Government
Office for Science

CARBON MANAGEMENT

Carbon management technologies aim to reduce carbon dioxide emissions from industry and gas power plants and remove emissions from the atmosphere. The carbon can then be stored or used. Technologies are maturing but face challenges to wider deployment.

CONTEXT

Carbon management technologies (CCUS) are deemed as necessary to reduce current emissions and remove historic emissions to mitigate sectors that are hard to decarbonise. All International Panel on Climate Change scenarios that limit global temperature rises to 1.5°C or 2°C by 2050 include use of carbon management technologies.

TECHNOLOGY

Many different approaches are in development. They range from capturing carbon from industrial point sources, directly from the atmosphere or the sea, through to nature-based systems where features and management of the environment are used to capture and store CO_2.

78 BILLION
tonne storage capacity in the UK continental shelf.

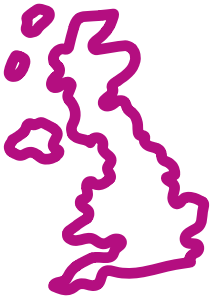
Source: UK Storage Appraisal Project

FUTURE THINKING

Research and Development (R&D) efforts are concentrated on enhancing the efficiency of carbon capture technologies and demonstrating their effectiveness on a large scale. This involves optimising the processes to capture more carbon dioxide with less energy and cost, as well as conducting extensive trials and pilot projects to validate the technology's performance in real-world industrial settings.

UK POSITION

The UK is supporting carbon management technology development and deployment, with aims to capture 20-30 Mt of CO_2 per year by 2030 to help meet the UK's net zero targets.



3RD
globally for research impact & publication output from 2017-2022.

