EDISON

Edison Explains

Deep geothermal energy

Its potential role in heating the UK

What is deep geothermal energy?

Geothermal energy is a renewable energy source that is derived from the heat contained in the rocks and fluids beneath the earth's crust, which can be used for heating and cooling purposes, or to generate electricity. Deep geothermal accesses heat from depths greater than 500m and, at depths of over one km, the temperature can be hot enough to be used in direct space heating. Temperatures above 150oC are required for electricity generation, but temperatures between 50oC and 150oC can be used for heating residential, commercial and industrial spaces. The UK's subsurface heat gradient makes it generally better suited to heating projects than for power generation, and The Durham Energy Institute has concluded that, if deep geothermal energy were fully realised, it could provide 91,000TWh of heat to the UK, equivalent to c 100 times the UK's annual heat consumption.

What is the potential for geothermal energy in the UK?

To meet its aim of reaching net zero carbon emissions by 2050, the UK will need to change the way it heats homes and buildings. Heating accounts for 74% of buildings emissions and c 23% of all the UK's emissions. The government recognised the argument for decarbonising heat in its 2020 Energy White Paper, but has not provided any plan to support geothermal energy, although it could be part of the solution, providing a reliable and flexible baseload to heat certain districts across the UK. A 2021 report by ARUP and the Association for Renewable Energy & Clean Technology (REA) has identified 10–12 projects across England where geothermal potential is high. These initial projects are estimated to potentially provide 0.5–0.6TWh of heat per year, the equivalent of heating to up to 50,000 homes, and could be in operation by 2025. ARUP assumes that 360 projects can be delivered by 2050 if drilling is accelerated after 2025. This would generate 15TWh of heating per year, the equivalent of more than one million homes. and saving c 3m tonnes of CO2 annually. However, this growth would be dependent on the ability to develop these projects commercially, which would need to compete with other heat decarbonising technologies such as heat pumps, electric heaters and hydrogen.

Edison insight

'Deep geothermal energy has the potential to play a role in the decarbonisation of large-scale heat in the UK.'

Elaine Reynolds, Edison Energy Analyst

What are the pros and cons of geothermal energy?

Geothermal energy is predictable, reliable and consistently available, unlike other renewable energy sources such as wind and solar which are intermittent. In addition, the surface footprint for deep geothermal is small and visually unobtrusive. However, geothermal energy is limited to areas with suitable subsurface conditions, and projects are subject to high upfront costs associated with drilling wells to characterise, access and efficiently extract the geothermal resources. Some greenhouse gas emissions can occur, but this is minimal compared to fossil fuel extraction. There is also the possibility of inducing seismic events caused by water pressure creating movement in naturally occurring faults or fractures. This is not the same as events caused by fracking, where large volumes of fluids are injected at high flow rates and pressures.

Open- or closed-loop systems?

Historically, deep geothermal systems have used open-loop systems, which use heat convection to bring energy via hot water or steam to surface. A well is drilled to extract geothermal water from an aquifer deep underground before this water is passed through a heat exchanger and returned back underground via a second well.

In contrast, closed-loop systems rely on heat conduction through the rock to transfer heat to a conductive fluid circulated within a well, or in more recent designs, through an underground loop. For both designs, critics question the ability to conduct heat at a fast enough rate through the rock. The underground loop design relies on the thermosiphon effect, where cool water sinks on one side while hot water rises on the other, without the need for a pump. At present, there are a couple of demonstration projects ongoing in North America to evaluate the feasibility of such systems for power generation.

Closed-loop systems have a lower environmental footprint, as no fluid leaves the system, and have the potential to be able to operate in a greater range of locations, as they do not require the presence of large volumes of water or subsurface permeability.

What has been the uptake of deep geothermal projects in the UK?

The development of deep geothermal projects in the UK is very low and lags behind a number of continental European countries. At present, there is a district energy scheme in Southampton that came online in 1986. In Cornwall, the United Downs Deep Geothermal Power Project is the first geothermal power plant in the UK and was commissioned in 2021. (Lithium is also present in the geothermal waters in Cornwall, where Cornish Lithium and Geothermal Engineering are collaborating to extract lithium as part of the United Downs project, with a pilot plant due to be commissioned by March 2022. Vulcan Energy is also planning to extract lithium from geothermal brine in Germany, with Phase 1 of the production plant due to commence in 2022, and come onstream in 2024.)

For comparison, Germany currently has 190 geothermal heat projects in operation, France has 74 and the Netherlands 21. To kick-start projects in the UK, the ARUP/REA report recommends that the UK government provides a geothermal development incentive (GDI) of £55/MWh per year for the first 30 suitable projects and an update of the existing Contracts for Difference scheme for Renewable Electricity Generation. Government consultation on this is expected to be launched in autumn 2021 although, at this level of incentivisation, the economics would need to evolve for geothermal to become more widely adopted.

Projects driven by oil & gas expertise

The expertise required to identify suitable subsurface aquifers and to drill wells for geothermal systems has a significant overlap with the skill sets of the oil & gas industry, and several onshore UK oil & gas operators are looking at the potential for developing these projects.

IGas Energy acquired geothermal heat project developer GT Energy in September 2020 and its key project is to provide zero carbon heat to Stoke-on Trent City Council (SoTCC). This will supply 45GWh of heat annually into the SoTCC district heating network, enough to heat public buildings across the city including university, school, hospital and council buildings. The project will require the drilling of a deviated water producer and a water injector, with the wells being c 2,000m apart at total depth. Surface facilities will be built underground to minimise the visual impact. The company has all planning approvals in place, but is now waiting for the outcome of the government's consultation on providing support before going ahead with the project. IGas has identified 50–100 projects nationwide and is in discussions to secure potential additional sites, including in Newcastle, Crewe and Southampton, for its development pipeline.

Egdon Resources and Europa Oil & Gas both hold licences and well stock in the East Midlands and are separately assessing the potential to utilise deep geothermal energy using different closed-loop systems on their licences. Egdon has identified a number of potentially suitable sites that are being reviewed further, but initial work will focus on its Dukes Wood and Kirklington wells as potential candidates for geothermal repurposing. The wells sit in an area of anomalously high heat flow for the sedimentary basins of the UK. It is planned to recomplete the wells as single-loop geothermal installations (to circulate fluid down the annulus and up the tubing) to test the geothermal potential. The company is also assessing the commercial options for these sites for both space heating and agricultural use.

Europa is working with CausewayGT to assess the potential of its West Firsby oil field to be used as a test site for CausewayGT's proprietary closed-loop system, with initial studies to be carried out over the next two years.

Finally, dCarbonX is part of a consortium looking at the offshore geothermal resources of the UK and is working with a number of large North Sea operators to explore the potential of existing assets, with an initial focus on identifying a suitable well in which to carry out a trial to provide geothermal energy for platform electrification. As such, it is the only company looking at UK geothermal applications offshore and to provide power rather than heat.