

NETL RWFI Energy 101- Point Source Carbon



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. Introductions to the NETL RWFI – Anthony Armaly, NETL RWFI Coordinator
2. Point Source Carbon Capture Program- Ron Munson, Technology Manager
3. Economic & Workforce Development Roundtable Discussion

The NETL RWFI Energy 101 Series provides a basic primer on the research and development conducted at NETL. Researchers at the Lab present information on their work in an easy-to-follow and thus easy-to-communicate fashion. Discussion topics include the potential economic and workforce development opportunities that successful research into these topics and their related challenges.

NETL Regional Workforce Initiative (NETL RWFI)



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**



The U.S. Skilled Technical Workforce

Expected Future Challenges to the U.S. Skilled Technical Workforce



Significant shortfall of nearly
3.4 million
skilled technical workers by 2022*

RECOMMENDATION

Build national and regional coalitions and partnerships of stakeholders to address skills gaps and collaborate to harness shared resources

NETL RWFI's Tri-State Energy and Advanced Manufacturing consortium panel on the workforce of the future.



Consistent Engagement & Output

Outreach Tools




- Webinars
- Networking (meetings, lab tours, site visits)
- E-note (monthly) Webinars Archive
- RWFI website and archives
- www.netl.doe.gov/rwfi

REGIONAL WORKFORCE INITIATIVE

The mission of NETL's Regional Workforce Initiative is to create a platform for regional stakeholders to engage the laboratory and other federal agencies in collaborative workforce development efforts. These efforts complement energy and advanced manufacturing innovation and research by addressing the necessary workforce needs and gaps necessary to successfully commercialize and deploy energy technologies. The RWFI works to catalyze research investments into enduring economic development and workforce/job opportunities for the Appalachian region and the nation.


- [NETL E-Note Archives](#)
- [Current Events](#)
- [Webinar Archives](#)
- [NETL RWFI Fact Sheet](#)
- [NETL Pilot Workforce Workplan Technical Report](#)

NETL RWFI and Workforce and Economic Development



Energy and advanced manufacturing jobs support millions of direct and indirect jobs in the US economy and ensuring a trained workforce is a critical component of a vibrant economy. Through working with local, state, and national governmental, non-governmental and educational institutions, the RWFI works to identify skills and training gaps with respect to energy and advanced manufacturing jobs. Once identified, RWFI can provide an opportunity to leverage federal activities related to workforce development to the workforce infrastructure of the Appalachian region and all regions where NETL has a presence. The NETL RWFI also strives to connect economic development stakeholders to activities within NETL, as well as to the Department of Energy and other federal agencies that support economic development activities focused on energy and advanced manufacturing.

Key Activities of NETL RWFI



Regional in Focus, National in Reach

400+ Organizations Representing Multiple Stakeholder Groups



Stakeholder groups include:

- Economic Development Organizations
- Federal, State, & Local Governments
- Community Colleges & Universities
- Philanthropic Organizations
- National Laboratories
- Workforce & Other NGOs
- Industry

Appalachian Regional Commission
America Makes
Belmont College
TEAM Consortium
Benedum Foundation
BRITE Energy Innovators
Catalyst Connection
Carnegie Mellon University
Claude Worthington Benedum Foundation
Energy Futures Initiative
National Association of Workforce Boards
Coalfield Development Corporation
Community College of Allegheny College
Westmoreland Community College
PA Department of Economic Development
University of Pittsburgh

Siemens Corporation
Eastern Community College West Virginia
E2 Network
IACMI
ARM consortium
IN-2-Market, Inc.
Manufacturing Extension Partnership
West Virginia University
WVU Industrial Extension/MEP
Allegheny Conference
Charleston Area Alliance
Electric Power Research Initiative
Pittsburgh Regional Alliance
Robert C. Byrd Institute
Oak Ridge National Laboratories
West Virginia University

Key Outcomes to Date



Establishment of a new network of regional stakeholders



Consistent engagement with key regional partners



Integration of Workforce Workplan



Increased communication of NETL mission



Increased growth for potential collaborative opportunities

R-AME Innovation Group

NETL RWFI Advanced Manufacturing & Energy (R-AME)



- **5 themes/questions**
- **Engagement platform for region**
- **Network** for regional entrepreneurship and innovation
- **Best practices** in the issue areas
- **Regional funding** opportunities

REGIONAL FOCUS

Supporting
innovation,
entrepreneurship,
and economic
development

Workforce Training 1.0

Advanced Welding Workforce Initiative

- **1st** workforce training funding effort, worked with DOE & ARC to structure
- **\$1M** award for Advanced Welding
- **5** awardees across Appalachia
- **More women** than ever enrolled in 3 of the 5 tech schools



NETL RWFI Workforce Readiness Plan

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"> Efficiently extract large scale complex business data (time series data, structured/unstructured) from various data sources and prepare them for data analytics. Partner with product experts, leverage common open-source machine learning/deep learning packages for identifying data patterns/trends or building predictive models. Deploy solutions to business units using software technologies to generate measurable values for businesses. 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. 	<ul style="list-style-type: none"> Undergraduate degree in Data Science, Computer Science, Math, or Statistics. For candidates who hold an engineering degree, we require candidates have taken data science classes already. 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. 	Yes	
Geologists	<ul style="list-style-type: none"> 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. 	<ul style="list-style-type: none"> Undergraduate & Professional 	Yes	

