Energy & Environmental Research Center (EERC)

INITIAL ENGINEERING AND DESIGN FOR CO_2 CAPTURE FROM ETHANOL FACILITIES

Project Number: DE-FE0031938

U.S. Department of Energy National Energy Technology Laboratory

Carbon Management and Natural Gas & Oil Research Project Virtual Review Meetings, August 2–31, 2021

Jason Laumb

Director of Advanced Energy Systems Initiatives

AGENDA

- Project Overview
- Red Trail Energy, LLC (RTE) CCS
- Technology and Scope
- Project Status
- Summary and Questions

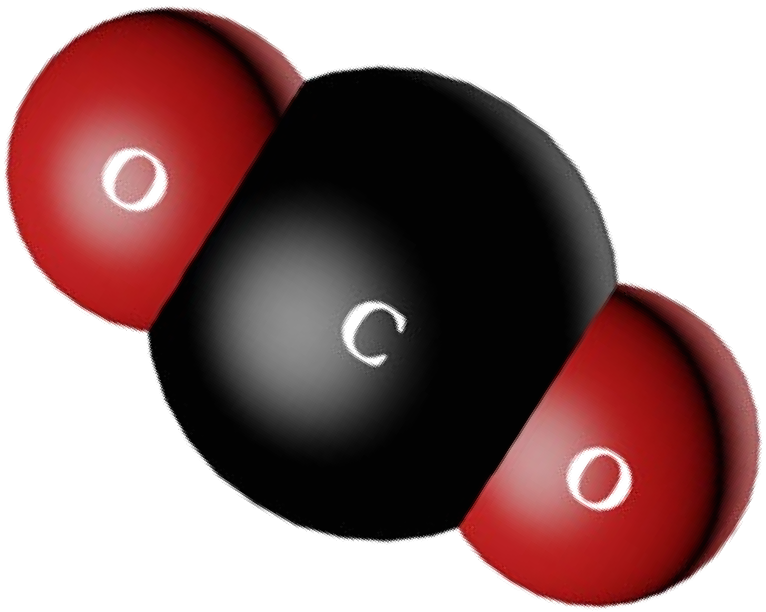
Image Credit: Red Trail Energy

PROJECT OVERVIEW

- Project Budget: $1,949,954
  - $1,559,954 DOE cash
  - $390,000 RTE in-kind match
- Period of Performance (POP): Oct 1, 2020 – March 31, 2022
- Goal: Develop an initial engineering design (IED) and estimated cost for capture and compression of CO_2 generated from an operational ethanol production facility

