Partnership for Offshore Carbon Storage Resources and Technology Development in the Gulf of Mexico

Partnership for carbon capture & offshore geologic storage

GoMCarb

DE-FE0031558

Gulf Coast Carbon Center

Tip Meckel

Co-I Susan Hovorka and Ramon Treviño

Gulf Coast Carbon Center, Bureau of Economic Geology

Jackson School of Geosciences The University of Texas at Austin

U.S. Department of Energy

National Energy Technology Laboratory

Carbon Management and Oil and Gas Research Project Review Meeting – Carbon Storage

August 2 - 11, 2021

U.S. DEPARTMENT OF ENERGY

NETL

TEXAS Geosciences

Bureau of Economic Geology

Jackson School of Geosciences

The University of Texas at Austin

Program Overview

– Funding
  - DOE: $14 million (5 years)
  - Cost Share: $3.5 million

– Overall Project Performance Dates
  - BP 1 (NCE 3/31/20 → 12/31/20)
  - BP 2 1/1/21 – 3/31/23

Technical Approach/Project Scope

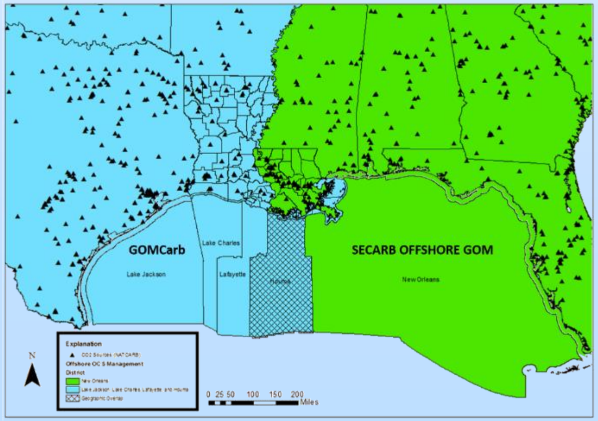
Task 2: Offshore Storage Resource Assessment

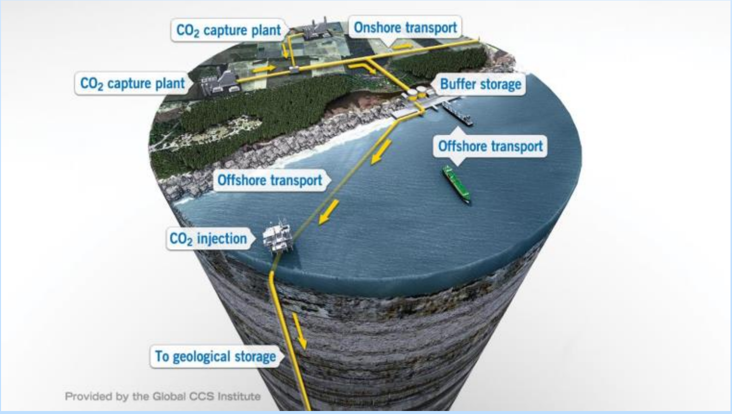
Task 3: Risk Assessment, Simulation & Modeling