Pilot Conclusions

Report Findings: www.netl.doe.gov/rwfi

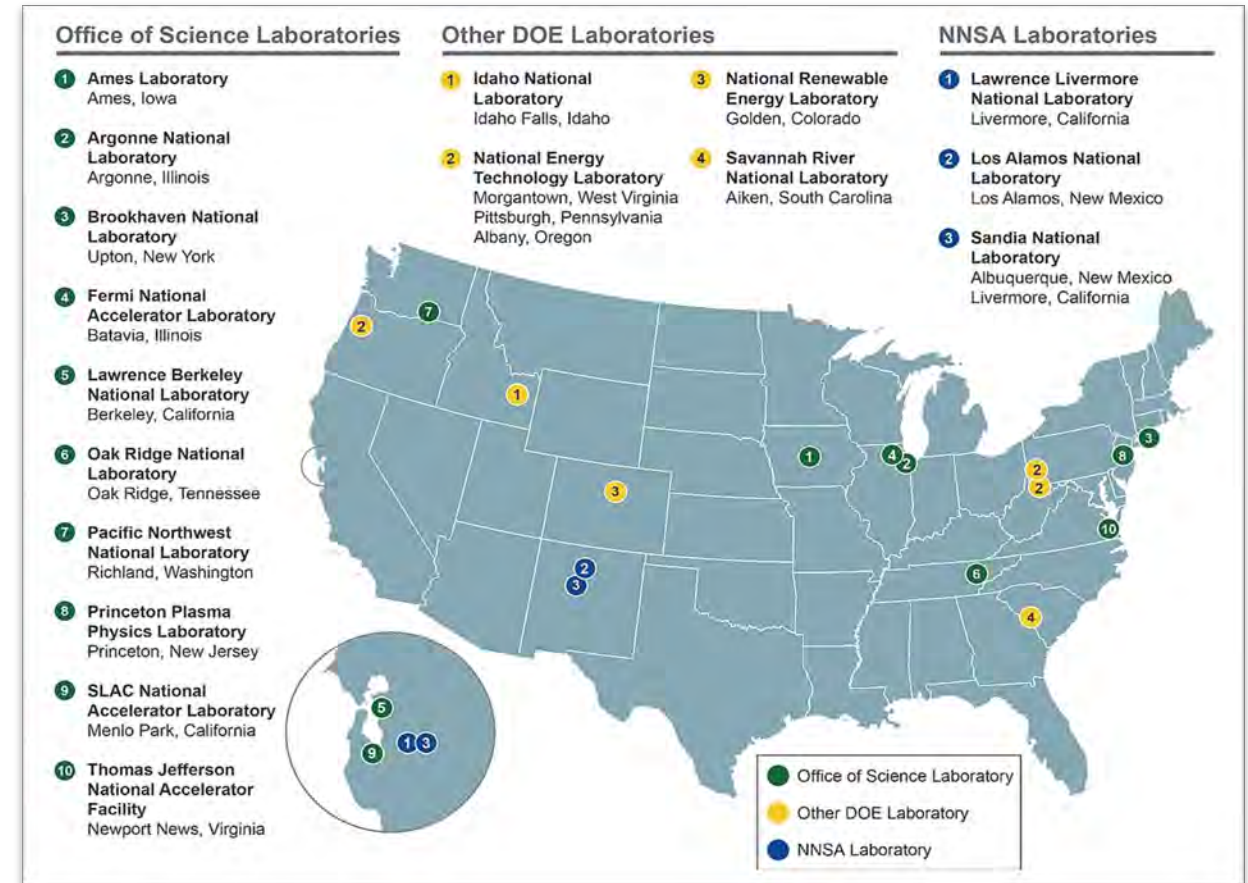
- ✓ **Skilled technical workforce** is essential
- ✓ Technical workforce occupations are high paying and in-demand
- ✓ Energy and Advanced Manufacturing industries are rapidly evolving towards high skilled and increased experience
- ✓ The Workforce **Workplan** is an effective tool in identifying emerging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



Opportunity?

Report Findings: www.netl.doe.gov/rwfi

- 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



Next Steps

Let's Connect, Communicate and Collaborate!

- Pursuing external funding opportunities to amplify our impact
- Continuing to work closer with the other national labs and creating a National Lab community of practice
- Developing new focus groups regionally around emerging technical areas such as DAC, Hydrogen, etc.
- Increasing our reach with our webinars and E-Note growth by working closer with DOE HQ Comms



www.netl.doe.gov/rwfi
netl.rwfi@netl.doe.gov
Anthony.Armaly@netl.doe.gov



Solutions for Today | Options for Tomorrow

Carbon Capture Research & Development



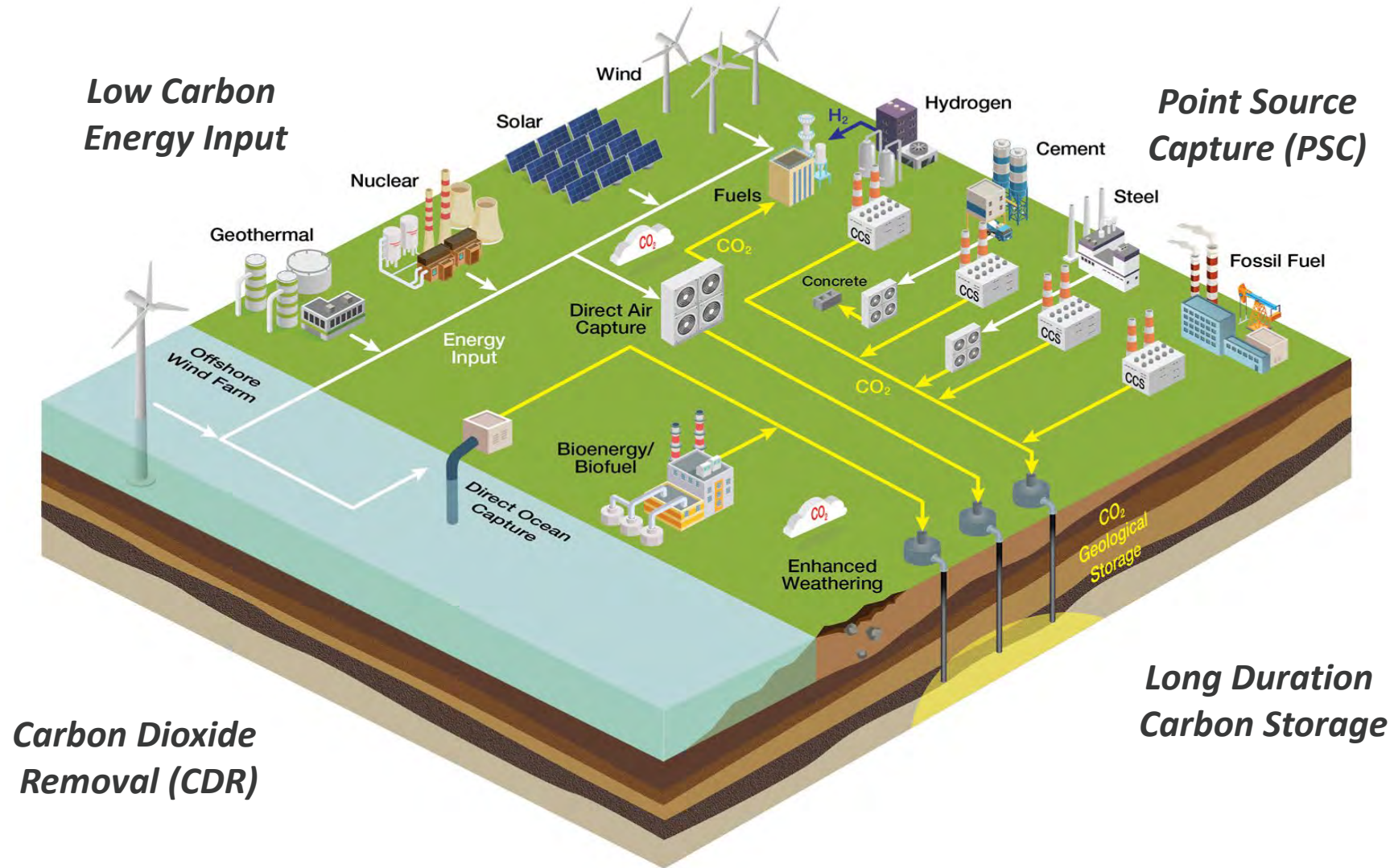
RWFI Energy 101 – Point Source Carbon Capture – March 9, 2023



