

Societal Engagement in Geothermal Energy in the United Kingdom: Early Lessons from a Nascent Sector



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Abstract Whilst still in its infancy, there has recently been an increased focus from both the public and private sectors on developing the UK geothermal sector, and the capacity for geothermal heat and electricity production is beginning to increase. In terms of societal engagement, top-down models of decision-making (initiated by project developers and/or operators) with an instrumental goal of fostering acceptance tend to dominate. From a justice perspective, this elides the important aspects of process, procedure and distribution of costs and benefits in energy projects. Yet, we have also found examples of societal engagement practices driven by other goals, such as a commitment to transparency and accountability, with some geothermal developers and operators demonstrating an “ethics of care”. We advocate for future projects to go beyond “communicating to” publics and towards “developing with” publics, to ensure that the geothermal energy sector contributes fairly to the energy transition.

Keywords United Kingdom · Ethics of care · Social acceptance · Place-washing

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1 Introduction

In this chapter, we set out the developmental stage of the UK geothermal energy sector and explore engagement carried out for specific projects. Whilst often motivated by achieving acceptance and planning permission, some UK geothermal project operators also showed an ethics of care¹ towards local communities (e.g., working to create relationships of trust with local communities; Ryder et al. under review). As the sector gathers pace, there is an exciting opportunity to push forward innovative and sector-leading engagement practices. As such, this chapter provides reflections on the UK geothermal engagement landscape and contributes to a wider discourse on the role of engagement for the development of geothermal energy and other renewable energy technologies (RETs).

1.1 Overview of the UK Energy Mix

Heating and electricity supply are key sectors for realizing the emissions reductions the UK has committed to by 2050. National Grid, the electricity system operator of England, Scotland and Wales, reports that in 2023 their network met their monthly average demand with 48.6% of the electricity provided by zero carbon sources, mostly offshore wind power (National Grid 2023a). This figure excludes Northern Ireland which is within the Irish Single Electricity Market. Fossil fuels constituted around 33% of the UK electricity supplies in 2023 (Carbon Brief 2024). However, electricity constituted only 18.5% of the overall energy demand of the UK in 2022, whilst provision of heat represents over half of the UK's energy consumption—more than that used to produce electricity or used for transport (OFGEM 2016).

Recent reports observe that the provision of heat from renewable sources only represented 8.4% of the total heat used in 2022 (Department for Energy, Security and Net Zero 2023). Geothermal energy, to date, contributes to this through ground source heat pumps (GSHPs), although recently a deep geothermal heating project has come online. Overall, the geothermal resource remains underused, and there is an opportunity for geothermal energy to contribute to increasing the production of both renewable heat and electricity generation in the UK.

¹ We use the concept of 'ethics of care' as it puts an emphasis on relationships and on responsibilities to attend to others' needs within those relationships (Bennett, 2023; Collins, 2015). The concept has started to be deployed in energy social science research, e.g., Groves et al. (2021), Damgaard et al. (2022), Gram-Hanssen (2024).

1.2 *History of Geothermal Energy in the UK*

Most of the UK's geothermal potential exists within onshore deep sedimentary basins which occur in many parts of the UK (Busby 2014). The range expected within these basins makes them most suited for use in geothermal heating applications such as district heating networks and horticulture. Radiothermal granites are also potential geothermal sources (Busby 2010), with temperatures demonstrated as suitable for electricity generation (Farndale and Law 2022).

Between 1977 and 1994, the UK's geothermal potential was investigated through a UK Government and European Commission-funded national geothermal programme (NGP). It funded seven deep geothermal boreholes, three targeting granites in Cornwall and four in deep sedimentary basins. It established one operational geothermal production well that supplied geothermal heat to the Southampton District Energy Scheme for more than three decades (Busby 2010; Gearty et al. 2008) but has recently been taken offline. The NGP provided a comprehensive review and data of the geothermal potential of the UK (Downing and Gray 1986a, b; British Geological Survey 1988), concluding that geothermal energy could represent a significant energy source. However, against the background of increasing commercial oil and gas discovery and production in the North Sea in the 1970s and 80s, it was seen as unlikely that the technology would attract timely private sector funding, and the programme was discontinued. Since then, several studies have produced updated estimates (Busby 2014; Pasquali et al. 2010; Rollin et al. 1995) or re-mapped some of the geothermal prospects (Busby and Terrington 2017; Jones et al. 2023; Abesser et al. 2023a) (Fig. 1).

Deep geothermal drilling activities restarted in 2000, including three wells in the Northeast of England, two in Northern Ireland and, more recently, three commercial deep wells in Cornwall drilled by two Enhanced Geothermal System projects; the United Downs Deep Geothermal Power project (expected to start production of geothermal heat and power later in 2024) and the Eden Geothermal Project which supplies heat to the Eden Project since 2023. In addition, several new deep geothermal projects in Cornwall are awaiting or have recently been granted planning permission. In Northern Ireland, two geothermal demonstrator projects have begun, completing site investigations for a shallow geothermal system and a deeper geothermal borehole (Gonzalez Quiroz et al. 2023).

Ground source heat pump (GSHP) technologies have been adopted throughout the UK (Abesser and Walker 2022), and though the number of installed GSHP systems has increased in recent years (Gonzalez Quiroz et al. 2023), they deliver less than 0.3% of the UK's annual heat demand (Abesser and Walker 2022). Following earlier schemes in Scotland (Banks et al. 2009), increasing interest in the geothermal use of abandoned mines in the last years (Farr and Busby 2021) has resulted in several mine water geothermal projects undergoing development or being taken into operation (Gonzalez Quiroz et al. 2023).

Recently, UK policy makers have shown increasing interest in geothermal energy as evidenced by recent parliamentary publications and debates (Sutherland et al.

