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

DE-FE0032224

August 5, 2024

2024 Carbon Management Research Project Review Meeting

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ACKNOWLEDGEMENT & DISCLAIMER

Tampa Electric appreciates the opportunity to collaborate with the U.S. Department of Energy on this project.

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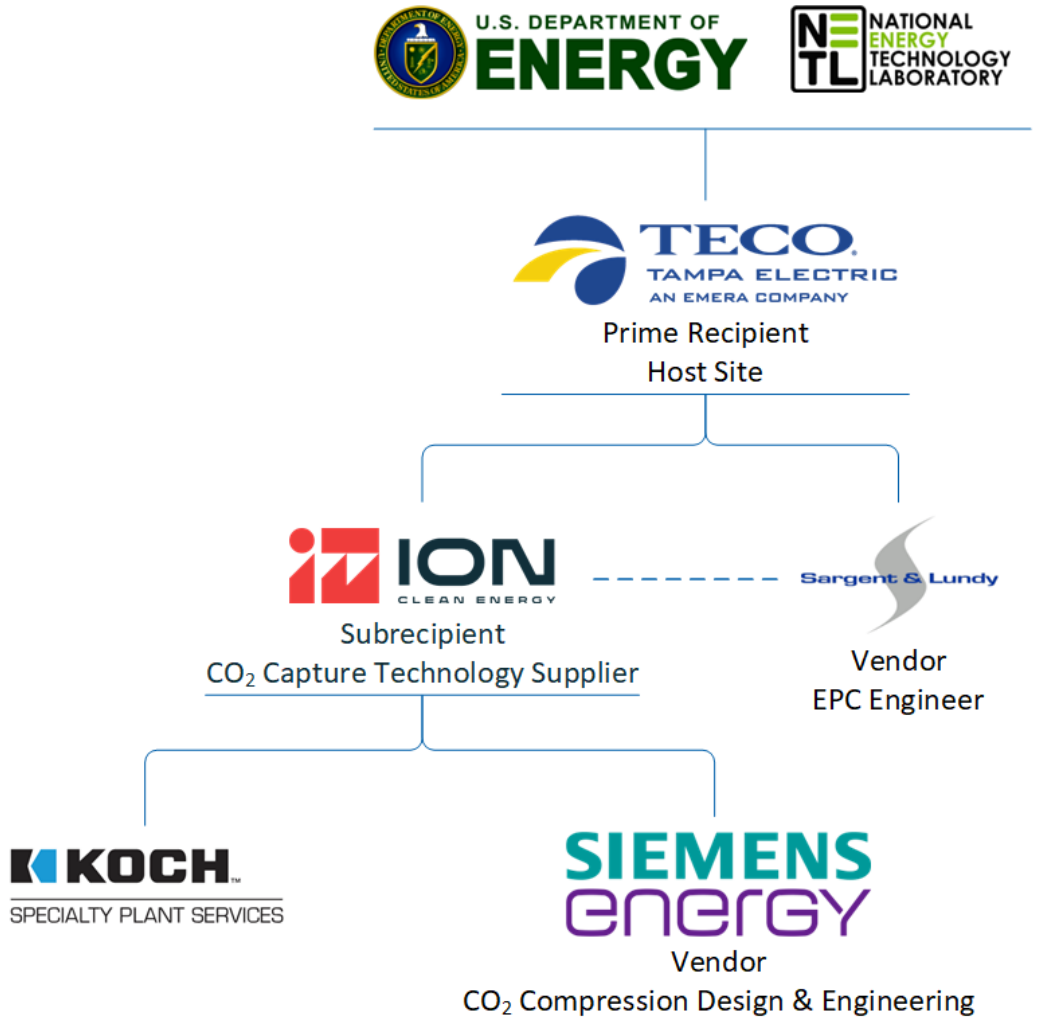
PROJECT OVERVIEW

