Carbon Dioxide Capture and Storage Challenges

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Background: Participants’ Motivation

- Companies are responding to the concern which exists around Climate Change and CO₂ concentrations in the atmosphere.
- Commercially viable technologies are not available at scale.
- A portfolio of options are needed, which include technologies that allow us to take constructive action in the medium term.
- Technology is only part of the solution.
Background: Why Focus on Capture and Geologic Storage?

- Opportunity to add value through beneficial use of CO₂
- Possibility to achieve very material reductions in CO₂ emissions
- Energy companies often control both source and sink
- Many years of experience successfully managing geologic reservoirs and storage of fluids/gas
  - Early opportunity to learn by utilising high purity, concentrated streams of CO₂ already available and store it in oil and gas reservoirs

CO₂ Capture Project Objectives

- Achieve major reductions in the cost of CO₂ Capture and Storage:
  - 50% reduction when applied to a retrofit application.
  - 75% reduction when applied to a new build application.
- Demonstrate to external stakeholders that CO₂ storage is safe, measurable, and verifiable.
- Progress technologies to:
**What will be delivered**

- Over 50 internationally peer reviewed key studies on capture and storage
- Capture technologies for real scenarios demonstrating possible cost reductions
- Guidelines on HSE risk assessment, monitoring and verification for geologic storage
- Final reports, papers, produced in a variety of media
- Conclude outreach activities

**Program Structure**

- International technology development effort.
- Distinct regional programs in the US, Norway, and European Union.
- Sharing among programs to leverage results and reduce duplication.
- Project Funding
  - Cash $25mm + ca. $25mm In-kind

- Industry-CCP
  - Eight Participants: 54%

- Europe
  - EU: 12%

- Norway
  - Klimatet: 13%

- United States
  - DOE: 21%
CO₂ Capture Project

How we are organised

CO₂ Capture Project
Executive Board

Technical
Advisory
Board

Program
Manager

Pre
Combustion
Post
Combustion
Oxyfuel
Storage,
Monitoring &
Verification
Common
Economic
Modelling
Policy &
Incentives
Communications

Technology Providers
Universities, National Laboratories, Engineering Consultants, Specialists

NGO/
Outreach

Media -
TV, Print,
Internet

Project Overview- We’ve come a long way!

start up phase

• CCP agreement
• Funding applications
• Contract negotiations commence

>200 Technologies Reviewed

Tech teams screen tech options & recommend detailed evaluation of promising candidates

50 Capture & 50 storage Techs Screened
50 Techs Pass Stage Gate

Number of technology options focused based on Screening Criteria:
• Likelihood of success in timeframe
• Ability to deliver target cost reductions
• Materiality to Participants’ sources
• Fit within available funding

Screening favored technologies

delivery of results

• Over 80 contracts signed
• Program focused thru value management
• Optimum technology options progressed to proof of feasibility

Screening favored technologies

Today
CO₂ Capture Project

CO₂ Capture & Storage Options

Post Combustion Decarbonisation

Precombustion Decarbonisation

Oxyfuel

Fossil Fuel

Storage options

CO₂ Compression & Dehydration

Amine absorption

• Enhanced Oil Recovery
• Enhanced Coal Bed Methane
• Old Oil/Gas Fields
• Saline Formations

Critical Gaps Identified
**Gaps: Post Combustion**

- Cost
- Temperature & amine performance
- Alternative absorption processes
- Size of equipment
  - Absorber technology
  - Membrane materials
- Energy requirements
  - Waste heat recovery (WHR)
  - Compression
  - Amine conditioning/recovery

**Gaps: Pre Combustion**

- Cost
- Hydrogen manufacture processes
  - New processes to reduce cost and improve efficiency at scale
  - Integrating Syngas production with CO₂ capture
- Size of equipment
  - Can we scale up what works on small scale?
- Energy requirements
  - WHR
  - Compression
CO₂ Capture Project

Gaps: Oxyfuel

- Cost
- Temperature of process
- Process efficiency
  - Integration with pre-and post combustion processes for CO₂ Capture
- Energy requirements

Capture: Summary of Progress

Post Combustion studies
Process Integration and standards review underway
Advanced membrane separation & solvent pilot scale study complete
Specific, nanoporous, stable solid adsorbents under Development
other novel chemistries and approaches investigated

Pre-Combustion studies
Scale up e.g. VLS autothermal reforming
Gas Turbine retrofit, Heaters & boilers conversion
Compact reformer development
Step reduction & integration; H₂ membrane reactor

Example of solid adsorbant

Oxyfuel studies in progress
Chemical looping, i.e. O₂ generation in-situ
Heaters and boilers conversion studies
**Storage Technology – Geologic options**

- The industry has many of the competencies and answers we need
  - Decades of experience in sequestering CO₂ in EOR fields
  - Industry has experience in naturally occurring CO₂ producing fields (analogs) in the US
  - In the US and Europe, the natural gas industry has 90 years of experience storing natural gas in 100s of fields
- CCP should not duplicate significant, third-party research & development worldwide
  - Understanding geologic storage, maximizing storage efficiency, short-term verification & monitoring are understood or are receiving significant third-party R&D
Gaps: Storage Monitoring and Verification

- Cost
- HSE Risk Assessment Methodology
  - Leakage
  - Contamination
  - Mitigation
- Long term monitoring standards and tools
- Verification

Storage: Summary of Progress

HSE Risk Assessment & Methodology
- Legal aspects of CO₂ storage *
- Learning from acid gas storage
- Learning from natural analogs
- HSE risk assessment SOA*
- HSE risk assessment & methodology guidelines
- Probabilistic study on CBM storage
- Learning from long term EOR and gas storage
- Modeling CO₂ movement
- Geological studies
- Effects of injection on properties of reservoirs and cap-rock

Long Term Monitoring
- Spectral analysis of plant stress from aerial images
- CO₂ impact on well tubulars & cement
- Optimum monitoring methods
- Noble gas labeling to detect CO₂ leak source
- CO₂ detection techniques*
- Pipeline transportation costs material selection

& Others…..
Models!!!
Understanding geologic storage requires the development and integration of many models and results.
Next Steps: Demonstration Needs

• Necessary to prove technology, reduce business risk demonstrate track record
• Separation and Capture
  • Detailed process engineering and design of concept and technology
  • Large scale field demonstration of technology
• Geologic Storage
  • Large scale field demonstrations
  • Various types of formations
  • Demonstrate tool performance and reliability

Next Steps: SMV Communications

• We don’t want to have 40 studies “sitting on the shelf”
• Rather, we want integrated series of reports that demonstrate that
  • CO₂ storage can be safe and effective
  • CO₂ can be monitored both short and long-term
  • CO₂ storage is verifiable
• Have engaged professional communications consultants to help us.
Next Steps: General Communications

- We plan to engage a professional association and journal
  - Extensive peer-review world-wide
- Current vision is for 3-4 key audiences e.g.
  - Scientific Journal, highly technical (200 - 500 pages)
  - Government Report and Road Show (10 -100 pages)
  - Public reader-friendly version (3 -10 pages)
  - TV documentaries for BBC, Nova, Discovery Channel
- Consultant’s work proposals in hand
- Deployed by 1Q 2004

Watch this space!

Or visit CO2captureproject.org