Ron Munson
Point Source Carbon Capture
Technology Manager
National Energy Technology Laboratory



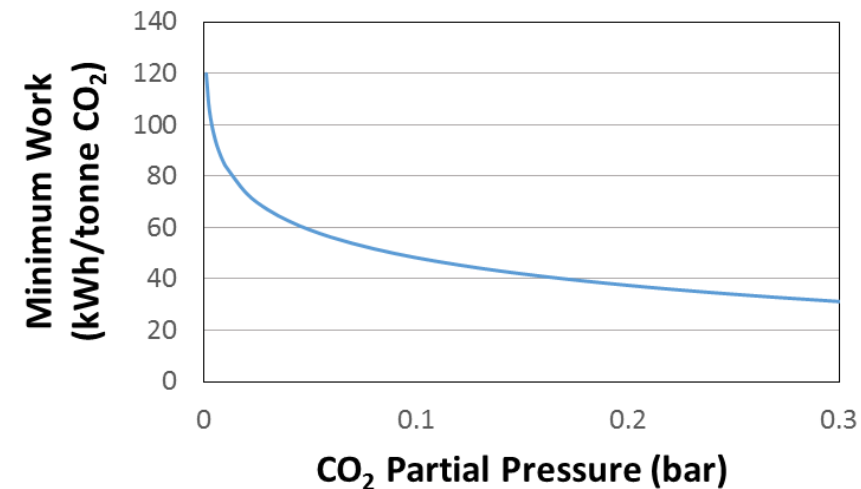
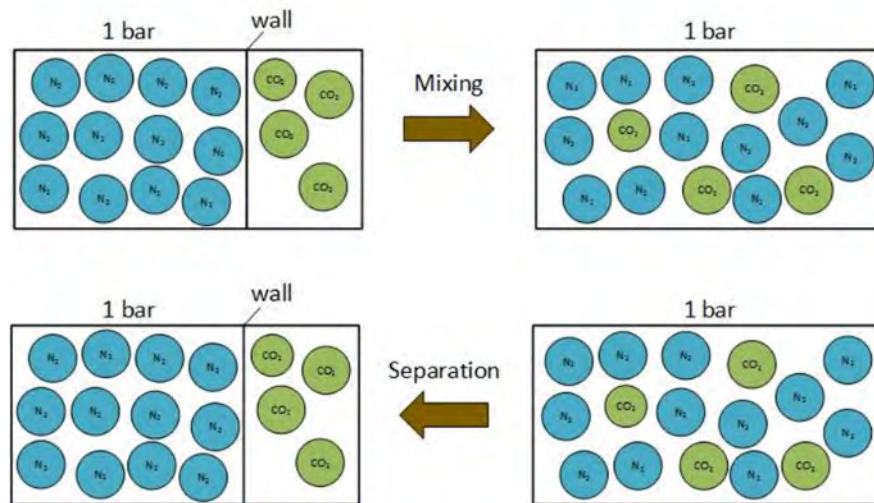
Integrated Approach to Carbon Management...



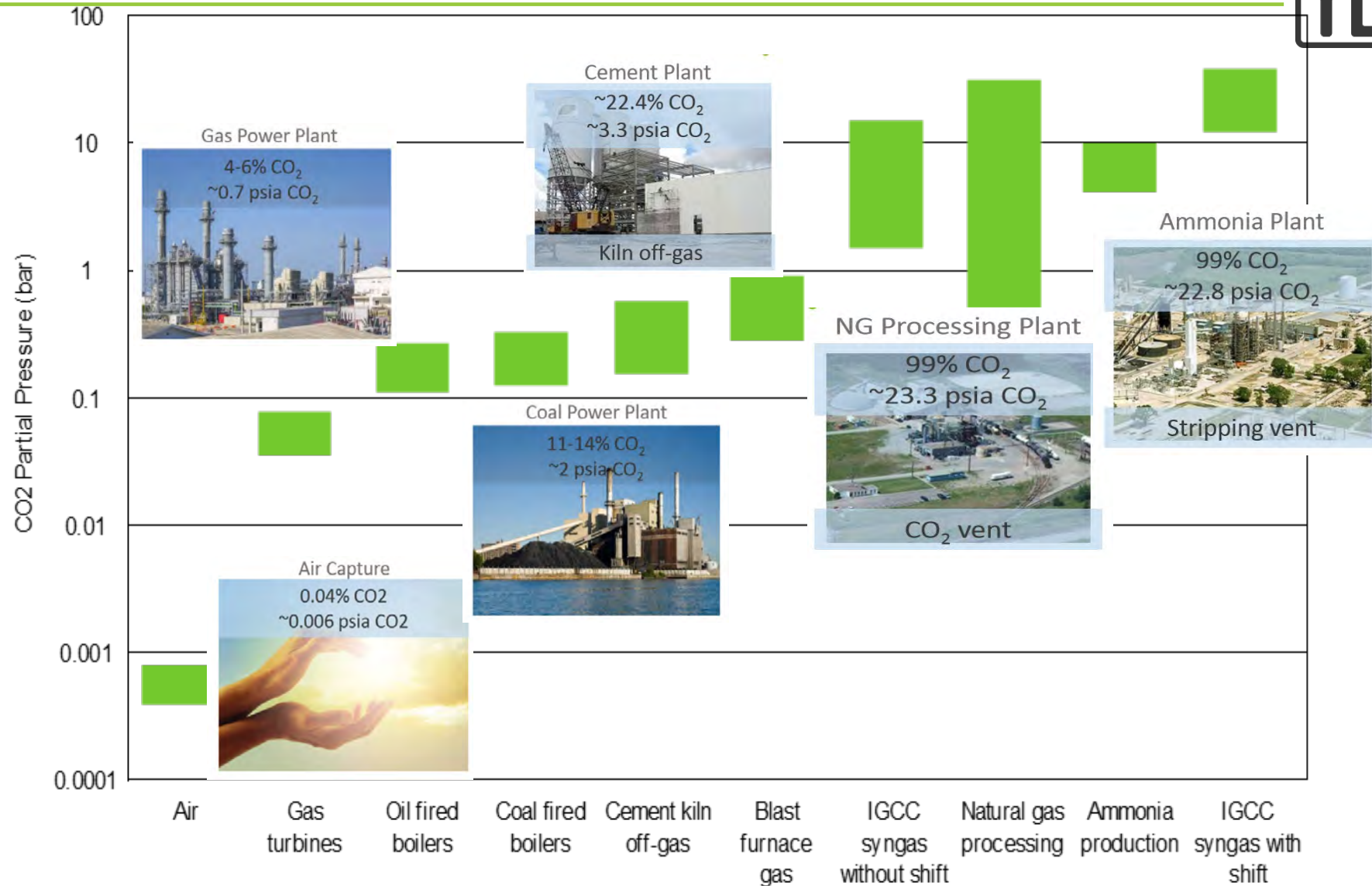
Graphic adopted from: https://static1.squarespace.com/static/58ec123cb3db2bd94e057628/t/612e4603a57548759c38d779/1630422541002/LEP-Building_to_Net-Zero-June-2021-v4.pdf