PROJECT TEAM



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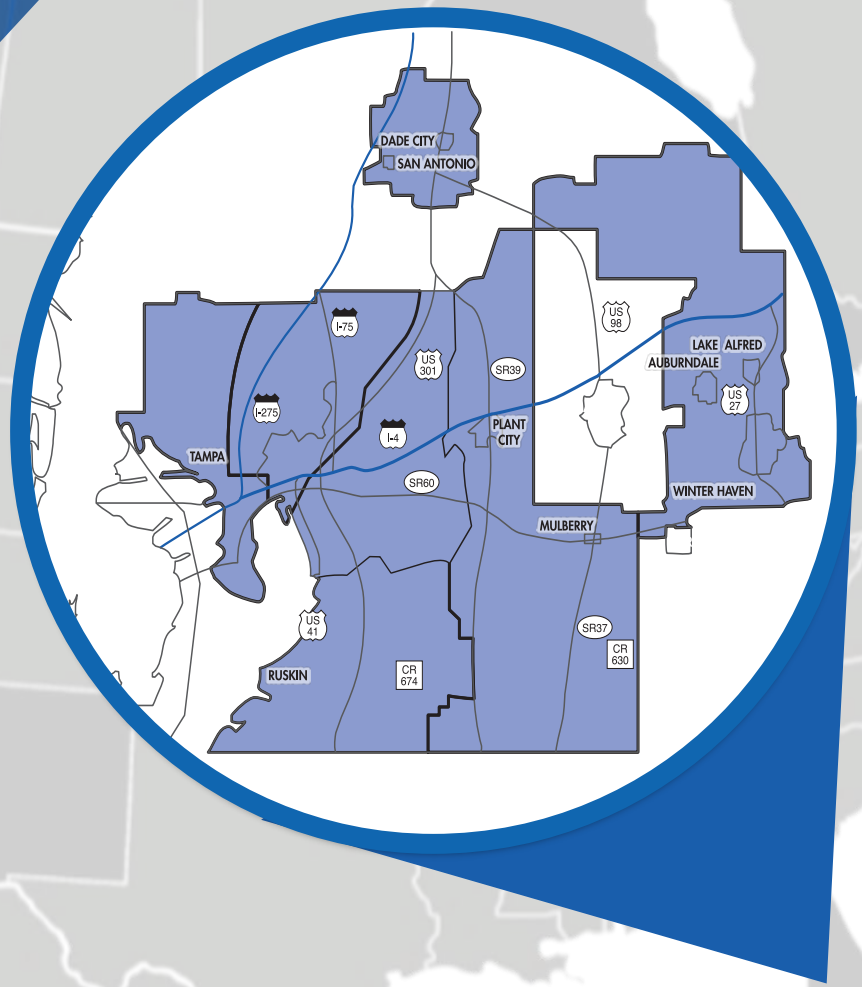

About Tampa Electric

We're committed to safely delivering reliable energy to 840,000 customers across 2,000 square miles of West Central Florida, including all of Hillsborough and parts of Polk, Pasco and Pinellas counties.

840K
Customers

2,500
Employees

125+ YRS
Service to Community

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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 – December 31, 2024
- Project Participants:
  - Recipient: Tampa Electric Company
  - Subrecipient: ION Clean Energy
  - Key Vendors: Sargent & Lundy, LLC; Koch Specialty Plant Services; Siemens Energy

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PROJECT OBJECTIVES

- The Polk CO_2 Capture FEED Study is to design and cost the retrofitting of ION Clean Energy's post-combustion CO_2 capture technology at Polk Power Station Unit 2 Combined Cycle, located in Mulberry, Florida.
- The CO_2 capture system will be designed in a way that: maintains the necessary flexibility of a dispatch-based generating asset, pushes the boundaries of scalability, maximizes energy efficiency and utilizes a transformational solvent while maintaining a robust and flexible system.
- The FEED Study will produce an AACE Class 3 cost estimate.
- The system will be designed to achieve 95% capture efficiency, resulting in approximately 3 MM tonnes/CO_2 captured per year.
- The study aims to develop a business case analysis for implementation at Polk Unit 2.
- This FEED study will demonstrate how a large and critical unit can be equipped with CO_2 capture to operate within and support a decarbonized electric grid in the future.

