The energy transition

Achieving net-zero emissions requires interdisciplinary science solutions and effective stewardship of the planet. Rob Knipe and colleagues report on how geoscientists are reaching out and down to support the energy transition

THE TRANSITION towards a carbon-neutral economy is now a pressing international effort and geoscience will play a fundamental role in enabling the energy transition. Geoscientists are reaching out to combine knowledge of Earth processes and behaviours in the subsurface with the know-how of engineers, social scientists, policy makers and financers to promote shared engagement, as well as to test and deploy the technologies that are urgently needed for a sustainable energy transition. To facilitate discussions, the Geological Society has organised a series of webinars on the theme *Geosciences and the Energy Transition*.

The first event, held in April 2021, provided an overview of the various ways in which the geosciences can contribute to the energy transition and Sir Andrew Mackenzie FRS (Chair of Shell) provided a powerful overview of the geological challenges and the need to closely interact with other communities.

The second webinar, in June 2021 and reviewed in this report, focused on the use of the subsurface for energy transfer and carbon injection and storage. As well as considering the new understanding, plans and challenges associated with storing CO_2 in geological formations, discussions also touched on the economics required to achieve a net-zero/low-carbon world, as well as the critical issue of building public confidence – it is essential to understand public perceptions of different subsurface solutions for driving down carbon emissions.

Economics and policies

Paul Monks, Chief Scientific Adviser to the UK's Department of Business, Energy and Industrial Strategy (BEIS), emphasised how essential geoscience is to the energy transition and outlined the major investment planned by the UK government to promote action. Support for scientific solutions, as well as their deployment, is – at last – high on the Government agenda, especially as COP26 approaches.

FUTURE MEETINGS

6-7 Sep 2021: Resources on a Finite Planet

26-27 Apr 2022: What does Geoscience need to do now for a sustainable transition to net zero?'

For details, visit: www.geolsoc.org.uk/engtrans

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Additionally, investment companies, such as Ernst and Young, now have dedicated teams to facilitate investment and advise policy makers on issues related to subsurface storage of CO_2 (as discussed by Graham Beal, Ernst and Young, UK).

Interestingly when the costs of different carbon capture approaches are considered over the timeframe of carbon drawdown, subsurface geological storage comes out cheapest in the long-term (~10,000 years), as noted in a presentation by Niall MacDowell (Imperial College London, UK) Stuart Haszeldine (University of Edinburgh, UK) and Jon Gibbins (University of Sheffield, UK).

Geological storage

The UK has an abundance of potential geological storage locations that could securely hold the UK's carbon emissions. Engineers, geologists and industrial partners are combining efforts to optimise storage options, whether for hydrogen storage or CO_2 disposal.

Experience of CO_2 injection at some geological sites stretches back for more than 20 years, and geologists are sharing their knowledge of how to manage the operation of new injection sites. For example, Linda Stalker (CSIRO, Australia's National Science Agency) shared the results from CO_2 field experiments, while Masoud Babaei (University of Manchester, UK) and Jon Gluyas (Durham University, UK) described a novel combination of CO_2 injection into the subsurface and recycling in a closed system for heat extraction and power generation.

A hydrogen economy is high on the list of priorities in the planning discussions of many countries. Geoscientists are working with engineers to assess the challenges of storing hydrogen in subsurface salt caverns, such as beneath the Cheshire basin, UK (as discussed by Alan Leadbetter, Storengy Ltd., UK), with the aim of supporting the power supply for near-by net-zero industrial clusters. At present, the hydrogen generation and storage for each industrial area is planned to link to a subsurface CO_2-storage site in offshore geological formations (reviewed by Katriona Edlmann, University of Edinburgh, UK); hence an integrated 'systems-within-systems', as well as an innovative industrial and engineering decarbonisation approach is required, as stressed by Paul Monks (BEIS, UK), Nilay Shah (Imperial College London, UK) and Bryony Livesey (Industrial Strategy Challenge Fund, UK Research & Innovation).

Geothermal

The subsurface has untapped potential as a natural geothermal heat source. Abandoned coal mines full of warm water, that is largely unaffected by seasonal temperature variations, can be used for local heating requirements (Charlotte Adams, The Coal Authority, UK). Around 25% of all homes in the UK have been built in former coal mining areas, so several towns and cities are now assessing this future energy source.

The water deep in Cornish granites is even hotter and a new geothermal project to recover this ubiquitous subsurface resource to heat the 'tropical rain forest' at the Eden Project has recently been initiated (Lucy Cotton and Peter Ledingham, GeoScience Ltd, UK).

The volcanic geology of Iceland has provided geothermal heating for decades. Sandra Snæbjörnsdóttir and Bergur Sigfússon (Carbfix, Iceland) described how Iceland is now extending this innovation to new carbon-capture projects, whereby captured CO_2 is pumped into the subsurface to react with basalts to permanently fix the carbon by growing new minerals, thereby lowering emissions from geothermal.

Societal acceptability

The science behind these geological opportunities and solutions to support and enable the energy transition all require public confidence and social acceptability (Emily Cox, Cardiff University, UK; Gareth Johnson, University of Strathclyde, UK). At long last, there is the realisation in scientific communities that trust and acceptability of our 'science solutions' for future energy systems cannot be assumed.

Psychologists and social scientists, as well as public bodies, are not isolated from the geoscientists and engineers who are developing the technical solutions needed for the energy transition – and they never should have been. We are learning from past experience, such as our approaches to the communication and public perception of hydraulic fracturing, or fracking, for shale gas (Richard Davies, Newcastle University, UK and colleagues), as well as for radioactive waste disposal (Jonathan Turner, Nuclear Decommissioning Authority, UK). A notable example of a place sensitive and community connected development is coal mine geothermal, where heat from abandoned coal mines is being used to heat local homes.

Although there is still progress to be made, the growing interdisciplinary collaborations, with ever increasing interactions between geologists, engineers, social scientists, policy makers and financers to meet the challenges of the energy transition, is an important, positive and absolutely necessary step.

The next webinar in the series (6-7 Sept), will include an introduction from Julian Kettle, a Vice President at Wood Mackenzie, and will assess the role of the geosciences for future mineral extraction, hydrocarbon stewardship, and the management of water resources during the energy transition. In addition to the technical challenges of sustainable and low-carbon resource management, we will discuss issues surrounding policy, investment and public awareness of the energy transition.

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WITH MEETING CO-ORDINATORS:
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