

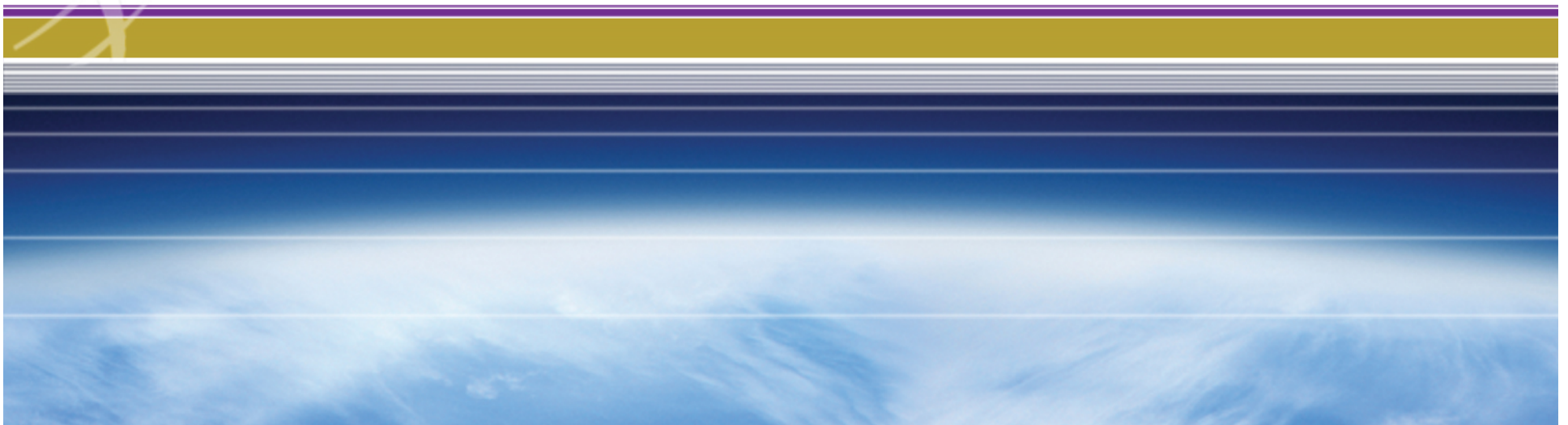


CO₂ Capture Project - phase 4

Advancing CCS technology deployment and knowledge for the oil and gas industry

CCP4 presentation to CSLF Technical Group – 2nd November 2015

Nigel Jenvey (BP): CCP Chair



This presentation has been prepared for informational purposes only. All statements of opinion and/or belief contained in this document and all views expressed and all projections, forecasts or statements relating to expectations regarding future events represent the CCP's own assessment and interpretation of information available to it as at the date of this document.

