Status for Offshore CCUS in the Gulf of Mexico

Seyyed Hosseini
Tip Meckel, Ramon Trevino, Susan Hovorka
The University of Texas at Austin
Bureau of Economic Geology
Gulf Coast Carbon Center
Offshore continental margins are the most promising for near-term Gigatonne-scale storage

Ringrose and Meckel, in review
TOPICS

• What is the maturity of CCS in the northern Gulf Coast?
  • Many prior projects (research/demo, industrial).
  • Existing capture and pipeline transport infrastructure.
  • Current 45Q Tax Credits make CCUS very attractive

• Prior and current work to mature near offshore storage
  • Summary of prior geologic storage assessments since 2009.
    • Texas Offshore Atlas publication.
    • NETL: Two active Offshore partnerships; Screening & Identification Study

• Examples of Miocene-age reservoir capacity estimates and basin storage implications for meeting 2050 targets.
Regional Gulf Coast setting for rapid large-scale carbon management in U.S. heavy industry

Gulf Coast CCS @ GCCC

1) Frio Saline tests 2004 & 2006
2) Cranfield stacked storage (EOR + CCS)
3) Air Products - Hastings (EOR + CCS)
4) NRG – West Ranch (EOR + CCS)
5) BOEM BPM Offshore Storage
6) Offshore GoM Storage Characterization
   A. 2009-2014 Texas Offshore Miocene
   B. 2015-2018 TXLA Project
   C. 2016-2018 CarbonSAFE Phase I
   D. 2018–2023 GoMCARB Partnership
A) Offshore Storage Resources
B) Risk Assessment, Simulation, Modeling
C) Monitoring, Verification, Assessment
D) Infrastructure, Operations, Permitting
E) Outreach

www.sseb.org/programs/offshore/
1. Regional Geology of the Gulf of Mexico and the Miocene Section of the Texas Near-offshore Waters

2. Implications of Miocene Petroleum Systems for Geologic CO₂ Storage beneath Texas Offshore Lands

3. Evaluation of Lower Miocene Confining Units for CO₂ Storage, Offshore Texas State Waters, Northern Gulf of Mexico, USA

4. Capillary Aspects of Fault-Seal Capacity for CO₂ Storage, Lower Miocene, Gulf of Mexico

5. Regional CO₂ Static Capacity Estimate, Offshore Saline Aquifers, Texas State Waters

6. Field-scale Example of Potential CO₂ Sequestration Site in Miocene Sandstone Reservoirs, Brazos Block 440-L Field


8. Appendix A: Regional Cross Sections, Miocene Strata of Offshore Texas State Waters
GOM Paleogeography

- Dominant environment: Coastal-Deltaic, shallow marine
- Red River merging with Mississippi River
Seismic inversion for porosity volume
- NETL Methodology
- 40,000 sq. km.
- 3,300 logs
  - Tops, net sand, porosity
- 172 Gt CO$_2$ storage total
  TX State Waters
3 Texas GoM CO₂ Hubs: La Porte, Texas City, Port Arthur

RED LINES ARE CONCEPTUALIZED INDUSTRIAL CO₂ TRANSPORT

Studied Storage Site

Hastings Field CO₂-EOR

CO₂ Capture Air Products

Existing CO₂ Pipeline

Offshore Storage Complex

Texas City

La Porte

Port Arthur

Gulf of Mexico

20 MILES
Port Arthur Hub, Phase I
~20 Mta total
17 Mta, 7 sources

Red pin = > 1 Mt
Yellow pin = 100+ kt
Green pin = <100 kt
Typical large growth fault setting on inner shelf – Dip Section

Osmond, 2016
High Island 24-L Field – Southeast Texas

Bottom SIOI horizon

STATIC VOLUMETRIC CALCULATIONS

<table>
<thead>
<tr>
<th></th>
<th>P10</th>
<th>P50</th>
<th>P90</th>
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<tbody>
<tr>
<td>( E_{\text{saline}} = E_v E_d )</td>
<td>7.4%</td>
<td>14%</td>
<td>24%</td>
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<tr>
<td>SIOI: NETL CO2 Screen (Mt)</td>
<td>63</td>
<td>120</td>
<td>206</td>
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<tr>
<td>SIOI: 3-D Eff. Porosity Model (Mt)</td>
<td>57</td>
<td>108</td>
<td>185</td>
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<tr>
<td>HC Sand: 3-D Constant Avg. Eff. Porosity Model (Mt)</td>
<td>6</td>
<td>12</td>
<td>20</td>
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</tbody>
</table>
Reservoir Performance – Nonproductive Setting (San Luis Pass)
RESERVOIR PERFORMANCE

Approximately 5 Mt in 90’ sand, unless completely open flow boundaries

Cumulative Injection Results for 27 dynamic 3D flow simulations

Table 7.2. Cumulative injection results for 27 model cases of dynamic 3D flow model

<table>
<thead>
<tr>
<th>3D Flow Model Injected-Mass Results (Mt)</th>
<th>Homogeneous</th>
<th>Statistic-Based Heterogeneous</th>
<th>Seismically Derived Heterogeneous</th>
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<tbody>
<tr>
<td>Base case</td>
<td>5.4</td>
<td>5.3</td>
<td>4.5</td>
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<tr>
<td>High-quality reservoir</td>
<td>6.9</td>
<td>6.8</td>
<td>5.7</td>
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<tr>
<td>Low-quality reservoir</td>
<td>3.7</td>
<td>3.5</td>
<td>3.1</td>
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<td>Open boundaries</td>
<td>116.2</td>
<td>114.4</td>
<td>64.0</td>
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<tr>
<td>Open faults</td>
<td>5.6</td>
<td>5.3</td>
<td>4.6</td>
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<tr>
<td>1 well</td>
<td>6.0</td>
<td>5.7</td>
<td>5.0</td>
</tr>
<tr>
<td>15 wells</td>
<td>5.4</td>
<td>5.2</td>
<td>4.8</td>
</tr>
<tr>
<td>Optimized array</td>
<td>5.4</td>
<td>5.3</td>
<td>4.9</td>
</tr>
<tr>
<td>Constant-rate injection</td>
<td>4.8</td>
<td>5.1</td>
<td>4.5</td>
</tr>
</tbody>
</table>

![Diagram showing CO2 saturation and injection well locations over time]
Uniformity, clarity, familiarity
Bookable storage
Similar to PRMS
  SRMS exists
  https://www.spe.org/industry/CO2-storage-resources-management-system.php
Guidelines currently being drafted
Training workshops to come.
SUMMARY

• The global offshore continental margins represent the best near-term opportunity for Gigatonne-scale CCS.
  • Gulf of Mexico is ideal geologically and geographically.
  • National resource of consequence.
  • **Research needs**: understand hub development and scaling, impact of Gt-scale pressure perturbation, fault performance.

• GoM ready to apply and expand upon the many successful examples.
  • North Sea, Japan, Brazil
  • CC(U)S perspectives benefit from knowing prior petroleum history: capacity, seal, reservoir performance, well development.

• Offshore CCS can deliver needed scales on needed time frames.

• CO₂ storage can be a **bookable resource** for reassuring investors and evaluating project economics.
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Tip Meckel, Ramon Trevino, and Susan Hovorka

tip.meckel@beg.utexas.edu