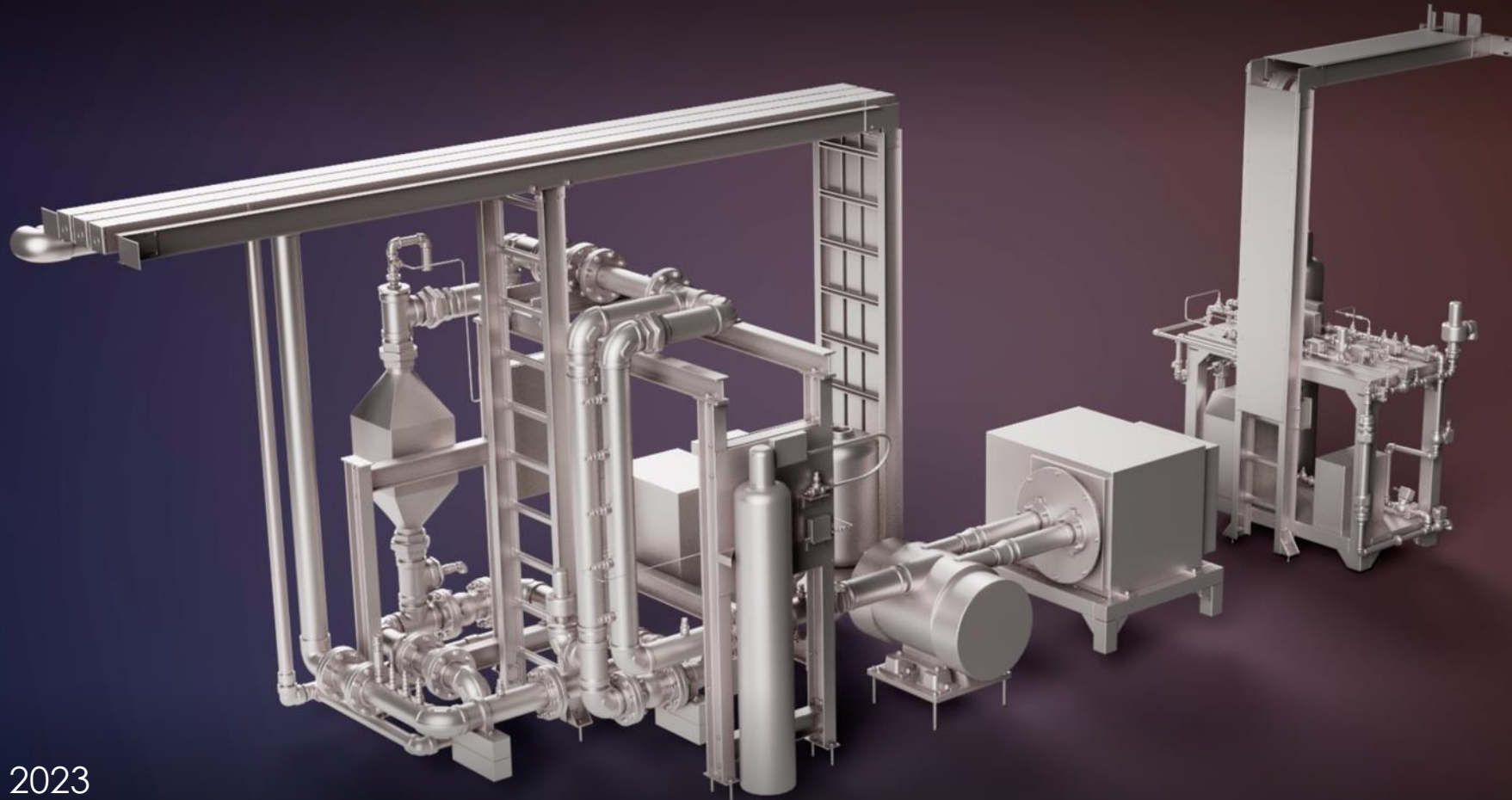




NETL DIRECT AIR
CAPTURE CENTER



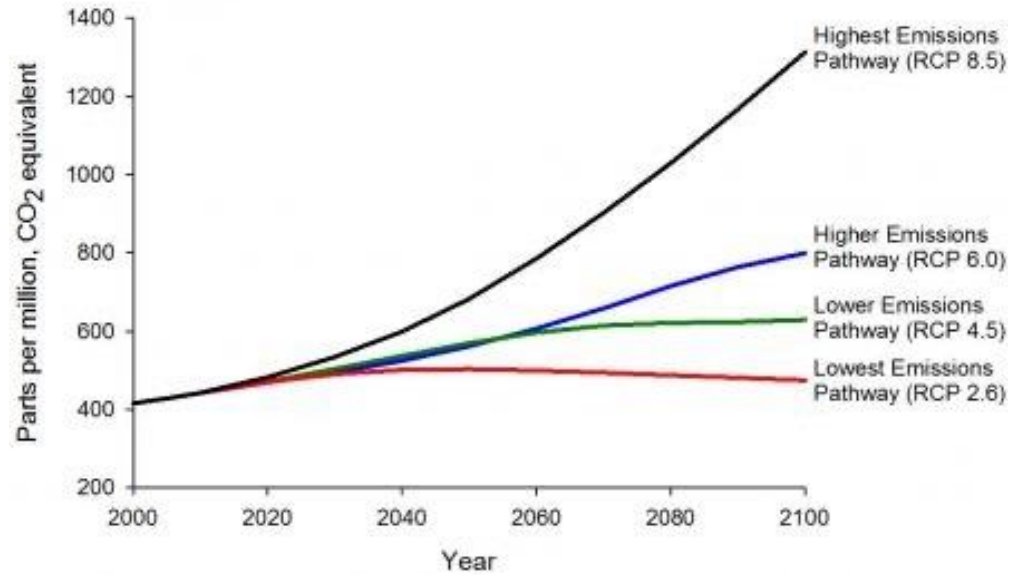
August 16, 2023



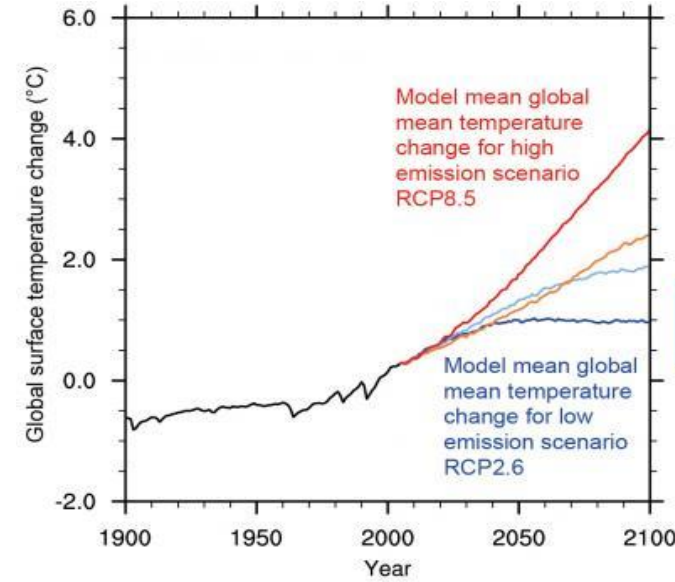
U.S. DEPARTMENT OF
ENERGY

Climate Change

Projected Atmospheric [CO₂]



