SECARB Offshore Gulf of Mexico Project Status Highlights – August 2020



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# SECARB Offshore Project Objectives

- <u>Objective 1</u>: Combine the capabilities and experience of industry, academia, and government to develop and validate key technologies and best practices to ensure safe, long-term, economically-viable CO<sub>2</sub> storage in offshore environments, which includes collaborating and coordinating with international organizations.
- <u>Objective 2</u>: Facilitate the subsequent development of technologyfocused permitting processes needed by industry and regulators (i.e., Department of Interior and BOEM).
- <u>Objective 3</u>: Collaborate with Federal and State agency programs to improve the confidence in containment of CO<sub>2</sub> in the subsea offshore environment in storage reservoirs over both short and long timeframes.
- <u>**Objective 4**</u>: Provide a comprehensive assessment of the potential to implement offshore CO<sub>2</sub> storage in the defined GOM Study Area.



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## SECARB Offshore Study Area & Project Boundaries

	FEDERAL WATERS								
	Depleted Oil & Gas Fields, and Potentially Associated CO <sub>2</sub> -EOR	Deep Saline							
Western Planning Area	No	No							
Central Planning Area	Study Area is East of Houma District's Western Boundary (includes Houma District)	Study Area is East of New Orleans District's Western Boundary (excludes Houma District)							
Eastern Planning Area	All	All							
	STATE WATERS								
	Depleted Oil & Gas Fields, and Potentially Associated CO <sub>2</sub> -EOR	Deep Saline							
Texas	No	No							
Louisiana	Partial, Includes State Waters East of Houma District Boundary Extension	Partial, Excludes Chandeleur Sound/Islands							
Mississippi	Yes	Yes							
Alabama	Yes	Yes							
Florida		N/							



Study Area | Saline Aquifers



# **Primary Tasks**

- T1: Project Management & Planning (standard for all contracts – not discussed here)
- T2: Knowledge Dissemination (not discussed)
- T3: Offshore Storage Resource Characterization
- T4: Risk Assessment, Simulation, and Modeling
- T5: Monitoring, Verification, and Accounting
- T6: Infrastructure, Operations, and Permitting



# Task 3: Offshore Storage Resource Characterization

Objective: Assemble, review, analyze, integrate, assess existing available information on storage resource potential in the GOM.

- Task 3.1: Assemble Data and Review Existing Information
  - Saline storage prospects, depleted oil and gas fields, including that associated with CO<sub>2</sub>-EOR – in Federal and State waters.
- Task 3.2: Integrate and Assess Available Information
- Task 3.3: Screen for "Representative" Storage Opportunities
  - For variety of geologic and operational settings, including stacked storage and CO<sub>2</sub>-EOR.
- Task 3.4: Identify and Address Risks and Data Gaps
  - By identifying and partnering with private companies or organizations to obtain real-world data.



## Salt Structures, Shelf, Deep-Water Reservoirs, Central GOM (OSU)





- Geological characterization (Stratigraphy, sedimentation, structure, hydrodynamic analysis).
- Analyze reservoir properties, storage volumetrics, potential storage mechanisms, migration pathways, and reservoir integrity.
- Understand pressure regime and implications for geologic CO<sub>2</sub> storage and enhanced recovery.
- Design heuristic decision support system using SAS Viya software.

# Heuristic Decision Support System Design (OSU, SAS)

### Geologic Information

- Reservoir location, dimensions
- Rock type
- Depth
- Reservoir thickness
- Structural and depositional geometry
- Trap type

#### Reservoir properties

- Porosity
- Permeability
- Fluid composition and properties
- Pressure
- Storage resource

### EOR/EGR information

- API gravity
- Gas-oil ratio
- Resource/reserve volumes
- Production volumes
- Production history
- Drive type
- Production systems

### Considerations

- Quantified factors
- Ranked factors
- Infrastructure
- Fluid transport options

### • What are your objectives?

- Saline formation storage
- Depleted reservoir storage
- Enhanced oil recovery
- Pressure maintenance

## DSCB Estimated CO<sub>2</sub> Storage Resource – Cretaceous Only (P50) (GSA)



### **Potential CCUS Resource**

- Large portfolio of potential sinks and seals in eastern GOM
- Main storage prospects in Cretaceous-Miocene section.
- Porosity of sandstone in DeSoto Canyon Salt Basin commonly > 20%;
- West Florida Shelf contains dolomite with porosity > 15% and anhydrite seals on Sarasota Arch.
- **TOTAL** P<sub>50</sub> storage resource of 1,027 Gt (148 Gt in DeSoto Canyon Salt basin, 879 Gt in West Florida Shelf)

