Systems Engineering and Analysis Projects for Task 10.0 of the Carbon Storage FWP

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Presentation Outline

- Technical status
- Accomplishments to date
- Synergy opportunities
- Project summary: next steps
Technical Status

• This Task consists of five separate projects involving the development and application of performance and cost models for CO₂ saline storage and CO₂ enhanced oil recovery (EOR)
  – Onshore saline storage of CO₂
  – Offshore saline storage of CO₂
  – Onshore storage of CO₂ using CO₂ EOR with application to the residual oil zone (ROZ)
  – Life cycle analysis for CO₂ storage
  – Market analysis of saline storage and CO₂ EOR
Technical Status

Onshore saline storage of CO₂

• Updated the FE/NELT CO₂ Saline Storage Cost Model and revised the FE/NELT CO₂ Transport Cost Model
  – Models will be posted to NELT website

• Updated QGESS Report: Carbon Dioxide Transport and Storage Costs in NETL Studies
  – Provides cost of transport and storage in four basins

• Performed an analysis of CO₂ transport options
  – Examined sources in northeast with storage options in Appalachia, Midwest and Southeast
  – Examined costs of dedicated pipelines versus trunk-lines with short connecting pipelines
Technical Status

Offshore saline storage of CO₂

• Developed the Offshore FE/NETL CO₂ Saline Storage Cost Model
  – Model applicable to shallow water of the Gulf of Mexico (660 ft)
  – Model will be posted to NETL website

• Developing geologic database
  – Utilizing extensive data from BOEM
  – BOEM data summaries focus on sands with oil or gas
  – Need to account for all sand that could be used to store CO₂
    » Sands without hydrocarbons are much thicker
Storage of CO₂ using CO₂ EOR and application of CO₂ EOR to the ROZ

- Updated the FE/NETL CO₂ Prophet Model
  - Model was too efficient at extracting oil
- Developing FE/NETL Onshore CO₂ EOR Cost Model
- Developed geologic databases for ROZ oil fields in 12 counties in Permian Basin
  - San Andres and Grayburg formations
- Developed Python interface to apply each model to oil fields in database
  - Output used to generate cost-supply curves
Technical Status

Storage of CO₂ using CO₂ EOR and application of CO₂ EOR to the ROZ

Oil produced and CO₂ in reservoir within selected ROZ fairway locations as a function of oil price

Output is for illustrative purposes and should not be cited
Technical Status

Life cycle analysis for CO\textsubscript{2} storage

- Incorporating the FE/NELT CO\textsubscript{2} Prophet Model and FE/NELT Onshore CO\textsubscript{2} EOR Cost Model into CO\textsubscript{2} EOR Life Cycle Model
  - Calculates greenhouse gas emissions

- Performing Life Cycle Inventory expansion for CO\textsubscript{2} saline storage and CO\textsubscript{2} EOR models
  - Will allow for holistic environmental assessment of these technologies

- Performing life cycle analyses of CO\textsubscript{2} enhanced methane recovery applied to conventional and unconventional natural gas reservoirs and coal beds
Market analysis of saline storage and CO$_2$ EOR

- Project examines influence of Carbon Storage Program’s projects on the macroeconomy

- Utilizes EIA’s National Energy Modeling System (NEMS)
  - NEMS is used to forecast energy economy of US
  - NEMS is used for reports to government stakeholders (e.g., Congress) to assess prospective government policies

- Modifying NEMS Modules
  - Updated CTUS model in NEMS with results from updated FE/NETL CO$_2$ Saline Storage Cost Model
  - Incorporating results from FE/NETL CO$_2$ Prophet Model into CO$_2$ EOR portion of Oil and Gas Supply Module (OGSM) in NEMS
  - Reviewing cost assumptions for CO$_2$ EOR in OGSM
Accomplishments to Date

• Updated onshore FE/NETL CO₂ Saline Storage Cost Model
• Developed Offshore FE/NETL CO₂ Saline Storage Cost Model
• Updated FE/NETL CO₂ Prophet Model and developing FE/NETL Onshore CO₂ EOR Cost Model
• Developed geologic databases for ROZ fields in Permian Basin
• Incorporating models or outputs from models into Life Cycle Analysis models for CO₂ saline storage and CO₂ EOR
• Incorporating reduced order versions of models in NEMS
• Performed analyses with updated FE/NETL CO₂ Saline Storage Cost Model
• Shared the updated FE/NETL CO₂ Prophet Model with USGS for their effort evaluating CO₂ EOR in US
Synergy Opportunities

- Significant interaction and sharing of models between participants in this Task
- Geologic database for onshore FE/NETL CO$_2$ Saline Storage Cost Model based on NATCARB data and RCSP reports
- BOEM data provided by Geology & Geospatial Analysis Team with continuing interactions with this team
- Projects funded by Carbon Storage Program that characterize storage in Gulf of Mexico
- Tools developed by NRAP could provide useful input for the FE/NETL CO$_2$ Saline Storage Cost Model for site-specific analyses
- Continued interactions with USGS could enhance the FE/NETL CO$_2$ Prophet Model
- SEA individuals have been successful in the past in getting EIA to include NETL products in NEMS (CTUS model)
Project Summary

• Next steps
  – Estimate cost of storing CO$_2$ in a variety of offshore saline formations
  – Estimate the potential to produce oil and store CO$_2$ by applying CO$_2$ EOR to the ROZ in the Permian Basin and conventional oil fields in EIA oil field database
  – Update the life cycle analysis of greenhouse gas emissions using CO$_2$ EOR with updated models
  – Estimate the potential for CO$_2$ capture and storage with CO$_2$ EOR at the national level with updated version of OGSM in NEMS
  – Develop FE/NETL Offshore CO$_2$ EOR Cost Model
Questions?

- Thank you.
Appendix
Benefits to the Program

- The models developed and analyses performed in this Task are intended to assist NETL management in their management of the Carbon Storage Program
  - Identify costs associated with different approaches to storing large masses of CO₂ in the subsurface
  - Identify key cost drivers for carbon storage that might be affected (lowered) by R&D
  - Assess the potential benefits that successfully executed R&D can have on the economy of the US
Participants

• SEA project managers
  – Tim Grant, David Morgan, Don Remson & Chris Nichols

• SEA management
  – Kristin Gerdes, Peter Balash and Chuck Zelek

• NETL site support contractors:
  – KeyLogic: Derek Vikara, Chung Yan Shih, Allison Guinan, ShangMin Lin, Anna Wendt, Arun Iyengar, Tim Carr
  – Advanced Resources International: Vello Kruuskraa, Matt Wallace, Michael Godec
  – OnLocation: Less Goudarzi, Francis Wood, Niko Kydes
  – The CETER Group: Nick Azzolina
Bibliography

Presentations and Papers


- Estimation of CO₂ Storage Coefficients from CO₂ Enhanced Oil Recovery Using the FE/NETL CO₂ Prophet Model Calibrated to Field Data
- A Four-County Appraisal of the San Andres Residual Oil Zone (ROZ) “Fairway” of the Permian Basin

9th Trondheim Conference on CO₂ Capture, Transport and Storage – Trondheim, Norway, June 12-14, 2017

- Comparative Analysis of Transport and Storage Options from a CO₂-Generating Source Perspective
- A paper will be submitted for publication either in The International Journal of Greenhouse Gas Control or conference proceedings.

AAPG Eastern Section meeting – Morgantown, West Virginia, September 24-27, 2017

- Comparative Analysis of Transport and Storage Options from a CO₂-Generating Source Perspective (Submitted)