Site Selection and Cost Estimation of Pilot-Scale CO_2 Saline Storage Study in the Gulf of Mexico

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U.S. Department of Energy

National Energy Technology Laboratory
Carbon Management Project Review Meeting
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Outline

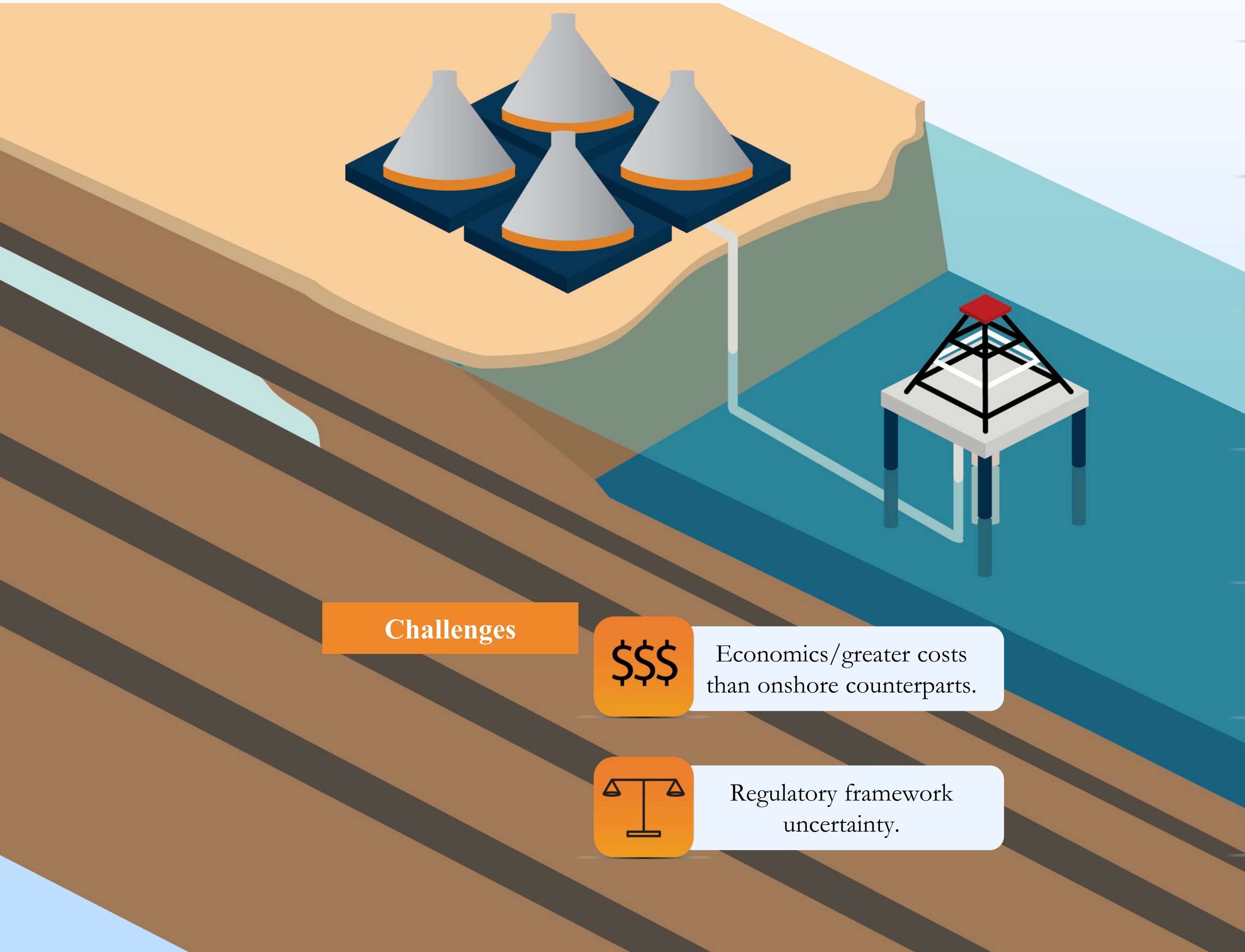
– Project Overview.

– Accomplishments to Date:

- Project design and conceptualization.
- Multi-criteria Carbon Capture, Utilization, and Storage (CCUS) Screening Evaluation of the Gulf of Mexico (GOM), USA.
- Demonstration QUE$TOR™ O&G project cost estimator software.
- Results: site screening, geology, infrastructure, and cost.
- Publications.

– Lessons Learned.

Why CCS in Offshore GOM?



Opportunities

- Large CO_2 emitters are concentrated along the Gulf Coast.
- Adjacent to existing shallow-water infrastructure for potential reuse.
- Single lease-owner.
- Absence of underground sources of drinking water.
- Away from population centers.
- Multiple stacked reservoirs.
- Favorable reservoir properties (porosity, permeability).