Task 4: Monitoring, Verification & Assessment

Task 5: Infrastructure, Operations & Permitting

Task 6: Knowledge Dissemination

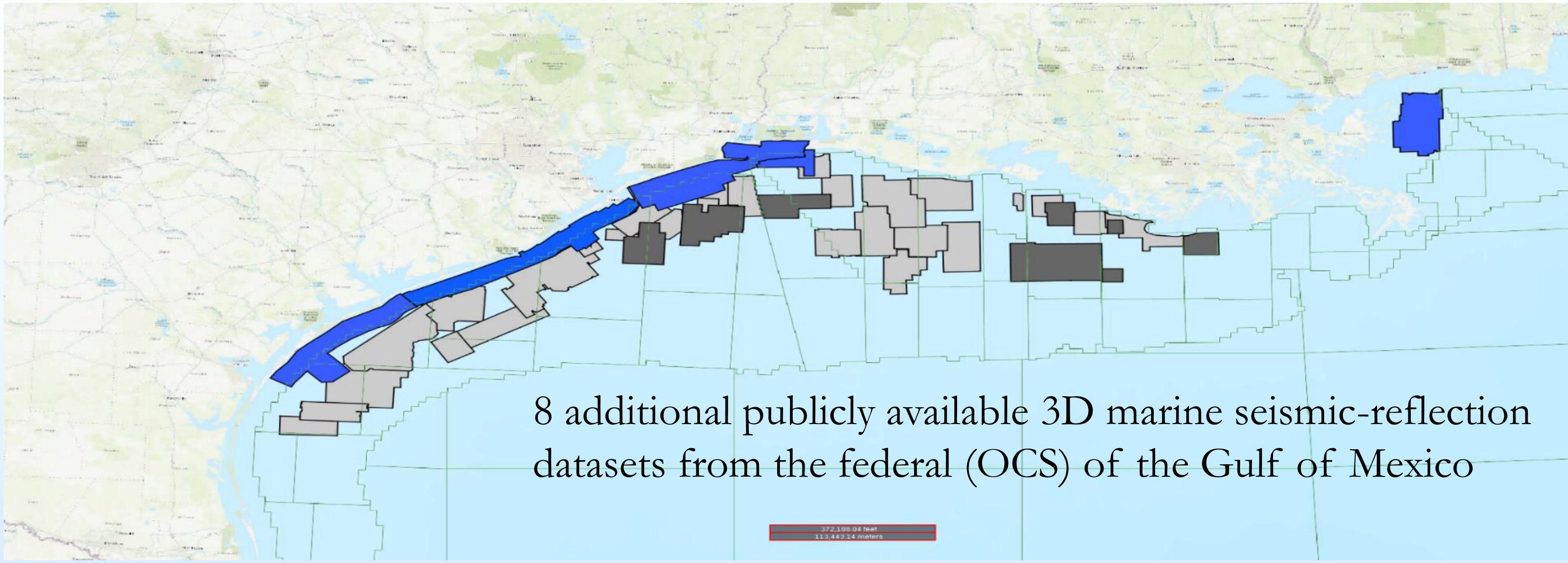




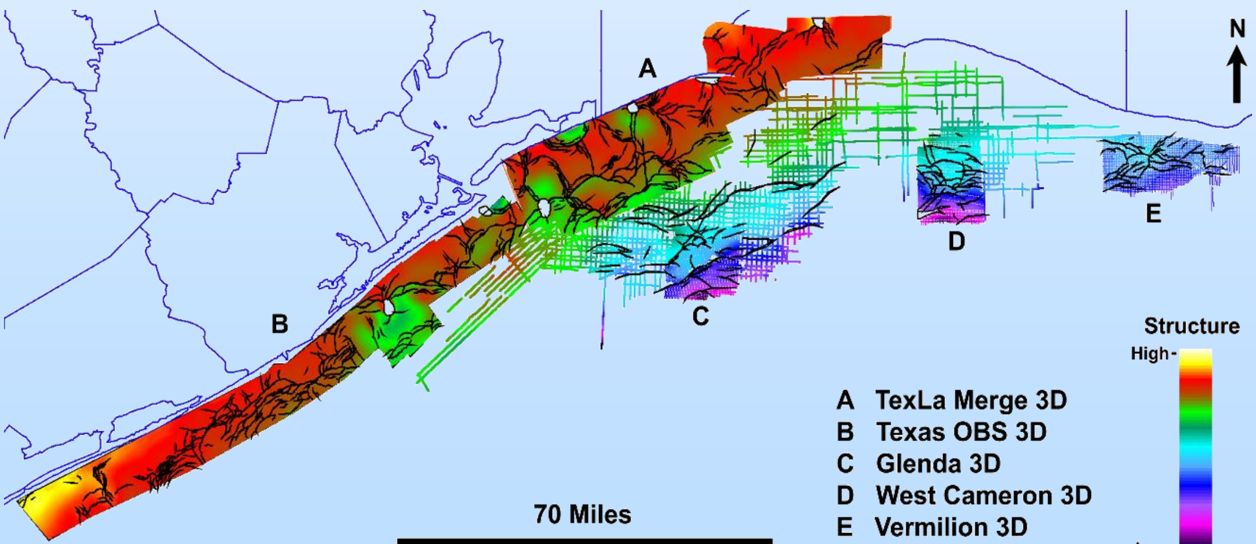
Partnership Participants

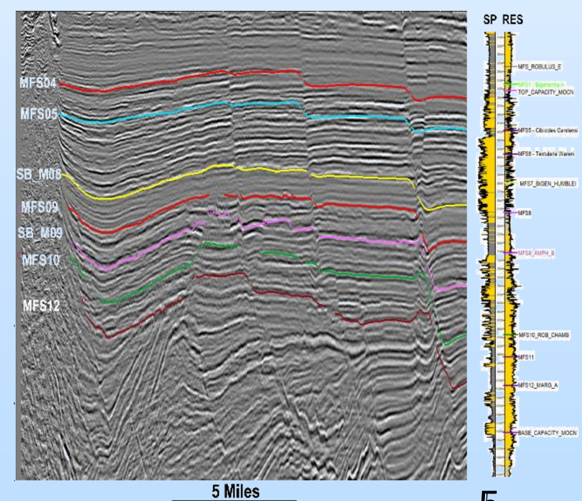
Institution	Location	Expertise
University of Texas at Austin		Project Lead
Gulf Coast Carbon Center	Austin, TX	Geo-Sequestration
Gulf of Mexico Basin Synthesis (GBDS)	Austin, TX	GoM Basin Regional Geology
Petroleum & Geosystems Engineering	Austin, TX	Reservoir Simulation
Stan Richards School	Austin, TX	Public Relations
Aker Solutions	Houston, TX	Subsea Infrastructure
Fugro	Houston, TX	MVA Technologies
TDI-Brooks, Intl.	College Station, TX	MVA Technologies
Lamar University	Beaumont, TX	Risk Assessment; Outreach
Trimeric	Buda, TX	Engineering; Infrastructure & Operations
USGS	Reston, VA	Characterization & Capacity Assessment
Louisiana Geological Survey	Baton Rouge, LA	Database Development
Texas A&M (GERG)	College Station, TX	Ocean & Environmental Science
LBNL	Berkeley, CA	Risk Assessment; MVA Technologies
LLNL	Livermore, CA	Risk Assessment

Task 2: Offshore Storage Resource Assessment

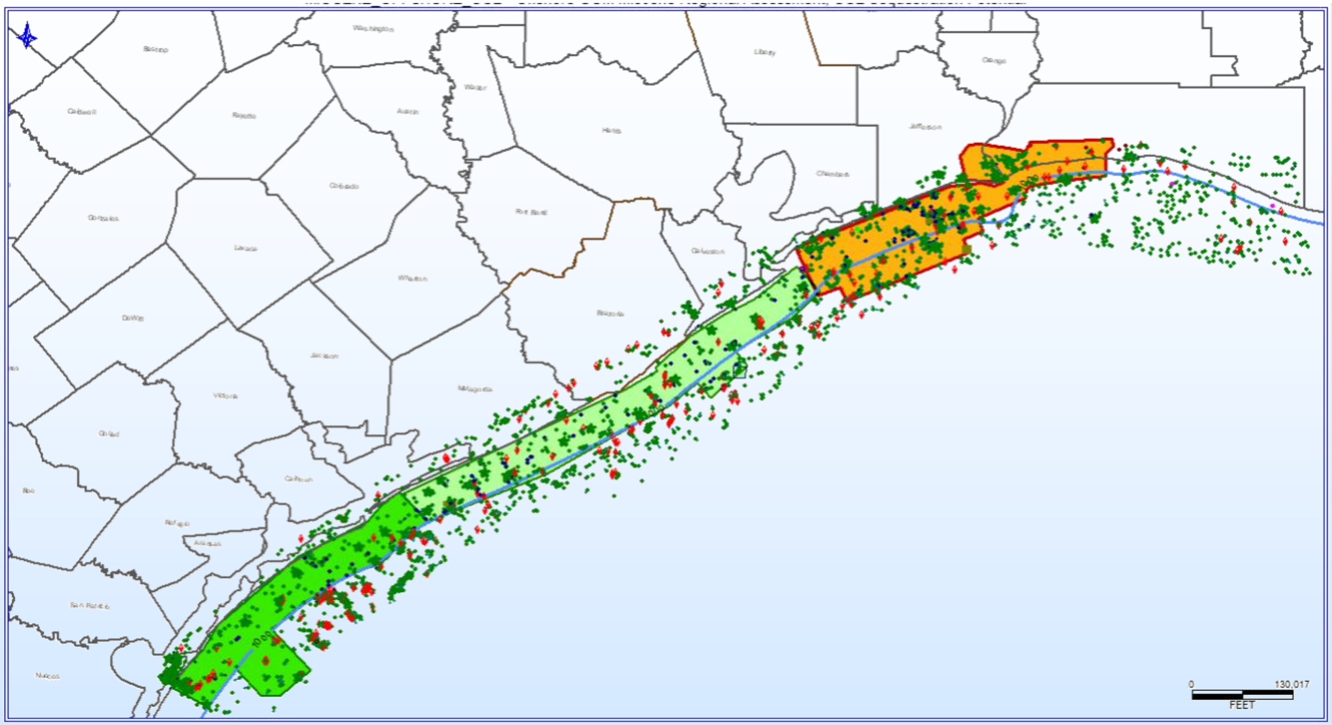


8 additional publicly available 3D marine seismic-reflection datasets from the federal (OCS) of the Gulf of Mexico