CCP Overview and accomplishments

CCP4 Capture Program

CCP4 Storage Program

CCP4 Comms/P&I Programs

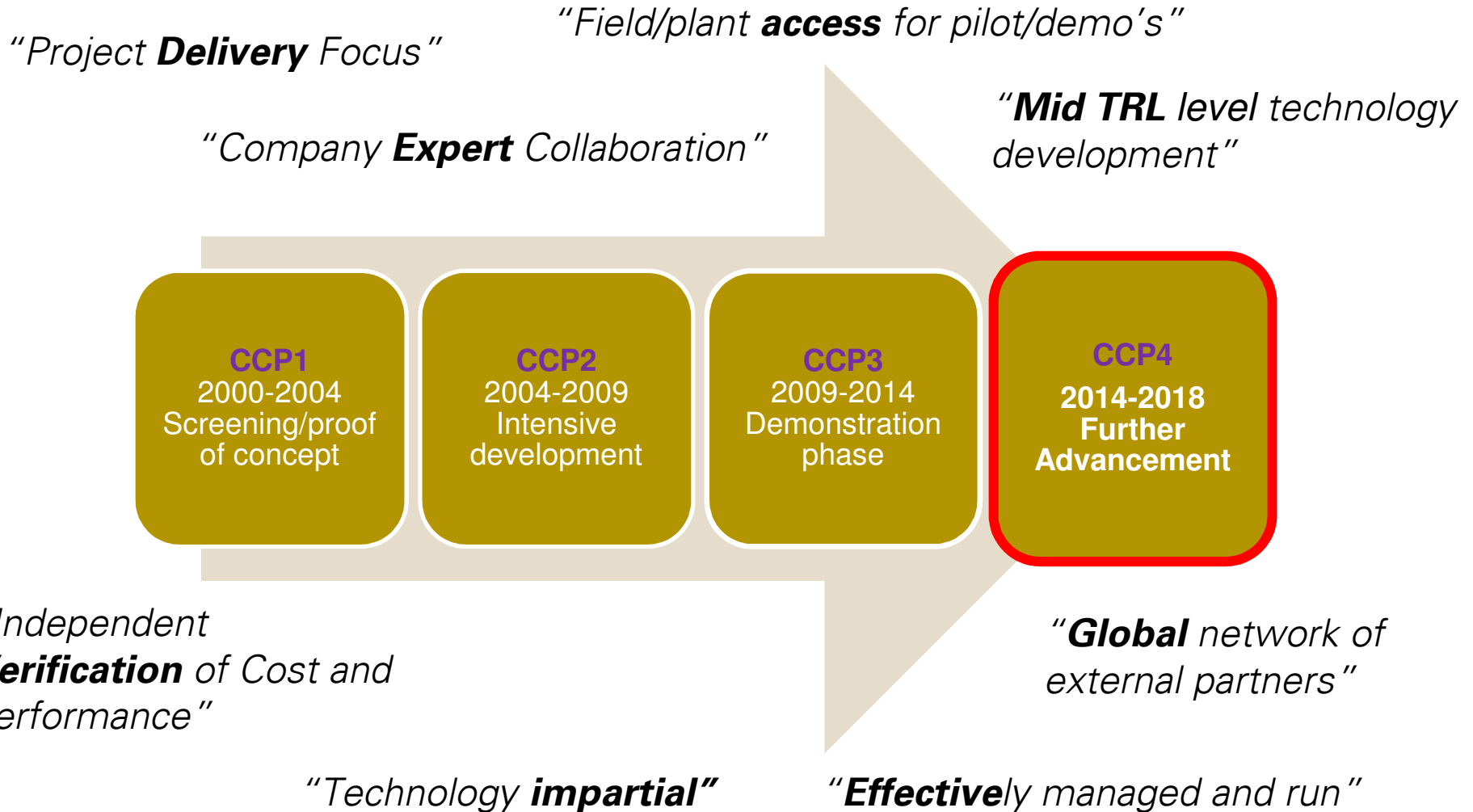
CCP Overview and accomplishments

CCP4 Capture Program

CCP4 Storage Program

CCP4 Comms/P&I Programs

CCP Overview and Accomplishments



CCP4
participating organizations



CCP3 Capture Program



Oxy-firing demo at a refinery FCC unit



Image courtesy of Petrobras

Oxy-firing demo at a production OTSG



Image courtesy of Cenovus Energy Inc.

