




Project Enterprise (DE-FE0031950)

Engineering-Scale Pilot for the Demonstration of ION's Transformational Solvent on NGCC Flue Gas

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Aug 29, 2023



Project Overview: 1 mw co₂ capture plant - NGCC

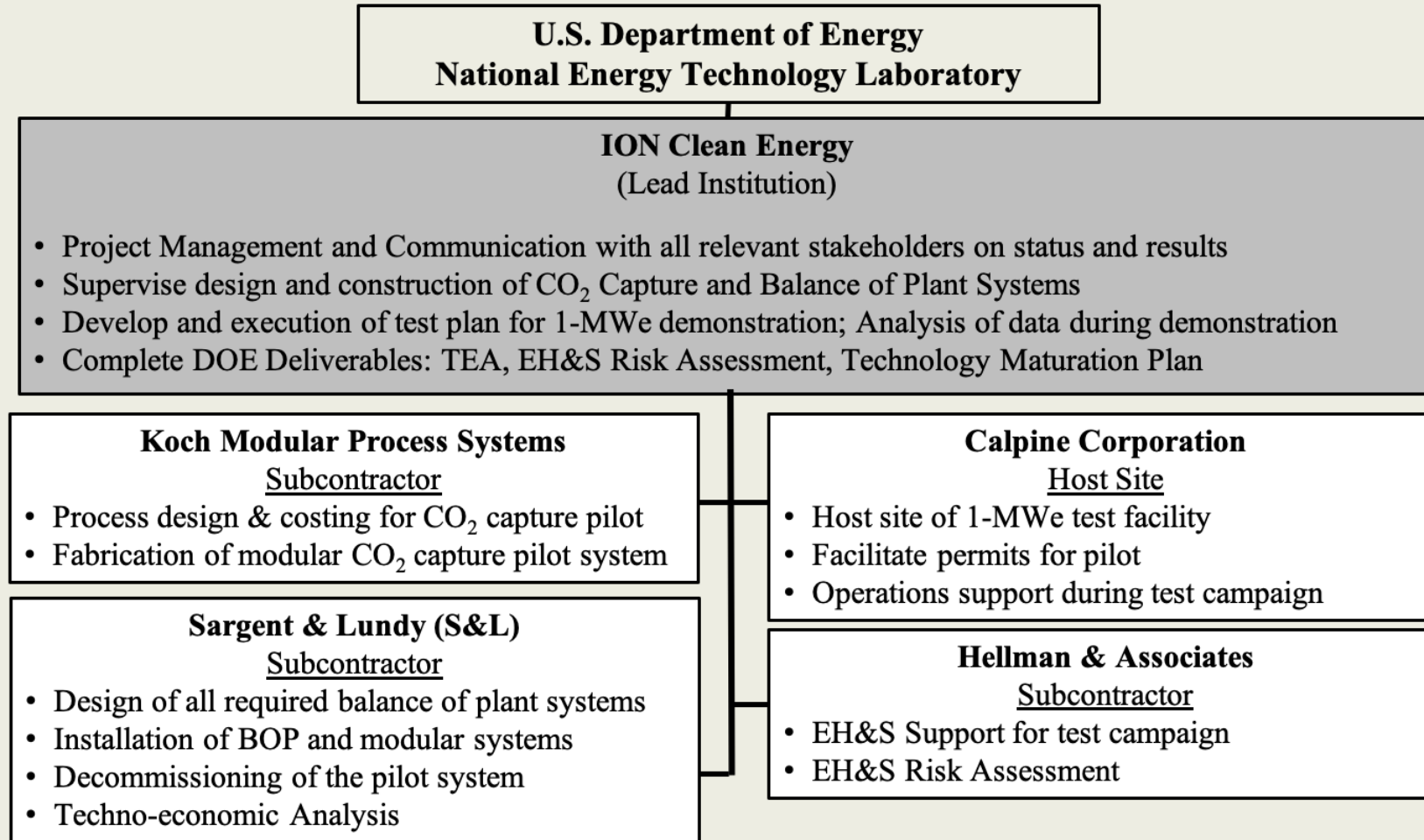


Project Objective

- The overall objective of this project is to field test an engineering scale 10 tonnes per day (tpd) CO₂ capture system on a 1 megawatt-electric (MWe) slipstream flue gas from a commercially dispatched natural gas combined cycle (NGCC) power plant to empirically validate the low capital and operating costs for ION's 3rd generation solvent (ICE-31).
 - The Budget Period 1 (BP1) design phase will result in an engineering scale system design that has the necessary flexibility for solvent performance optimization and demonstration.
 - The construction phase (BP2) will realize both the CO₂ capture island and balance-of-plant (BOP) engineering designs and result in a completely assembled facility that has completed shakedown testing.
 - The operational phase (BP3) will commence with baseline testing using 1st and 2nd generation solvents before parametric and long-term testing of ICE-31. The long-term test campaign will include demonstration of end-to-end process optimization, as well as produce comprehensive chemical costs of the NGCC carbon capture facility.