LAS Well Data



Map of the study area showing **all wells with LAS files**

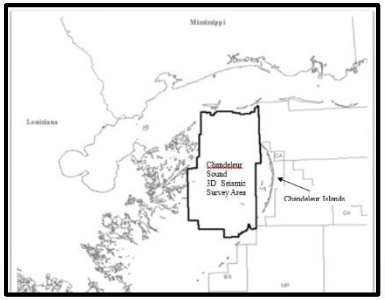
There are **2959 digital wells** in the study area:

2501 of which have LAS **SP** curves (green dots)

139 have LAS **density**, **porosity** and **sonic** curves (blue dots)

243 have **GR** curves (red rhombs)

Chandeleur Sound, LA



- 121 raster logs have been digitized
- 9 sonic logs were selected to generate synthetic seismograms.
- The synthetics will subsequently be used to convert the seismic volume to depth.

Proprietary 3D seismic removed

The Middle Miocene (MM) target interval is located between the cyan line (top Middle Miocene) and the magenta line (top Lower Miocene).

Proprietary 3D seismic removed

Within the MM are potential stratigraphic traps that have been interpreted:

- mass-transport complex (MTC)-related canyons,
- a "break-away MTC" that is fault-bound at the northern end (shelf/landward),
- a slope channel,
- and a 'wedge' of mixed lithologies.

Two MS Theses - Spring 2021

- Hull, 2021, **Characterizing Reservoir Quality for Geologic Storage Of CO_2—A Case Study From The Lower Miocene Shore Zone At Matagorda Bay, Texas**, 208 p.

- Franey, J., 2021, **High Order Stratigraphic Framework of Intra-slope Growth Faulted Subbasins Near Offshore Matagorda Bay**, TX, 186 p.

Newly developed machine-learning workflow

(1) estimate (invert) acoustic impedance with sparse wells and a large 3D seismic dataset,

(2) map sandstone (reservoir) and shale (seal) volume at high-frequency stratigraphic sequence (5-100 m) level, and

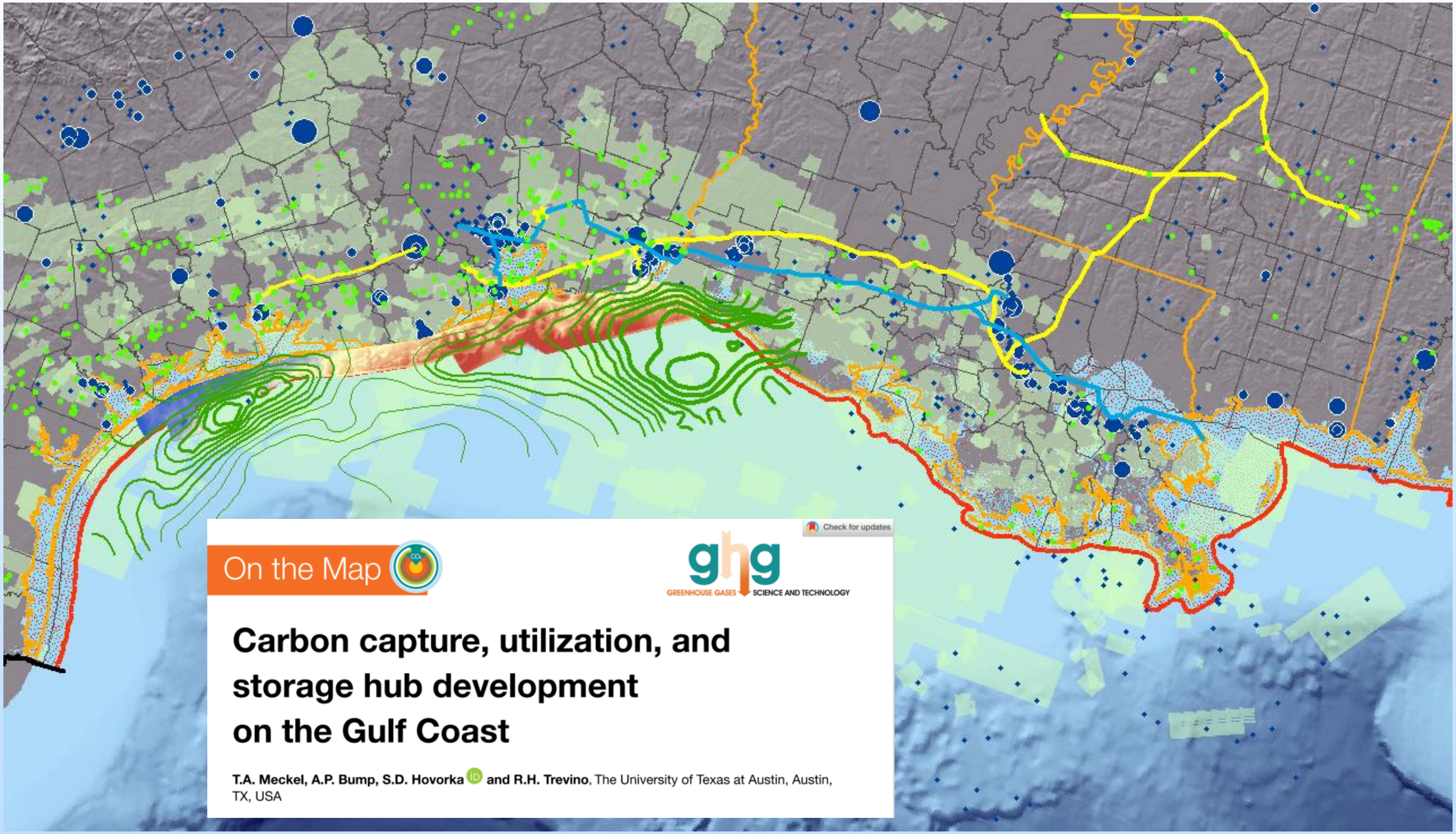
(3) evaluate reservoir and seal quality for CO_2 storage.

The conclusions are:

- The machine learning approach is powerful and useful: quantitative, high resolution, high accuracy, and stable.
- The pilot study established workflows and parameters, which may be applicable to a larger area.
- The expected resolution of 5 m vertically is limited by seismic sample rate (4 ms), and 20 m horizontally, restricted by seismic bin size.

