Towards widespread deployment in CCS:

Advances in CO_2 capture and storage technology

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CCP mission

Develop technologies that will reduce the risks and further advance CO2 capture and geological storage; making CCS a practical reality for atmospheric carbon mitigation

CCP mission

HOW does CCP work?

- Collaboration of leading oil & gas companies, government, NGOs, academic institutions
- 3-phase programme, started in 2000
- Over 200 joint projects to date, broad scope ranging from policy to technology development to R&D and knowledge sharing
- Phase 2 just completed, critical third phase about to begin
- Incorporates oil & gas industry expertise + power industry experience
- CCP is now a leading authority on CCS, sharing learnings through several avenues

Project focus

FOUR KEY AREAS

- Capture technology development
- Storage, monitoring and verification development
- Understanding of policy to support development of frameworks that will encourage CCS deployment
- Communications with broader stakeholder audiences to improve understanding

CAPTURE

CHALLENGES

- Identify suitable capture technologies with potential for widespread deployment
  - ❑ narrow field from 200+ technologies
  - ❑ maximise performance, understand limits
  - ❑ scale up at least one to demo

- Reduce cost of capture
  - ❑ reduce uncertainties around cost
  - ❑ deliver significant reductions in cost

CAPTURE

RESULTS HIGHLIGHTS

- Cost reduction potential of 60-80% identified for large, fixed combustion sources
- Reduced cost uncertainties
- Promising technologies identified, taken to further testing, including….

CAPTURE

RESULTS HIGHLIGHTS

- Oxy-firing
  - a) advanced techniques examined for high performance alternative to air combustion
  - b) full field demonstration on FCC unit, Petrobras refinery, Brazil – planned for 2010
  - c) novel Chemical Looping Combustion variant shows high potential for heavy oil/tar sands extraction

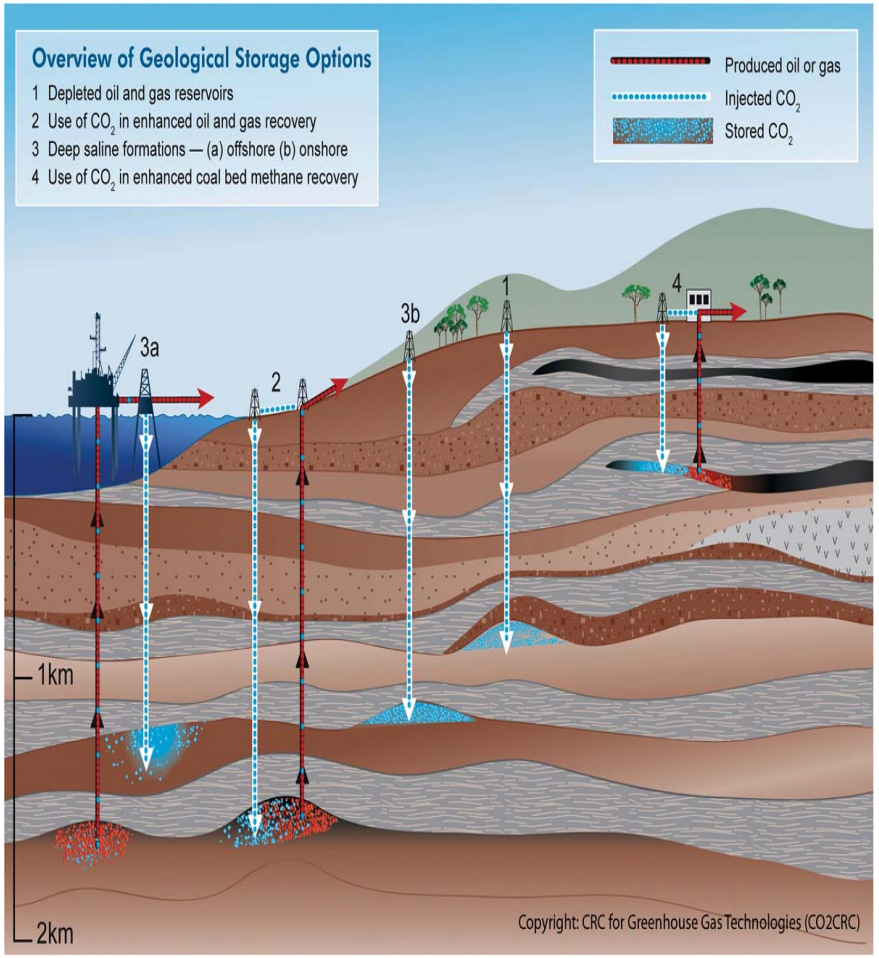
- Post-combustion
  - a) Best Integrated Technology for capture from gas fired power station, improved through testing of Exhaust Gas Recycling
  - b) initial cost advantages eroded but still suitable for 800MW power stations