Source: Dimensions

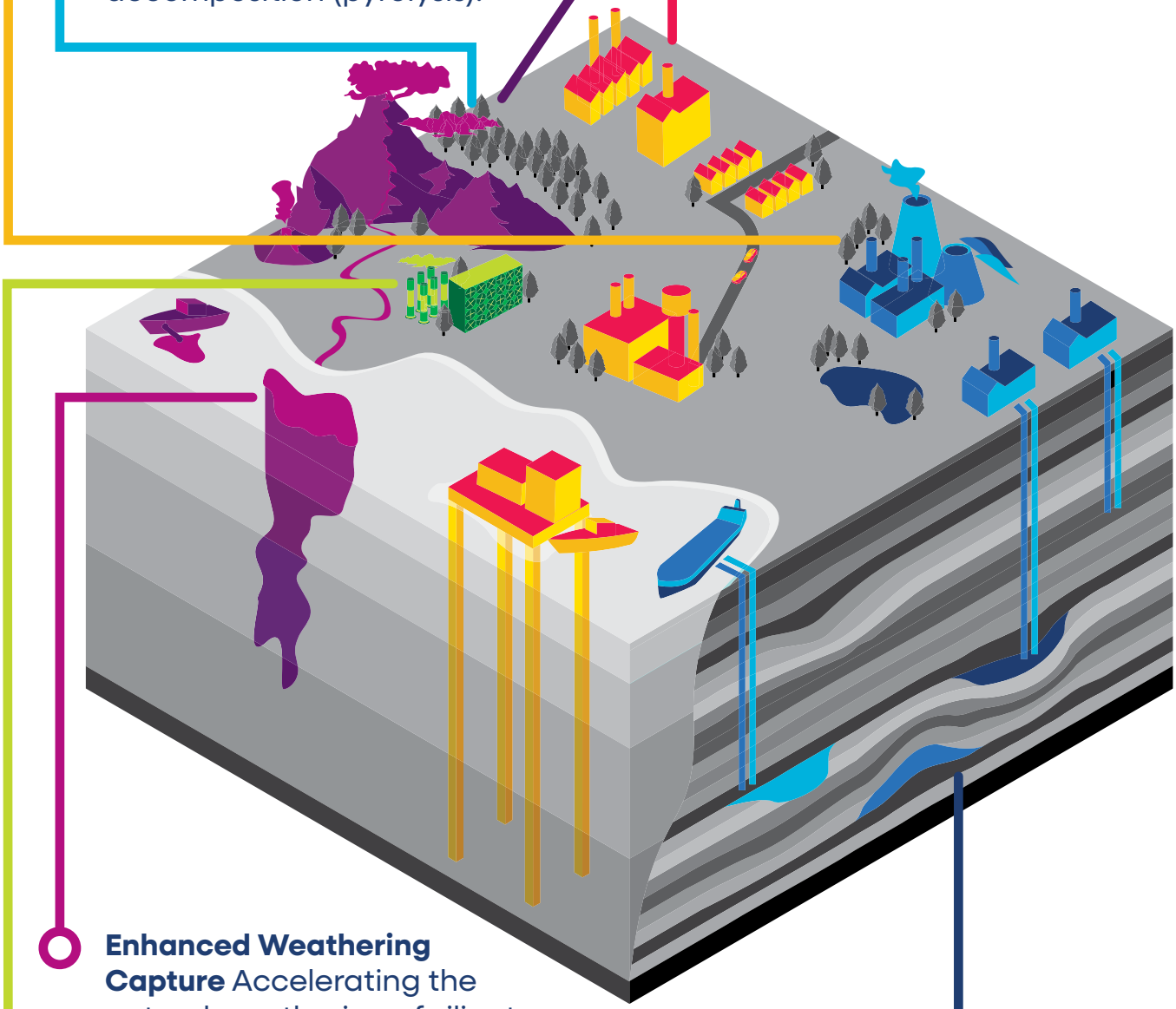
APPROACHES TO CARBON MANAGEMENT

Bioenergy with Carbon Capture and Storage (BECCS)
Burning biomass for energy while capturing and storing the resulting CO_2 emissions.

Biochar
Biochar is a carbon-rich material produced from biomass via controlled thermal decomposition (pyrolysis).

Nature Based Solutions (NbS)
Using natural systems like reforestation to capture and store CO_2.

Point Source
Capture emissions directly at power plants or industrial sites for storage or use.



Enhanced Weathering Capture Accelerating the natural weathering of silicate rocks to sequester CO_2.

Direct Air Capture (DACCS)
CO_2 is extracted from the air using chemical reactions, then compressed for storage or use.

Geological Storage
Storing CO_2 in porous geological formations to reduce emissions, part of the CCUS value chain.

OPPORTUNITIES

- **Combatting Climate Change:** To reach net zero, we must reduce current emissions and actively remove historic emissions to offset hard-to-abate sectors (e.g. steel, cement). Carbon management technologies are considered essential by many experts to reaching 2050 net zero targets.
- **Leveraging the UK's Carbon Storage Capacity and Skilled Workforce:** The UK continental shelf is reported to have capacity to store around 25% of Europe's CO_2, or 78 billion tonnes. The UK's expertise and skilled workforce in the oil & gas sector mean it is well positioned to benefit from transporting and storing CO_2.
- **Additional Environmental Benefits:** Some methods, like enhanced weathering and bio-char, increase the storage capacity of the natural carbon sink. Initial trials have noted improved soil quality and crop yields, while supporting ecosystem restoration.
- **Benefits Across Other Sectors:** Captured CO_2 can be used in a wide range of products and fields such as chemicals, food production, and construction.

CHALLENGES

- **Deployment at Scale:** CCUS technologies have yet to be demonstrated at scale. Technical and non-technical challenges remain, for example improving capture efficiency and reducing energy demand.
- **Cost Competitiveness:** These technologies need to be cost effective for widespread adoption. Although a lack of standardised measuring, reporting, and verification technologies makes it difficult to compare with the decreasing costs of other technologies like solar power.
- **CO_2 Transport and Storage:** The UK is still developing CO_2 transport and storage infrastructure. This is expected by 2030.
- **Public Perception:** While climate change mitigation is generally welcomed, novel technologies could require substantial land, resources, and be perceived as enabling ongoing emissions with implications for delivery.
- **Shifting Focus:** Some experts are concerned that investment in carbon management technologies could shift focus from more proven approaches that directly reduce emissions now.

Please share your views.
Email us at **emtech@go-science.gov.uk**