The Role of Geoscience in Decarbonisation

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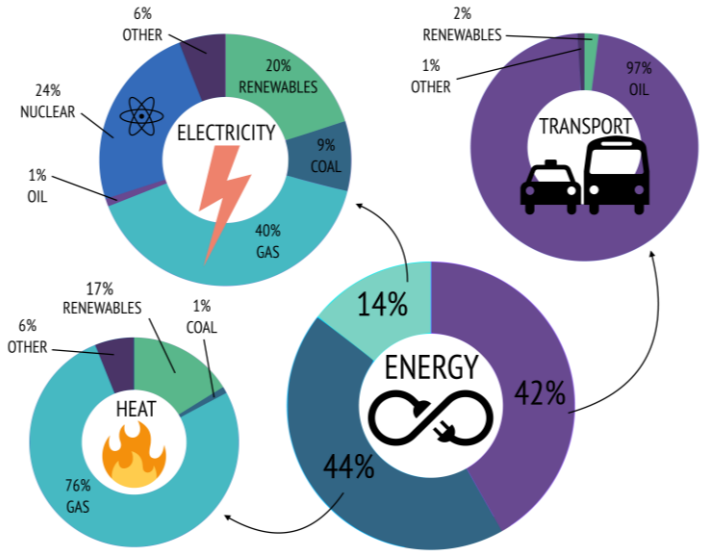
At the Geological Society 2019 Bryan Lovell Meeting, 100 delegates gathered to discuss the opportunities for decarbonisation offered by geoscience and the subsurface. The meeting was attended by both geoscience and social science academics, representatives from industry (BP and Equinor), the British Geological Survey, statutory bodies such as the Committee on Climate Change and public organisations such as Radioactive Waste Management.

The decarbonisation of electricity production, industry, transport and heating to meet both UK and international climate change targets is a major challenge, and the subsurface has an important role to play.



UK energy demand and supply by sector. Data: Digest of UK Energy Statistics 2018.

Geoscience was central to the carbonisation of our environment through the exploration, extraction and use of fossil fuels. The same skills and expertise that developed these resources can significantly contribute to decarbonisation solutions.

Many of the technologies involved share common scientific, regulatory and technical challenges, which will be a priority to address moving forward.

Key challenges to address

Policy and regulatory

- Secure funding to deliver pilot schemes scaled-up from successful experimental or lab-based projects.
- Development of regulatory and licensing frameworks to deliver technologies such as geothermal energy for heat. Development of the UK's geothermal resources requires a Contract for Difference (CFD) for heat and licensing to regulate the use of the subsurface.

Decarbonisation and the subsurface

Energy storage

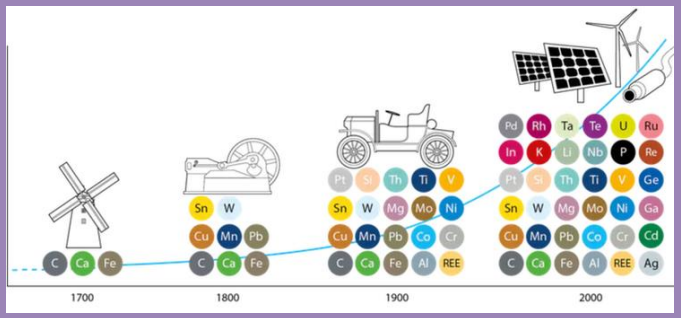
Intermittency of energy supply must be addressed by increasing our **energy storage** capabilities. This could include advancement in **battery technologies** (which rely on secure sources of minerals and metals e.g. lithium and cobalt), as well as subsurface **thermal energy storage**, **pumped hydro storage** schemes, and **compressed air energy storage.**

Geothermal energy

Use of **geothermal energy** for electricity, heating and cooling will require drawing from UK resources and the establishment of effective licensing frameworks. Deep geothermal resources could meet UK heat demand for a century.

Critical metals and raw materials

Decarbonising electricity generation requires expansion in **renewables** and **nuclear**, many of which require **critical raw materials and metals** to manufacture. This requires a sustainable and secure supply of mined materials.



Consumption of mineral raw materials has significantly increased since the industrial revolution, both in volume and variety of minerals used.