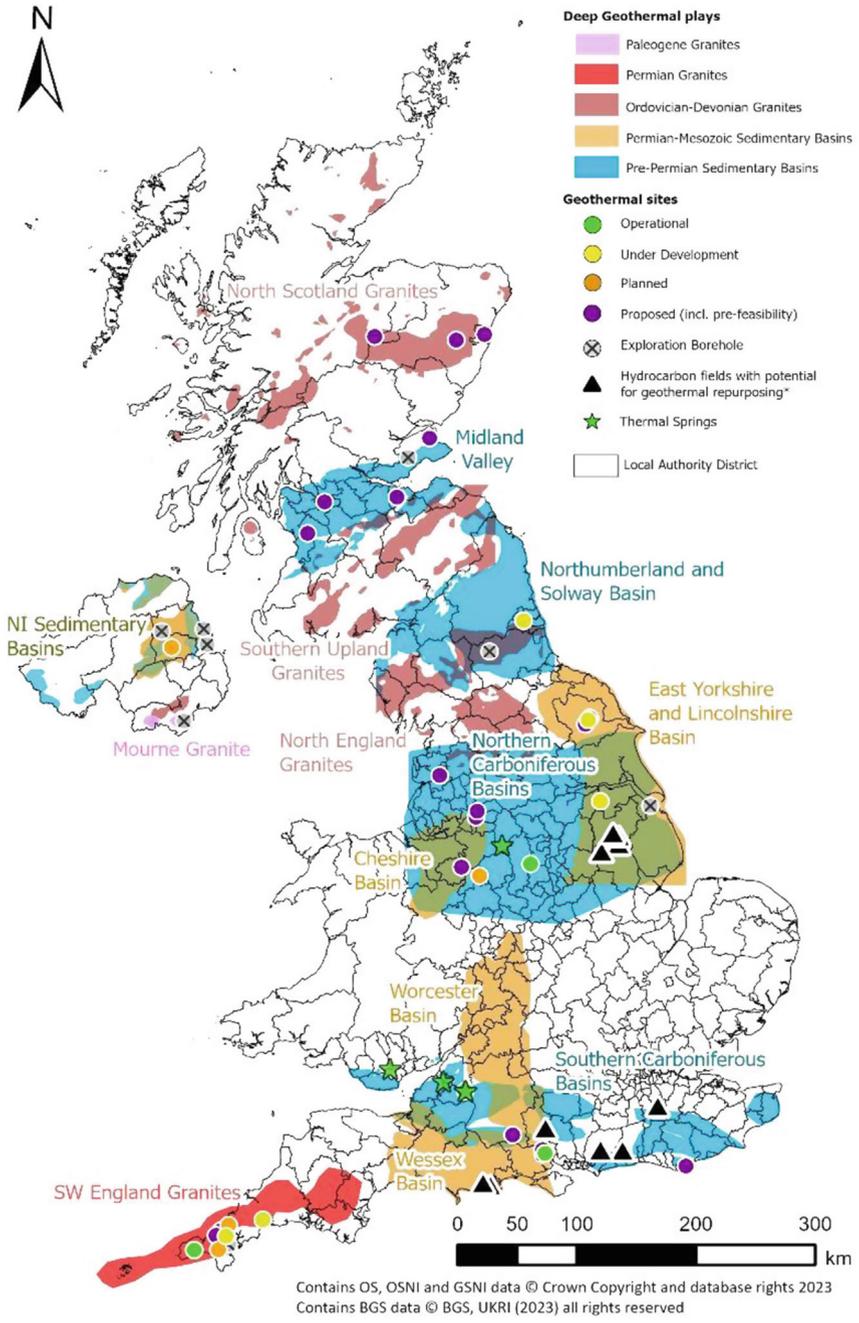


Fig. 1 Map showing the location of potential deep geothermal targets across the UK alongside selected onshore hydrocarbon fields (triangles), occurrences of known thermal springs (stars) and geothermal projects at different stages of development from pre-feasibility to operational (See Appendix 1 in Abesser et al. 2023a, b for data sources). Contains OS and GSNI data © Crown copyright and database rights 2024. Contains BGS data© BGS, UKRI (2024) all rights reserved

2021; Abesser and Walker 2022; Waitzmann 2023) and a parliamentary inquiry (Environmental Audit Committee 2022). UK government departments are showing increased interest too, commissioning several publications, including a report on deep geothermal (Mullan 2023) and white papers on mine water energy (North East LEP 2021) and deep geothermal energy (Abesser et al. 2023b). Implementing the recommendations from the latter, the Department for Energy Security and Net Zero is currently reviewing the support mechanisms for geothermal projects in the UK.

1.3 Regulatory Framework of Geothermal Energy in the UK

The regulation of geothermal energy exploitation is determined by the devolved administrations of the four UK nations. There are currently no bespoke planning rules, environmental regulation, or licensing systems specific for the planning and operation of geothermal schemes. Instead, geothermal aspects are covered by existing regulation, involving several public bodies in the regulation and control of activities undertaken during the exploration and exploitation of geothermal energy (Abesser et al. 2020). To date, Scotland is the only UK nation that has published regulatory guidance for geothermal systems (Scottish Government 2024).

For both deep and shallow geothermal systems, environmental regulatory controls are aimed at protecting the groundwater, not regulating the heat resource, or guaranteeing that the abstracted water is suitable for its intended use. For shallow systems, regulations are largely similar between the nations, with some slight variations (e.g., around arbitrary water return temperatures). Mine water geothermal systems (Adams et al. 2019) require additional written authorization from the Coal Authority and, whilst a licensing system is under review, drilling into or through a mine, and installing a borehole for heat abstraction currently require a drilling permit and agreements for borehole siting and accessing heat.

