Global CO₂ Geological Storage Capacity in Hydrocarbon Fields

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IEA GHG Weyburn-Midale Monitoring Project PRISM meeting, June 2009, Regina
Content of Presentation

- Introduction to IEA GHG
- Global geological storage capacity for CO$_2$
- Storage in depleted gas fields
- Storage associated with CO2-EOR
Global CO₂ Storage Capacity

IPCC 2005 estimates

- 1,000 to 10,000Gt in saline aquifers
- 675 to 900Gt in depleted oil and gas fields
- 3 to 200Gt in coal beds
Depleted Gas Fields Study

- IEA GHG study undertaken in 2008 by Poyry Consulting, Element Energy and BGS
- Regional theoretical, effective and practical capacities calculated using USGS petroleum assessments
- Regional matched capacities calculated using AAPG Giant Fields database and GIS based source-sink matching
Simplifying Assumptions

• Many made, due to nature of study, e.g.
  • Total recoverable gas reserves converted to equivalent \( \text{CO}_2 \) capacities (0.7t/m\(^3\), GEF 200)
  • Reservoirs re-filled to original pre-production pressure
  • Minimum depth 800m
  • Minimum economic storage capacity of 50Mt onshore/100Mt offshore
  • Estimated dates for close of gas production
Global Gas Field Capacities from USGS Dataset

- **Theoretical** – *assuming all available pore space through gas production utilised* – 900Gt
- **Effective** – *assumed 75% of theoretical to allow for geological & technical factors* – 680Gt
- **Practical** – *discounting effective capacity by 40% to allow for sub-economic field size, and 1% of sites to be rejected due to risk assessment (leakage)* – 390Gt
CO2-EOR Study

- Undertaken by Advanced Resources International, based in the USA
- Global study involving:
  - Characterisation of hydrocarbon basins
  - Estimation of OOIP
  - Judgement of CO2-EOR potential
  - Estimation of CO2 storage potential
- Preliminary Results
USGS World Petroleum Assessment
Identification of World Basins

• The top 40 basins from the USGS assessment were selected, as ranked by volume of oil produced and booked as reserves, for further study.
  – Contain 96% of the “Known Oil” identified
  – Spread over every continent, but concentrated in the Middle East and Eastern Europe/Russia

• Also included 12 U.S basins with large volumes of “Known Oil”
<table>
<thead>
<tr>
<th>Region</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asia &amp; Pacific</td>
<td>9</td>
</tr>
<tr>
<td>Central and S America</td>
<td>7</td>
</tr>
<tr>
<td>Europe</td>
<td>2</td>
</tr>
<tr>
<td>Former Soviet Union</td>
<td>6</td>
</tr>
<tr>
<td>Middle East and Africa</td>
<td>13</td>
</tr>
<tr>
<td>North America</td>
<td>15</td>
</tr>
</tbody>
</table>
Establishing the CO₂-EOR Target

<table>
<thead>
<tr>
<th>Volume (Billion Barrels of oil)</th>
<th>% of OOIP</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>2,156</td>
<td>48%</td>
<td>Certain fields within a basin may be too shallow or contain oil too heavy for miscible CO₂-EOR operations</td>
</tr>
<tr>
<td>3,213</td>
<td>72%</td>
<td>Some reservoirs are too small, or otherwise inaccessible to CO₂-EOR operations</td>
</tr>
<tr>
<td>4,368</td>
<td>98%</td>
<td>Five basins did not meet criteria for Miscible CO₂-EOR</td>
</tr>
<tr>
<td>4,465</td>
<td>100%</td>
<td>The total volume of OOIP in the 52 basins will not be available for CO₂-EOR</td>
</tr>
</tbody>
</table>

OOIP in basins with favorable characteristics for CO₂-EOR operations

Oil in Fields Accessible to CO₂-EOR Operations

Oil Amenable for CO₂-EOR
Top 10 World Basins for CO2-EOR Potential

Mesopotamian Foredeep Basin
Greater Ghawar Uplift
West Siberian Basin
Zagros Fold Belt
Rub Al Khali Basin
Volga-Ural Region
Maracaibo Basin
Permian
North Sea Graben
Villahermosa Uplift

CO2-EOR Technically Recoverable Oil (MMBO)
Top 10 World Basins for CO2-EOR

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- Permian
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- Villahermosa Uplift

CO2 Volume (Million Tons)

- CO2 Demand
- CO2 Supply
Top 10 World Basins for CO2-EOR

(As ranked by access to CO2 supplies)

- Mid-Continental Basins
- East/Central Texas Basins
- Rockies Basins
- Bohaiwan Basin
- Gulf Coast Basins
- Williston Basin, US
- Williston Basin, Canada
- Carpathian-Balkanian Basin
- Songliao Basin
- Gippsland Basin

CO2 Volume (Million Tons)

- CO2 Demand
- CO2 Supply

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## Revised CO₂ Storage Capacities

<table>
<thead>
<tr>
<th>Storage Type</th>
<th>IPCC Estimated Global Capacity (Gt)</th>
<th>IEA GHG Estimated Global Capacity (Gt)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saline Formations</td>
<td>1,000 to 10,000</td>
<td></td>
</tr>
<tr>
<td>Depleted Gas Fields</td>
<td>675 to 900</td>
<td>160 to 390</td>
</tr>
<tr>
<td>CO₂-EOR</td>
<td></td>
<td>11 to 130</td>
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<tr>
<td>Coal Beds</td>
<td>3 to 200</td>
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</table>
IEA Greenhouse Gas R&D Programme

- General - www.ieagreen.org.uk
- CCS - www.co2captureandstorage.info