



THE OHIO STATE UNIVERSITY



GTI ENERGY



U.S. DEPARTMENT OF
ENERGY

DE-FE0031946

Engineering Scale Design and Testing of Transformational Membrane Technology for CO₂ Capture

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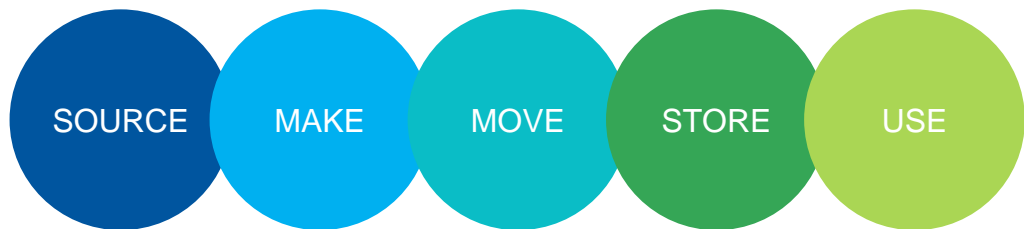
1: GTI Energy, 2: The Ohio State University (OSU)

3: Trimeric Corporation (Trimeric), 4: Wyoming Integrated Test Center (ITC)

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

GTI Energy: 80-year history of turning raw technology into practical energy solutions

GTI Energy is a leading energy research and training organization



Across the entire energy value chain

World-class facility in Chicago area



CCUS is one of GTI strategic focus areas

Active DOE Projects

Carbon capture

- **FE0031946**: 20 TPD facilitated transport membrane (FTM) for power plant application
- **FE0032466**: 3 TPD ROTA-CAP for steel plant application
- **FE0032463**: 3 TPD FTM for cement plant (sub to OSU)
- **FE0031598**: Bench-scale GO-based membrane
- **FE0032215**: Nano-confined ionic liquid membrane
- **FE0031730**: Size-sieving adsorbent (sub to UB)

Carbon conversion

- **FE0031909**: Membrane reactors for conversion of CO₂ to fuels/chemicals
- **FE0032246**: Converting CO₂ to carbon-negative alternative cement (sub to WashU)

Carbon dioxide removal (CDR)

- **FE0031969**: Trapped small amines in capsules (sub to UB)





Carbon transport and storage

- **FE0032239**: CarbonSAFE Phase II

Project Overview

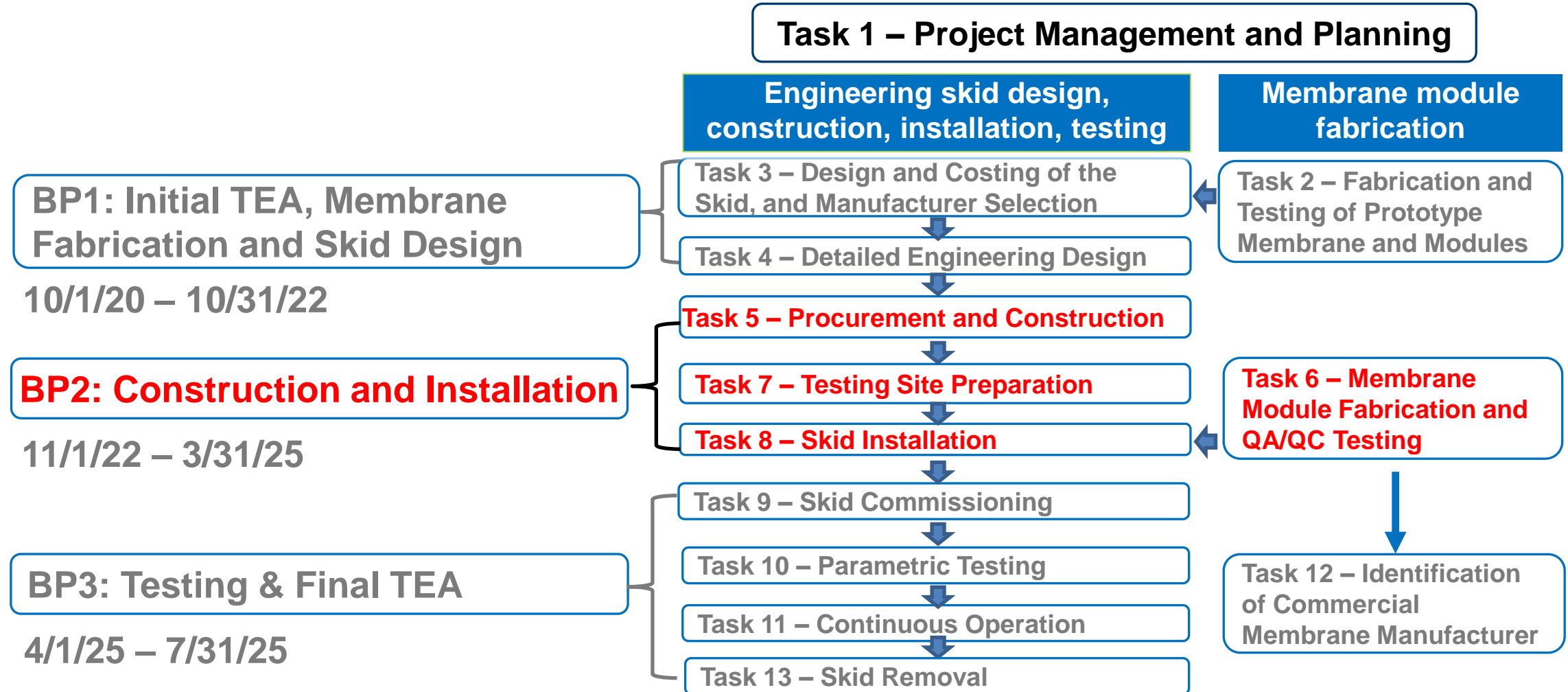
- **Performance period**: October 1, 2020 – July 31, 2025
- **Total funding**: \$20,815,061 (DOE: \$16,650,507, Cost share: \$4,164,554)
- **Objectives**: 1) Design and build an engineering-scale CO₂ capture system using OSU’s transformational membrane in commercial-sized modules; 2) Conduct tests on coal flue gas at ITC and demonstrate a continuous, steady-state operation for a minimum of two months; and 3) Gather data necessary for further process scale-up
- **Goal**: Achieve DOE’s Transformational Carbon Capture performance goal of CO₂ capture with 95% CO₂ purity at a cost of \$30/tonne of CO₂ captured and at a cost of electricity (COE) at least 30% less than baseline CO₂ capture approaches by 2030

- **Team**:

Member	Roles
	<ul style="list-style-type: none"> • Project management and planning • Skid design, selection of skid fabricator, skid installation, and testing • Support TEA and EH&S assessment
	<ul style="list-style-type: none"> • Participate in project management and planning • Membrane and module fabrication and QA/QC testing • Support skid design and field testing, TEA and EH&S study
	<ul style="list-style-type: none"> • Site host, lead on testing site preparation
	<ul style="list-style-type: none"> • TEA and EH&S assessment

Project Timeline and BP2 Overview/Roadmap

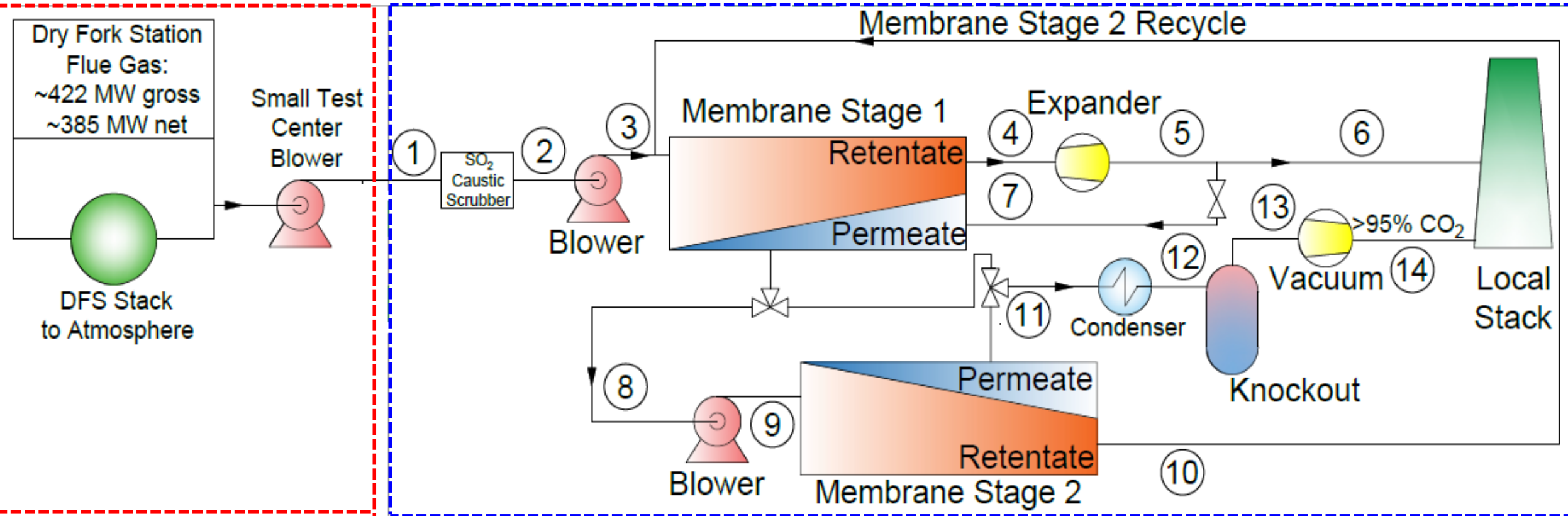
- Current project performance period: October 1, 2020 – July 31, 2025