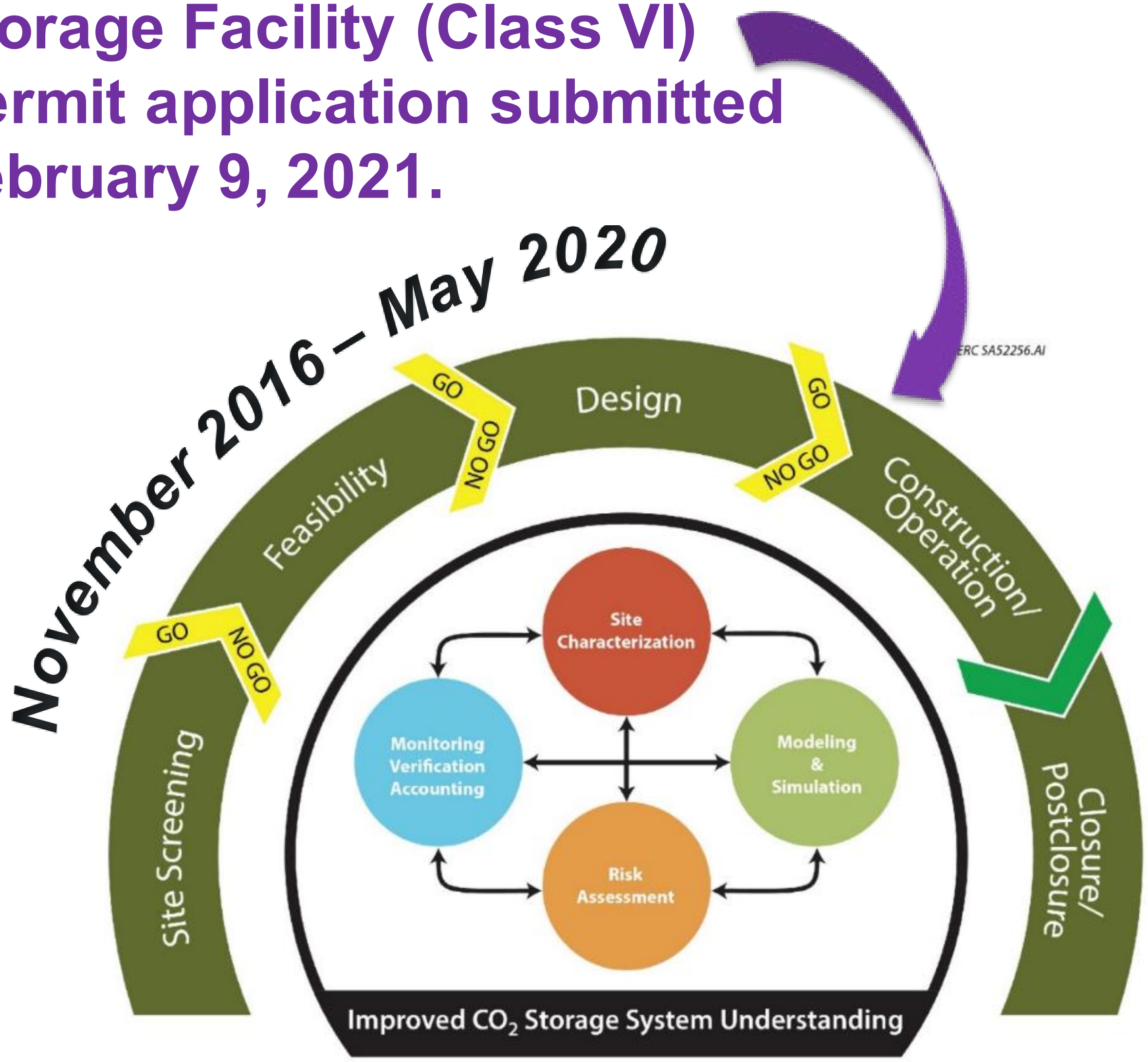
PROJECT OBJECTIVES

- Design a hybrid capture system using CO_2 emissions from both bioprocessing and heat production at the RTE facility.
- Complete a pre-front-end engineering and design (FEED) analysis of the hybrid capture system which includes environmental health and safety (EH&S), constructability report, identification of permits, and corporate approvals.
- Complete a techno-economic assessment (TEA) in accordance with DOE's methodology, as demonstrated by the bituminous baseline study.

