

# NETL RWFI Energy 101- DAC



## Welcome to the Webinar

- ✓ Please place yourself on Mute
- ✓ Presentation will be posted on the NETL RWFI website Webinar Archives
- ✓ Workforce Forum at end of presentations
- ✓ Submit questions via chat

## Agenda

1. NETL RWFI Introduction- Anthony Armaly, NETL RWFI Federal Coordinator
2. Direct Air Capture 101- Ronald Breault, Research Scientist, Subject Matter Expert
3. Round Table Discussion

In this month's NETL RWFI Energy 101, we learn the basics of Direct Air Capture or DAC, and about NETL and DOE research efforts in DAC, including some of potential economic and workforce development implications upon successful deployment of this technology.

# NETL Regional Workforce Initiative (NETL RWFI)

A photograph of a male worker in a white hard hat, safety glasses, and a blue work shirt. He is wearing gloves and is focused on measuring a large, complex industrial metal part with a caliper. The background shows an industrial setting with various pipes and machinery. The image is framed by diagonal stripes in green and orange on the left and right sides.

A Focus on Appalachia and the future of Energy and Advanced Manufacturing Regional Workforce Readiness and Economic Development

# NETL RWFI Mission Statement



NETL RWFI is a platform for engagement and collaboration with key stakeholders who are critical for the deployment of U.S. DOE and NETL Energy and Advanced Manufacturing technological research.

Supporting Regional Economic and Workforce Development opportunities.

# Measuring Our Impact - People First



Key Metrics are Levels of Engagement and Outreach

**800+**

individual  
stakeholders

**400+**

institutions and  
organizations  
represented

**1300+**

registrants to the  
NETL RWFI Webinar  
Series

**300+**

subscribed to the  
NETL RWFI e-Note  
Monthly Newsletter

**Catalyzed over 1M in energy/advanced manufacturing  
workforce & economic development funding**



## Pilot Program

- ✓ Available and accessible training programs
- ✓ Ongoing or planned collaborations with education and training providers
- ✓ Identify necessary certifications or other educational attainment involved in technology/activity
- ✓ Identify Economically Distressed Communities or state or federal designated Opportunity Zones or other geographically defined empowerment zones where this activity may occur

Originated from conversations with stakeholders and through ARC workshop participation (2017-18)

### Prevalent questions were:

- What are the occupations needed?
- What skills/education is required for those occupations? "Future casting"

### NETL technologies 3-5 years from commercialization

Effort to understand occupations and skills necessary for the present and the future

DOE now requires a statement of job creation on FOAs

# Workforce Readiness Plan Database



Job/Career Field Name	Skills Needed	Education Requirements	Availability of Training Programs	Any Other Relevant Items Provided?
Big Data Programmer/Analyst	<ul style="list-style-type: none"> <li>• Efficiently extract large scale complex business data (time series data, structured/unstructured) from various data sources and prepare them for data analytics.</li> <li>• Partner with product experts, leverage common open-source machine learning/deep learning packages for identifying data patterns/trends or building predictive models.</li> <li>• Deploy solutions to business units using software technologies to generate measurable values for businesses.</li> <li>• Grasp the application of the latest machine learning and artificial intelligence open-source packages, cloud, and distributed computing technologies to ensure the best technologies are implemented to meet businesses' data challenges.</li> </ul>	<ul style="list-style-type: none"> <li>• Undergraduate degree in Data Science, Computer Science, Math, or Statistics.</li> <li>• For candidates who hold an engineering degree, we require candidates have taken data science classes already.</li> <li>• 7 years of experiences with a minimum of 2 years experiences in extracting the data, using common classification or regression open-source packages through R or Python.</li> </ul>	Yes	
Geologists	<ul style="list-style-type: none"> <li>• Geologists with a passion for subsurface materials and skillsets such as geologic characterization, well log and core analysis, petrophysical calculations, geostatistics, model development, and field work are needed to quantify rock property estimations and integrate subsurface interpretations using different datasets.</li> </ul>	<ul style="list-style-type: none"> <li>• Undergraduate &amp; Professional</li> </ul>	Yes	

# Pilot Conclusions

Report Findings: [www.netl.doe.gov/rwfi](http://www.netl.doe.gov/rwfi)

- ✓ Skilled technical workforce is essential
- ✓ Technical workforce occupations are high paying and in-demand
- ✓ Energy and Advanced Manufacturing industries are rapidly evolving towards high skilled and increased experience
- ✓ The Workforce Workplan is an effective tool in identifying emerging skills and occupations in energy industries = a skills/occupations early warning system