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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
- Combustion Turbines are GE 7FA.03 with DLN 2.6 Combustors
- Maintains peaking capacity with bypass dampers
- 500 MW Alstom Double Tandem Compound Reheat steam turbine
- 4 Vogt HRSGs with natural gas 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 Tampa Electric's generating fleet representing 22% of the company's total generating capacity.
- Polk Unit 2 is a highly-efficient and heavily used asset, generating approximately one-third of Tampa Electric's total energy. It has consistently operated at a high capacity factors.
- Tampa Electric 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 regional geology is suitable for large-scale geologic sequestration of CO_2.

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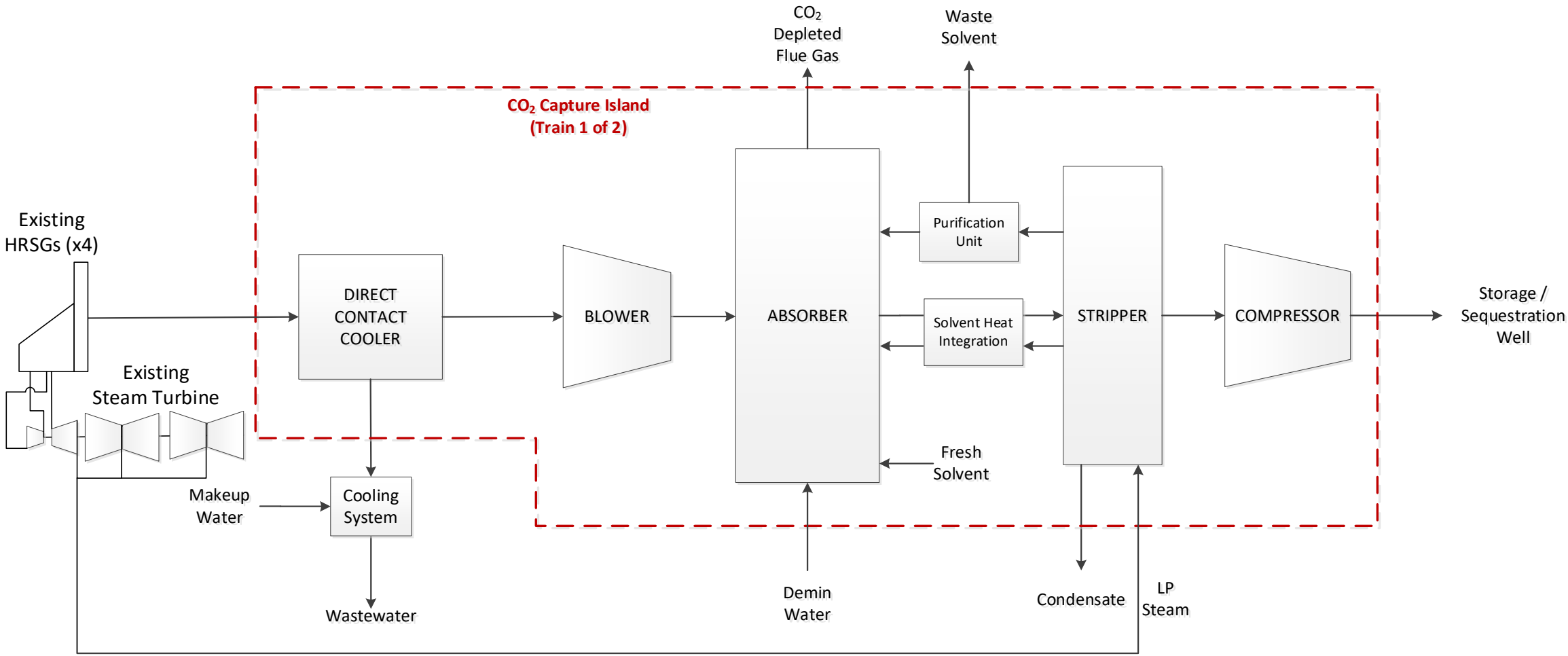
CO_2 CAPTURE INTEGRATION