There is currently no licensing system for geothermal energy in the UK—largely because the sector is still in its infancy with few systems in operation, but also because geothermal energy is not defined or recognized in the UK legal system. Currently, it is regarded as a physical property, not a recoverable (raw) material such as other natural resources, water, or minerals. As such, ‘heat’ is not a legally defined entity, and this causes difficulties when it comes to assigning legal ownership and regulating the use of the resource (Abesser et al. 2020; McClean and Pedersen 2023).

2 Geothermal Energy and Society

2.1 *Low Awareness of Geothermal Energy and Spillover Risks from Other Technologies*

Research shows very low levels of public awareness of geothermal technologies in the UK (Addario et al. 2020; Dickie et al. 2020). Perhaps due to this and the nascent state of the sector, research into UK perceptions of geothermal energy is lacking (Tiroto 2022). However, inferences about geothermal energy can be made from research on other subsurface interventions, as we explore next.

Accessing deep geothermal energy can mirror subsurface techniques used in shale gas development, a practice met in the UK with much public concern and controversy (Ryder and Devine-Wright 2022; Short and Szolucha 2019). When initially surveyed in 2012, shale gas was supported by most UK residents. However, this support had dropped rapidly by December 2013, and has remained below 50% since (Ryder et al. 2020). According to Ryder et al. (2023), risk perceptions, notably around induced seismicity, were important to the public and in local communities where exploration was proposed. It is unknown whether the public concerns over technical and social aspects of shale gas projects will impact how deep geothermal developments are perceived and experienced.

Importantly, shale gas opposition was also driven by concerns about the impacts of fossil fuel on the climate (Chilvers et al. 2018). The renewable nature of geothermal energy may mean that people respond to it and its associated risks differently. Low awareness of subsurface technologies restricts the ability of publics to express strong opinions about geothermal energy. However, when publics were given information and a space to speak openly about the risks and benefits of subsurface technologies including shallow mine, and deep geothermal in participatory workshops, levels of support increased (Dickie et al. 2020). In contrast, Westlake et al. (2023) proposed that negative perceptions of shale gas may negatively impact perceptions of deep geothermal energy. In our own research related to operational geothermal sites in the UK, we observed generally positive community attitudes to the technology.

2.2 *Overview of Engagement Practices with Energy Projects*

Research on community engagement with RETs in the UK has prioritized wind (Devine-Wright 2009; Fournis and Fortin 2017), with some work on engagement practices for tidal (Devine-Wright 2011; Hooper et al. 2020) and solar (Barnett et al. 2012; Peters et al. 2018) projects. Research across RETs highlight the dominant instrumental view of engagement used to foster social acceptance (Chilvers et al. 2018). Some wind project developers discuss the need for engagement to go beyond instrumental benefits, but often focus on awareness raising and consultation—both

top-down approaches—and the lasting damage of perceived engagement bad practice (Aitken et al. 2016). Recently, San Martin et al. (2022) found that project developers and regulators can implement meaningful community engagement and benefit sharing, and that perceived fairness of projects and engagement should be prioritized.

Beyond RETs, recent community engagement failures in the UK shale gas industry have also been documented, where institutional framings of fracking did not align with public concerns (Williams et al. 2017) and community engagement efforts were seen as insincere and insufficient (Short and Szolucha 2019; Ryder and Devine-Wright 2022).

Community engagement in geothermal energy projects is currently under-researched, although some notable exceptions include a perspective piece on community participation in minewater geothermal technologies (Roberts et al. 2023) and a completed project on public perceptions of geothermal power in Cornwall.² At the time of writing, the authors' own research as part of a Ph.D. project (Hambley 2024) and a small study (Ryder et al. under review) make up much of the UK work in this area. A Web of Science literature search conducted in March 2024, found just one study briefly describing engagement activities in a potential mine-water project in South Wales (Brabham et al. 2020). In addition, a 2020 report makes one mention of an “example of successful public engagement” (Abesser et al. 2020) at UDDGP, described in a conference paper as “community outreach”, with “education programmes” (Ledingham, Cotton and Law 2019) (see Sect. 2.3.2). We are aware of ongoing interdisciplinary work also on minewater geothermal energy in the North East of England,³ which includes an anthropological perspective.

In his research across three sites (The UDDGP Project, a power and heat generation project; UKGEOS Cheshire, a research facility testing energy storage; and UKGEOS Glasgow, a research facility investigating mine-water heat energy and storage), Hambley (2024) studied how geothermal operators experience place relationships during engagement practices. He observed that operators predominantly reported experiencing public concerns about their project, and that operators' expectations of publics are often different to the publics they experience. Hambley researched how these experiences and interpretations in turn impacted on engagement exercises, e.g. when operators interpreted their projects as contentious, they focused more resources on engagement, and changed their approaches to engagement, at times thanks to having fostered strong relationships with local publics.

In a smaller study investigating operator and community experiences of community engagement (Ryder et al. under review), we observed that operators' values and attitudes impact on the design and implementation of community engagement practices. We found that where operators placed value on transparency, honesty, trust-building, and respect of local communities, therefore demonstrating an ethics

² Further details can be found here: <https://www.plymouth.ac.uk/research/institutes/sustainable-earth/deep-geothermal> (accessed 09 July 2024), although we could not identify much published work from this project. We did identify a related unpublished thesis (see Tiroto 2022) and conference abstracts (e.g., Tiroto et al. 2019).

³ For further details, see <https://gems.ac.uk/research/> (accessed 09 July 2024).

of care, community engagement practices tended to be early, two-way, and responsive to place-based needs.

2.3 A Spectrum of Engagement Approaches and Activities Across Various Scales

2.3.1 Social-Scientific Research in Which Citizens and Stakeholder Share Their Views Around Geothermal Technologies and Developments

Social-scientific work researching citizens and stakeholder views and perceptions of geothermal technologies has predominantly focused on public awareness and perceptions of ground source heat pumps and less on deep geothermal project or mine-water projects, with some exceptions.