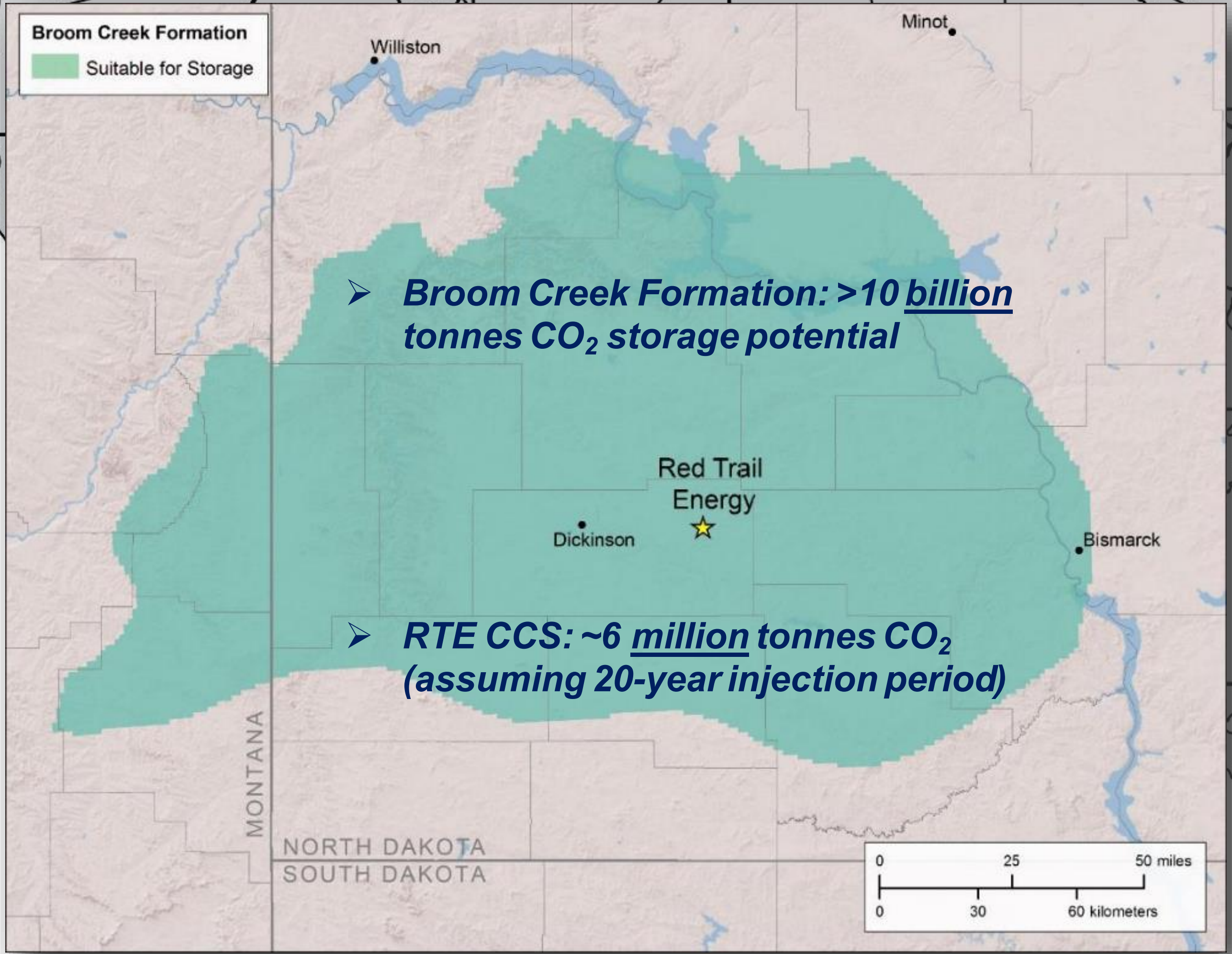


RTE CCS PROJECT:
Partners and Progress

- The <u>first</u> North Dakota CO_2 Storage Facility (Class VI) Permit application submitted February 9, 2021.



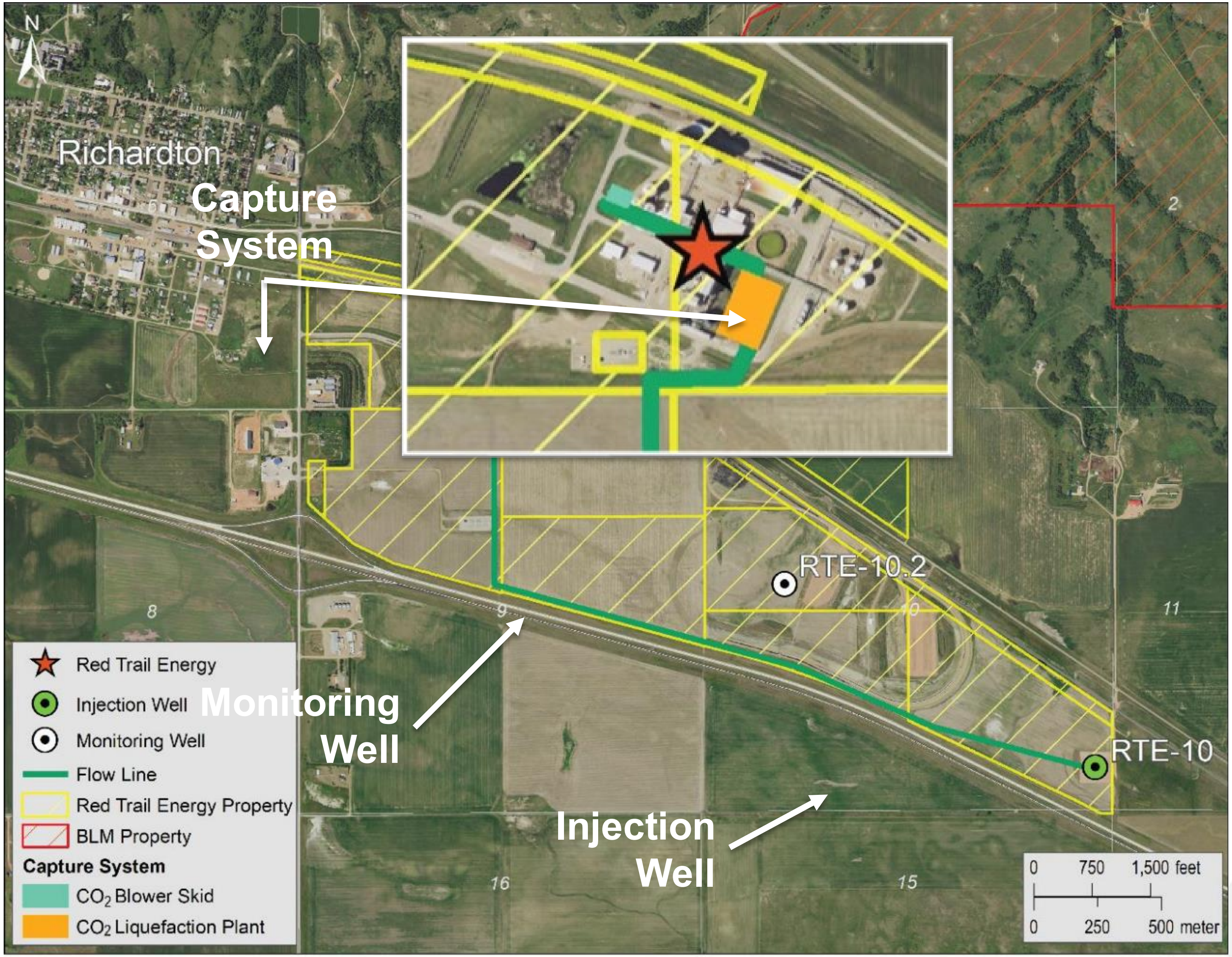
RTE SITE:
Excellent CCS Case Study



- ***Broom Creek Formation: >10 billion tonnes CO_2 storage potential***
- ***RTE CCS: ~6 million tonnes CO_2 (assuming 20-year injection period)***