# Opportunity?

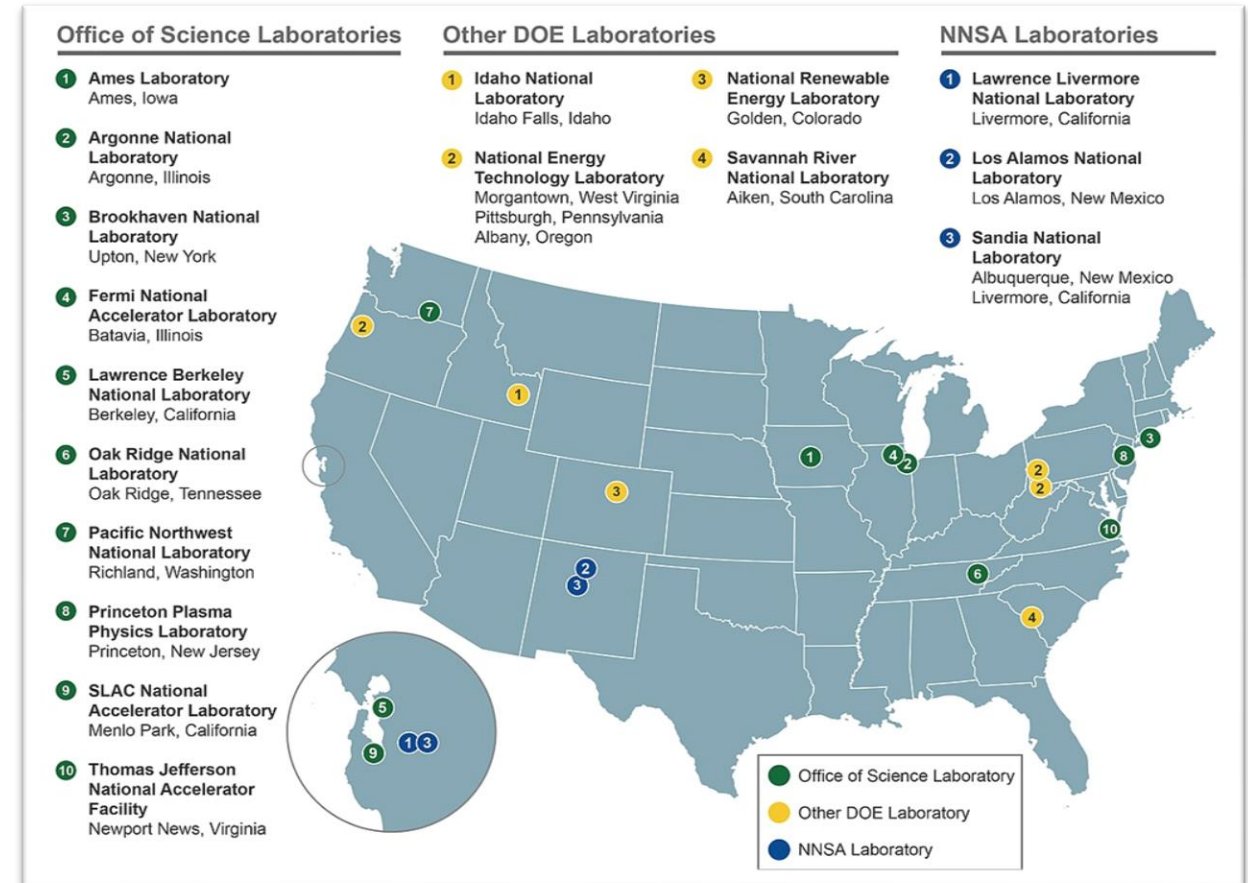
Report Findings: [www.netl.doe.gov/rwfi](http://www.netl.doe.gov/rwfi)



## What if the Workforce Readiness Plan could be implemented at other labs?

Indirect benefits and support of occupations and skills being supported by DOE funding

Clearer picture of future industry sector needs





# Conclusions

Let's Connect, Communicate and Collaborate!

NETL RWFI relies on our being consistent, communicative, and collaborative with stakeholders

Substantive engagement and results – Webinars, E-Note, R-AME, Workforce Readiness Pilot, NETL/ARC AWWI