Ground Source Heat Pumps (GSHPs)

Surveys conducted within the UK have shown that public awareness of ground source domestic heat pumps is low (Addario et al. 2020; Whitmarsh et al. 2011) for reasons that are unclear. Addario et al. 2020 (p. 21) note that awareness varies across socio-economic groups (e.g., groups with higher income tend to know more about GSHPs than others), whilst Whitmarsh et al. (2011) found that negative perceptions of GSHPs included perceptions that GSHPs may not be as environmentally friendly as thought and that they require a lot of land. However, Phillips and Seaford (2021) observed widespread public support for an ambitious approach to the decarbonization of heat that prioritizes the installation of heat pumps alongside the insulation of UK buildings. Members of the Climate Assembly UK (2020) showed a high level of support for heat pumps, emphasizing the absence of emissions at point of use, location versatility (with particular emphasis on rural usage), and technological maturity and safety. Negative public perceptions around GSHPs focused on installation costs and a lack of grant funding or subsidies, additional changes to existing heating systems through e.g., new radiators, but these contrast with positive focuses on lower costs and the provision of support and warranties (Smith et al. 2024).

Other Geothermal Technologies

For larger scale geothermal energy developments, research exploring the perceptions of publics surrounding the deep geothermal project at United Downs Cornwall found that whilst there was a general positive evaluation towards the technology through historic links to mining within communities, this positive evaluation was contrasted with perceived procedural unfairness in decision-making which resulted in more negative perceptions of the project (Tiroto et al. 2019).

Using a nationally representative sample, Westlake et al. (2023) showed that perceptions of hydraulic fracturing can spillover into deep geothermal⁴ and lead to negative perceptions of the technology both when participants were given varying levels of information about the two technologies, and when unprompted (which they term *spontaneous spillover*) as publics draw connections between the technologies themselves. As the geothermal energy sector matures, those within the sector may therefore need to be aware of wider discourse around alternative RETs, as well as technologies that may share similar characteristics or are currently the subject of both national, regional, or local debate.

2.3.2 Public Consultations Commissioned by Public Authorities, Private Actors or Civil Society Organizations

In this section, we focus on project-related engagement, where most societal engagement work on geothermal energy has been carried out in the UK. Whilst specific mechanisms and exercises undertaken by geothermal project developers vary, the rationale for engagement across the UK examples primarily focuses on instrumental, developer instigated, top-down engagement undertaken to gain acceptance and planning permission. Whilst an instrumental rationale dominates, it did at times co-exist with substantive and normative engagement rationales (Demski 2021), with examples of geothermal project developers conducting engagement that goes beyond minimum requirements. In this sub-section, we set out four key instances in which engagement has been conducted for specific developments. These are:

- The United Downs Deep Geothermal Power project (UDDGP)—Cornwall, England.
- United Kingdom Geoenergy-Observatories (UKGEOS) Cheshire, England.
- UKGEOS Glasgow, Scotland.
- Eden Geothermal—Cornwall, England.

United Downs Deep Geothermal Power Project (UDDGP)

The UDDGP project is the first geothermal power plant in the UK. It developed and delivered a considerable (and as of writing, ongoing) engagement strategy. Project developers for the UDDGP project were mostly local, with local staff, resulting in considerable internal local knowledge and established social capital with local publics. The engagement programme was broadly split into two programmes of (1) education, and (2) community outreach.

Education focuses on students aged 7–21 with exercises tailored to age groups and education stage. Cotton et al. (2020) describe how they also used different techniques

⁴ We note that in this study, the authors use the term ‘deep geothermal’, ‘enhanced geothermal’, and ‘deep enhanced geothermal’. Importantly, in terms of the focus groups they carried out, they state “We emphasize that the information provided to participants explicitly discussed ‘enhanced geothermal systems’ (that is, those involving fractures in the rock)” (Westlake et al. 2023).

to suit different learning styles ‘visual’ with an animation of a water molecule character, and ‘written’ with a worksheet to evaluate understanding. For older students, project developers provided nine secondary schools (ages 11–16) with seismographs as part of a network monitoring Cornwall’s seismic events, and for students aged 16–21 project developers focused on attending career fairs and providing work experience opportunities (Holmgren and Werner 2021; Ledingham et al. 2019). A conscious effort was made to attend events specifically aimed at encouraging young women to enter geoscience, in line with the Women in Geothermal (WING) and Girls into Geoscience initiatives.

Community Outreach was split into three stages, shown in Table 1 alongside the different engagement mechanisms, where most are categorized as communication (Rowe and Frewer 2005).

The two programmes form an approach to reach ‘middle generations’ (i.e., working generations) who were perceived as harder to reach (Hambley 2024). These ‘middle generations’ were engaged through the UDDGP team’s attendance at county shows and summer fairs, which attract large number of visitors from a range of backgrounds but were otherwise sought through word of mouth. Younger generations were engaged through the education programme, whilst older generations were engaged at community coffee mornings during traditional working hours. A staff member was

Table 1 Engagement mechanisms at the three stages of UDDGP project community outreach engagement

Stage	Engagement mechanism
A year in advance of drilling	<ul style="list-style-type: none"> • Public information events held in community centres • Hand delivery of information flyers to homes and businesses • Formation of a Community Liaison Group • Attendance at local Parish Council meetings to present project plans • Creation of a dedicated project website and social media feeds • Education programme (continuous throughout the project)
Six months prior to drilling	<ul style="list-style-type: none"> • Appointment of a Community Relations Manager • Introductions to local community groups • Regular updates on the website and social media feeds • Regular updates to village and parish magazines and newsletters • Attendance at summer fairs and other community events
During drilling	<ul style="list-style-type: none"> • Public drop-in sessions (open days) at the drilling site • Presentations to interested groups, both on-site and at other locations • Drilling updates to the project website and social media feeds • Visiting local community groups on a regular basis • Repetitive attendance at local summer fairs and shows to reach a wider geographical audience • Contributions to the local economy (including a community grant fund)

Adapted from Cotton et al. (2020)

specifically hired to attend meetings of existing community groups, benefits of which were described as removing the barriers of engagement opportunities being attended only by those with the time and ability to travel (Farndale and Law 2022). Through this hire, project developers perceived they were able to overcome the distrust that Tiroto et al. (2019) suggest arose due to perceptions of procedural unfairness. As these regular visits began during drilling, as opposed to a year in advance (see Table 1), project developers may have implemented a shift from a uni-directional flow of information to a two-way flow of information too late for publics to perceive that they are being procedurally included with decision making.

