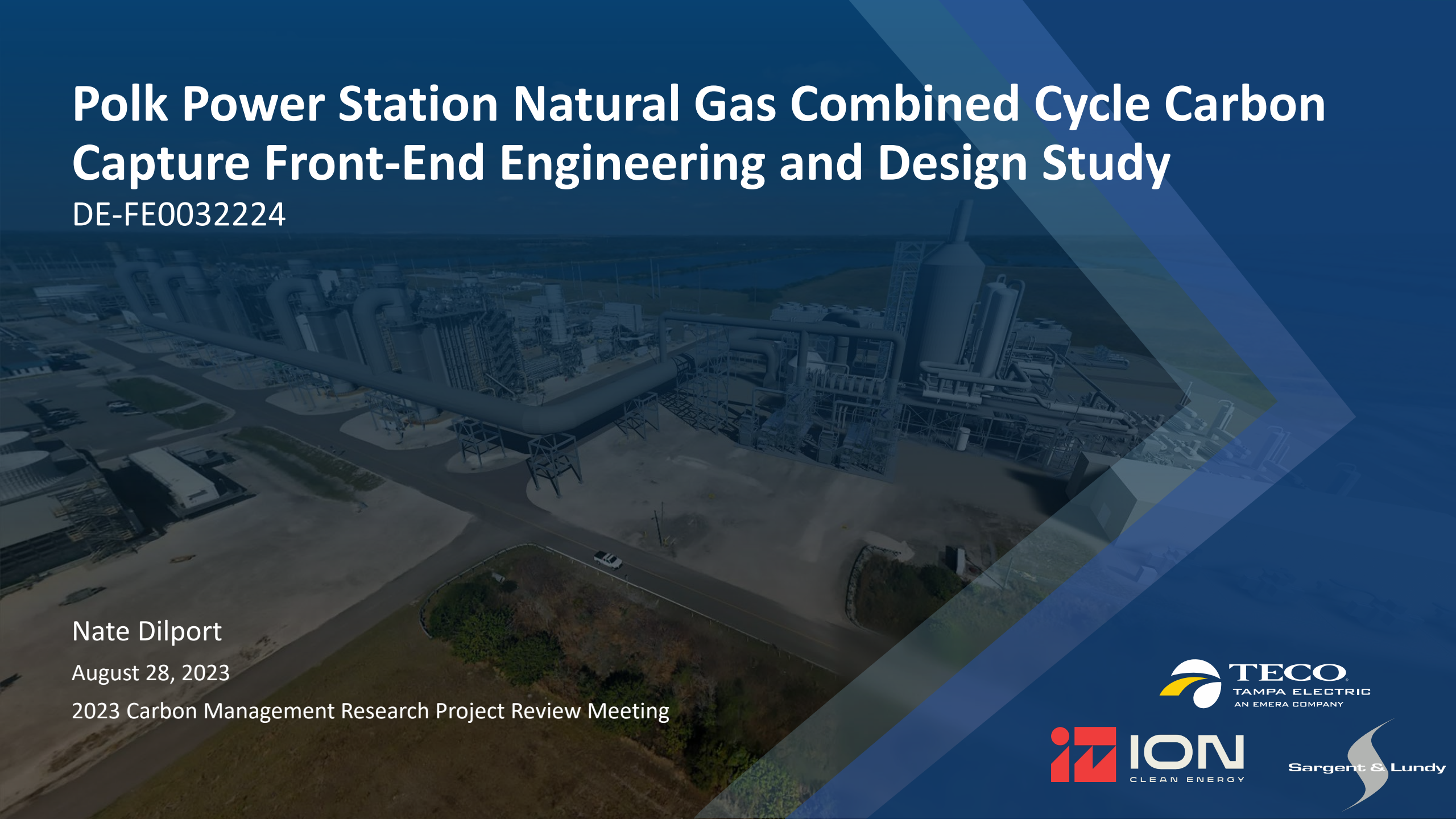
Polk Power Station Natural Gas Combined Cycle Carbon Capture Front-End Engineering and Design Study

