A revised estimation of CO2 storage capacity in North American Gas Fields

Neil Wildgust, IEA Greenhouse Gas R&D Programme

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Contracting Parties and Sponsor Organisations of IEA GHG
Background

• Depleted gas fields offer significant potential advantages for CO\textsubscript{2} storage
• Previous IEA GHG studies:
  – in 2000 estimated 797Gt global capacity
  – in 2004 estimated 39Gt effective capacity in USA/Canada
• Study undertaken by Poyry Energy Consulting, in association with Element Energy and BGS, starting in April 2008
• Main aims of the study were twofold:
  – Re-assess global storage capacity of depleted gas fields
  – Derive cost curves for storage in depleted gas fields
CSLF Resource Pyramid
Limitations of Study

• High level data sources due to global context:
  – USGS 1995 world and US petroleum assessments
  – 2008 AAPG Giant Fields Atlas
  – IEA GHG point source emission database

• Study necessitated use of many generic factors and simplifying assumptions

• Regional results must be treated with caution
Basic Storage Capacity Assumptions

• Fields will be refilled to original pre-production pressures, but not above
• Total recoverable gas reserves converted to CO₂ storage capacities using gas expansion factor of 200 and injected CO₂ density of 0.7t/m³
• Global nature of study necessitated many simplifying assumptions and generic factors
Storage Capacities from USGS Data

- USGS national and world datasets from 1995 used to estimate theoretical, effective and practical storage capacities
- USGS data not field-specific
- Allowances made for associated gas in oil fields, reserve growth and undiscovered reserves
Global Storage Capacities from USGS Data

- **Theoretical capacity** calculated by simple conversion of total recoverable gas reserves – 870Gt
- **Effective capacity** estimated as 75% of theoretical, to allow for technical factors – 650Gt
- **Practical capacity** reduced by 40% from effective to allow for uneconomic field sizes and by a further 1% to allow for unsuitable sites due to probability of leakage – 390Gt
Regional Capacities from USGS Data (Gt)

<table>
<thead>
<tr>
<th>Region</th>
<th>Theoretical</th>
<th>Effective</th>
<th>Practical</th>
</tr>
</thead>
<tbody>
<tr>
<td>N America</td>
<td>75</td>
<td>56</td>
<td>33</td>
</tr>
<tr>
<td>Asia-Pacific</td>
<td>100</td>
<td>75</td>
<td>45</td>
</tr>
<tr>
<td>South America</td>
<td>60</td>
<td>45</td>
<td>27</td>
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<tr>
<td>Europe</td>
<td>83</td>
<td>62</td>
<td>37</td>
</tr>
<tr>
<td>Former Soviet Union</td>
<td>340</td>
<td>260</td>
<td>150</td>
</tr>
<tr>
<td>Middle East &amp; Africa</td>
<td>240</td>
<td>180</td>
<td>110</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>900</strong></td>
<td><strong>680</strong></td>
<td><strong>390</strong></td>
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</tbody>
</table>
Matched Storage Capacities

- Source data: IEA GHG point source emissions and AAPG Giant Fields Atlas
- Source-sink matching exercise using a GIS-based network connection algorithm
- Assessment made on decade-by-decade basis with estimated close of production (CoP)
- Fields closing after 2050 or shallower than 800m discounted
Source-sink matching

- GIS-based algorithm used to undertake source-sink matching exercise
- Sinks allocated by decade according to estimated CoP
- Up to 3 sources allowed to connect to each sink per decade, provided capacity sufficient
- Matching based on technical/economic factors, not geopolitical
### Matched Regional Capacities (Gt)

<table>
<thead>
<tr>
<th>Region</th>
<th>By 2020</th>
<th>By 2030</th>
<th>By 2040</th>
<th>By 2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>N America</td>
<td>11</td>
<td>15</td>
<td>17</td>
<td>17</td>
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<tr>
<td>S America</td>
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<td>5</td>
<td>6</td>
<td>8</td>
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<tr>
<td>W Europe</td>
<td>4</td>
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<tr>
<td>E Europe</td>
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<tr>
<td>Middle East</td>
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<td>33</td>
</tr>
<tr>
<td>Africa</td>
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<td>11</td>
<td>13</td>
<td>13</td>
</tr>
<tr>
<td>Asia/Oceania</td>
<td>2</td>
<td>5</td>
<td>19</td>
<td>28</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>33</strong></td>
<td><strong>89</strong></td>
<td><strong>140</strong></td>
<td><strong>160</strong></td>
</tr>
</tbody>
</table>
Storage Costs

• Matched source-sink connections used to estimate transport and storage costs
• New infrastructure assumed
• Pipelines mapped as straight lines but costs estimated on 1.25x route length
• Geopolitical factors not considered
• North America: 8Gt capacity <$5/t by 2050
Cost Abatement Curve
North American Capacity and Costs

- Matched capacity 17Gt by 2050, costs under $10/t (under $5/t for first 8Gt)
- Study could be refined with better data and assumptions:
  - Gas production and remaining reserves
  - Forecast reserve growth
  - Undiscovered gas resources
  - Appropriate field capacity cut-off
Conclusions

• Study has provided fresh perspective on storage potential of depleted gas fields and use of resource classification schemes

• Matched global capacity of 160Gt may be more realistic than previous estimates

• Some assumptions conservative, so 50Gt capacity <$10/t emphasises important economic potential of CO₂ storage in gas fields
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