# GEOLOGICAL SKILLS AND KNOWLEDGE CRUCIAL IN DELIVERING NET-ZERO

Professor Mike Stephenson
Executive Chief Scientist (Decarbonisation), British Geological Survey

Florence Bullough
Head of Policy and Engagement, The Geological Society of London

**The UK is well placed to research and develop geological solutions to climate change due to the excellent and well-developed knowledge base, mature understanding of the UK's subsurface, as well as world-class universities and research centres.**

The geology of the UK - and the geoscientists that have studied it - have played a vital role in the development of the UK's economy. One of the main components of the industrial revolution was the abundance of easily accessible high-calorific coal in parts of England, Wales and Scotland - and the co-location of materials like iron-ore, limestone and coal allowed large-scale construction for the industrial revolution, such as the famous Iron Bridge in Shropshire. More recently since the 1960s offshore oil and gas has brought huge economic benefits and revenue for private industry and UK Government. Around 42 billion barrels of oil equivalent have been produced from the UK offshore so far, each year bringing around £5 billion in tax revenue, and supporting around 450000 jobs. [1]

These developments are related to coal and hydrocarbons – what we could call a process of 'carbonisation' of the economy - but geology and geoscientists will have a powerful and critical role in the 'decarbonisation' of the economy and in delivering the UK Government's commitment to 'net zero' by 2050.[2] Reports from the IPCC [3], the Committee on Climate Change [4] and the Science and Technology [5] and BEIS [6] parliamentary select committees all outline the critical role that carbon capture, utilisation and storage (CCUS) will play in delivering net zero for the UK economy through decarbonisation of industry and power. The decarbonisation of domestic heating and air conditioning across the world is likely to need geothermal energy and a hydrogen economy will need large-scale geological storage.

Ironbridge *(Source – Keith Havercroft, Geograph.org)*

## DECARBONISATION TECHNOLOGIES

Three key geologically-related technologies will be needed for decarbonisation: CCUS, hydrogen as fuel and geothermal energy. The UK is well-placed to develop and deliver these technologies due to its favourable geology. The North Sea has the potential to be a major resource for a future CCUS industry, due to the concentration of highly skilled professionals and significant data and understanding that already exists about the subsurface in the North Sea. In the area of geothermal energy, there has been significant activity in the UK, primarily in Cornwall and Glasgow. In Cornwall, investigative drilling at the United Downs site is ongoing, aimed at developing a deep geothermal energy resource in Cornwall, with the potential for a further 20 sites. The British Geological Survey, as part of NERC-UKRI, is also investigating the potential for low temperature geothermal energy at their field site at the abandoned mine workings in East Glasgow as part of the UK Geo-energy Observatories project [7] (UKGEOS). As described below, there are also a

