

A COMBINED WATER AND CO₂ DIRECT AIR CAPTURE SYSTEM

DE-FE0031970

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IWVC, LLC

U.S. Department of Energy
National Energy Technology Laboratory
Carbon Management Project Review Meeting
August 15 - 19, 2022

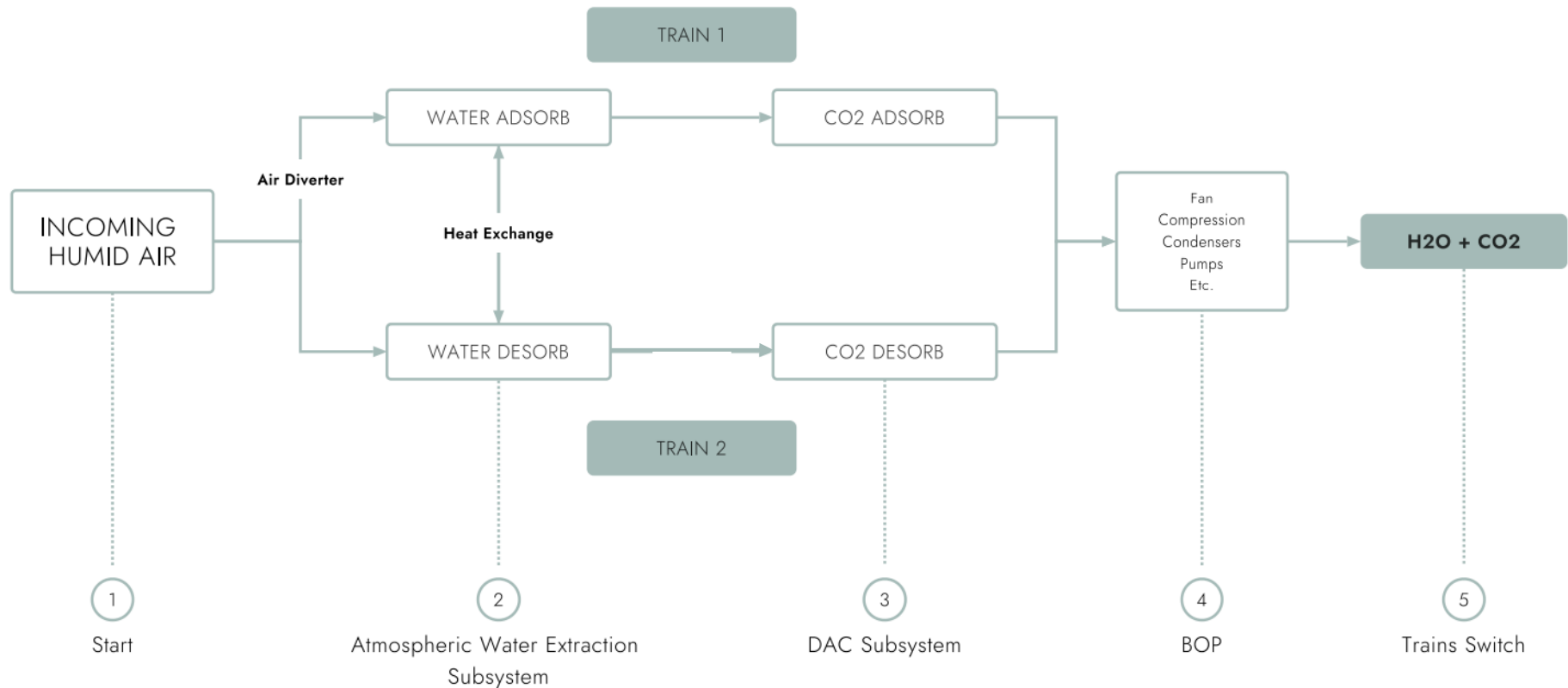


PROJECT OVERVIEW

- Funding: \$3.2M Budget (\$2.5M Federal, \$0.7M Cost share)
- Objective: Successful operation of a combined water and CO₂ capture system @ 1100 L/d water and 30t/y CO₂
- Project Duration: 10/1/2020 – 9/30/2023
 - BP 1: HDAC Unit Detailed Design 10/1/2020 – 09/30/2021
 - BP 2: HDAC Unit Fabrication 10/1/2021 – 12/31/2022
 - BP 3: Field Performance Test 01/1/2023 – 09/30/2023
