Status and prospects of the Capture Programme

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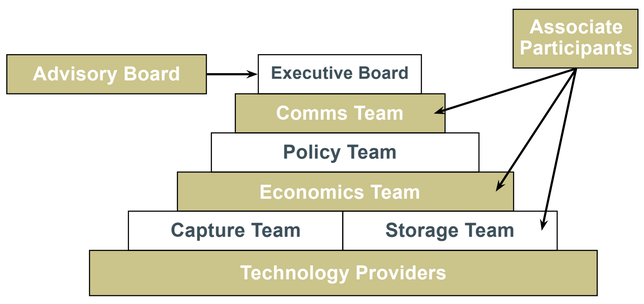
Programme Overview

The CO_2 Capture Project (CCP) is an award-winning partnership of several major energy companies working to advance the technologies that will underpin the deployment of industrial-scale CO_2 capture and storage (CCS). The CCP is currently in its third phase of activity:

- Phase 1 (CCP1, 2001-2004) technology screening/proof of concept – completed
- Phase 2 (CCP2, 2004-2009) intensive development – completed
- Phase 3 (CCP3, 2009-2013) demonstration – on going

Structure of CCP



Programme Objectives

- **Increase technical and cost knowledge** associated with CO_2 capture technologies and confirm that geological storage of CO_2 is a secure and viable means of reducing greenhouse gas emissions
- **Reduce CO_2 capture costs** by 20-30% by supporting the development of improved technologies
- **Quantify remaining assurance issues surrounding geological storage of CO_2** through site assessments, field surveys and numerical approaches; and rapid dissemination of results to stakeholder groups

Three areas for application of capture technologies

Oil Refining

- Responsible for 6% of total emissions of CO_2
- Up to 4 million tons/year from single refinery
- Multisource/multistack environment:
  - Fluid Catalytic Cracking (FCC) unit
  - Hydrogen production
  - Boilers and process heaters

Heavy Oil Extraction

- Extraction technique by steam injection (SAGD) produces fuels with 20% higher footprint than conventional sources
- Major source of future growth for GHG emissions in producing countries (e.g. Canada)
- Once Through Steam Generators (OTSG) are the typical boilers used in SAGD operation

Natural Gas Power Stations

- Power generation from natural gas is widely used by oil & gas companies
- Current low cost of gas in North-America should increase the share of power from gas
- Low concentration of CO_2 in the flue gas (4% vs. 12% typical of coal combustion) makes capture more difficult

Oxy-fired Technology Demonstrations

Fluid Catalytic Cracking Regenerator

- Pilot FCC unit
- Location: Sao Mateus do Sul (Brazil)
- Size: 33 bbl/day of feed (~200 times larger than conventional FCC pilot units)
- Retrofit to oxy-firing included installation of:
  - Oxygen supply system
  - CO_2 recycle system
- Test duration: September 2011/September 2012
- Main results:
  - Demonstrated that FCC may work steadily in oxy-firing mode
  - CO_2 concentrations > 93% vol. achieved in the flue gas
  - Corrosion problems in the flue gas recycle system identified and solved
  - In oxy-firing mode the unit capacity may be increased by ~10%
- Economic evaluation confirmed that oxy-firing is competitive with post-combustion for this application

FCC Pilot unit in Sao Mateus do Sul (Courtesy of Petrobras)

Once-Through Steam Generator

- Partnership including Cenovus Energy, Devon Canada, MEG Energy, Praxair and Statoil
- Co-funding by the Climate Change and Emission Management Corporation of the Province of Alberta
- 50 millions BTU/hr commercial OTSG unit owned by Cenovus Energy in Christina Lake (Canada) is going to be retrofitted to oxy-firing
- Feasibility study concluded in 2011
- Retrofit detailed design ongoing
- Installation of oxygen supply system, flue gas recycle system and burner modifications by April 2013
- Test run by June 2013

50 million BTU/hr OTSG unit in Christina Lake (Courtesy of Cenovus Energy)

Main R&D Projects in CCP3

Oxy-fired burners for process heaters

- CFD simulation and pilot testing of conventional John Zink burners operated in oxy-firing mode.
- Project concluded June 2012
- Main results:
  - Heater efficiency increases by 4 (air-preheat) to 15 (no air pre-heat) % points up to 93%
  - Conventional burners may work steadily in oxy-combustion mode
  - NOx formation strongly decreased
  - High air ingress due to negative operating pressure

Membrane Water Gas Shift

- Intensive testing of Pd-alloy membrane tubes and modules developed by Pall
- Construction of base module for a field pilot unit
- Sizing and costing of pilot and commercial unit for refinery application in view of a carbon-free hydrogen-fired refinery

Heater pilot unit in Tulsa (courtesy of John Zink Co.)

Pilot unit at EERC (courtesy of EERC)

Chemical Looping Combustion

- Next generation technology for heavy oil and potential breakthrough in capture cost
- Developed with CCP co-funding in previous phases to 120 kW unit with Ni-based carrier
- CCP3 is supporting work by several institutions in view of:
  - Verifying the potential of Cu-based carriers as a cheaper alternative to Ni-based carriers
  - Designing and costing demo unit (10 Mw) and commercial unit for heavy oil extraction

PCO2C Partnership

- Pilot plant testing of novel post-combustion technology at the Energy & Environment Research center of the University of North Dakota (EERC)
- Programme conclusion by December 2012
- Specific focus on application to natural-gas fired power stations
- Extended testing of selected technology specific for the CCP during the first quarter of 2013

About the CCP

The CO_2 Capture Project (CCP) is an award-winning partnership of several major energy companies, working to advance the technologies that will underpin the deployment of industrial-scale CO_2 capture and storage.

For further information on the work of the CO_2 Capture Project, please visit:
www.co2captureproject.com

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