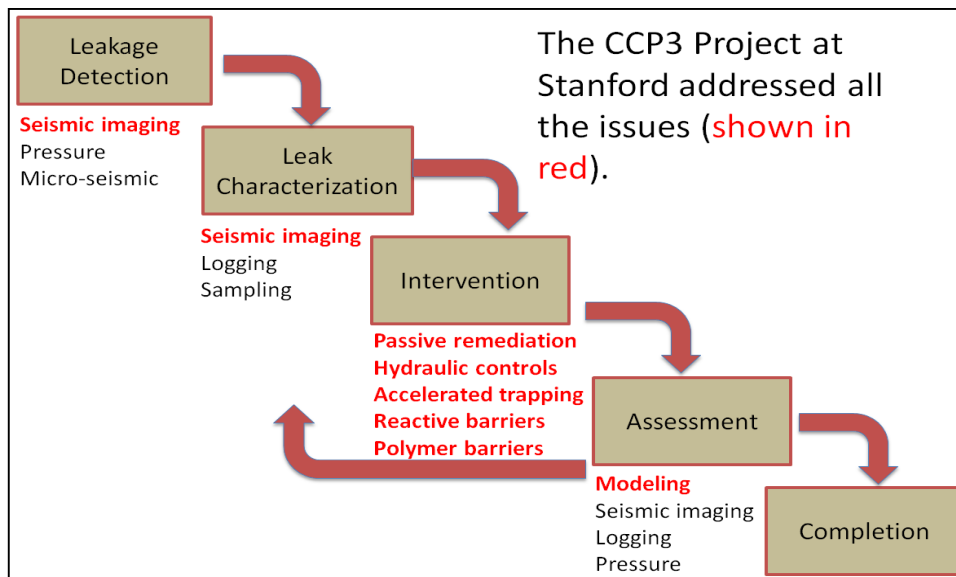
CCP4
participating organizations



CCP3 Storage Program



Contingency planning desk-top study



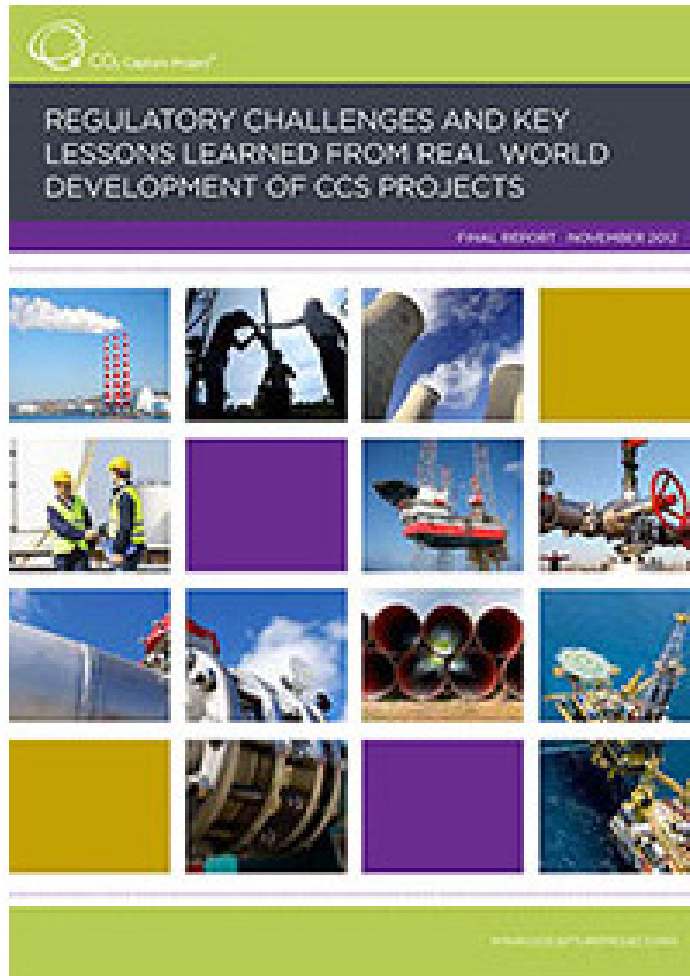
Modeling and simulation topics covered for Stanford / CCP3 Contingencies study

Field trialling of Monitoring technologies

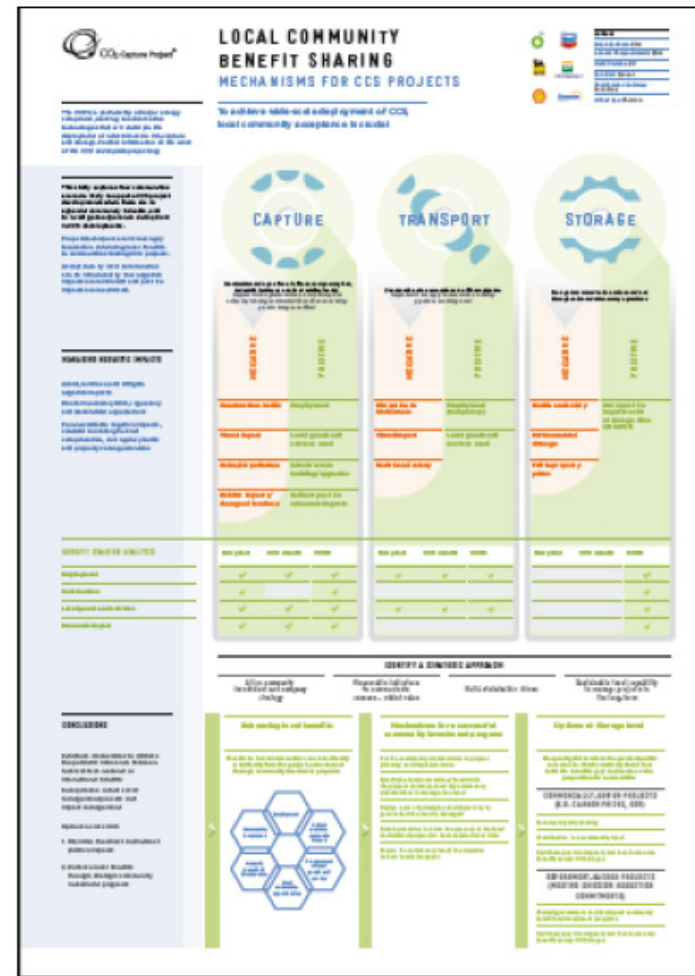


D9-8 wellhead as completed with control lines penetrating through port collars and collar sleeves.

