Written evidence submitted by The Association for Renewable Energy & Clean Technologies (REA)

Environmental Audit Committee Inquiry Into Geothermal Technologies

The Association for Renewable Energy & Clean Technologies (REA) is pleased to submit this response to the above inquiry.

Summary

Geothermal is an underutilised UK resource that could bring a myriad of benefits to the parts of our country that needs it most:

- By 2050 the industry could deliver 10,000 jobs and a further 25,000 indirect jobs across the UK supply chain - many of these would be located in strategic "levelling up" and "red wall" areas - including post industrial towns in the North and Midlands.
- Geothermal also has great potential for a just transition by retraining the 150,000 highly skilled workers from the oil and gas industry - who may struggle to transfer to less familiar technologies.
- Geothermal is also a "shovel ready" industry, with an industry ready to deliver projects at scale in a small space of time, such as the record breaking United Downs deep geothermal power project in Cornwall.
- Geothermal would also aid Britain in securing energy independence, especially in light of ongoing issues in Ukraine. Geothermal is a natural resource available on British soil, with a strong UK supply chain already established in the UK mining, oil and gas industries. By strengthening geothermal energy Britain's move to energy and heating independence could be greatly expedited - reducing our reliance on overseas imports.

Despite all these benefits, **there is currently no dedicated Government support available for the deep geothermal sector.** This committee must call on government to urgently address this by taking the following actions:

- Introduce a "Geothermal Development Incentive" to support ready to build projects,
- Support an ambitious support scheme for low carbon heating generally to replace the RHI.
- Under Contracts for Differences (CfDs) setting a Minima to 50 MWe for geothermal projects along with guaranteeing the current administrative price (£140/MWh).
- Streamline the regulatory regime for deep geothermal projects. The current status and suggestions for improvements to existing regulatory regimes as described by the BGS and should be reviewed.
- Afford Geothermal plants the same drilling rights as recently extended to shale gas firms.
- Work with the geothermal industry to create independent geothermal health and safety standards.
- Offer grant funding support for early geothermal projects

Our CEO, Dr Nina Skorupska, would welcome the opportunity to give oral evidence to the Committee on behalf of our geothermal members. The REA is also available to organise visits to geothermal sites for committee members.

1. What role can geothermal technologies take in the transition to net zero in the UK?

We cannot rely on only a few technologies to get us to Net Zero – we need to broaden out to others such as Deep Geothermal. 360 geothermal plants by 2050 could provide 15,000 GWh of annual heat and carbon savings of around 3 megatons annually. This significant decarbonisation of large-scale heat can only be achieved through Government support, as has been successfully demonstrated in other European countries. The Durham Energy Institute estimates that there is currently enough deep geothermal heat energy to supply all of the UK's needs for at least 100 years, this would grant the UK complete energy independence in regards to heat.

By delivering on average 12 heat projects per year over the next 30 years, the UK could expect to generate up to 15,000 GWh of heat annually by 2050. In addition, around 400 GWh of electricity annually is also feasible by 2050. In combination, this level of growth would provide a carbon saving of up to 3 million tonnes annually; and would represent a crucial contribution in meeting the UK's net zero ambitions (as outlined by the Government's Energy White Paper, Dec 2020).

It is possible to achieve carbon savings of around 1M tons per year by 2050 if 100 heat projects are operational. If 10 to 12 projects can be developed within the next 5 years, a carbon savings of up to 80k to 100k tons per year can be achieved. If 10 power projects were delivered by 2050 this could provide around 50MWe (c. 200 to 300 GWh of electricity per year).

We should particularly note areas with the greatest potential for geothermal are in strategic levelling up areas where jobs and investment will be especially valuable. Indirect jobs will come from industries that supply materials and services to the developers of geothermal projects including:

- Manufacturing
- Drilling fluids and parts
- Haulage
- Utilities and district heating installation
- Building retrofitting / upgrades
- Operations and maintenance

In the Netherlands at least 2 to 3 indirect jobs have been estimated to be created for every direct geothermal job[1] .

Geothermal projects create jobs throughout all stages of the supply chain. The number of jobs created is proportional to the size of the project. In countries with developing / mature geothermal markets (for example Germany) a geothermal heating project can create up to 30 direct jobs and an electricity project can create 100 jobs, many of which are highly skilled.

