Large-scale CO$_2$ storage: What does it take?

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Technoport 2012
Trondheim, Norway
Central Proposition

• The IEA Roadmap for Global CO$_2$ Emissions calls for a 19% contribution from CO$_2$ Capture and Storage (CCS)

• This requires:
  ~100 MT/yr CCS projects in operation by 2020
  ~10 GT of CO$_2$ captured and stored within 2050

• CO$_2$ capture is an expensive but realistic challenge:
  • but requires matching large-scale CO$_2$ storage

• CO$_2$ storage achieved to date is:
  ~40 MT CO$_2$ stored via 5 large-scale CCS projects

➢ So how do we get from the current 10MT level to the 100-1000 MT CO$_2$ Storage level?
Current Status – Large-scale Storage

- There are currently five Million-ton/year CO$_2$ storage projects in operation:
  - Sleipner, Norway
  - Weyburn, Canada
  - In Salah, Algeria
  - Snøhvit, Norway
  - Cranfield, USA

- Europe and North America have several Mtpa projects in development (about 15)
  - EU CCS Network, USDoE RCSP
  - Gorgon and Boundary Dam projects under construction
  - Many other smaller pilot studies:
    - GCCSI documented 238 capture and storage projects in 2010
<table>
<thead>
<tr>
<th>Project</th>
<th>Capture</th>
<th>Storage</th>
<th>Where</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Boundary Dam</strong></td>
<td>Post combustion</td>
<td>EOR</td>
<td>Saskatchewan, Canada</td>
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<td>Start-up in 2014</td>
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<td><strong>Gorgon</strong></td>
<td>Pre combustion</td>
<td>Saline aquifer</td>
<td>Western Australia</td>
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<td>Start-up in 2015</td>
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<tr>
<td><strong>Project Pioneer</strong></td>
<td>Post combustion</td>
<td>Saline/EOR</td>
<td>Alberta, Canada</td>
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<td>Start-up in 2015</td>
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<tr>
<td><strong>Quest</strong></td>
<td>Bitumen upgrader (amine)</td>
<td>Saline (and EOR?)</td>
<td>Alberta, Canada</td>
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<tr>
<td>Start-up in 2015</td>
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<tr>
<td><strong>USDoE RCSP Sequestration Partnerships</strong></td>
<td>Various</td>
<td>Saline/EOR</td>
<td>US/Canada Several demos (Cranfield and Illinois have started injection)</td>
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<tr>
<td><strong>EU CCS Demos</strong></td>
<td>Post and Pre combustion, Oxyfuel</td>
<td>Saline (and EOR?)</td>
<td>EU Up to 6 project depending on funding decisions in 2012</td>
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<td>Start-up in 2015</td>
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<td><strong>100’s CO2 EOR Projects</strong></td>
<td>Natural CO2 (captured CO2)</td>
<td>EOR</td>
<td>Mainly onshore USA (Not monitored as CO2 Storage)</td>
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Statoil’s CO\textsubscript{2} Storage Sites

A valuable blend of
• Offshore/onshore
• Shallow/deep
• Horizontal/vertical wells

Eiken et al. 2011
Realising 1-10MT/yr CO$_2$ Storage projects

• Statoil’s 15 years of operational experience reveals several important features:
  ➢ 0.3-0.9MT CO2/year/well
  ➢ Injectivity and capacity highly dependent on reservoir properties
  ➢ Geological heterogeneity means that flexible well solutions will be required
  ➢ Rock mechanical response to $P_{\text{inj}}$ is critical factor
  ➢ Importance of pressure and fluid management
  ➢ Fit-for-purpose reservoir monitoring portfolio

• A combination of saline aquifer CO2 Storage with CO2 EOR/EGR projects is the most likely way of realizing large-scale CO$_2$ storage

• 1-5 MTpa CCS projects require capex of 1-5 BUSD
  ➢ Only economic with carbon price >50 USD/Tonne
CO2 EOR versus CO2 storage?

A CO₂ EOR Project constitutes a CO₂ storage project if:
- The acquired CO₂ is anthropogenic
- They are appropriately monitored

CO₂ EOR projects can transition to CO₂ storage

CO2 Stored

CO2 Acquired

Fraction of CO2 recycled

Mixed CO2 EOR/Saline Storage Project

Saline Aquifer CO2 Storage Project

Time (years)
To realise large-scale CO₂ storage we need to employ all of the following key technologies:

- CO₂ EOR (oil and gas fields)
- CO₂ storage in saline aquifers
- CO₂ management and injection for unconventional hydrocarbons
- Technology for injection of CO₂ in low/moderate permeability formations
- Technology for injection close to the geomechanical limit
- Technology for pressure management
Thank you

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