DE-FE0032224



Nate Dilport

August 28, 2023

2023 Carbon Management Research Project Review Meeting

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ION CLEAN ENERGY

Sargent & Lundy

Agenda

- Project Overview
- Technology Background
- Project Scope
- Project Progress

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PROJECT OVERVIEW

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KEY INFORMATION

- Funding: Total $6,985,046
  - Federal: $5,588,037
  - Recipient: $1,397,009
- Period of Performance: March 1, 2023 – August 31, 2024
- Project Participants:
  - Recipient: Tampa Electric Company
    - Principal Investigator: Kris Stryker, VP Clean Energy and Emerging Technology
    - Co-Principal Investigator: Nathan Kirkconnell, Manager, Construction Projects
  - Subrecipient: ION Clean Energy
  - Key Vendors: Sargent & Lundy, LLC; Koch Specialty Plant Services; Siemens Energy

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PROJECT OBJECTIVES

- The overall objective of the project is to complete a front-end engineering and design (FEED) study and cost estimate (AACE Class 3: -20% to +30%) for a commercial scale carbon dioxide capture facility retrofitted onto the existing Polk Power Station Unit 2 natural gas combined cycle (NGCC).
- The results of this FEED study will be used as the basis of evaluating a future full-scale installation.

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PROJECT/TECHNOLOGY BACKGROUND

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POLK POWER STATION UNIT 2

- 4 x 4 x 1 Combined Cycle – 1,190 MW (1,168 MW Net)
- Commercial operation – January 2017
- Converted existing CT units 2,3,4 & 5 by adding 4 HRSGs and 1 Steam Turbine
- CTs are GE 7FA Combustion Turbine with DLN 2.6 Combustors
- CTs 2 & 3 are dual fuel (natural gas/oil) units
- Maintains peaking capacity with bypass dampers
- 500 MW Alstom Double Tandem Compound Reheat steam turbine
- 4 Vogt HRSGs with gas-fired duct firing (120 MW total)
- Produces about 10,000 ton/day of CO_2 at full load (~3.6 - 4.2%/vol CO_2 in flue gas)

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SITE SUITABILITY FOR CCS

- Polk Unit 2 is a critical component of TEC's generating fleet representing 22% of total generating capacity.
- Polk Unit 2 is a highly efficient, heavily used asset in the current fleet, generating approximately 1/3rd of the total energy produced for our customers, and has consistently operated at a high capacity factors.
- TEC owns the site and controls all aspects of its operations.
- There is significant open area near the generating units that can accommodate the large footprint needed for the CCS equipment.
- The site is suitable for on-site large-scale geologic sequestration of CO_2.

