



# Diamond Vault Carbon Capture FEED Study DE-FE0032165

**Mark Bordelon**  
**Cleco Power**

2024 Carbon Management Research Project Review Meeting  
August 5 – 9, 2024



# Disclaimer

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

# Project Overview

**Total Funding: \$11,314,994**

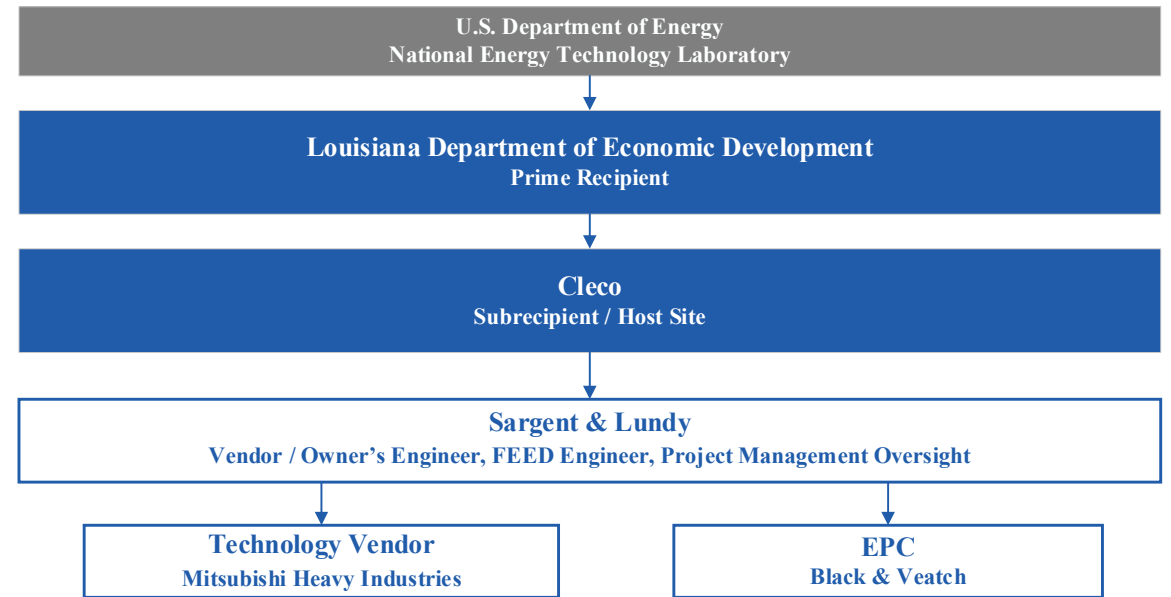
- DOE: \$9,029,540
- Cost Share: \$2,285,454 (20%)

**Work Period: April 1, 2023 –  
September 30, 2024**

*An extension has been requested to Q2 2025.*

## Project Objectives:

- The overall objective of this project is to perform a front-end engineering and design (FEED) study for the installation of a carbon dioxide (CO<sub>2</sub>) capture system at a power plant in Louisiana.
- Diamond Vault is anticipated to reduce Madison Unit 3's CO<sub>2</sub> emissions by 95% by storing the CO<sub>2</sub> in geological features.
- The future implementation and operation of this project would be a first-of-a-kind (FOAK) installation and would serve as an example for other coal facilities considering the adoption of carbon capture technology.