CCP3 Policy & Incentives (P&I) Program



Regulatory Study, 2012



Local community benefit sharing Study, 2011



CCP3 Communications



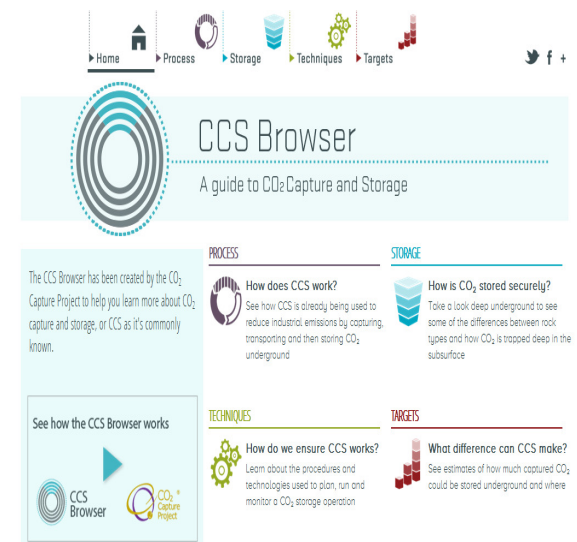
Knowledge Sharing
www.co2captureproject.org

Conferences

Public engagement
www.ccsbrowser.com



- UNFCCC (Side events)
 - COP 16/17/18/19 in MX, ZA, QA, PL
- GHGT (Sponsor/Exhibitor/Presenter)
 - GHGT10/11/12 in USA, JP, NL
- CCUS Conference (Partner/Exhibitor/Presenter)
 - March 2009-2014 in Pittsburgh, PA
- CSLF (Recognized Project/Exhibitor/Presenter)
 - 4-7th November 2013 in Washington, DC
- CO₂ Conference Week (Sponsor/Presenter)
 - December 2012-2014 in Midland, TX



CCP4
 participating organizations



CCP4 - Advancing CCS technology deployment and knowledge for the oil and gas industry

Tactical Demonstration (applicable for short-medium term)

Capture: Development & field testing high-concentration CO₂ sources

SMV: Development & field testing Measurement Monitoring & Verification

P&I: Regional Incentives & Global Regulations

Comms: Industry Knowledge Sharing

Strategic Deployment (applicable for medium-long term)

Capture: Breakthrough Technologies, NG Power/Cogen

SMV: Basin Scale Development and Operation

P&I: FOAK to NOAK Pathway

Comms: External Stakeholder Engagement

Advancing CCS

CCP Overview and accomplishments

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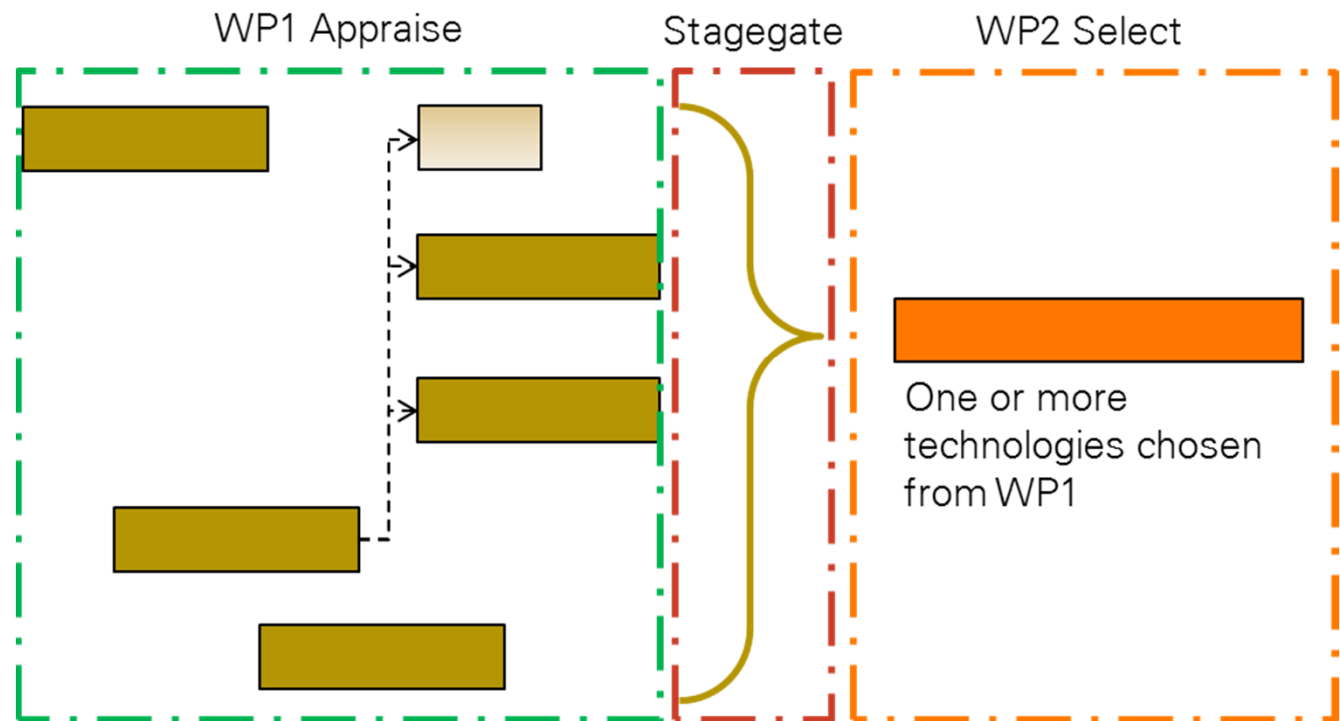
Step-out Novel Capture Technologies Assessment



