

Regulation and public decision making in geothermal energy

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Executive Summary

The potential for geothermal energy resources to play a key part in reaching the UK's Net Zero target is significant (Abesser et al., 2020). However, geothermal energy developments are yet to take-off in the UK. In July 2022, the "Underground energy on the ground" project hosted a workshop in London with academic, industry and policy representatives. International speakers from the Netherlands, Republic of Ireland (ROI) and Italy gave their country-perspective on geothermal energy resources, focusing on the themes of regulations, community engagement, and driving a national agenda. The Underground energy on the ground team shared their preliminary findings from research in the UK on regulations and engagement within the 'deep' geothermal sector. Through the presentations and interactive sessions, the following set of key messages emerged:

- **Financial support** (e.g., financial incentives; risk mitigation and insurance schemes), coordinated and supported by government is needed. This should be on a phased basis with supports for pilot projects to demonstrate feasibility and encourage financial investment.
- **Comprehensive regulation, identifying the regulators** and a clear scheme for how the regulations are implemented and revisited as the sector progresses are required.
- **Good practices of community engagement need further development:** collaborative, transparent, inclusive and informative engagement throughout the lifespan of geothermal developments will be key to building trust in the technology, the sector, regulators and policy-makers alike.
- **Further data, as well as sharing of data** between operators but also with academics, governments and the public are needed. Who should be producing the data and where it should be held, and whether this should be an obligation are important questions to be addressed.
- **Creating an environment which values collaboration**, including collaborations across the energy sector (i.e., cross-technologies), can help facilitate data sharing and enable the transdisciplinary policy, regulation, industry, and academic research necessary to ensure the role of geothermal energy in the UK's future energy mix.

Workshop Background and Context

There is an increased emphasis on the potential contribution of geothermal energy to the UK's energy mix. The UK's Net Zero target, Green Growth and Levelling Up agendas, together with more recent concerns around Energy Security have drawn attention to a wide range of renewable technologies, including geothermal energy. This has resulted in the production of a White paper on mine water (NELEP, 2021) as well as geothermal commitments in Powering our net zero future (BEIS, 2020), a Research Briefing (Abesser and Walker, 2022), and a Call for Evidence (Technological Innovations and Climate Change: Geothermal Technologies¹) with written and oral evidence given² on the role of geothermal in the diversification of the UK's energy mix.

As part of the Unconventional Hydrocarbons in the UK Energy System (UKUH) programme³, a collaborative project between the Global Sustainability Institute at Anglia Ruskin University, the BGS and the University of Exeter titled 'Underground energy on-the-ground: risk perception, community engagement and lessons learned for geothermal energy in a post-shale energy landscape' has been investigating learnings from the UK's shale gas experience in terms of regulation, governance and community engagements as experienced by operators and the public to identify lessons for the emerging geothermal energy developments. The focus of the project was on 'deep' geothermal technologies, i.e., those that require deep drilling (1-5 km) to exploit resources for direct-use heating (i.e., without requiring a heat pump) or power generation. The project addresses research gaps around public engagement, and regulation and licensing for geothermal energy including potential environmental impacts.

Whilst there is a growing interest in the role that geothermal energy can play as part of the UK's portfolio of renewable and low carbon energy, there are only very few geothermal projects in development, and geothermal energy is still a nascent sector (Ireland et al., 2021). Meanwhile, in continental Europe (e.g., Germany; the Netherlands, France, Italy) geothermal plants have been operational for multiple decades (Abesser et al., 2020). To harvest learning and experience from these countries and facilitate exchange of knowledge and good practice, a workshop titled 'Regulation and public decision making in geothermal energy' was organised in July 2022 to bring together a small number of European experts with leading UK geothermal experts from industry, regulations, policymaking, and academia (see Appendix for list of participants and affiliations)⁴.