Experience and skills in the oil & gas sector are directly transferable, in particular exploration, planning and development. Therefore, this offers a direct opportunity for re-skilling and re-directing fossil fuel based jobs.

360 projects by 2050 could create over 10,000 jobs and a further 25,000 indirect jobs. Many of which could be transferred from the oil and gas sector from existing Northern and Midlands workforces.

2. **What barriers (technological, regulatory, or otherwise) are there to deploying operational geothermal technologies in the UK?**

Lack of investment is the main barrier to deep geothermal, to get it off the ground the sector needs a new 'Geothermal Development Incentive' to support the 30 ready to build projects, and then an ambitious support scheme for low carbon heating generally to replace the RHI.

The capital expenditure (Capex) for deep geothermal heating projects varies based on the number and depth of the boreholes and without public support can be prohibitive still. However, costs typically range between £2M to £4M per MWth of heat capacity. Drilling and testing comprise the majority of this cost (between £1.6 to £1.8M per km depth, for 1 to 2 km deep wells) and can be greater where directional drilling is required. The remaining costs relate to heat plant, exploration and planning, and surface works. UK benchmarks suggest a cost of around £1k to 5k per m for materials and installation (in-house data). Electricity projects will incur additional Capex related to the additional power generation equipment required and grid connection (amongst other aspects).

The UK has a relatively lower heat gradient in the subsurface (as compared to places like Iceland and Turkey). Deep wells are therefore required, and these wells need to encounter not only geothermal fluids which are hot enough, but also at locations where the ground is permeable enough to sustain pumping of the fluids to the surface (and back to the Introduction subsurface). This obviously requires significant capital investment at the early stages of the wells' life, as well as technical expertise, and support from the planning process.

Deep geothermal energy has very similar attributes and behaviours to mineral development. Most notably oil and gas exploration, appraisal and production. The development uses the same drilling rigs and well testing spreads and similar layouts to onshore oil and gas sites. This is characterised by temporary use of equipment to drill and test the wellbores and long-term low-level production equipment. The National Planning Policy Framework (NPPF) provides very clear guidance for planners to assess mineral development when a site is located in sensitive areas.

The 2021 National Planning Policy Framework (NPPF) specifies that low carbon and renewable development should be approved:

[1] Stichting Platform Geothermie, DAGO, Stichting Warmtenetwerk, EBN, May 2018, Master Plan Geothermal Energy in the Netherlands: A broad foundation for sustainable heat supply https://geothermie.nl/images/bestanden/Masterplan_Aardwarmte_in_Nederland_ENG.pdf

Paragraph 158 p 44. ‘’When determining planning applications for renewable and low carbon development, local planning authorities should: a) not require applicants to demonstrate the overall need for renewable or low carbon energy, and recognise that even small-scale projects provide a valuable contribution to cutting greenhouse gas emissions; and b) approve the application if its impacts are (or can be made) acceptable. Once suitable areas for renewable and low carbon energy have been identified in plans, local planning authorities should expect subsequent applications for commercial scale projects outside these areas to demonstrate that the proposed location meets the criteria used in identifying suitable areas.’’

Geothermal energy developments are particularly suitable for sensitive and urban areas due to the fact that significant visual, transport and noise impacts are limited to the development phase, and that in 35+ years of operation geothermal development has the benefit of having the smallest surface footprint of any energy source, and provides the benefit of baseload distributed heat and power.

Geothermal has uniquely high capacity when compared with other renewable resources. A single MW of geothermal development is equivalent to ~3MW of wind development in delivering electrons to the grid.

Whilst there is significant opportunity, geothermal is currently underutilised in the UK for heat where the Southampton district heating scheme is the only historical deep geothermal project. There are significantly more areas across the UK with the potential to provide deep geothermal heat but lack the capital needed to exploit this resource. Therefore, the growth of geothermal energy in the UK is expected to be reliant on the ability to commercially develop deep geothermal heat projects.

Growth in deep geothermal projects is expected to continue to be slow without government intervention / incentives, such as those used all over the world to accelerate growth for heat and electricity projects. The Netherlands, Germany and France have all benefited from government financial support and risk-sharing to stimulate deep geothermal projects. The resulting project trends in these countries may provide an insight into possible UK growth with government support.