Project Team Members



Project Scope and Key Milestones

- Preliminary design, permit, and cost the pilot plant
- Finalize engineering, fabricate modules, and develop controls
- Build and install modules; Connect Balance of Plant; Commissioning
- Field-test MEA, ICE-21 and ICE-31 with NGCC flue gas
- Data evaluation and extensive reporting

#	Milestone Title / Description	Planned/Actual Completion Date
M2	Kickoff Meeting	12/09/2020
M4	HAZOP Completed	05/27/2021
M6	Modular Pilot System Fixed Cost	06/18/21
M10	All Required Permit Documents Submitted	4/29/2021
M11	Balance of Plant Host Site Preparation Complete to Accept Modules	1/27/2023
M12	Modular Pilot System Fabricated & Factory Acceptance Testing	2/13/2023
M13	Modules Delivered to Host Site	5/10/2023
M14	Commissioning of Pilot System Complete	8/30/2023
M16	Baseline MEA and ICE21 Testing Complete	11/30/2023
M17	ICE31 Testing Complete	12/31/2024





Project Enterprise – BP1

Budget Period 1: Design Phase

Task 1 – Project Management

Task 2 – Design of NGCC 1 MWe (10tpd) Engineering Scale System

Subtask 2.1 – Carbon Capture System Basic Engineering

Subtask 2.2 – Balance of Plant Design

Subtask 2.3 – Host Site Agreement & Permitting

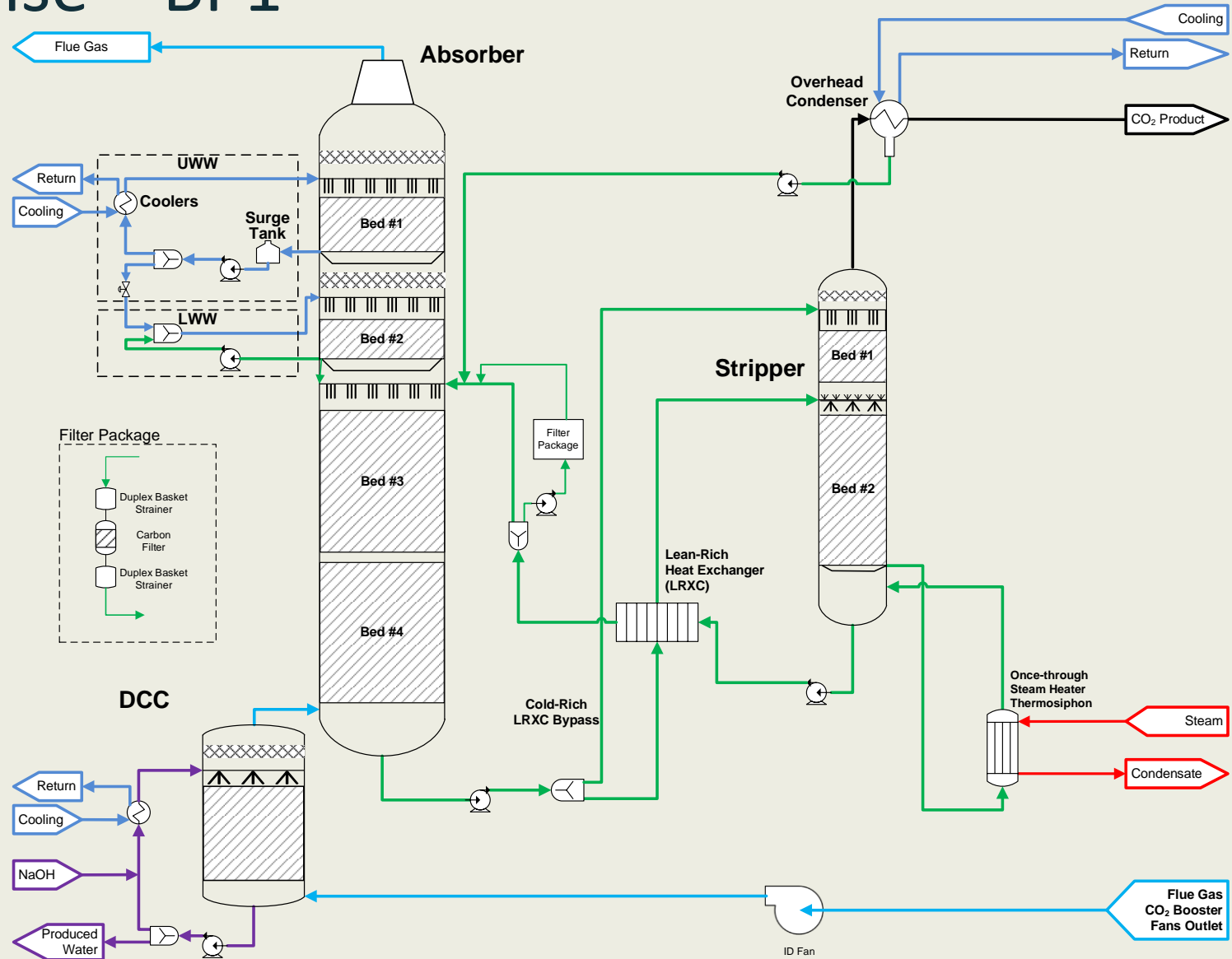
Success Criteria for BP1:

Signed Host Site Agreement, all necessary permits submitted, and refined pricing for the cost of fabrication and installation of the modular capture system with supporting BOP systems.



Project Enterprise – BP1

Process Flow Diagram



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Project Enterprise – BP2

Budget Period 2 – Construction Phase

Task 3 – Construction of NGCC 1MWe (10tpd) Engineering Scale System

- Subtask 3.1 – Host Site Preparation
- Subtask 3.2 – Carbon Capture System Detailed Engineering
- Subtask 3.3 – Fabrication of Carbon Capture System Modules
- Subtask 3.4 – Shipment of Modules
- Subtask 3.5 – Modular Plant Installation & On-site Tie-ins
- Subtask 3.6 – Site Acceptance Testing

Task 4 – Operational Preparation

- Subtask 4.1 – Solvent Procurement
- Subtask 4.2 – Detailed Test Plan & Training

Success Criteria for BP2:

The modular pilot has been fabricated, installed on site, and commissioned to verify operation. Required solvents have been delivered, and a detailed test plan has been reviewed and approved by ION and Calpine. Budget and revised project plan presented for approval to DOE for Budget Period 3.