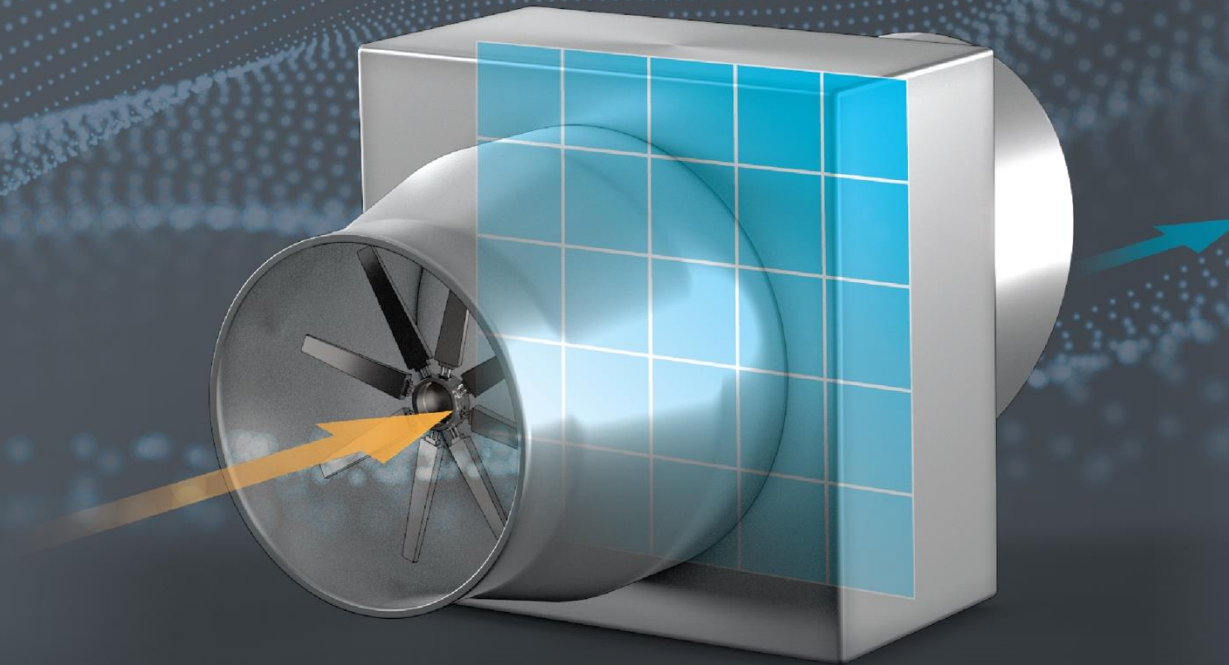
[www.netl.doe.gov/rwfi](http://www.netl.doe.gov/rwfi)  
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# NETL Direct Air Capture (DAC) Center



• Ron Breault, *Thermal Science Team Supervisor*

Presented for NETL Regional WorkForce Initiative (RWFI) Energy 101



• September 27, 2022



# What is Direct Air Capture

- **Direct Air Capture of DAC is the removal of Carbon Dioxide directly from the atmosphere.**
  - **This is in contrast to Point Source carbon dioxide capture at power plants and other generators like cement plant, refineries and other concentrated sources of carbon dioxide.**
  - **It targets economic sectors that are difficult to address with point source capture like transportation and “legacy carbon” or the historical buildup of carbon dioxide in the atmosphere.**
  - **When thinking of DAC, if it is a term not familiar to you, think of a tree. In fact, some of the passive DAC systems are referred to as artificial trees.**
  - **In a DAC system,**
    - **Air is passed over a material that captures the carbon dioxide from it by either an absorption or adsorption process.**
    - **The captured carbon dioxide is released from the capture material by adding heat and drawing a vacuum to regenerate the capture material.**
    - **The released CO<sub>2</sub> is either sequestered or converted to another product.**

# DAC Center Overview

- ✓ **\$20M budgeted for NETL to create a National DAC Test Center, with \$25M authorized**
- ✓ **Test capture materials, integrate capture and regeneration processes, advance developer skids**
- ✓ **Integrated experimental and modeling facility to rapidly advance DAC technologies from TRL 2 to 6**
- ✓ **Capture data → test in model → test commercially viable processes**