Subsurface disposal and storage

Fuel switching from coal to natural gas and hydrogen would reduce CO_2 emissions. This will require **underground storage of hydrogen fuel** and **natural gas**. **Carbon capture and storage (CCS)** and **'bio-energy with CCS' (BECCS)** have the potential to store atmospheric carbon over geological timescales, removing carbon from the atmosphere permanently. Both could be critical in meeting the Paris Agreement. Geological disposal is the UK Government's adopted policy for dealing with our nuclear waste and the siting process for a facility is ongoing.

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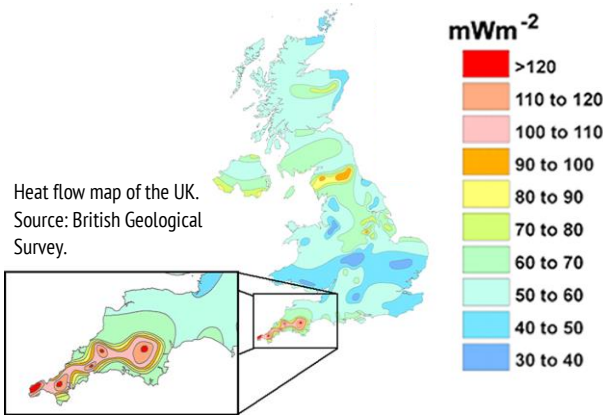
- Support for demonstration projects like the H21 Project, which aims to convert 3.7million homes and 40000 businesses from natural gas to hydrogen fuel by 2034, decarbonising 14% of the UK's heat supply.
- Actualisation of a regulatory system that supports the valuation and use of the subsurface, along the lines of fossil fuel licensing, incorporating management of conflicting interests.

The UK has considerable experience in subsurface development and a wealth of knowledge that will be invaluable when addressing the decarbonisation challenge. It is essential that future generations are trained in skills for the emerging geoscience sectors. This requires support for geoscience education to deliver the skilled workforce needed for emerging subsurface industries. Continued support for doctoral training centres that focus on the geosciences are vital to equip students with advanced technical and scientific skills, as proven by the Centre for Doctoral Training in Oil and Gas at Heriot-Watt University.

Communication and awareness

- Raise awareness of the key role of geoscience in achieving decarbonisation.
- Highlight the importance of critical subsurface resources (mined metals and minerals) in delivering decarbonisation through technologies such as wind turbines (e.g. neodymium, cobalt) and batteries for electrification (e.g. lithium and cobalt).
- Engage communities with field-scale projects for various subsurface technologies, including carbon capture and storage and geothermal heating schemes.
- Undertake high-quality, independent environmental monitoring to ensure confidence in project safety. In densely populated areas, very high levels of environmental assurance will be needed to gain a social licence to operate.
- Understand public attitudes to subsurface decarbonisation technologies.



Heat flow map of the UK. Source: British Geological Survey.

Scientific and technological

- Characterise the physical properties, chemistry and structure of the subsurface to determine feasibility of various subsurface storage and infrastructure projects.
- Improve understanding of how the properties of the subsurface respond to changing physical and chemical conditions, e.g. during cyclical pressurisation and depressurisation of hydrogen or thermal fluids.
- Assess the origin, distribution and extractability of critical raw materials needed for decarbonisation in the subsurface of the UK.
- Develop and design effective and cost-efficient monitoring techniques for various uses of the subsurface.
- Improve scientific understanding of how fluids flow in the subsurface as they pertain to decarbonisation technologies such as underground thermal energy storage and characterisation of geothermal resources.

Critical to the success of the decarbonisation initiative is knowledge and data sharing across geographical borders, between industries, and by all stakeholders of the subsurface – ensuring competing interests are well managed. There are key geoscientific lessons to be learned from users across planning, exploration, exploitation and remediation.

The opportunity

The UK and Europe are well placed to develop subsurface decarbonisation technologies. The UK has an excellent base of world-class universities, research institutes, the experience of oil and gas companies, and novel subsurface experimental infrastructure such as the new £31million British Geological Survey/ NERC UK Geoenergy Observatories.

A combination of state-of-the-art technology, improvements to efficiency and low-carbon fuel switching will be needed to achieve our ambitious decarbonisation targets. However, for some industrial processes, such as steel manufacturing, cement production, and refining, subsurface carbon-capture technologies are the only viable decarbonising solution. Net negative emissions can only realistically be achieved by bioenergy with carbon capture and storage (BECCS), which may be vital if our current decarbonisation efforts fail to match our ambitious targets.

Read more about the role of geology in decarbonisation at www.geolsoc.org.uk/lovell19