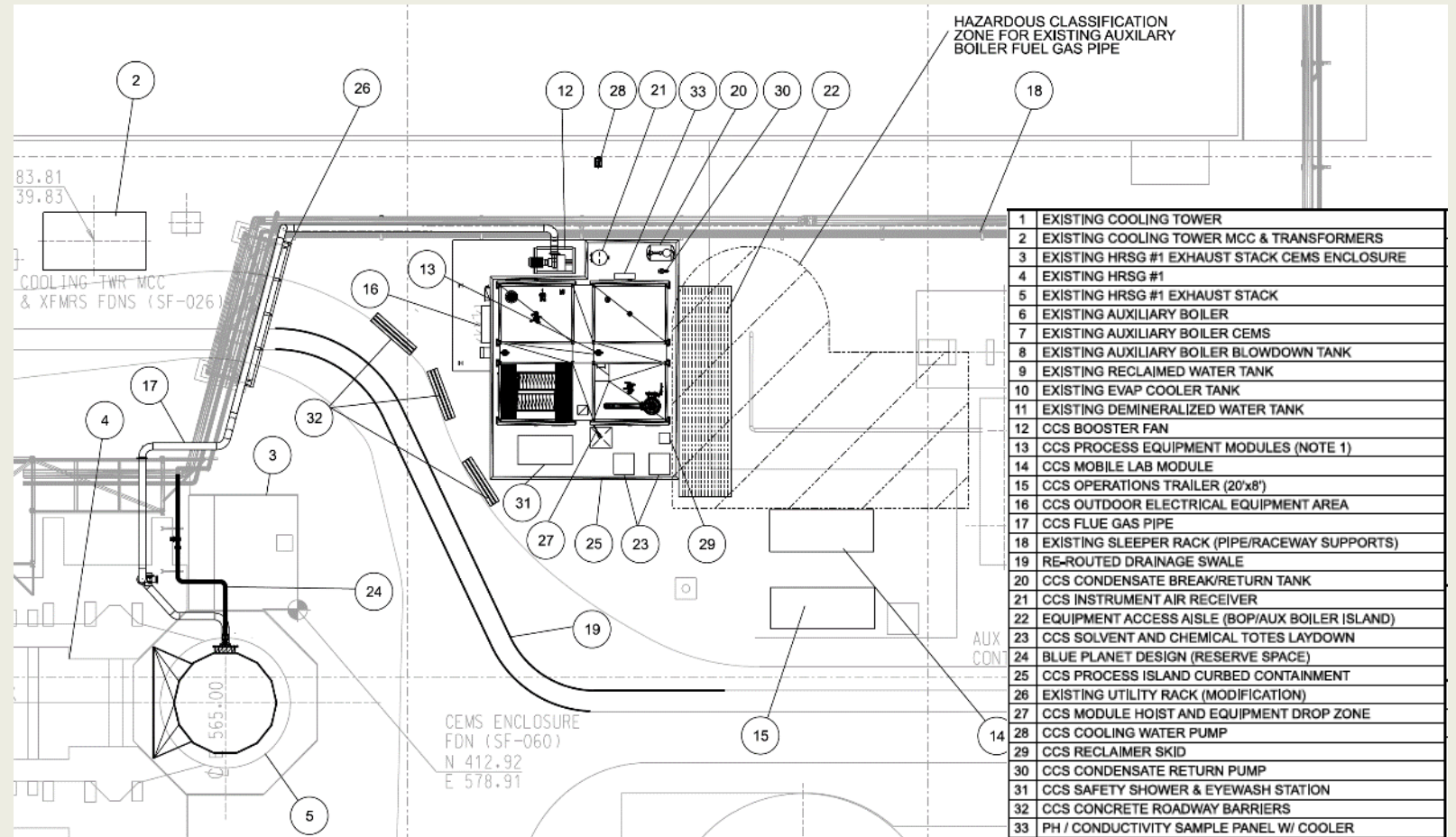
Design Tasks



Project Enterprise – BP2

Host Site Preparation

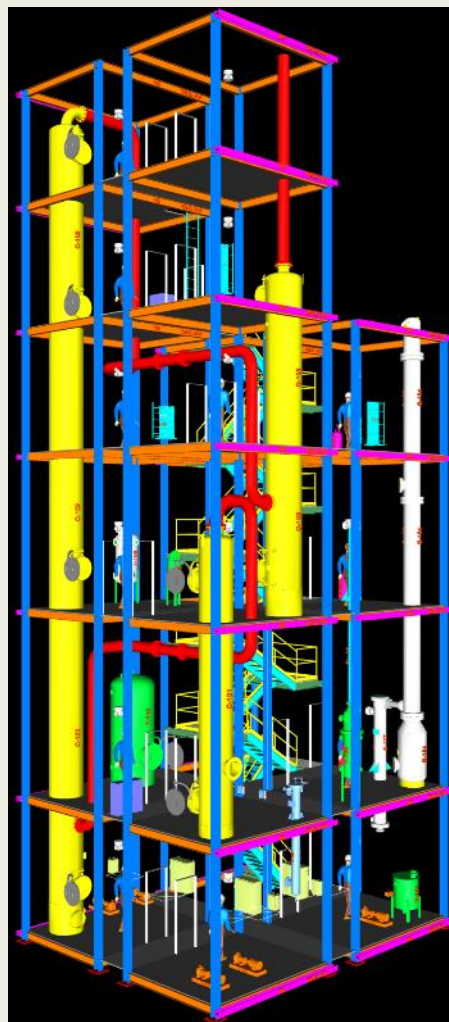
- BOP Systems
 - Flue Gas
 - Electrical
 - Cooling Water
 - Steam/Condensate
 - Foundations