- CO_2 capture potential
  - ~310,000 tonnes/yr of CO_2 from bioprocessing, heat production.
  - Bioprocessing CO_2 stream is nearly pure.
- Geologic storage potential:
  - Broom Creek Formation
  - 6400 ft directly underlying RTE facility, ~300 ft thick

RTE CCS SITE


N
Richardton
Capture System
Monitoring Well
Injection Well
RTE-10.2
RTE-10
2
8
9
10
11
15
16
Red Trail Energy
Injection Well
Monitoring Well
Flow Line
Red Trail Energy Property
BLM Property
Capture System
CO_2 Blower Skid
CO_2 Liquefaction Plant
0 750 1,500 feet
0 250 500 meter
EERC KL59582.AI

PROJECT TECHNOLOGY

CO_2 from Bioprocessing

Steam/Electricity

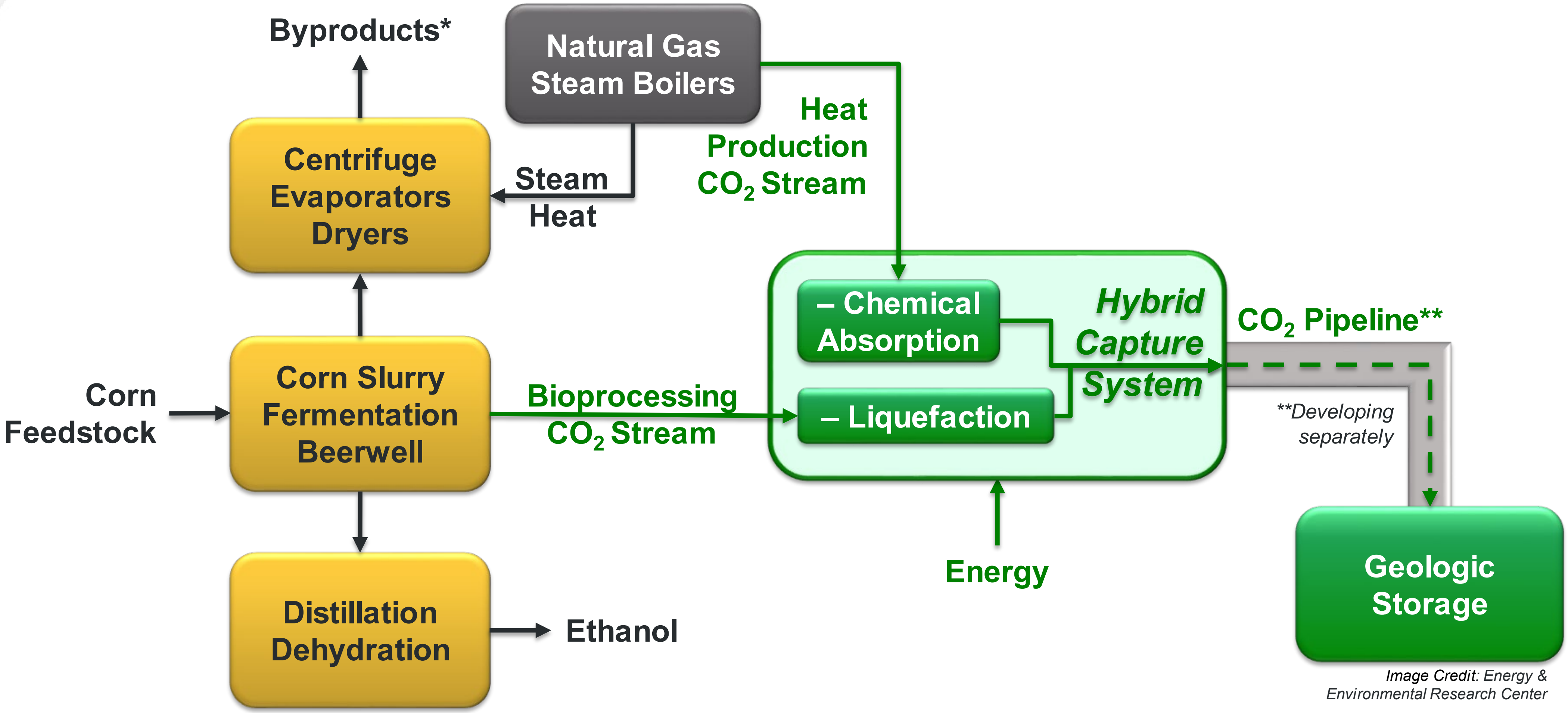
CO_2 from Heat Production

Hybrid Capture System

Injection for Geologic Storage

Image Credit: Energy & Environmental Research Center

ETHANOL–CCS PROCESS WITH NOVEL HYBRID CAPTURE SYSTEM



*Includes distillers grains, etc.