There are no current supply chain constraints for the development of UK deep geothermal resources. If required, technologies can be imported from countries with mature geothermal markets. For example, steel casing is required to drill and line the boreholes. This is currently mostly produced overseas, mainly in China. reliance on the use of overseas vendors could lead to a missed opportunity in the UK for utilising existing knowledge /skills from the O&G sector and developing and enhancing our own supply chain. High quality manufactured specialist equipment such as drill bits and well valves is hard to acquire, and a UK supply chain must be supported.

Parts of a UK geothermal supply chain exist but are not coordinated because there are currently very few UK deep geothermal projects. The oil and gas supply chain in particular could easily be modified to support the requirements for deep geothermal well installation. Strengthening the supply chain and the resource pool for geothermal projects will ultimately reduce the cost and improve the appeal of these projects for developers and private investors. Crucially, the cost of early development stages including the initial site wells will reduce as the supply chain matures.

There are currently only four UK oil & gas drilling rigs with capability to drill to the depths needed for deep geothermal heat (typically between 1km and 3km deep). A reduction in demand for / drilling of new oil and gas boreholes in the UK means that drilling companies are unlikely to invest in additional drilling equipment and would need reassurance that deep geothermal projects justify their investment. Until that time, additional rigs will be sourced from mainland Europe or elsewhere. However, with clear market signals led by government intervention we could see a rapid shift from the oil and gas industry towards geothermal.

Once capacity has been developed within our borders, the UK has the potential to become a world leader in deep geothermal heat projects, building on the success of the record breaking United Downs deep geothermal power project in Cornwall.

Before this though we need new public support for the sector – until it is established when this can be withdrawn or changed. We would like to see a new ‘Geothermal Development Incentive’ to support 30 already ready to build projects, and then an ambitious support scheme for low carbon heating generally to replace the RHI. We would also like to see geothermal explicitly supported in renewable heating subsidy schemes such as the Public Sector Decarbonisation Scheme

Finally, we should note the Health and Safety Executive doesn't have any specific guidance for geothermal, with the technology currently covered under oil and gas regulation. This means geothermal sites have to put a lot of irrelevant safety measures into sites to meet oil based safety guidance. The industry would appreciate the government working with them to create independent geothermal health and safety standards.

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?**

Potential markets for geothermal energy include the following:

District heating

- The heating of buildings presents a major decarbonisation challenge. Geothermal heat is a viable zero carbon alternative to heating as compared with gas and other fossil fuels. Further detail on case studies can be found in a 2018 publication by BEIS[2]. District heating networks linked to a deep geothermal plant could be utilised for:
    - **Net-zero estates & retrofit** – A 10 MWth capacity geothermal doublet could provide heat to around 4,500 homes in a district heating network.
    - **Hospitals, Schools, Universities** – A 10 MWth capacity project would supply much of the heating requirements for a given site, in particular larger universities and hospitals.

Manufacturing

- The manufacturing industry is increasingly interested in investigating the potential for geothermal to provide a sustainable, low carbon and cost effective alternative for heat and cooling, in a move away from gas powered heating. The Janssen Pharmaceutical plant in Beerse Belgium is an example of how geothermal heat production is feasible at an industrial scale with government support provided.
    - Geothermal electricity is currently excluded from the Industrial Energy Transformation Fund (IETF), limiting its potential in industrial decarbonisation

Process heating

- Pre-heating for other processes and greenhouses.

Green Distilleries | Green Whiskeys

- The number of new distilleries registered in 2019 translated to a 22% increase compared to the previous year, as numbers reached at least 422 in the UK, up from 361 in 2018. The UK Government is already committed to help decarbonise UK distilleries, including the whisky sector. In addition, the United Downs geothermal power project has partnered with a rum distillery to provide the distillery with the heat from the geothermal power plant.

The UK deep geothermal resources occur in a range of geological settings, some of which are unique to the UK or very complex. This complexity will drive UK innovation to develop methods and equipment which maximise the potential and longevity of the resource. One example of recent innovation is the coproduction of lithium from the geothermal brine in Cornwall.