Carbon Capture Definition

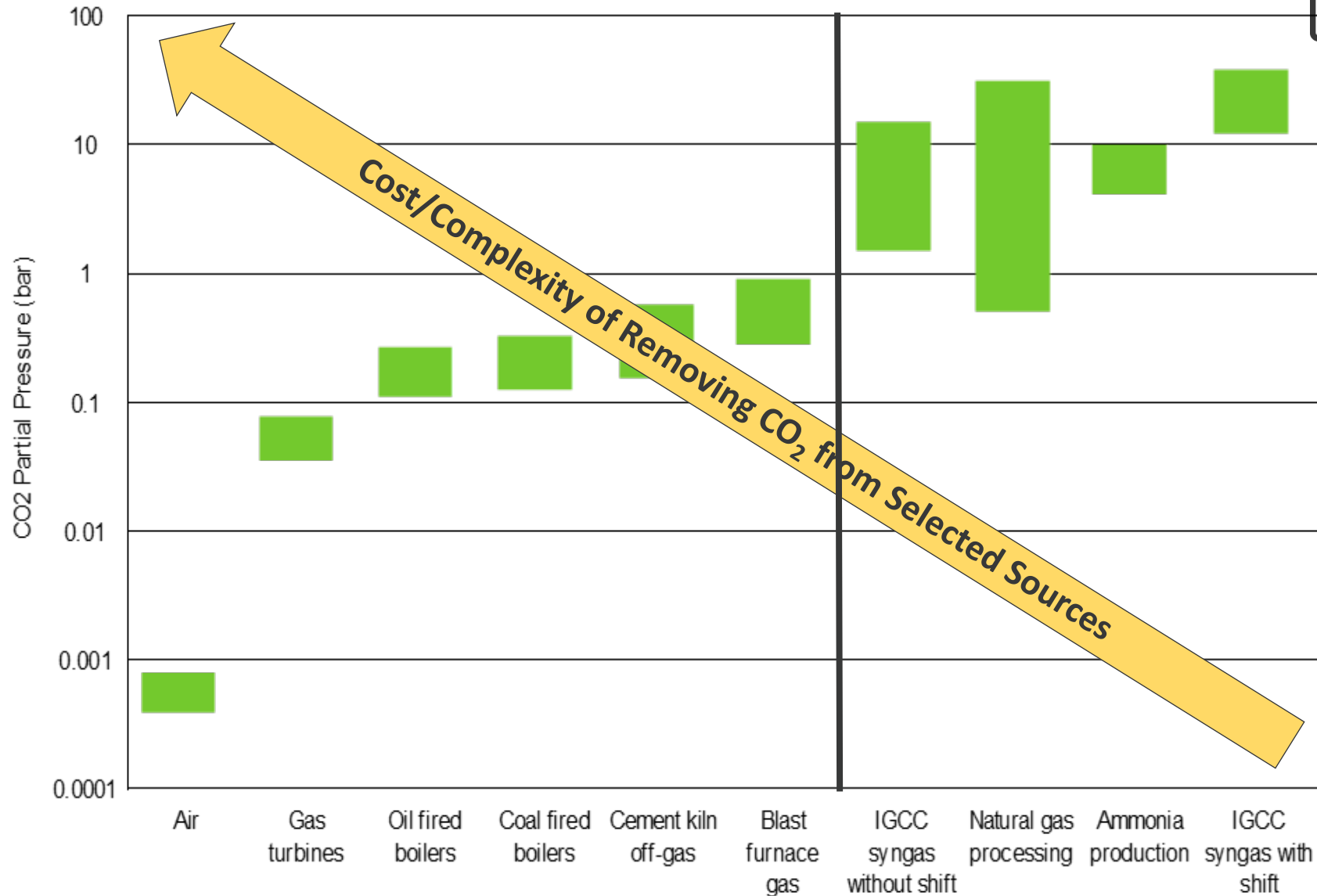
Separation of the CO_2 from a gas stream produced in a power station or an industrial process to obtain pure CO_2 for geological storage or further use