## CAPABILITIES

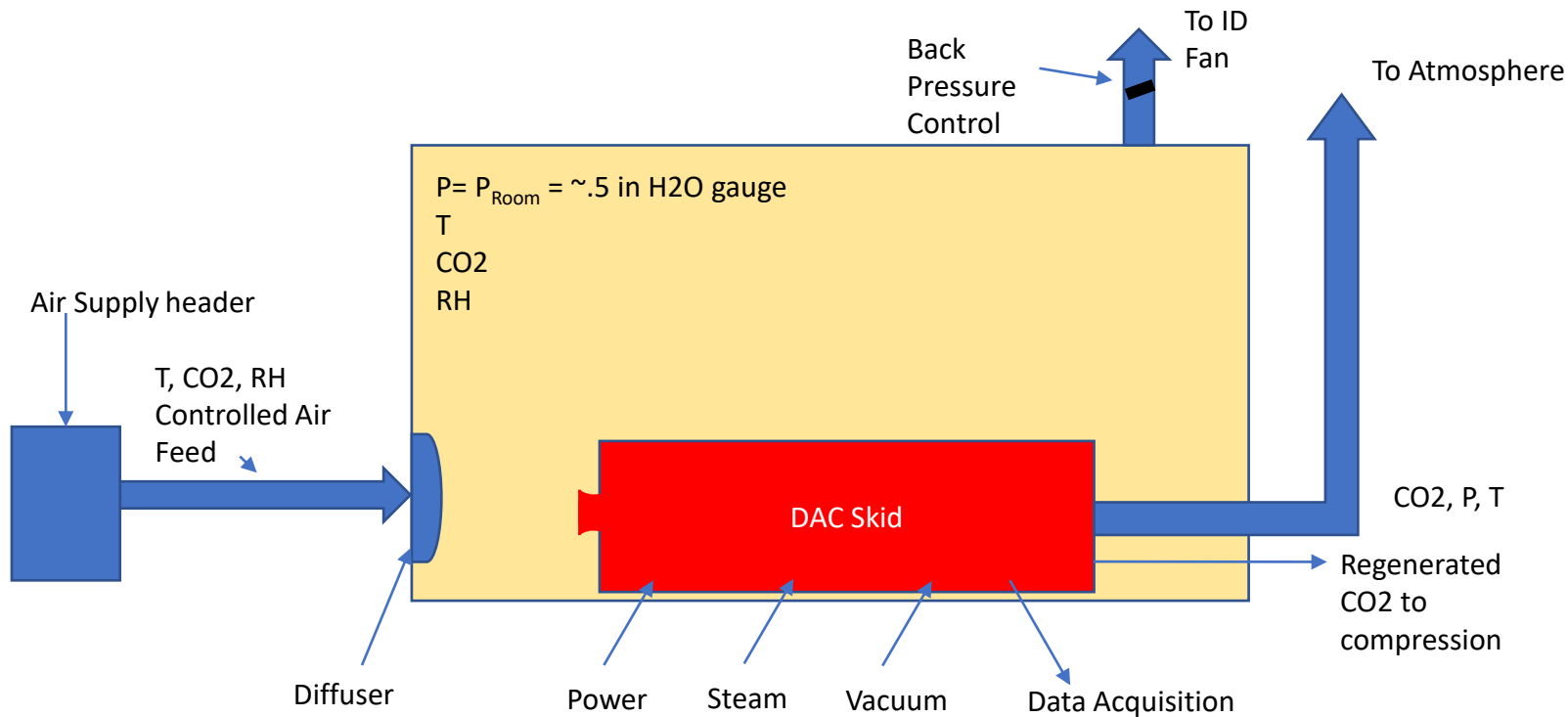
3-4 batch reactors for novel solvent and sorbent material development	2-3 reconfigurable test beds with flexible reactor designs	2 full test cells for evaluating developer-built DAC skids	Advanced instrumentation with remote and autonomous operation	Air feed with a wide variety of environmental conditions	Compression and storage equipment for reuse of captured CO <sub>2</sub> at NETL
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# DAC Center Test Capabilities

## Skid Rooms and Developmental Reactors

- Nominal air feed – 2000 to 3000 scfm
- Concentration– 400 to 600 ppm of CO<sub>2</sub>
- Humidity – RH= 20% to ~98 %
- Temperature – T = -10C to 40C
- CO<sub>2</sub> exit conditions – 50% to 90% reduction
- Utilities
  - Power
  - Steam
  - Vacuum
- Instrumentation and Controls
  - CO<sub>2</sub>, Temperature, Pressure (feed, effluent and numerous locations within the process loops)
  - Remote access for operational control
  - 24/7 operation