An open access journal article published on **CCUS hub development in the Gulf Coast**.

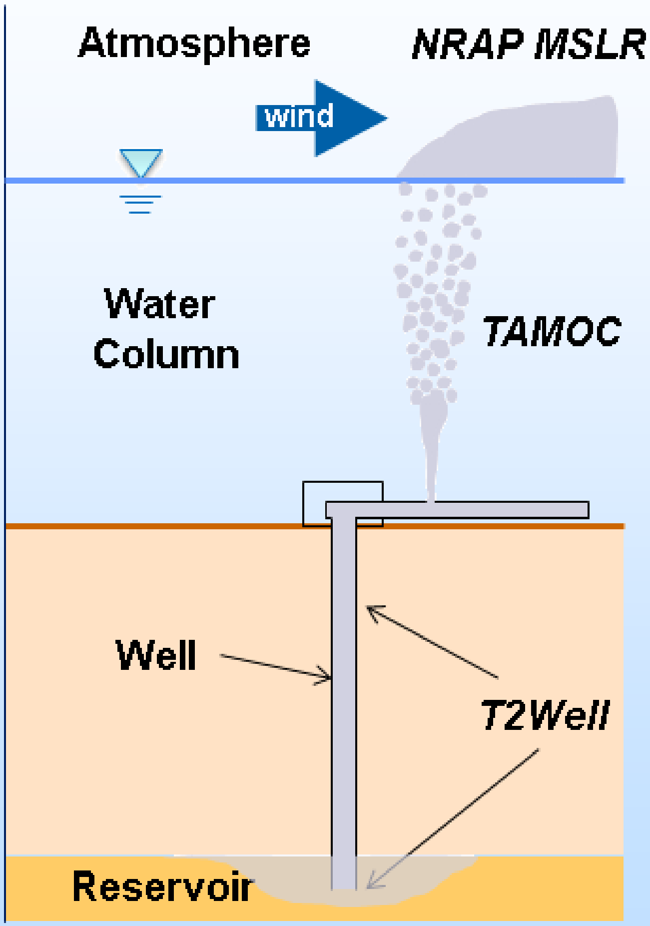
https://onlinelibrary.wiley.com/doi/10.1002/ghg.2082



Accomplishments to Date – Task 2

- FF_3DCameron **seismic depth volume** was interpreted to further extend our understanding of the subsurface of the near offshore **Cameron Parish, LA**.
- Well-log correlation and determination of **gross-sandstone distribution** of lower Miocene in **Corpus Christi Bay and Redfish Bay** and adjacent areas.
- **CO_2 storage capacity** for a portion of the **middle Texas coast** was calculated using the methods of Goodman et al. (2011) as modified by Wallace et al. (2014). The resulting storage capacity totals **38 Gt**.
- Extension of **well correlation** primarily in Texas State waters from the **Corpus Christi Bay** area southward to the **lower Rio Grande** valley area.
- Construction of a **static geologic model** of the TexLa Merge 3D dataset's coverage area began: six stratigraphic zones and the 147 faults.
- **LBNL** requested from BEG the **geological models** for two GoMCarb sites: the **GoM HI-24L** model and the **Offshore Galveston** model.
  - LBNL planned to use a newly developed multi-continua model to deal with natural heterogeneity and its effects on CO_2 migration and trapping.

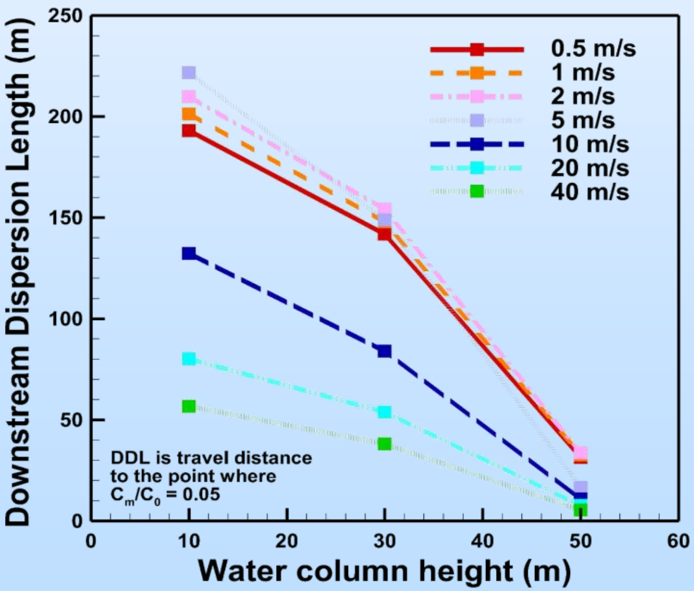
Task 3: Risk Assessment, Simulation & Modeling



(Oldenburg and Pan, 2020)

Oldenberg, LBNL
Modeling of atmospheric dispersion of the CO2 that reaches the sea surface from the hypothetical large-scale blowout.

Applying the NRAP MSLR
(National Risk Assessment Partnership Multi-Source Leakage ROM)



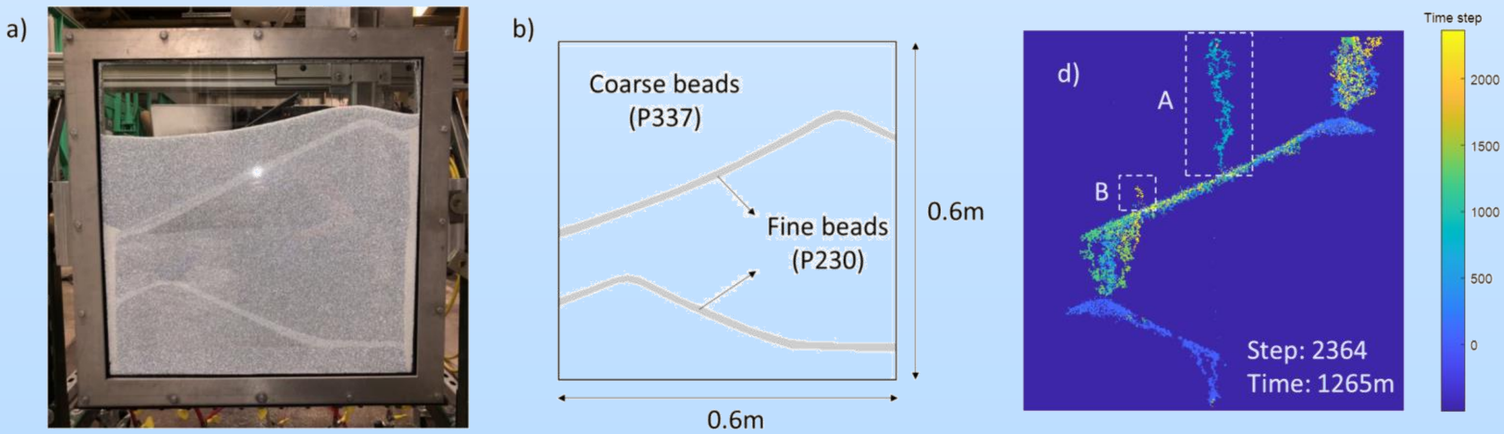
Task 3: Risk Assessment, Simulation & Modeling

Hailun Ni, GCCC Post-doc

Analyzed engineered sand tank bead-pack experimental data with time series clustering and frequency analysis methods in order to characterize how small-scale heterogeneity affects buoyancy-driven CO_2 flow.