Image Credit: *Energy & Environmental Research Center*

PROJECT SCOPE

➢***POP: Oct 1, 2020 – March 31, 2022***

1. Project Management and Planning
2. Project Engineering and Design
3. Determine Pre-FEED Cost Estimate

Milestone Title	Planned Completion Date
M1 – Design Basis Determined	End of Month 4
M2 – Complete Pre-FEED Analysis	End of Month 12
M3 – Complete Design	End of Month 12
M4 – Complete TEA	End of Month 15

SUCCESS CRITERIA

✓ Completion of design basis for hybrid capture at RTE.

Photograph by Lars Plougmann

- Completion of TEA for design basis at RTE.
- Pre-FEED-level cost estimate for implementation of hybrid capture technology at RTE.
- Designed capture process that provides negative CO_2 emissions for RTE.
- RTE management approval of hybrid capture design such that it is considered by the RTE Board.

RISKS AND MITIGATION

Risk Category	Perceived Risk	Mitigation/Response Strategy
Financial Risks	Insufficient Cost-Share Acquisition	Agree to cost-share terms with cost-share partners and DOE prior to start of project.
	Budget Insufficient to Complete Project	PI will work with task leads to ensure priority is given to schedule and use of allocated hours. Hours and schedule will be tracked using the EERC's internal project cost-tracking system.
Cost/Schedule Risks	Inadequate Plant Information	RTE is committed to the project as evidenced by its letter of support. The project team will communicate regularly to mitigate this risk.
	Subcontractor Delays	Subcontractors for this project have worked with the project team in the past. Regular communication will be key to mitigate this risk.
Technical/ Scope Risks	Data Lost Because of Hacking or System/Human Failures	Maintain the EERC's high internal standards for data management. Ensure team is trained to comply with existing internal data management plan. Ensure server data are regularly backed up.
	Design Concept Not Feasible	The team has chosen commercial technologies to implement.

Risk Category	Perceived Risk	Mitigation/Response Strategy
Management, Planning, and Oversight Risks	Inefficient Communication Leads to Schedule Overruns or Cost Overruns	Schedule regular or weekly stand-up meetings to ensure project priority is addressed and stakeholders are informed of schedule requirements and milestone dates.
	Loss of PI, Task Lead, or Key Researcher(s) to Health Matters or Attrition	Ensure project goals, milestones, and schedule are communicated to task leads and researchers regularly. The EERC has many qualified personnel to assist.
EH&S Risks	Office-Based Work Unsafe	Employ safe office practices such as proper ergonomics.
	Unsafe Laboratory Conditions	Complete safety training. Follow industry standard laboratory safety practices such as proper use of personal protective equipment and fume hoods.
External Factor Risks	Economic Conditions Decrease Funding	The EERC will adjust scope items as necessitated by reduced funding.

TASK 1.0 – PROJECT MANAGEMENT AND PLANNING

- **Subtask 1.1 – Project Management Plan**
  - ✓ Update due 30 days after award.
  - ✓ Updates submitted, as needed, throughout the project POP.
- **Subtask 1.2 – Technology Maturation Plan**
  - ✓ Initial due 90 days after award.
  - ❑ Final due within 90 days of project completion.
- **Subtask 1.3 – TEA and Technology EH&S Risk Assessment**
  - ❑ Within 90 days of project completion.
- **Subtask 1.4 – State Point Data Table**
  - ❑ Updated within 90 days of project completion.
- **Subtask 1.5 – Life Cycle Assessment (LCA) Report**
  - ❑ Final LCA results within 90 days of project completion.

TASK 2.0 – PROJECT ENGINEERING AND DESIGN

- Subtask 2.1 – Design Basis
- Subtask 2.2 – Utility Requirements
- Subtask 2.3 – Flow Diagrams
- Subtask 2.4 – Balance of Plant (BOP)
- Subtask 2.5 – Develop Permitting Strategy
- Subtask 2.6 – Optimization Studies