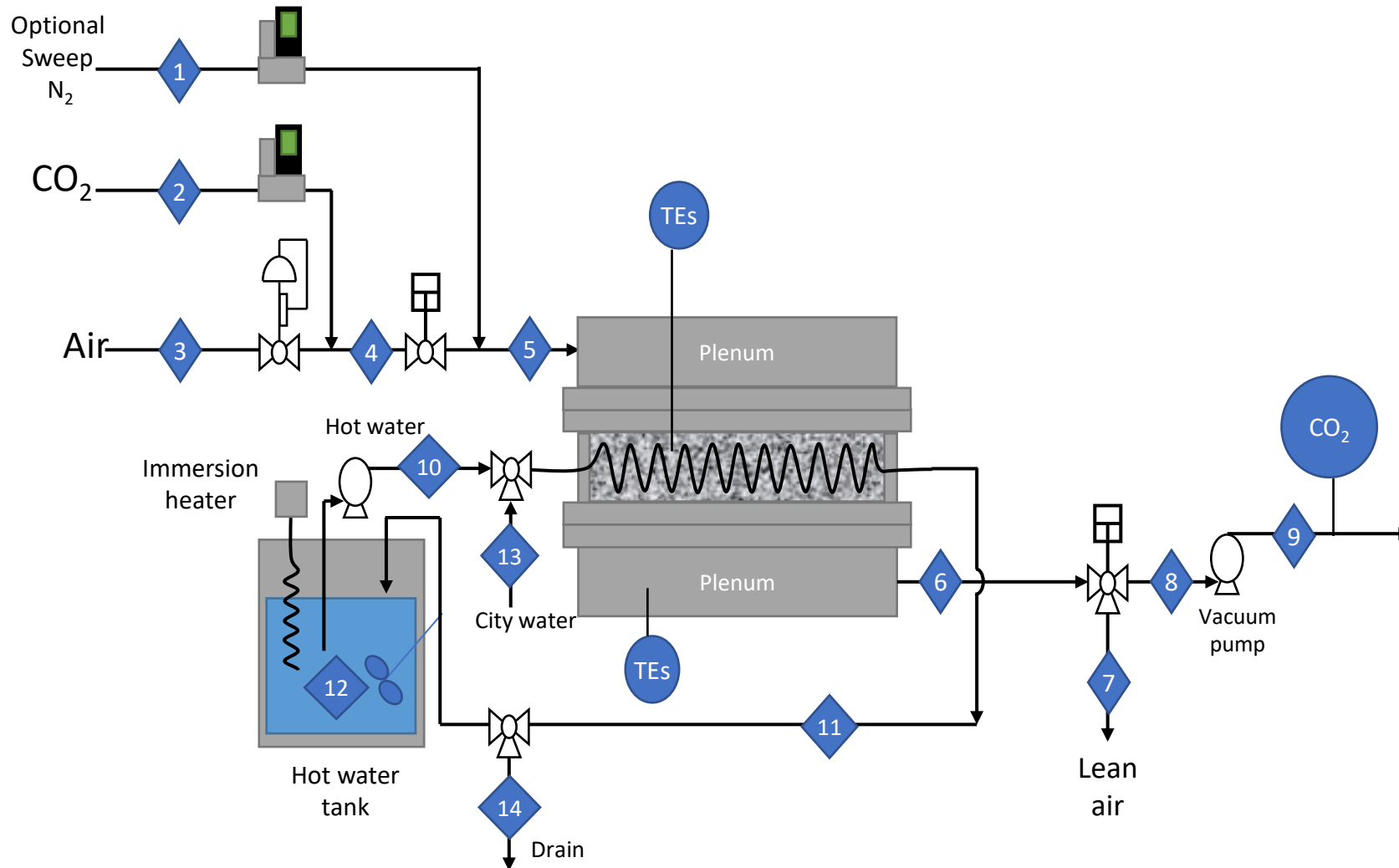
# DAC Skid Test Cell



## Features:

- Two identical test rooms
- Test cell supplied with 3000+ scfm of CO<sub>2</sub>, temperature and RH controlled air
- Cell maintained at 0.5 in water while feeding test skid at up to 3000 scfm of air to treat
- Power, steam, vacuum and data acquisition provided
- Private control room
- 24/7 operation with remote operator access and control