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PROJECT SCOPE

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POLK UNIT 2 CCS PROJECT

- The project utilizes ICE-31 solvent-based CO_2 capture technology, developed and demonstrated by ION to be able to achieve CO_2 capture efficiencies greater than 95%.
- The host site is currently dispatched directly behind Tampa Electric's solar generation; this has led the team to aim to minimize overall net power reduction from the site.
- Low-pressure steam extracted from the site's existing Steam Turbine 2 IP-LP crossover will be used in the reboiler for solvent regeneration.
- Parasitic load and ST2 power loss due to extraction will be partially offset by Advanced Gas Path upgrades for the four existing gas turbines.
- Mechanical Draft Cooling Towers are selected for all necessary cooling as the site has ample makeup water available due to the onsite reclaimed water treatment plant.

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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

Milestone	Task/ Subtask	Milestone Title and Description	Planned Completion Date	Actual Completion Date	Verification Method	Status
1	1.1	Updated Project Management Plan	3/31/2023	3/31/2023	Transmittal to DOE FPM	**Complete**
2	1.0	DOE Kickoff Meeting	4/14/2023	4/14/2023	Meeting Held and Presentation sent to DOE	**Complete**
3	2.2	Basis of Design for Project Finalized and Verified	5/19/2023	5/19/2023	Basis of Design Report; Completion Memo to DOE	**Complete**
4	2.3	Train Configuration Selection Verified	6/15/2023	6/15/2023	Final Train Configuration Evaluation; Completion Memo to DOE	**Complete**
5	3.2	Process Design Package Reviewed and Verified	7/13/2023	7/13/2023	Final Process PFD, H&MB, UFD, Equipment List, and Equipment Drawings; Completion Memo to DOE	**Complete**
6	2.3	Balance of Plant Scope Defined and Verified	8/3/2023	11/15/2023	Final Steam and Electric Sourcing Study, Final Cooling Water Options Study, Final Water and Wastewater Treatment Study; Completion Memo to DOE	**Complete**
7	3.3	Initial Site Layout Reviewed and Verified	9/26/2023	9/26/2023	Final Project Site Layout / Site Plan Drawing; Completion Memo to DOE	**Complete**
8	3.2	Process P&IDs Reviewed and Verified	10/25/2023	4/22/24	Final Process P&IDs; Completion Memo to DOE	**Complete**
9	3.3	HAZOP Complete and Report Reviewed and Verified	11/21/2023	4/22/24	Final HAZOP Report; Completion Memo to DOE	**Complete**
10	3.3	Permitting Requirements Identified and Verified	12/21/2023	12/19/2023	Final Permitting Matrix; Completion Memo to DOE	**Complete**
11	1.3	Initial Workforce Readiness Plan Reviewed and Verified	1/30/2024	1/30/2024	Initial Workforce Readiness Plan to DOE	**Complete**
12	3.3	Final Project General Arrangement Reviewed and Verified	2/13/2024	4/22/24	Final General Arrangement Drawings; Completion Memo to DOE	**Complete**
13	4.0	Cost Estimate Input Received and Verified	4/24/2024	6/28/24	Budgetary Quotes Received, Engineering Complete; Completion Memo to DOE	**Complete**
14	4.1	Capital Cost Estimate Reviewed and Verified	8/18/2024		Final Capital Cost Estimate; Completion Memo to DOE	**In-Progress**
15	1.0	Final Engineering Design Package	8/18/2024		Topical Report	**In-Progress**
16	1.0	Project Stakeholder Results Review	9/11/2024		Meeting Held w/ Feedback Documented; Completion Memo to DOE	**In-Progress**
17	1.0	Final DOE Report & Presentation	12/6/2024		Topical Report and Presentation Completed /Submitted	**In-Progress**

