UNIVERSITY OF CAMBRIDGE
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The current state of CCS: Ongoing research at the University of Cambridge with application to the UK policy framework

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The Earth's climate is changing and the release of carbon dioxide (CO2) and other greenhouse gases (GHGs) into the atmosphere is recognised as the principal cause. To meet legally binding targets, UK GHG emissions need to be cut by at least 80% of the 1990 levels by 2050. It is acknowledged that the future energy use will likely contain fossil fuels into the foreseeable future, and therefore using Carbon Capture and Storage (CCS) is the only method of preventing atmospheric greenhouse gas (GHG) emissions.

Some key challenges face the deployment of CCS and are concerned with a breadth of different issues. Research at the University of Cambridge is resolving some of these issues and assisting the deployment of CCS technology. One significant challenge is cost, with the capture of CO2 representing the largest share of this. Research at the Engineering and Chemical Engineering Departments has been conducted into alternative capture technologies with improved efficiencies to reduce costs, and innovative solutions have arisen. These include pre-combustion technologies such as chemical looping using solid fuels that produce pure CO2 as a by product with energy penalties as low as 5-8%.

Uncertainty of CCS deployment is also a major challenge and is mainly due to costs and liabilities should a storage reservoir leak. Research at the Departments of Applied Mathematics and Theoretical Physics, Earth Sciences and the BP Institute has addressed some of the concerns surrounding CO2 storage and potential leakage from the storage site. Analytical and numerical models have been developed to assist understanding of the propagation of fluid CO2 in a reservoir, the different methods of trapping that might occur and the likelihood of leakage through

a fissure or fracture in the reservoir. Experimental studies have been conducted in order to help validate the models, and an understanding of the migration of CO2 through a reservoir has also been gained through seismic studies of the Sleipner Field in the North Sea. Dissolution of carbonate or silicate minerals can provide the CO2 with a leakage pathway. Rates of reactions occuring in reservoirs that might act to dissolve carbonate or silicate minerals have been investigated using geochemical studies of analogue natural sites.

An important aspect of the CCS process is sending a clear and scientifically grounded assessment of the risks associated with long-term CO2 burial. Thus public communication of CCS is also vital for commercial deployment. Research has been conducted at the Judge Business School into the communication of CCS, with the findings that CCS technologies are currently not sufficiently well known or understood by the public and that there are gaps in the types of information (predominantly technological) that are available and in the types of institutions (predominantly corporations and Government) actively providing information on CCS. Research is also conducted into the economics of CCS because cost is a major issue.

Another challenge is that the technology has not yet been tested at the commercial scale and therefore the associated risks may not have been fully characterised. However, unless the technology is commercially deployed, the full technological capability will not be understood. The key is to generate the right market conditions in order to allow the technology to be deployed and remain viable when competing with other low-carbon energies. The right regulatory framework needs to be set so that the financial burden placed on operators of storage sites is not prohibitive, but that negative environmental and health impacts due to leakages are minimised.

The current UK policy framework for CCS is outlined in this document and the immediate barriers to deployment are highlighted. The ongoing CCS research taking place primarily at the University of Cambridge is described. There are many steps that need to be taken if CCS deployment is to ultimately succeed; this document attempts to highlight these steps and address them.

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