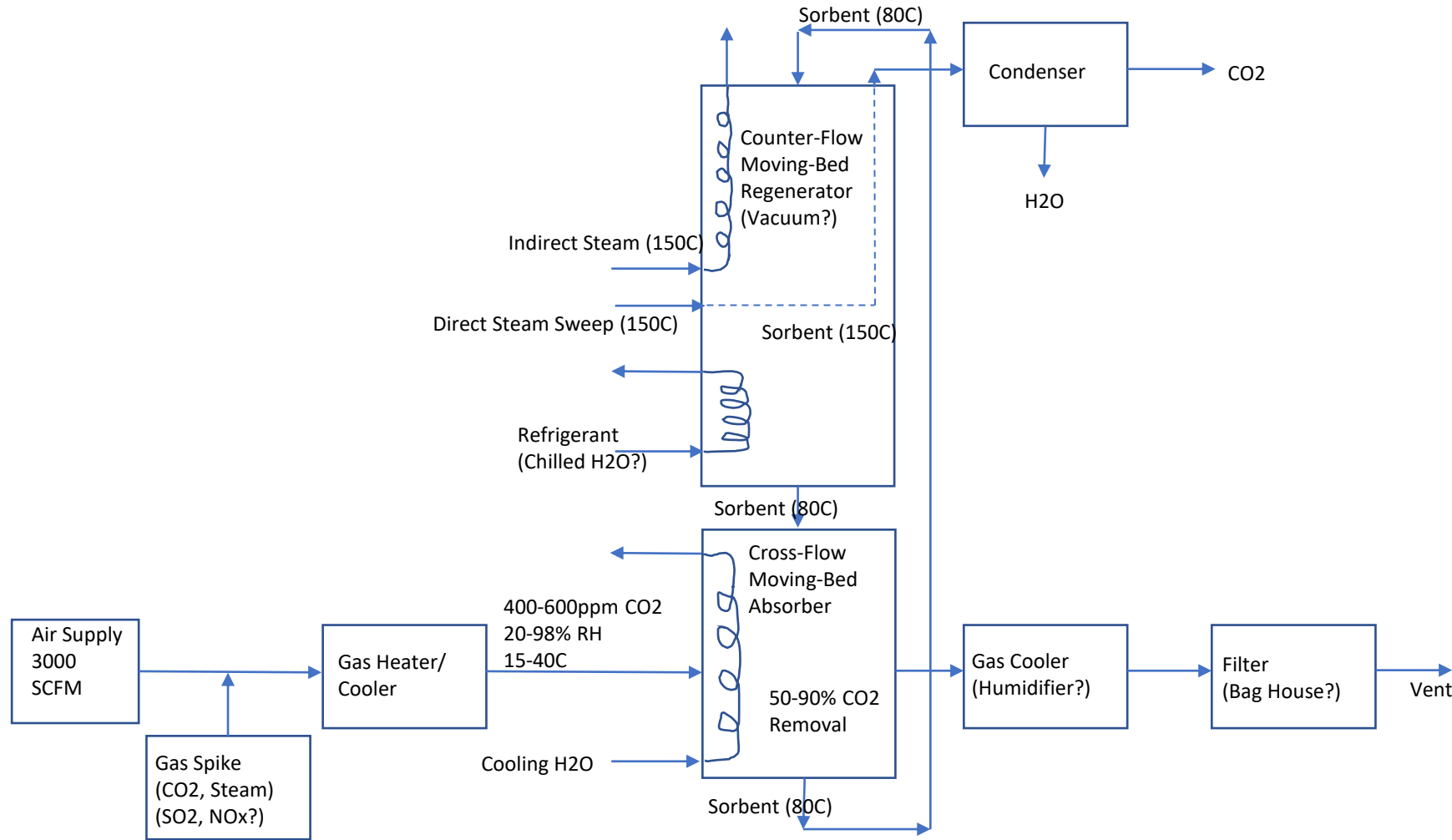
# Reconfigurable Cyclic Test Bed



## Features:

- Test bed supplied with up to 3000 scfm of CO<sub>2</sub>, temperature and RH controlled air
- Power, steam, vacuum and data acquisition available
- 24/7 operation with remote operator access
- Bed expandable from 6 inches to 36 inches
- Bed can be monolith, particles, or fiber mats
- In bed cooling and heating, shown with hot water but could be steam or electric
- Ability for steam sweep

# Moving Bed Cross Flow Reactor for Continuous Removal

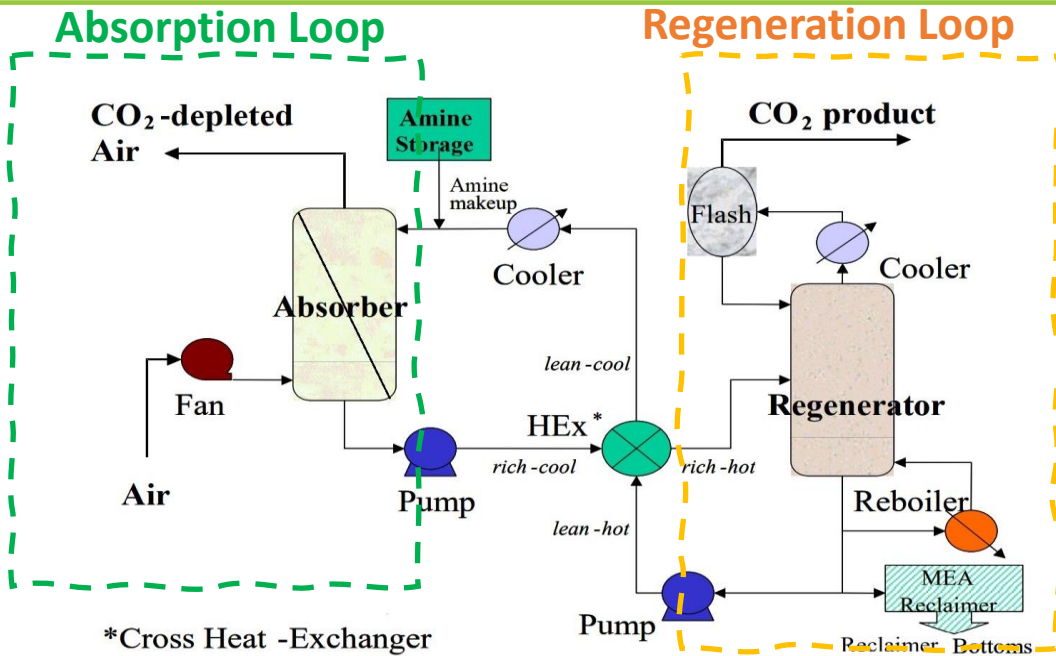


## Features:

- Test bed supplied with up to 3000 scfm of CO2, temperature and RH controlled air
- Power, steam, vacuum and data acquisition available
- 24/7 operation with remote operator access
- Bed expandable from 6 inches to 36 inches
- Various size sorbent particle capability
- In bed cooling and heating
- Ability for steam sweep