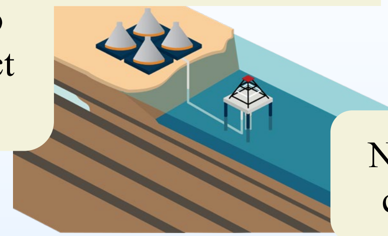
Challenges

- $$$ Economics/greater costs than onshore counterparts.
- Regulatory framework uncertainty.

Necessary Analysis on CCS in Offshore GOM

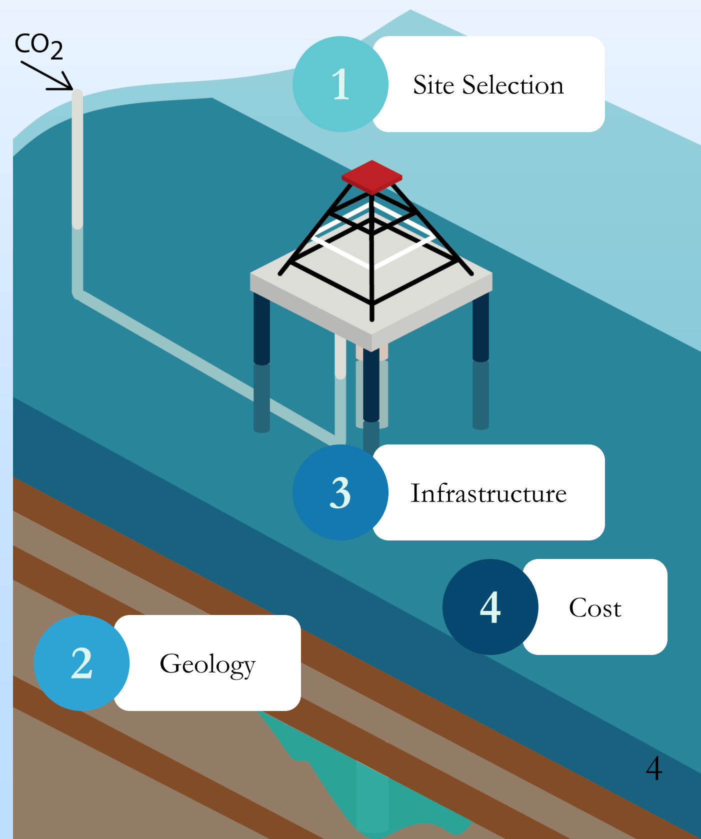
Needed Analysis

There has been no CO_2 storage project in the GOM.



Need for project cost estimates.

This analysis addresses the opportunities and challenges by investigating key metrics, including:



Pilot-Scale CO_2 Storage Analysis

To provide an initial analysis to develop a methodology to evaluate the CO_2 storage potential in the GOM.

To develop modeling scenarios with pilot-scale injection magnitudes of 0.5 Mt/yr for 12 years.

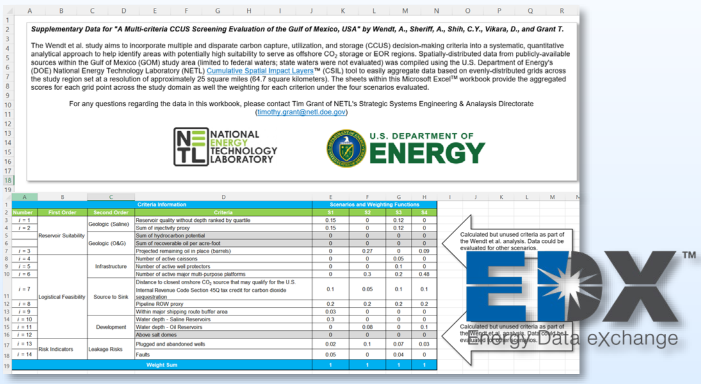
To analyze key technical and geologic considerations to develop a site in both (1) part of GOM federal waters and (2) Texas state waters for pilot-scale CO_2 storage.

To estimate the cost to develop the site.

*Mt/yr = million metric tons per year

Federal Waters

Leveraging NETL Multi-criteria CCUS Screening Evaluation of the Gulf of Mexico, USA[1]



Supplementary Data for "A Multi-criteria CCUS Screening Evaluation of the Gulf of Mexico, USA" by Wendt, A., Sheriff, A., Shih, C.Y., Vikara, D., and Grant T.