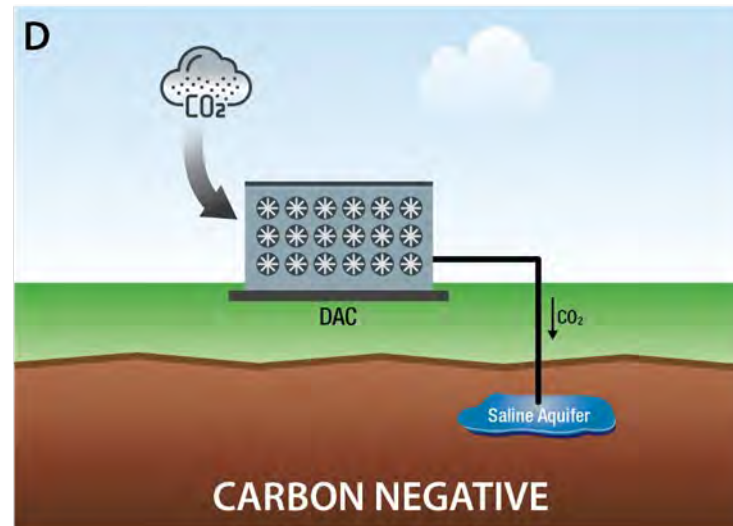
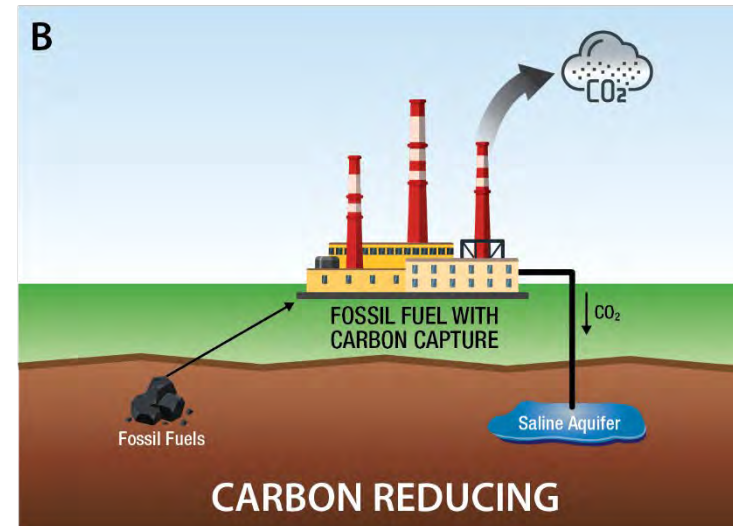
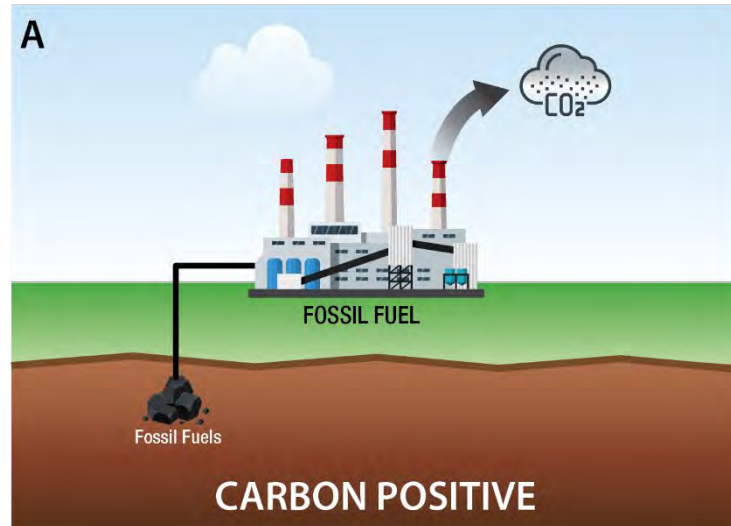
CO₂ Concentrations: Select Sources



Historic CCS Deployments



Carbon Reducing vs Removal



Carbon Reducing vs. Carbon Negative

CARBON REDUCING

Point-Source Capture (PSC) for Power Generation and Industrial Sectors



Power Plants



Cement Plants



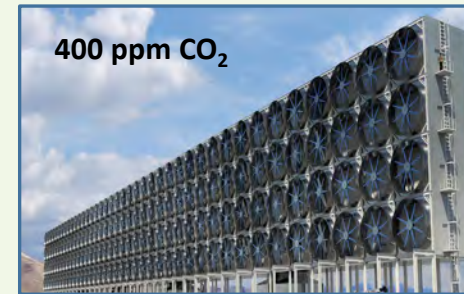
Steel Plants



Hydrogen Plants

CARBON NEGATIVE

Carbon Dioxide Removal (CDR) from Air



Direct Air Capture (1)



Enhanced Weathering



Bioenergy Carbon Removal and Storage (BiCRS)

(1) Assume C storage as CO₂ off-take

Point Source Capture Program...Mission



• Mission

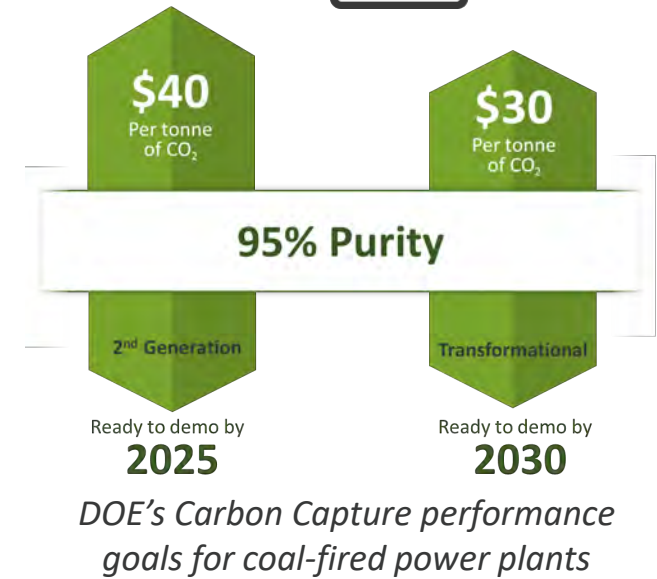
- Develop advanced cost-effective CO₂ capture technologies throughout the power-generation and industrial sectors
- Ensure the U.S. will continue to have access to safe, reliable, & affordable low-carbon energy generation