UK Geoenery Observatory (UKGEOS) Cheshire

The UKGEOS observatories are developed by BGS as research facilities for collecting data and knowledge on different geothermal technologies: energy storage (UKGEOS Cheshire), and mine-water geothermal (UKGEOS Glasgow).⁵ Whilst some staff had local knowledge of the proposed regions (Cheshire, Glasgow), BGS had different prior organizational presence in each location. The extent of engagement for these projects varied, with UKGEOS Cheshire allocated more resources (capital expenditure, staff hours, etc.) than UKGEOS Glasgow (Hambley 2024). In Glasgow, BGS had prior collaborations with Glasgow City Council, Clyde Gateway and Scottish Government, which is partly how a location was chosen (Starcher et al. 2021).

Similarly to the UDDGP project, engagement mechanisms used for UKGEOS Cheshire mostly fall under *communication* (Rowe and Frewer 2005), primarily consisting of taking scientists and engagement specialists to drop-in sessions (one daytime, one evening) at community hubs. These drop-ins were held in towns around the drilling site, as project developers focused on engaging publics at a regional scale. At the drop-ins, project developers used a large satellite floor map of Cheshire that publics could stand on and locate themselves in relation to the proposed drill site and pinpoint important personal landmarks (Fig. 2).

Project developers perceived the floor mat as *the* successful element of the engagement as it enabled publics to relate the project to their place and project developers to experience a wider array of place relationships (Hambley 2024). This was supplemented by opportunities for project developers to speak at regular meetings of local groups (e.g., wildlife groups), enabling project developers to widen project boundaries and deliver engagement opportunities in collaboration with publics (Ibid).

UKGEOS Glasgow

Engagement for UKGEOS Glasgow was similarly grounded in an instrumental rationale, but whilst the engagement rationale was similar, engagement conducted for UKGEOS Glasgow had two key differences from UKGEOS Cheshire.

⁵ An affiliated geo-observatory in Cardiff explores groundwater movement in geologies impacted by industrial and urban development but did not conduct sufficient engagement for inclusion in this chapter.



Fig. 2 Images of Cheshire floor map at community drop-in sessions. Credit BGS © UKRI (2024)

Firstly, BGS developed their already existing relationship with a local regeneration company. The company had a history of development in the area of Glasgow where UKGEOS is located, but more importantly was trusted by local publics due to its prior approaches. Previous developments, ranging from creation of a park to the placing of park benches, were implemented with procedural inclusion of publics in decision-making, including the rejection of a proposed office block due to the local community preferring to reserve the land for alternative future projects. Therefore, this local company with local staff were largely trusted by local publics. Project developers reflected that this level of trust was highly beneficial in gaining the trust of specific publics and enabled UKGEOS Glasgow to engage with publics that may have been difficult to reach (Hambley 2024).

The second key difference between UKGEOS Glasgow and Cheshire is the engagement with a difficult to reach community. Whilst engagement for UKGEOS Cheshire focussed on engaging publics regionally, engagement for UKGEOS Glasgow primarily focused on a community directly adjoining the site. Engagement with this specific community began with an initial drop-in session but evolved collaboratively. Notably, engagement professionals within the development team were invited to the homes of certain community members and began to add information to a physical community notice board. Community leaders were specifically

engaged to support dissemination into the wider community. As a result, project developers were able to deliver engagement exercises in collaboration with publics and whilst the project itself was not co-productive, the engagement did become progressively more co-produced (Hambley 2024).

Eden Geothermal Project (EGP)

The Eden Geothermal Project's core aim is to decarbonize the heat supply of the Eden Project's biomes. We found that the team at the EGP held community members in high regard, and were concerned with ensuring that their opinions and feedback were respected, which most notably led to abandoning a windfarm following community feedback to pursue a geothermal project instead. In terms of engagement good practice, the EGP team made itself available to members of the public, being praised for being approachable and responsive. They did this in part by establishing and maintaining a community liaison group, and by relying on those embedded in the local community to lead some of their engagement efforts. Particularly, they made a point of being honest and transparent about unknowns relating to the project, or when things did not go exactly to plan. For instance, they paused operation after testing led to induced seismicity in March 2022, informing the local community and resuming a week later. They have also paid particular attention to the redistribution of benefits from the project, creating a community fund with little barriers to application for community organizations who know their community's needs best to fund local projects, such as a mobile food truck during the COVID19 pandemic.

2.3.3 Empowering Citizens Through New Energy Systems, Such as Energy Communities

Community energy faces challenges in the UK from complicated regulations and legal frameworks that prioritize large-scale operators over smaller connections. As such, it requires considerable expertise and effort to successfully implement community energy projects (Brummer 2018).

In this landscape, community heating projects are rare. A guide for community energy organizations to develop community heat projects (National Grid 2023b) highlights different types of community heat options, several of which include geothermal technologies (e.g., street and neighborhood heating with shared ground source heat pump) and provides a small number of examples of project using these technologies (albeit not all in the UK). Several of those are at the proposal stage and there was limited information on the extent to which communities were engaged or leading. For instance, the information we could find about a project for the communal heating of a single building through ground source heat pump seemed to be developer-led.