The Wendt et al. study aims to incorporate multiple and disparate carbon capture, utilization, and storage (CCUS) decision-making criteria into a systematic, quantitative analytical approach to help identify areas with potentially high suitability to serve as offshore CO_2 storage or EOR regions. Spatially-distributed data from publicly-available sources within the Gulf of Mexico (GOM) study area (limited to federal waters; state waters were not evaluated) was compiled using the U.S. Department of Energy's (DOE) National Energy Technology Laboratory (NETL) Cumulative Spatial Impact Layers™ (CSIL) tool to easily aggregate data based on evenly-distributed grids across the study region set at a resolution of approximately 25 square miles (64.7 square kilometers). The sheets within this Microsoft Excel™ workbook provide the aggregated scores for each grid point across the study domain as well the weighting for each criterion under the four scenarios evaluated.

For any questions regarding the data in this workbook, please contact Tim Grant of NETL's Strategic Systems Engineering & Analaysis Directorate (timothy.grant@netl.doe.gov)

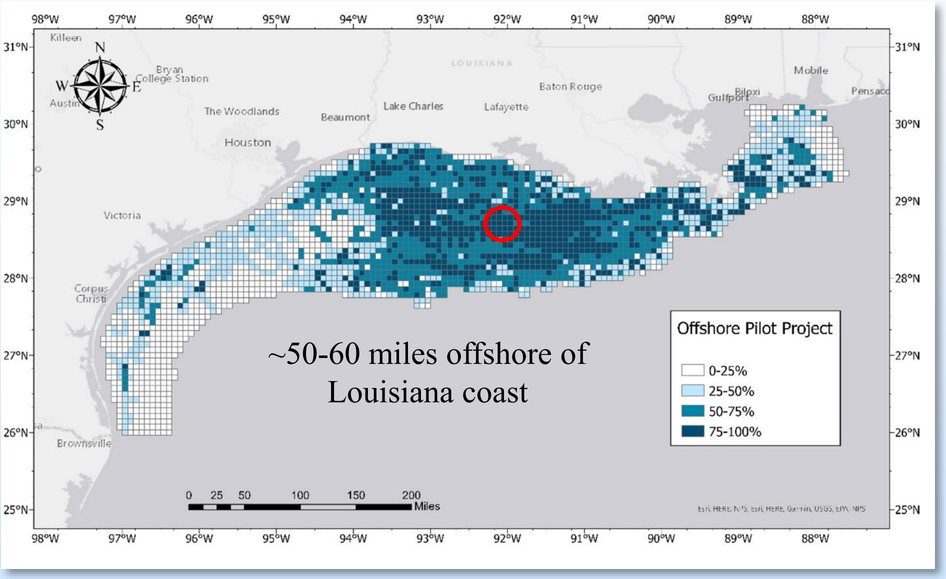
Criteria Information				Scenarios and Weighting Functions			
Number	First Order	Second Order	Criteria	S1	S2	S3	S4
i = 1	Reservoir Suitability	Geologic (Saline)	Reservoir quality without depth ranked by quartile	0.15	0	0.12	0
i = 2			Sum of injectivity proxy	0.15	0	0.12	0
		Geologic (O&G)	Sum of hydrocarbon potential	0	0	0	0
			Sum of recoverable oil per acre-foot	0	0	0	0
i = 3			Projected remaining oil in place (barrels)	0	0.27	0	0.09
i = 4	Logistical Feasibility	Infrastructure	Number of active caissons	0	0	0.05	0
i = 5			Number of active well protectors	0	0	0.1	0
i = 6			Number of active major multi-purpose platforms	0	0.3	0.2	0.48
i = 7		Source to Sink	Distance to closest onshore CO_2 source that may qualify for the U.S. Internal Revenue Code Section 45Q tax credit for carbon dioxide sequestration	0.1	0.05	0.1	0.1
i = 8			Pipeline ROW proxy	0.2	0.2	0.2	0.2
i = 9			Within major shipping route buffer area	0.03	0	0	0
i = 10		Development	Water depth - Saline Reservoirs	0.3	0	0	0
i = 11			Water depth - Oil Reservoirs	0	0.08	0	0.1
i = 12			Above salt domes	0	0	0	0
i = 13	Risk Indicators	Leakage Risks	Plugged and abandoned wells	0.02	0.1	0.07	0.03
i = 14			Faults	0.05	0	0.04	0
Weight Sum				1	1	1	1

Calculated but unused criteria as part of the Wendt et al. analysis. Data could be evaluated for other scenarios.