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SUCCESS CRITERIA

Date	Success Criteria
July 13, 2023	Process design of ION CO_2 capture technology using ICE-31 solvent designed for 95% target CO_2 capture efficiency complete.
August 18, 2024	Feasibility of Polk Unit 2 NGCC CO_2 capture project demonstrated by completing engineering design package including capture system and balance of plant systems suitable to support a Class 3 cost estimate accuracy.
August 18, 2024	Final cost estimate and cost-of-capture to establish project economics to evaluate a business case for the project, targeting $80/tonne or less.
December 6, 2024	Complete FEED Study report with project execution plan and workforce readiness plan to demonstrate proof of concept for project and establish path forward for project.

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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.

- Tampa Electric has a comprehensive risk matrix.
- Throughout the project, Tampa Electric has and will continue to impose risk mitigation (technical, schedule, and cost) steps to ensure 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

PROJECT STATUS

- Project Basis of Design finalized
- FEED Engineering complete, Final Engineering Design report in progress
- Capital Cost Estimate input received from all vendors and verified by project team
- Constructability Review complete, Site Plan finalized
- Balance of Plant selection studies complete
- ST OEM has confirmed feasibility of IP-LP XO Extraction
- HRSG OEM completed assessment of AGP Upgrade and steam extraction impacts
- Process water balance complete, site has confirmed adequate makeup water is available
- Business Case Modeling in progress

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CONCLUSION OF FEED ENGINEERING

- Conducted initial process design review meeting early
  - Results indicated initial decision of steam source (auxiliary boilers) needed further evaluation
  - Project team performed evaluation of four different steam sources
  - Decision to shift to steam extraction coupled with CT AGP upgrades based on economic evaluation of CCS impact to Tampa Electric's overall generation portfolio
- Began Constructability discussions early with GWC and Vessel Fabricator
  - Numerous discussions throughout FEED Engineering effort, with feedback from construction team integrated into the design
  - Site layout optimized vessel locations to minimize large crane movement and exclusion zones
  - Modularization and heavy haul reviewed, transport envelope minimizes benefit of large-scale modularization
- Critical Design Review and HAZOP Meetings held Q1 2024
  - LP steam supply pressure optimization identified in CDR allows steam extraction at lower ST loads
  - Process improvements identified in HAZOP are expected to lead to capex reduction