Projected Global Temp. Increase



Transition to a Carbon-free Economy

- President Biden's goals:
 - 50% emissions reduction by 2030
 - CO₂ emissions-free power sector by 2035
 - Net-zero emissions economy by 2050



Tackling the
Climate Crisis

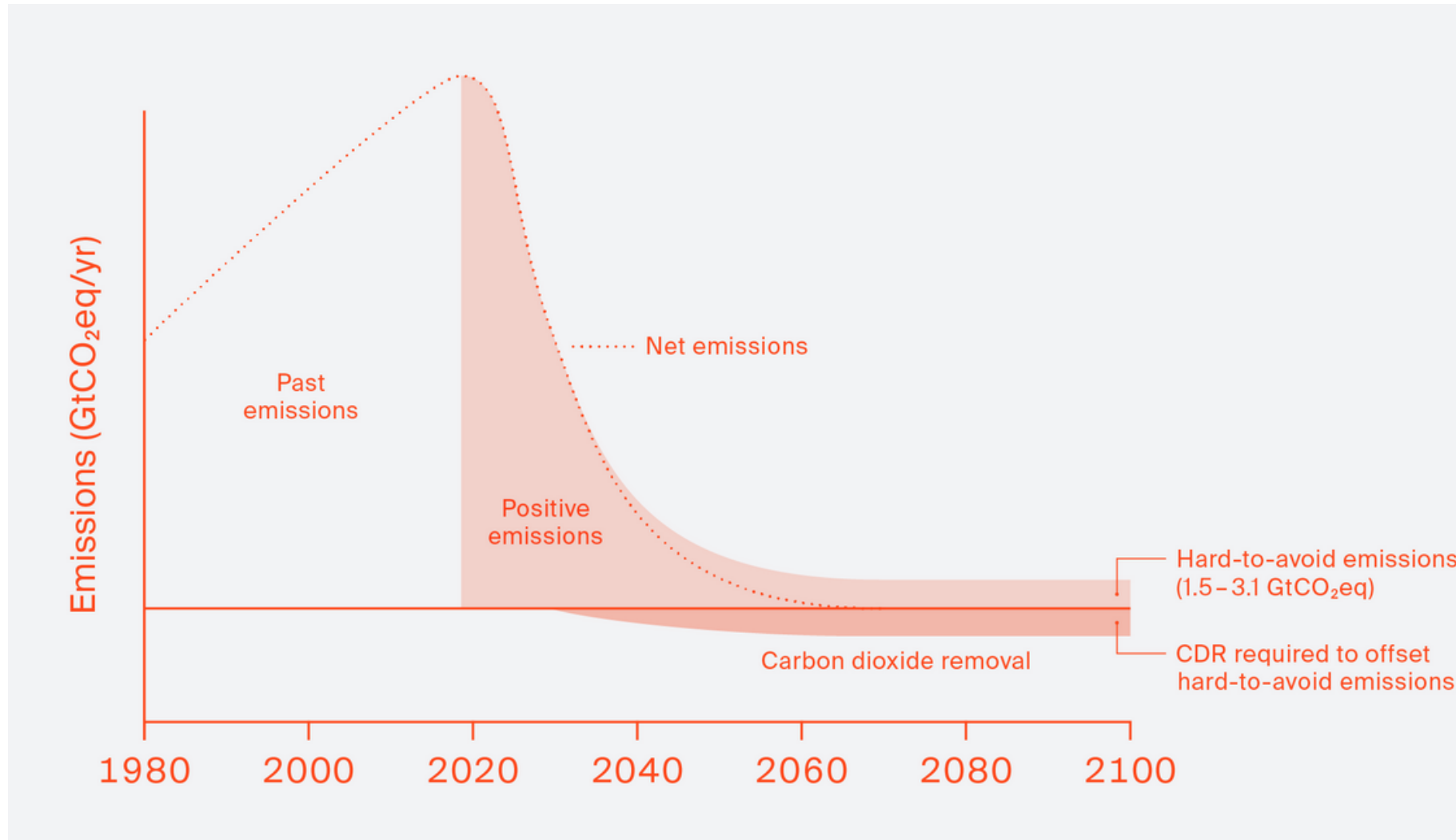


Advancing
Environmental
Justice



Domestic Clean
Energy
Manufacturing

The Path to Net-Zero by 2050



Carbon Reduction vs Carbon Removal

Point Source CCS for Power Generation and Industry



Power Plants



Cement Plants

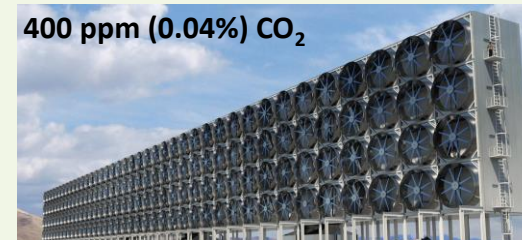