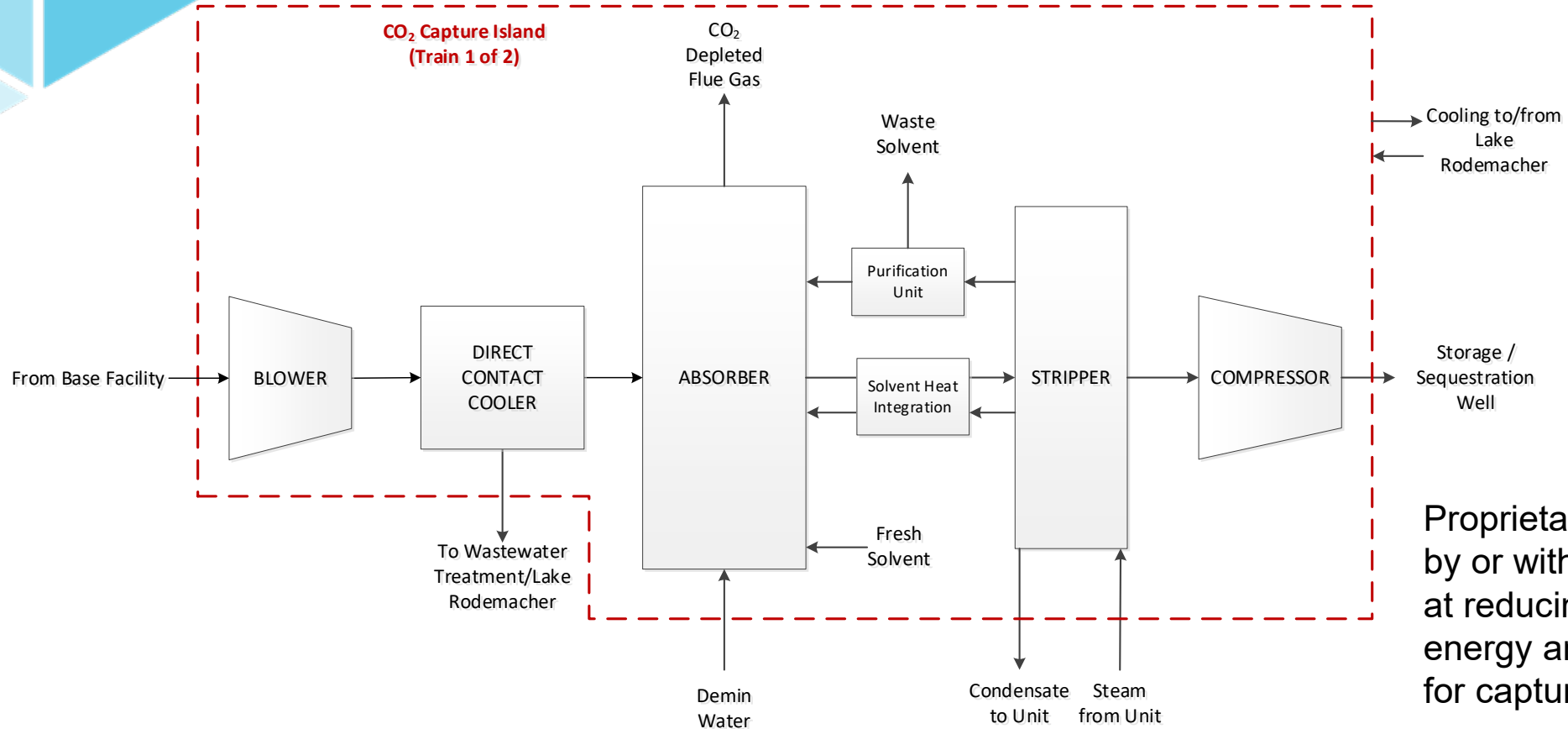
# Brame Energy Center

## Madison Unit 3

- Boiler: 600 MW, Circulating Fluidized Bed (CFB)
- Fuel: 70% petroleum coke (a waste product of oil refining) and 30% Illinois Basin coal
- Existing AQCS Controls: Circulating Dry Scrubber (CDS), Selective Non-Catalytic Reduction (SNCR), and fabric filter for SO<sub>2</sub>, NO<sub>x</sub>, and PM.
- Commercial Operation: 2010



# Technology Overview and Plant Integration



CO<sub>2</sub> rich solvent sent to regenerator where CO<sub>2</sub> is steam-stripped from the solvent.

Low pressure steam required to regenerate solvent and strip CO<sub>2</sub> out.

Proprietary amine blends developed by or with technology providers aim at reducing thermal regeneration energy and improve overall kinetics for capture.

Direct Contact Cooler (DCC) cools and pre-treats incoming gas.

CO<sub>2</sub> absorbed by reaction with amine-based solvent in the absorber.

CO<sub>2</sub> depleted flue gas exits through absorber stack.

# Technical Approach / Project Scope



The FEED Study will be performed in three separate phases:

- (i) an initial feasibility phase that defines the project and establishes preliminary costs;
- (ii) a pre-FEED phase based on the feasibility phase results to further refine the project and preliminary costs; and
- (iii) a final-FEED phase which will be a continuation of the pre-FEED phase with a construction contractor to develop a final cost estimate for the project and make the project execution ready.