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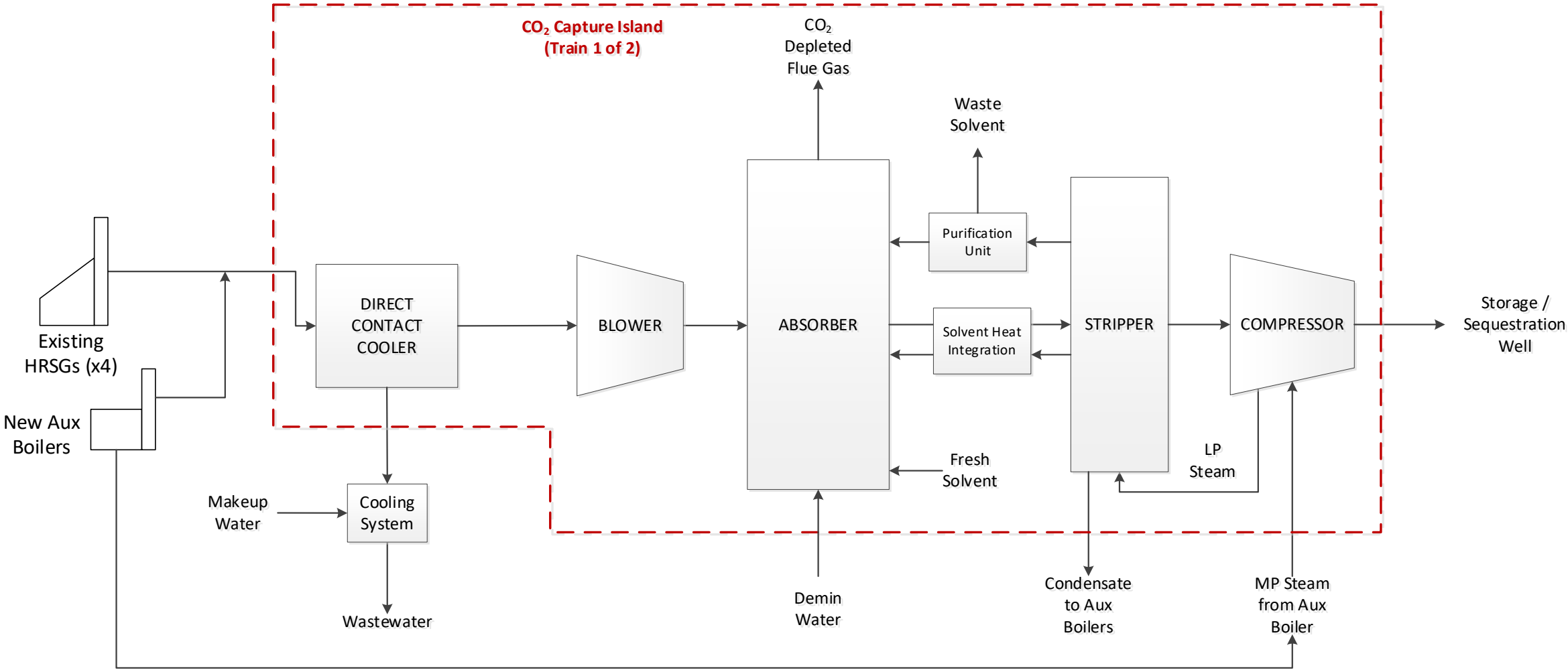
CO_2 CAPTURE INTEGRATION



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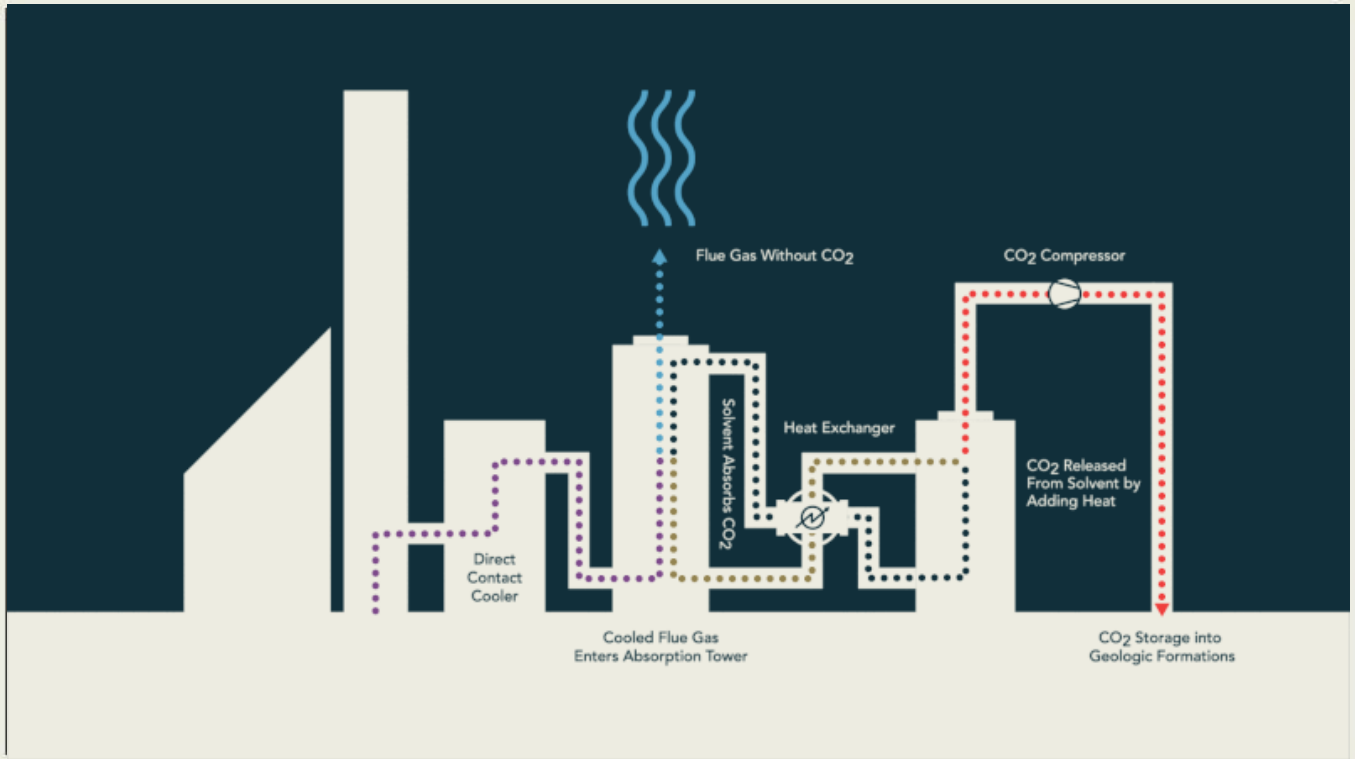
ICE-31 OVERVIEW