Project Enterprise – BP2

Detailed Design

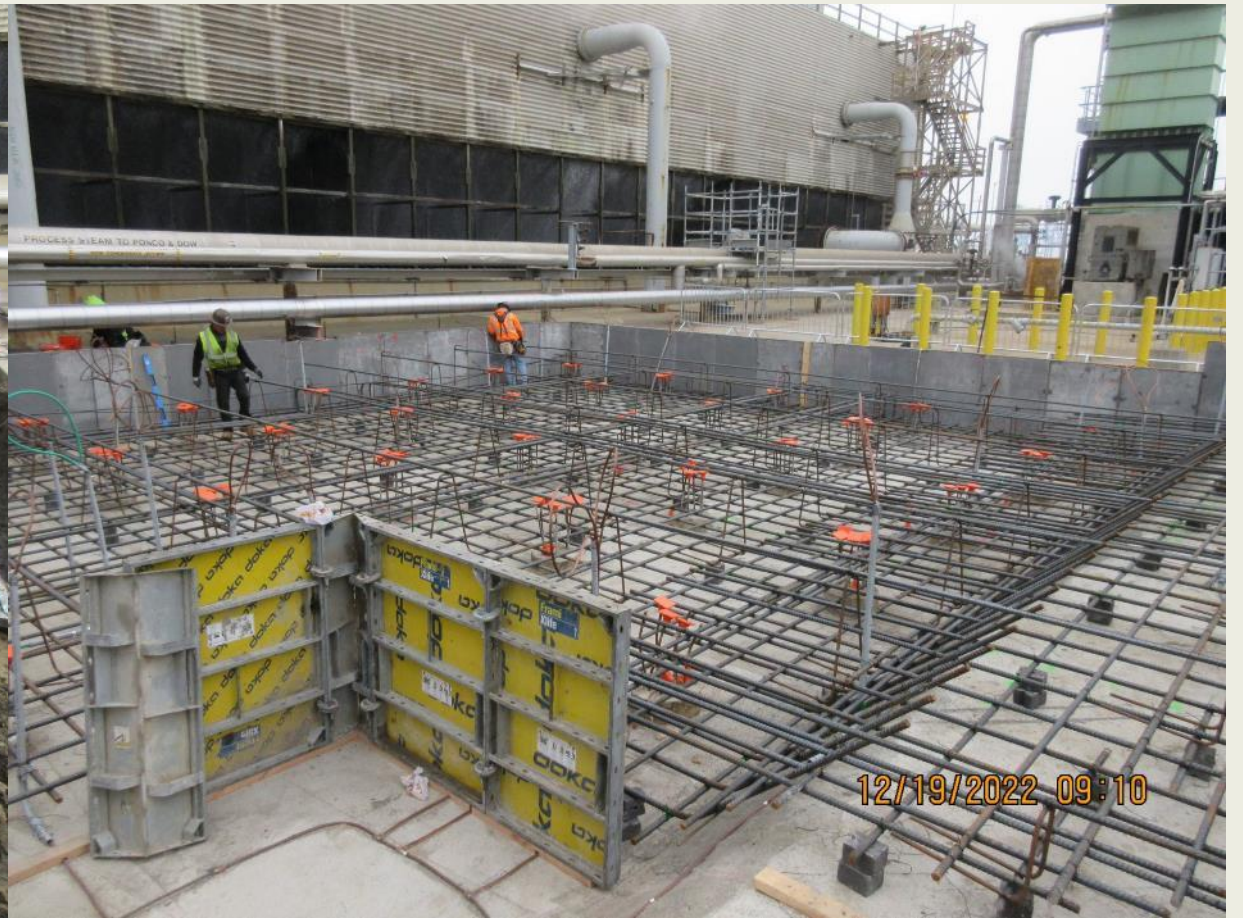
- Detailed Engineering Packages
 - Piping Design
 - Structural Steel Design
 - Column Design
 - Column Internals
 - Vessels
 - Heat Exchangers
 - Pumps
 - Strainers
 - Agitators
 - Instrumentation
 - Control System
 - Valves