Process Description

ITC and Dry Fork Facilities

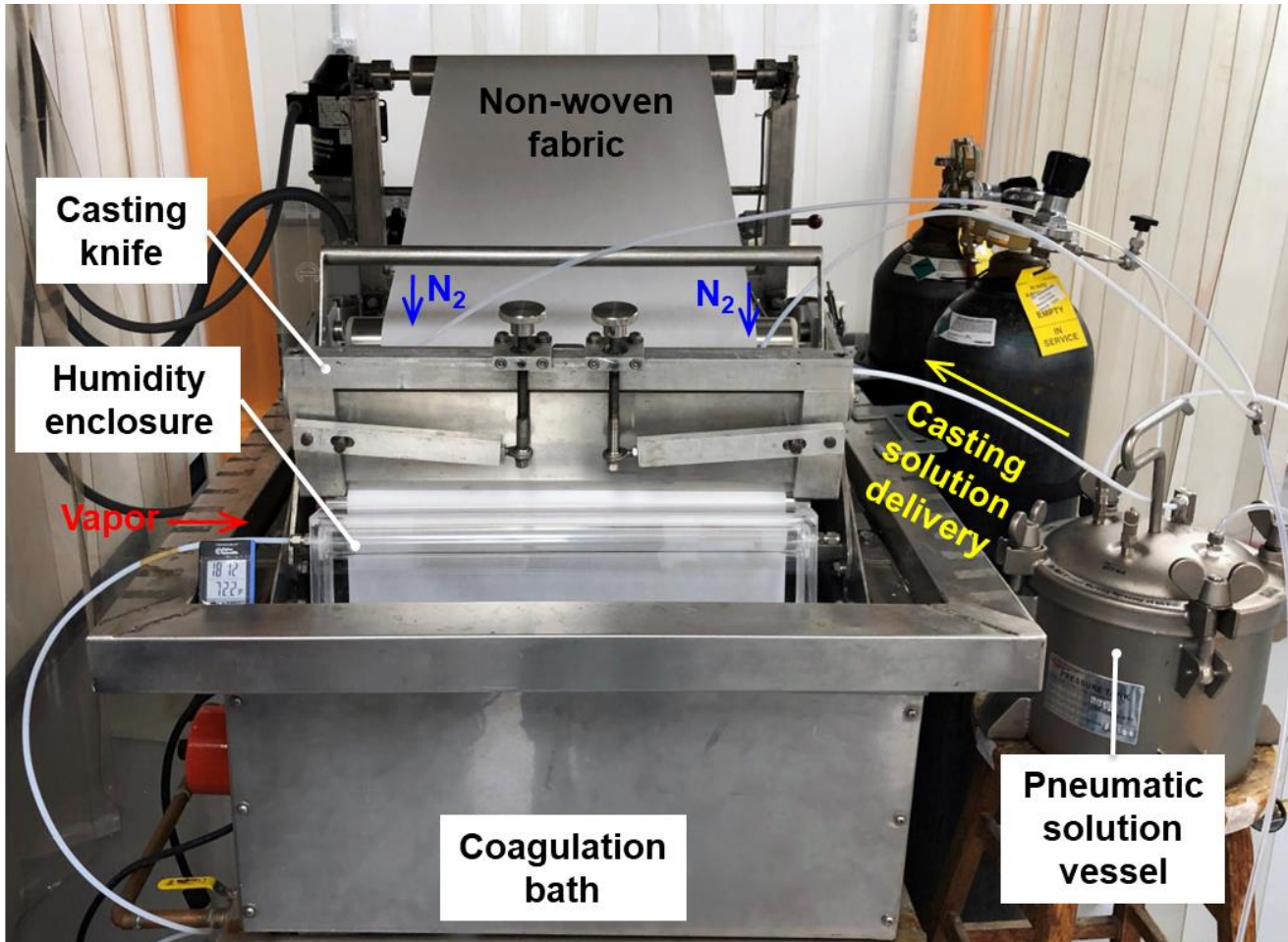
OSU & GTI Skid Boundary



Roll-to-roll Support Casting and Selective Layer Coating

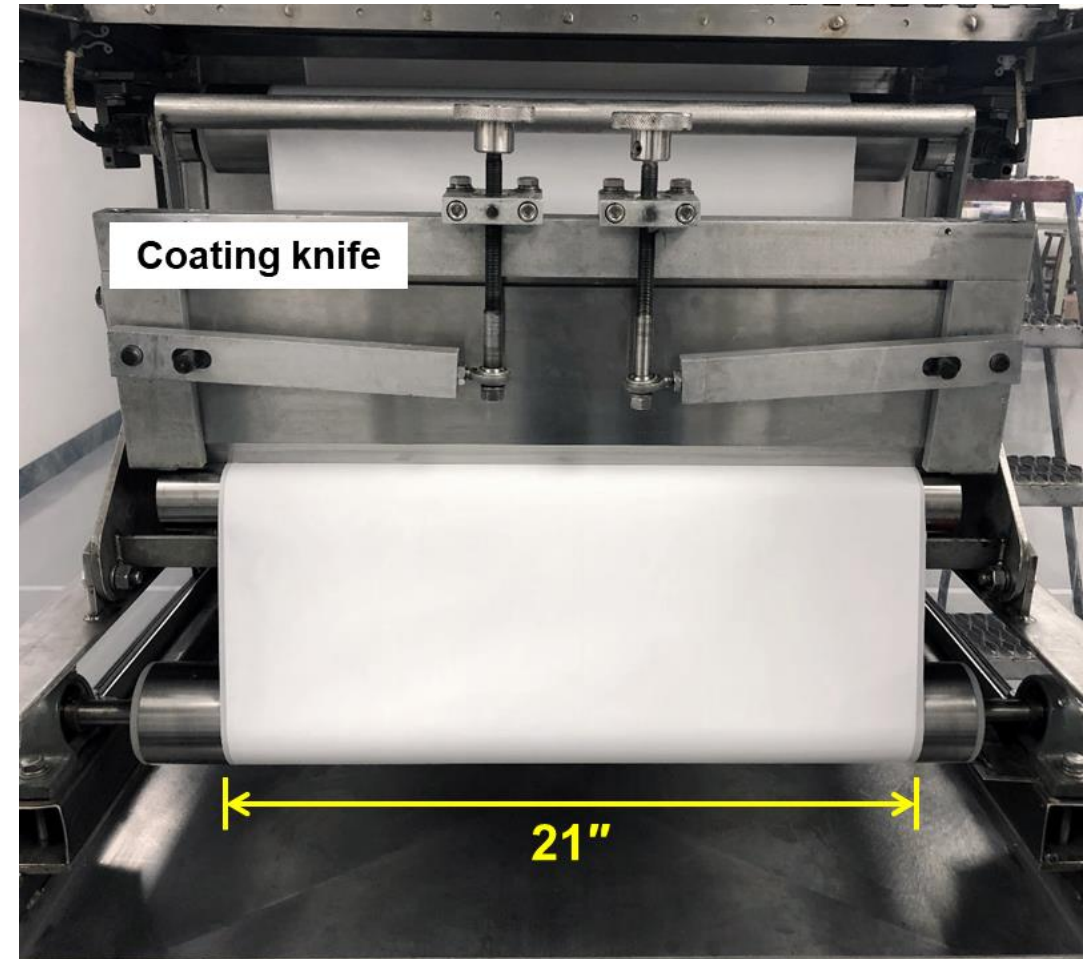
Polymer Support Casting

6,500 ft fabricated (100% of BP2 commitment)