¹ Available here: <https://committees.parliament.uk/call-for-evidence/2669/>

² Available here: <https://committees.parliament.uk/work/6777/technological-innovations-and-climate-change-geothermal-technologies/publications/>

³ <http://www.ukuh.org/>

⁴ Due to the unprecedented heat wave of the Summer of 2022 in the UK, combined with COVID-related travel uncertainties, transportation disruptions at the last minute prevented a number of scheduled workshop attendees

Workshop Design

The workshop was split into 5 sessions:

Morning Sessions

Session 1: The first session consisted of plenary presentations to facilitate knowledge exchange from European geothermal sectors. These were focused on:

- Regulation – Drs. Harmen Mijnlief, Geological Survey of the Netherlands (TNO),
- Engagement – Dr Anna Pellizzone, Fondazione Giannino Bassetti
- Driving a National Agenda – Dr Aoife Braiden, Geological Survey Ireland (GSI)

Session 2: For the second session, three breakout groups were formed on each of the topics to explore the relevance and learnings for the UK. The discussions were led by one speaker and one of the conveners.

Afternoon Sessions

Session 3: The third session consisted of plenary discussions with each of the three breakout groups presenting key points arising from their discussions.

Session 4: A presentation of preliminary findings from the 'Underground energy on-the-ground: risk perception, community engagement and lessons learned for geothermal energy in a post-shale energy landscape' was given by Dr Stacia Ryder (University of Exeter).

Session 5: The workshop concluded with a plenary discussion on the key takeaways from the workshop, as well as next steps and potential outputs.

This report highlights the contributions from the presentations, then explores the themes discussed across the breakout groups and concludes with the key messages identified in the closing plenary discussion.

Presentations

The presentations highlighted key lessons and experiences from two countries with more mature geothermal markets (Netherlands/Italy) and from the Republic of Ireland (ROI), which is building up its geothermal sector. The presentations focused on three main aspects: regulation, engagement and driving a national agenda.

Regulation

Drs. Harmen Mijnlief from the Geological Survey of the Netherlands (TNO) spoke of the Dutch experience in building a geothermal sector through policy and regulation of 'deep' geothermal energy systems. He described how policy and regulation are developed in tandem with the sector including during the transitional state as it moves from a nascent sector towards substantial development. To support growth, a succession of targeted subsidy schemes such as the MEI⁵, SDE++⁶ and the RNES⁷ were made available which have helped to reduce uncertainty and risk around geothermal energy development (Mijnlief et al. in press). Policy and regulation are frequently reviewed and updated. A recent amendment to the Dutch Mining Act, for example, included geothermal energy and introduced new licensing principles. These licensing principles have allowed geothermal energy to be produced under exploration licenses whilst awaiting issuing of their production license. Licensing options includes vertical separation licenses with multiple licences on top of one another, for exploration and production, and horizontal licenses based upon spatial planning and area of influence (drawn from the French method; see Weisenborn and Linskaill, 2017). These production licenses are issued for a maximum of 35 years.

Government policy has also focused on supporting data sharing across sectors (namely geothermal with the horticultural sector), between industry and government, and with the broader public through open access data practices. For example, all data from geothermal operations are now required to be deposited to the Ministry of Economic Affairs and Climate (MEAC). Information transfer has been a particular focus of regulatory bodies in the Netherlands, with bespoke events and materials created for a range of stakeholders from the general public to the national government to support informed decision-making. Under Dutch mining law, all subsurface activities are obligated to deliver data to the Ministry. The data is put in the public domain after 5 years, but beneficiaries of subsidy schemes must make data available immediately.

⁵ Market Introduction Energy Innovation; a subsidy grant for the first 10 geothermal systems during the initiation of the geothermal sector up to 2013

⁶ Subsidy Sustainable Energy Production; a feed in premium scheme with a budget reserved based upon a projection of pre-drilling capacity multiplied by a fixed amount of full load hours for 15 years, with the government paying the unprofitable energy cost price per kWh during this 15 year period (Mijnlief et al. in press)

⁷ Exploration Guarantee Fund; an exploration risk mitigation scheme

These regulatory steps were taken alongside the development of the geothermal energy sector, ensuring that regulation is timely and fit for purpose. In addition, policy mechanisms such as financial supports have eased concerns around risk and uncertainty and provided clarity and security for stakeholders across the board. The need for engagement throughout the development of geothermal energy projects was underlined, including the need to address issues of public trust and concerns surrounding environmental impacts such as induced seismicity and subsidence.