- Team
 - Awardee: IWVC
 - Subawardees: PNNL, BARR Engineering
 - Additional Participants: SoCalGas, U. North Texas

TECHNOLOGY BACKGROUND

Isothermal Water Vapor and CO₂ Capture (IWVC)



TECHNOLOGICAL APPROACH

Project Objective:

Pilot HDAC field unit – 30 t_{CO2}/y and 1100 l_{H2O}/d

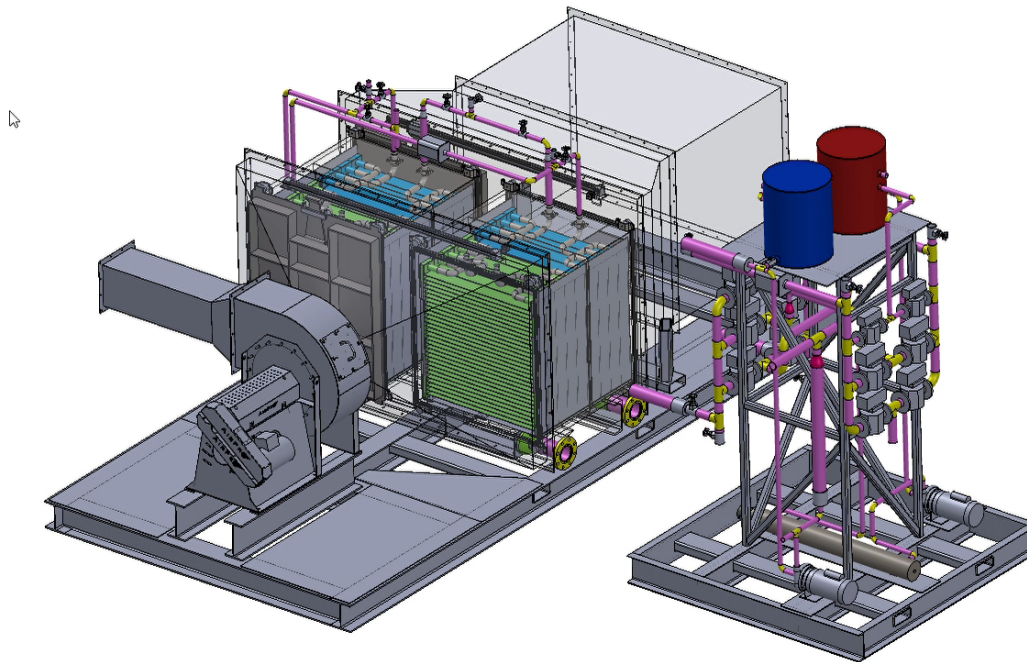
- Key Scheduling Milestones:
 - Sep 2021: HDAC Unit Detailed Design
 - Dec 2022: HDAC Unit Manufacture
 - Sep 2023: Field Performance Test, Data Analysis & Reporting
- Risk Mitigation by way of extensive R&D in
 - design of the HDAC unit
 - desiccant and sorbent manufacturing methods
 - coating procedures and coating performance