TECHNOLOGY OVERVIEW

- Water lean liquid absorbent-based capture
- World-wide Patents
- Utilization of standard thermal swing absorption engineering process optimized for ICE-31 chemical properties

KEY PERFORMANCE INDICATORS

- < 1,030 Btu/lb CO_2 (2.4 GJ/tCO_2)
  - Fast kinetics
  - Working capacity
  - Low heat capacity
  - Lower corrosion
- High stability in oxidative environment
- Extremely low emissions



PROJECT SCOPE

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POLK 2 CCS PROJECT

- The project will utilize the ICE-31 solvent-based CO_2 capture technology, developed and demonstrated by ION to be able to achieve CO_2 capture efficiencies greater than the 95% capture.
- The host site is currently dispatched directly behind TEC's renewable generation; this has led the team to aim to minimize overall net power reduction from the site.
- Natural gas fired auxiliary boilers were preliminarily selected for steam production.
  - Medium pressure steam generated will drive the CO_2 compressor,
  - Low-pressure steam will be used in the reboiler for solvent regeneration.
- The site has sufficient natural gas supply for the added heat input for the new aux boilers.
- The flue gas produced from the boilers will combine with the exhaust from PK2 and treated in the CCS system. Although this increases sizing and cost, the efficiency of the CCS system increases.

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FEED STUDY SCOPE

Task 1.0 Project Management and Planning	• DOE Reporting, Project Management Plan, Technology Maturation Plan, Workforce Readiness for Technology Development
Task 2.0 FEED Study Planning and Definition	• Project Scope and Design, Project Design Basis / Design Criteria, Initial Scope Definition Studies
Task 3.0 FEED Study Engineering and Design Package	• Initial Engineering Design, Process Engineering Design, Overall Project Engineering Design, HAZOP, Permitting Matrix, Constructability Review, Project Execution Plan
Task 4.0 FEED Study Project Cost Estimate	• AACE Class 3 Cost Estimate, Operating Cost, and Cost of Capture
Task 5.0 Reporting and Project Req. Deliverables	• Business Case Analysis, Life Cycle Analysis, Environmental Health and Safety Analysis, Environmental Justice Analysis, Economic Revitalization and Job Creation Analysis