Engagement

Dr Anna Pellizzone from Fondazione Giannino Bassetti, a civil society organisation based in Milan, Italy, spoke of their focus on responsible innovation and their work on stakeholder and citizen engagement. Dr Pellizzone argued that engagement, when addressing complex societal problems with science and technology, is crucial to increase trust and anticipate concerns, but also to increase scientific literacy and design better services.

To conduct engagement in Italy, Dr Pellizzone introduced a range of approaches, including deliberation, citizen science, knowledge co-creation, focus groups, and citizen's assemblies and juries. While these methods are both time and resource intensive, they can enhance an operator's understanding about local knowledge, preferences, and recommendations (Pellizzone et al., 2015). Due to the time-consuming nature of these activities, offering compensation for stakeholders' and citizens' time and participation were found to be crucial to achieve the required engagement.

Dr Pellizzone discussed how the design of participation may lead to different levels of ability for stakeholders and citizens to impact on decision-making. For instance, simply "informing" the public (e.g. through talks or information leaflets) may not facilitate much participation whilst actively including the public in the decision-making process may be perceived as more empowering and participatory. However, increasing the level of participation does not intrinsically increase the value of engagement. All involvement is valuable, but awareness of the differences in levels of engagement and transparency in the objectives of engagement activities are crucial. This is illustrated in the IAP2 Spectrum, shown in Figure 1 on next page.

	INFORM	CONSULT	INVOLVE	COLLABORATE	EMPOWER
PUBLIC PARTICIPATION GOAL	To provide the public with balanced and objective information to assist them in understanding the problem, alternatives, opportunities and/or solutions.	To obtain public feedback on analysis, alternatives and/or decisions	To work directly with the public throughout the process to ensure that public concerns and aspirations are consistently understood and considered.	To partner with the public in each aspect of the decision including the development of alternatives and the identification of the preferred solution.	To place final decision making in the hands of the public.
PROMISE TO THE PUBLIC	We will keep you informed.	We will keep you informed, listen to and acknowledge concerns and aspirations, and provide feedback on how public input influenced the decision.	We will work with you to ensure that your concerns and aspirations are directly reflected in the alternatives developed and provide feedback on how public input influenced the decision.	We will look to you for advice and innovation in formulating solutions and incorporate your advice and recommendations into the decisions to the maximum extent possible.	We will implement what you decide.

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Figure 1: IAP2 Spectrum of Public Participation (IAP2 2018)

Drawing on data from three Italian case studies, Dr Pellizzone highlighted the importance of both transparency and trust in the context of proposed geothermal projects. Further, she noted how citizen engagement is essential for increasing trust in industry and government.

Driving a National Agenda

Dr Aoife Braiden of Geological Survey Ireland (GSI), a division of the Department of the Environment, Climate and Communications, presented on policy driving geothermal energy development in ROI. Like TNO in the Netherlands, GSI advises government on policy concerning geothermal energy, and was instrumental in ensuring that geothermal exploration and the importance of decarbonising heat were included in Ireland's Climate Action Plan 2019 (and subsequent iterations). Both 'shallow' and 'deep' geothermal energy have yet to gain significant traction in ROI due to a lack of awareness, policy, regulation and data. GSI has identified several essential factors for supporting the country's geothermal sector, including:

- de-risking the subsurface through collecting data and creating open access data products,
- encouraging communication and engagement to raise awareness of the technology within the general public and amongst policy makers,
- providing funding and open access to data, for research to improve the understanding of the available resources, including geological setting and geothermal potential, as well as environmental impacts of exploitation and
- using the resulting knowledge and evidence for establishing effective policy, legislation and regulations.

To date, several key policy and technical reports have been published including a public consultation on national policy: Geothermal Energy in Ireland, Geothermal Energy for a Circular Economy, and An Assessment of Geothermal Energy for District Heating in Ireland. These documents (Blake et al., 2020; Department of The Environment, Climate and Communications, 2020) are the first steps toward bringing policy, regulation, research, data, industry, and communication together. It also moves ROI closer to other European countries in terms of establishing geothermal regulations and licensing. Despite the current progress, it is important to acknowledge that gaining momentum in the geothermal energy sector has been difficult relative to more mature technologies (e.g., wind).