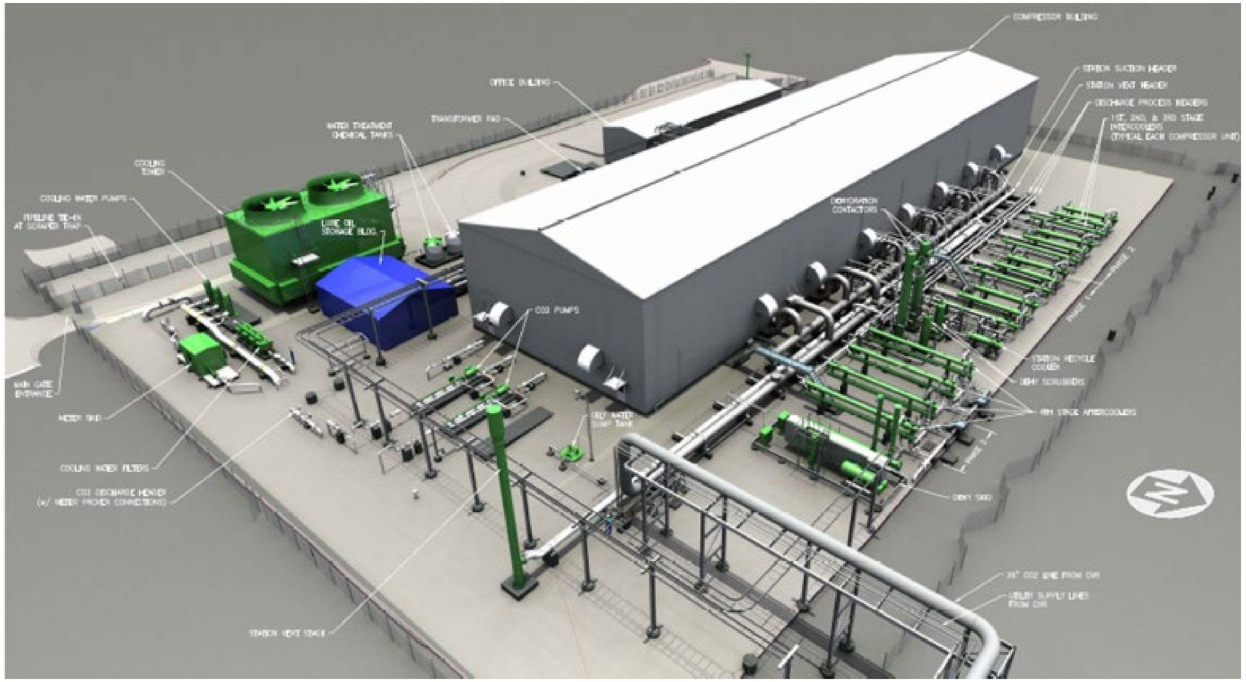


Image Credit: Willbros Engineering

TASK 2.0 – PROJECT ENGINEERING AND DESIGN

Subtask 2.1 – Design Basis

- ***Completed:*** Capture technology island capacity
- ***Completed:*** Site and operating conditions
- ***Completed:*** Expected fuel consumption
- ***Completed:*** Performance requirements

Subtask 2.2 – Utility Requirements

- ***Completed:*** Water, electricity, and steam needs

❑ Identify locations of utilities, strategies, and other site specifics

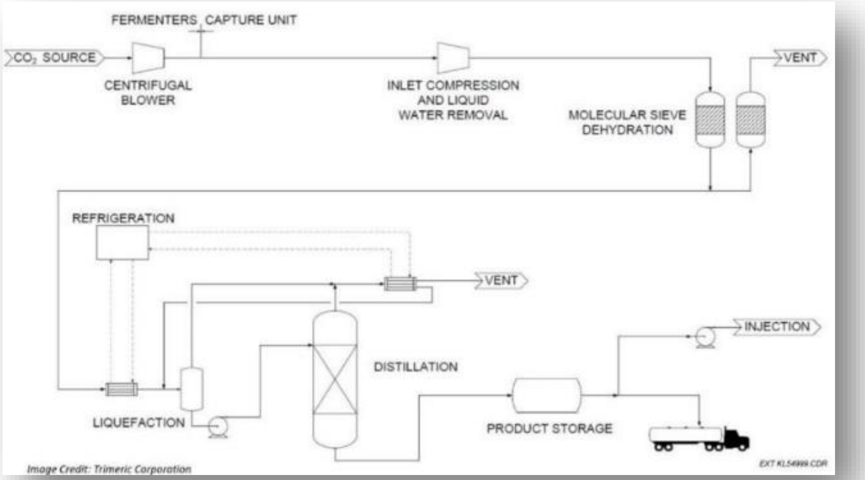
❑ Determine potential impacts to the RTE site

Image Credit: Red Trail Energy

TASK 2.0 – PROJECT ENGINEERING AND DESIGN (cont.)

Subtask 2.3 – Flow Diagrams

- ***Completed:*** Existing diagrams updated
  - ✓ Process flow
  - ✓ Block flow
- ***Completed:*** Major equipment list



Subtask 2.4 – BOP

- ***Completed:*** Interconnection requirements
  - ✓ Electrical power sources
  - ✓ Treated water
  - ✓ Steam for process heating
  - ✓ Water for process cooling
  - ✓ Interconnecting gas flues to support the capture island requirements
- Develop designs and technology island configurations
  - ❑ PFDs and site layouts
  - ❑ Equipment lists, preliminary piping, wiring routings
  - ❑ Preliminary foundation requirements

TASK 2.0 – PROJECT ENGINEERING AND DESIGN (cont.)

