Cost Analysis Associated with CTUS of CO_2

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Poster Overview

The National Energy and Technology Laboratory (NETL) performs cutting-edge systems engineering and analysis modeling that evaluates the techno-economics, logistical feasibility, life cycle environmental impacts, and market effects of Carbon Capture, Utilization, and Storage (CCUS). Each modeling approach provides a unique perspective of the potential for CCUS in the United States. This poster features a select assortment of recent analysis in each of the modeling areas. Techno-economic and feasibility modeling related to CCUS deployment was performed for both onshore and offshore settings. Onshore, analyses assessed the future feasibility of a CO_2 "intermediate storage" concept, as well as potential for deployment of CO_2-EOR to residual oil zones in the Permian Basin. Offshore, publicly-available datasets were integrated with the NETL-developed Cumulative Spatial Impact Layers (CSIL) tool to identify high-suitability offshore regions/sites for CCUS projects in the Gulf of Mexico. Another study presents GIS-based analyses and Monte Carlo simulations to evaluate the benefits of transporting CO_2 via pipeline or ship to offshore injection sites. From a life cycle perspective, the CELiC model is presented. This open-source model defines the life cycle impacts of CO_2 enhanced oil recovery (EOR) by calculating a system's life cycle greenhouse gas emissions for CO_2 captured from different sources. The market research team presented case studies focused on investigating the overall cost of capture from different types of anthropogenic sources and analyzing the reliability of delivery of anthropogenic CO_2 from industrial sources to long-term storage or EOR sites for injection.

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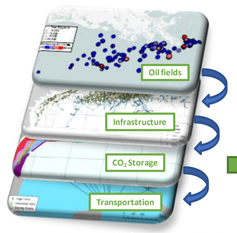
Multi-criteria CCUS Screening Framework of GOM OCS

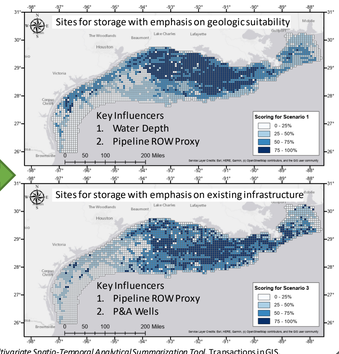
- Developed a framework to use disparate data and expert opinion to select priority sites



Incorporate criteria into quantitative analysis to identify areas with potentially high suitability using NETL developed CSIL tool. [1]

Number	Criteria
i = 1	Reservoir quality without depth ranked by quartile
i = 2	Sum of injectivity proxy
i = 3	Sum of oil in reserve (barrels)
i = 4	Number of active caissons
i = 5	Number of active well protectors
i = 6	Number of major active multi-purpose platforms
i = 7	Distance to closest onshore CO_2 source > 25,000 tonnes/year
i = 8	Pipeline right-of-way proxy
i = 9	Within major shipping route buffer area
i = 10	Water depth – saline reservoirs
i = 11	Water depth – oil reservoirs
i = 12	Above salt domes
i = 13	Plugged and abandoned wells
i = 14	Faults

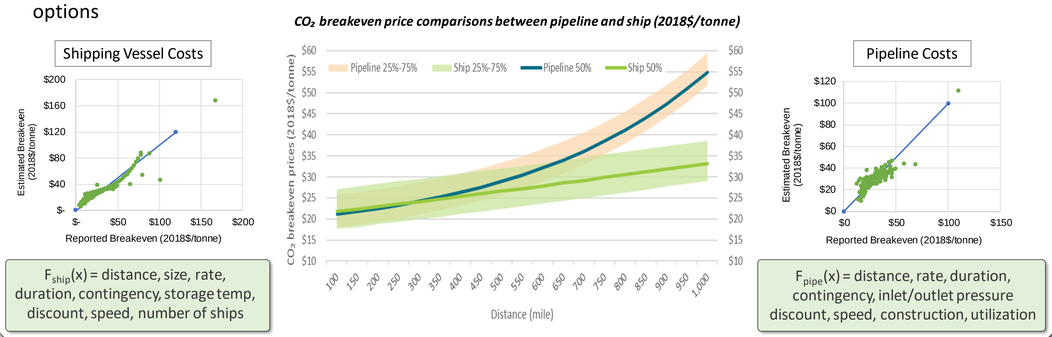
Qualitative input from experts weighted for 4 separate scenarios