SCOPE OF WORK

- All Budget Periods
 - Subtask 1.1 – Project Management
 - Subtask 1.2 – Technology Maturation Plan
- BP1 - HDAC Unit Detailed Design
 - Task 2.0 – HDAC Unit Detailed Design
 - Process Modeling and Equipment Sizing
 - System Layout
 - Detailed Design
 - Update cost estimate
- BP2 - HDAC Unit Fabrication
 - Task 3.0 – HDAC Unit Fabrication
 - Barr: Build Pilot System
 - PNNL: Contactor Assembly and Condenser Design
 - UNT: Supplemental CO₂ Sorbent
- BP3 - Field Performance Test, Data Analysis & Reporting
 - Task 4.0 – Field Site Setup and Performance Testing
 - Barr: Install Pilot System, Assist with Operations
 - SoCalGas: Pilot System Site
 - Task 5.0 – Data Analysis and Reporting
 - PNNL: Data Analysis & Reporting
 - IWVC: Final TEA

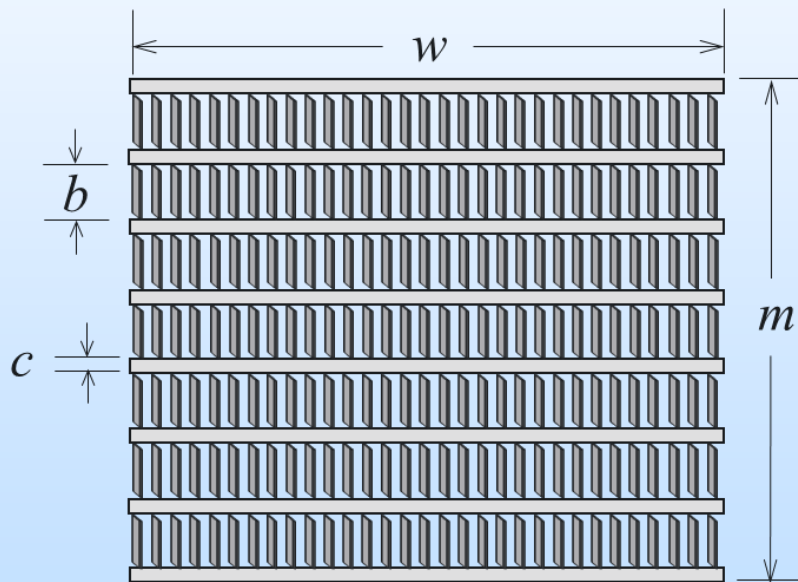
PILOT UNIT ASSEMBLY AND DETAILED DESIGN

Module and BOP engineering has been completed.



CUSTOM CONTACTOR DESIGN

Contactor bed constructed of multiple contactor panels – consisting of heat transfer channels and fins



4 panel AWE section
5 panel DAC section

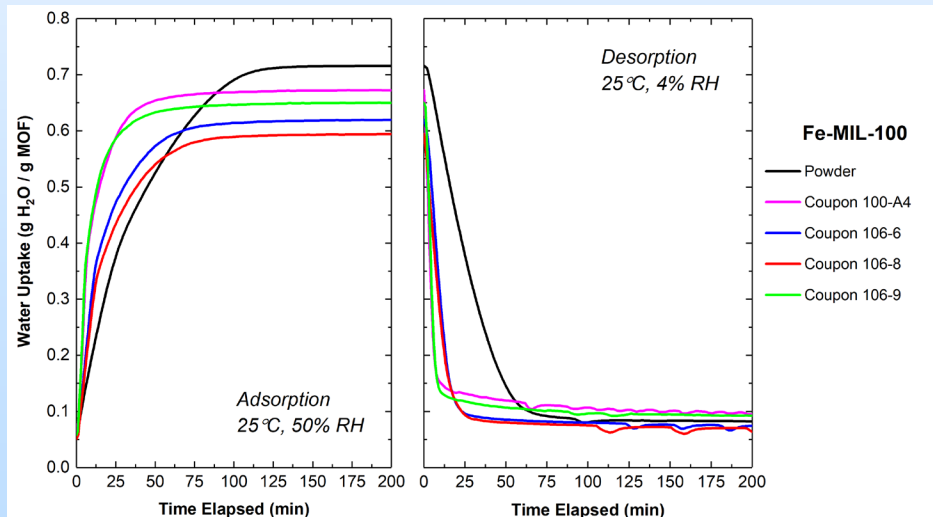
AWE DESICCANT EVALUATION AND COATING PERFORMANCE

Desiccant coating sorption/kinetic performance shown to be on par with powder material