EDX Energy Data eXchange

Criteria		Pilot Project
#	Criteria	Average Normalized Weight
i = 1	Reservoir quality without depth ranked by quartile	0.087
i = 2	Sum of injectivity proxy	0.147
i = 3	Sum of hydrocarbon potential	0.000
	Sum of recoverable oil per acre-foot	0.000
	Sum of oil in reserve (barrels)	0.000
i = 4	Number of active caissons	0.033
i = 5	Number of active well protectors	0.054
i = 6	Number of active major multi-purpose platforms	0.145
i = 7	Distance to closest onshore eligible CO_2 source	0.185
i = 8	Pipeline right-of-way proxy	0.118
i = 9	Within major shipping route buffer area	0.021
i = 10	Water depth - Saline Reservoirs	0.124
i = 11	Water depth - Oil Reservoirs	0.000
i = 12	Above salt domes	0.000
i = 13	Plugged and abandoned wells	0.045
i = 14	Faults	0.039
	Weight Sum	**1**

Scoring Quartiles Map



Easy to use

Open Source

Portable

Scalable

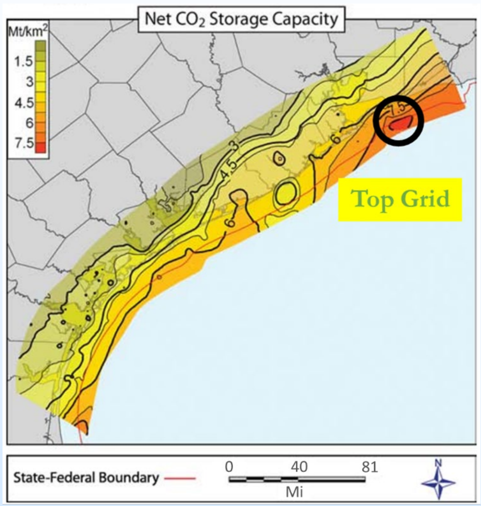
Transparent

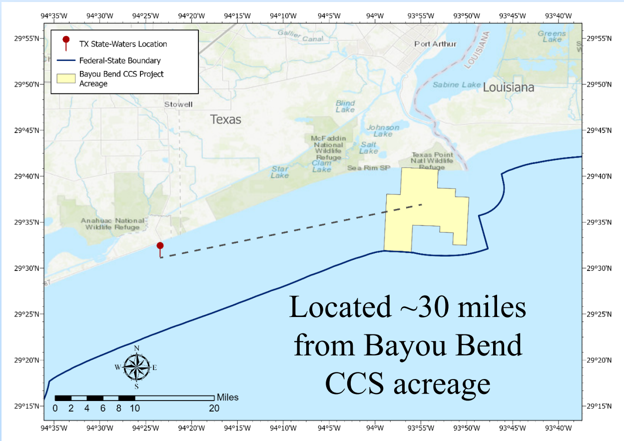
People

[1]https://edx.netl.doe.gov/dataset/multi-criteria-ccus-screening-evaluation-supplementary-data