2.3.4 Media Analysis

Contrasting the volume of media analysis on shale gas (e.g., Bartie et al. 2023; Neil et al. 2018; Stephan 2017), we could only identify one example of media analysis on geothermal energy in the UK (Willems et al. 2021). Using newspaper analysis, it found that the UK public appears to be supportive of geothermal energy across different regions, and identified induced seismicity and environmental pollution as potential concerns. The research shows a concerted sectoral effort to associate geothermal with other RETs and carbon reduction, and distance the practice from shale gas. This is likely to require continuous work considering the findings from Westlake et al. (2023) discussed earlier on spillover effect.

2.4 Summary Table

In Table 2, the examples represent engagement carried out for specific developments. The primary impact of these engagement activities is that operators modified aspects of the projects as a result of perceived contentiousness of the projects, with these representing sensory experience driven changes (e.g., efforts to reduce noise), changes to avoid disrupting regular behaviors (such as commuting), and to ensure transparency and responsiveness (Hambley 2024). As a result, the impact of the engagement described in the table is specific to the projects, with impacts on wider policy or national governance not identified in the UK sectoral context.

3 The Future of Geothermal Energy in the UK: Raising Public Awareness and Going Beyond Social Acceptance

Whilst a small number of surveys and studies have started to tease out public views of geothermal energy, they have tended to be small scale (Tiroto et al. 2019) and to try and gauge what could be inferred about geothermal technologies when compared to other technologies (Westlake et al. 2023) rather than investigate geothermal energy technologies in and of themselves. Still, they have drawn out useful messages in terms of a potential ‘spillover effect’ both from similar technologies or from other energy projects. One notable exception to the lack of research on perceptions of geothermal energy in the UK is work by Tiroto et al. (2019), which focused on perceptions of deep geothermal around a site in Cornwall and found generally positive attitudes towards the project. This leaves many open questions about how different publics perceive geothermal energy in the UK and what the impact of those perceptions might be on the future of the sector. As a result, there is an urgent need to raise awareness of the huge potential that geothermal technologies can play in reaching the net zero goals of the UK government.

Table 2 Sample of UK geothermal projects and their related engagement activities

Name describing the engagement experience and date of implementation	Methodology	Committing authority	Funding body	Objective	Actors engaged in the process	Territorial level	Geothermal technology	Impact and outcome
1. United Downs Deep Geothermal Power Project	<ul style="list-style-type: none"> - Two-pronged approach focusing on (1) education and (2) community outreach - Engagement exercises delivered in the homes of publics - Presentations to elected officials 	Private actors	European regional development fund	Gain planning permission Outreach and widening participation	<ul style="list-style-type: none"> - Schools - Community Groups - Elected Officials 	Regional	Deep geothermal	<p>Outcome:</p> <ul style="list-style-type: none"> - Project successfully developed <p>Impact:</p> <ul style="list-style-type: none"> - Community grant fund of £20,000 per well - Project details were changes after engagement with publics - Project details altered as a result of community engagement

(continued)

Table 2 (continued)

Name describing the engagement experience and date of implementation	Methodology	Committing authority	Funding body	Objective	Actors engaged in the process	Territorial level	Geothermal technology	Impact and outcome
2. UKGEOS Cheshire	<ul style="list-style-type: none"> - Drop-in sessions for publics at community hubs in surrounding conurbations - Targeted events for key elected officials and sectoral leader 	BGS	Natural Environment Research Council/UK Research and Innovation	Gain planning permission	<ul style="list-style-type: none"> - Regional communities groups - Elected officials - Sectoral leaders 	Regional	Research laboratory	<p>Outcome:</p> <ul style="list-style-type: none"> - Project development underway <p>Impact:</p> <ul style="list-style-type: none"> - Project details were changed after engagement with publics - Project details altered as a result of community engagement

(continued)

Table 2 (continued)

Name describing the engagement experience and date of implementation	Methodology	Committing authority	Funding body	Objective	Actors engaged in the process	Territorial level	Geothermal technology	Impact and outcome
3. UKGEOS Glasgow	<ul style="list-style-type: none"> - Drop-in sessions for publics at community hubs - In-depth engagement with neighbouring communities - Engagement exercises delivered in the homes of publics 	BGS	Natural Environment Research Council/UK Research and Innovation	Gain planning permission	<ul style="list-style-type: none"> - Neighbouring community - Regional communities - Local elected officials 	Local	Mine water geothermal	<p>Outcome:</p> <ul style="list-style-type: none"> - Project successfully developed <p>Impact:</p> <ul style="list-style-type: none"> - Deepened operator—public relationships - Project details were changed after engagement with publics - Project details altered as a result of community engagement

(continued)

Table 2 (continued)

Name describing the engagement experience and date of implementation	Methodology	Committing authority	Funding body	Objective	Actors engaged in the process	Territorial level	Geothermal technology	Impact and outcome
4. Southampton District Heating Scheme	<ul style="list-style-type: none"> - Creation of environment forum 	Southampton City Council	<ul style="list-style-type: none"> - Multiple over years including: Southampton City Council - Department of Energy and Climate Change - Department for Energy Security and Net Zero (to the whole heating scheme, not solely the geothermal component of it) - Operator 	Gain planning permission	<ul style="list-style-type: none"> - Local communities - End users/customers - Businesses 	Local	Direct heat from deep geothermal, as one of multiple heat sources	<p>Outcome:</p> <ul style="list-style-type: none"> - Project successfully developed; has been operational for over 30 years, but geothermal component has recently been taken offline by the operator

(continued)

Table 2 (continued)