Subtask 2.5 – Develop Permitting Strategy

- ***Completed:*** Required information determined
  - ✓ Approvals, permits, concurrences, clearances, and environmental studies
  - ✓ Federal, state, and local
- Generate a permit matrix
  - ✓ Name or type of permit/approval
  - ✓ Regulatory agency issuing the permit/approval
  - ✓ Reason for permit/approval
  - ❑ Estimated agency review time
  - ❑ Potential permit application requirements
  - ❑ Permit fee (if required)

Subtask 2.6 – Optimization Studies

- ***Completed:*** Process equipment, redundancy, materials of construction defined
- ***Completed:*** Scoping/optimization
  - ✓ Effluent identification and disposition
  - ✓ Process heat recovery
  - ✓ Process heat integration
  - ✓ Redundancy evaluation
  - ✓ Cooling system evaluation (water availability)
  - ✓ Contracting approach

TASK 3.0 – DETERMINE PRE-FEED COST ESTIMATE

Subtask 3.1 – Develop Capture Island Cost Estimate

- ❑Determine pre-FEED-level costs
- ❑Estimate postcombustion capture costs
- ❑Integrate with compression and liquefaction subsystems

Subtask 3.2 – Develop BOP Cost Estimate

- ❑Complete integration of the hybrid capture system with the remainder of the plant

Image Credit: Energy & Environmental Research Center

PROJECT SUMMARY

Tentative Takeaways

- **Completed Milestone:** Design Basis Determined
- **Completed Deliverables**
  - TMP (initial)
  - HAZOP Report
  - Updated PMP

Remaining Products

- Milestones
  - Pre-FEED Analysis
  - Design
  - TEA
- Deliverables
  - Pre-FEED Report
  - TEA and Technology EH&S Risk Assessment
  - TMP (final)
  - State Point Data Table
  - LCA Report

Questions?

Image Credit: Energy & Environmental Research Center

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PROJECT ORGANIZATION

Project Partners
DOE
Red Trail Energy
Energy & Environmental Research Center
Trimeric
KLJ

Lead Organization
EERC

Project Manager
Jason Laumb

Task 1: Project Management and Planning

Lead
J. Laumb

Task Assist
J. Kay

Task 2: Project Engineering and Design

Lead
K. Leroux

Task Assist
Trimeric
KLJ
Red Trail Energy

Task 3: Determine Pre-FEED Cost Estimate

Lead
J. Kay

Task Assist
Trimeric
KLJ
Red Trail Energy

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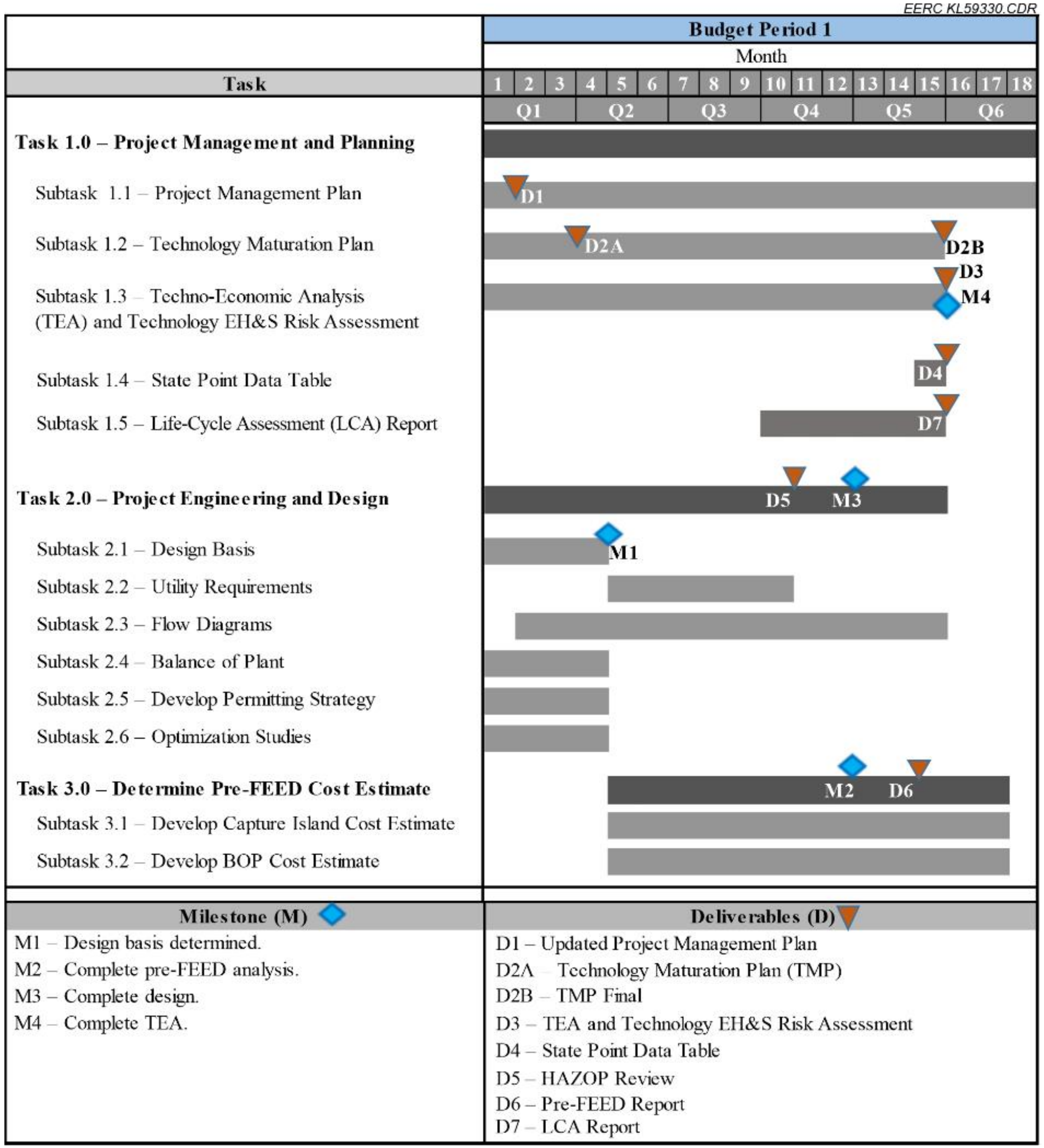
PROJECT TIMELINE