• Drivers/Challenges

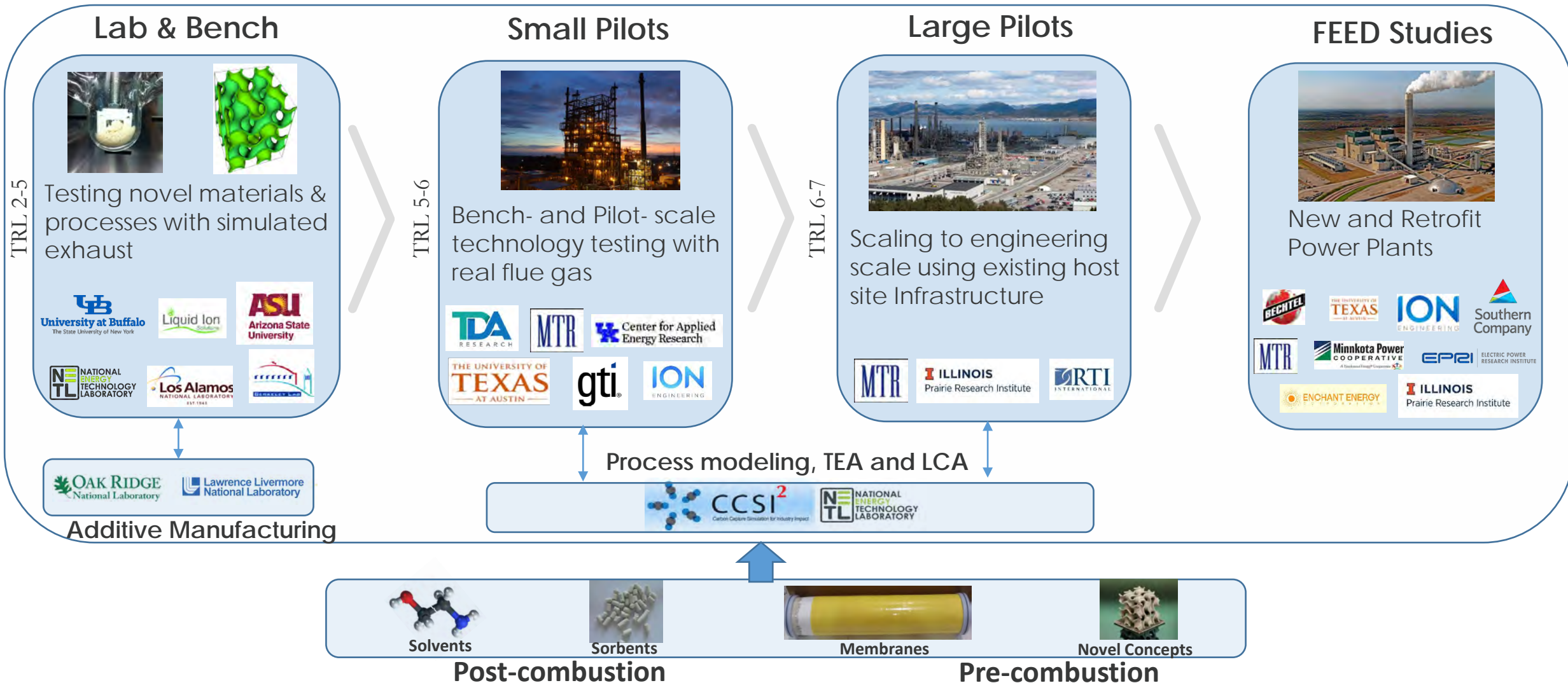
- Reduce carbon capture CAPEX/OPEX under a wide range of feed conditions and high capture efficiencies
- Demonstrate first-of-a-kind carbon capture on power and industrial sectors coupled to dedicated and reliable carbon storage, that will lead to commercially viable nth-of-a-kind opportunities for widescale deployment

• Goal & Metrics

- Support U.S goal to achieve carbon pollution-free power sector by 2035 and zero-carbon economy by 2050 (facilitated by an interim goal of achieving 50% reductions by 2030)



Carbon Capture.. Program Structure



Carbon Capture Program.. Evolution

1st and 2nd Generation Technologies

2025: \$40/tonne CO₂



2008 -

- ✓ Lower CAPEX/OPEX
- ✓ Reduced regeneration energy
- ✓ Increased working capacity

Transformational Technologies

2030: \$30/tonne CO₂



Hollow Fibers



3D Print



Biphase Solvent

2015 -

- ✓ Water Lean Solvents
- ✓ Adv. Membranes
- ✓ Hybrid Systems
- ✓ Process Intensification