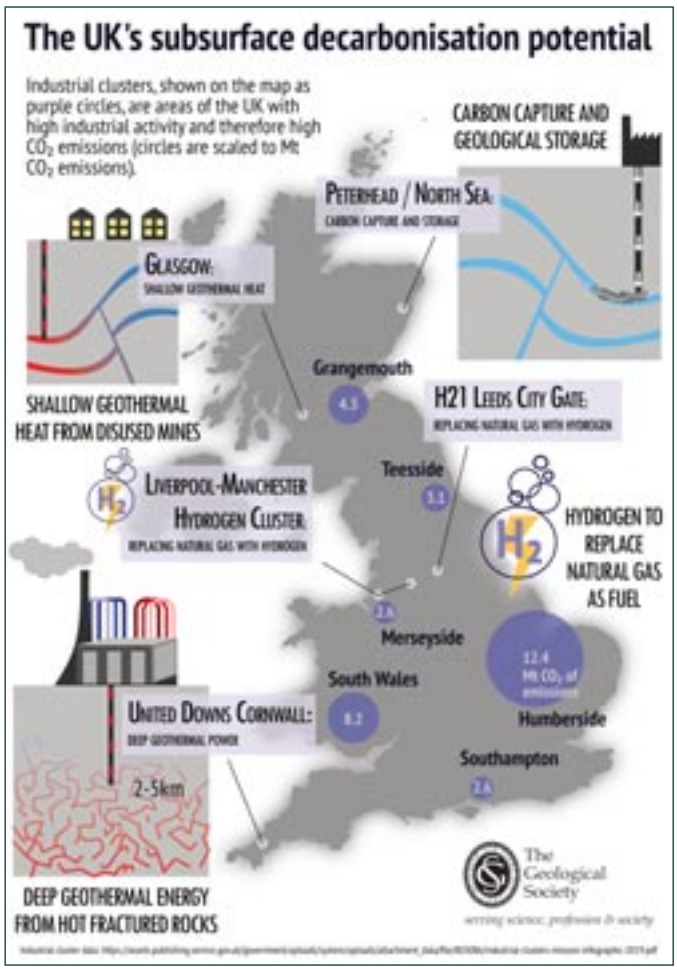


Figure 1 – The UK's subsurface decarbonisation potential *(Image source – The Geological Society)* – Several areas of the UK where there are large industrial clusters, also have significant decarbonisation potential.

number of hydrogen projects in development around the UK. See Figure 1.

## LINK TO UK REGIONAL DEVELOPMENT

The nature of geological resources and materials is such that their use in decarbonisation will tend to be place-based. For example, the development of a regional 'hydrogen economy' – where hydrogen provides fuel for vehicles, heating houses and powering industry. Hydrogen's mass production in the short term will be by steam methane reforming (SMR), from natural gas which produces $CO_2$ and hydrogen. The hydrogen is a zero-carbon fuel, but the $CO_2$ will have to be used, or disposed of geologically. The key point here is that geological disposal of $CO_2$ cannot be done everywhere, because only specific geologies are suitable. Critically, there are many suitable locations with supporting infrastructure in the North Sea. It is also known that to make the hydrogen economy work, huge amounts of the gas will be needed, and therefore so will large local storage in the subsurface. In most cases, this means geological storage in underground salt layers.

A practical example is the 'H21' Leeds City Gate project which will convert the existing natural gas network in Leeds – used mainly for heat – to 100% hydrogen. Decarbonisation of heat is a major challenge for the UK, where fossil fuels dominate the sector, see Figure 2. In the H21 project, SMR plants on Teesside will produce the hydrogen and the waste $CO_2$ will be disposed of offshore in the rocks under the southern North Sea. Subsurface salt cavern storage in the Tees and York areas will be needed for 'intra-day' and 'intra-seasonal' swings in demand as heating is turned on and off by consumers.

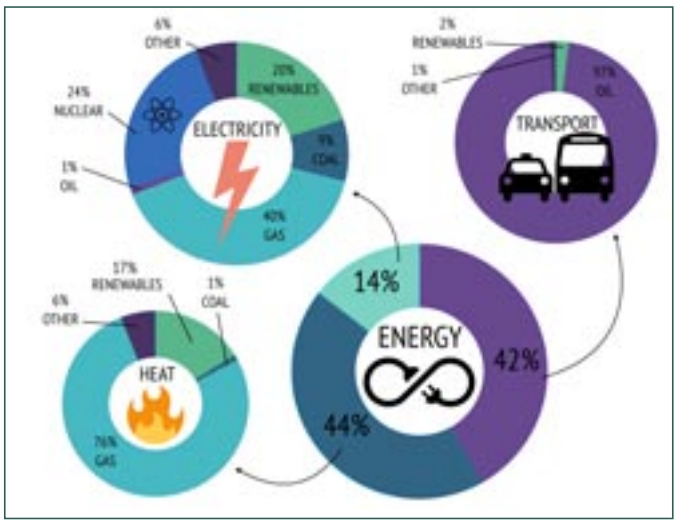


Figure 2 – UK energy demand and supply by sector *(Image source – The Geological Society).*

The Liverpool-Manchester Hydrogen Cluster will decarbonise domestic heat, but also major industrial gas users in the oil refining, glass manufacturing, food and drink, chemicals and pulp and paper sectors. The Liverpool-Manchester area also has suitable geology: the gas fields located in the East Irish Sea off the coast of Merseyside, could be repurposed to provide $CO_2$ storage; the area is rich in salt deposits suitable for the storage needed for the roll out of hydrogen.