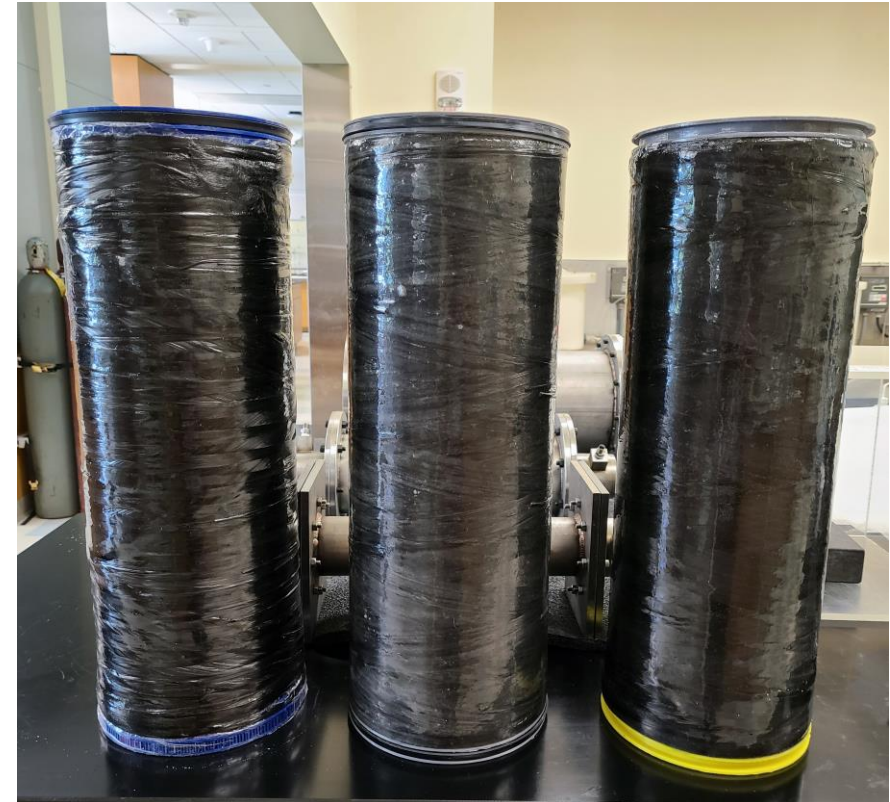
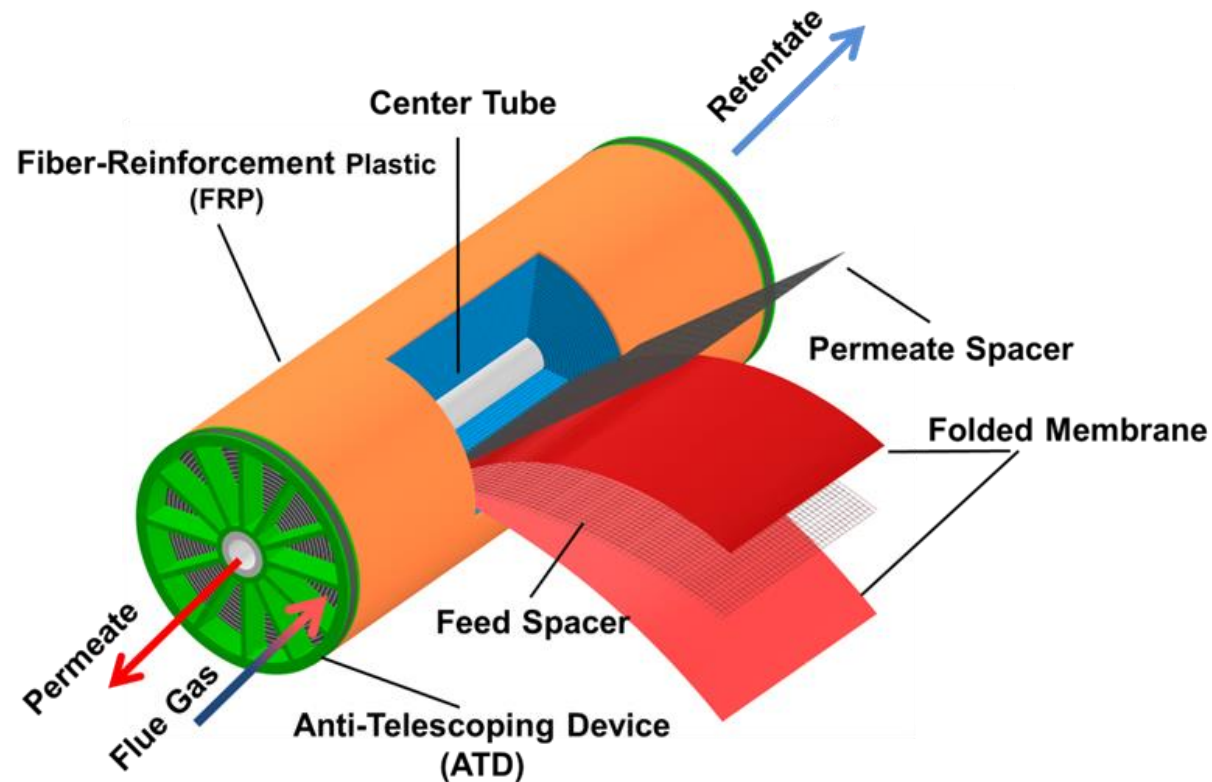
Selective Layer Coating

6,000 ft coated (100% of BP2 commitment)

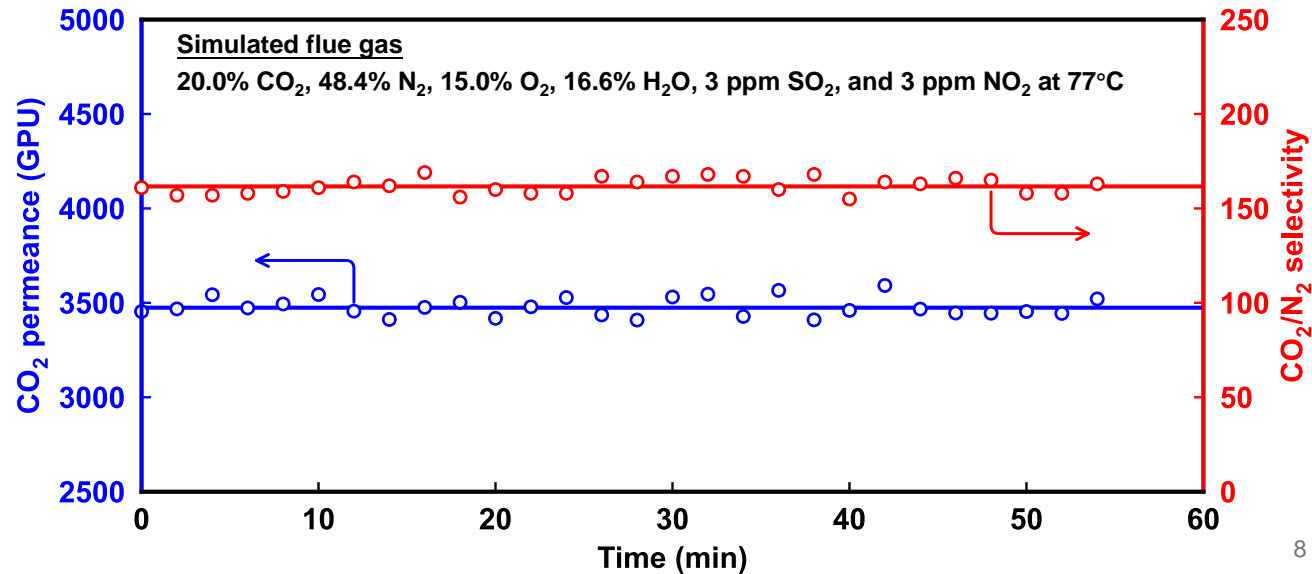
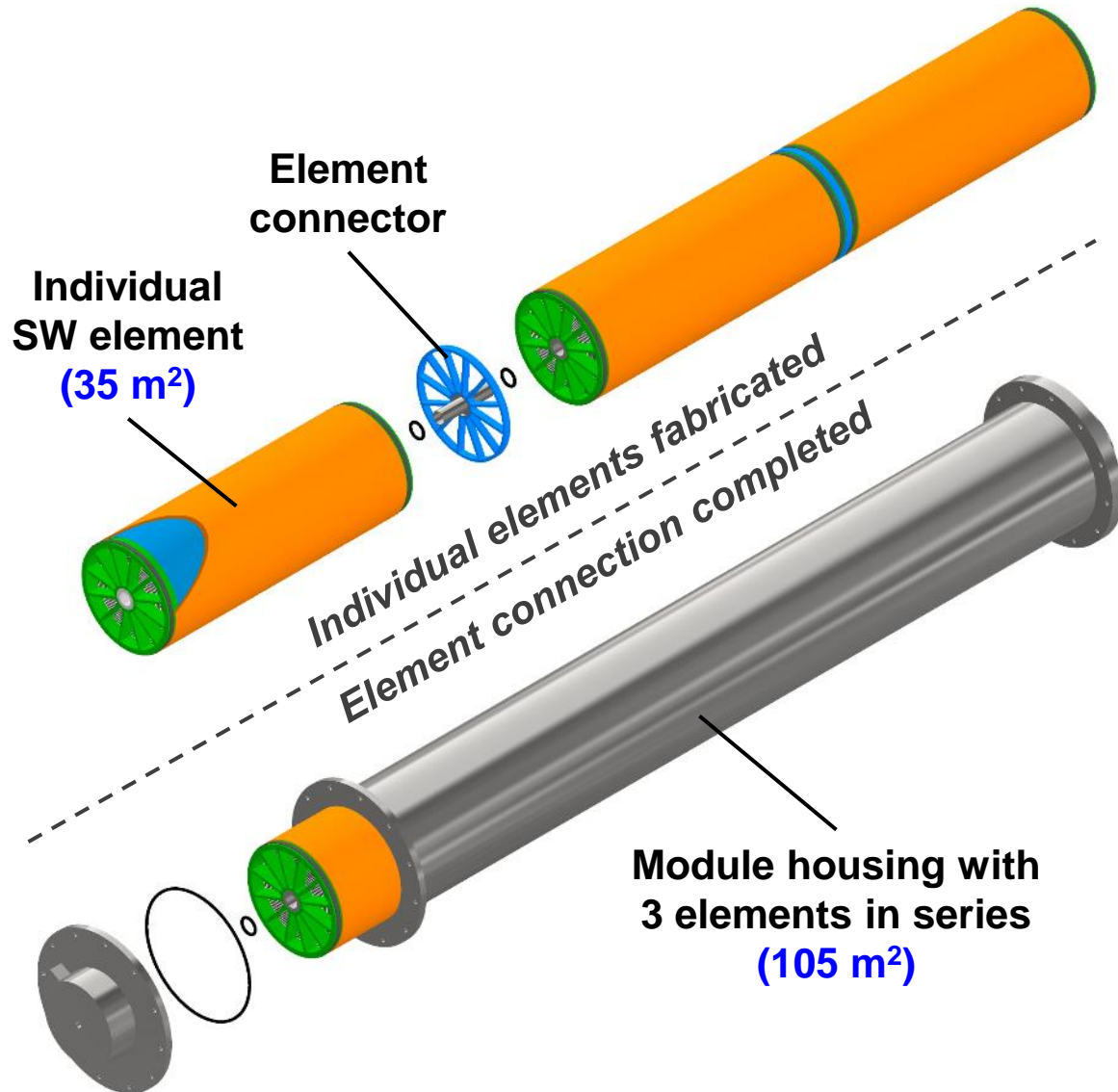