Scale-up

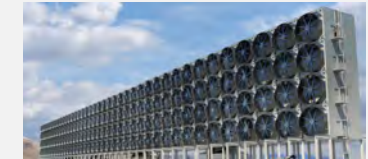


TCM

2018 -

- ✓ Engineering Scale testing
- ✓ FEED studies

Negative Emissions Technologies & Industrial



Carbon Engineering, DAC

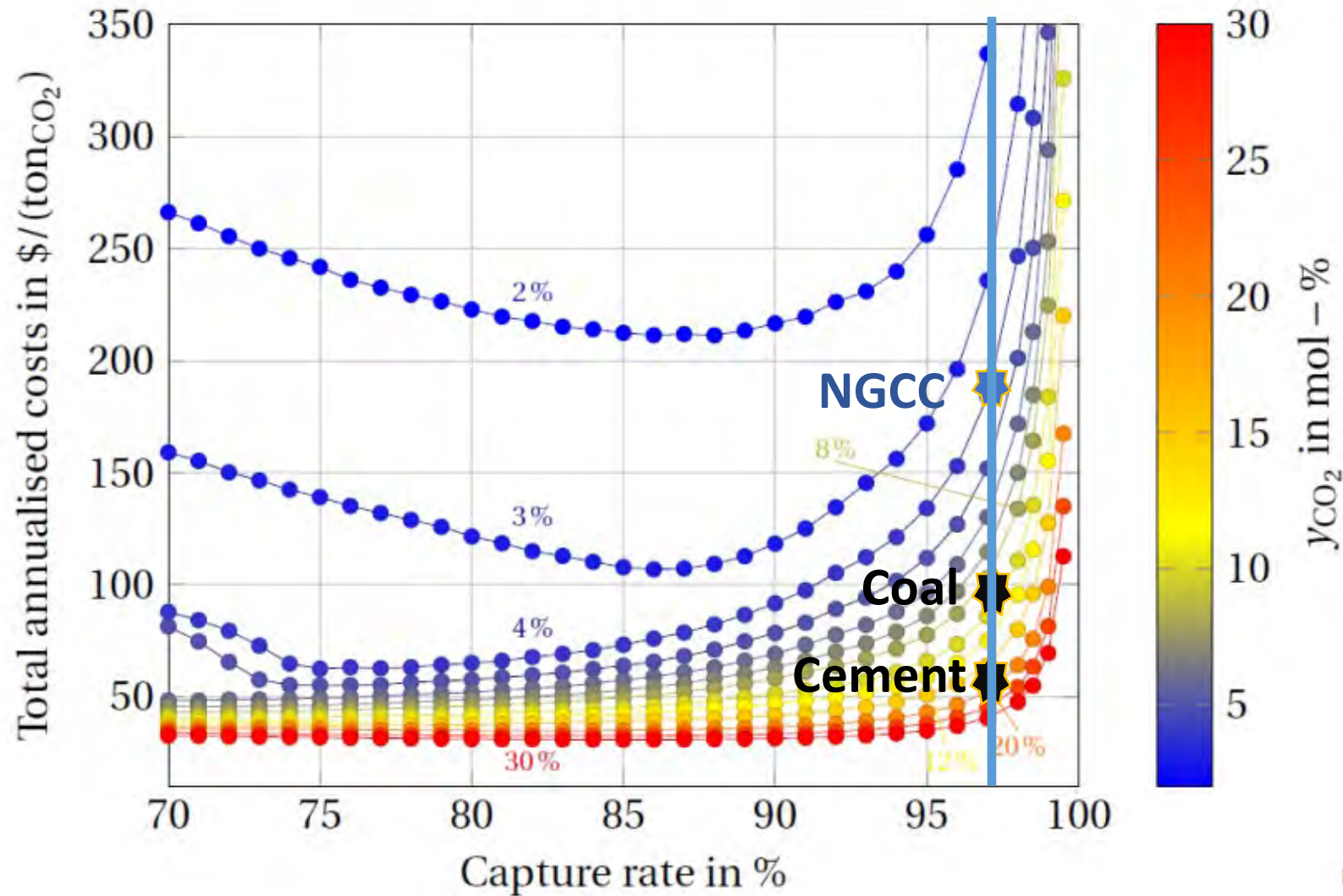


Ethanol Plant

2020 -

- ✓ DAC & BECCS
- ✓ Industrial
- ✓ NG

Deep Decarbonization.. Beyond 90%+ Capture



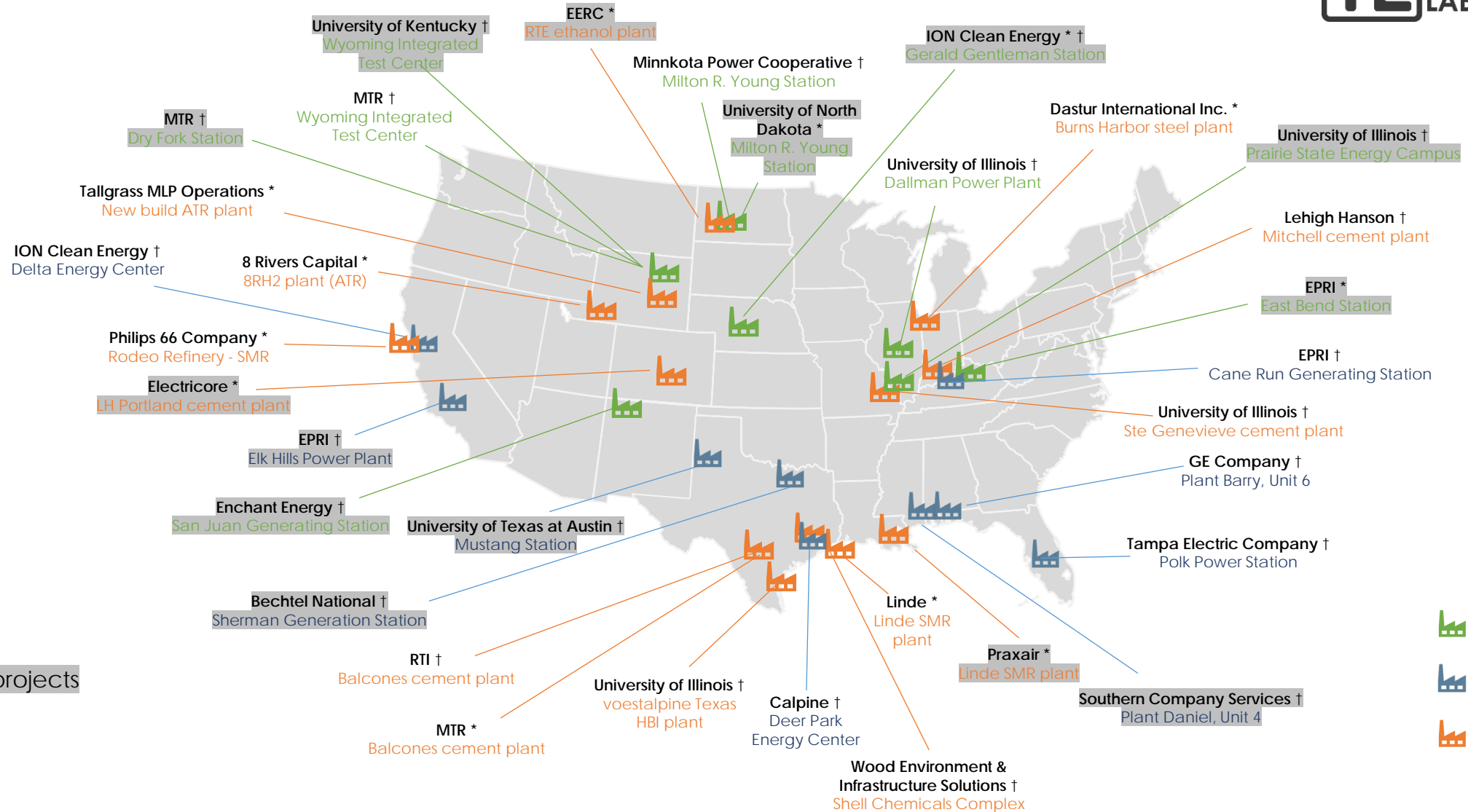
Brandl, et al, Int J GHG Con, 2019

Point Source Carbon Capture.. FOAs Issued



Fiscal Year	Funding Opportunity Announcement Number	Funding Opportunity Announcement Title	Issue Date	Close Date
2022	DE-FOA-0002515/Amendment 000002	<p>Carbon Capture R&D For Natural Gas and Industrial Point Sources, and FEED Studies for Carbon Capture Systems at Industrial Facilities and Natural Gas Plants (\$96M)</p> <p>AOI-4: Carbon Capture R&D: Laboratory-Scale Testing of Highly-Efficient Materials or Novel Concepts for Natural Gas Combined Cycle (NGCC) Power Plants</p> <p>AOI-5: Engineering-Scale Testing of Transformational Post-Combustion Carbon Capture Technologies for NGCC power plants</p> <p>AOI-6: Engineering-Scale Testing of Transformational Carbon Capture Technologies for Industrial Plants and Waste-to-Energy Plants</p> <p>AOI-7: Front-End Engineering Design Studies for Carbon Capture Systems at Existing (Retrofit) Domestic Industrial Facilities and NGCC Power Plants</p>	3/08/2022	4/11/2022
2022	DE-FOA-0002400/Modification 000007	<p>Clean Hydrogen Production, Storage, Transport and Utilization To Enable A Net Zero Carbon Economy (\$28.6M total; \$18M for AOI-8)</p> <p>AOI-8: Front-End Engineering Design Studies for Carbon Capture Systems at Domestic Industrial Facilities Producing H₂ from Natural Gas</p> <p>AOI-8A: Front-End Engineering Design Studies for Carbon Capture Systems at Domestic Steam Methane Reforming (SMR) Facilities Producing H₂ from Natural Gas</p> <p>AOI-8B: Front-End Engineering Design Studies for Carbon Capture Systems at Domestic Autothermal Reforming (ATR) Facilities Producing H₂ from Natural Gas</p>	2/07/2022	3/30/2022