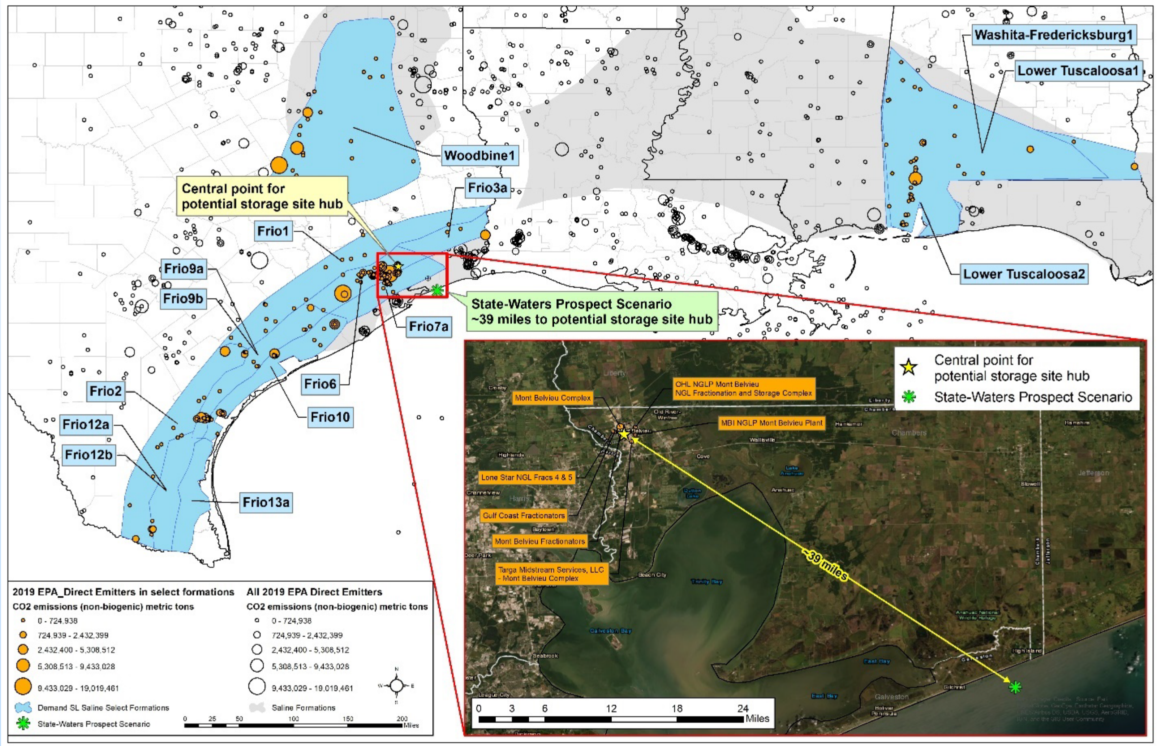
Texas State Waters

Figure Data Compiled from Wallace et al. (2014)[1]





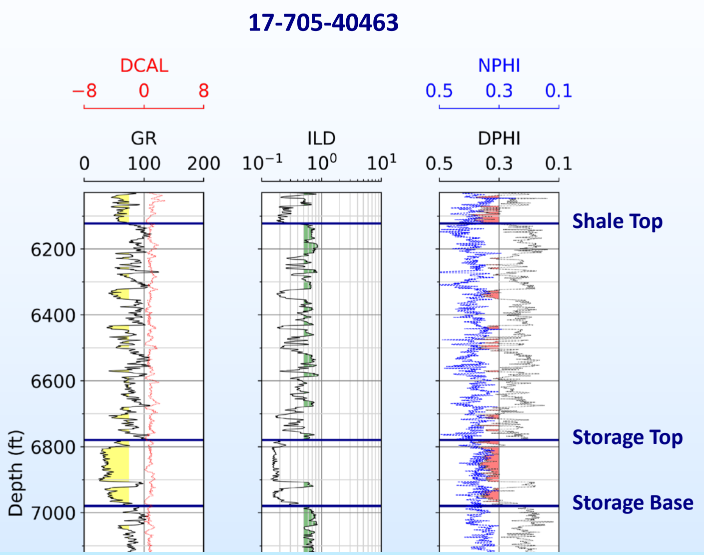
Storage Site with Nearby CO_2 Emissions Sources

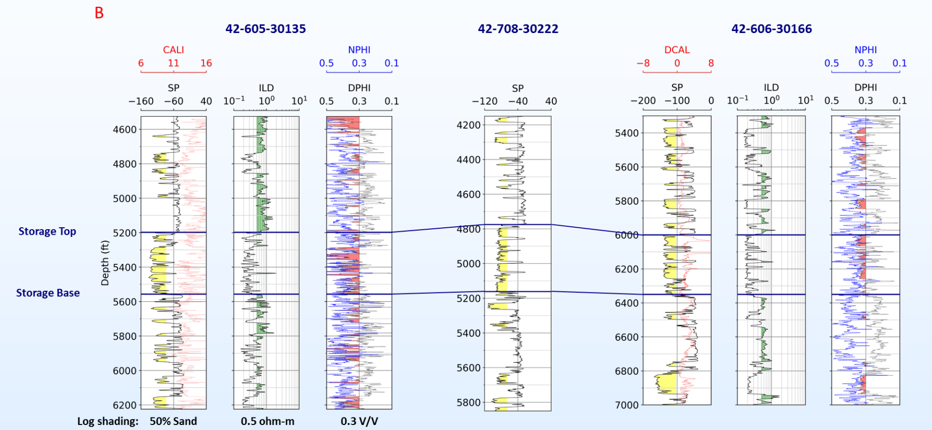


[1]Wallace, K. J., Meckel, T. A., Carr, D. L., Treviño, R. H., & Yang, C. (2014). Regional CO_2 sequestration capacity assessment for the coastal and offshore Texas Miocene interval. Greenhouse Gases: Science and Technology, 4(1), 53-65.