This is largely due to a general lack of awareness of geothermal technologies and a limited appreciation of their applicability in low-enthalpy geological settings, particularly for larger scale non-residential heating/cooling systems. To continue the drive towards geothermal implementation in ROI, open access data and increased research—including revisiting inaccurate prior research to provide more accurate maps of the geothermal potential in ROI—are high priorities. These efforts will not just benefit ROI but will present useful learnings for the wider UK geothermal sector.

Findings from ‘Underground energy on-the-ground: risk perception, community engagement and lessons learned for geothermal energy in a post-shale energy landscape’

For this project, Dr Ryder, along with colleagues Dr Rohse and Dr Abesser, used qualitative research to compare regulation, risk and engagement strategies between shale gas and ‘deep’ geothermal energy in the UK. They noted that a lack of a geothermal ‘culture’ in the UK has resulted in a lack of bespoke regulations for geothermal technologies, highlighting the industry’s desire for a clearer regulatory landscape. In this presentation, Dr Ryder raised three questions around regulation. Firstly, what to regulate?, with ground water quality, seismicity and safeguarding of sites all potential foci of future regulation. Whilst surface site regulation appears to be satisfactory, the burden of existing oil and gas legal structures are seen by some in the sector as additional barriers without mitigating risk. The second question is who should regulate? Regulatory bodies currently exist, but there are questions about whether existing bodies sufficiently cover the regulatory scope of geothermal, or if a new regulator with experts specifically from the geothermal sector would be required. The third question revolves around how we should regulate, exploring questions of scale, authority, and responsibility. Regulation could take alternative forms, through licencing schemes; bodies that distinguish between forms of geothermal (e.g., open and closed loop); and regulatory flexibility for sites where there has been a lot of previously successful geothermal experiences.

At present, regulatory and policy barriers in the UK are in part due to a lack of political recognition. Developers suggest that geothermal energy is not sufficiently subsidized by the government, hindering development because of the technology's high upfront costs and risks. With only a few projects in development, the regulatory knowledge is still very immature, and operational evidence is lacking. Hence, there are no plans to review or streamline regulatory processes until a better understanding of these systems is available. Whilst policy and regulation advances are slow, the sector has made progress in modelling positive examples of community and public engagement that may help to move the industry forward in the long run. Community and public engagement can foster support for the sector and increase demands for regulation and policy inclusion. Early and continuously tailored engagement can be beneficial both for those developing projects (e.g., allowing them to access local knowledge) and for those publics who can be empowered by taking part in the decision-making process. In this process, trust and transparency are key. Continuous and proactive engagement is key, and fostering community ownership in an authentic way is foundational to 'successful' engagement and social acceptance. In addition, perceptions of risk can spill over from adjacent industries, countries and operators and are important to note when conducting engagement and introducing regulation or policy (see also Westlake et al., 2023).

Supporting the geothermal sector: Themes arising through discussions

Throughout the day, several issues arose from the first-hand experiences of the presenters and attendees. They were primarily focused on the challenges currently facing the geothermal sector as it seeks to develop and reach operational maturity in the UK. The need for wider technology recognition, political signposting, and financial support along with improving our understanding of the deep geology to reduce development risks were overarching themes throughout the day. In addition, an urgent need to provide evidence (i.e., data) to decision makers on costs and performance of geothermal development was made apparent. Such evidence is vital to inform decision-making against a backdrop of numerous other low-carbon energy options. It emerged that the case needs to be made (including in terms of monetary value) for why policy makers should support geothermal energy, yet investment is needed for pilot or demonstrator projects to support this case.