Construction Tasks



Site Preparation



Site Preparation



Module Fabrication – Beaumont, TX



Ion Clean Energy - Enterprise



Module Fabrication – Beaumont, TX



Ion Clean Energy - Enterprise



Module Fabrication – Beaumont, TX



Ion Clean Energy - Enterprise



Module Fabrication – Beaumont, TX



Ion Clean Energy - Enterprise



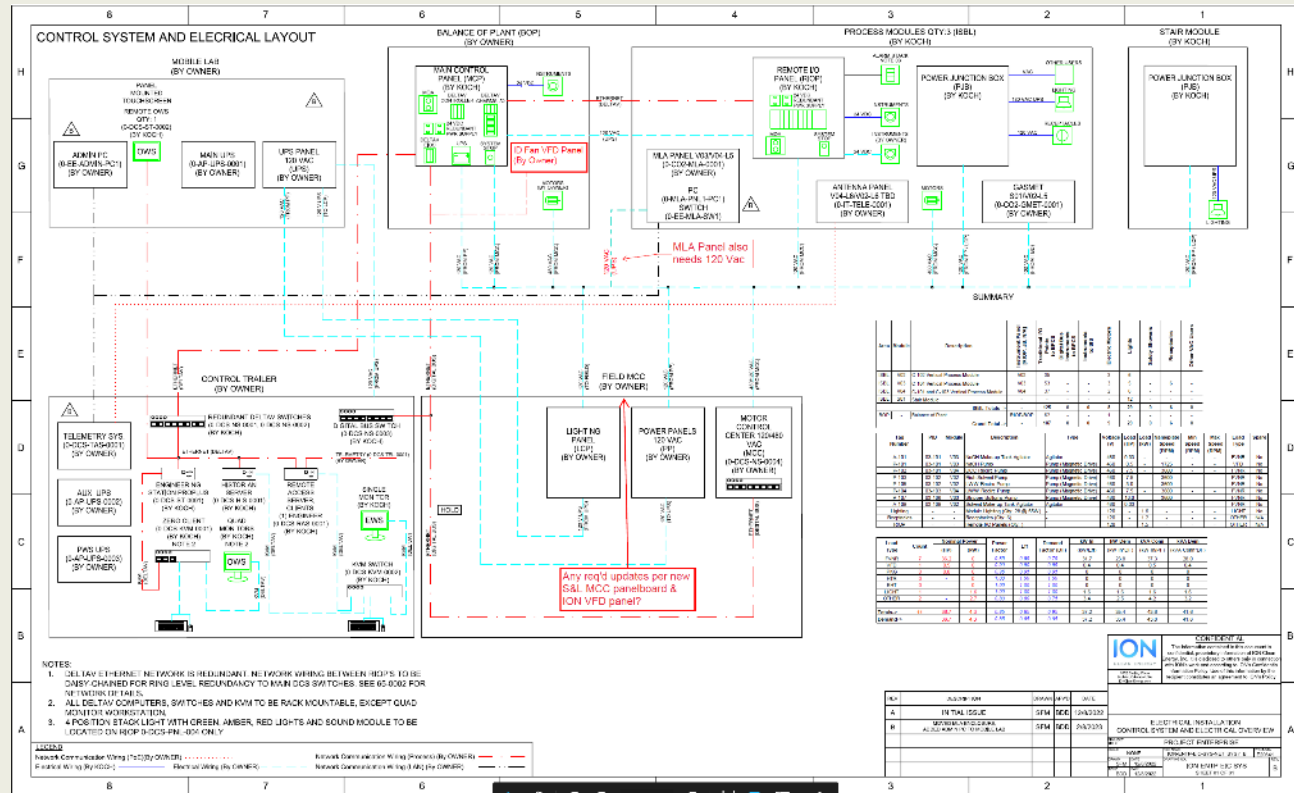
EIC Development

ENTP EIC Activities during BP2 included:

- Develop Control System and Electrical Layout
- Module Assembly Shop (MAS) FAT: milestone check of ISBL/process instrument installation and communications
- EIC Commissioning: Power-On, Communication, Configuration, and Loop Testing

Challenge:

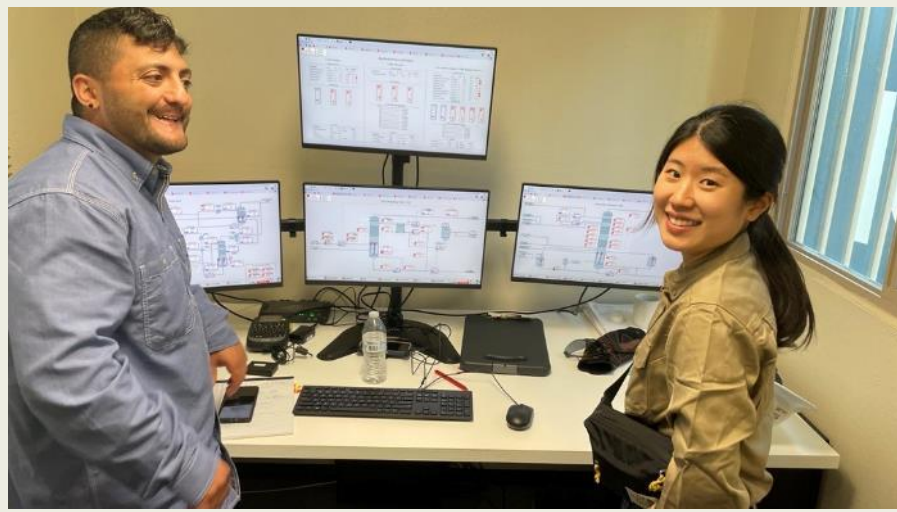
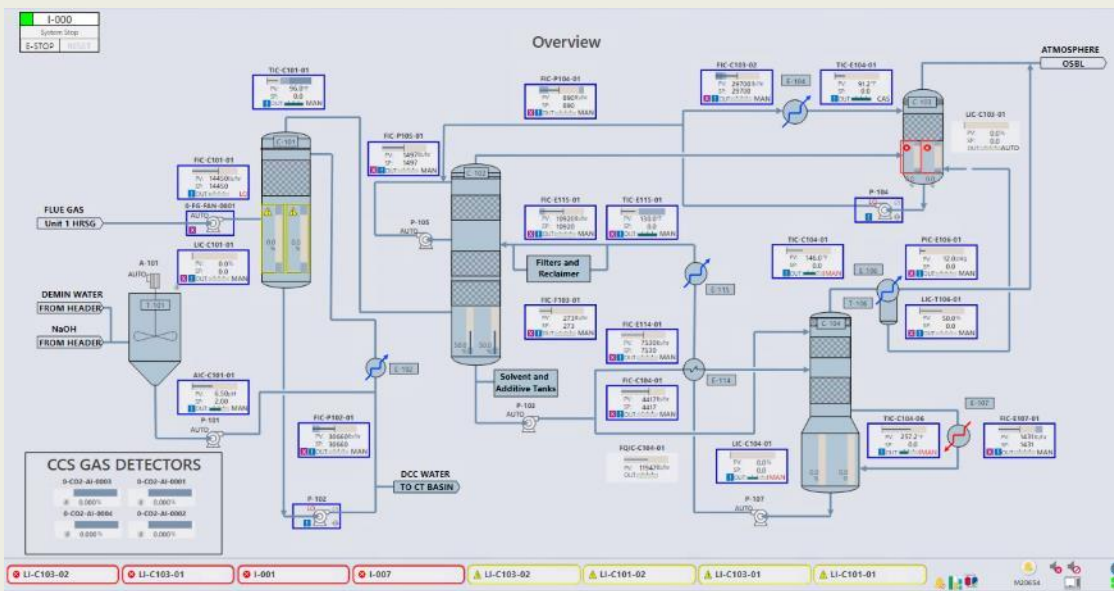
- Eaton kept slipping the delivery of the MCC necessary for powering the modules.
- Ultimately, Eaton could not commit to meeting a drop-dead date so an alternate route was taken to utilize a 480V panel and a series of combination motor starters with disconnects.