## Central Planning Area CO<sub>2</sub> EOR Resource Characterization (ARI)

#### **Shallow Water Resources**

			Resources (Millio	on Barrels)	
Area	OOIP	Original	Cumulative	Remaining	Remaining
		Reserves	Production	Reserves	OIP
South Pass	1,902	702	699	4	1,200
West Delta	1,790	859	859	4	926
South Timbalier	1,975	998	910	6	1,059
South Marsh	1,160	435	426	9	725
Main Pass	2,270	817	807	10	1,453
Ship Shoal	1,272	597	586	12	674
Grand Isle	1,573	645	631	14	928
Eugene Island	1,769	774	754	20	994
Other*	999	320	296	24	679
Total	14,709	6,147	5,968	102	8,639

\*Ewing Bank, Vermillion, East Cameron

#### **Deep Water Resources**

		Resources (Million Barrels)										
	Original OIP	Original Reserves	Cumulative Production	Remaining Reserves	Remaining OIP							
Viosca Knoll	1,193	461	441	20	732							
Garden Banks	1,729	662	604	58	1,067							
Walker Ridge	4,837	591	117	473	4,246							
Mississippi Canyon	12,549	4,002	2,859	1,143	8,547							
Green Canyon	14,280	3,393	2,168	1,224	10,887							
Other*	384	154	68	86	231							
Total	34,972	9,262	6,258	3,004	25,709							

### Central Planning Area CO<sub>2</sub> EOR Oil Resources



Source: Modified from BOEM 2017-082, OCS Report.

\*Keathley Canyon, Atwater Valley, De Soto Canyon

### Prospective Oil and Gas Fields in LA State Waters Relative to Large Nearby CO<sub>2</sub> Sources (LSU)



# Task 4: Risk Assessment, Simulation, Modeling

Objective: Refine/adapt existing tools, geologic models, and risk assessment/mitigation strategies for site-specific assessments.

- Task 4.1: Evaluate and Adapt Onshore Simulation, Modeling, and Risk Assessment Tools for Offshore Settings
  - Including National Risk Assessment Partnership (NRAP) tools.
- Task 4.2: Adapt Models for Offshore Storage Opportunities
  - Geologic/dynamic flow models of CO<sub>2</sub> movement.
  - For "representative" opportunities for CO<sub>2</sub>-EOR/storage, depleted oil and/or gas field storage, and deep saline aquifer storage, in shallow and deep water.
- Task 4.3: Risk Assessment and Mitigation Planning and Strategies for the Different Scenarios



# Offshore Well Integrity Analyses (Battelle, ARI)

- Initial focus is on Mobile and Viosca Knoll to develop a initial methodology for collecting and analyzing data required for well integrity analyses.
  - Includes 7,575 files for Mobile and 23,443 files for Viosca Knoll
- Objective -- develop an assessment method that considers the types of existing well data available and adapt it to a risk model
- Data requirements for a well integrity analysis were established.

API	Spud Date	BH Total MD	TVD	TD Date	Status Date	Surface Lat.	Surface Long.	Bottom Long.	Bottom Lat.
608164005400	1978/10/20	5260	4524	1978/11/08	1978/11/14	-88.429876	29.227589	-88.42548	29.223335
608164005500	0000/00/00			0000/00/00	0000/00/00	-88.437277 29.271234			
608164005600	0000/00/00			0000/00/00	0000/00/00	-88.424134	29.27051		
608164005700	1978/12/01	10842	7461	1979/01/03	1979/01/12	-88.74278	29.062708	-88.734923	29.043967
608164005701	1979/03/03	10700	7439	1979/04/02	1979/04/02	-88.74278	29.062708	-88.724942	29.056218
608164005800	0000/00/00			0000/00/00	0000/00/00	-88.373232	29.064922		
608164005900	1979/04/03	7057	6843	1979/04/21	1989/03/23	-88.742775	29.062763	-88.739129	29.062641



# Customized Black Oil Modeling (Virginia Tech)

- CO<sub>2</sub> can be potentially trapped in the nanopores of tight rocks and shale, and shale nanopores may also host water and hydrocarbon mixtures.
- VaTech team applying molecular dynamics to better understand the transport of multicomponent mixtures, e.g. ethane and heptane, in kerogen nanopores, observe density variation over pore radius, and adsorption preferences of the kerogen.
- Molecular dynamics simulation used to model three connected nanopores of shale.
  - Few previous studies implemented pores with irregular cross sections (non-circular and not a slit-pore).
  - When they did, the pore walls connections at the vertices can be considered unnatural since the force field they used did not account for these bonds on its parametrization.