[1] Romeo, Lucy; Nelson, Jake; Wingo, Patrick; Bauer, Jennifer; Justman, Devin; and Rose, Kelly (In Press). *Cumulative Spatial Impact Layers: A Novel Multivariate Spatio-Temporal Analytical Summarization Tool.* Transactions in GIS.

Offshore CO_2 Transportation Assessment

- Assessed the feasibility of using pipeline or ship for delivery of CO_2 offshore for injection for storage of EOR
- Completed Cost Uncertainty assessment using Monte Carlo simulation Excel add-in to evaluate offshore delivery options

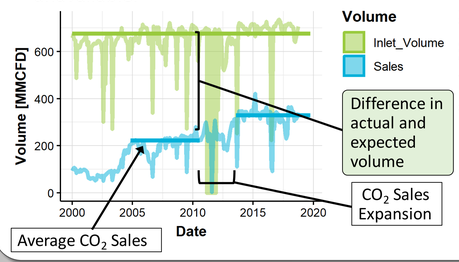


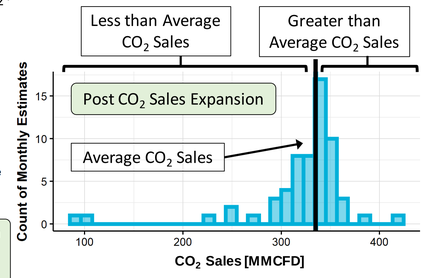
$F_{ship}(x)$ = distance, size, rate, duration, contingency, storage temp, discount, speed, number of ships

$F_{pipe}(x)$ = distance, rate, duration, contingency, inlet/outlet pressure discount, speed, construction, utilization

Reliability of CO_2 Delivery from Anthropogenic Sources

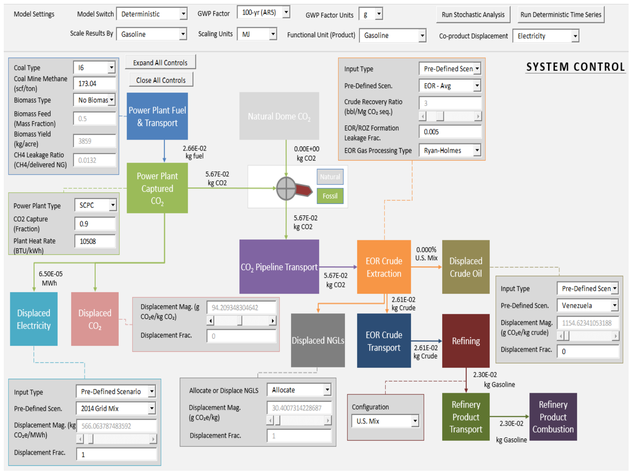
- What are Reliable Sources?
  - ➤ Consistent
  - ➤ Predictable
- Shute Creek Natural Gas Processing Plant, in Wyoming
  - ➤ Inlet gas - 65% CO_2
- Reproducible analysis to evaluate the reliability of sources. Use inlet volume at other plants where CO_2 sales data is unavailable.
- Quantify reliability by looking at historical inlet volume and CO_2 sales. The variability in inlet volume can be used to predict the variability in CO_2 sales.
- How often does the plant deliver an expected volume of CO_2?