Name describing the engagement experience and date of implementation	Methodology	Committing authority	Funding body	Objective	Actors engaged in the process	Territorial level	Geothermal technology	Impact and outcome
5. Eden Geothermal Energy Project	<ul style="list-style-type: none"> - Creation of community liaison group - Transparency and responsiveness - Redistribution of benefits 	Private actors	EU Regional Development fund	Gaining planning permission Facilitating knowledge exchange	<ul style="list-style-type: none"> - Community Liaison Group - Community leaders 	Regional	Deep geothermal	Outcome: - Project successfully developed Impact: - Ongoing positive relationships between operators and local communities - Project pivoted from wind energy to geothermal as a result of community engagement

In terms of community engagement with decision-making around geothermal energy projects, there are a few ongoing projects that are either exploratory or operational, meaning that the opportunities for investigating engagement are equally low. Across our own work and the studies reviewed in this chapter, we have found that engagement tends to be viewed by operators as a way to foster support and acceptance in the planning permission process, and that the behaviors of publics engaging with a given project can often be framed as ‘raising concerns’ instead of as ascertaining place-technology fit (Hambley 2024). At the same time, in another piece of research we conducted (Ryder et al. under review), we found evidence of geothermal operators going beyond the minimal requirements of engagement within the framework of planning application to include continuous engagement guided by an ethics of care, including where relationship building was perceived as being just as important as social acceptance. As a result, in our small study, community participants expressed mostly positive views of operators and geothermal technologies.

Up until now, in the UK, societal engagement around geothermal technologies is top-down and overwhelmingly initiated by operators. We were unable to find an example of deliberative or co-produced⁶ engagement, although we acknowledge that in some cases (e.g., Eden Geothermal Project), projects were responsive and flexible to feedback, and in many occasions had a strong commitment to taking into account the needs and wants of local communities. This also raises important questions about who should initiate engagement activities, what mechanisms exist for publics to engage and what support they may need to, for instance, initiate engagement, especially as we know that there are examples of co-produced geothermal projects in other countries (Hildebrand and Klein 2022). This is an important gap as research in other areas has shown that co-produced projects, or projects that included deliberative elements can be perceived as procedurally fair and increase community ownership and support of a project (Devine-Wright 2009). This is also not to say that the positive views expressed in our research are ‘definitive’. Indeed, one geothermal operator that was praised for their continuous engagement has recently received some community pushback to another project (Trehwela, 2023; Whitehouse 2023).

Perceived levels of inclusion, as well as the extent to which a project is perceived to fit with existing place images can all impact on the likelihood that publics trust project developers and accept a project (Firestone et al. 2018). As argued however, engagement for geothermal should focus beyond the instrumental rationale of fostering acceptance and gaining planning permission, and move towards co-producing geothermal energy projects with publics. As part of this, geothermal energy operators will need to consider the relationships with place that are held by the local publics that they are engaging with. Hambley (2024) suggests that engagement that superficially engages with the subjective meanings and place relationships

⁶ We recognise that co-production can take many different forms. Here, when looking for examples of co-produced engagement, we were searching for instances where communities had either a leading or equal role to developers/operators in initiating and developing geothermal projects. Examples outside the UK exist (see for instance Hildebrand and Klein 2022).

associated with place with the goal to suggest place-technology fit represents ‘place-washing’. Operators that undertake place-washing, whether consciously or not, are likely to encounter challenges from local publics to the constructions of place in operators’ messaging and engagement. In addition, projects that have not authentically engaged with publics are more likely to fit with operator images of place than those held by publics. This can be problematic once project developers engage with publics, who may subsequently both challenge these images of place and interpret projects as threatening to held place relationships as a result of misaligned place images. As such, operators with local links to projects may be able to engage with publics in more depth to co-produce projects that authentically fit with place, and all operators, especially those without local links, may need to scope the surface for subjective meanings associated with place at the same depth that the subsurface is scoped for appropriate geology.

There are several other challenges the sector faces in the UK (as summarized in Abesser et al. 2023a), which we have not explored here. They include high project costs and risks, low visibility in government strategies, limited government support and investment and limited data availability and accessibility. While some funding mechanisms exist for geothermal energy projects, these are perceived as insufficient by many in the sector, especially for geothermal heat projects, and when compared to support available in other European countries.

Finally, we have observed that the UK research landscape on geothermal energy is dominated by geoscience disciplines, and that policy-facing evidence and reports tend to neglect social sciences and humanities evidence. This is apparent for example in the evidence submitted to the parliamentary enquiry that ran in 2022. Out of 34 submissions, only three brought forward social science evidence. In another example, the recent white paper on mine-water energy (North East LEP 2021) does not mention community engagement as an aspect of technology deployment. Failing to include social science evidence and expertise runs several risks, such as perpetuating common myths about citizens and communities (e.g., as being NIMBY, which has been debunked multiple times in past research, see e.g., Burningham 2000; Devine-Wright 2009), neglecting the needs and wants of communities, and reinforcing pre-existing injustices. Interdisciplinary collaborations across Social Sciences and Humanities and Natural Sciences can be productive and effectively bring together different aspects pertaining to the geothermal sector (see for example Rohse et al. 2024, including on how the technical specificities of geothermal developments impact on societal engagement). Interdisciplinary collaborations have the potential to support the scaling up of geothermal technologies in a way that is fair to communities and should be supported.

4 Conclusions

4.1 Summary

We have outlined the history of development of the geothermal sector in the UK, highlighting that despite exploratory programmes in the 1970s and 1980s that demonstrated its potential, the sector did not take off at that time. There has been a renewed interest in geothermal energy in the context of the net zero agenda and of efforts to decarbonise heat and electricity production, yet a lack of technology recognition in government strategies, high project costs and lack of a regulatory body with responsibility for geothermal energy have been identified as potential barriers for the sector development (Abesser et al. 2023a, b; Hambley et al. 2023). We have also emphasized how various research projects have shown there is broadly low awareness of geothermal energy within the UK public. This body of work is small and inconclusive on whether geothermal energy is perceived positively or negatively and why. Overall, there is perhaps more evidence that people feel positively towards geothermal energy, whilst concerns have been raised regarding a spillover effect from similar technologies.

