



CO₂ Capture Project

CCP2-NGO Focus Group Meeting (North America) Storage Monitoring & Verification (SMV)

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Presentation Outline

The CCP2 Storage Monitoring & Verification (SMV) Team

Current Issues in CO₂ Storage

CCP2-SMV Projects

- Flagship
 - Certification Framework
 - Well Integrity Field Study
 - Coupled Geochemical-Geomechanical Simulations
- Additional
 - ECBM Operability & Monitoring
 - Aerial Monitoring
 - *In-Situ* Well-Based Detection

Previous NA NGOFG Feedback (2005) – Updated Responses

Major Points





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The CCP2 Storage Monitoring & Verification (SMV) Team

BP		Hydro	
- Charles Christopher (co-Lead)	Resv. Engr.	- Lars Ingolf Eide	Geol. Engr.
- Dan Ebrom	Geophysics		
- Venkataramanan Muralidharan	Resv. Engr.	Petrobras	
- Walter Crow	Petr. Engr.	- Rodolfo Dino	Geology
Chevron		Repsol	
- Scott Imbus (Lead)	Geochemistry	- Martin Fasola	Geology
- Dan Kieke	Chemistry		
ConocoPhillips		Shell	
- Chip Feazel	Geology	- Nigel Jenvey	Petr. Engr.
- Alan Rezigh	Resv. Engr.	- Jos Maas	Resv. Engr.
Eni		Suncor	
- Antonio Pellegrino	Resv. Engr.	- Cal Coulter	Resv. Engr.



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CCP-SMV Objectives

- **CCP1 (2000-2004)** – Identify and evaluate promising technologies in “integrity”, “optimization”, “monitoring” & risk assessment
- **CCP2 (2004-2008)** – Develop processes / technologies that address key assurance issues
- **CCP-3 (2008-2012)** – Demonstrate and systematize processes / technologies with field projects





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Current Issues in CO₂ Storage (1)

Containment

- Geologic system evaluation is key but is there anything we can do that is more systematic, quantitative and understood by stakeholders?
- Wells seem OK from decades-long EOR experience but lab exposed cements dissolve in weeks. What will be the case with long term storage?
- What do we know about containment in saline formation seals or “open” systems?

Optimization

- Migration / trapping simulations are becoming more sophisticated and based on real systems. Do they need experimental / field verification?
- For EHR: Is there merit in WAG EOR alternatives? Is EGR possible? What is the real promise of ECBM?



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Current Issues in CO₂ Storage (2)


Monitoring

- What is the potential if i-Well and i-Field technology for sampling / sensing injection reservoirs, wells, potable aquifers and the near surface?
- Should monitoring technology / protocols be standardized or “fit-for-purpose”?
- Should monitoring requirements be open-ended or based on performance criteria?


Risk Assessment (RA)

- Major applications have become unwieldy and too complex. Is it possible to streamline the process and make it useful to stakeholders?
- What are the appropriate analogs (e.g., civil engineering; arctic or deepwater drilling) and benchmarking criteria?

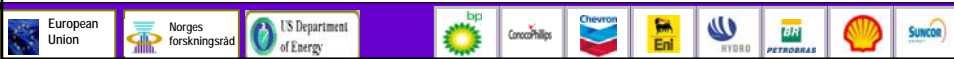






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CCP2-SMV Projects

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Certification Framework (1)

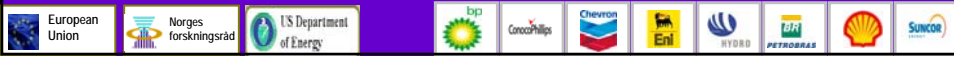
A simple, transparent, and accepted basis for regulators and stakeholders to certify that the risks of geologic CCS projects to HSE and resources are acceptable is critical to the wide scale deployment of CCS (LBL/UT-Austin)