Study Purpose:

- Target is >50% reduction in the CO₂ capture cost for NGCC application

- CO₂ selective membranes,
- Molten Carbonate Fuel Cells,
- High-Pressure Solvent Absorption (integrated and non-integrated with power generation)
- Low-Temperature CO₂ Freeze-Out



Development of High Concentration CO₂ Sources

1. CO₂ Capture from SMR H₂ Plants

Study Purpose:

- Evaluate various CO₂ removal process schemes in a SMR hydrogen plant and estimate the cost of CO₂ capture

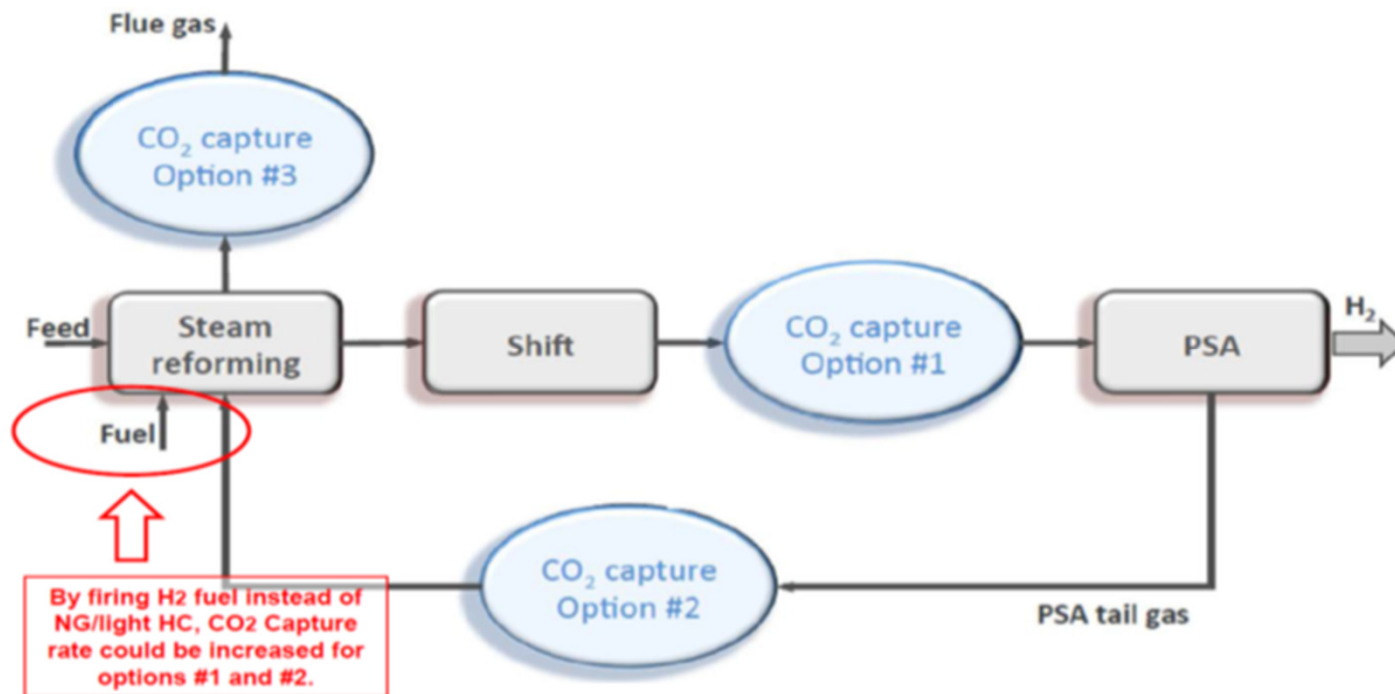


Image courtesy of Amec Foster Wheeler

Development of High Concentration CO₂ Sources



2. Offshore NG Treating

Study Purpose:

