CO_2 Capture Project

CCP Overview of Project and Results

Bill Senior, BP

www.co2captureproject.org

Brussels Workshop
2nd June, 2004

Introduction

- Background on CO_2 Capture Project
  - Cooperating for a better environment
  - Program structure
  - Project objectives
- Project Progress and Timeline
- Overview of CCP Findings
  - Capture
  - Geologic storage
  - Progress of other program areas
    - Policy, Technology Advisory Board and Communications
- Conclusions

CO_2 Capture Project

Cooperating For A Better Environment

US Dept. of Energy
National Energy Technology Laboratory
David Hyman, Program Manager

EU DG Research
Directorate-General Research
Program Manager: Denis O'Brien

Norges forskningsråd
The Research Council of Norway
Program Manager: Hans-Roar Søarheim

EU DG Energy and Transport
Directorate-General Energy and Transport
Program Manager: Vassilios Kougionas

Joint Industry Partnership (JIP)

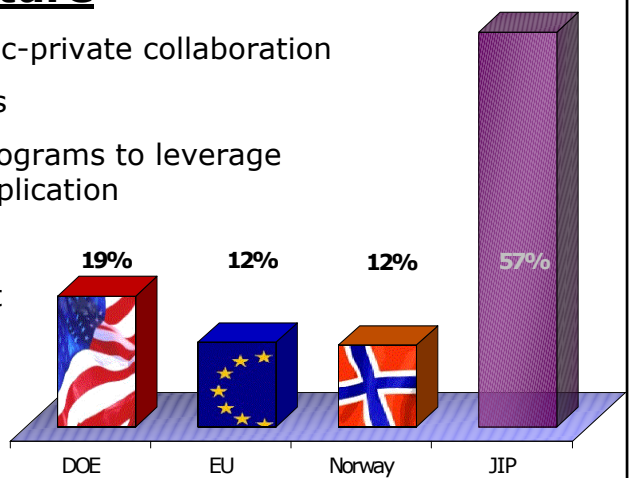
bp · ChevronTexaco · EnCana · Eni · Hydro · Shell · Statoil · Suncor

www.co2captureproject.org

CO_2 Capture Project

Project Structure

- International public-private collaboration
- Regional programs
- Sharing among programs to leverage results, reduce duplication
- $25m Funding
- $50m Project Cost



Why CO_2 Capture and Geological Storage?

1. Fossil fuels will be required to meet the world's energy needs for the foreseeable future
2. Reducing CO_2 emissions associated with energy use can help mitigate the risk of Climate Change
3. Capture and Geological storage:
   - Enables large scale reductions in CO_2 emissions with
   - Is applicable to a range of industry sectors & fuels
   - Enables Hydrogen economy in medium term
   - Is a win ~ win for energy security and environment
   - Provides a bridge to a lower carbon future

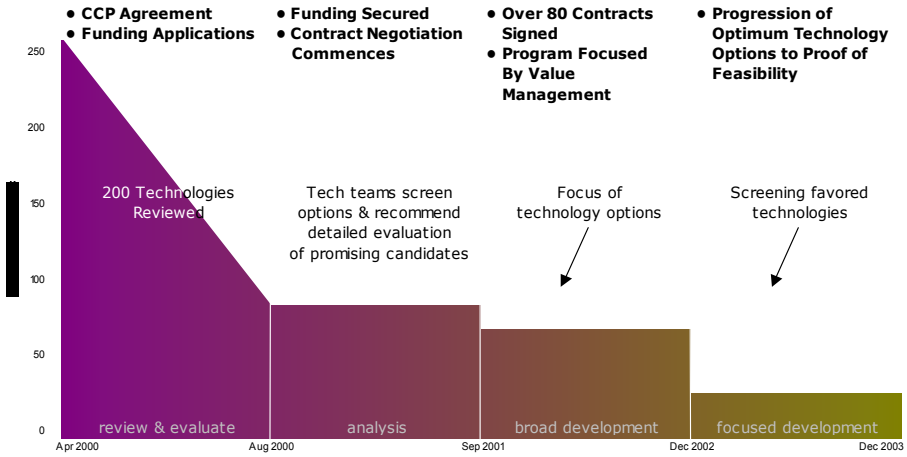
CO_2 Capture Project

CO_2 Capture Project - Objectives

- Achieve major reductions in cost of CO_2 capture & storage:
  - 50% reduction when applied to a retrofit application.
  - 75% reduction when applied to a new build application.
- Demonstrate to external stakeholders that CO_2 storage is safe, measurable, and verifiable.
- Progress technologies to:
  - 'Proof of concept' stage by 2003/4 (Commercialization post 2010).

CO_2 Capture Project

Project Overview *we've come a long way*!