Simulation setup for three connected pores containing methane and ethane

## Risk Assessment -- Gas Hydrates (OSU)

- The hydrate stability field is highly fluctuating through time and space at Woolsey Mound.
- 4-D seismic anomalies are spatially associated with faults and may represent changes in the subsurface pore-fluid content.
- AVO analysis proves to be a reliable tool to identify hydrates in the absence of clearly defined BSRs.
- Results will provide fundamental numerical parameters of the development and evolution of a gas hydrate-bearing system and its response to natural perturbations over a time window comparable to human scale processes (14 years).



Source: Macelloni et al., 2012

## Initial Risk Registry (ARI, CrescentRI)

- In this effort, we build on two previous risk assessment approaches.
  - The CarbonSAFE ECO2S Project Risk Assessment
  - The Shell Goldeneye "Bow-Tie" Risk Assessment
- From these, a proposed combination process was developed, to document all potential risks that members of the team identify as initial risks that should be investigated.
- Plan was to conduct a risk characterization workshop to ensure initial data acquisition and analysis activities are conducted to ensure the best possible characterization – postponed due to Covid-19.

Potential Risks	Severity of Risk	Likelihood of Risk	Data to Characterize Risk	Possible Monitoring Methods	Possible Mitigation Approaches	Links to Sources

## Task 5: Monitoring, Verification, Accounting

Objective: Identify/evaluate MVA technologies/ methodologies for  $CO_2$  storage projects designed for prospective storage opportunities.

- Task 5.1: Assemble and Review Available Information on MVA Methods That May Be Employed in Offshore Environments
  - Representative opportunities for shallow and deep water CO<sub>2</sub>-EOR/storage, depleted fields, and deep saline aquifers.
  - For storage in existing fields, the integrity of legacy wells will be assessed.
- Task 5.2: MVA Lessons Learned for Offshore Environments
  - Specify suite of MVA technologies and methodologies, based on lessons learned, including from international collaborations.



# Task 6: Infrastructure, Operations, and Permitting

Objective: Address infrastructure, operations, permitting topics for offshore  $CO_2$  transport, delivery, storage.

- Task 6.1: Offshore CO<sub>2</sub> Transport/Delivery Options
  - Assess feasible CO<sub>2</sub> options: existing infrastructure and potential accessibility; logistical/regulatory obstacles; and requirements of decommissioning.
- Task 6.2: Legal and Regulatory Frameworks
  - Communicate with BOEM, other agencies.
  - Updated assessment of legal and regulatory frameworks applicable to U.S. offshore storage.

## Emerging Deep-Water CO<sub>2</sub> EOR Technology (Aker Solutions)



- Performed activities:
  - Defined case to use as basis for sizing
  - Agreed on base case system
  - Process simulations conducted
- Ongoing activities:
  - Sizing of main equipment
- Upcoming activities:
  - Layout of subsea system
  - Cost estimate
  - Initial Report

# Review of Legal and Regulatory Frameworks (ARI, IOMLaw)

- Work has begun to understand the potential applicability of the Section IRS 45Q tax incentives to offshore
- Attempt to understand possible changes that may be necessary to the to better facilitate offshore storage.
- In 2010, Presidential Interagency Task Force on CCS examined the existing U.S. regulatory framework and recommended the development of a comprehensive U.S. framework for leasing and regulating sub-seabed CO<sub>2</sub> storage operations on the OCS
  - However, this comprehensive framework has yet to be established; therefore, the existing regulatory framework is shared across multiple Federal agencies, and there are several gaps.
  - We are reviewing literature/official documents on status, previous studies, recommendations, frameworks for offshore CO<sub>2</sub> storage in the U.S. and Europe, particularly Norway



## Summary -- Anticipated Project Outcomes

- Integrate data to characterize offshore CO<sub>2</sub> storage resources, to identify and high-quality "prospects" for offshore CO<sub>2</sub> storage.
- Develop concepts for commercial CO<sub>2</sub>-EOR and saline storage prospects
- Refine/adapt simulation tools, geologic models, risk assessment/mitigation strategies for site-specific assessments of prospects in the GOM.
- Develop "best practices" based on understanding of the offshore storage prospect(s), uncertainties, performance of site characterization, MVA and other technologies, and understanding of risks.
- Reduce uncertainties/risks, better understand/validate technology performance, and assist regulators to better understand risks and appropriate MVA approaches
- Address regulatory gaps in the oversight and regulation of  $CO_2$  storage activities (with and without EOR) in the offshore GOM.

