins (Carboniferous Limestone) and Granite batholiths.

Five submissions highlighted potential for exploiting mine water energy in former coal mining areas and shallow geothermal technologies.

3.2 BENEFITS OF USING GEOTHERMAL ENERGY

Different uses for deep geothermal were identified in the submissions, including heating (21), power generation (13), cooling (10), as well as heat provision for agriculture, horticulture, and industrial processes (6). Several submissions mentioned repurposing of oil and gas wells (12), highlighting similarities in terms of drilling /well-testing technologies and skills between deep geothermal and oil and gas projects. Four submissions mentioned the potential for thermal energy storage.

One submission pointed out that the energy demand will increase in the future due to the electrification of residential, commercial and transport sectors. The submission highlighted that the energy demand for heating and cooling of buildings could increase between 7 – 40%. Another submission emphasized that geothermal could deliver 30% of the UK heat demand, providing heat to schools, airports, hospitals, offices and factories. Additionally, one submission pointed out that aquaculture, which provided £590 million to the UK economy in 2016, could benefit from geothermal by saving energy costs for heating.

Although not related to deep geothermal, one submission highlighted the opportunity for using abandoned, flooded mines as "Geobattery", storing excess heat in summer months in the flooded mines and re-using it for heating in winter.

Another opportunity identified in the submissions is the co-production of lithium - an essential product in electric battery production from geothermal brines (2). It was suggested by two submissions that the geothermal energy is safer than a nuclear plant. Also, one submission identified that 360 geothermal plants could provide 15 000 GWh of annual heat by 2050.

Regarding other opportunities, two submissions recognised that the development of geothermal technologies could create 10,000 direct and 25 000 indirect jobs by 2050 and support the transition of skills from 150,000 oil and gas industry staff.

One submission pointed out that the supply chain for developing geothermal technologies does not rely on rare earth or precious metals such as lithium and cobalt. It highlighted that although steel casing is required, this could be imported from overseas (China). However, another submission expressed concerns around steel pricing instability.

3.3 CURRENT BARRIERS

There was wide consensus by the submissions that government support for deep geothermal technologies is insufficient or lacking (16).

Regarding government support, the following concerns were mentioned:

> "*Little or no recognition of geothermal in government policy, planning and funding schemes as geothermal is not recognised as a natural resource / renewable resource and is should not be treated as fossil or mineral resource"*

> *"No clear rules of defines ownership, no regulatory framework for geothermal ownership, licencing, or exploration rights. Regulatory schemes are needed"*

> *"No regulation to prevent thermal interaction in between multiple heart schemes"*

> *"Policy gap to support commercial scale geothermal heating schemes"*

> *"No national system or agreed regulatory framework for managing induced seismicity from geothermal developments exists*".

Technology recognition

Many of the submissions identified concerns related to funding and financial risks, for both deep and shallow technologies. One submission highlighted that the term "geothermal" is not mentioned in the Ten Point Plan for a Green Industrial Revolution, making geothermal less visible to stakeholders and investors compared to other renewable technologies, and hence challenging to attract investment.

Risks

Main concerns identified in the submissions included lack of financial support (17) and high upfront costs (14). Some (3) submissions highlight that deep geothermal is a new technology in the UK, compared to oil and gas, and hence it experiences difficulties in attracting funding. They point out that the considerable time lag between the initial investment for exploration and drilling, and the first revenue creates a perceived risk to investors. Other submissions (11) identify additional risks related to drilling, operation and sustainability of geothermal schemes, including supply chain aspects (availability of drilling rigs), difficulties during drilling, borehole and reservoir performance issues over the project lifetime (25 years), e.g. related to rock cooling, insufficient recharge, or injectivity issues which might impact the geothermal production.

Regulation

One submission stated that local authorities lack policy power to influence developers to install heat networks in England. It also mentioned licensing issues for mine water geothermal projects and highlight a need for wider coordination. Regulatory issues were also mentioned for deep geothermal, mainly the lack of regulatory oversight and the fact that regulatory responsibilities are spread between local authorities, environmental regulators, the Coal Authority, and the Health and Safety Executive.

Environmental impacts

The submissions not always clearly identify which type of geothermal systems they refer to. In summation, environmental impacts mentioned in the submissions (in response to question posed by the inquiry) include water pollution, noise, light, transport, waste, and emissions of greenhouse gases, e.g. from deep geothermal fluids or from electricity generation where heat pumps use non-renewable electricity and gas released from deep geothermal fluids. One submission identified risk of pollution from mine water leaks and mixes with groundwater and possible land subsidence issues.