Iron and Steel Plants



Hydrogen Plants

Carbon Dioxide Removal from the Atmosphere



Direct Air Capture



Direct Ocean Capture

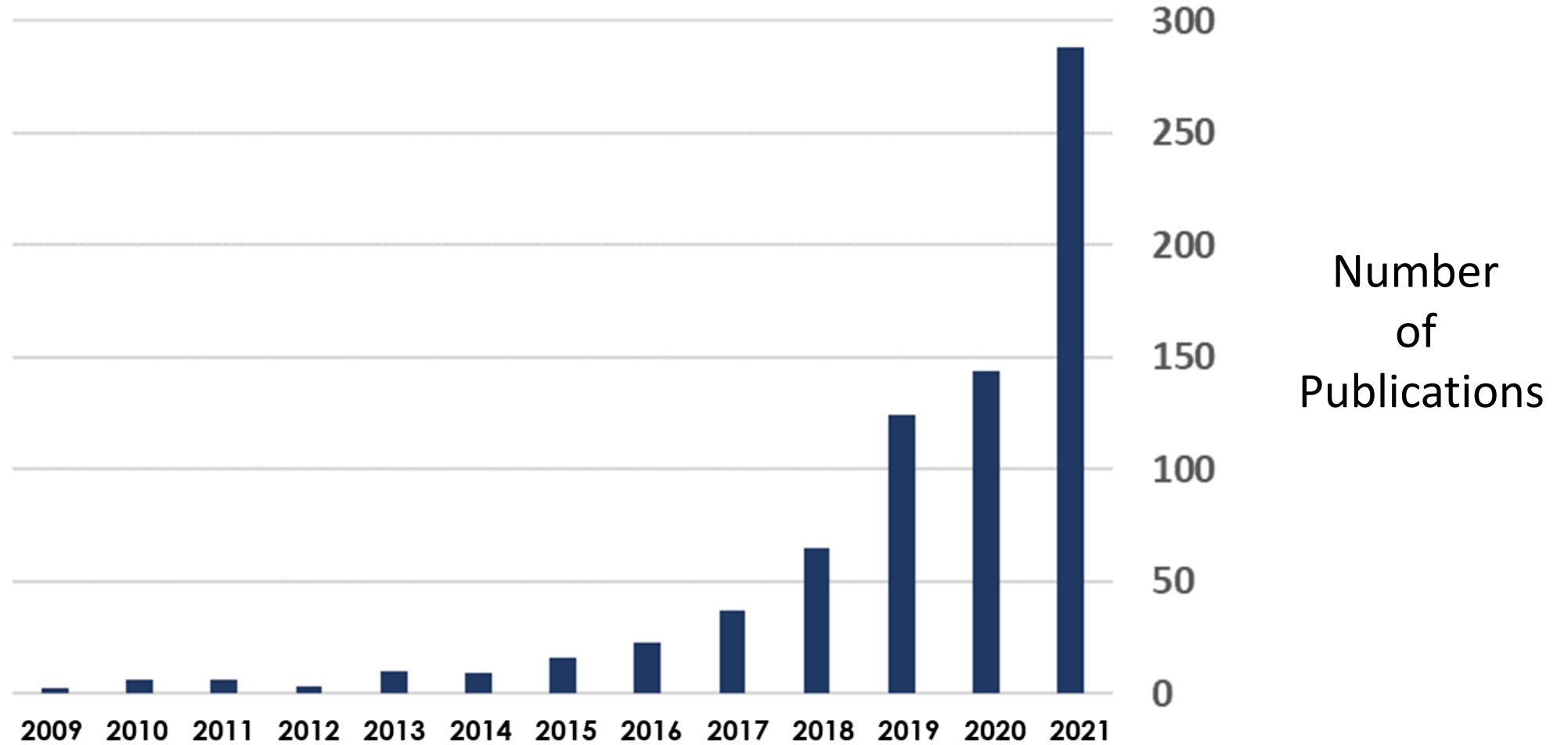


**Biomass Carbon
Removal and Storage**



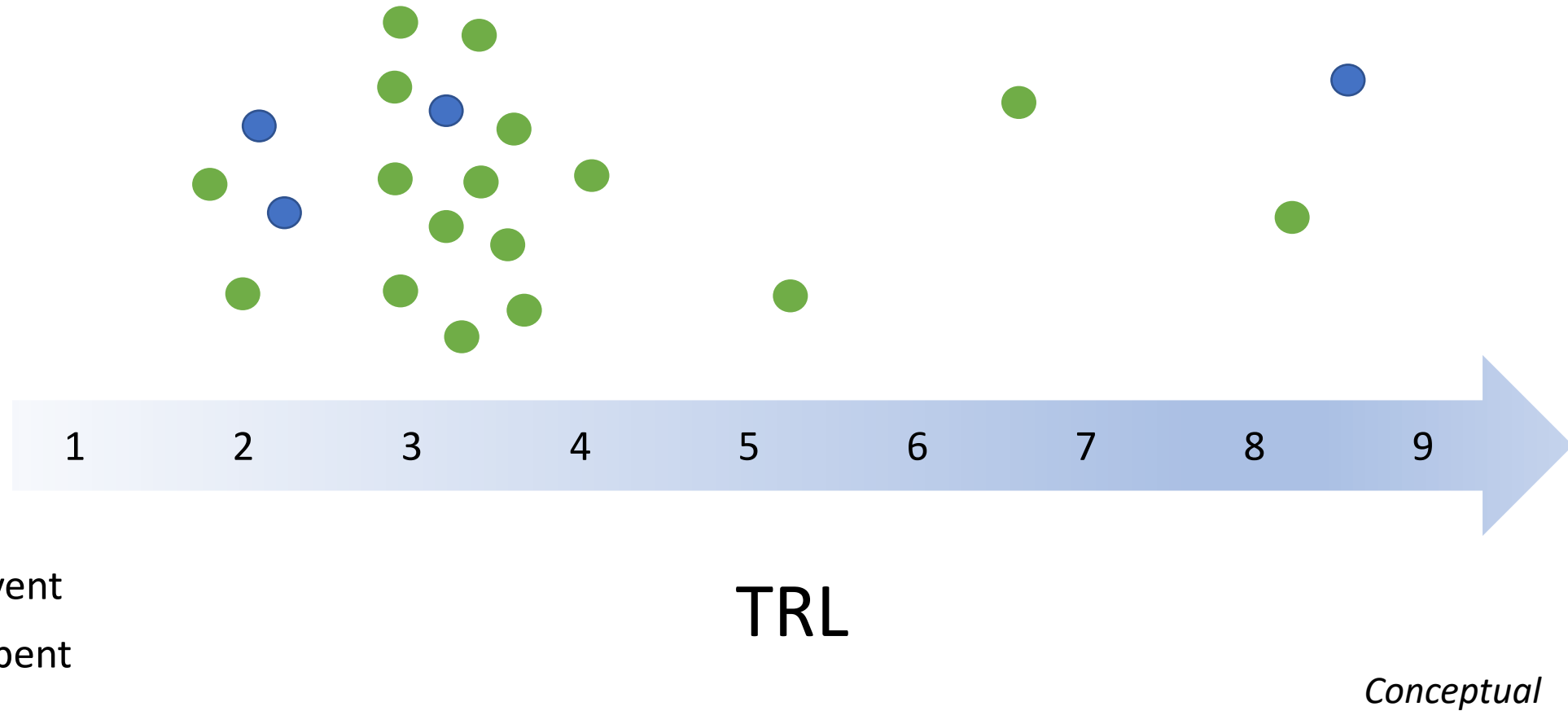
**Enhanced
Mineralization**

Exploding Interest in DAC



Source: Science Direct database

DAC Technology Readiness



NETL – Driving Innovation, Delivering Solutions



OREGON

- Materials Performance
- Alloy Development/Manufacture
- Geospatial Data Analysis