CO_2 Capture Project

Overview of CCP Findings

Capture

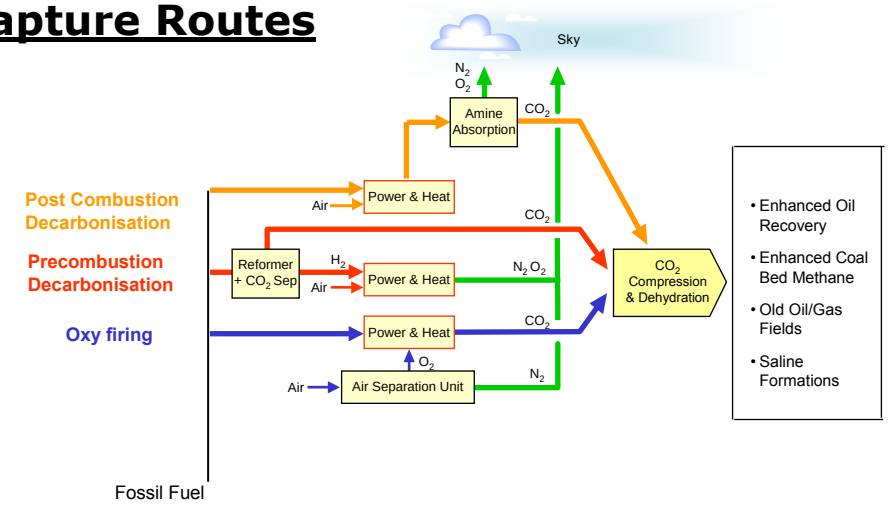
- Made significant headway in developing technology, resulting in step reduction in costs and importantly, ruled out some technologies

Storage

- Identified a comprehensive suite of questions we must address, to understand and demonstrate long term secure storage. Pioneered the risk based approach for site identification, operation and monitoring

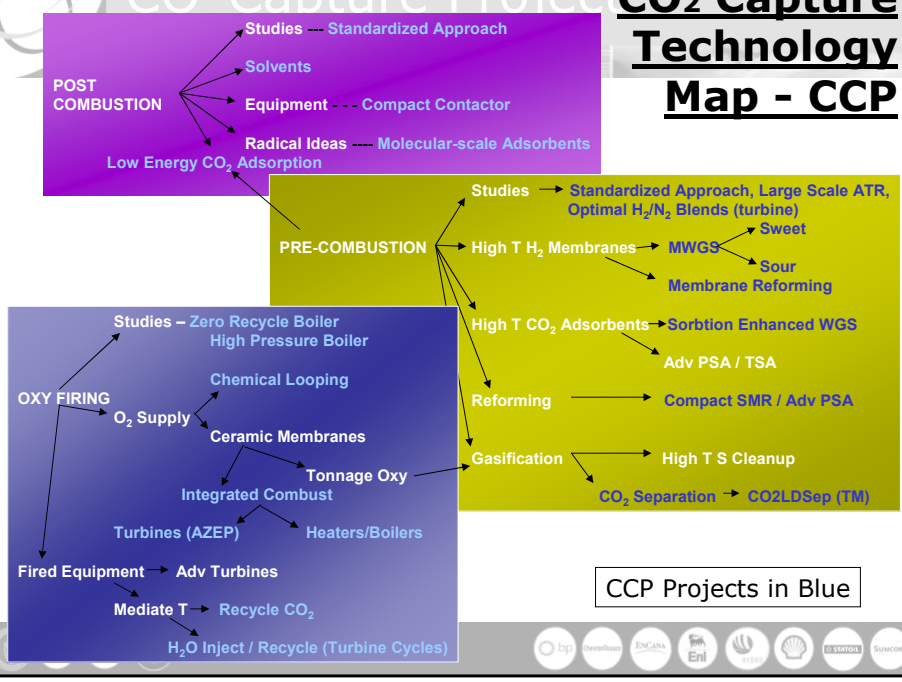
CO_2 Capture Project

Capture Routes



CO_2 Capture Project

CO_2 Capture Technology Map - CCP



CCP Projects in Blue

CO_2 Capture Project

Capture: Precombustion - Top Technologies

- **Sorption Enhanced Water Gas Shift (Air Products)**
  - Field demonstration by 2007+
  - CO_2 avoided cost reduction ~ 50%
- **Membrane Water Gas Shift**
  - Two alternative membrane compositions: Eltron and SINTEF.
  - Both could be ready for field demonstration by 2007+
  - CO_2 avoided cost reduction ~ 50%.
- **Hydrogen Membrane Reformer (Hydro)**
  - Field demonstration by 2008-10
  - Potential to reduce the cost of CO_2 avoided by over 60%