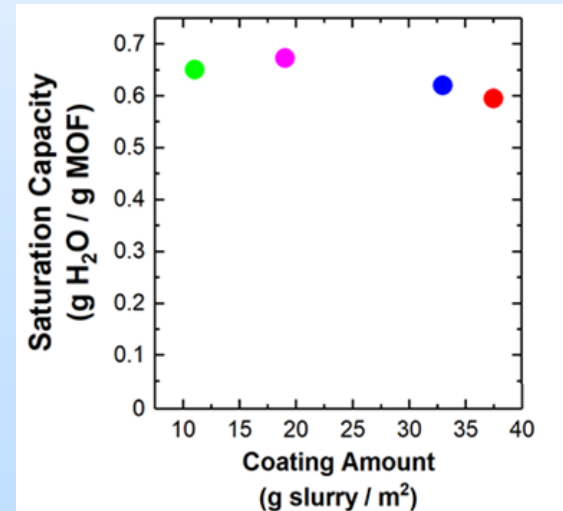
Coating preparation via dip-coating methodology



Coating evaluation via gravimetric sorption experiments



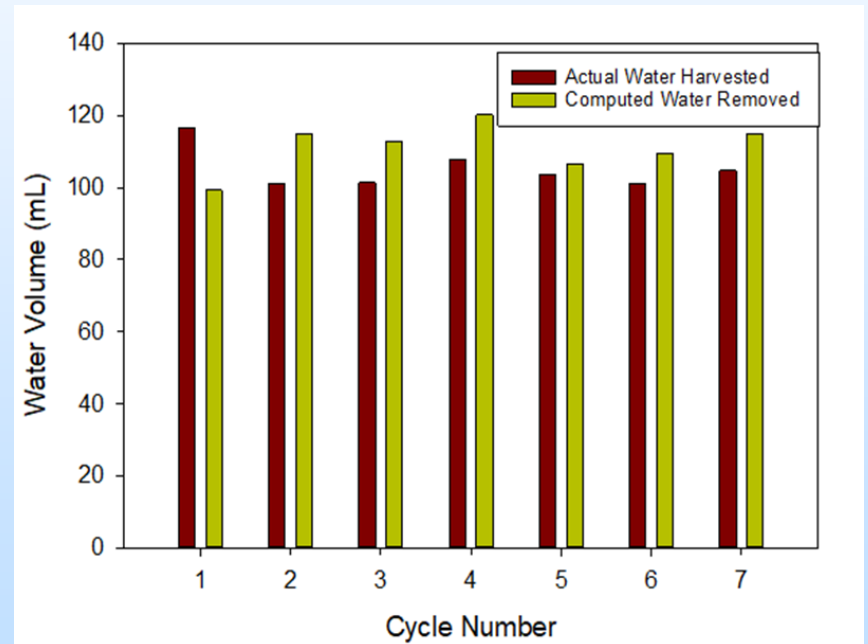
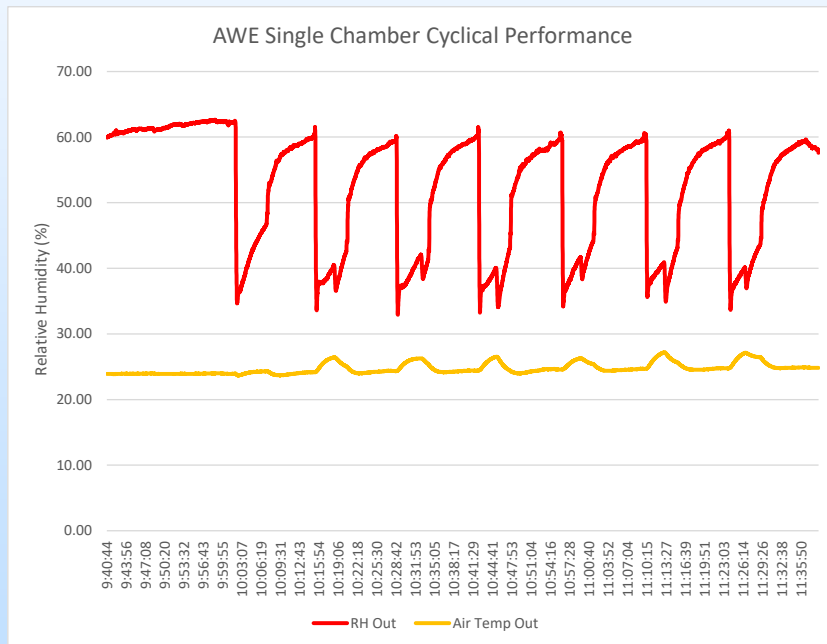
coated sample capacities



