CCS Technical Status Brief – April 2017

The IEA Greenhouse Gas R&D Programme (IEAGHG) is part of the IEA's Energy Technology Network and its role is to assess the potential to mitigate greenhouse gas (GHG) emissions from the use of fossil fuels in the power, oil and gas and industry sectors. The IEAGHG's remit covers all greenhouse gases but we focus on research activities primarily on assessing CO_2 mitigation options. Of the CO_2 mitigation options, Carbon Capture and Storage (CCS) is considered to offer the most potential for CO_2 mitigation from the use of fossil fuels across the sectors we consider. Further details of the activities of the IEA Greenhouse Gas R&D Programme can be found on our website at **www.ieaghg.org**.

This CCS Technical Status brief has been prepared to summarise key technical developments on CCS in the last 6 months, identified by IEAGHG providing information for both its members and the broader community. The IEAGHG provides reports and webinars, those directly relevant to this brief are referenced at the end of the document.

CCS is Essential for Europe to Meet the Paris Agreement

The European Zero Emission Platform (ZEP) has modelled the least cost CO_2 reduction pathways across 10 EU countries to assess their ability to meet the Paris Targets[1]. When CCS was not available to the model, total emissions in 2050 from the 10 countries modelled were found to be 3 to 4 times higher. Across the European energy system, ZEP's modelling shows that the value CCS to the EU could be in excess of €1 trillion by 2050 alone.

CCS is Proven and in use around the World

The Global CCS Institute's 2016 status report[2] informs us that there are 22 large-scale CCS projects in operation or under construction globally. The combined CO_2 capture capacity of these 22 projects is around 40 million tonnes per annum (Mtpa). Two more projects are anticipated to be operational in 2017.

20-years of CCS Progress Reviewed

The IEA launched a new report at GHGT-13, which reviews progress with CCS technologies over the past 20 years and examines their role in achieving 2°C and well below 2°C targets[3]. The report emphasises the fact that CCS technology is not new and highlights that the Sleipner CCS project in Norway has been operational for 20 years. The Sleipner project has captured almost 17 million tonnes of CO_2 from an offshore natural gas production facility and permanently stored them in a sandstone formation deep under the seabed.

Worlds largest CO_2 capture facility begins operation[4]

Construction on the Petra Nova project began in 2014 with a goal to be operational by the end of 2016. With construction completed, on budget and on-schedule, the Petra Nova carbon capture facility achieved this goal. Petra Nova uses the Mitsubishi Heavy Industries, amine based capture technology to capture 90% of the flue gas from a slipstream off an existing coal fired boiler. The captured CO_2 is transported by pipeline for use in EOR operations.

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World's largest Bio-CCS/BECCS project begins operation[5]

The Illinois Industrial CCS (ICCS) Project began operation in April 2017. It captures 1 $MtCO_2$/yr from Archer Daniels Midland's (ADM) corn ethanol plant in Decatur, Illinois, transports it via a 1.6 km pipeline and stores it in the nearby Mount Simon sandstone formation. Thus, the project is currently the largest CCS demonstration on a bioenergy application. The permit allows ADM to capture and store a total of 5.5 $MtCO_2$, over the course of 5 years. The project is following its successful predecessor, the Illinois Basin Decatur Project (IBDP), which already captured and stored a total of 1 $MtCO_2$ from 2011-2014.

World's first CCUS project in the Middle East and in the Steel sector begins operation[6]

The Al Reyadah CCUS Project is the Middle East's first commercial scale CCUS facility that began operation in late 2016. The facility uses amine-scrubbing technology to capture 800,000 tonnes of CO_2 from the direct reduced iron process used at Emirates Steel plants 1&2. The captured CO_2 is then transported 42km by pipeline to the ADNOC oil fields in Rumaitha and BAB, where the CO_2 is injected for EOR.