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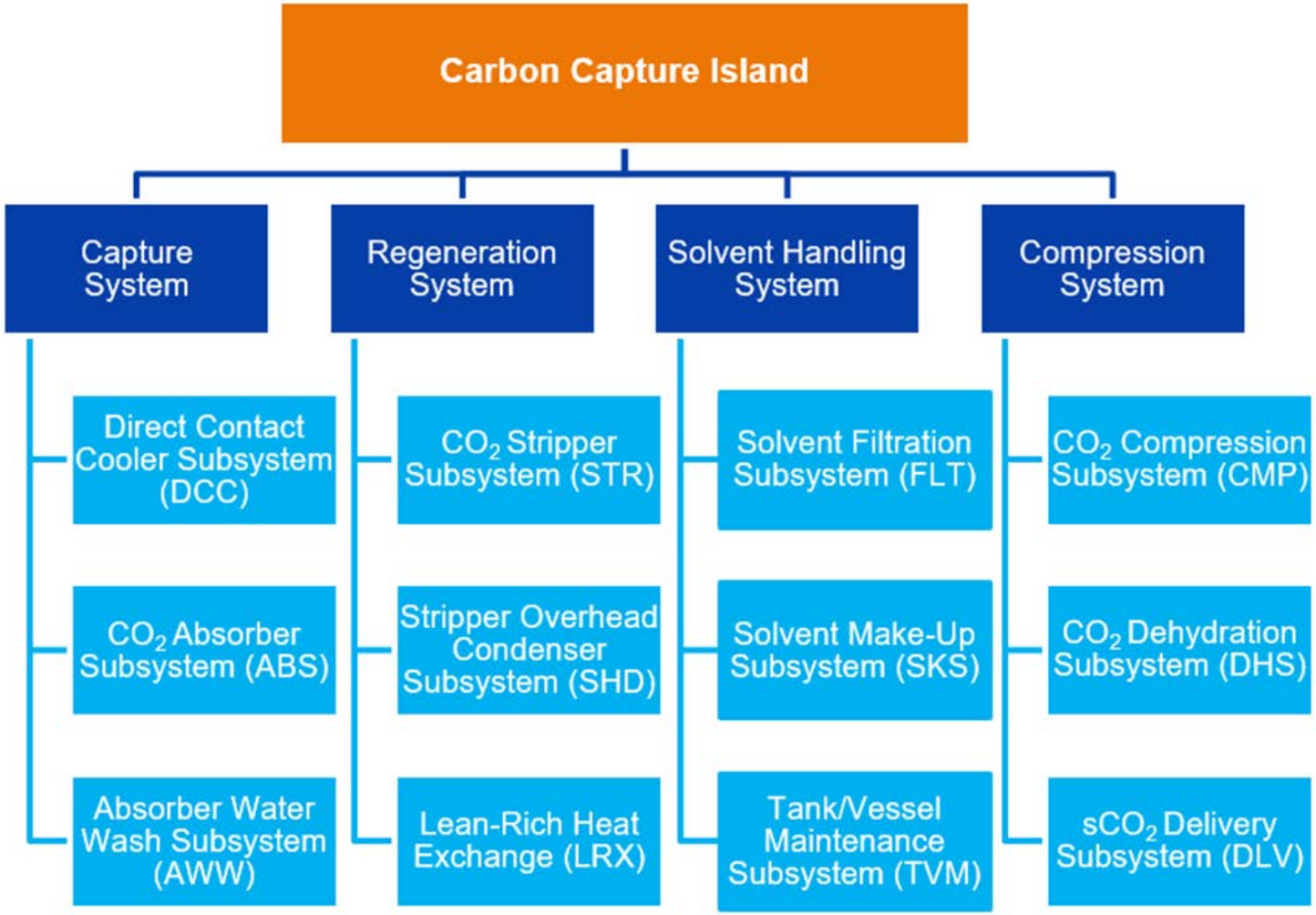
POLK UNIT 2 CCS SYSTEM ARCHITECTURE



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PROCESS DESIGN PACKAGE: DESIGN BASIS

KEY ITEMS

- Process design at 2x50% trains for the Carbon Capture Island (CCI)
  - Each Train contains: direct contact cooler, absorber, stripper, compressor and various heat exchangers, tanks and pumps
  - Large direct contact cooler and absorber vessel – Tank vendor can support the large size (63’ diameter, DCC; 62’ diameter ABS)
  - Vendor confirms that the large absorbers can support turndown to 38% of design flue gas flow rate
- Significant utilities:
  - Steam extracted from existing steam turbine
  - Cooling water temperature at 88°F
- The CO_2 product shall satisfy 1,300 psig discharge pressure and ≥95% purity

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CCI DESIGN PROCESS

- ION predicted capture efficiency based on operating conditions and equipment.
- ION generated full HMB, steam, electrical and cooling duties required for operation (per train).
- Koch Specialty Plant Services designed columns based on ION specifications.
- S&L designed tanks, pumps, heat exchangers, piping etc. based on ION specifications.
- Siemens designed CO_2 compression and dehydration based on captured CO_2 at full load and turndown.
- The team iterated based on equipment limitations and design considerations.