EIC Development

ENTP EIC Activities during BP2 included

- Control Functional Description (CFD) document (requirements of the process control software)
- Software Development: integration of ISBL + BOP CFD's
- Operator Work-Station (OWS) Screen Review
- Software Unit Testing



This block contains two screenshots of the operator workstation interface.

The left screenshot shows an 'Interlocks' window for system 'I-000'. It lists various interlock conditions and their states:

I-001: Stop Flue Gas Blower (Red X)	I-002: Flue Gas Isolation Valve (Green)
I-003: Booster Fan Shutdown (Green)	I-004: PS Isolation Valve (Green)
I-005: Condensate Pump (Green)	I-006: Cond Ret Throttling Valve (Green)
I-007: CWS Pump (Red X)	I-008: CWR Isolation Valve (Green)
I-009: DCC Blowdown Isolation Valve (Green)	

 The right screenshot shows a detailed view of the 'A-101 NaOH Makeup Tank Agitator'. The status is 'Running'. Key parameters include:

- Power Monitor: 0.0 Amps
- State Transition Time Limit: 10.0 s
- Elapsed Time: 1.0 s
- Device State: Confirmed State 1
- Operation State: Normal
- Failure State: Failure State

 The interface includes 'Stop' and 'Start' buttons, an 'Ack Alarm' button, and a 'Help' button.



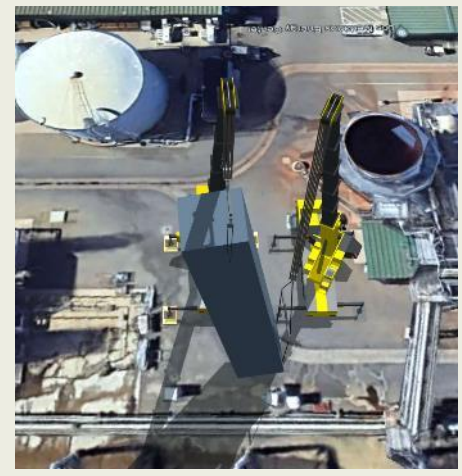
Shipping and Installation



Modules Lift Plan



Crane	
Grove CMR619KCL	
120.5 Main Boom at 75.5'	
Base - 90% Outriggers (28.8' x 27.8')	
Counterweight: 300,000 lbs	
75' L/R Radius (600')	
Crane Capacity at 75' = 140,000 lbs	
Load	
Base:	3,670 lbs
Rigging:	2,013.1 lbs
Total Rigging Weight:	10,700 lbs
50% of Load:	40,000 lbs
Total Load:	50,700 lbs
82% of capacity	
Upper Ring Tension:	59,073 lbs
Middle Ring Tension:	44,414 lbs
Lower Ring Tension:	11,208 lbs
Crane	
Grove CMR6275	
118' Main Boom at 72.7'	
Base - 90% Outriggers	
Counterweight: 155,000 lbs	
80' L/R Radius (160')	
Crane Capacity at 80' = 420,000 lbs	
Load	
Base:	3,300 lbs
Rigging:	1,813.1 lbs
Total Rigging Weight:	4,113 lbs
50% of Load:	40,000 lbs
Total Load:	44,113 lbs
74% of capacity	
Upper Ring Tension:	33,829 lbs
Lower Ring Tension:	31,208 lbs
Not issued for construction. For pre-planning only	
Title:	Lift Plan
Project:	EDPS
Customer:	GenCorp
Prepared by:	UD: J...



Module Loading



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Module Transport

Routing Survey and Considerations:

- Texas – no police escort, route approved
- New Mexico – no police escort, route approved
- Arizona – police escort around Phoenix, must schedule 5 days in advance
- California
 - Only allowed to ship 2x modules per week
 - Permit required for each module – 30 day permitting process, valid for 30 days
 - California Highway Patrol Escort
 - Needed for each module - no caravan
 - Must have permit in hand before scheduling CHP
 - 15-20 day lead time typical for CHP escort schedule

Challenges Resulting In Transport Delays:

- Initial permit request rejected (Dollar General being built too close to route)
- Delayed police escort available around Phoenix (Taylor Swift Concert)
- 50yr flood event in California closed roads on the approved routes
 - No alternate routes, had to park modules
 - Permits expired and CHP escort reservation lost
 - New Permits requested (up to 30-day clock reset)
 - New CHP escort after new permits assigned