PENNSYLVANIA

- Process Systems Engineering
- Decision Science
- Functional Materials
- Environmental Sciences



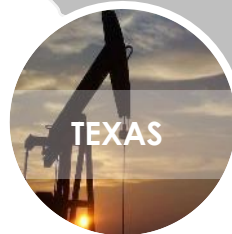
WEST VIRGINIA

- Energy Conversion Devices
- Simulation-Based Engineering
- In-Situ Materials Characterization
- Supercomputer Infrastructure



ALASKA

Oil and Gas
Strategic Office



TEXAS

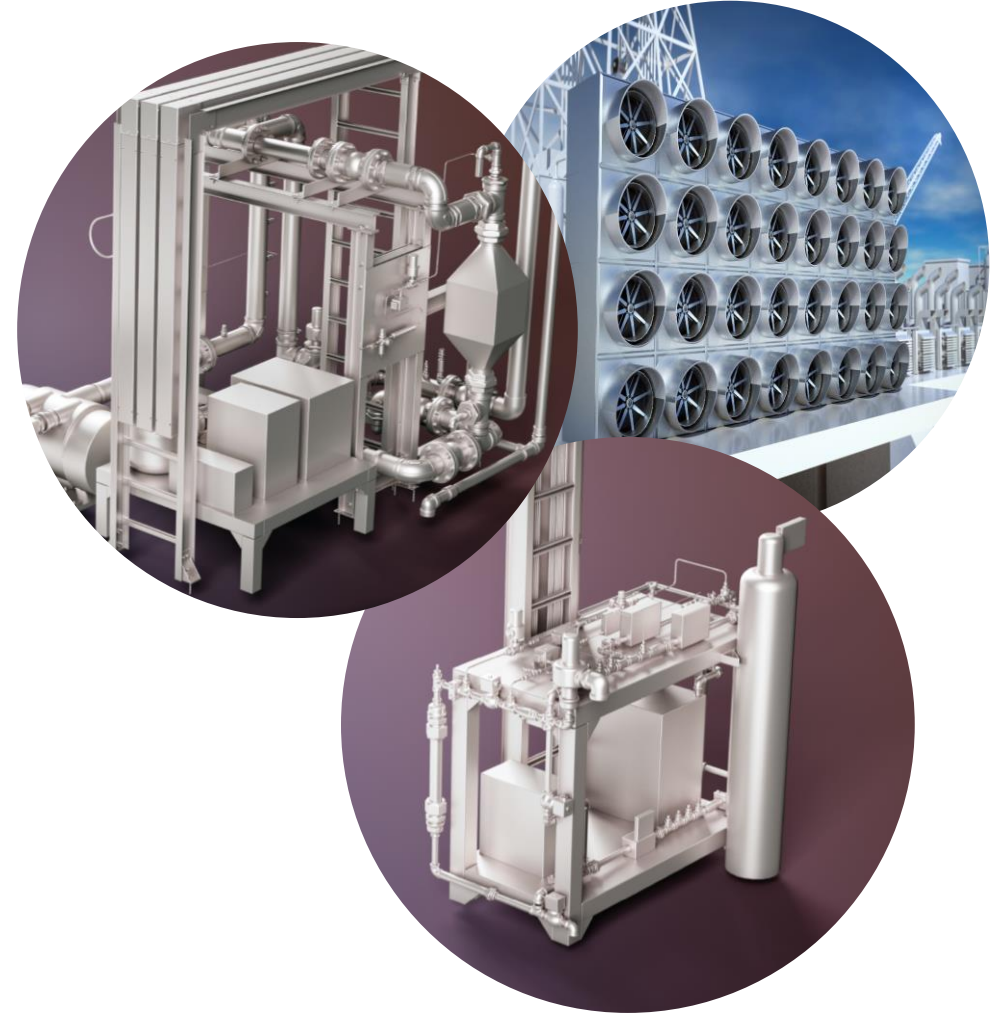
Oil and Gas
Strategic Office

NETL DAC Center

Supporting Rapid Technology Development for Atmospheric CO₂ Capture



- ✓ Inclusive, State-of-the-Art Testing Facilities
- ✓ Collaborative Access to NETL's World Class Expertise
- ✓ Standardized and Bespoke Testing Options Representing the "Gold Standard" in Technology Validation
- ✓ Authoritative Lifecycle Analysis as an Outcome of Partnerships



DAC Center Capabilities

Targeting Technologies TRL 3 – 6

CAPABILITIES



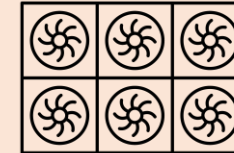
Lab scale

systems for novel solvent and
sorbent material assessment
(~0.1 kg CO₂/day)



Bench scale

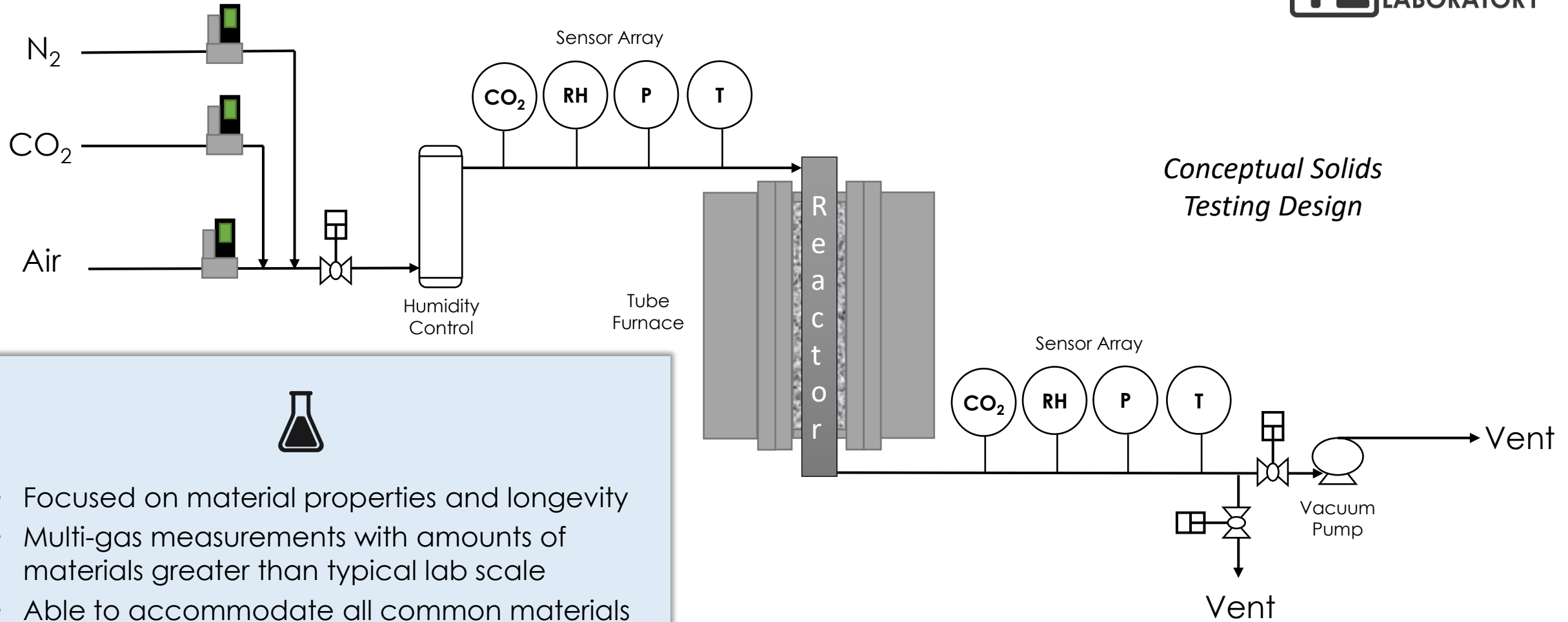
test beds with
flexible reactor designs
(~4 kg CO₂/day)