- To inform and align CCP on the state of the art in *offshore* CO₂ removal and identify potential technology development projects and provide a basis for deciding whether to invest in one or more of them



Image courtesy of Petrobras

CCP4 Capture Program – Future Field Testing Projects



Purpose:

Participate in field testing projects to advance CCS technology deployment in oil and gas scenarios

Field testing options:

1. **Novel capture technology** – post combustion capture - NGCC
2. **CO₂ removal from SMR syngas streams** – pilot/demo of a novel technology with cost advantage over MDEA
3. **CO₂ removal from natural gas streams** – potentially a membrane technology demonstration



CCP Overview and accomplishments

CCP4 Capture Program

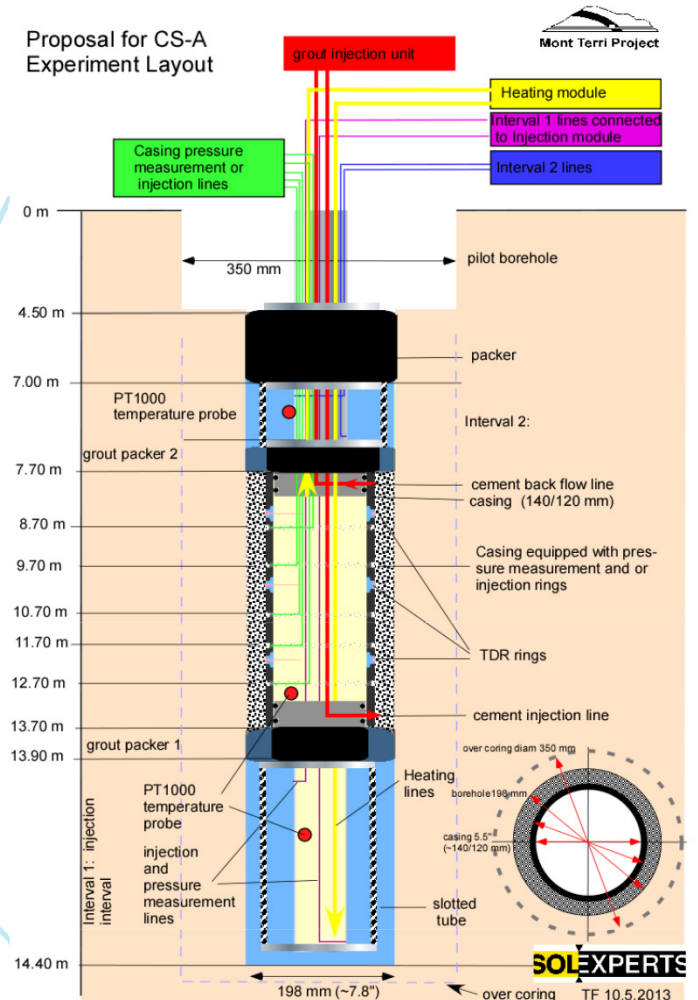
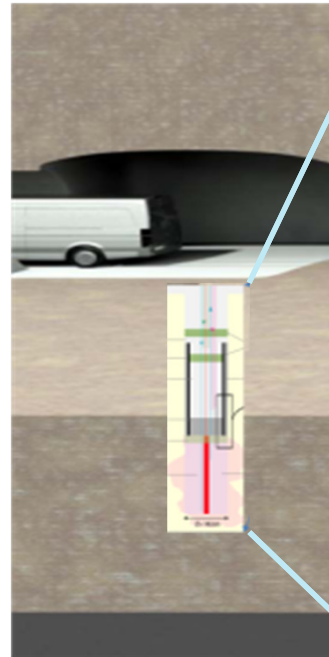
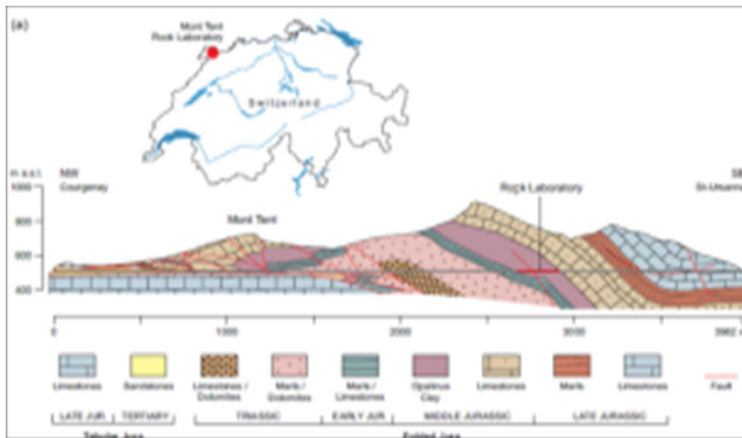
CCP4 Storage Program