AWE PROTOTYPE

WATER PRODUCTION VALIDATION

Atmospheric water extraction (AWE) prototype operated successfully and shown expected performance



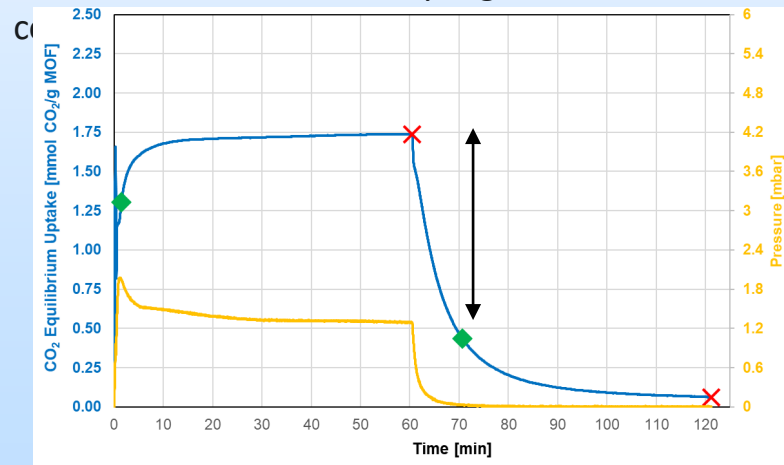
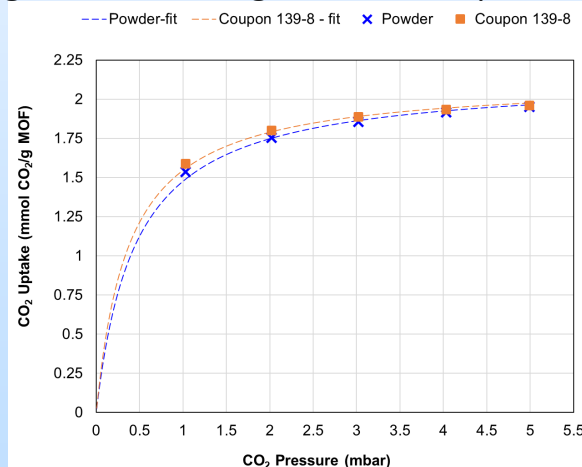
DAC SORBENT EVALUATION AND COATING PERFORMANCE

DAC sorbent coating sorption/kinetic performance shown to be on par with powder sorbent

Coating preparation via dip-coating



Coating evaluation via gravimetric sorption experiments. Sorbent effectively regenerates under lab process