Characterizing the Effect of Capillary Heterogeneity on Multiphase Flow Pulsation in an Intermediate-Scale Beadpack Experiment using Time Series Clustering and Frequency Analysis

- Conducted a low-rate gravity-driven drainage experiment in a dm-scale beadpack and simulations to study nonwetting phase flow behavior
- Modified invasion percolation probabilistic simulations can satisfactorily match dynamic 13 experimental fluid flow results



Accomplishments to Date

- BEG **simulated CO_2 injection** into the offshore Galveston Island Miocene age geologic section using numerical software CMG-GEM.
- Presented virtually at GHGT-15 (Oldenburg and Pan, 2021) results of the loosely coupled T2Well and TAMOC **models of wellbore release and the marine system**.
- Analyzed tank-scale bead-pack experimental data with time series clustering and frequency analysis methods in order to characterize how **small-scale heterogeneity affects buoyancy-driven CO_2 flow and resulting saturation**.

Task 4: Monitoring, Verification & Assessment

International Journal of Greenhouse Gas Control 109 (2021) 103388

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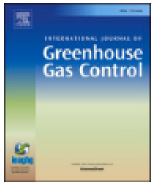
International Journal of Greenhouse Gas Control

journal homepage: www.elsevier.com/locate/ijggc



Efficient marine environmental characterisation to support monitoring of geological CO_2 storage

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ARTICLE INFO

Keywords:
Carbon capture and storage
Marine
Environment
Monitoring
Impact assessment
Baselines
Characterisation
Oceanographic data

ABSTRACT

Carbon capture and storage is key for mitigating greenhouse gas emissions, and offshore geological formations provide vast CO_2 storage potential. Monitoring of sub-seabed CO_2 storage sites requires that anomalies signifying a loss of containment be detected, and if attributed to storage, quantified and their impact assessed. However, monitoring at or above the seabed is only useful if one can reliably differentiate abnormal signals from natural variability. Baseline acquisition is the default option for describing the natural state, however we argue that a comprehensive baseline assessment is likely expensive and time-bound, given the multi-decadal nature of CCS operations and the dynamic heterogeneity of the marine environment. We present an outline of the elements comprising an efficient marine environmental baseline to support offshore monitoring. We demonstrate that many of these elements can be derived from pre-existing and ongoing sources, not necessarily related to CCS project development. We argue that a sufficient baseline can be achieved by identifying key emergent properties of the system rather than assembling an extensive description of the physical, chemical and biological states. Further, that contemporary comparisons between impacted and non-impacted sites are likely to be as valuable as before and after comparisons. However, as these emergent properties may be nuanced between sites and seasons and comparative studies need to be validated by the careful choice of reference site, a site-specific understanding of the scales of heterogeneity will be an invaluable component of a baseline.

Task 4: Monitoring, Verification & Assessment

GERG – Texas A&M University

- Identified some of the most important and characteristic processes that create variability in the GoM; namely, currents, freshwater riverine input, hydrocarbon seeps, hurricanes and major hypoxia.

- Determined geochemical parameters that can most effectively separate the effects of natural variability from those of seepage or leakage.

- CO_2 in the seawater column is mostly controlled by **biologic respiration** and **photosynthesis**. This interplay of processes forms the basis of monitoring approaches that use stoichiometric relationships to determine the origin of CO_2.

- The GERG work was found to be of great interest, and the idea of looking into **how to explain the large natural outliers of data** that were shown could be very useful to understand marine processes and thereby assist in developing approaches for **leak detection**.

Task 4: Monitoring, Verification & Assessment

Accomplishments to Date

Rice University /LBNL MVA team completed final analysis of the **MBARI off-shore fiber/DAS dataset.**

Continued our discussion with GoM off-shore **fiber providers** in an attempt to locate a suitable area for an offshore marine DAS experiment. Unfortunately, much of the fiber is connected to platforms but not to shore locations, complicating experimental logistics.

Task 5: Infrastructure, Operations & Permitting

TRIMERIC

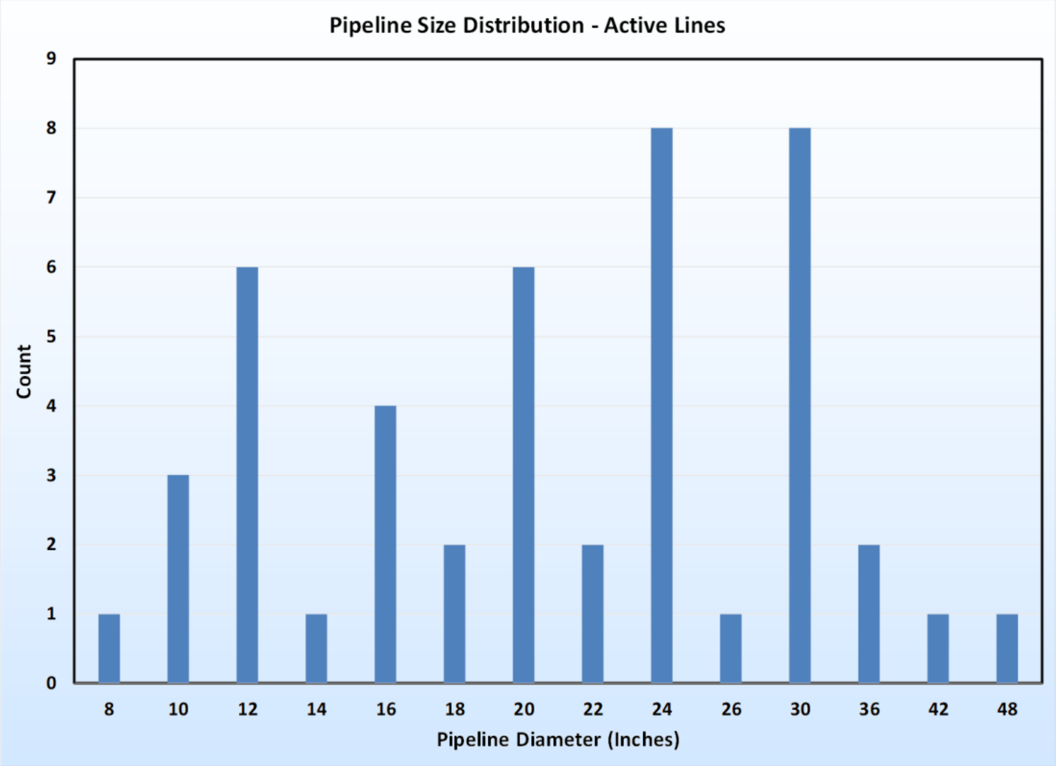
Assessment of existing infrastructure for re-use in CO_2 transport and storage applications