CCP4 Comms/P&I Programs

Well-Sealing Experiment at Mont Terri

Study Purpose:

- Determine ability to intervene in difficult to mitigate, small aperture CO₂ leaks in annular space or cement sheath using novel materials



Images courtesy of Mont Terri Consortium / Solexperts AG



Demonstration of de-facto CO₂ storage at a CO₂-EOR site



Study Purpose:

- Utilize results from simulations and experiments to characterize and quantify the different trapping mechanisms that contribute to retention of CO₂ in a reservoir during the course of a CO₂ EOR flood.

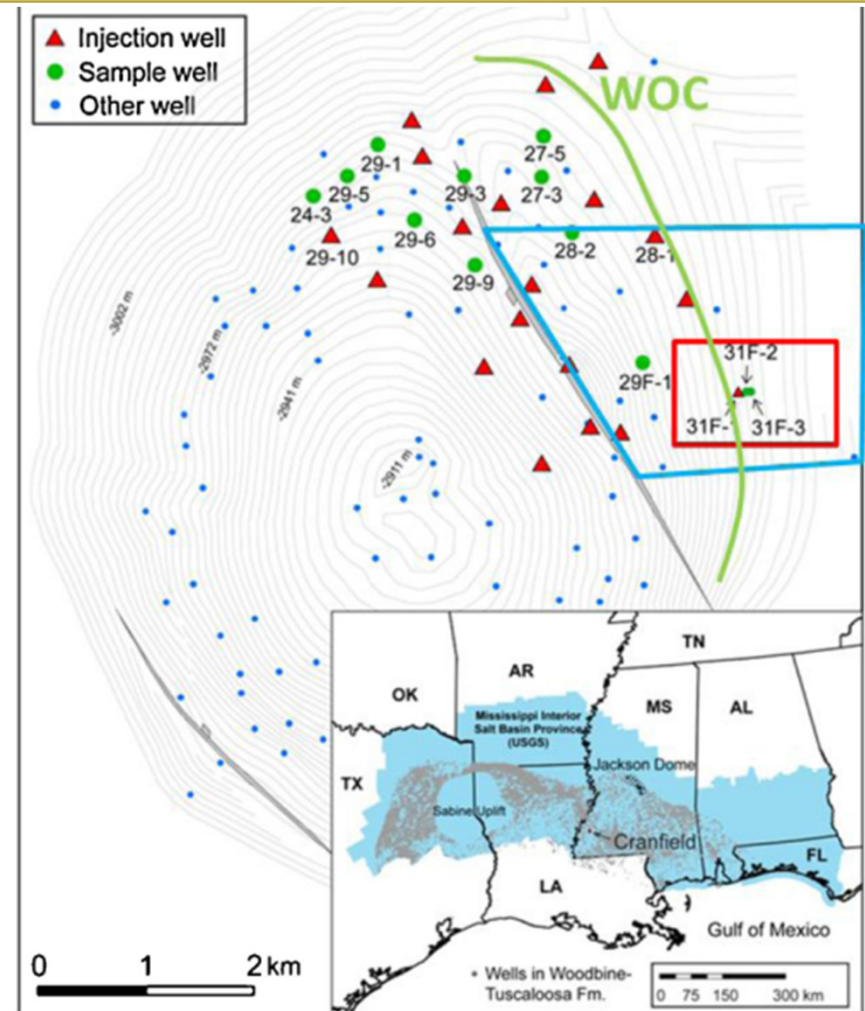


Image courtesy of UT-BEG

CCP4 SMV Program –Future Field Testing Projects



1. Contingencies:

- Fracture-sealing experiment at Mont Terri
- Intervention in failed P&A wells



Image courtesy of Mont Terri Consortium

2. Field-based monitoring:

- Modular Borehole Monitoring (MBM) tool
- Repeat EM survey at Aquistore

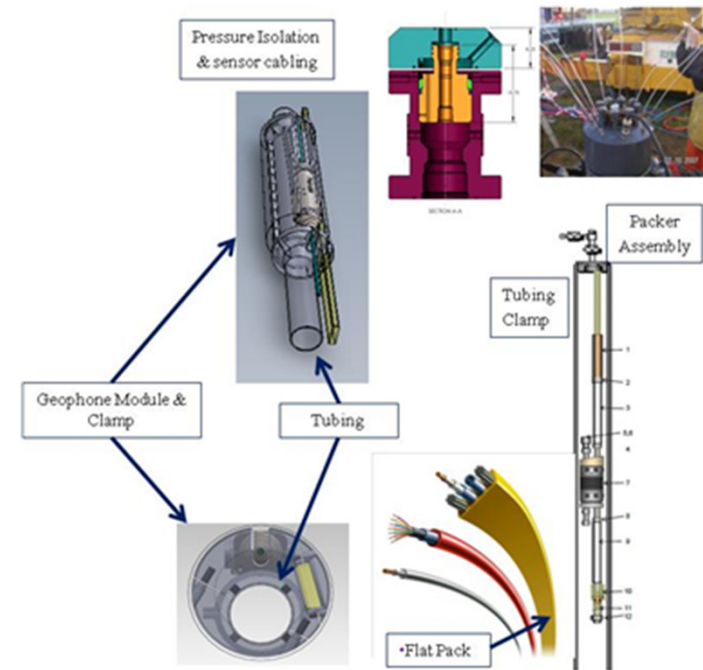


Image courtesy of LBNL

CCP Overview and accomplishments

CCP4 Capture Program

CCP4 Storage Program

CCP4 Comms/P&I Programs

CCP4 P&I and Comms Program



CCP will continue to share knowledge and inform on CCS

Carbon Dioxide Capture for Storage in Deep Geologic Formations

As a partnership of major energy companies, the CO₂ Capture Project (CCP) was founded in 2000 with the objective to advance technologies and improve operational approaches to help make CCS a viable option for CO₂ mitigation.

The CCP assembles competitive geologists and other subsurface specialists, engineers, policy and regulatory specialists and communications experts drawn from each of the member companies. Together, they focus on delivering projects to increase understanding of the science, economics and practical engineering applications of CCS.

The CCP has completed its third phase (2009-2014) which has seen significant progress resulting in an array of demonstrations, field trials and studies. The results from this phase are presented in this Volume, the fourth in the CCP series.

There are 44 peer-reviewed chapters which cover topics ranging from field demonstration and lab testing of advanced capture technology, to computational studies of CO₂ behavior in geologic formations, field testing of advanced monitoring technology and aspects of policy barriers and regulatory hurdles for CCS deployment. There are also eight chapters of context and summary information, as well as outlines of recommendations and plans for future work.