Approach

- Streamlined and integrated platform for site characterization, reservoir simulation of injection strategies, modeling leakage scenarios, life cycle risk calculation
- Criteria established injection and abandonment "certification" (predicted and actual performance, resp.)
- Acceptability -Understandable, defensible, expert and stakeholder advice, demonstration

Status

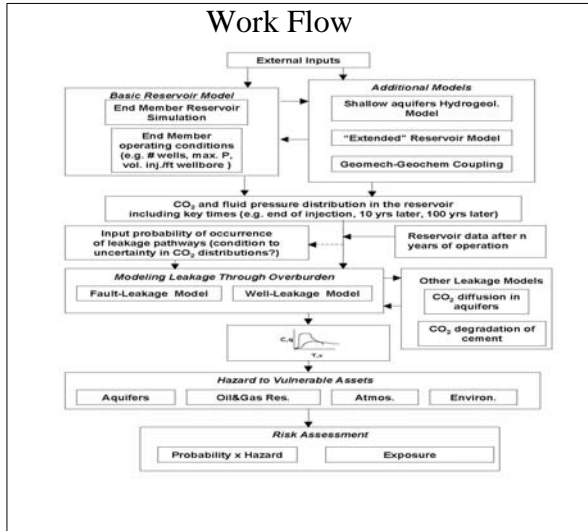
- Definitions and scope detailed
- Generic reservoir framework established
- Advisory board (AB) comprised of NGOs, regulators, industry and technical experts convened
- Recent funding increase to accelerate and/ or develop prototype application, include an atmospheric dispersion module and fund a dedicated regulator interface





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Certification Framework (2)



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Well Integrity Field Study (1)

Field-based study to realistically assess CO₂-experienced well status, history match well "defects" with production / work over data and simulate well survivability over an extended time period under CO₂-rich conditions (Schlumberger; others TBD)

Approach

- Well selection (decades-long CO₂ exposure), clastic system
- Well evaluation via logging and sampling / analyses and experiments
- 4D well model with observed "defects" and history match (production and work over) to explain "defects"
- Forward simulation to 1000 yr. under end member CO₂ influenced conditions
- Engineering solutions including design, old well rehabilitation, intervention and remediation

Status

- Initial site access to Sheep Mtn. Production Facility (Sept.-Oct. 2006) – Analyses of solid and fluid samples and interpretations underway
- Main field study planning in Jan. 2007





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Coupled Geochemical-Geomechanical Simulation

Improve and integrate existing simulation programs to more accurately predict fluid – rock response to CO₂ injection and its impact on containment system integrity. Test on consolidated and unconsolidated North Sea reservoirs (U Bergen)

Approach

- Adapt of existing geochemical and geomechanical simulators to accept up-to-date code
- ID optimal programs with code for coupling
- ID of data representative of rocks / fluids and conditions (PT) in typical reservoirs
- Coupling and testing of coupled simulator
- Application to consolidated and unconsolidated North Sea reservoirs

Status

- Initial simulator program selection has been switched to those with more robust code
- Code corrections for physico-chemical processes
- Near-ready for trial run on a reservoir
- Seeking collaborative relationships with EU and Japanese institutes



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CCP2-SMV Additional Projects

ECBM Operability and Monitoring -Simulation of operational limits for CO₂ ECBM injection strategies and feasibility of geophysical monitoring for performance and leakage from the coal reservoir and associated rock system (Sproule Associates / LBL)

- Geologic model build for operation simulation underway (Alabama Coal)
- Rock model build for geophysical monitoring feasibility pending

Remote, Aerial Direct Detection of CO₂ and Methane – Identify, tune and test a sensor capable of detecting CO₂ and methane (UCSC).

- NASA MASTR sensor selected and tuned
- Overflight over controlled CO₂ / methane release; Interpretation Underway

In-Situ Well-Based Detection of CO₂ – Proof of concept conventional logging tools can detect small quantities of CO₂ leaking into an accumulation chamber (Schlumberger)

- Large test cell constructed and tested at reservoir conditions
- Test cell charged with sediment and brine and charged with CO₂
- Logging tool (RST) was capable of detecting CO₂ in one of two modes





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2005 NA NGOFG Questions & Responses – Updated (1)

Q2. Will CCP II be able to complete the risk assessment / certification model presented in the policies discussion?

