Temporary Working Group – Future CCS Technologies

Progress Report: September 2016

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The TWG has completed the final draft report that discusses technology needs for capture, transport and storage and is intended to be used as a basis for CCS R&I / R&D topics for the coming period – informing both the ZEP community and the Commission.

The report has been reviewed by several parties (IEAGHG, SCCS, Shell) and submitted to the AC for approval at the September 2016 meeting.

The report will be used to inform the Commission on R&D priorities for the coming years. A summary of the conclusions is given here.

CO_2 Capture

General R&D priorities applicable to all or distinct capture technologies lie in the following areas:

- Improvement of load-following ability of capture systems. The flexibility of capture systems is expected to become a key property in both power and industry applications.
- Reliable estimates of cost and performance by leading emerging technologies to appropriate TRL levels.
- Moving emerging technologies through the "valley of death" towards TRL7.
- Alternative fuels such as biomass as well as fuel conversion.
- Sensitivity of capture systems and robustness with respect to flue gas components other than CO_2.
- Degradation issues and environmental aspects.
- Materials, properties and packing structures improvements both for separation and capture systems construction.
- Volume decrease for capture systems by developing more effective separations, productivity, contacting surfaces and faster cycles.
- Integration of capture facilities into different power plants – indicating and guiding the trade-off between integration degree, efficiency penalties and operation flexibility.
- Processes optimisation and heat integration.
- Efficiency penalty reduction.

The analysis of capture technologies suggests that solid sorbent processes and solid looping systems are promising compared to benchmark solvent processes, under specific criteria. On the growing interest and demand for operation flexibility, polymeric membranes show significant potential as they can be switched off and on easier than other systems.

While new power cycles or enabling technologies to the power or industrial sectors has been out of the scope of analysis, it is acknowledged that they can contribute significantly to improvements with regards to CO_2 capture and should definitely be considered as future R&D priorities.
It is essential that current first-generation capture technologies are tested in actual CCS projects, to subsequently enable emerging techniques to progress.

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Transport

Transport of CO_2 by pipeline:

- This is a well-established technology and is commercially available.
- Minor issues exist around the modelling of transient flow in pipelines, across platforms and into wells, especially to account for the effects of impurities in the CO_2. With recent developments in databases of physical CO_2 mixture properties, advancements are required in software that is capable of performing transient flow calculations.
- In more complex transport networks, the quality of CO_2 becomes a management issue, taking into account mixing of streams of different quality and maintaining control over the performance of the system. In principle, the knowledge about the relation between CO_2 quality and the behaviour of the CO_2 in the system is available.

Transport of CO_2 by ship:

- This is well established but for large-scale CCS ship transport needs to be scaled up. CO_2 carriers exist, but larger ships will be required; the same can be said about loading and unloading facilities at ports. Offloading offshore, near the injection location requires some technology development and demonstration, such as flexible hoses and mooring systems.
- Ship transport to offshore storage locations may lead to batch-wise injection. The effect of intermittent injection, with pressure and temperature cycling, on injection wells needs to be investigated. An on-site buffer storage could remove some of the intermittency.
- The design of CO_2 carriers and that of a possible buffer storage remains to be optimised and demonstrated; the optimisation relates to the location of and power source for facilities to condition the CO_2 prior to injection.

Storage

- The required operational flexibility holds for the whole CCS chain including CO_2 injection and storage, in particular in the early stages of CCS development from demonstration to early deployment where the dependence on single sources for a reliable continuous supply will dominate availability of CO_2. Systems analysis of the whole chain is necessary to evaluate where the capacity for flexibility is to be built most cost-effectively, e.g. flexible, cost-effective capture technology, in buffering and in networking to stabilize transport grid and storage load.
- Research including full-scale demonstration is required on expanding the operational envelope of injection wells and subsea equipment under repetitive cycles of pressure and temperature changes, particularly for injection into low pressure stores like depleted pressure gas fields.
- Approaches for effective storage portfolio management are necessary to efficiently exploit the available pore space, e.g. in large areal extent aquifers, to shorten the appraisal lead time and to timely expand the infrastructure for injection of CO_2 including mothballing of existing infrastructure.
- Sufficient storage capacity must be assured before investors can decide on financing CCS. A good starting point for tackling this research item is the work done for the UK sector [504].

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- Pressure management for increasing the capacity and injectivity, e.g. by using water production wells; research is to be directed to strategies for water production, the breakthrough of CO_2 and water treatment. In 2016 US DoE has selected two projects on technologies for the production of usable water from CO_2 storage sites (EWR).[1]
- Lower-cost monitoring and mitigation technologies which are cheaper than current technologies from the oil and gas industry. Combined techniques such as seismic with gravity or seismic with controlled source electromagnetics (CSEM) with less impact on the earth's surface; for tracking CO_2 in the shallow subsurface and atmosphere and water need further development. Technology development should also be directed to less invasive leakage mitigation techniques and cost-effective methods for closing wells.

[1] http://energy.gov/fe/articles/energy-department-selects-projects-demonstrate-feasibility-producing-usable-water-co2

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