Federal Waters

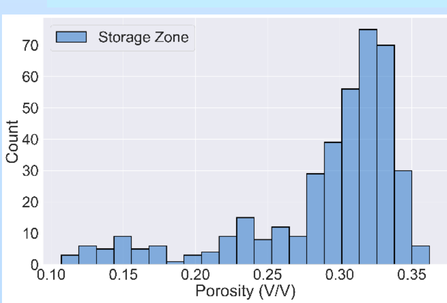
Texas State Waters

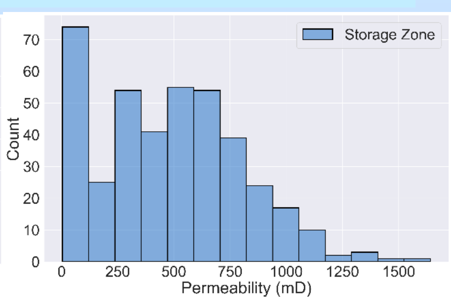


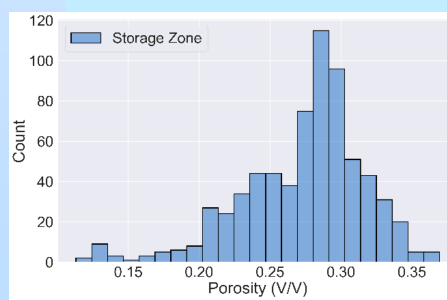


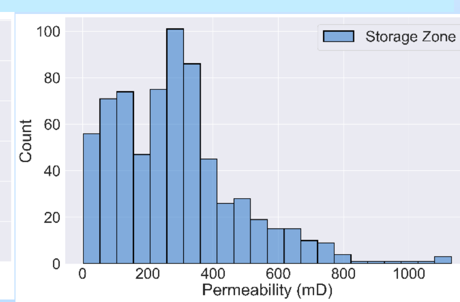
- Average net porosity: 31%.
- Average permeability: 482 mD.
- Gross thickness: 148 ft.
- After 12 years, plume is 3.8 mi^2 with a radius of 1.1 mi.

- Average net porosity: 27%.
- Average permeability: 283 mD.
- Gross thickness: 384 ft.
- After 12 years, plume is 1.6 mi^2 with a radius of 0.7 mi.

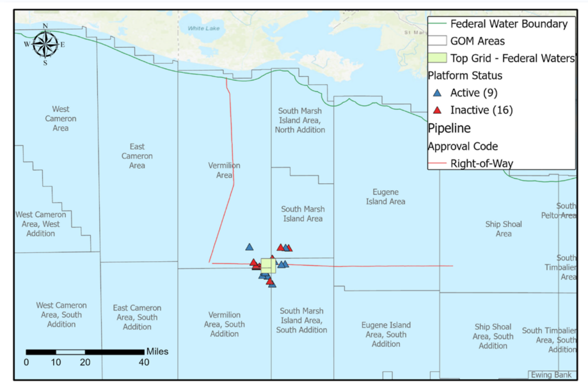








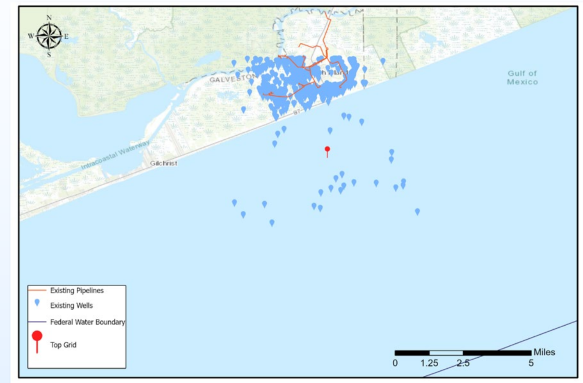
Federal Waters



Platform data within 0.1 degrees of the selected injection point.					
Structural Type	**Operating Status**	**Major Structural Flag**	**Count**	**Average Water Depth**	**Average Age**
Fixed Platforms	**Active**	Yes	6	148.5	29.2
		No	2	145	4
	Inactive and removed	Yes	9	N/A	N/A
		No	1		
Caissons	**Active**	Yes	1	133	12
	Inactive and removed	No	1	N/A	N/A
Well Protectors	**Inactive**	Yes	1	N/A	N/A
		No	4		

High-level pipeline screening criteria: diameter, maximum operating pressure, age, service status, length, and water depth.

Texas State Waters



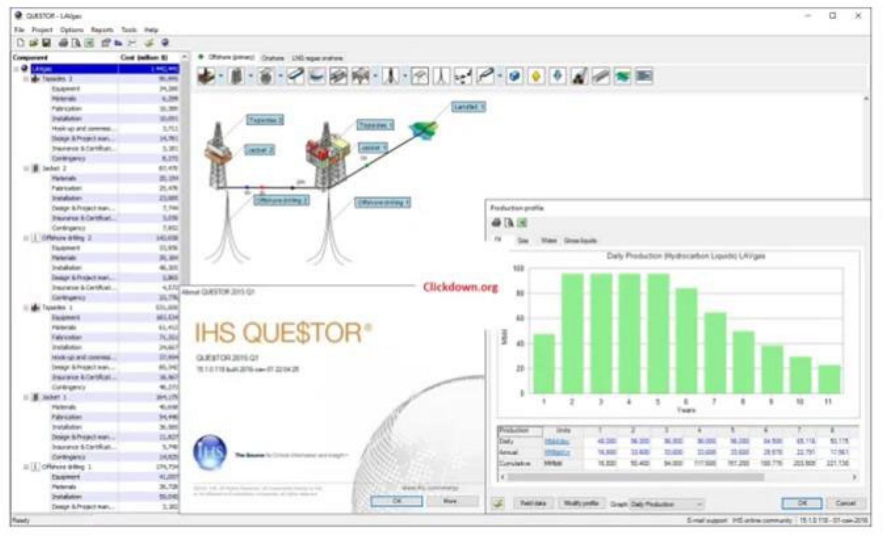
Summary of wells within 0.1 degrees of the selected injection point.				
Operating Status	**Count**	**True Vertical Depth (ft)**	**Average Age (years)**	**≤ 30 years old**
Active	126	6001	55	22
Inactive	61	5628	39	18
Plugged and Abandoned	266	6425	52	15
Other	18	6400	39	4