Small pilot scale

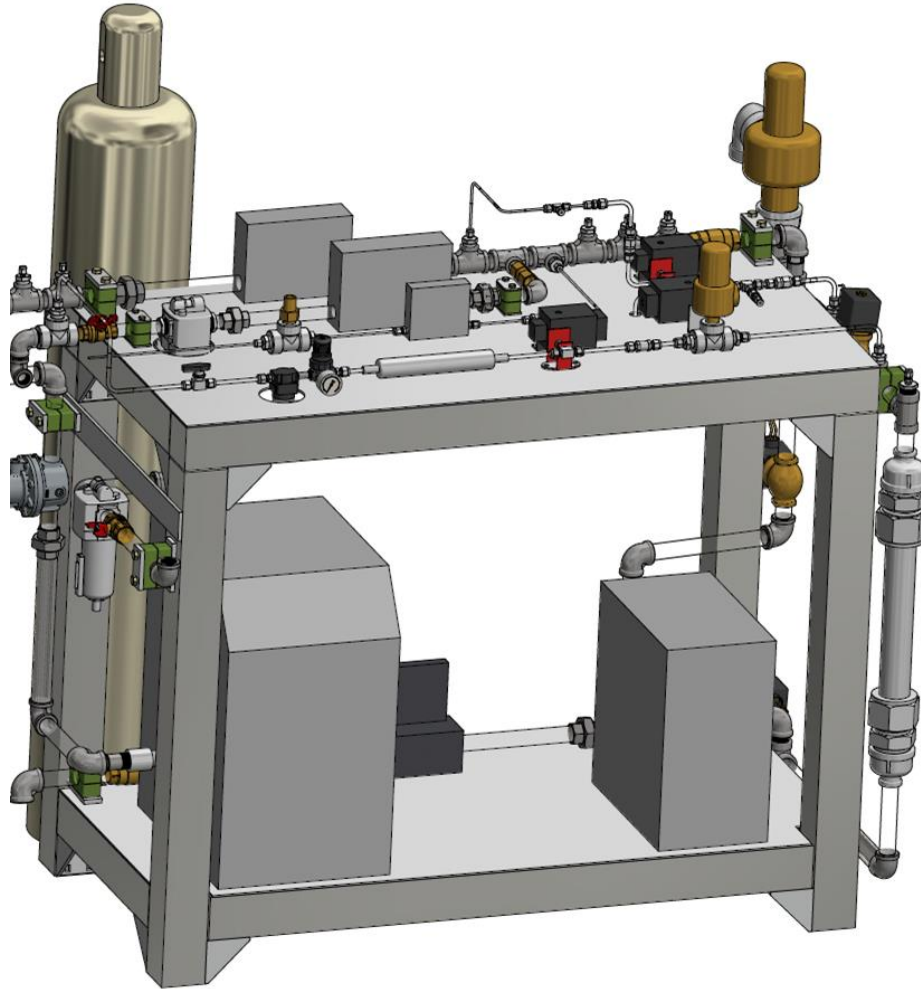
bays for evaluating
developer-built DAC skids
(~30 kg CO₂/day)