Environmental impacts do not seem to be considered as barriers by the submissions. One report expressed concern that induced seismicity is falsely understood to be a considerable risk to deep geothermal and that impact of this perception on public acceptance could limit the development of deep geothermal in systems that require hydraulic stimulation/fracturing, e.g. granites. It is recognised by one submission that a small risk exists to generate micro seismicity to a magnitude 2 to 3.2.

Seven submissions mentioned that deep geothermal has a smaller surface footprint (spatial) compared to solar and wind energy structures. One submission highlighted that geothermal wells are cased with multiple layers of steel and cement and suggest that this helps prevent environmental pollution. Three submissions further pointed out that no hazardous materials are used during drilling and that careful site design will allow to lower the noise levels during drilling.

3.4 SUPPORT MEASURES

Most of the submissions (20) suggested that more government support is required, and 14 submissions also identify a need for clear regulations. Other support identified in the submissions include engagement and awareness raising (5), and a necessity of an industry task force were highlighted as support factors (4) and data and tools (3).

Policy support

One submission mentioned that the Renewable Heat Incentive (RHI), which included a tariff for geothermal heat, was removed in March 2011 without an adequate replacement. It also highlighted that European Regional Development Funding (ERDF) is no longer available to support deep geothermal projects in the UK.

For shallow geothermal technologies, some (3) submissions suggested that support like the Contracts for Difference could benefit the development of mine water heat projects.

Regulations

17 submissions suggested an established responsibility regulator is needed that could help geothermal resources to be managed and safeguarded. Also, they mentioned that a complete regulatory framework that defines shallow and deep geothermal (with depth specified) is also required to support the development of geothermal technology while also meeting the requirements of the various stakeholders (industry, urban and rural communities).

Two submissions call for definition of geothermal with bespoke regulations within existing laws, highlighting that deep geothermal in the UK is currently regulated under the oil and gas regulations.

Data sharing

Five submissions highlight the importance of data sharing and regulation that define data ownership and sharing via a centralised data system. One submission stated that many subsurface datasets are unavailable for use outside of academic agreements with data owners.

Another called for a publicly available GIS tool to view geothermal / mine water energy opportunities. They suggest that this will support engagement and increase the visibility of geothermal/ mine water projects to the public and developers, planners, investors, and environmental regulators. That submission also said that such a tool could also map the numbers of properties that benefit from geothermal / mine water heat. Geological and geothermal installation data digitalisation was also considered to be beneficial by two submissions.

Public engagement

Most of the submissions (17) stated that geothermal technology is generally unfamiliar to the public, industry, investors, regulators, and local government, which may be acting to increase the perceived risk. These submissions identified that the resistance to change and fear of the unknown contribute to public opposition. The perceived risk is a concern in communities close to project sites, and these concerns need to be addressed by objective community engagement as suggested by six submissions. One submission mentioned that the jargon-free education and outreach programs for existing resources in mine water heat development in former mining communities would be beneficial.

It is also mentioned by one submission that public pressure has restricted geothermal development in some countries stating that much of this concern relates to perceptions around unconventional oil & gas (fracking) developments, and the perceived risk is much greater than the actual risk.

One submission stated that seismic events have occurred at all three deep drilling sites in Cornwall. Both recent projects have adopted so-called 'traffic light' systems to manage operations in response to induced seismicity. Although no induced events came close to the thresholds that would cause damage, there is a high sensitivity to the issue.

4 Summary

This report assessed written evidence submitted to UK Parliament's Environmental Audit Committee (EAC). 34 evidence reports were submitted, and out of these reports, 31 were selected after an initial screening. These reports were then qualitatively assessed using an inductive method, during which four themes were identified to develop in this study. These were the geothermal potential of the UK, the types of benefits that geothermal technology could provide, current barriers, and the required support.

Most of the reports agreed that the UK has potential both in deep and shallow geothermal technologies and could deliver 30% of the country's energy demand (heating, cooling, agriculture purposes, etc.), boosting the economy. However, many submissions identified a lack of, or insufficient government support as a barrier to the development of geothermal energy projects in the UK. They identify financial risks as one of the main barriers and highlight how measures by the UK government could support the geothermal sector, mainly through policy support and regulations. The importance of community engagement is recognised by many submissions in order to gain public acceptance of deep/shallow geothermal systems.

5 References

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