85% monthly CO_2 sales are more than 90% of average sales

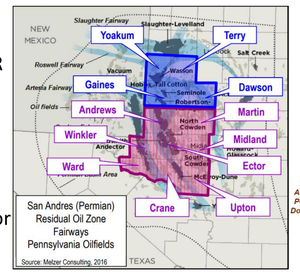
The CO_2 Enhanced Oil Recovery (EOR) Life Cycle (CELiC) Model

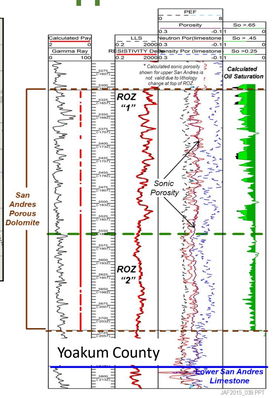


- CELiC Calculates life cycle greenhouse gas (GHG) emissions for a CO_2-EOR system
- Users can select 3 sources of injected CO_2
  - ➤ Extracted from a natural dome
  - ➤ Captured from a coal-fired power plant
  - ➤ Captured from a natural gas power plant
- Several parameters and options allow for the assessment of the system for a wide-array of products
  - ➤ Electricity, CO_2 Pipeline, Crude Oil, Refined Fuels
- Capable of deterministic and stochastic analyses
- Outputs a time-series analysis that shows changing GHG emissions for the CO_2-EOR system over time

Residual Oil Zone (ROZ) Resource Appraisal

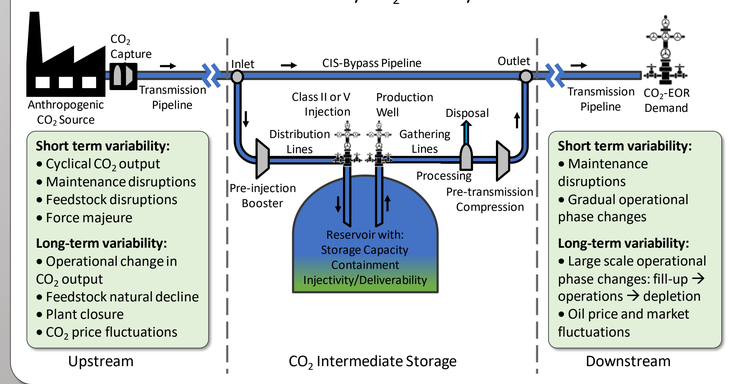
- 12 county assessment of greenfield CO_2 EOR to San Andres ROZ in Permian Basin
- FE/NETL CO_2 Prophet and Onshore CO_2 EOR Cost Model used for analyses
- **Modeling Results:**
  - ➤ 35.9 Bbbl of oil recoverable
    - (Assumes an oil price of $75/bbl)
  - ➤ 16.6 Billion metric tons of CO_2 purchased
    - (Assumes a CO_2 cost of $28.35/metric ton or $1.50/Mcf)
  - ➤ 0.39-0.55 metric tons per bbl oil produced





CO_2 Intermediate Storage (CIS)

- CIS is a mechanism to ensure steady CO_2 delivery from sources to end users



Short term variability:
- Cyclical CO_2 output
- Maintenance disruptions
- Feedstock disruptions
- Force majeure

Long-term variability:
- Operational change in CO_2 output
- Feedstock natural decline
- Plant closure
- CO_2 price fluctuations

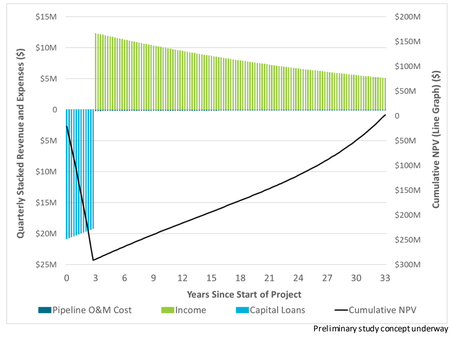
Upstream

CO_2 Intermediate Storage

Short term variability:
- Maintenance disruptions
- Gradual operational phase changes

Long-term variability:
- Large scale operational phase changes: fill-up → operations → depletion
- Oil price and market fluctuations

Downstream



- Results from the case study indicate that government tax incentives will likely have to be increased to encourage widespread CIS.