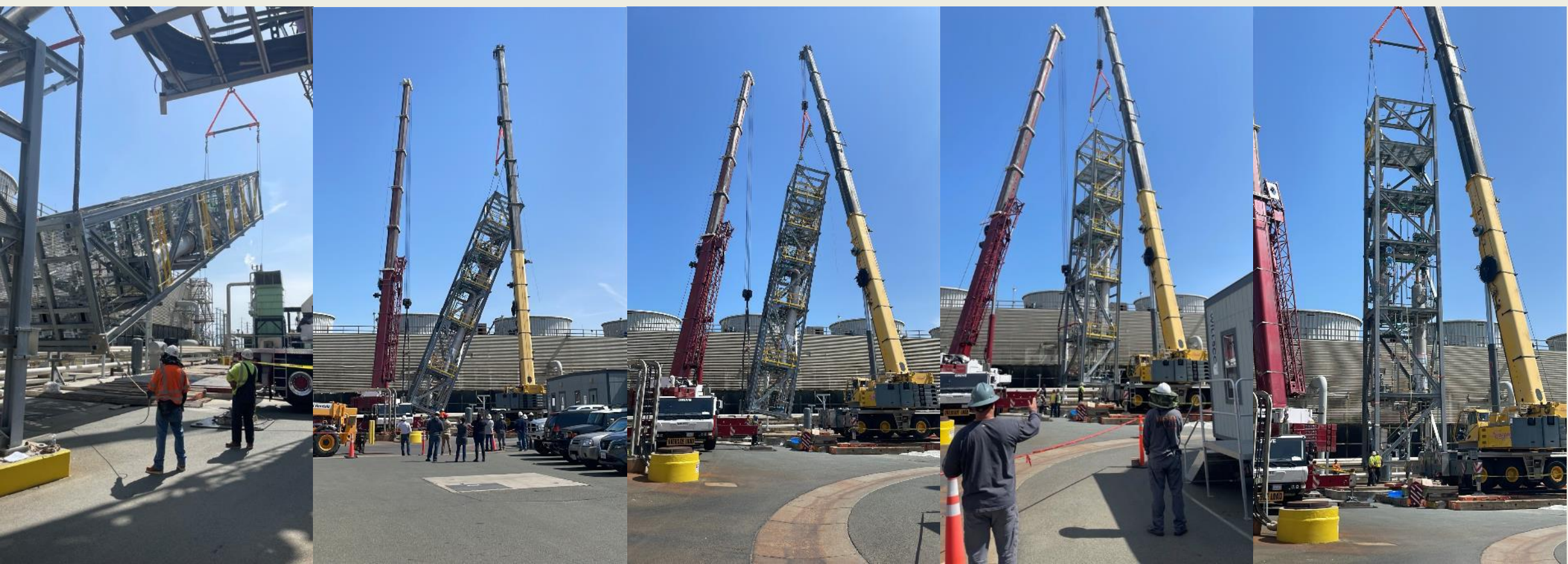
Module Transport



First Module Left Fabrication Yard: February 28, 2023
Last Module Arrived at Los Medanos: May 10, 2023



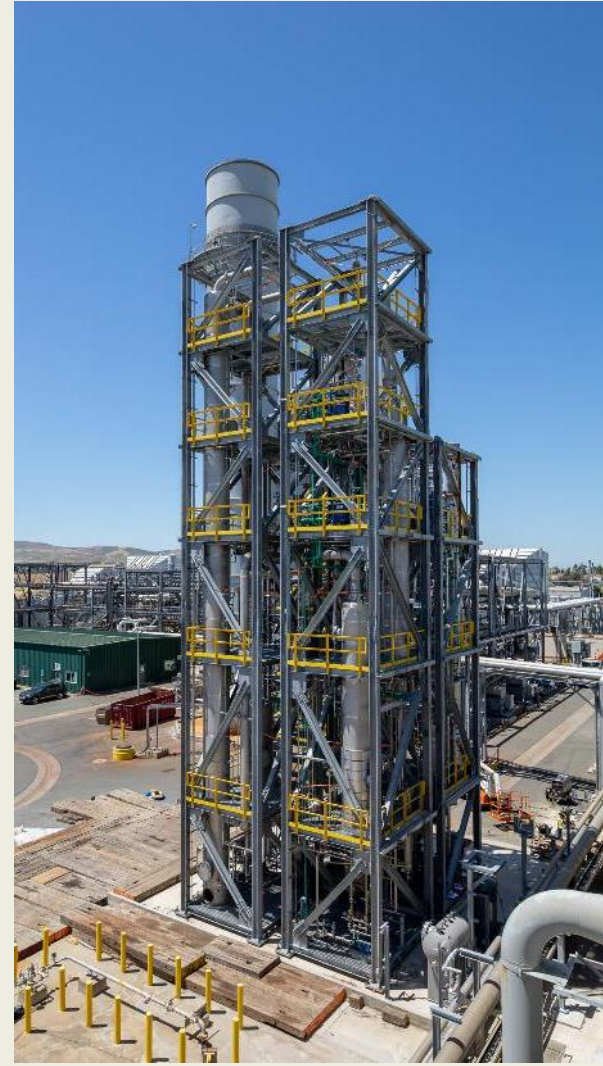
Module Lifting/Setting



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Module Lifting/Setting



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Operations Planning



Enterprise Test plan

Detailed Test Plan:

- System Level Commissioning w/ water and then MEA
- Parametric testing w/ MEA – baseline system
- Parametric testing w/ ICE-21 – baseline advanced system
- Stability test w/ ICE-21
- Parametric testing w/ ICE-31
- Long-duration stability test w/ ICE-31
 - Dynamic system testing
 - Steady-state operating solvent chemistry and performance