Access to Data

Producing and sharing data more widely is an important way to encourage uptake of geothermal technology. Increased knowledge and data access was discussed by attendees as providing a key step in highlighting where opportunities exist for deploying geothermal technologies. Data acquisition, data sharing and building tools for their distribution will require availability of funding. In the Netherlands for example, such activities are supported by central government and delivered through government-owned companies (EBN- Energie Beheer Nederland B.V) who undertook a national scale geophysical survey and the geological survey (TNO), who maintains the open online geothermal tool (ThermoGIS). For the UK, participants perceived there to be a “catch-22” where funding required evidence from data acquisition and data acquisition required funding. The important role of the UK’s geological survey (i.e., BGS) as collector, manager and provider of such data was apparent.

Issues of how data should be made accessible is another potential area for regulation and policy making focus. Government has a key role to play here. In the Netherlands, all data from subsurface activities (not solely geothermal) is deposited at the Ministry of Economic Affairs and Climate Policy. In ROI, anything collected by the Geological Survey, or funded by government through research grants, is open access. Data collected by commercial or industry operators under license will need to be submitted to the GSI/Department of the Environment, Climate and Communications. Similar structures in the UK would allocate responsibility for data management to BGS as the central location of geological data, and attendees discussed the potential of BGS to situate itself in this subsurface advocacy and coordinating role.

Beyond governance, participants identified a need to create an environment of collaboration for sharing geothermal energy project success. The role of academic research in producing knowledge and data, and the contribution that research councils can make towards this element of de-risking the subsurface and driving the sector forwards was discussed, especially through provision of cross – council funding (e.g., involving social science, natural environment, and engineering research). For example, research funding requiring the public archival of data can further support open access data goals, in line with FAIR data principles⁸. Collaborative government-industry-academia partnerships (demonstrated by ROI and the Netherlands, and similarly to support the shale industry received in the UK) to address the gaps in data and encourage open access data would help to more rapidly create shared knowledge sets that further de-risk the sector to make financial backing a safer investment.

⁸ <https://www.ukri.org/what-we-offer/supporting-healthy-research-and-innovation-culture/open-research/>

Funding

Conversations established that funding is needed for two aspects: grants, incentives and support schemes for demonstration projects and sectoral development, and research and data collection. This section focuses on the former.

The need for incentives for the geothermal industry as laid out in the regulation presentation by Harmen Mijnlief included several financial aids for the geothermal sector to mitigate some of the financial risk associated with geothermal developments currently available in the Netherlands. Incentives such as the SDE++ and the RNES through which financial risk is partly absorbed by the government could be one method through which development in this sector is encouraged. Another method could be through the claiming of 'low hanging fruit': geothermal energy projects strategically targeted to give the geothermal sector as much penetration into the electricity and heat production mix as possible for the least risk. These include for example, decarbonising large heat users in the public estate (e.g., hospitals, prisons, military estate) or using geothermal energy for heat production for food production or processing, e.g., greenhouses in the agricultural sector.

Producing value for the public through engagement can also contribute to reducing the financial risks associated with geothermal. The potential for community owned, small-scale projects could play a role for incorporating the general public into the geothermal sector going forward through both engagement and financial involvement. This financial value can align with the current requirement for procurement contracts to contain 10% of social value for central government departments.

The Role of Engagement

The primary focus remains on the value of engagement for the sector. Attendees discussed the power of trust, with Dr Pellizzzone noting that trust in a company, industry, regulator, or policy maker can precipitate support where knowledge of the technology is low. This trust can be built through transparency and openness and as such the value of public access to data was further discussed by attendees. In addition, the value of local knowledge of the subsurface (e.g., in former mining communities) can be vital for the sector and as such a collaborative approach within the sector for data production should include the general public where possible. Whilst it is not necessarily a knowledge deficit that leads to resistance from the public towards geothermal (e.g., it could be an issue of trust in local politics and firms, see Pellizzzone et al., 2017), informing the public about geothermal—including being open to the risks, potential difficulties, and mitigation measures—is important in allowing for fully informed decisions to be made. Conducting this collaborative, informative and transparent engagement is crucial for the sector but is not at present required, legally or otherwise, and there is a lack of structure to facilitate engagement. Attendees discussed where the accountability for conducting such engagement should lie, and how this would potentially be enforced, noting especially that poor engagement practices can have negative consequences on the sector.