There is also potential for geothermal energy to play a significant role in decarbonising heating in the UK with the added potential for electricity generation. Low temperature geothermal energy in particular, typically groundwater with a temperature less than 20°C, can play a part in decarbonising heating. Huge volumes of such waters exist under the UK's towns and cities. Former industrial areas where waters move very freely because of old coal mine workings may be


Hydrogen-powered bus (© Mike Stephenson) - For a hydrogen economy, for example for use in hydrogen powered-buses, we will need to be able to store large amounts of hydrogen in salt layers.

particularly well suited to domestic heating using below-ground energy. Coal mine heat is being tested right now at the NERC-UKRI British Geological Survey test site, UKGEOS, in the former coal mining area in the east end of Glasgow. Other industrial towns based on or near coalfields, often with fuel poverty, could also benefit from coal mine heat.

Drilling an observatory in Glasgow to study heat in flooded mineworkings. © *Mike Stephenson.*

The research and development associated with CCUS, geothermal and hydrogen will develop in geographical clusters around the UK that can exploit existing industrial infrastructure as well as natural geological resources and other advantages to allow local solutions. These regional hubs will concentrate skills and investment, as previously in the development of North Sea oil and gas off the coast of Aberdeen. Development of regional energy projects such as these will also be important for delivering the UK Government's support of 'strength in place' and regional development policies set out in the Industrial Strategy [8]. Across the UK, local 'energy ecologies' – collections of energy users and producers - are beginning to work together to decarbonise. The local funding arrangements of the Government's new Industrial Strategy will target government funding along with co-funding from industry to address market failure. The cluster concept underlines the need for industry and government to work together to decarbonise, but also the importance of the distribution of useful rock types, and ultimately the importance of geoscience knowledge and skills in decarbonisation [9].

The solution to net-zero will not be a 'silver bullet' technology but a variety of solutions, both national and local. Incorporation of geological solutions into local industrial strategies and investment in geological skills will be critical to meeting the decarbonisation challenge and stimulating economic growth across the UK.

## HOW CAN PARLIAMENTARIANS HELP…

- Appraise and build geological solutions to climate change into local industrial strategies. For example, where there is the potential for geothermal energy in a given area, ensure that the requisite licensing regulation is developed to support technological development.
- Promote the important role of geological skills and the UK's local geology in the development of decarbonisation technologies, both regionally and nationally, particularly when developing national policy around investment in research and development and workforce training.
- Strengthen the geoscience skills pipeline through investment in the UK's outstanding universities sector and support the development of immigration policies that allow for the movement of international researchers and students.


**References**

1 https://www.ogauthority.co.uk/media/1014/ukcs_maximising_recovery_review.pdf

2 'Geoscience and decarbonization: current status and future directions' https://pg.lyellcollection.org/content/25/4/501

3 IPCC Climate Change 2014 Synthesis Report https://www.ipcc.ch/report/ar5/syr/

4 Committee on Climate Change - Net Zero – The UK's contribution to stopping global warming - https://www.theccc.org.uk/publication/net-zero-the-uks-contribution-to-stopping-global-warming/

5 Clean Growth: Technologies for meeting the UK's emissions reduction targets https://www.parliament.uk/business/committees/committees-a-z/commons-select/business-energy-industrial-strategy/news-parliament-2017/carbon-capture-report-published-17-19/

6 Carbon Capture and Storage: third time lucky? https://www.parliament.uk/business/committees/committees-a-z/commons-select/business-energy-industrial-strategy/news-parliament-2017/carbon-capture-report-published-17-19/

7 https://www.ukgeos.ac.uk/observatories/glasgow

8 Industrial Strategy White Paper https://www.gov.uk/government/publications/industrial-strategy-building-a-britain-fit-for-the-future

9 'Energy and Climate Change', Michael Stephenson https://www.elsevier.com/books/energy-and-climate-change/ stephenson/978-0-12-812021-7.