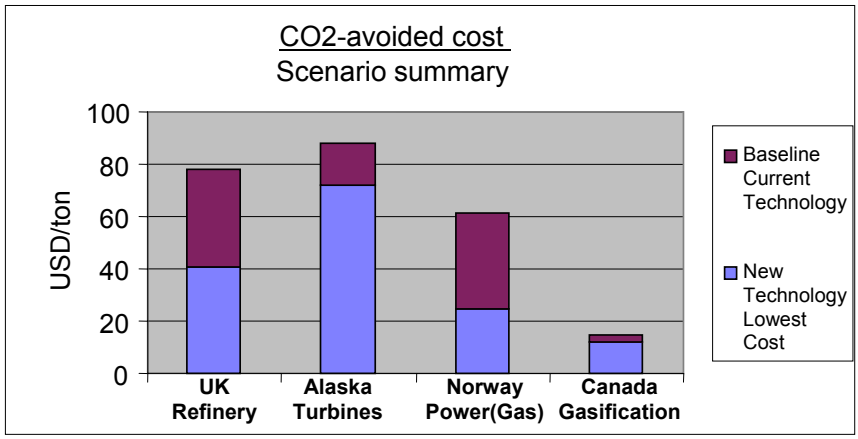
CO_2 Capture Project

Capture: Other – Top Technologies

- **Oxy-firing, Chemical Looping (Chalmers, Alstom et al)**
  - Could be ready for field demonstration 2007+
  - CO_2 avoided cost reduction ~ 38%
- **Post-Combustion, Design Integration (Nexant)**
  - Ready for field demonstration today
  - CO_2 avoided cost reduction ~ 55%
- **Common Economic Model**
  - Allows cross technology comparisons on a common basis.
  - Used to compare CCP technologies across four real-life scenarios.

CO_2 Capture Project

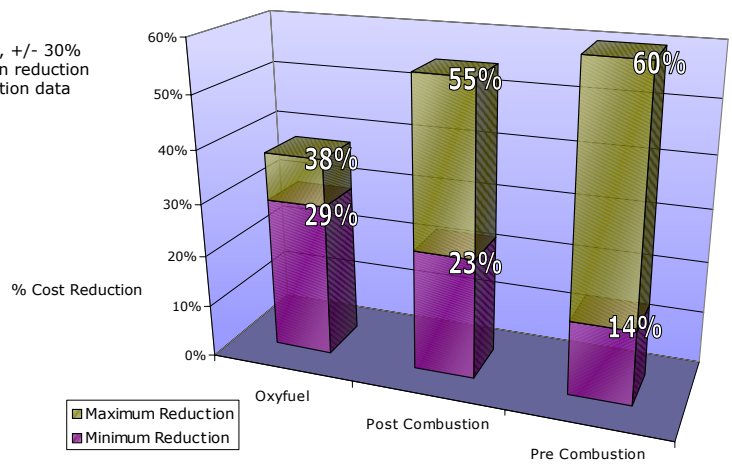
CCP Capture Cost Estimates



CO_2 Capture Project

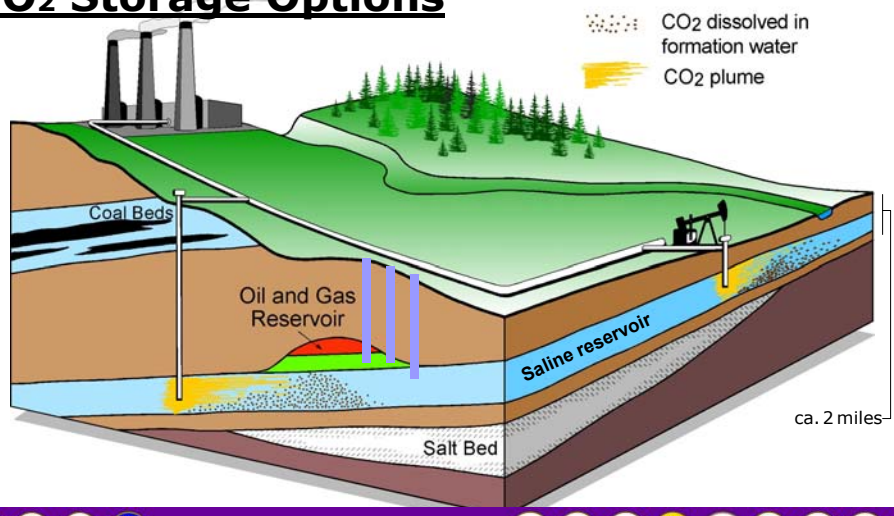
Capture: CO_2 Avoided Cost Reductions*

* Preliminary data, +/- 30% cost estimates, min reduction & maximum reduction data points shown.