4. **Are current government support schemes sufficient to grow geothermal energy deployment in the UK?**

No. The UK's existing Renewable Heat Incentive (RHI) has a dedicated tariff for deep geothermal heat. However, the application window for RHI ended in March 2021. **There is currently no further support available for the deep geothermal sector** leaving a gap in support for geothermal projects. This will likely have a significantly detrimental effect on the development of deep geothermal in the UK.

Experience in UK solar and wind markets along with the deep geothermal markets in Europe has proven that government funding during early stages of market development is the main factor in stimulating new markets in the renewable technology sector. Early government support and risk sharing are instrumental for developing successful deep geothermal markets by providing confidence to developers of deep geothermal energy and their investors. With increasing project delivery, market confidence grows as precedent is set and projects become more cost effective and sustainable requiring increasingly less government interventions as the market matures.

The BGS 2020 report provides detailed recommendations for policy and regulatory support for the UK geothermal sector.[3] However, the following two government interventions are recommended for the UK to

[2] BEIS, Nov 2020, Heat Pump Manufacturing Supply Chain Research Project Final Report

[3] Abesser, C., J. P. Busby, T. C. Pharaoh, A. J. Bloodworth and R. Ward (2020). Unlocking the potential of geothermal energy in the UK. British Geological Survey Open Report, OR/20/049, British Geological Survey: 22.

accelerate growth of the deep geothermal industry. Both interventions will allow projects to point to a secure revenue stream. This will help to make projects 'bankable' and for private funding to be secured for the high risk/ high capital drilling phase of the project.

Geothermal Development Incentive (GDI)

- A heat production incentive dedicated to deep geothermal projects (referred to as a geothermal development incentive, or GDI) could be structured such that it provides assurance to the geothermal market, but only provides funding for projects which successfully generate heat energy. Successful heat production incentives are typically in place for a reasonable time period, for example 20 years, to stabilise project finance conditions. The UK could control the long term cost by limiting the use of a GDI to the first 30 projects which meet application conditions. The GDI could be funded through a variety of sources, for example future carbon tax receipts.
- A heat plant with a 10 MWth capacity may provide 44 GWh of heat annually. The heat plant would deliver a carbon saving of around 8,000 tons CO2 per year throughout its life. This would equate to c. 2,200GWh heat and saving 400k tons CO2 over its operational lifetime.
- With a GDI of £55/MWh (in line with the existing RHI tariff) the cost per year would be £2.4M for the first 20 years with potential CO2 emissions savings of £16M (based on BEIS Carbon Valuation method[4] between 2025 and 2045, using central traded values).

Contracts for Difference (CfD)

- The existing Contracts for Difference Scheme for Renewable Electricity Generation (CfD) remains an appropriate mechanism for geothermal electricity pricing. At the time of writing, two geothermal power projects are in development, both in Cornwall, illustrating that there is a commercial potential to develop geothermal power in the UK. Given these conditions, we have identified that setting a Minima to 50 MWe for geothermal projects along with guaranteeing the current administrative price (£140/MWh) for the Minima would improve investor confidence. Review of planning permission requirements is also recommended.

UK regulatory provisions

Whilst the interventions above are considered to be the main drivers that will accelerate the deep geothermal market there is also a need to streamline / consolidate the regulatory regime for deep geothermal projects. The current status and suggestions for improvements to existing regulatory regimes are described by the BGS and should be reviewed.[5]

Geothermal plants must be afforded the same drilling rights as recently extended to shale gas firms – the provision is already there and just needs to be extended to geothermal projects.

5. **What environmental concerns are associated with geothermal technologies, and are they appropriately accounted for in regulations?**

Deep geothermal does have limited potential for some adverse impacts but these are relatively minor and can be managed. The potential for induced seismicity and land contamination can exist (although nowhere near to the same extent as other technologies such as fracking) but careful management during construction and operation minimises the risk. However, these potential environmental impacts can be mitigated or reasonably minimised. Nevertheless, it is important that geothermal projects are developed appropriately and transparently with a focus on community engagement.

6. **What risks are there to investors, operators, and consumers of geothermal energy? How can these be mitigated?**

Deep geothermal projects have a higher risk in early project stages due to the need to prove the geothermal resource at a project level (largely related to accessing sufficient flow of fluid from the reservoir). As has been

[4] BEIS, 2020, Government greenhouse gas conversion factors for company reporting 2020 Methodology Paper for Conversion factors Final Report

proven throughout the world, as the number of projects grows, the actual project risks are better quantified, leading to improved confidence for investors. Once this 'critical mass' of projects are in place, geothermal projects will increase at a rate appropriate to the market conditions.