Operation Documents

Test Plan

1. Overall Piloting Philosophy
2. Solvent Sequence and Set Points
3. Sampling Schedule and Data Sharing

Solvent Handling

1. Safety and Spill Containment
2. Transportation and On-site Loading
3. Hazardous Materials Records and Compliance

Operating Manuals

1. Start-up, Normal Shutdown, Emergency , and Standard Operations
2. Establishing Safety Culture
3. Environmental Compliance
4. Managing Data Quality

Operating Safety Measures

1. All required daily operator actions (via filters, sensors, valves, etc.) are on the bottom two levels
2. Access via stair tower for levels 1 – 5 and ladder only for 6th level platform
3. Hoist access to allow for equipment/supplies to be moved to all levels
4. Scrubbed flue gas vented to safe height and restricted access to upper level
5. Automated control system with visible/audible signals for high/low alarms; System shutdown triggered on high-high and low-low alarms
6. Combination safety shower / eye-wash station on the ground level with eye-wash stations on each upper level



Project Enterprise

Status on ION's 10tpd CO₂ capture pilot

- System Commissioned and ready for use (pending a few punch list items).
- MEA, ICE-21 and ICE 31 solvents have been procured and warehoused for stand-by shipping where they will be received and inspected before use – MEA is on site.
- Mobile Chemistry Lab installed (electricity and plumbing) and fully stocked.
- Control Trailer installed and furnished on-site.
- Control system and Operator Workstation - Configured and tested throughout commissioning (a few punch list items remain)
- Detailed Test Plan in final revision before operation.
- Operator and host facility training ongoing.





Project Enterprise – BP3

Budget Period 3: Operations

Task 5 - Testing on the 1 MWe (10tpd) NGCC Engineering Scale System

Subtask 5.1 – MEA Baseline

Subtask 5.2 – ICE-21 Baseline (2nd Generation Solvent)

Subtask 5.3 – ICE-31 Campaign

Task 6 – Decommissioning of the 1 MWe (10tpd) NGCC Engineering Scale System

Task 7 – Data Analysis & Final Reporting

Subtask 7.1 – Data Analysis

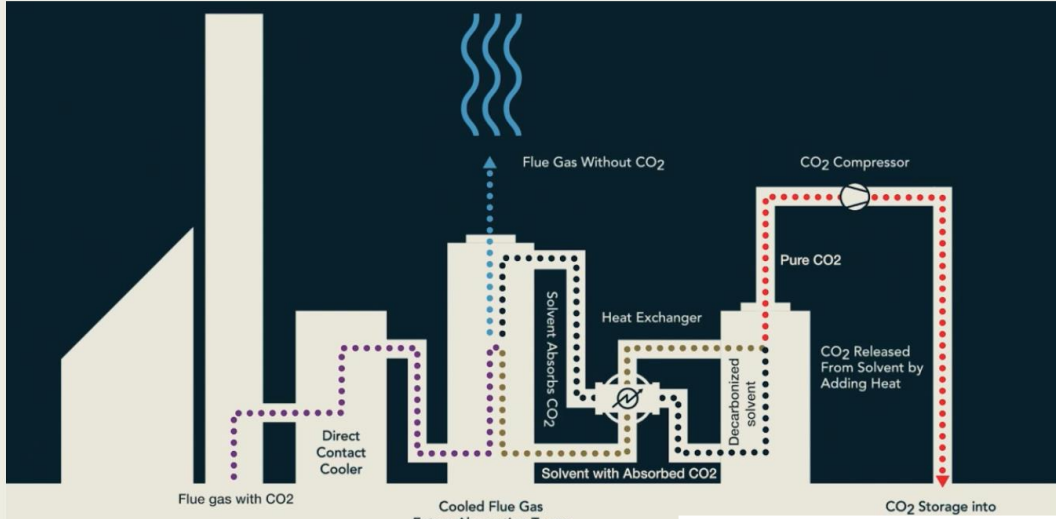
Subtask 7.2 – Preparation of Final Briefing and Report(s)

Success Criteria for BP3:

Completion of test plan on MEA, ICE-21 and ICE-31 solvents. Decommissioning of the modular system.
Completion of all required reporting and DOE Deliverables







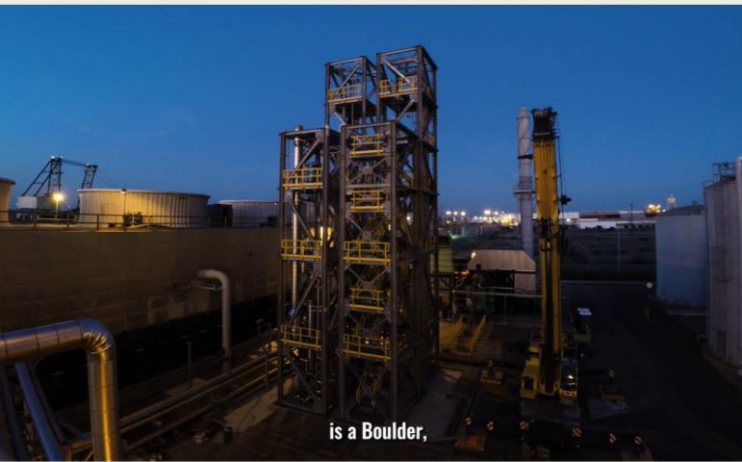
95% of the CO2 emissions

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BARBARA MCBRIDE
Calpine Corporation

monstration pilot



is a Boulder,



Aug 29, 2023



Los Medanos Energy Center

2023

Thank you





Acknowledgement & Disclaimer

Acknowledgement

This material is based upon work supported by the Department of Energy National Energy Technology Laboratory under cooperative award number DE-FE0031950.

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