Screening of existing pipelines focused on abandoned lines and had other limiting search criteria.

- Diameter > 8”
- Maximum Operating Pressure > 1000 psig
- Age = No Restriction (Original Screening < 40 years)
- Service Status: Active (Original Screening = Not In Service)
- Pipeline Length: > 2 miles
- Water Depth: No Restriction (Original Screening < 100 feet)

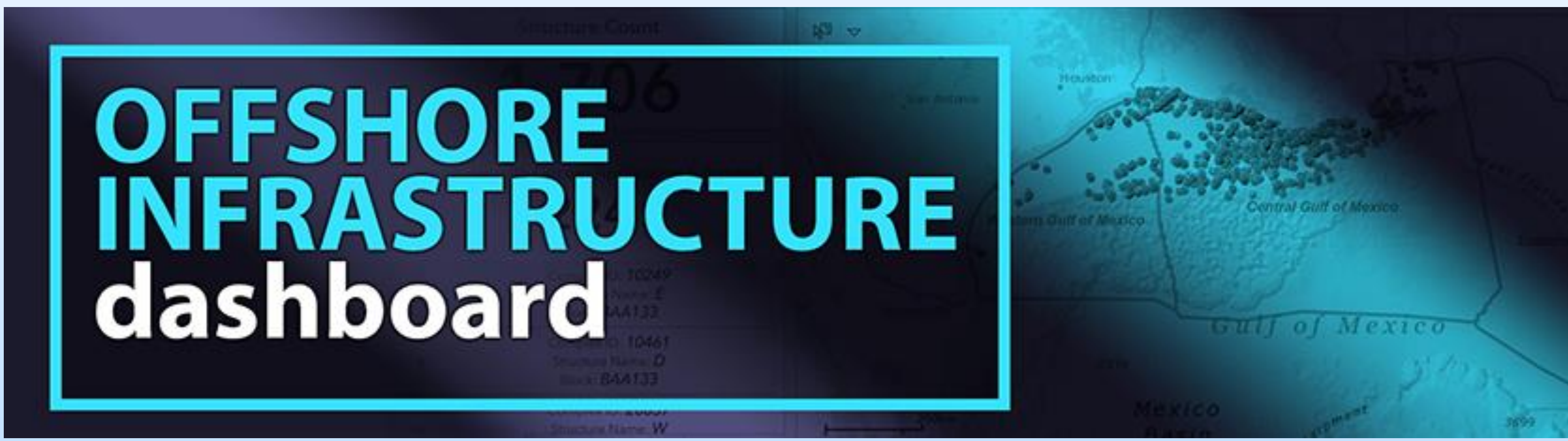
46 key segments from screening

1200 and 1440 psi were most common



Recently identified resource for evaluating infrastructure reuse potential

https://www.bsee.gov/stats-facts/offshore-infrastructure-dashboard



Offshore Lease RFP for Jefferson County

TEXAS GENERAL LAND OFFICE / SCHOOL LAND BOARD

REQUEST FOR PROPOSALS
for
Lease of Permanent School Land Fund Land
for Storage of Carbon Dioxide

REQUEST FOR PROPOSALS NO. 21-SLB-1-ST

Class 926 / Item 25; Class 926 / Item 90; Class 926 / Item 91; Class 925 / Item 15; Class 925 / Item 43; Class 925 / Item 45; Class 925 / Item 46; Class 493 / Item 42

Release Date: April 7, 2021
Deadline for Submission: May 10, 2021 at 2:00 p.m. CDT

Solicitation Point of Contact: Susan Tipton-Hines, CTCM, CTCD
Susan.Tipton-Hines@GLO.Texas.Gov

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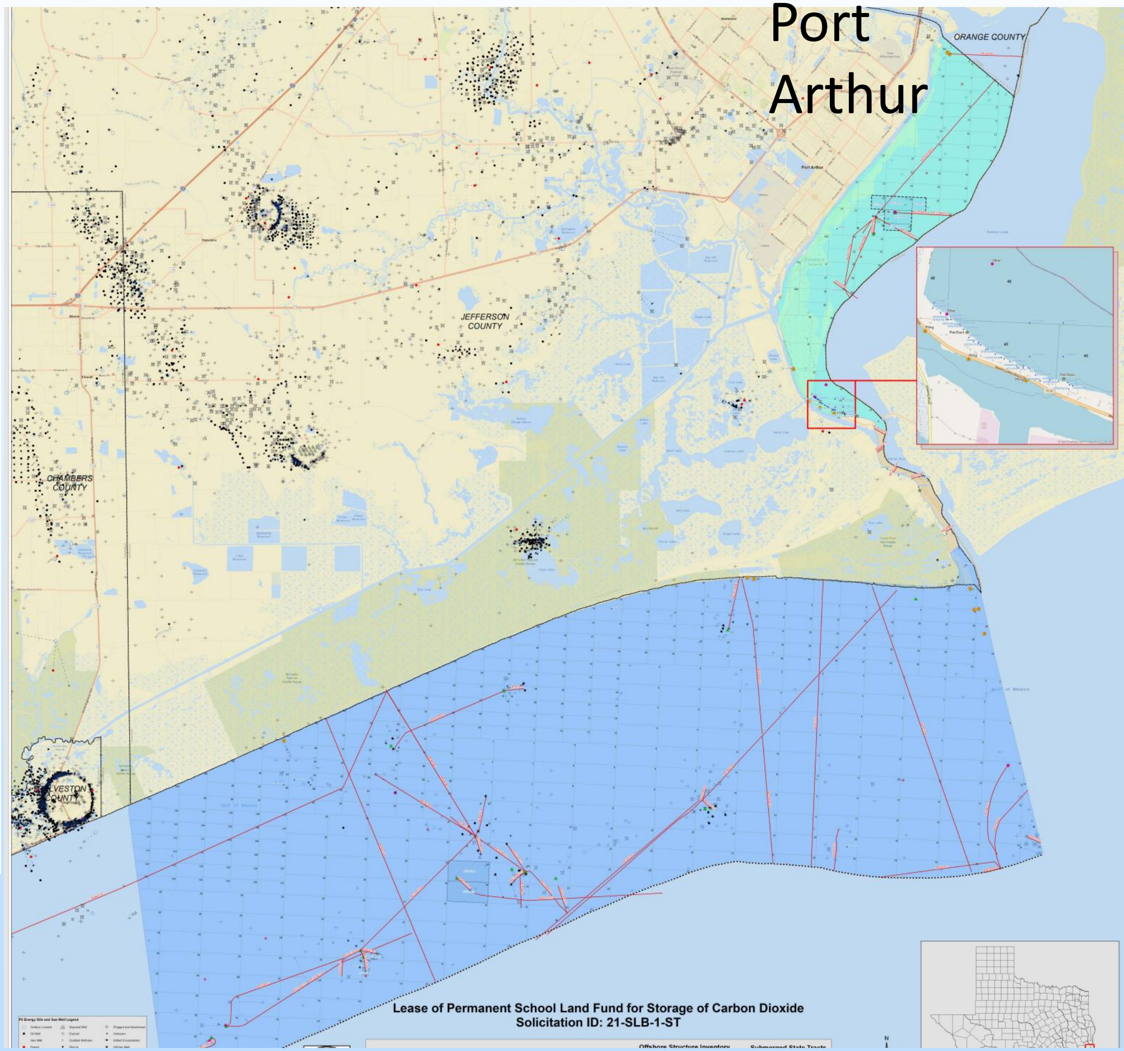