Spiral Wound (SW) Membrane Module Fabrication

- OSU has been rolling the prototype membrane into SW membrane elements
 - Each element is 8" in diameter and 35 m² in membrane area
 - 15 SW elements have been fabricated so far, equivalent to 5 full commercial-size membrane modules + 62.5% of BP2 commitment completed

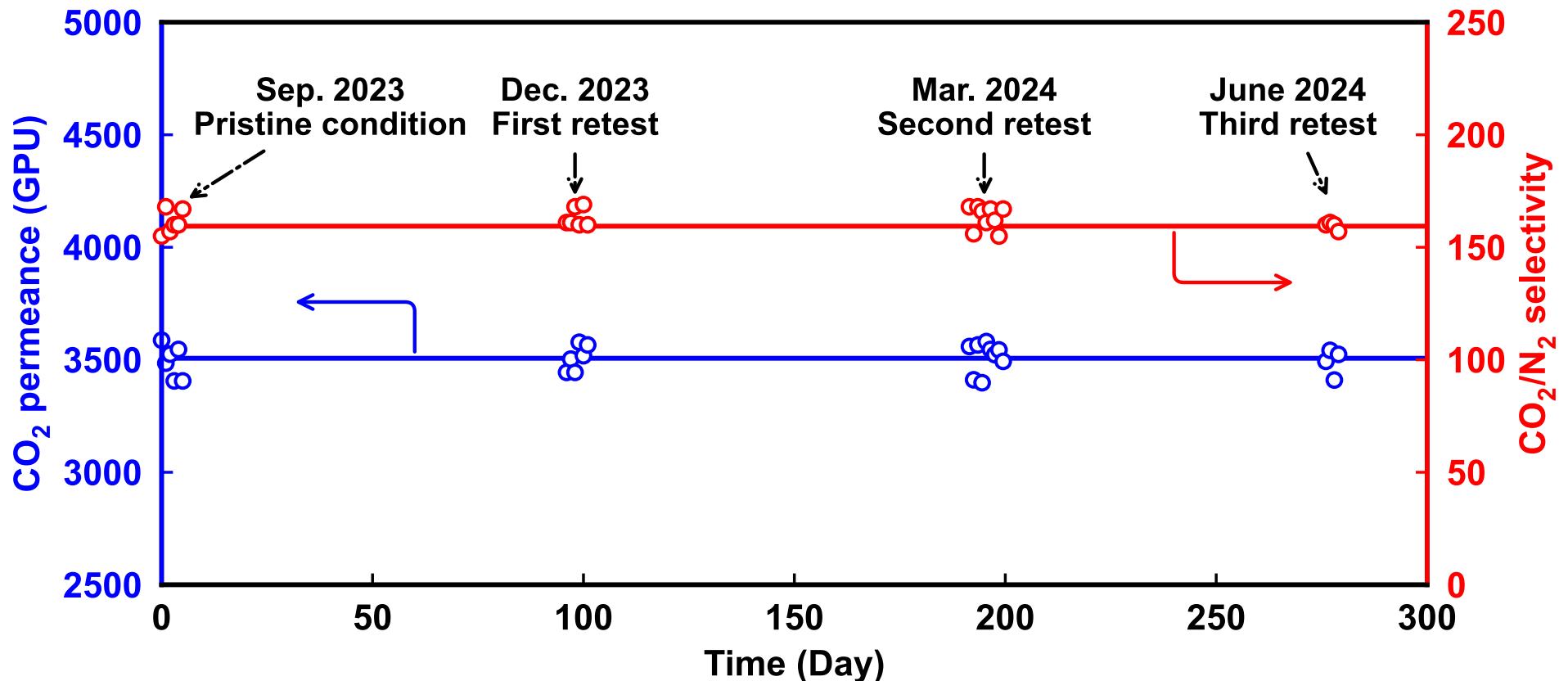


SW Module Successfully Scaled up to 105 m² Area

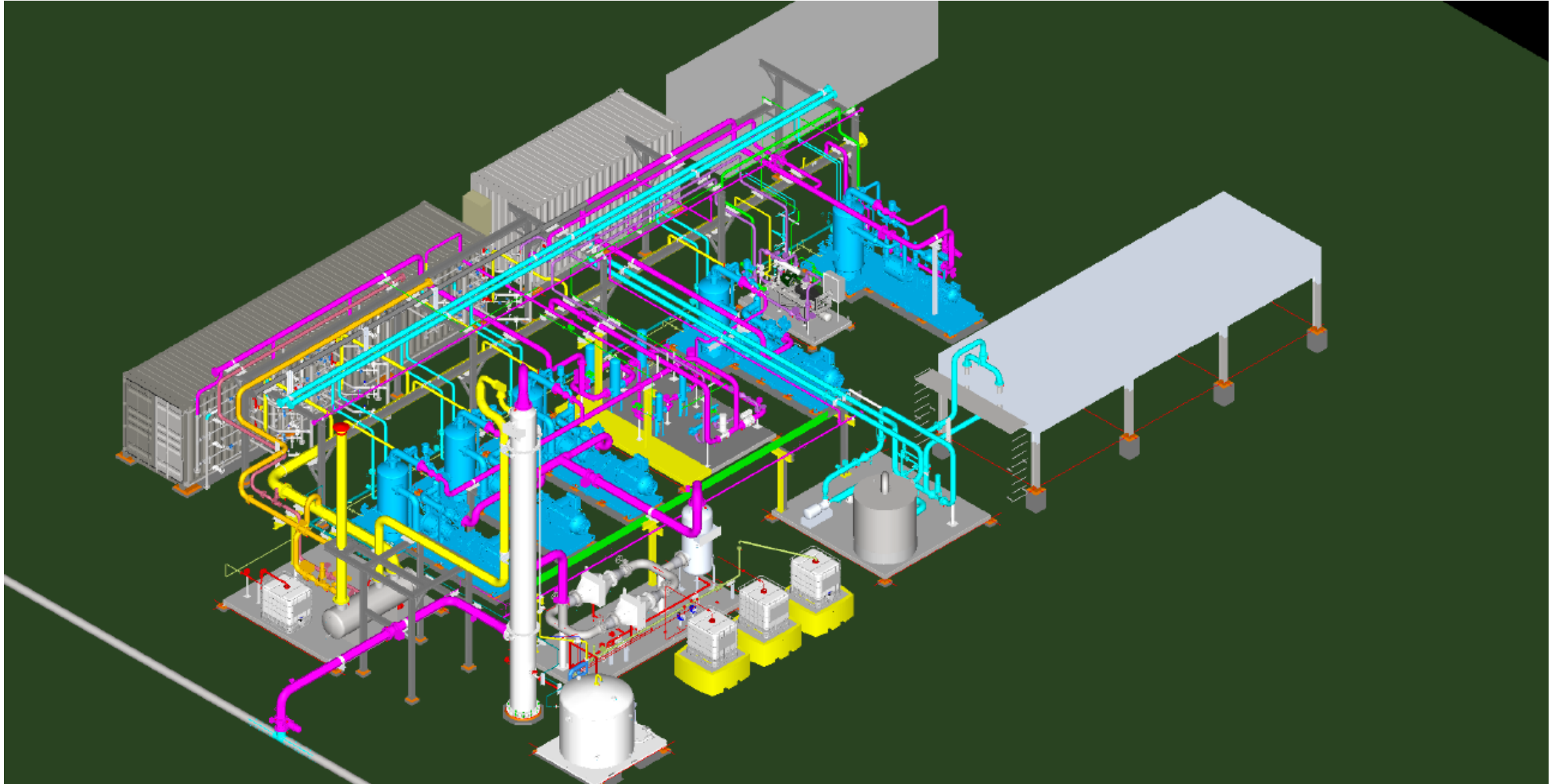