For earlier work, the results from Phase 1 were published in two volumes in 2005 and from Phase 2 in a third volume in 2009.

Improving the technologies to capture and store CO₂ is vitally important not only for the competitiveness of CCS as a key solution, but for the global fight against climate change. A viable contributor at the forefront of development, the CO₂ Capture Project has been actively analyzing and testing various new solutions over the years. Bringing together several leading companies and government organizations, the CCP is also fostering the critically important public-private collaboration.

John Lippert, Head of CCS Unit, E.ON

There is a common misconception that environmental and social safeguards will increase the cost of CCS. However, the perceived risks of CCS are high and without such safeguards the technology will never be supported by the public, governments, business, etc. The CCP has played an important role in developing these safeguards through a robust research program. This latest volume includes research findings that represent improvements in mature technologies that will reduce the cost of capture, advances in R&D technologies which will improve our understanding of subsurface CO₂ movement and simulation and experiments testing leak mitigation/intervention approaches which improve confidence in CO₂ storage security.

Carbon dioxide capture and storage (CCS), second only to efficient use, is one of the few responses to climate change that acknowledges the staying power of fossil fuels in the global economy. The CO₂ Capture Project represents 14 years of continuous due diligence about CCS by the oil and gas industry. This volume arrives at a time when expectations for CCS are more realistic than when the project began. Such persistence is evidence that important segments of the industry anticipate the pendulum swinging back toward strong CCS-enabling policies within business-relevant planning horizons.

Robert Scoville, Co-head, Carbon Mitigation Initiative, Princeton University



CCP4 Participant Organizations
www.co2captureproject.org
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CCP4 participating organizations