CO_2 Capture Project

CO_2 Storage Options



CO_2 Capture Project

Storage: Technologies Delivered

- Developed a **comprehensive understanding of the HSE risks** of, and the requirements for, secure geological storage
  - Geological formations more likely to be secure than man-made wells
  - Depleted oil & gas fields generally be more secure than saline formations
- Assembled a **large database of knowledge**, which will allow the risks associated with geological storage to be quantified and compared to other activities
- Developed an extensive repertoire of **monitoring options**, applicable to a broad range of settings
- Potential **leakage scenarios** have been mapped and matched to remediation actions

CO_2 Capture Project

Risk Assessment

Comprehensive Methodologies
- Tools, Scenarios, Models (TNO, INEL)
- Testing On & Offshore Aquifers (TNO)
- Leakage Risk & Failure Scenarios (INEL)

Mitigation & Remediation
- Leak Scenarios & Response (LBNL)

Environmental/Regulatory/ Public Perception
- HSE Review (LBNL)
- Effect on Subsurface Ecosystems (Princeton)
- Lessons on Honesty & Transparency (MSCI)

Optimization

Hydrocarbon Reservoirs
- CO_2 EOR Record (NMT,NGCAS)
- Gas & Condensate Compatibility (TTU)

Coal Reservoirs
- CBM Potential & CO_2 Capacity (INEL)

Saline Aquifer Reservoirs
- CO_2 Movement & Immobilization (UT)

Transportation
- Corrosion & Materials Selection (IFE / Reinertsen)
- CO_2 Impurities (Battelle)

CO_2 Capture Project

Integrity

Natural & Engineered Analogs
- CO_2 Reservoirs (ARI)
- Leaky Systems (Utah State)
- Natural Gas Storage Experience (GTI)
- North Sea Oil field (NGCAS)

Reservoir & CapRock Competence
- CO_2 / Rock Changes at Reservoir P&T (GFZ-Potsdam)
- Reactive Transport Modeling (LLNL)

Well Materials
- Cement / Steel Corrosion / Erosion (SINTEF)

Monitoring

Geophysical
- Seismic Resolution & Modeling (TNO)
- Seismic Resolution & Costs (LBNL)
- Novel Non-Seismic (LBNL)

Geochemical
- Noble Gas Tracers & Costs (LLNL)

Satellite & Aerial
- InSAR Resolution (Stanford)
- Hyperspectral Geobotanical (LLNL)

Near Surface, Surface & Atmosphere
- State-of-the-Art & Strategies (Caltech)
- Eddy Covariance (Penn State)

CO_2 Capture Project

Progress in other program areas

- **Policy and Incentives** - conducted review of current policy matters and identified opportunities and barriers for technology development and application
- **Technology Advisory Board** – provided an unbiased review of project technology and progress
- **Communications** – communications strategy and engagement of NGO's from an early stage.
  - Website, Video & Brochure available
  - Peer review of results
  - Two volume book available Q4.

CO_2 Capture Project

Conclusions

- Industry & governments have come together on an international scale, to provide strong leadership on technology development
- A portfolio of technologies with broad application have been developed and represent state-of-the-art
- Technology R&D is producing step reductions in cost
- CO_2 sequestration must be proactively managed to reduce risks and ensure broad acceptance
- Communication and publication of results is in hand.
- Visit www.co2captureproject.org - for more information
- Planning in hand to build on this success with CCP2

End of Presentation

Questions ?

CO_2 Capture Project

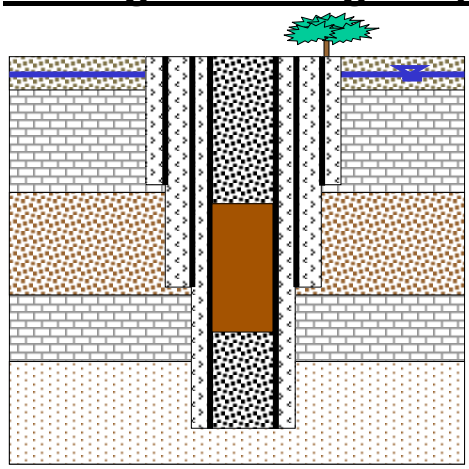
Backup material

Next Steps: CCP Phase 2 (2004 – 07)

- ✓ **Conduct research, development and pilot testing to reduce the cost of CO_2 capture from large, fixed sources.**
- ✓ **Reduce the technology and cost uncertainty associated with those technologies and deliver favored, low-cost CO_2 capture technologies to demonstration stage by 2007.**
- ✓ **Demonstrate that the geological storage of CO_2 is secure and can represent a viable Greenhouse Gas mitigation technique. Further develop technology, best practice and industry standards for storage site selection, risk assessment, well integrity, monitoring & verification.**
- ✓ **Establish an extended network for CO_2 storage demonstrations to share learning.**

CO_2 Capture Project

Leakage- Framing the problem - Wells



Its about:

- ➢ Identifying old wells
- ➢ Preparing competent new wells and configurations-J?
- ➢ Evaluating the reactivity of well construction materials with CO2
- ➢ Monitoring for any leakage
- ➢ Remediating wells if and when needed

CO_2 Capture Project