Accomplishments to Date – Task 5

- GCCC support of GLO offshore Leasing development
  - RFP Release, 7 applicants; lease awards pending.
- Trimeric updated and finalized a memorandum for pipeline re-use.
- Cost estimates for a new offshore pipeline were developed.
  - additional impact considered of shore crossing and onshore routing on the overall pipeline costs.

Task 6: Knowledge Dissemination

GCCC (Meckel) met with the **Port of Corpus Christi** and industry and NGO stakeholders to discuss CCS in the region.

Energy Policy 139 (2020) 111312

Contents lists available at ScienceDirect

Energy Policy

journal homepage: http://www.elsevier.com/locate/enpol

Understanding public support for carbon capture and storage policy: The roles of social capital, stakeholder perceptions, and perceived risk/benefit of technology

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ARTICLE INFO

Keywords:
Carbon capture and storage
Energy policy support
Social capital
Environmental risk perception
Risk knowledge
Climate change mitigation technology

ABSTRACT

As climate change mitigation technologies emerge, there is an increased need to understand public support for the technology and the policies that will shape or thwart its evolution. Of particular importance are the communities most directly impacted. The current study focuses on a random sample of 970 adults in eight counties within the oil and gas industry-reliant region of southeast Texas in order to explore support for carbon capture and storage (CCS), which is a climate change mitigation technology that has seen a great deal of investment in that area. Results of ordinary least squares (OLS) regression analysis and general linear modeling (GLM) suggest that policy support –individual support and perceived community support – is dependent on perceived risks and benefits of CCS, community-focused perceptions (including Bourdieu's social capital), and perceptions about stakeholders (trustworthiness and expected role in CCS policy making). One key takeaway is that social capital was both a predictor and moderator in community-level CCS support and helped explain the hidden effects of risk perception of CCS and CCS knowledge on community-level CCS support. Implications for public policy and stakeholder relations are discussed.

Accomplishments to Date – Task 5

- Dr. Meckel and Dr. Hovorka regularly attended State of **Louisiana DNR** (Dept. of Natural Resources) meetings with CCS stakeholders.
- GoMCarb researchers met with **ACTOM** team (ACT on offshore monitoring) to discuss modelling parameters needed for input to GoM models
- Trevino presented an overview talk about the GoMCarb to the **UT Gulf Basin Depositional Synthesis (GBDS)** consortium sponsors' annual meeting.
- David Carr presented "Regional CO_2 Static Capacity Estimate, Offshore Saline Aquifers, Texas State Waters, U.S.A." at the **AAPG CCUS conference.**

Broad Project Lessons Learned

- Our ability to quantify **saturation of CO_2 on structural dip** (fetch areas) remains a major challenge for assessing project areas needed and capacity outside of structural closure.
- Opportunities for **infrastructure reuse**, while realistic, are very site-specific.
- **Environmental and Social Justice** issues related to storage is a rapidly evolving topic of interest.
  - Emissions hubs
  - GLO revenue to Permanent School Fund

Project Summary

- The Gulf of Mexico continues to evolve as an **excellent giga-ton scale CO_2 storage province**.
  - Immense geologic and geophysical database.
    - Early focus on inner shelf.
  - Rapidly growing industry interest in developing State waters in TX & LA.
- Some **infrastructure re-use opportunities** exist, with focus on pipelines initially.
  - Need better estimates of costs for inspection & re-commissioning.
- **Environmental risks** appear to be manageable.
- **Monitoring strategies** are diverse and well suited to CCS.
  - Many lessons learned from international work can be applied in GoM.

Appendix

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

Benefit to the Program

- Identify the program goals being addressed.

- Insert project benefits statement.
  - See Presentation Guidelines for an example.