Membrane Properly Stored and QA/QC Testing Periodically

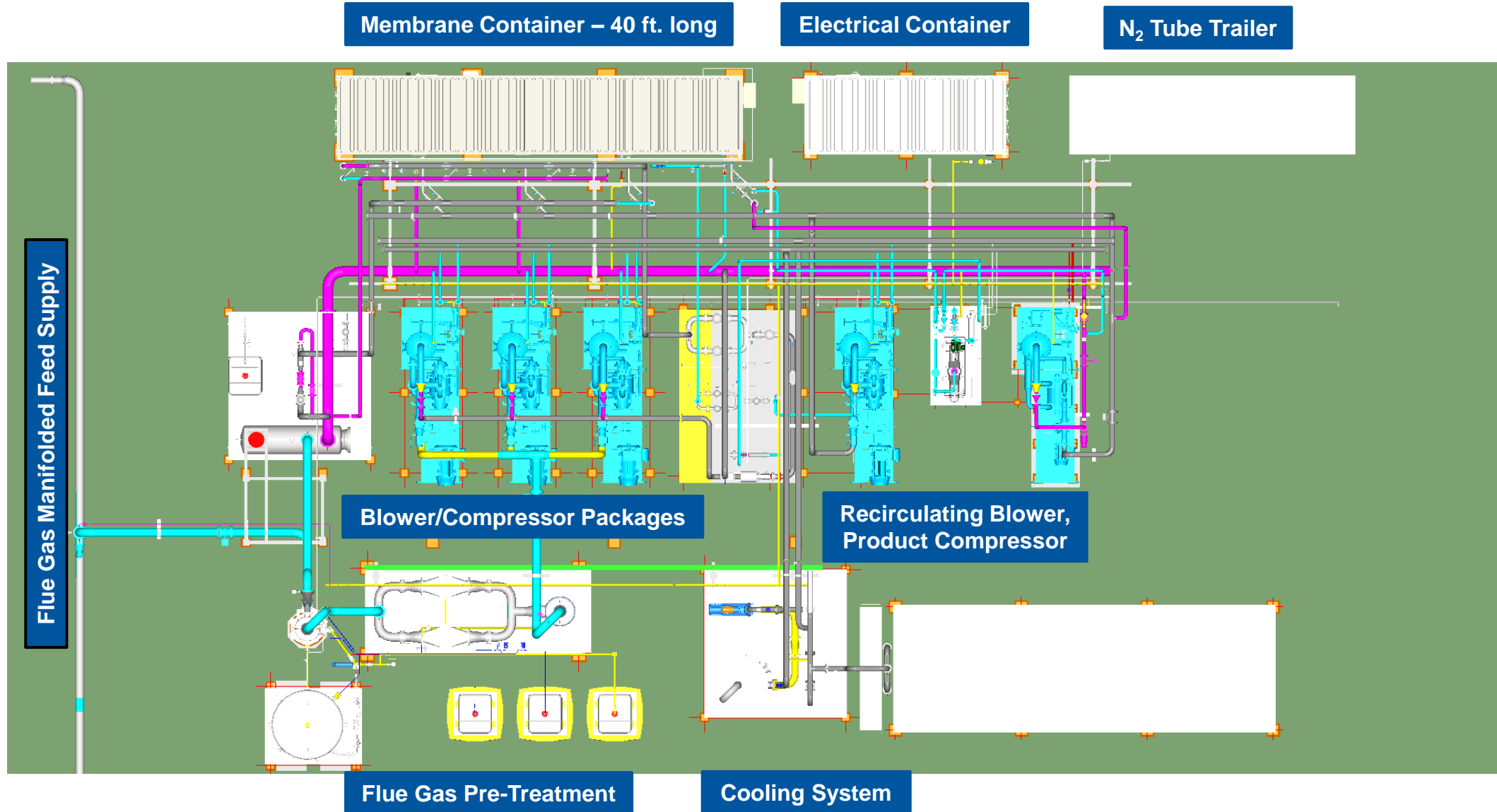
- OSU has been conducting ongoing monitoring of membrane element storage
 - A spiral-wound element ($\varnothing 8''$ & 35 m^2) fabricated in Sep. 2023 has been vacuum-sealed for storage
 - The plan was to remove the element from the packaging every 3 months for retesting
 - The element have been retested 3 times (Dec. 2023; Mar. & June 2024); no degradation was observed