Task	Description	Target/Actual Start Date	Target/Actual Completion Date
1.0	Project Management and Planning	July 25, 2022	February 28, 2025
2.0	Phase 1: Feasibility Study	July 25, 2022	February 27, 2023
3.0	Phase 2: Pre-FEED Study	February 28, 2023	January 25, 2024
4.0	Phase 3: FEED Study	April 11, 2024	February 28, 2025
5.0	Phase 3: DOE Reporting and Required Project Deliverables	October 31, 2024	February 28, 2025



# Project Success Criteria



Goal/Objective	Date	Success Criteria
Competitively Evaluate Technology Options to Select Preferred Technology	February 27, 2023	Two Vendor Feasibility Studies Complete and Vendor Selection Memo Complete
Process Design for Technology Finalized	December 4, 2023	Process Design Package Complete and Reviewed
Select Preferred EPC Contractor	January 8, 2024	Preliminary Project Execution Plan Complete and DOE Review Meeting
Provide Cleco with information to evaluate whether to pursue CC at Madison Unit 3 as part of their overall GHG reduction approach.	December 25, 2023 March 7, 2025	Initial: Pre-FEED Summary Report Complete Final: FEED Summary Report and Business Case Analysis Complete
Provide proof of concept that an amine-based CO <sub>2</sub> capture process can be economically applied on a large-scale coal/petcoke electric generating unit.	May 30, 2025	DOE Topical Report Submitted
Accelerate Project Development of Diamond Vault	Future	The project will be ready to move into execution at the conclusion of the FEED study having selected a technology vendor and EPC to support the FEED study and develop the documents needed to obtain permits and approvals as well as funding to move into project execution.

# Risk & Mitigation Strategy



Perceived Risk	Risk Rating			Mitigation/Response Strategy
	Probability	Impact	Overall	
<b>Financial Risks:</b>				
Availability of Cost Share	Low	Medium	Low	An estimated spend plan has been developed based on the proposed schedule and firm price proposals, allowing Cleco, the primary source of cost share, to plan for the expected spend.
Budget Overruns	Low	Medium	Low	Firm priced proposals have been received from all participants based on the SOPO. Additional costs, if encountered, will be covered by Cleco.
<b>Cost/Schedule Risks:</b>				
Schedule Delays	Low	High	Medium	A Level 1 schedule has been developed for the proposed project. Pre-award authorization we received on July 26, 2022 to allow the project schedule to be maintained during negotiation. The schedule will continue to be tracked to ensure any adjustments to the schedule are identified early.
Resource Availability	Low	Medium	Low	Core project team members have been designated for each organization that will be assigned to support the project through its duration.
<b>Technical/Scope Risks:</b>				
Feasibility of Applying CC Technology to this Application	Low	High	Low	A preliminary TEA was completed prior to award. In addition, a feasibility phase is included to evaluate multiple technology vendors and select a technology vendor.
Unidentified Trace Constituents in the Flue Gas Adversely Impact CC Performance/Costs	Low	Medium	Low	As part of the project, trace constituents will be identified in the design criteria from fuel sources and data from similar applications and flue gas testing will be performed. Constituents of major concern will be highlighted by the technology suppliers.
<b>Management, Planning, and Oversight Risks:</b>				
Lack of Coordination Between Participants	Low	Medium	Low	All organizations have a historical working relationship, and recurring status updates are planned.





# Progress and Current Status

# Project At-a-Glance

## Phase 1: Feasibility (complete)

### Phase Outcome: AACE Class 4 Estimate

#### Deliverables:

- Flue Gas Design Basis
- Process Flow Diagrams
- Heat & Material Balances
- Utility and Chemical Consumption List
- Equipment List (preliminary)
- Electrical Load List (preliminary)
- Emissions and Effluent List (preliminary)
- Site Plan / Site Layout (preliminary)
- General Arrangement Drawing (preliminary)
- Engineering Studies (preliminary)
- Capex and Opex Estimates

## Phase 2: Pre-FEED (complete)

### Phase Outcome: AACE Class 3 Estimate

#### Deliverables:

- Project Design Criteria
- Updated Phase 1 Deliverables
- Tie-In List
- Piping & Instrumentation Drawings
- Control Description & Operating Philosophy
- Equipment Layout Drawings
- Structural Load List (preliminary)
- Terminal Point List
- BOP Mechanical System Design
- Foundation List
- Ductwork Sketches
- Geotechnical Investigation / Civil Design
- Engineering Studies
- HAZOP
- Constructability Review
- Major Equipment Vendor Quotes
- Capex and Opex Estimates