High-level platform reuse criteria: proximity to the injection site, age and general condition of the platform, space on the platform, and regulatory and legal considerations revolving around liability and transfer of decommissioning responsibilities.

On average, active lines are rated to transport supercritical CO_2, so opportunities to reuse existing pipeline and platforms exist.

Accomplishments to Date

Demonstration of QUE$TOR™ O&G project cost estimator software



Select databases
- Cost database – regional costs by cost center.
- Technical database – local technical inputs.

Input field data
- Reservoir properties – recoverable reserves, production profiles, well counts.
- Select concept – field architecture and export options.

Modify concept
- Change field architecture – add and remove components.
- Adjust individual components – processing options, pipeline diameters.

Calculate OPEX
- Change field architecture – add and remove components.
- Adjust individual components – processing options, pipeline diameters.

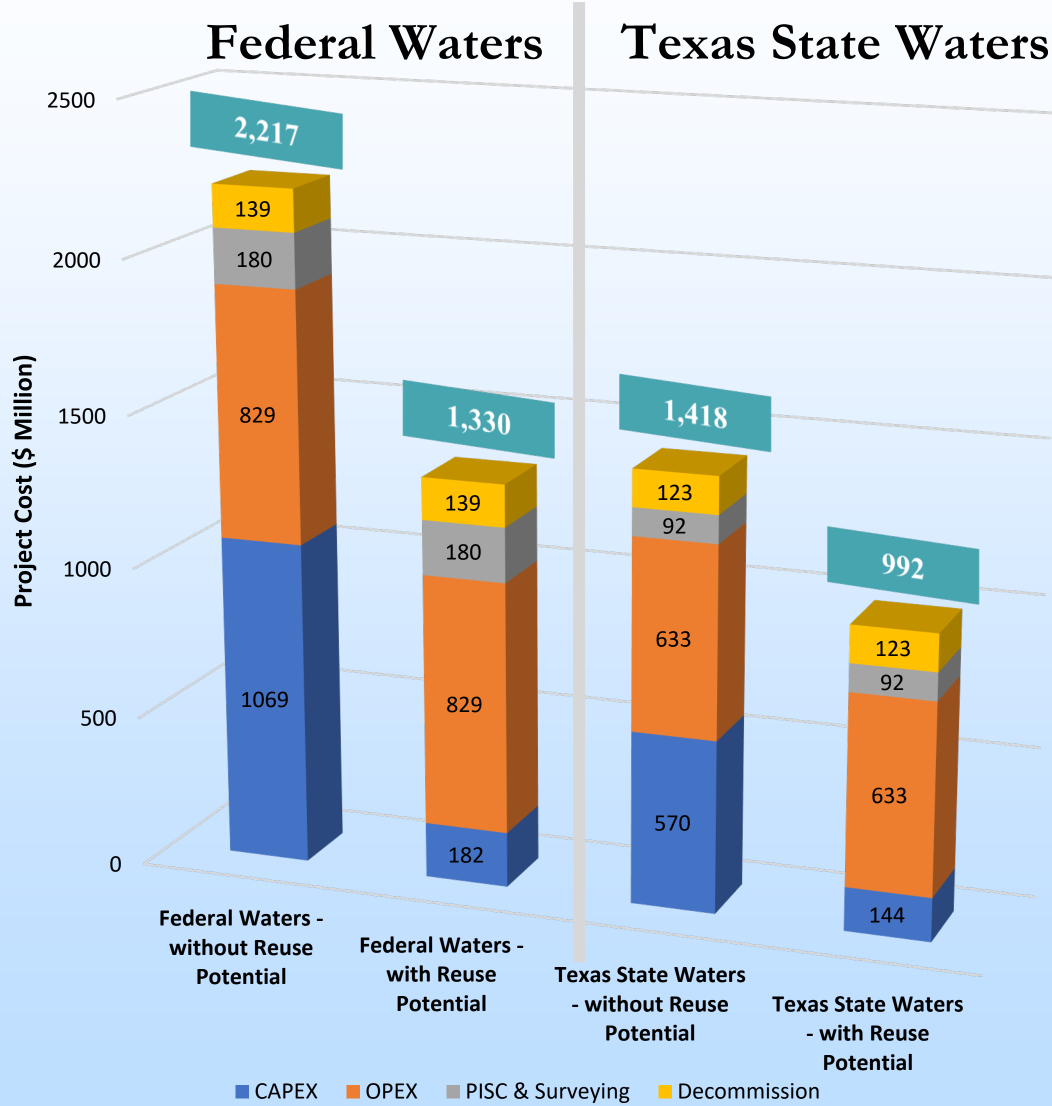
Schedule CAPEX
- Total CAPEX to CAPEX forecast.