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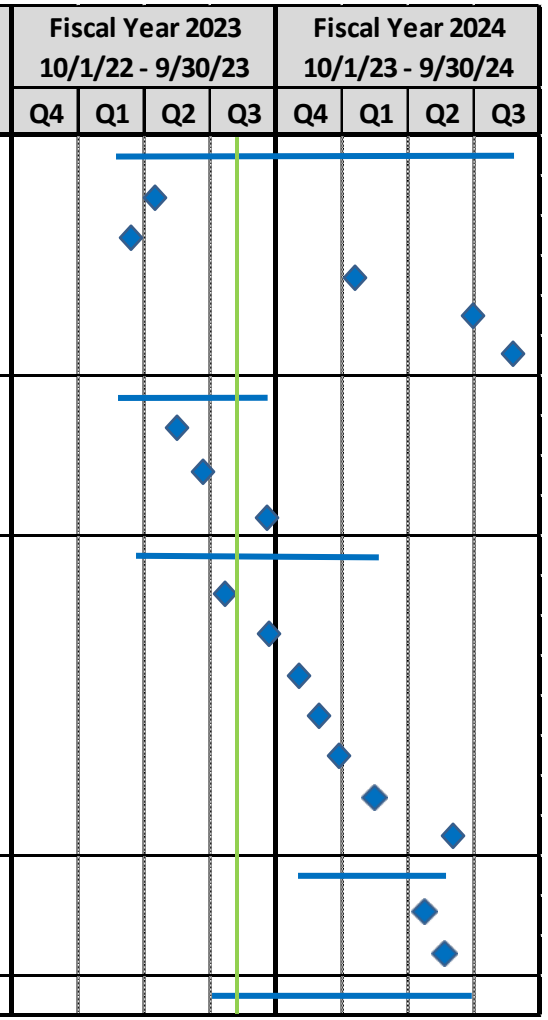
PROJECT TIMELINE & MILESTONES

	Project Tasks	Task Start Date	Task End Date	Cost per Task
	Task 1. Project Management and Planning	**3/1/2023**	**8/28/2024**	**$588,217**
	Milestone. DOE Kickoff Meeting	*4/13/2023*	*4/13/2023*	
	Milestone. Updated Project Management Plan	*3/30/2023*	*3/30/2023*	
	Milestone. Initial Workforce Readiness Plan Verified	*1/30/2024*	*1/30/2024*	
	Milestone. Project Stakeholder Results Review	*6/26/2024*	*6/26/2024*	
★	*Milestone. Final DOE Report & Presentation*	*8/27/2024*	*8/27/2024*	
	Task 2. FEED Study Planning and Definition	**3/20/2023**	**8/3/2023**	**$1,020,961**
★	*Milestone. Basis of Design for Project Finalized and Verified*	*5/19/2023*	*5/19/2023*	
	Milestone. Train Configuration Selection Verified	*6/15/2023*	*6/15/2023*	
	Milestone. Balance of Plant Scope Defined and Verified	*8/3/2023*	*8/3/2023*	
	Task 3. FEED Study Engineering and Design	**3/15/2023**	**5/7/2024**	**$4,086,707**
	Milestone. Process Design Package Reviewied and Verified	*7/13/2023*	*7/13/2023*	
	Milestone. Initial Site Layout Reviewed and Verified	*9/26/2023*	*9/26/2023*	
	Milestone. Process P&IDs Reviewed and Verified	*10/25/2023*	*10/25/2023*	
	Milestone. HAZOP Complete and Report Verified	*11/21/2023*	*11/21/2023*	
	Milestone. Permitting Requirements Identified and Verified	*12/21/2023*	*12/21/2023*	
	Milestone. Final Project General Arrangement Verified	*2/13/2024*	*2/13/2024*	
★	*Milestone. Final Engineering Design Package*	*5/29/2024*	*5/29/2024*	
	Task 4. FEED Study Project Cost Estimating	**1/5/2024**	**5/14/2024**	**$1,130,830**
	Milestone. Cost Estimate Input Received and Verified	*4/24/2024*	*4/24/2024*	
★	*Milestone. Overall Cost Estimate and Cost of Capture Review*	*5/14/2024*	*5/14/2024*	
	Task 5. Project Planning Deliverables	**7/5/2023**	**6/26/2024**	**$158,502**