D/A2. The CCP is attempting to do this. The NGOs strongly endorsed the idea of creating this framework and also suggested some kind of advisory group to provide additional input to that process. This will be considered by the CCP2 Board. **Additional funding has been provided by the board to accelerate the project (from mid-2008 to early 2008). Per NGOFG suggestion, an advisory board has been established and has met (via teleconf. On Sept. 25).**

Q3. How can the CCP help to ensure public safety and the absence of both chronic and acute leakage over the long term?

A3. The CCP is doing what it can through modeling and field testing to develop confidence in the veracity of long term storage as well as the ability to detect and mitigate leaks. In addition, the policy group is considering options to manage the long-term responsibility / liability for storage reservoir integrity. **The Certification Framework used to assess the relative risk of potential HSE threats thus clarifying long-term liability issues). A key feature of the Well Integrity study is to identify well leakage risk over time and to develop engineering solutions.**



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2005 NA NGOFG Questions & Responses – Updated (2)

Q4. How can the public have confidence in the adequacy of the MMV?

A4. The CCP will continue to share its results with policy makers and the public through the release of papers and future volumes of the CCP work. There are several other collaborations conducting related R&D work and they have access to scrutinize the results of the CCP effort.

Diverse monitoring techniques from multiple vantage points are established technologies. The SMV focus is on how these can be cost-effectively deployed over time based on evolving risk (e.g., migration towards potential conduits; Diminishing need based on pressure field reduction with time.

Q5. How do the technical specifications of the wells being used in the well integrity study compare to the technical specifications for wells constructed under US EPA's UIC Class I and Class II specifications? It would be helpful if the CCP study could be related to those design standards.

A5. CCP will consider modifying its studies to make such a comparison.

The Well Integrity Field Study investigates the present status of actual CO₂ wells (~Class II) and simulates the long-term fate of well materials exposed to CO₂. A key deliverable of the study is to infer specific strengths and vulnerability of such well. From this the suitability of standard design can be assessed with recommendations for new designs as well as intervention techniques. It may be possible to use the same simulation protocol to infer the fate of other well designs (in a generic sense).





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2005 NA NGOFG Questions & Responses – Updated (3)

Q13. Is there any effort underway to develop some kind of guideline or hierarchy that will guide companies to use the best geologic formations?

A 13. The CCP planned to complete a certification framework during Phase 1 but was unable to finish the study. This framework would serve as a checklist for selecting sites and designing storage projects. CCP plans to complete this work during Phase 2 and will share it with stakeholders.

The CCP1 "Certification Framework" referred was a Risk Assessment process that became unwieldy.

As a lesson learned, the CCP2 Certification Framework is aimed at streamlining the process by integrating site assessment (e.g., compartments), reservoir simulation and risk assessment. The initial "application" will be a screening tool upon which more complex modules can be added. A possible CCP3 undertaking is to further develop the application and test it on several planned pilot, demonstration and commercial projects.



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Major Points

- The CCP2-SMV program was developed to address key gaps and opportunities in CO₂ storage while avoiding redundancies
- The "Certification Framework" aims to:
 - Develop a simple, transparent and credible interface between technical professionals and stakeholders
 - Comprise a technical basis for permitting and performance-based field management with eventual decommissioning
- The Well Integrity Field study directly confronts the issue of long-term stability of CO₂-exposed wells with recommendations on well design modification and intervention techniques based on findings
- With the coupled geochemical-geomechanical simulation study, an open source application will be available to assess pressure field effects over the near- to long-term
- Other projects, although of high technical risk, seek step changes in CO₂ storage operability and cost-effective monitoring.