Laboratory Scale Materials Testing Units

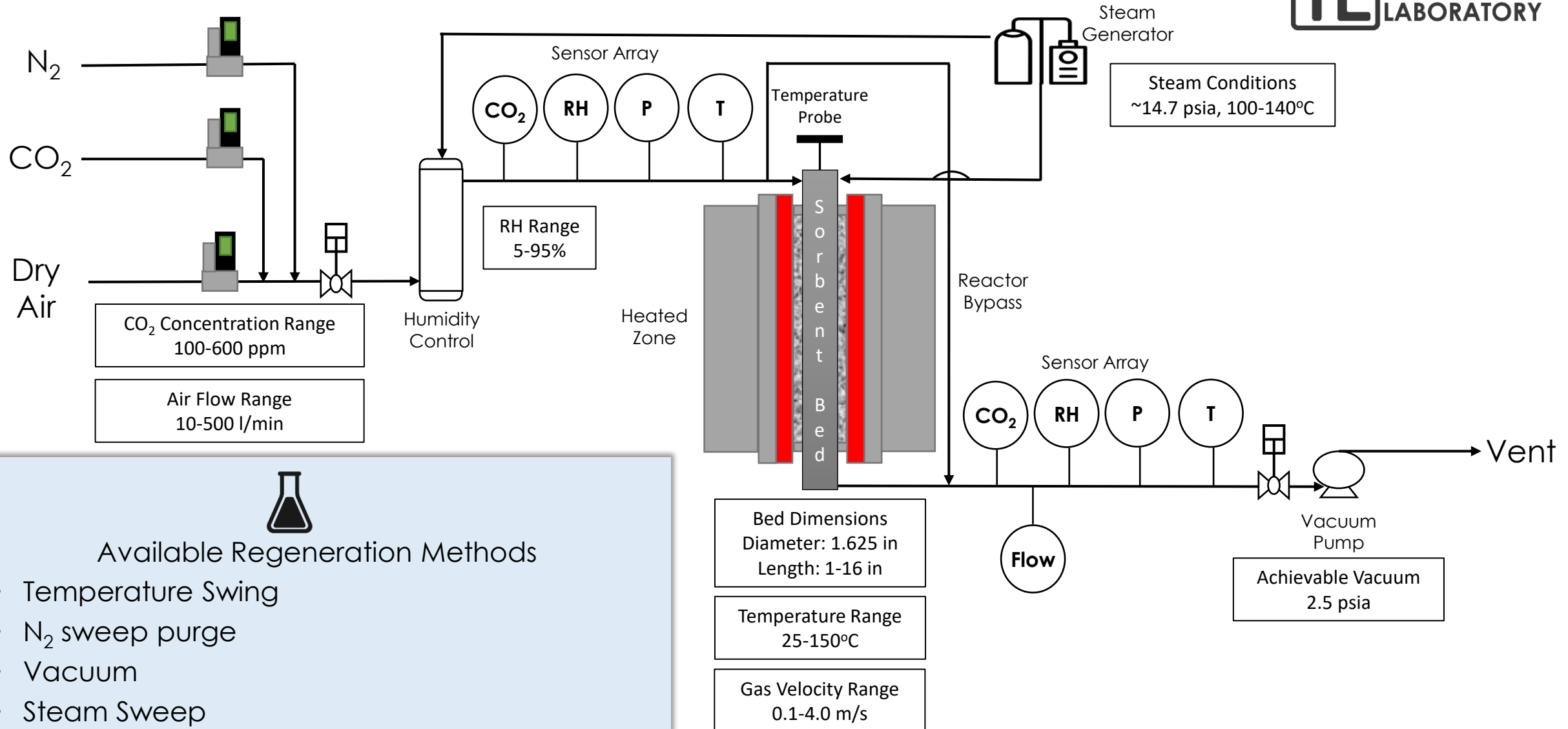


- Focused on material properties and longevity
- Multi-gas measurements with amounts of materials greater than typical lab scale
- Able to accommodate all common materials (liquid, powder, granular, fiber, structured)
- Automated for extended, multi-cycle testing

Laboratory Scale Materials Testing Prototype



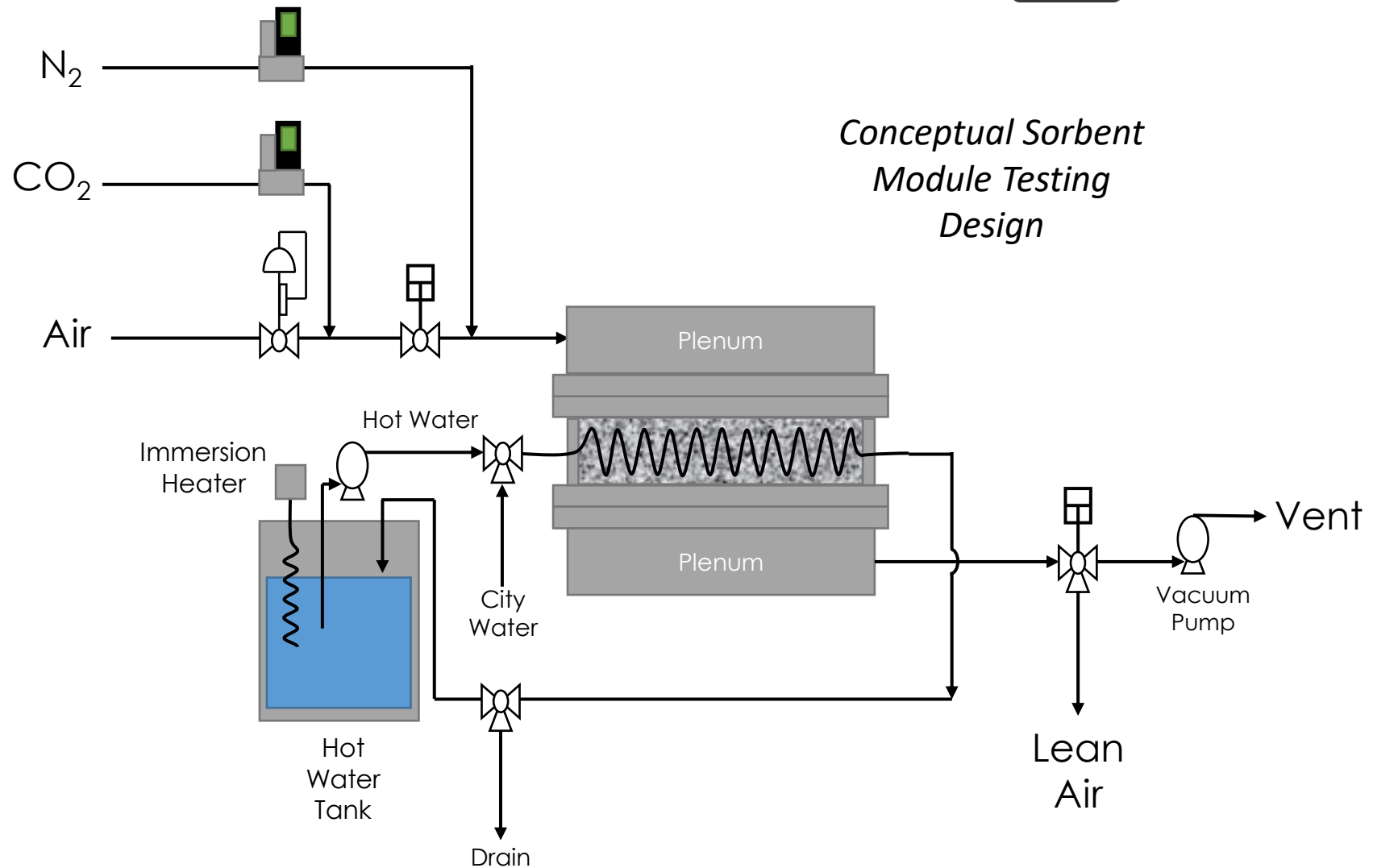
Laboratory Scale Materials Testing Units