★ = KEY DELIVERABLE

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RISK MANAGEMENT PLAN

Perceived Risk	Risk Rating			Mitigation/Response Strategy
	Prob.	Impact	Overall	
Financial Risks:				
Availability of Cost Share	Low	Low	Low	An estimated spend plan has been developed based on the schedule, subrecipient budget, and vendor proposals, allowing TEC, the source of cost share, to plan for the expected spend. TEC is committed to ensuring the minimum 20% cost share is met to complete the FEED study.
Budget Overruns	Low	Medium	Low	The technology vendor, subrecipient, has provided a budget justification form. In addition, the major vendors have provided detailed firm priced proposals. Additional vendor costs are based on typical costs for similar scopes.
Cost/Schedule Risks:				
Schedule Delays	Medium	High	Medium	A Level 1 schedule has been developed for the project. This schedule will be revised upon award to include additional detail. S&L will track the overall project schedule to ensure any adjustments to the schedule are identified early.
Resource Availability	Medium	Medium	Medium	Core project team members have been designated for each organization that will be assigned to support the project through its duration, commitment letters from each key organization have been provided. In addition, S&L has a large and flexible staff and will adjust resources as needed to maintain schedule.

- TEC has a comprehensive risk matrix.
- Throughout the project, TEC will impose risk mitigation (technical, schedule, and cost) steps to ensure that the project milestones and goals are met.
- Focusing on the following Key Risks:
  - Financial
  - Cost/Schedule
  - Technical/Scope
  - Management, Planning, and Oversight
  - External Factors
  - Environmental Health & Safety

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PROJECT PROGRESS

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PROJECT STATUS

- Preliminary Design Basis Issued
- Min / Max Operating Cases Confirmed
- CO_2 Process Modeling in progress
- Preliminary CO_2 Compression Specification Issued
- Steam Sourcing Study in progress
  - Natural Gas Fired Auxiliary Boilers selected for the preliminary design basis
  - CT Advanced Gas Path Upgrade/Steam Extraction looks promising
  - Final selection of steam source will inform compression drive selection
- Cooling Options being evaluated
  - Evaporative Cooling via Mech. Driven Cooling Towers Preliminarily Selected
  - Proposed redesign of absorber water wash will reduce cooling demand by ~40% over baseline

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PROJECT STATUS

- Project Management Plan Issued
- Design Criteria complete
- Heat and Material Balance Match Case verified
- Vogt and GE engaged
  - First round of thermal performance information has been received from Vogt
  - GE contract in final negotiation
- Additional scenarios being considered as part of Steam & Electric Sourcing study has caused a small delay in the project, but overall end date is not expected to be impacted due to schedule efficiencies in later tasks

PROJECT STATUS

- Project team is meeting regularly for status updates, and has facilitated several in person meetings to discuss critical design and economic decisions such as the preliminary capture process design, facility constructability, construction schedule, and FEED schedule
- TEC's experience operating solvent-based gas treatment and the air separation unit for the co-located integrated gasification combined cycle facility has led to a number of suggested changes in the design to facilitate long term operability and maintenance of the capture process

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PRELIMINARY DESIGN BASIS

Key items

- Process Design at 2x 50% trains for the Capture Island
- Each Train contains: direct contact cooler, absorber, stripper, compressor and various heat exchangers, tanks and pumps
- Large direct contact cooler and absorber vessel
  - ION/Koch can support the large size of the proposed absorbers
- Turndown
  - ION/Koch have confirmed that the large absorbers can support the necessary level of turndown (1x1 @ 75% CT Load)
- Redundancy within the trains is at N+1
- Utilities
  - Steam available at 600 psia
  - Cooling water Temperature at 88°F
- Materials of construction
  - 304/L, 316L and Duplex are acceptable steel EPDM, HDPE, Polypropylene and PTFE are acceptable gaskets
- The CO_2 product shall satisfy required discharge pressure and ≥95% purity

