

Carbon Capture & Storage

Carbon Capture and Storage (CCS) is considered to be one of the more promising solutions for dealing with the problem of removing carbon dioxide (CO₂) from the flue gases produced by coal and gas fired power stations, as well as industrial processes of cement, glass, fertiliser and steel making.

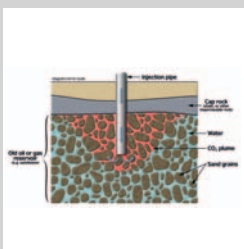
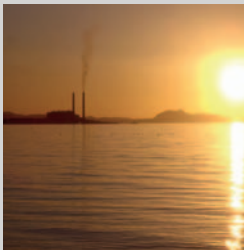
CCS can be split into three distinct operations. Carbon capture has been undertaken for decades, but scaling-up at low cost remains a major technological challenge and requires a strong research effort. Transport of carbon dioxide is often neglected, but has to be safe, reliable and efficient. Permanent storage of the carbon dioxide in geological formations is a process that is understood in principle, but needs much further development to provide the efficiency required commercially, and the predictive confidence desired by regulators.

Some current carbon capture technologies use chemical solutions to absorb the carbon dioxide. These solutions - known generically as Amines and Ammonia – are then heated to recover the carbon dioxide. The recovery process is inefficient, requiring considerable amounts of energy, the reactions are imperfect producing undesirable by-products, and solvents react with minor components of the flue gas. Reducing these effects by improving solvent chemistry and by improving hardware design are major challenges for current research. CO₂ capture can add considerable costs to the generation of electricity and therefore any new cheaper technologies would be welcome. New capture methods under development include pressure-swing absorption gas separation, membrane gas separation and chemical oxide looping.

Site-specific research for capture includes the use of algae that absorb carbon dioxide and in return produce protein for animal feed and oils for liquid fuel. In some settings, the use of mineral carbonation reactions may be applicable. Synthetic biology can create bacteria that consume carbon dioxide and excrete useful oil or other products. Large scale greenhouses can use carbon dioxide, and the waste heat, to accelerate crop growth.

Transport of carbon dioxide inevitably involves compression of the gas – minimising these energy losses requires compressor improvements, and modelling the safety and efficiency of pipeline, shipping, or other transport mechanisms integrated into a continuous flow system. The final part of the CCS operation involves long term storage of the carbon dioxide in subsurface geological formations. This is currently the least well-known part of the CCS chain.

Selecting the right geological site for carbon dioxide storage is critical in order to ensure that firstly, it can accept the amounts of carbon dioxide involved, secondly, it will remain secure and not leak carbon dioxide back into the environment and thirdly, the site



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can be evaluated and developed at feasible cost. This involves modifying petroleum and hydrocarbon geoscience (based on geology, geophysics, geo-engineering and subsurface fluid flow), as well as borehole design, determining local and regional reservoir effects, and predicting to the required standard of certainty.

CO₂ can be used to enhance oil recovery (EOR) it's important to understand how the carbon dioxide will interact with the site-specific hydrocarbons within the reservoir rock micro-structure. This can be achieved experimentally using rock samples and also by using reservoir simulation techniques.

Remote monitoring the status of a deep subsurface storage site for many decades is legally required. Existing hydrocarbon technologies can be adapted – using reflection seismic and direct electromagnetic imaging of CO₂. New low-cost but high sensitivity monitoring systems are being developed, and these will need to be tested at full-scale during CCS validation projects.

All the technology challenges must finally combine into a profitable and legal business. Research is underway, inventing how to regulate, fund and price carbon dioxide capture and storage. Solutions to licensing and liability aspects need to be evolved during the validation of this technology.

Within Scotland there is one of the largest and growing CCS research and development groupings in Europe, comprising a network of different universities and institutions with experience right across the CCS chain. Working together as Scottish Carbon Capture and Storage centre (SCCS) it comprises chemical engineering, next-generation carbon capture technology development; rare expertise in power plant design and operation; storage formation experimental analytical facilities; experience in storage capacity, field studies; reservoir modelling; and remote monitoring. This is augmented by research into innovative uses for carbon dioxide; legal, policy and regulation. Leadership is through several Professorial academics and SCCS aims to stimulate the development of innovative solutions to carbon capture and subsurface storage.

This SCCS group undertakes strategic fundamental research in the UK, EU and USA, and can provide tactical consultancy. The Centre also has the capacity for full evaluations of business concepts, public engagement, and economic robustness and technology innovation appraisal. CPD courses are offered from one day introductions to 5 days thematic training and one year CCS MSc.

For further information please email : contact@etp-scotland.co.uk