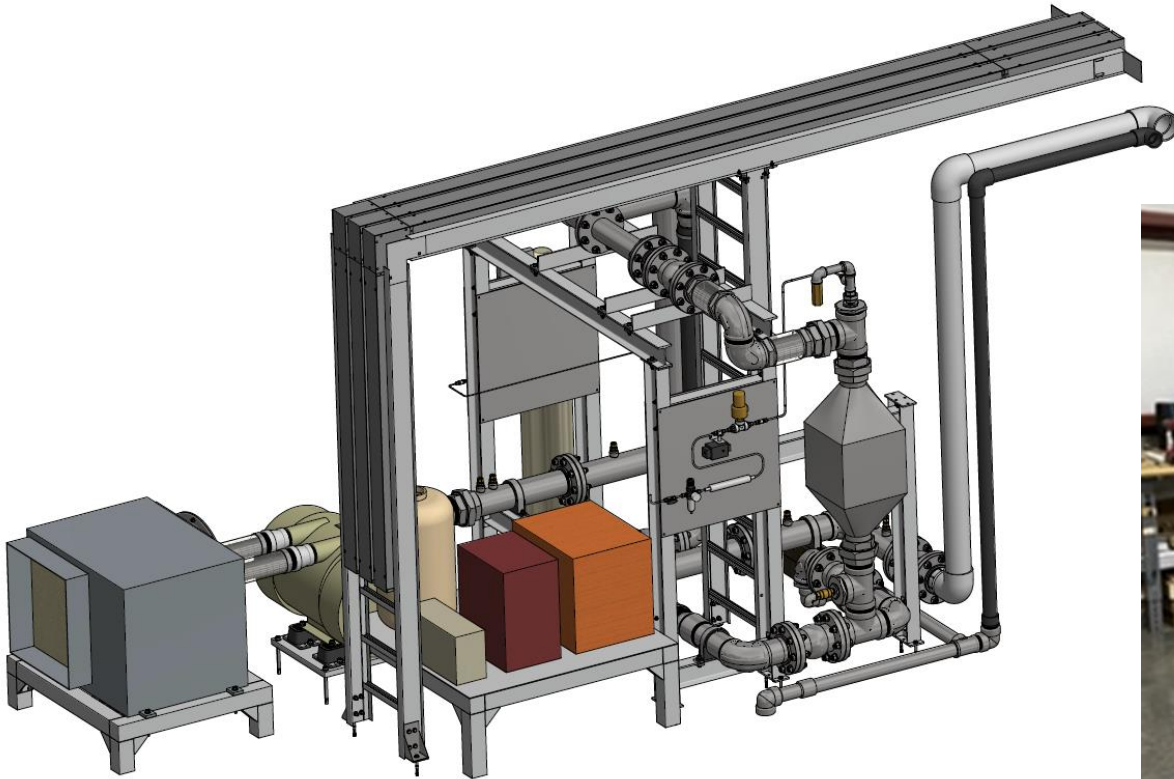
Bench Scale Module Testing Units



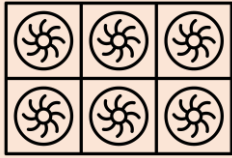
- Focused on module capture and flow measurements
- Sized for modules at typical scale: 12" X 12" X 12"
- Able to accommodate common form factors: granular solid, fiber mat, or monolith
- Instrumented to provide measurements of all parameters needed for prototyping models
- Designed to allow non-standard regeneration (Joule heating, microwaves)