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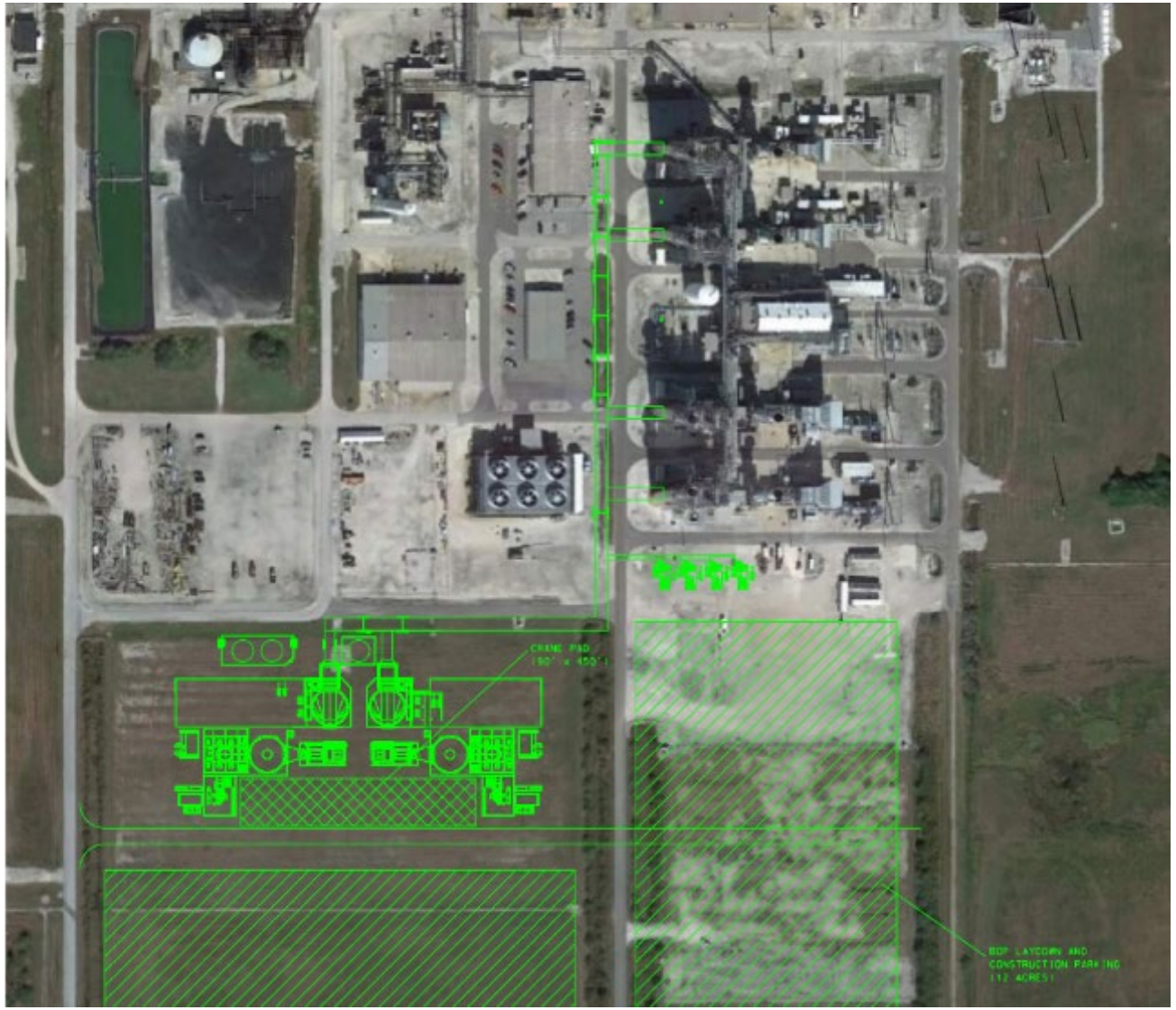
PRELIMINARY SITE PLAN



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