Imperial College London

Natural Environment Research Council

2021_63: Aquifer thermal energy storage for large-scale heating and cooling in the UK

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Aquifer Thermal Energy Storage (ATES) is a type of geothermal seasonal energy storage that has the potential to deliver large capacity (ca. GW) heating and cooling with high efficiency (ca. 70-90%) and be deployed with other renewable energy sources such as solar and wind [43-46].

ATES can decarbonise heating and cooling because it efficiently recycles surplus heat and cool that would otherwise be wasted. Energy from other renewable sources can be used to power pumps and associated equipment; energy from renewables during periods of excess supply/low demand can also be stored in the aquifer as heat or cool for later use. The large capacity of ATES can supply large space heating and cooling systems such as office blocks, factories, shopping centres, hospitals, universities, supermarkets and museums; domestic and small-scale commercial applications such as shops and industrial estates can be supplied via district heating/cooling networks. Multiple boreholes can be used to scale-up storage capacity to meet demand.

ATES is a key candidate technology for large-scale decarbonisation of heating and cooling in the UK, because there are suitable aquifers beneath numerous large urban and industrial centres. However, uptake of ATES in the UK is low, with just a handful of projects in a few locations delivering a total capacity of ca. 12 MW, compared against average UK energy demand for heating and cooling of ca. 50 GW. In contrast, Holland had > 2500 installations as of 2018.

The aim of this project is to undertake numerical modelling of ATES in one or more key UK aquifers, addressing research questions which include (i) How can ATES systems be optimised for capacity and efficiency while maintaining thermal balance? (ii) What is the impact of aquifer heterogeneity on capacity and efficiency? (iii) How do multiple ATES deployments interact at the city scale? (iv) What is the potential for ATES systems to modify groundwater composition, and what risks does this pose for deployment? (v) What fraction of UK demand for heating/cooling could be supplied by ATES?

The project will involve the use of advanced numerical methods for simulating fluid flow and heat transport in ATES system, combining methods developed and applied by the Novel Reservoir Monitoring, Modelling and Simulation (NORMS) group and the Minerals, Energy and Environmental Engineering (MERG) group in ESE. BGS have extensive experience of the aquifer(s) to be tested, in aquifer characterisation and modelling for energy storage, and in laboratory and field data acquisition.

Applicants should hold a degree in a related subject such as geoscience, physics, engineering

or mathematics and, ideally, some experience in reservoir or aquifer modelling. Training will be provided as required in specific aspects of the project. The research will deliver fundamental new understanding of aquifer thermal energy storage in UK, supporting ongoing research at ICL in geothermal energy.