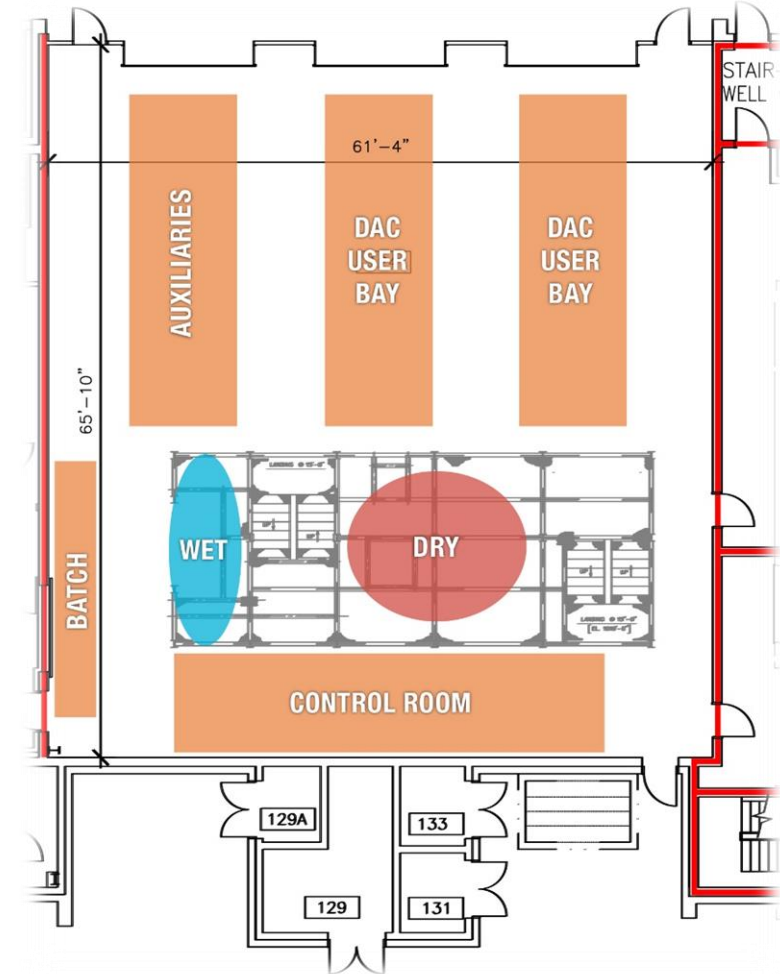
Bench Scale Module Testing Prototype



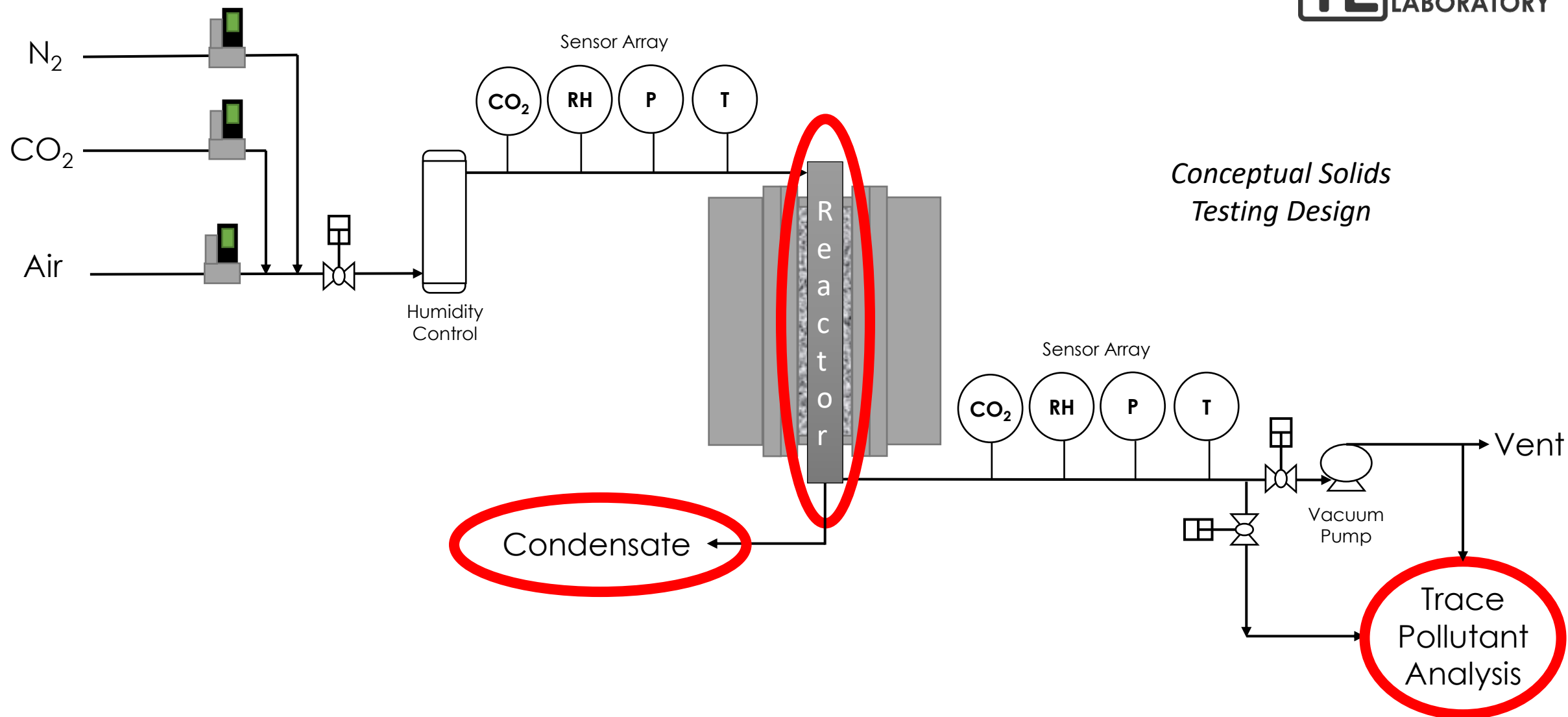
Small Pilot Scale Prototype Testing Units



- Focused on testing of small pilot scale prototype DAC units
- Able to accommodate a wide variety of technology types
- Testing under conditions representative of many climates
- Automated for extended, multi-cycle testing
- Instrumented for measurement of all parameters needed for assessment of field deployment at NCCC or a DAC hub



Trace Emissions Analysis Needs



CAPABILITIES



Material Scale

systems for novel solvent and sorbent material assessment
(~0.1 kg CO₂/day)

Sampling

Solid: Elemental Analysis
(Offline)
Liquid: GCMS (Offline)
Gas: PTR-TOF-MS
(Online, Periodic)

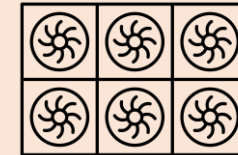


Module scale

test beds with
flexible reactor designs
(~4 kg CO₂/day)

Sampling

Solid: Elemental Analysis
(Offline)
Liquid: GCMS (Offline)
Gas: PTR-TOF-MS
(Online, Periodic)



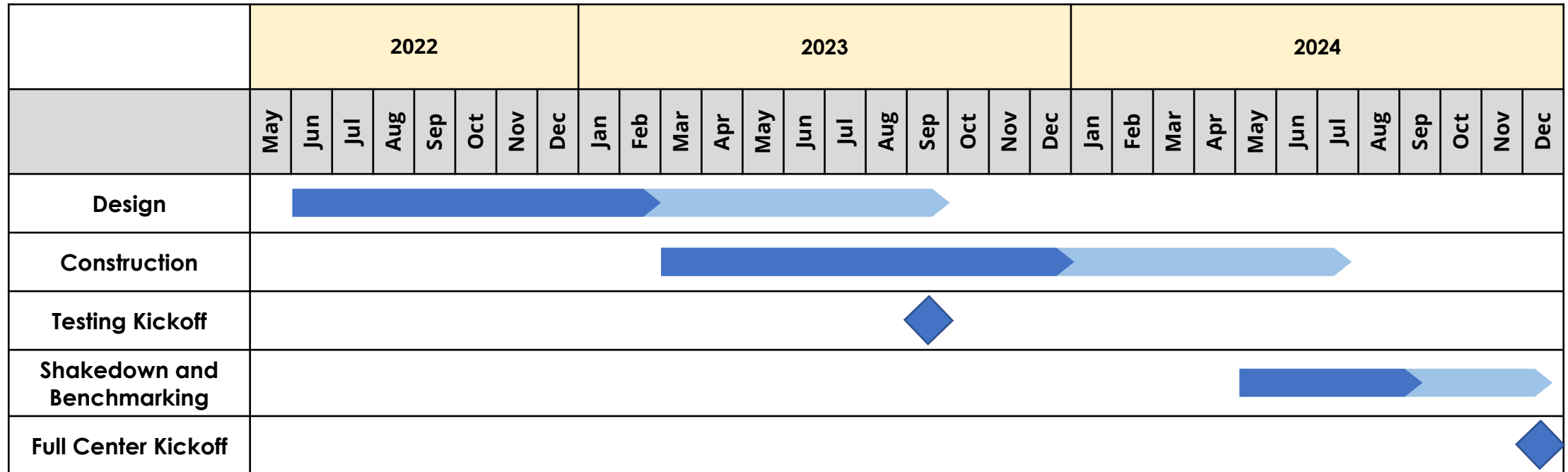
Prototype scale

bays for evaluating
developer-built DAC skids
(~30 kg CO₂/day)

Sampling

Solid: Elemental Analysis
(Offline)
Liquid: GCMS (Offline)
Gas: PTR-TOF-MS
(Offline)

DAC Center Timeline



Partnering with NETL



The TOOLBOX



- Cooperative Research and Development Agreement (CRADA)
- Contributed Funds-In Agreement (CFA)
- Memorandums of Understanding (MOU)/
Memorandums of Agreement (MOA)

- Small Business Innovation Research (SBIR) & Small Business Technology Transfer (STTR) Programs
- Unsolicited Proposals (USP)
- Non-disclosure Agreement (NDA)
- Funding Opportunity Announcement (FOA)

Available Technologies

- NETL's technology portfolio contains a broad range of innovations that have resulted from research
- Technologies and intellectual property available for licensing on NETL's website.

Available Technologies: <https://www.netl.doe.gov/business/tech-transfer/available-technologies>

Funding Opportunity Announcement (FOA)

- NETL uses FedConnect.net, Grants.gov and FedBizOpps.gov to post FOAs
- Proposals and applications are only accepted electronically through FedConnect.net or Grants.gov

Funding Opportunities:

<https://www.netl.doe.gov/business/solicitations>

Partner with us!

- ✉ Email: david.luebke@netl.doe.gov
- ✉ DACCcenter@netl.doe.gov
- 💻 NETL.doe.gov/direct-air-capture-center



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