Latest CCS Technical Developments Discussed

The GHGT-13 conference held in Lausanne, Switzerland in November 2016 brought together over 900 international experts on CCS to discuss the latest developments in CCS technology. Over 800 technical papers were presented, 6 discussions panels covered topics such as; CO_2 utilisation and BIOCCS. 6 CCUS demonstration projects presented their latest work including; Sleipner, Kemper County (USA), Quest, Boundary Dam (both Canada), Tomakomai (Japan) and the Al Jubial project in Saudia Arabia. A summary report of the outcomes has been produced for reference.[7]

New Road Map for CCS in Australia

The University of Queensland, with support from Commonwealth Government, NSW Government, CSIRO, CO2CRC Limited, ACALET (COAL21 Fund) and ANLEC R&D has developed a road map for CCS in Australia. The road map's key messages[8] suggests CCS is vital to Australia's long-term economic prosperity and energy security. CCS is needed in Australia's energy mix to assure energy system security and affordability so that future emissions reductions targets are delivered at the lowest economic cost. In addition, that CCS will play a vital role in decarbonising energy intensive industries, which involve the continued use of fossil fuels.

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Industry CCS FEED Contracts Awarded

Gassnova has announced that contracts for FEED studies for CO_2 capture at 3 industrial facilities in Norway have now been awarded[9]. The contracts cover the Norcem cement facility, the Yara ammonia fertiliser plant and the Klemetsrudanlegget waste incinerator near Oslo. There are currently no commercial scale CCS projects at any of these industrial applications.

New Industry CCS Studies Completed

IEAGHG has completed two techno-economic studies that assess the potential for CCS integration at industrial hydrogen production facilities based on steam methane reforming and in the pulp and paper industry Both studies demonstrate the technical feasibility of integrating CCS into these industrial facilities. Adding CCS to an SMR based H_2 plant results in a CO_2 avoidance cost of between €47 and €70 per tonne of CO_2 depending on the configuration chosen. In the pulp and paper sector it has been estimated that adding CCS results in a CO_2 avoided cost of 62 to 92 €/t CO_2 for a pulp mill and between 82 and 92 €/t CO_2 for an integrated pulp and board mill. Summaries of both studies have been presented as webinars[10,11].

CO_2 Storage in Depleted Oil and Gas Fields

The use of depleted reservoirs for CO_2 storage can offer advantages because the geological characteristics that are important to CO_2 storage are known; also, there is strong evidence for secure containment of gas or fluids. IEAGHG have examined a number of cases where CO_2 has been stored in depleted oil and gas fields to serve as reference for future projects[12]. The case studies focused on how the sites have overcome relevant technical issues as well as those relating to regulation, and where possible, costs and economic viability.

Progress on Monitoring and Modelling CO_2 Injection

IEAGHG's international research network on modelling and monitoring CO_2 injection met in a joint session. The meeting showed that good progress is being made with the experience gained in both monitoring and modelling from demonstration and pilot projects[13]. There has been real progress in streamlining MMV at projects and reducing the costs of monitoring. Several sites have now demonstrated conformance of a modelling-monitoring loop, leading to an improvement in the understanding of this principle.

Assessing the Permeability of Faults on Long-Term Storage Integrity

IEAGHG has reviewed recent research on permeability and emphasises that if fault zones are present in or around CO_2 injection sites then they need to be carefully characterised to ensure the development of an effective containment assessment and to inform the development of operational constraints and monitoring plans[14]. A number of mitigation measures have been identified that could be used if required.

Economic Barriers to CO_2-EOR

Whilst CO_2-EOR is widely practised in North America, it has not expanded outside of that region. One key barrier is the absence of the necessary infrastructure to supply CO_2 and inject it into target reservoirs in other regions of the world. IEAGHG has assessed the economic barriers and has shown that the most significant factor that influences CO_2-EOR uptake is the prevailing price of oil[15]. High oil prices are therefore likely to stimulate the take up of CO_2-EOR in the Gulf States and China.

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References & Further Reading

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