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STEAM AND ELECTRIC SOURCING STUDY

PURPOSE:

- To determine how steam and power will be provided to the capture facility
- Evaluate based on performance and cost impacts
- Support from HRSG and STG OEM's

STEAM SOURCING SCENARIOS EVALUATED

1. Steam extraction
2. Auxiliary boilers (Preliminary Process Design Basis)
3. Combined Heat and Power (CHP)
4. Steam Extraction with Advanced Gas Path (AGP)

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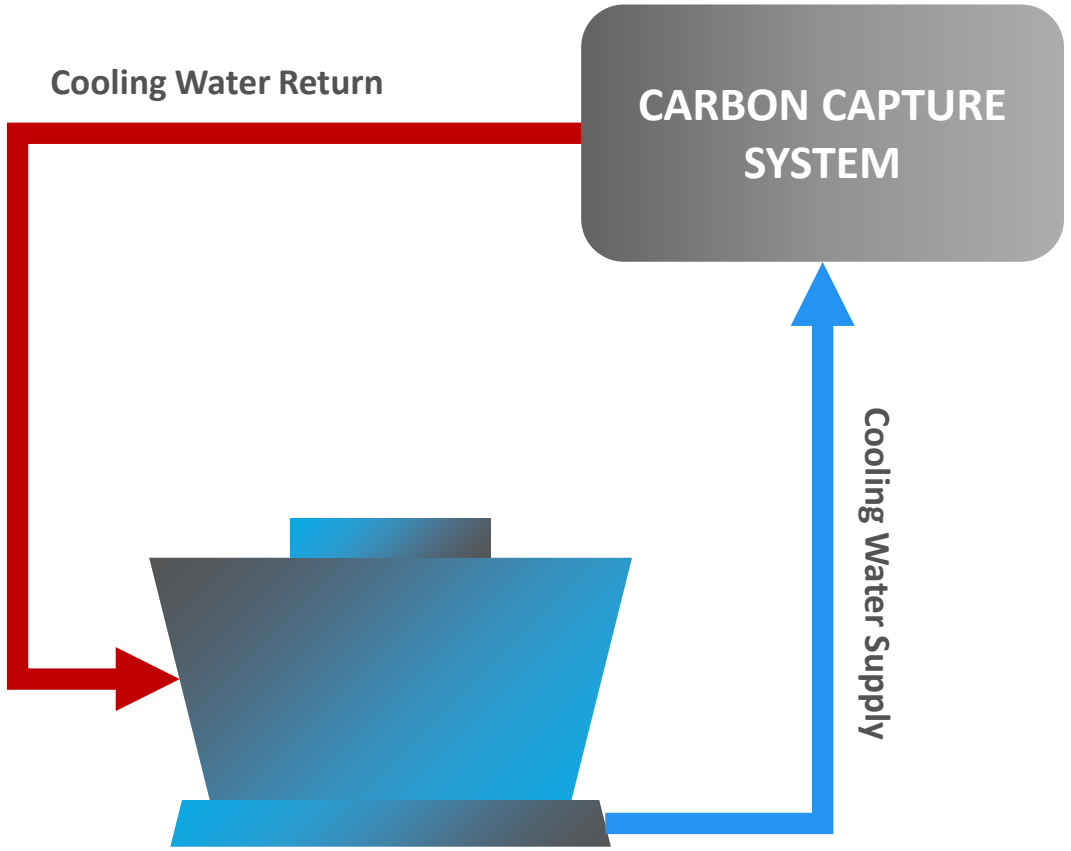
COOLING SOURCING STUDY

PURPOSE:

- To evaluate various cooling options to handle the heat rejection demands of the CCS.
- Review water availability along with existing permit limits for water demands and quality.

FOUR COOLING SYSTEMS EVALUATED

1. Evaporative systems (both closed and open loop)
2. Dry cooling
3. Hybrid cooling
4. Existing cooling reservoir



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COOLING SOURCING STUDY

RESULTS

- Evaporative system consisting of a mechanical draft cooling tower (MDCT)
- Selected due to overall cost and performance benefits compared to other cooling options
- Makeup to MDCT to be from produced water in the DCC and Polk RWTP
- Blowdown from MDCT will be sent to existing cooling reservoir

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WATER AND WASTEWATER TREATMENT STUDY

PURPOSE:

- To explore options to source and treat the water required for CCS and associated equipment
- Evaluate existing and new treatment systems to meet the water demands and quality requirements of CCS and associated equipment
- Review wastewater streams from CCS and associated equipment to identify the necessary treatment systems to meet permit limits for discharge