### **THANK YOU!**



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# Appendix

### Partners & Contractual Organizational Chart

### SECARB Offshore Gulf of Mexico Contractual Organizational Chart



## **Project Gantt Chart**

SECAPB Offebore Gulf of Movice	> 🔶 Mi	Milestone Phase I - Budget Period						1	1 Phase II - Budget Period 2										
SECARD ONSHOLE GUILOT MEXICO	🗄 🛑 De	cision Pt	3/1/18-2/28/20						3/1/20-2/28/22										
Task Description	Start	End	01	02	03	04	01	02	03	04	01	02	03	04	01	02	03	04	
Task 1.0: Project Management and Planning	3/1/18	2/28/22	<u> </u>	Q.L		G. T		Q.L.	QUU				G.U			Q.L	QU	-	
Subtask 1 1: Overall Proj. Mamt. Planning. Communication	3/1/18	2/28/22						1.000											
Subtask 1.2: Project Management Plan	3/1/18	2/28/22	-																
Milestone: Implement Project Management Plan		3/31/18	۵																
Subtask 1.3: Government-Industry Partnership	3/1/18	2/28/22											-		-				
Subtask 1.4: Data Management Plan	3/1/18	2/28/22																	
Task 2.0: Knowledge Dissemination	3/1/18	2/28/22																	
Subtask 2.1: Outreach, Education, and Knowledge Sharing	3/1/18	2/28/22																	
Milestone: Participate in Kickoff Meeting		5/31/18																	
Milestone: Host Offshore CO2 Storage Workshop		12/31/19		Ť						۵					1				
Milestone: Brief State Officials on Potential for Offshore CO2		120110														1			
Subsea Storage in GOM		12/31/21																٠	
Subtask 2.2: Capacity Building	3/1/18	2/28/22	-																
Task 3.0: Offshore Storage Resources Characterization	3/1/18	2/29/20																	
Subtask 3.1: Assemble Data and Review Existing																			
Information	3/1/18	11/31/18																	
Milestone: Complete Review of Existing Characterization	011110	Thomas	-												-				
Data		2/28/10																1	
Subtask 3.2: Integrate and Assess Available Information	3/1/18	8/31/21		-														$\vdash$	
Milestone: Complete Report on Characterization of Offshore	or in to	OFO ITE I									-								
Storage Resource Potential in the Study Area		2/28/20																	
Subtask 3.3: Identify and Address Bisks and Data Gans in		DLULU		-											⊢	$\vdash$		$\vdash$	
Characterization for Offshore Site(s)	3/1/18	5/31/19																1	
Task 4 0: Risk Assessment Simulation and Modeling	3/1/18	2/28/22																	
Subtask 4.1: Evaluate and Adant Onshore Simulation	0/1/10	LILUILL									1000								
Modeling and Risk Assessment Tools for Offshore CO2																		1	
Storage Projects	3/1/19	8/31/20																	
Subtask 4.2: Adapt Models for Offshore CO2 Storage	0/1/10	010 1120		-	-	-									-				
Projecte	12/1/19	2/28/21																1	
Subtack 4 3: Risk Assessment and Mitigation Planning and	12/1/10	LILOILI	_								-	-				_	-		
Stratenies	3/1/18	2/28/22																	
Milestone: Complete First Risk Registry Undate	0/1/10	12/31/20						-			-								
Task 5.0: Monitoring Verification and Accounting	1000	1201120													11				
Assessment	6/1/19	2128122																	
Subask 5 1: Assemble and Review Available Information on	0/ 1/ 10	LILOILL	⊢	⊢		-													
MVA Methods that May be Deployed in Offshore																		1	
Environmente	6/1/19	2/28/21																1	
Milestone: Complete Design Plan for MVA Field Testing		2/28/21	-	-	-	+						-		-	-				
Subtack 5.2: MVA Best Practices for Offshore Environments	9/1/20	2/28/22	-	⊢	-	-									1				
Task 6 0: Infrastructure Operations and Permitting	6/1/18	2/28/22		1					- 50										
Subtask 6 1: Offshore CO2 Transport and Delivery Options	6/1/18	2/28/22																	
Subtask 6.2: Prospect-Specific Feasibility Assessment	6/1/18	2/28/22																	
Milestone: Complete Prospect-Specific Feasibility	0/1/10	LILOILL																	
Assessment		2/28/22																	
Subtask 6.3: Assessment of Legal and Regulatory		L'LULL		1	$\vdash$	-	-								-			F	
Frameworks	9/1/10	2/28/22																	
Milestone: Complete Legal/Regulatory Assessment		2/28/22	-	-	$\vdash$	+										-			
milestone. Complete Legal Negulatory Assessment		LIZOLL					1								1	1			