## Phase 3: FEED (in progress)

### Phase Outcome: AACE Class 2 Estimate

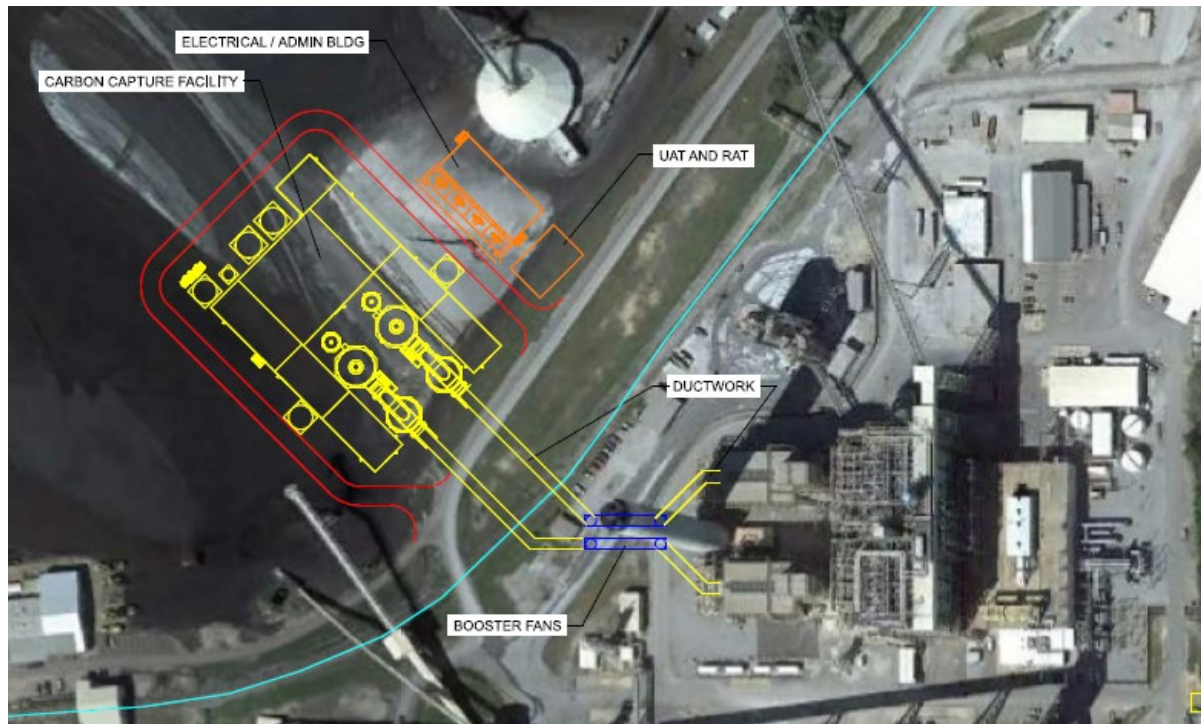
#### Deliverables:

- Updated / Final Phase 2 Deliverables
- Structural Design Package
- Mechanical Design Package
- Electrical Design Package
- Equipment Vendor Quotes
- Commodity Estimates
- Capex and Opex Estimates
- Execution Schedule
- Execution Plan

# Phase 1: Feasibility Results

Completed in February 2023

Total Cost of Capture:  
\$50 - \$55 per tonne  
(12 Year Evaluation Period)



## Preliminary Utility Sourcing

- Steam and Electric Supply:
  - Steam Extraction from Host Unit
  - Switchyard Expansion and Direct Sourcing
- Cooling Water Supply:
  - Once-Through Cooling System (mirroring existing facility)

CCS Island located adjacent to stack to minimize ductwork and utility routing.

MHI was selected as technology vendor for future phases.

# Phase 2: Pre-FEED Results

Completed in January 2024

Total Cost of Capture: \$66 per tonne (12 Year Evaluation Period)

## Engineering Studies

- Utility Sourcing decisions made in Phase 1 were finalized
- Water & Wastewater Treatment and Train Configuration Studies were completed

## General Arrangement

- The CO<sub>2</sub> capture system location was moved to the area north of the boilers

## BOP Engineering & Design

- A “What-If” PHA was conducted between Cleco, S&L, and MHIA
- A Constructability Review was performed, resulting in FEED follow-up actions



# Phase 3: FEED Progress



- The FEED phase was initiated at the end of April 2024.
- Major tasks completed as of July 2024:
  - Reviewed open items from Pre-FEED to be addressed and completed in FEED with Cleco, S&L, and MHIA
  - Prepared detailed DOR for FEED phase
  - Decided on basis for receiving heavy haul modules
- Tasks in Progress:
  - Modification of Plot Plan to shorten duct and steam piping lengths and associated flue gas blower requirements
  - Steam extraction & condensate return design
  - MHIA document reviews & updates to S&L deliverables



# Phase 3: FEED Progress



## Changes from Pre-FEED Phase:

1. Location of the CCS Island has moved to relocate carbon capture island adjacent to Madison 3 and shorten duct and steam pipe lengths
2. Additional redundancy added within ISBL design to address site-specific flue gas constituents
3. Optimized equipment configurations and design conditions

# Next Steps

- FEED Phase to be complete in Q1 2025.
  - AACE Class 2 Cost Estimate at end of FEED
- Develop LCA, BCA, EH&S, EJ, and Economic Revitalization and Job Creation Questionnaire based on the results of the FEED