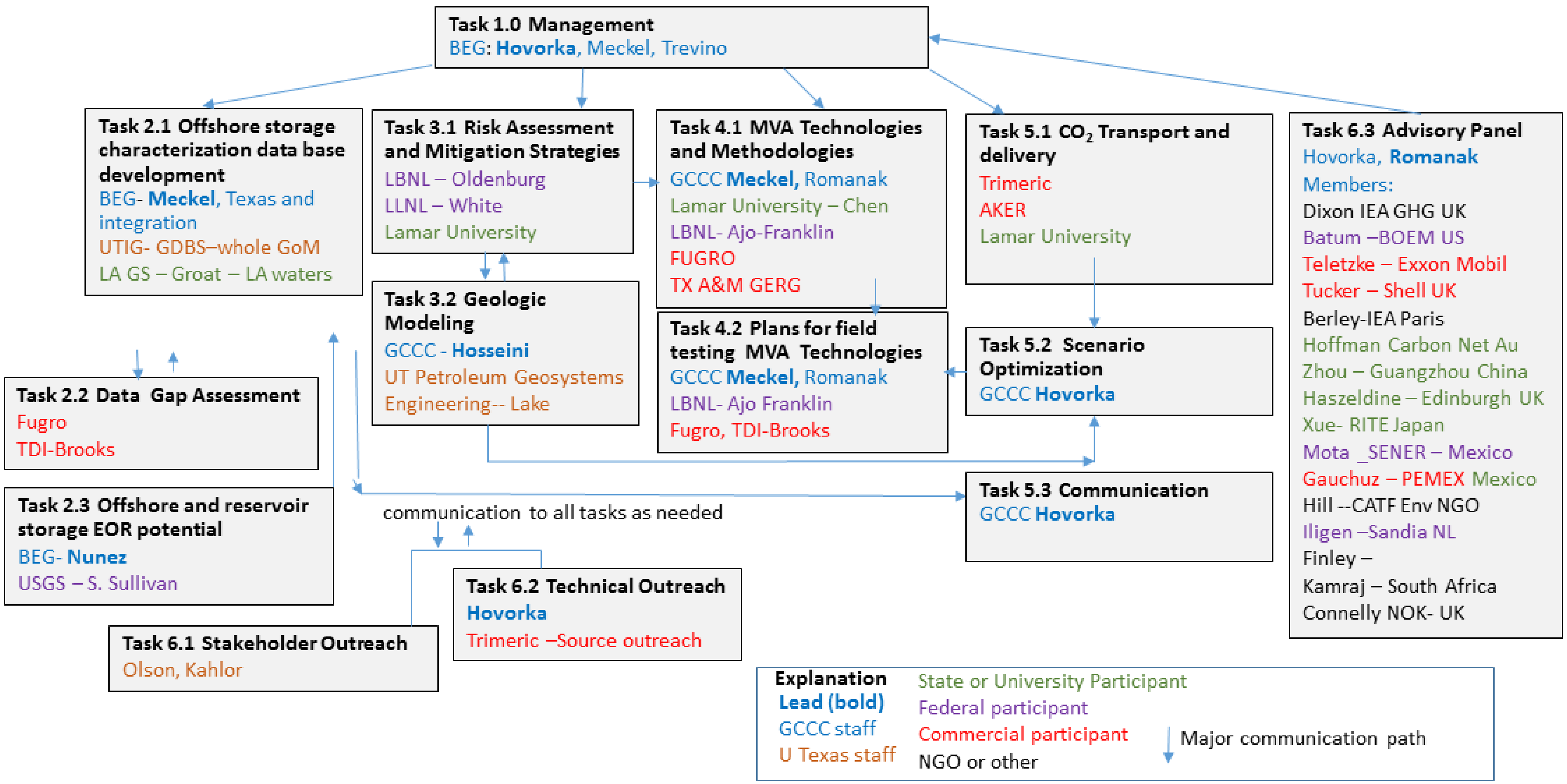
Project Overview

Goals and Objectives

- Describe the project goals and objectives in the Statement of Project Objectives.
  - How the project goals and objectives relate to the program goals and objectives.
  - Identify the success criteria for determining if a goal or objective has been met. These generally are discrete metrics to assess the progress of the project and used as decision points throughout the project.

https://netl.doe.gov/project-information?p=FE0031558

Organization Chart



Gantt Chart

Partnership for Offshore Carbon Storage Resources and Technology Development in the Gulf of Mexico		BUDGET PERIOD 1											BUDGET PERIOD 2								
		2018			2019				2020				2021				2022				2023
Task	Tasks	qtr2	qtr3	qtr4	qtr 1	qtr2	qtr3	qtr4	qtr 1	qtr2	qtr3	qtr4	qtr 1	qtr2	qtr3	qtr4	qtr 1	qtr2	qtr3	qtr4	qtr 1
		A-M-J	J-A-S	O-N-D	J-F-M	A-M-J	J-A-S	O-N-D	J-F-M	A-M-J	J-A-S	O-N-D	J-F-M	A-M-J	J-A-S	O-N-D	J-F-M	A-M-J	J-A-S	O-N-D	J-F-M
1	**Project Management, Planning, and Reporting**	M1		M2																	M11
	Revision and Maintenance of Project Management Plan								G-NG												
	Progress Report	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q
2	**Offshore Storage Resources Characterization**						M4			D2.1a		D2.2a	D2.3a		M8						
2.1	Database Development				M3																
2.2	Data Gap Assessment																				
2.3	Offshore EOR Potential																				
3	**Risk Assessment, Simulation and Modeling**				3.1a				M5		M6				D3.2a						
3.1	Risk Assessment and Mitigation Strategies																				
3.2	Geologic Modeling																				
4	**Monitoring, Verification, Accounting (MVA) and Assessment**					D4.1a							M7				D4.2a				
4.1	MVA Technologies and Methodologies																				
4.2	Plans for Field Testing of MVA Technologies																				
4.3	Testing MVA Technologies																				
5	**Infrastructure, Operations, and Permitting**						D5.1a						D5.2a							D5.3a	
5.1	CO2 Transport and Delivery																				
5.2	Scenario Optimization																				
5.3	Communication																				
6	**Knowledge Dissemination**			6.1a				6.2a			D6.3a					D6.3b	M9		M10		
6.1	Stakeholder Outreach																				
6.2	Technical Outreach																				
6.3	Advisory Panel																				

Q = Quarterly Report; A = Annual Report; M = Milestone; DP = Decision Point; D = Deliverable; G-NG = Go/no-go decision point; FR = Final Report

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  - Meckel, T.A., Bump, A.P., Hovorka, S.D., and Trevino, R.H.., 2021, *Carbon capture, utilization, and storage hub development on the Gulf Coast*. Greenhouse Gases Science and Technology, v. 0:1–14; DOI: 10.1002/ghg.2082.
- Theses:
  - Hull, 2021, *Characterizing Reservoir Quality for Geologic Storage Of CO_2—A Case Study From The Lower Miocene Shore Zone At Matagorda Bay*, Texas, 208 p.
  - Franey, J., 2021, *High Order Stratigraphic Framework of Intra-slope Growth Faulted Subbasins Near Offshore Matagorda Bay, TX*, 186 p.
  - Ramirez, O., 2019, *Geologic Characterization and Modeling for Quantifying CO2 Storage Capacity of the High Island 10-L Field in Texas State Waters, Offshore Gulf of Mexico*, 144 p.
  - Ruiz, I., 2019, *Characterization of the Gigh Island 24L Field for Modeling and Estimating CO2 Storage Capcity in the Offshore Texas State Waters. Gulf of Mexico*, 134 p.