Generate investment profile
- Forecasts – production, CAPEX, OPEX, decommissioning.
- Exported and used for economic analysis.

Append CO_2 storage – specific components

Comparison of Cost Magnitudes

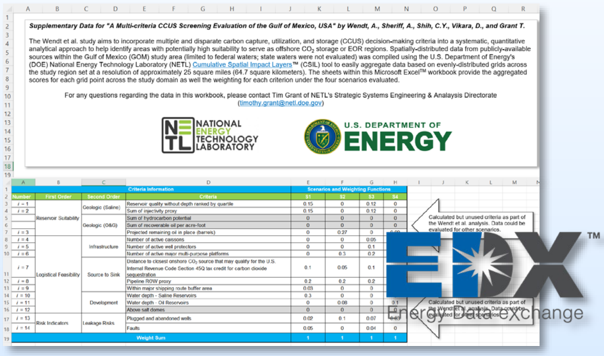
- Lowest-cost option is Texas state waters with reuse of infrastructure.
- Infrastructure reuse offers significant CAPEX / project cost reductions.
  - Cost reduction ~ $887 million in the federal-waters scenario compared to ~$426 million in the Texas state-waters scenario.
  - However, Texas state waters with infrastructure reuse offers the cheapest option.
- Economies of scale could exist in that maximizing the storage potential will improve the break-even cost and may change the outlook when comparing cost for projects in Texas state waters vs. U.S. federal waters.



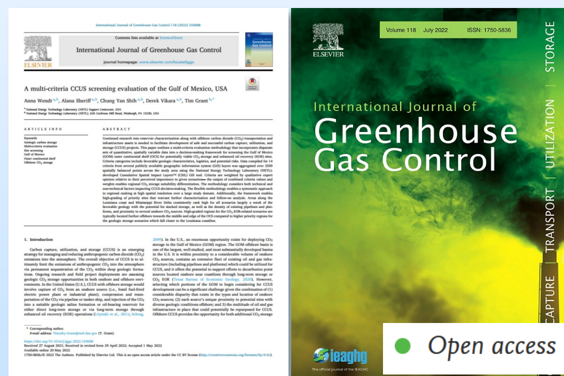
Accomplishments to Date

Publications

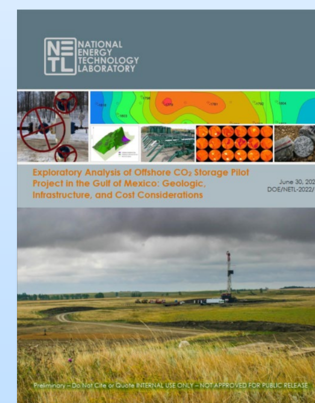
A Multi-criteria CCUS Screening Evaluation of the Gulf of Mexico, USA – Supplementary Data[1]



Peer-Reviewed Journal Manuscript for Tool Development and 4 Case Studies (International Journal of Greenhouse Gas Control)



NETL Report (Pilot Study)
(*under review*)



[1]https://edx.netl.doe.gov/dataset/multi-criteria-ccus-screening-evaluation-supplementary-data

Lessons Learned

Offshore GOM offers unique opportunities to establish large-scale storage opportunities, with the following key drivers:

- Reuse of existing infrastructure.
- Various and high density of CO_2 sources and sinks options.
- Favorable storage reservoir properties (porosity, permeability) / capacity.

However, challenges in deploying CCS in the GOM remain:

- Absence of promulgated regulatory framework for the federal waters.
- Apparently high total project cost.

Geology of offshore GOM seems conducive to safely and permanently store CO_2 in saline formations with potentially highly favorable geologic properties (porosity and permeability).

Total project costs may be on the order of 1 billion dollars or more. These costs will depend on how much CO_2 is injected as well as financial opportunities and regulatory requirements. This analysis is preliminary.

Findings from this analysis could facilitate further necessary steps to foster the deployment of CO_2 storage projects in the offshore GOM.

Thank you!

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Appendix

- These slides will not be discussed during the presentation but are mandatory.