Attendees discussed the potential for engagement to reach vulnerable or hard to reach groups, and how engagement can empower publics to mobilise government actions. Regionally tailored, specialised engagement that includes these communities should involve experts on engagement to maximise the value that the process can deliver. This engagement brokering can ensure engagement is timely, transparent, informative, and inclusive.

The approaches discussed in the workshop all have the potential to reduce the perceived risk and assist the general public in conceptualising the subsurface and could potentially increase support for the geothermal industry and/or individual geothermal projects. A collaborative, transparent and inclusive approach to engagement throughout project lifespan and beyond can increase the likelihood that the geothermal sector introduces projects that have been constructed with public support, and hence reduces the risk for the sector for project implementation.

State of the Sector

Finally, participants agreed that one step toward de-risking geothermal energy and moving the sector forward would be establishing a full overview of the current state of the geothermal energy sector in the UK. This would address questions regarding the current maturity levels of the technology and resource estimation, especially in relation to other countries. It would also explore how geothermal does and could potentially fit into the energy profile of the UK.

Furthermore, geothermal energy was not discussed in an energy bubble, but in relation to other renewable energy technologies. Attendees felt that the best approach moving forward is one wherein renewable energy technologies are not discussed discretely or in a way that pits them against each other for funding and attention, but rather to discuss them together and the ways in which they offer a range of complementary solutions and can be further integrated in the future. This thread of collaboration running through this workshop therefore extends both within the geothermal sector and with the wider renewable energy sector. These collaborations could be vital in gaining a full picture of the current demand for both renewable energy and heat that geothermal and the wider renewable energy sector can address.

Overall, policy and regulatory advancements, combined with legal implementation and protections could potentially allow the geothermal energy sector to solidify itself as a key contributor in the transition to a renewable energy future in the UK. However, it is understood that more momentum in the sector will be needed to justify a regulatory review or setting up of licensing arrangements – which will require some legislative changes. Financial support for a budding industry is, therefore, seen as the priority.

Key Messages

The key messages from the workshop are therefore as follows:

- Financial support (e.g., financial incentives; risk mitigation and insurance schemes), coordinated and supported by government is needed. This should be on a phased basis with supports for pilot projects to demonstrate feasibility and encourage financial investment.
- Comprehensive regulation, identifying the regulators and a clear scheme for how the regulations are implemented and revisited as the sector progresses are required.
- Good practices of community engagement need further development: collaborative, transparent, inclusive and informative engagement throughout the lifespan of geothermal developments will be key to building trust in the technology, the sector, regulators and policy-makers alike.
- Further data, as well as sharing of data between operators but also with academics, governments and the public are needed. Who should be producing the data and where it should be held, and whether this should be an obligation are important questions to be addressed.
- Creating an environment which values collaboration, including collaborations across the energy sector (i.e., cross-technologies), can help facilitate data sharing and enable the transdisciplinary policy, regulation, industry, and academic research necessary to ensure the role of geothermal energy in the UK's future energy mix.

Next Steps

The workshops outlined the need for next steps to include:

- Further sector meetings with a range of stakeholders to contribute to policy and regulatory advancements as well as to address the current challenges outlined above (financing; regulation; engagement; data sharing).
- Additional workshops and activities to engender collaboration between stakeholders to produce outputs outlining future steps to support development of the sector.
- Enquire of stakeholder groups where they currently see gaps in the sector, and where outputs and papers from upcoming meetings should be targeted at or given to.

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Appendix

List of participants who agreed to being named in this report:

Attendees	Affiliation
Abesser, Corinna	British Geological Survey
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Braiden, Aoife	Geological Survey Ireland, Department of the Environment, Climate and Communications
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Gough, Alexander	SSE plc
Hambley, Tom	Anglia Ruskin University
Jackson, Matthew	Imperial College London
Jans-Singh, Melanie	Department for Business, Energy and Industrial Strategy
Knevitt, Oliver	National Environment Research Council/United Kingdom Research and Innovation
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Pellizzone, Anna	Fondazione Giannino Bassetti
Rohse, Melanie	Anglia Ruskin University
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