The low number of live projects also means that there is limited research into the engagement practices of operators and the capacities of communities to engage with projects. The research that does exist demonstrates that societal engagement in the geothermal industry in the UK is predominantly top-down as it is initiated by operators. In our research and in the process of writing this chapter, we have observed that so far, publics in the UK have not been engaged through deliberative or dialogic mechanisms, and as such the geothermal energy sector has not yet been informed through co-production. Similarly, we could not find any examples of co-design activities to shape geothermal energy projects or financial mechanisms in the UK. During engagement for UKGEOS Cheshire, UKGEOS Glasgow, and UDDGP project, operators made changes to project details as a result of engaging with the public, but this was more as a mechanism to reduce perceived contentiousness than to co-design projects (Hambley, 2024). We also acknowledge that the Eden Geothermal Project (see Sect. 2.3.2) was initially meant to be a wind project, but due to feedback from local communities, this was changed to a geothermal development.

Overall, it appears that operators' motivations for engaging vary within projects and from one project to another, and can be guided by instrumental rationales, around ensuring social acceptance and gaining planning permission, and also by an ethics of care, and a desire to respond to the needs and wants of local communities, and work in partnership with them.

4.2 Further Studies

Considering that the UK geothermal sector is on the cusp of gathering pace, there are many opportunities for future studies to support, monitor and evaluate the sector's relationship with the wider UK society. A first step would be to conduct a large-scale survey of attitudes and perceptions towards geothermal across the country, paying particular attention to the devolved nations as their administrations are responsible for regulation of geothermal schemes. We could also envisage that this survey be repeated longitudinally as the industry becomes more established. Second, qualitative research focusing on communities local to geothermal developments is also lacking. The qualitative research that does exist is small scale and place and time-bound (e.g., Tiroto et al. (2019) conducted four focus groups with a total of 33 participants near a specific location in Cornwall, specifically before the start of drilling in a deep geothermal energy project). Our own qualitative research has predominantly focused on the views of regulators and project developers and/or operators, with only a small sample of community members interviewed on their perceptions of a specific project (i.e., developments that were local to them, specifically deep geothermal projects).

Future qualitative work could helpfully gather the perceptions and experiences of more people, not only around deep geothermal but also about other technologies such as mine water energy. This strand of research would also benefit from being longitudinal, recognizing that a key recommendation around societal engagement is that it should be continuous and repeated across projects, even where the same operator is proposing new projects. Whilst the qualitative research conducted so far on perceptions and engagement in geothermal projects has mostly relied on qualitative interviews, we propose that participant observation would be an interesting method for future research to keep building a picture of good practice and challenges encountered by operators in their societal engagement endeavors.

Finally, whilst the numbers of community heat projects are currently very low in the UK, a good starting point would be desk-based research to catalogue those initiatives and classify them based on the type of technology they are deploying. Then, researchers could dig deeper into how each of those projects are empowering citizens and communities to be involved in energy communities.

4.3 Policy and Engagement Considerations

There are several policy and practical implications from the work that we have presented above, that are of potential relevance to policy makers and operators.

Firstly, we would encourage a shift away from considering engagement as an (optional) add-on and move towards valuing it as an intrinsic part of project development and implementation. This could be facilitated by reviewing the current engagement requirements during planning and considering a policy framework that rewards early (e.g., before planning) and continuous engagement that is meaningful and

gives a voice to communities (e.g., through deliberative processes). Defining long-term engagement as a planning condition and/or project evaluation criteria for future energy projects could ensure that engagement activities are properly considered, staffed, and costed as part of overall project planning and budgeting. Embedding a culture of engagement within projects and businesses will require staff that have the necessary skills in societal engagement beyond communication and Public Relations. Advance planning and consideration are needed to ensure that training programmes and professional development opportunities in public and societal engagement are created, and that community engagement practice is more widely recognized as a career option in its own right.

Secondly, we recommend that operators consider developing an ethics of care (Ryder et al. under review), which includes, but is not limited to, building trust through transparency, information sharing, being approachable and available, tailoring engagement, acknowledging project risks and uncertainties as well as acknowledging mistakes, and putting strategies in place to correct them. An “ethics of care” is oriented toward the recognition of relationality, interdependence and moral obligation, and can be applied to energy systems (Damgaard et al. 2022; Groves et al. 2021). In this context, an ethics of care approach can foreground relations between communities and operators “based on mutual understanding and respect for difference” (Bussu et al. 2021, 677). The approach acknowledges that power relations exist between communities and operators, and in practice works to create equitable relationships, where communication is open and transparent, and collaboration is valued. Communities benefit from an “ethics of care” approach because they are able to participate in decision-making about projects that will impact their daily lives, and they have an opportunity to share their personal and experiential knowledge in safe spaces where this knowledge is valued. In turn, developers benefit from an ethics of care because they get an opportunity to work with and for local communities, not in spite of them. This can help them to gain community trust and secure a Social License to Operate (Barich et al. 2022) in the first place, and to work towards continuing to strengthen relationship building in the long term.

We advocate that operators focus on matters of community concern (Stewart and Lewis 2017) by truly engaging with and understanding communities’ needs and wants, rather than tackling technical and technological issues only. Finally, we highlight the need for operators to avoid ‘Place-Washing’, wherein superficial framings of place are developed and instrumentalized by superficially engaging with publics and place to suggest Place-Technology Fit rather than coproducing projects with publics (Hambley 2024). In practice, this requires operators to focus their initial scoping beyond the physical, geological characteristics of place to include the subjective meanings, social characteristics, and lived experiences of publics.

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