# Reconfigurable Solvent Based Systems

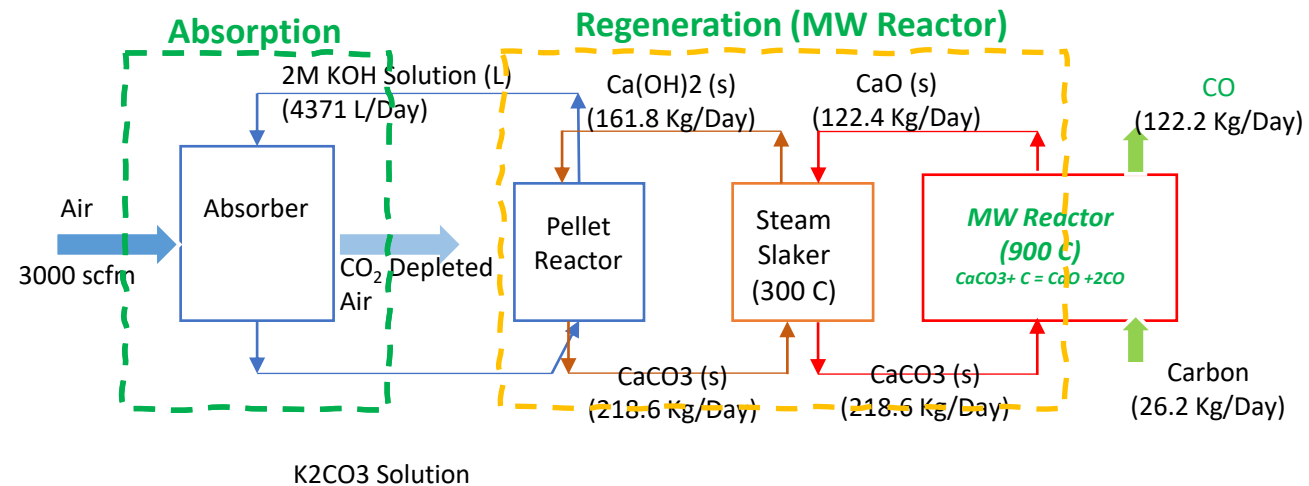


## Features:

- Absorber supplied with up to 3000 scfm of CO<sub>2</sub>, temperature and RH controlled air
- Power, steam, vacuum and data acquisition available
- 24/7 operation with remote operator access
- Low temperature amine regeneration

## Features:

- Absorber with up to 3000 scfm of CO<sub>2</sub>, temperature and RH controlled air
- Power, steam, vacuum and data acquisition available
- 24/7 operation with remote operator access
- Novel microwave regenerator

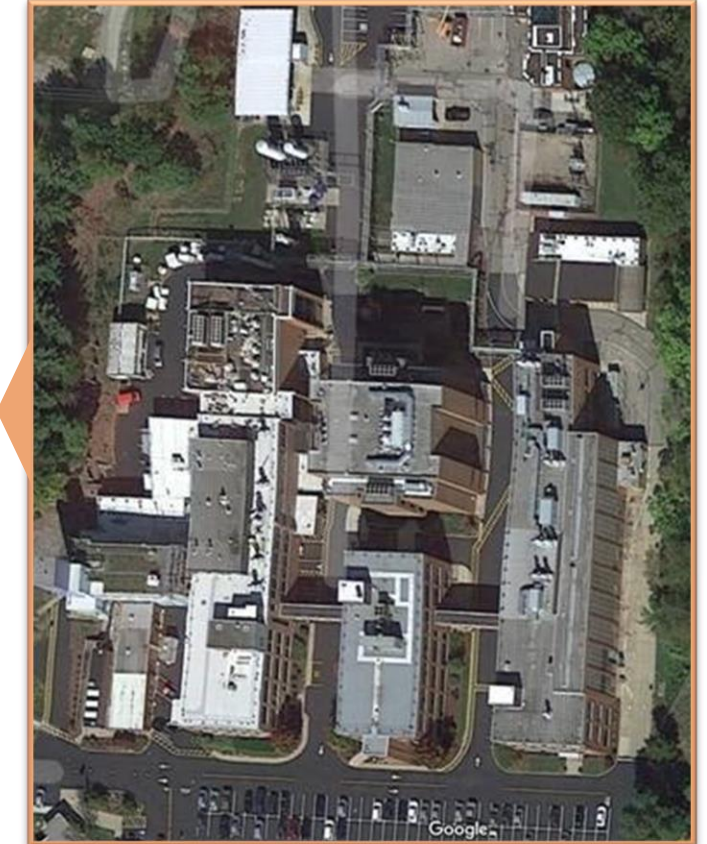
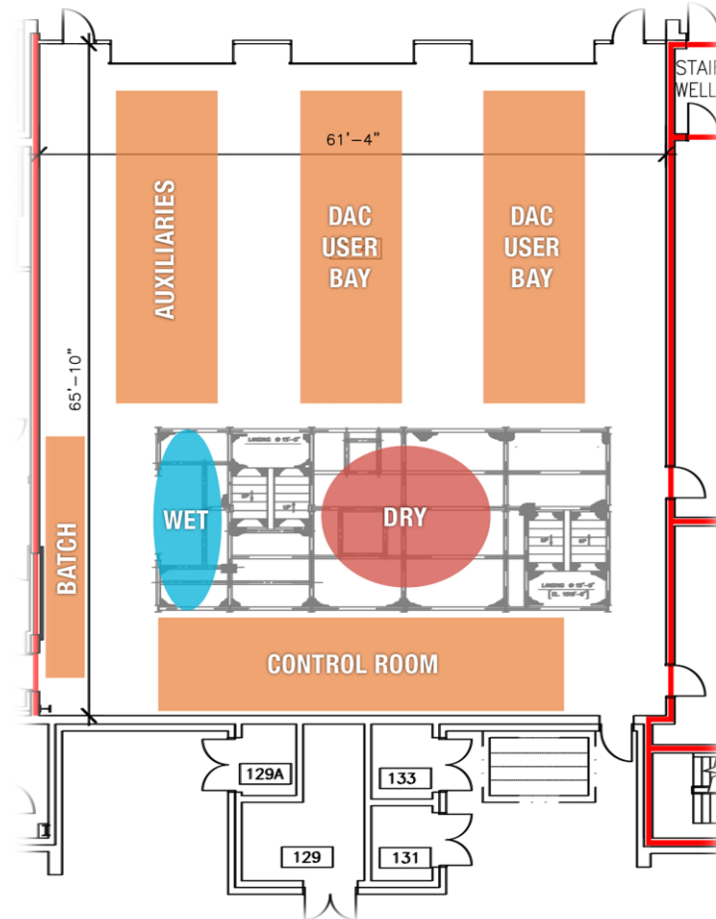


