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Dossier

CO_2 Capture and Geological Storage: State-of-the-Art
Capture et stockage géologique du CO_2 : état de l'art

Challenges in Capture Processes: The Way Forward

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1 OBSTACLES AND OPPORTUNITIES RELATED TO CO_2 CAPTURE

State-of-the-art CO_2 capture processes lead to a reduction of power plant efficiency and an increase in electricity costs when used with the dilute streams of CO_2 found in the flue gases from the current generation of fossil fuel power plant. It accounts for more than 75% of the overall cost of the CCS chain. The development of other, more cost-effective methods of capture of carbon dioxide is one of the key issues relating to CCS (along with public acceptance of geological storage). European Research and technology development projects are underway in the EU Framework Programme 6, *i.e.* the integrated projects ENCAP and CASTOR, focusing on a range of technology improvements and break-through technology components as well as enabling technologies. Other capture methods are under examination outside these projects (*e.g.* membranes or sorbents). A major part of the research is aimed at achieving more concentrated gas streams by way of, for example, pre-combustion decarbonisation or "oxyfuel", *i.e.* removing nitrogen prior to combustion.

As the number of promising approaches is narrowed down, it is clear that there is a need for a number of large scale demonstrations at several European locations, related predominantly to power generation from fossil fuel but possibly also using other major industry point sources to initiate the deployment of industry-scale CCS. Industrial scale capture (and storage) experiments could cost several hundred million euros. Wide scale application of CCS in Europe would probably be served best by a number of demonstration plants or activities embracing different technical applications as well as providing regional and geographical coverage, and thereby assisting in gaining public acceptance for the concept. It is recommended that priority be given to locating/designing a number of "small and smart" European "lighthouse" projects, supported by targeted research and development. Some of these may possibly be combined with industrial activities (*e.g.* new power plants or oil field development) or national programmes (*e.g.* those emerging in the United Kingdom, Germany and the Netherlands). The commercial introduction of CO_2-capture will most likely be determined by the operation of the emission trading scheme. This will put a commercial price on CO_2 and hence set the scene for the development of business cases incorporating CCS.

2 RESEARCH AND DEVELOPMENT REQUIREMENTS

Research is needed into post-combustion decarbonisation technologies, with a view to validation of solvent technologies in integrated pilot plants, development of novel chemical solvents and associated process technologies giving a break-through in capture costs and energy consumption. Other separation processes to be investigated include: membranes, adsorption, high temperature solid sorbents as well as cryogenic and bio-mimetic approaches.

Similarly, within the field of precombustion decarbonisation there is a need for validation of absorption technologies in integrated pilot plants as well as development of novel reactor concepts for H_2/CO_2 separation (membrane, adsorption and absorption for the enhanced reforming/gasification process). Some concepts for generation of multiple products, including CO_2 capture, warrant further study.

Validation of denitrogenation/oxyfuel technologies in integrated pilot plants is also essential, as are novel concepts

for oxygen production or oxygen transfer. High temperature oxygen production technologies can also be exploited in the conversion of fuels to hydrogen in the precombustion route. Further development of fuel conversion technologies should focus on drastic improvement of capture processes or avoidance of separation processes.

Capture technologies constitute a critical component of zero emission power generation schemes. It is necessary to work on development and validation of new integrated processes providing near-complete CO_2 capture while at the same time aiming at achieving higher energy efficiencies and/or lower costs. This could also include incorporation of biomass co-combustion and partial CO_2 capture resulting in a climate-neutral power plant as well as multi-pollutant removal concepts addressing sulphur components, NOx, Hg, etc.

It essential that the development of capture processes is properly integrated into complete CO_2 mitigation chains, providing a fertile backdrop for:

– enabling technologies such as combustion technologies, particularly to improve conversion efficiency;
– synergistic approaches for CO_2 capture and CO_2 storage;
– linking capture technology to CO_2 mineralisation routes.

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