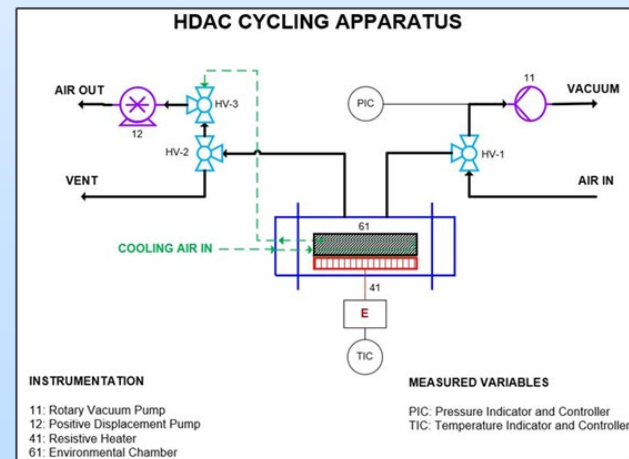
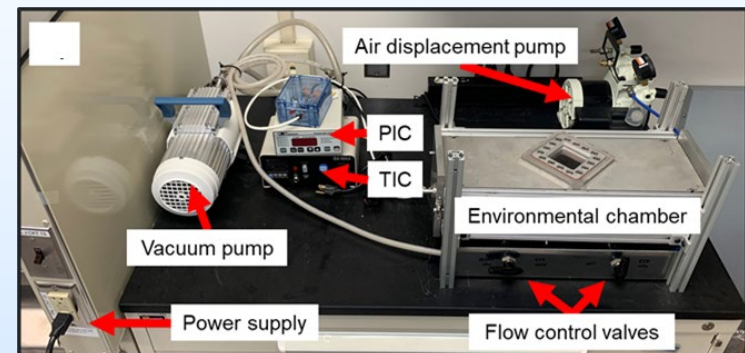
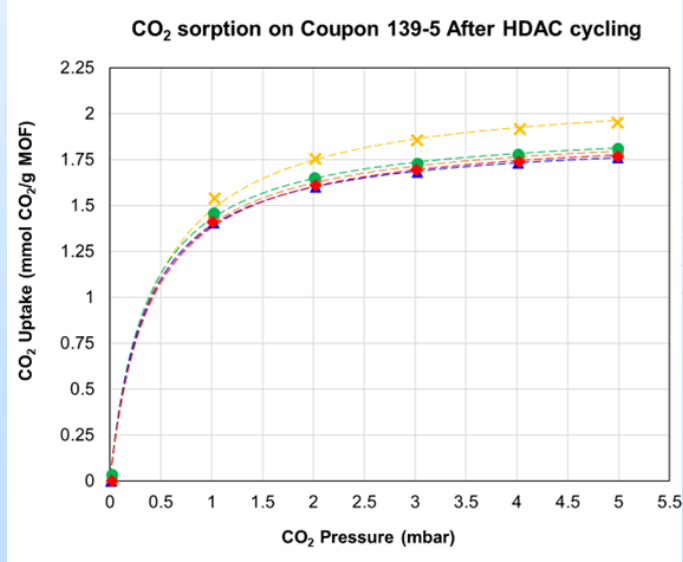


SORBENT/CONTACTOR LONGEVITY – CYCLING TESTS

Coupon performance was maintained after 30 cycles.