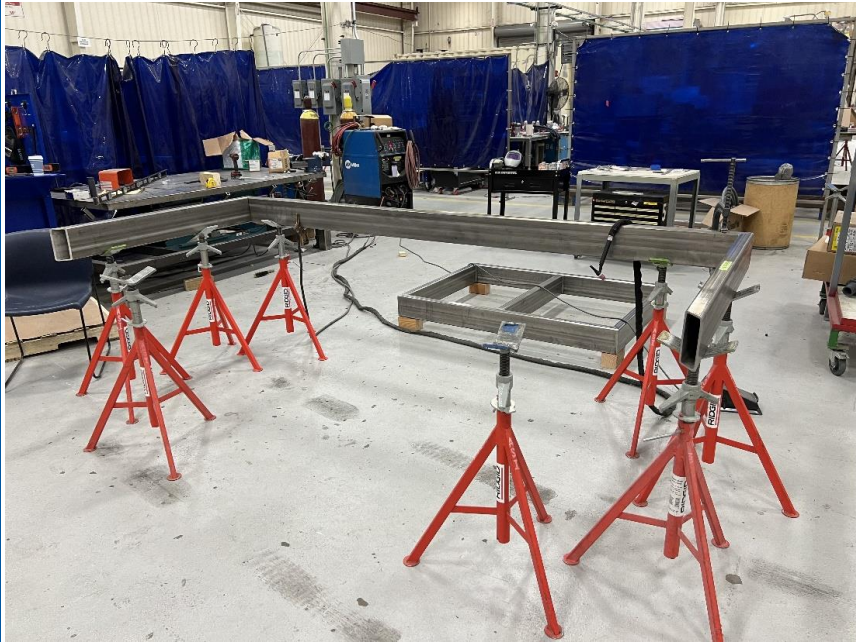
3D Model of 20 TPD System – Footprint: 66' X 104'



Arrangement of Major Equipment



20 TPD System Under Construction



Equipment skids fabricated

20 TPD System Under Construction (cont'd)



Build out of the membrane container complete, ready for piping

20 TPD System Under Construction (cont'd)



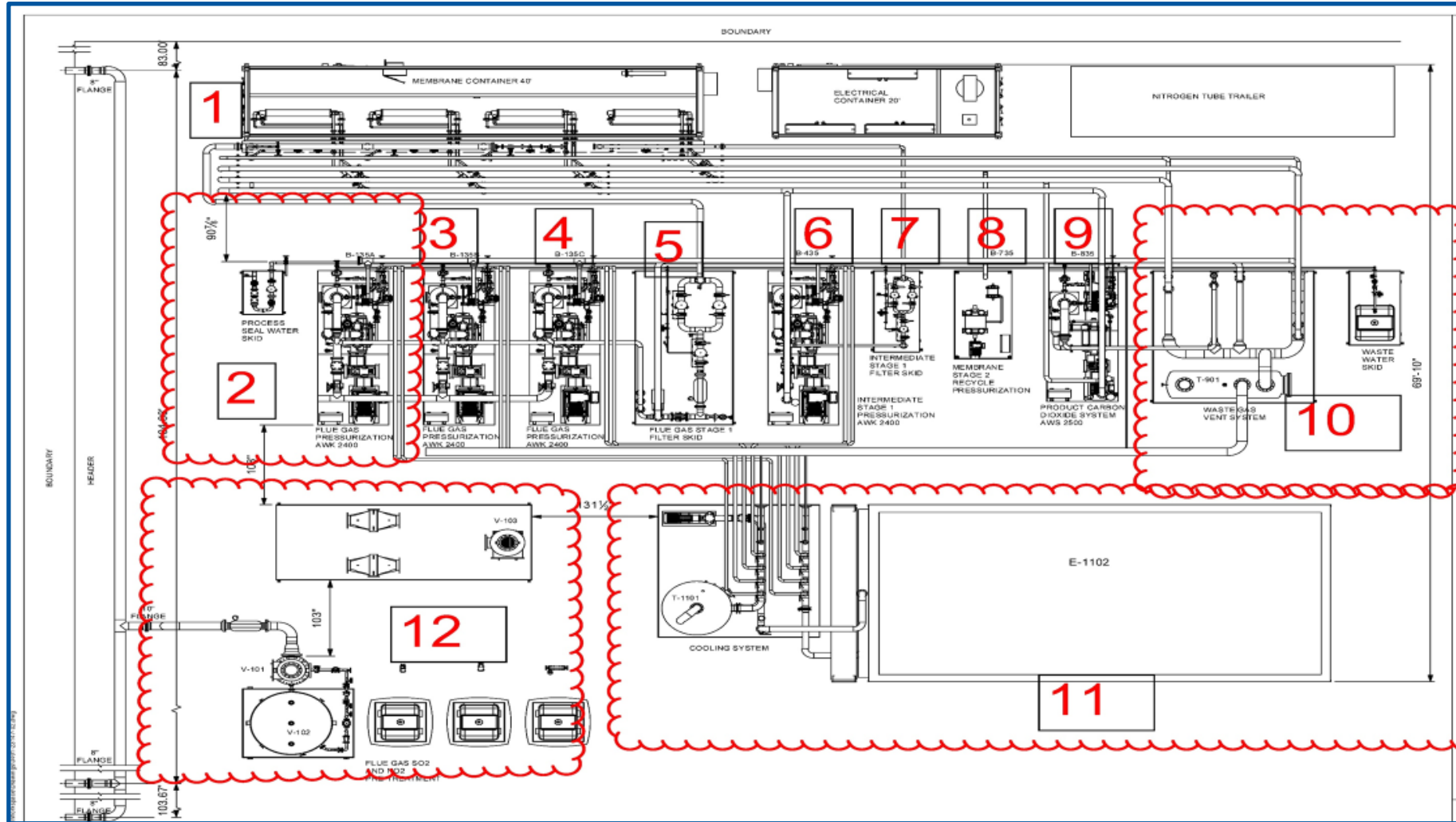
- Scrubber fabrication in progress at the supplier
- Piping isometrics created, piping procured, and pipe fabrication work started
- Valves, instrumentation and other supplies as part of the equipment skid received