MILESTONES

Milestone Title	Task/ Subtask	Planned Completion Date	Verification Method
M1 – Design Basis Determined	2.1	End of Month 4 ***Jan 31, 2021***	***Completed:*** Reported in subsequent quarterly report.
M2 – Complete Pre-FEED Analysis	3.0	End of Month 12 ***Sep 30, 2021***	Reported in subsequent quarterly report.
M3 – Complete Design	2.0	End of Month 12 ***Sep 30, 2021***	Reported in subsequent quarterly report.
M4 – Complete TEA	1.3	End of Month 15 ***Dec 31, 2021***	Reported in subsequent quarterly report.

DELIVERABLES

Task/Subtask Number	Deliverable Title	Due Date
1.1	D1 – Updated Project Management Plan	***Completed:*** End of Month 1 ***(Oct 31, 2020***)
1.2	D2 – Technology Maturation Plan (TMP)	***Completed:*** The initial TMP is due 90 days after award (***Dec 30, 2020***). Updates to the TMP shall be submitted, as needed, throughout the project period of performance. A final TMP is due within 90 days of project completion (***June 30, 2022***).
1.3	D3 – TEA and Technology EH&S Risk Assessment	Within 90 days of project completion (***June 30, 2022***).
1.4	D4 – State Point Data Table	Updated state point data are due within 90 days of project completion (***June 30, 2022***).
1.5	D7 – Life Cycle Assessment (LCA) Report	The final LCA results are due within 90 days of project completion (***June 30, 2022***).
2.0	D5 – HAZOP Review	***Completed:*** End of Month 10 (***July 31, 2021***)
3.0	D6 – Pre-FEED Report	End of Month 14 (***Nov 30, 2021***)

BUDGET: $1,949,954

	FY 2021		FY 2022		Total	
	DOE Funds	*Cost Share*	*DOE Funds*	*Cost Share*	*DOE Funds*	*Cost Share*
EERC – Prime	$810,518	$8,000	$352,870	$7,000	$1,163,388	$15,000
Trimeric Corp. – Subrecipient	$276,566	$ –	$120,000	$ –	$396,566	$ –
Red Trail Energy, LLC	$ –	$243,000	$ –	$132,000	$ –	$375,000
Total	**$1,087,084**	**$251,000**	**$472,870**	**$139,000**	**$1,559,954**	**$390,000**
Total Cost Share %	81.2%	18.8%	77.3%	22.7%	80.0%	20.0%

PROJECT MANAGEMENT

Jason Laumb
Principal Investigator (PI)
Task 1.0 – Project Management and Planning

Kerryanne Leroux

Task 2.0 – Project Engineering and Design

John Kay

Task 3.0 – Determine Pre-FEED Cost Estimate

ROLES OF PARTICIPANTS

- **EERC, *Lead Organization*** – Oversee all tasks and management activities.
- **RTE, *Project Partner***
  - Allow access to facilities, drawings, etc., to facilitate design and pre-FEED objectives.
  - Participate in the IED and information gathering to determine the pre-FEED-level cost estimate.
  - Provide valuable insight into commercial application of the CO_2 capture technologies investigated that support the viability of the project design and costing support.
- **Trimeric Corporation, *Project Partner*** – Design and costing of both components of the hybrid CO_2 capture system as well as compression.
- **KLJ, *Project Partner*** – BOP, civil engineering design, and costing support.