Deep geothermal is a hybrid between established renewable heat technology and natural resources. It is the latter which carries the so-called 'geological risk'. The following interventions would help stimulate the UK deep geothermal market to grow a self-sustaining industry for the longer term:

- Development of a dedicated deep geothermal development incentive (GDI) for heat projects
- Update the CfD for geothermal power in the next auction round to include a minima for such projects.
- Offer grant funding support for early projects

Both interventions will allow projects to point to a secure revenue stream at an early project stage.

Once successful projects have been implemented and a supply chain established, the market will have been 'de-risked', paving the way for further projects and investments. Ultimately the deep geothermal market will become more cost effective and sustainable.

Within the last decade there has been a considerable increase in the development of wind and solar power. This is due to the low risk profile associated with these technologies and due to early government support (through demonstrator projects and feed-in-tariffs). The growth of wind and solar in the UK illustrates the benefits of government intervention.

Geothermal incentives vary by country and therefore direct comparison is difficult. A summary of the incentives adopted in France, Germany, the Netherlands and Switzerland is provided in a recent BGS study[4]. As an example, the Netherlands has invested around €3M per MW capacity between 2012 and 2020. Government interventions have been successful in stimulating interest and growth of deep geothermal projects, as is highlighted in Europe[4]. Interventions are not necessarily long term commitments. As projects grow so does the supply chain, costs will ultimately reduce and confidence in the potential of a project to meet financial goals will increase. Germany is an example of a very mature deep geothermal market which is now self-sustaining. The market in Germany has created more than 22,000 jobs and provided an economic stimulus of €1.5Bn in 2019[5].

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?**

No comment

8. **What economic impact could the deployment of mine water geothermal systems have on the areas in which they are deployed?**

No comment

Appendix 1 - The REA

The REA represents industry stakeholders from across the whole renewables sector and includes dedicated member forums focused on green gas, biomass heat, biomass power, renewable transport fuels and energy from waste (including advanced conversion technologies). Our members include geothermal generators, project developers, heat suppliers, investors, equipment producers and service providers. Members range in size from major multinationals to sole traders. There are over 500 corporate members of the REA, making it the largest renewable energy trade association in the UK.

Appendix 2 - Geothermal and Net Zero

Geothermal energy, in particular geothermal heat, has the potential to significantly contribute to the UK's Net Zero goals within a larger portfolio of energy solutions. Geothermal energy benefits include offering flexible and dispatchable heat and power. There are currently a variety of places across the UK (in Cumbria, Cheshire, Greater Manchester, Tyne and Weir, Staffordshire, Hampshire and Dorset, Humberside, and Cornwall) which have both good geothermal prospects and existing heat users. The development of 10 to 12 projects over the next 5 years would lead to 500 to 600 GWh of heat per year providing heat to the equivalent of up to 50,000 homes with investment in the order of £10M to £15M for each project. Geothermal could also deliver heat decarbonisation for lots of urban areas where heat pumps might not be feasible or right.

The UK has considerable deep geothermal potential for heating and significant opportunities for power. Geothermal energy can provide a base load source of energy where the geological resource is suitable. Furthermore, deep geothermal offers dispatchable power offering flexibility. Geothermal is therefore one of the renewable low carbon energy technologies able to support the deployment of variable energy sources within a flexible energy system.

In certain geological settings the geothermal conditions are suitable for engineered geothermal systems (EGS) which can be used to access heat to generate power. With current drilling and power generation technology this is limited to areas of Cornwall, Devon, and possibly Cumbria. The total technical potential power that could be exploited by EGS technology is estimated around 222 GWe (GW electricity) at depths of up to 6.5km depth and 2,280 MWe (MW electricity) at 4.5km depth

Direct and indirect employment will be created in areas such as exploration, construction, operation & maintenance, planning, and research. Whilst exploration and planning phases can be short term for any single project, deep geothermal projects are generally long running businesses due to long-term agreements between developers and purchasers. In addition, once the market becomes de-risked from an investor's perspective, project development professionals will move from project to project (similar to the construction industry).

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