Carbon Dioxide Storage in Geological Media

Are we Ready?

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Talking!

- IEA studies show that CCGS is/must be a significant component of climate change mitigation strategies.
- IPCC Special Report on CO₂ Capture and Storage clearly shows that CCGS is feasible.
- CSLF and AP6 bring together the largest energy producers and users, and the largest CO₂ emitters for technology transfer and implementation.
- G8 asked for a review and recommendations in 2008.
- CO₂ storage under the sea bed is permissible under the London Protocol.
- The Future of Coal.
Predicted Electricity-Production Mix

(from IEA, 2004)
Predicted Use of CO₂ Geological Storage

(from IEA, 2004)
CO₂ Capture and Geological Storage is Gaining Political and Industry Acceptance!

*Then why is it not deployed??*
Barriers to Deployment

- Scientific and technological
- Economic and financial
- Policy, legal and regulatory
- Public attitude and acceptance
Do we know enough?

Can we start injecting?

Should we start injecting?
CO₂ Storage in Coals
– Science and Technology –

• How to address coal swelling and loss of permeability and injectivity

• What are the processes for supercritical CO₂
  • Adsorption or absorption? Does it matter?
  • Coal plasticization, is it real?
  • Are dual porosity models still valid?

• Effects of coal and CO₂ impurities

• Low permeability coals, if we frac them, how to control leakage

• Storage efficacy
CO₂ Storage in Coals
– What Coals –

• What is unmineable coal?

• Unmineable today, mineable tomorrow?
  • Look at oil (tar) sands, tight gas, shale gas

• In situ energy production (gasification, CTL)

• What coal is left between groundwater protection, coals for energy production, and low permeability limitations?
CO$_2$ Storage in Oil and Gas Reservoirs

– Science and Technology –

- Effect of pressure depletion and buildup on reservoir and caprock integrity
- Effect of water invasion in aquifer-supported reservoirs
- Multi-phase flow effects (oil, gas, CO$_2$, water)
- Storage efficacy
***CO₂ Storage in Oil and Gas Reservoirs – What Reservoirs –***

- How deep, how shallow?
- Are they ready (depleted)?
- Oil and gas production in an environment of increasing energy prices and declining reserves versus CO₂ storage with no market value yet
- Oil & gas production and CO₂ storage optimization
CO₂ Storage in Deep Saline Aquifers
– Science and Technology –

- Are geochemical reactions and effects quick or slow?
- Are they important?
- If yes, how and when do they affect:
  - flow (porosity and permeability)
  - storage integrity
  - storage capacity
- If yes, how to get the data needed for assessment and modelling (e.g., contact area, minerals)
CO₂ Storage in Deep Saline Aquifers

– *Science and Technology* –

- Relative permeability and irreducible saturations
- Geochemical and geomechanical effects on caprock
- Fate of displaced water/brine, where does it go?
  - 10 GtCO₂/yr in 2050 ≈ 20,000 km³ fluid ≈ 200,000 km³ aquifer rock
- Ground heaving and (micro)seismic effects
CO₂ Storage in Deep Saline Aquifers
– What Aquifers –

- How deep, how shallow, how extensive?
- Underlying other resources, or barren?
- Is that volume really available?
- In convergent basins?
Leakage

- Effects of CO$_2$ decompression and phase change
- Leakage rates and controls
- Well integrity and effects of CO$_2$ on cements
- Can we address/remediate/mitigate leakage once it occurs?
Worldwide Density of Oil and Gas Wells

From IPCC SRCCS, 2005
Modelling and Monitoring Technology

- Models of coupled processes
  - Can we model them?
  - Do we have/can we get the data?

- What monitoring technology works, where it works

- Monitoring beyond detection, towards quantification
Assessing the Risks

• Define and quantify risk
• Assess the risk, current and in the future
• Include risk in storage capacity assessments and site selection
Do We Have the Needed Capacity?

- 675 to 900 GtCO$_2$ in oil and gas pools
- 15 to 200 GtCO$_2$ in coal beds
- >1000 GtCO$_2$ in deep saline aquifers

(IPCC, 2005)
Source – Sink Matching
- *Is the Capacity Where is Needed?*

Potential geological sinks for $CO_2$ are not always where needed!
Do we know enough?  
NO!

Can we start injecting?  
YES!

Should we start injecting?  
YES!
What Do We Need?

- Definition, identification and evaluation of the resource
- Targeted, focused research to address key issues
- Several large, well chosen demonstration projects to advance the knowledge to the next level

*Enough with Talking and Tinkering at the Edges!*