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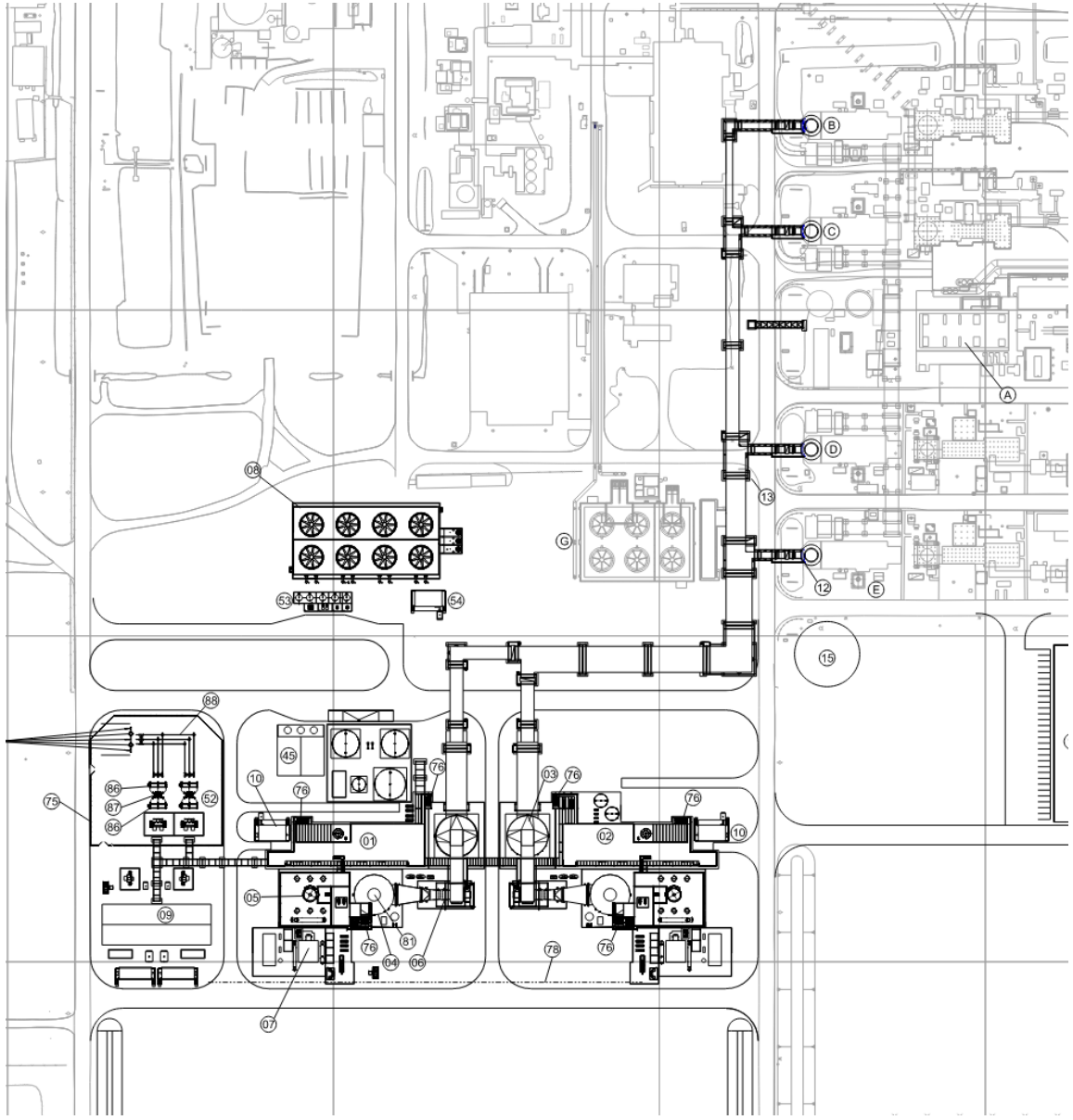
FINAL SITE PLAN



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