GTI Received Permit, Selected Vendor for Site Preparation



- GTI received approval from the WY Dept. of Environmental Quality for the air/construction permit
- GTI received three quotes for the foundation work, and selected Hladky for site preparation
- GTI is finalizing the contract with Hladky; foundation work expected to start August 2024
- ITC will fabricate the flue gas manifolding line after reviewing quotes received

Arrangement of Skid Installation Ongoing

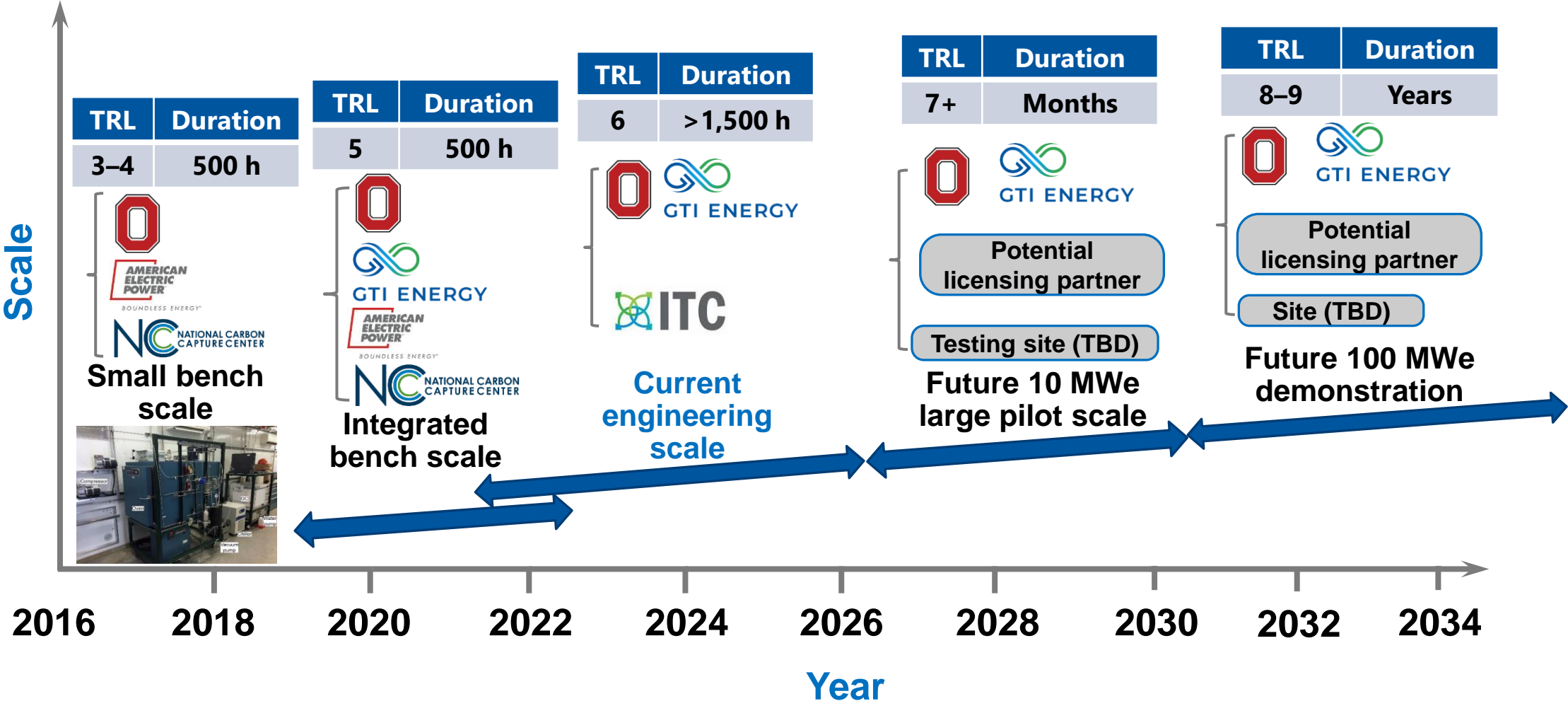


- GTI Energy received installation proposal from Hladky
- Planned to use flex I/O components with 12 major skids

Construction and Installation Milestones and Status

	Target date	Status
■ Confirmation of Blower/Scrubber PO	11/3/23	✓
■ 100% Design Review Drawings	12/15/23	✓
■ Structural Steel Procurement	3/4/24	✓
■ Piping, Valves & Fittings Procurement	6/14/24	✓
■ Vessels & Tanks Procurement	7/26/24	
■ Instrumentation Procurement	7/31/24	
■ Electrical Panels, Heat Trace, Insulation	8/16/24	
■ Mechanical Fabrication	9/6/24	
■ Blower FAT	9/6/24	
■ Final Assembly	9/27/24	
■ Visual, Hydrostatic and FAT	10/11/24	
■ Packaging and Shipment	11/8/24	
■ Installation (end of BP2)	3/31/25	

Technology Development Path



Summary

- GTI and OSU are scaling up OSU's FTM process to engineering-scale for carbon capture
- Prototype SW Module scaled up to 105 m²; gas separation properties validated
- Membrane properly stored and periodical QA/QC tests indicate no degradation
- 20 TPD system under construction, expected to be shipped to ITC in November 2024
- GTI received permit, selected vendor for site preparation
- Arrangement of skid installation ongoing

Acknowledgements

- Financial and technical support



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- DOE: Mariah I. Young, Andrew O'Palko, Andy Aurelio, Dan Hancu, José Figueroa and Lynn Brickett
- Partners



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