## A Renovation/utilization of Building 84 high bay (PGH)



# B84 High Bay

- 64ft x 60ft
- Can accommodate the dry and wet reactors
- Space for 2 user bays
- Sufficient space for facility auxiliaries



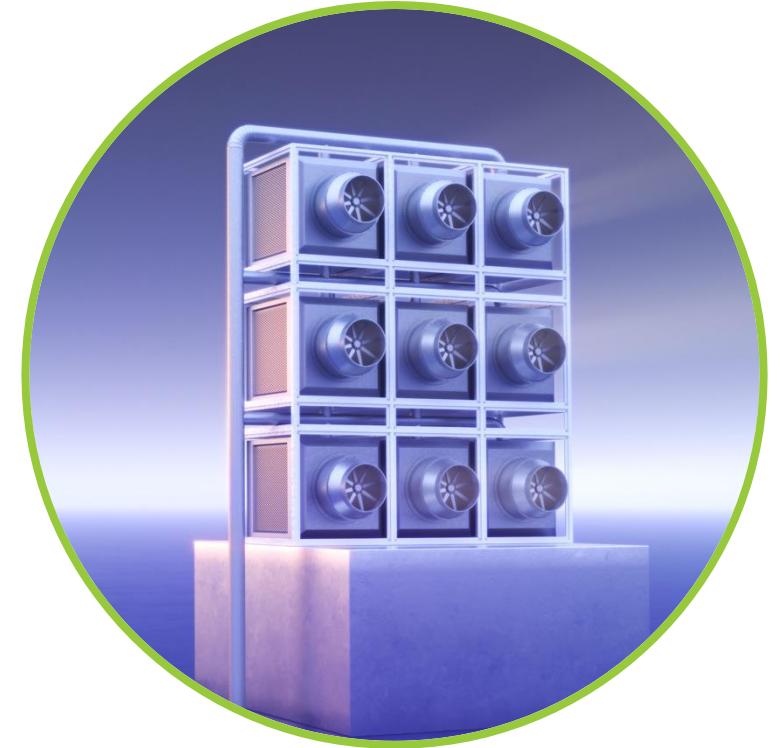
# Schedule for DAC Center



	FY22									FY23												FY24												FY25			
	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
<b>I – Siting Study &amp; 15% Design</b>																																					
<b>II – 50/95% Design</b>																																					
<b>III – 100% Design</b>																																					
<b>Approvals/Awards</b>																																					
<b>Construction</b>																																					
<b>Shakedown</b>																																					

# 15% Design Schedule Status

- ✓ Contract signed
- ✓ Kick-off meeting held early June
- ✓ Completion expected late October



# Summary

- NETL is building a user-friendly DAC test center
- It will have 2 test cells for evaluating user developed test skids for a wide variety of climate conditions (Summers in Miami – winters in Chicago)
- It will have 3 user developmental test facilities for testing cyclic and continuous designs for a variety of sorbents from liquid solvents to solid monoliths.
- It will have between 4 to 5 (liter sized) batch reactor test facilities for developing new and novel sorbents and accessing sorbent life.
- It is expected to be operational in May of 2024
- NETL will have interim testing capability at the 3000scfm scale for testing cyclic systems as early as the summer of 2023.

# Acknowledgements

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- A special thank is extended to Fan Shi, Jim Hoffman and Sam Bayham for taking the lead on the design of the reconfigurable test units as well as many, many others at NETL helping to make this center a success

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