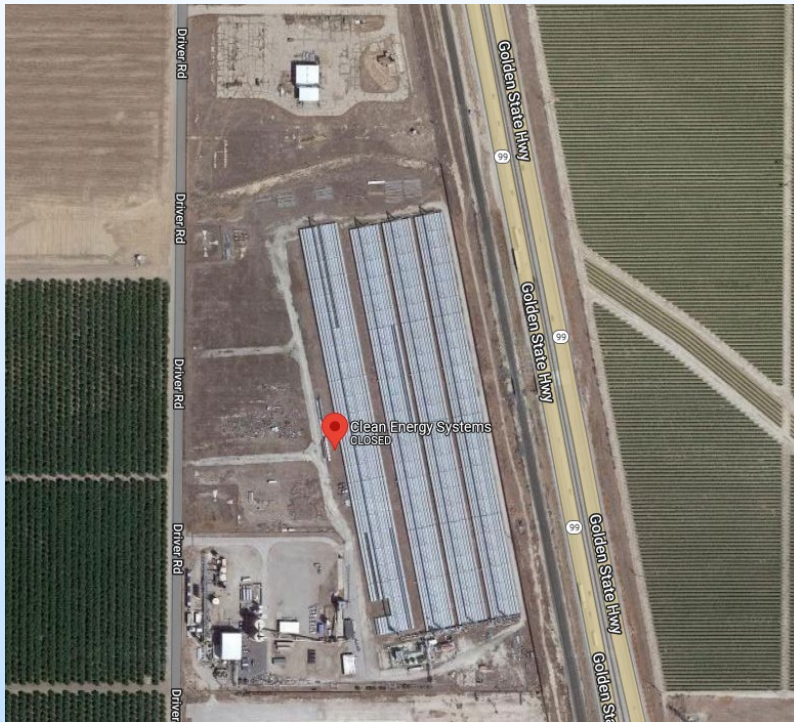
Custom test rig constructed to expose small sorbent-coated coupons to cycles of air exposure ($\text{CO}_2/\text{H}_2\text{O}$ adsorption) and removal ($\text{CO}_2/\text{H}_2\text{O}$ desorption).

Coupons were evaluated for sorption performance before and after a series of exposure cycles.



HOST SITE PLANNING

Host site agreement to be signed by September 2022.



- Site selected in conjunction with SoCalGas and Clean Energy Systems (CES) in Bakersfield, California.
- Previous CES Kimberlina Power Plant site, currently used by CES for R&D purposes.
- Power, water and drainage available.

FUTURE DEVELOPMENT AND COMMERCIALIZATION

COMMERCIALIZATION OF THE TECHNOLOGY BY



- Field performance testing part of BP3 in Q1 & Q2 of 2023.
- Field performance testing will provide necessary data for 10X scale-up of the technology
- Development of a full-scale module has begun in 2022.
- Avnos is developing the technology in modular scale-up for commercial application.
 - IWVC is a wholly-owned sub of Avnos

STATUS SUMMARY

Project is on time and within budget.

- Desiccant and sorbent production will be completed by end of Q3 2022.
- Coating tests show no reduction in capacity due to coating procedure. Contactors to be completed and coated by December 2022.
- Module and BOP to be constructed by November 2022.
- Ready to transfer all components to site end of 2022.



Thank you.



ORGANIZATION CHART



Will Kain



Ben McCool



Alex Spiteri

*IWVC
awardee, project and development lead*



Pete McGrail



Todd Schaefer

*PNNL
materials development and
contactor design/manufacture*



Shenqian Ma

*UNT
sorbent
development*



Dan Palo



Anne Weaver

*BARR
system engineering and manufacture*



Flavio da Cruz

*SoCalGas
Cost share and
site collaboration*



SoCalGas/CES-Kimberlina Site

Appendix


Gantt Chart

IWVC HDAC PROJECT TIMELINE

GANTT CHART



completion date or
expected completion date



completion date or

expected completion date

	FY21												FY22												FY23											
	BP1												BP2												BP3											
	Q1			Q2			Q3			Q4			Q1			Q2			Q3			Q4			Q1			Q2			Q3			Q4		
	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S
1. Project Management (IWVC)																																				
1.1 Project Management																																				
2. HDAC Unit Detailed Design (Barr)																																				
3. HDAC Unit Fabrication																																				
3.1 DAC and Desiccant Bed Fabrication (PNNL)																																				
3.2 Water Vapor Vacuum Pump (RadMax)																																				
3.3 Condenser (PNNL)																																				
3.4 Balance of Plant Assembly and Testing (Barr)																																				
4. Field Site Setup and Performance Testing (IWVC)																																				
5. Data Analysis and Reporting (IWVC)																																				