- Pre-combustion
  - a) identified as potential longer term solution for capture from gas fired power stations and oil refineries
  - b) emerging technologies incl. Hydrogen Membrane Reforming, Membrane Gas Water Shift, Sorbent Enhanced Water Gas Shift show potential

STORAGE

CHALLENGES

- Demonstrate that geological storage is secure and viable
  - a) optimum formations, structures
  - b) understand, minimise risks
  - c) build body of knowledge/science
- Develop site assessment protocols
  - a) simplify and create common process
- Develop technologies for critical issues
  - a) site certification – permitting, operation, decommissioning
  - b) well integrity – determining best practice
  - c) monitoring – advanced methods



STORAGE

RESULTS HIGHLIGHTS

- Certification Framework developed for regulators & stakeholders
  a) provides transparent workflow protocol for storage site assessment

- Well integrity study established best practice principles
  a) analysis of 30-year old CO_2 production reservoir (Colorado)
  b) correct placement more important than cement type

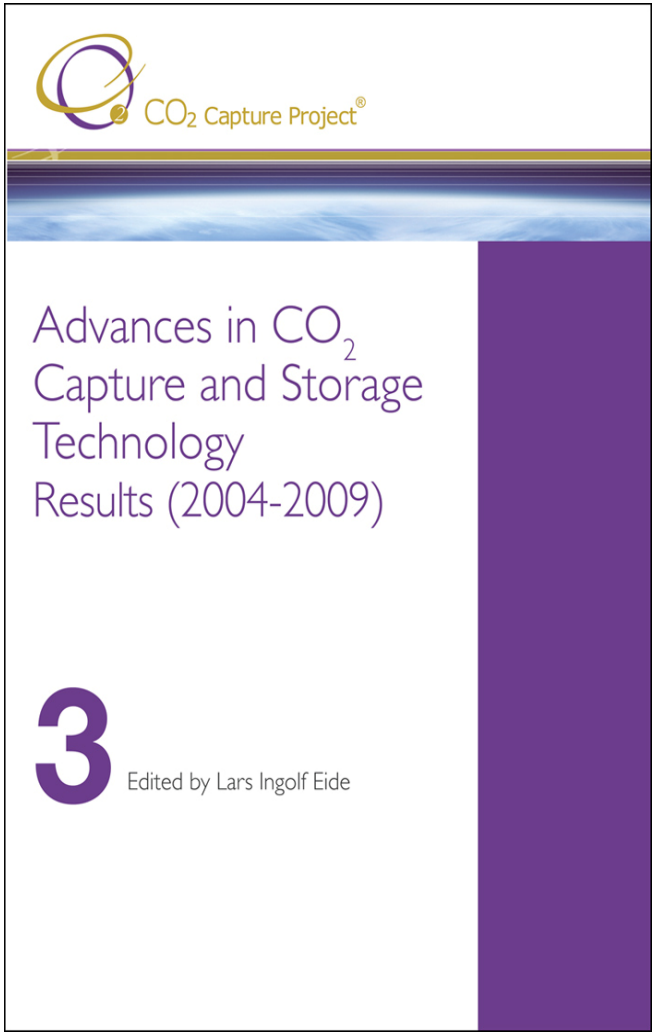
- Monitoring studies provided key learnings
  a) lower cost non-seismic methods suitable for coal bed CO_2 storage
  b) remote sensing through aerial monitoring requires advances in instrument design

- Definitive report produced
  a) Technical Basis for CO_2 storage
  b) aids understanding, decision making, communications

BROADER ENGAGEMENT

RESULTS HIGHLIGHTS

- Comprehensive results books – CCP1 and CCP2 (new)
- Peer reviewed capture, storage and transportation research
- Launched www.co2captureproject.org
- Regulator, NGO and media engagement programmes - continued dialogue adding insights into CCP results



Learnings and realities

- Technology to capture and store CO2 now largely proven
- Large scale storage projects in Norway, Algeria are proving that storage can be achieved safely and securely
- Driving down absolute costs - more difficult than expected
- Winning broader acceptance (public, media, NGO) continues to be critical and challenging

Towards large scale implementation of CCS – CCP 3 2009-2013

- The next 5 years for CCP:
  - a) scale up capture to demonstration level
  - b) further drive down costs
  - c) sampling, specialised testing and modelling protocols to aid assessment, operation and decommissioning
  - d) build broader programs for CO2 storage security
  - e) continue to implement within the oil & gas industry

- …and provide input to framing of appropriate policies to enable demonstration - and ultimately widespread rollout - of CCS