Pre-FEED and FEED Study Projects with Host Site Locations



Completed projects

* Pre-FEED

† FEED

Pre-FEED and FEED Study Projects with Host Site Locations

FEED Projects

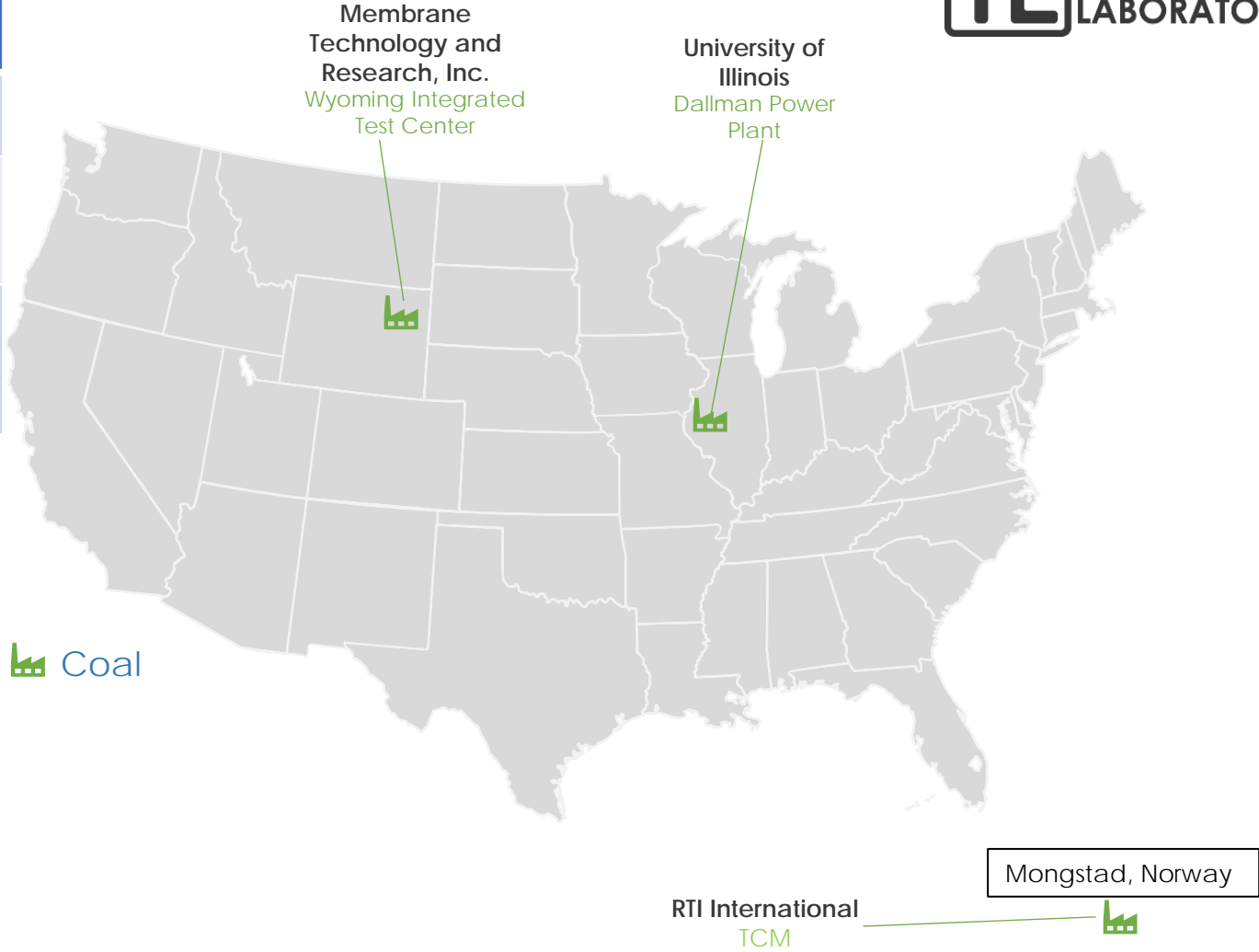
Pre-FEED Projects

Project Title	Prime Performer	Host Site	Host Site Location	Project Status	Project Title	Prime Performer	Host Site	Host Site Location	Project Status
Large Pilot Testing of Linde-BASF Advanced Post-Combustion CO2 Capture Technology at a Coal-Fired Power Plant	University of Illinois	City, Water, Light, and Power's Dallman Power Plant	Springfield, IL	Active*	Enabling Production of Low Carbon Emissions Steel through CO2 Capture from Blast Furnace (BF) Gases	Dastur International, Inc.	Cleveland-Cliffs' Burns Harbor steel plant	Burns Harbor, IN	Active
Large Pilot Testing of the MTR Membrane Post-Combustion CO2 Capture Process	Membrane Technology and Research, Inc.	Wyoming Integrated Test Center (with support from Basin Electric Dry Fork Station)	Gillette, WY	Active*	Blue Bison ATR Advanced CCUS System	Tallgrass MLP Operations, LLC	ATR plant under construction	Douglas, WY	Active
Industrial Carbon Capture from a Cement Facility Using the Cryocap FG Process	University of Illinois	Holcim Ste Genevieve cement plant	Bloomsdale, MO	Active	The 8RH2 Process for Producing Clean Hydrogen with Autothermal Reforming and Carbon Capture	8 Rivers Capital, LLC	New build 8 Rivers Hydrogen (8RH2) plant	Evanston, WY	Active
FEED for Carbon Capture from Shell's Deer Park Chemical Complex	Wood Environment & Infrastructure Solutions	Shell Chemicals Complex	Deer Park, TX	Active	Initial Engineering Design Study for Advanced CO2 Capture from Hydrogen Production Unit at Phillips 66 Rodeo Refinery	Phillips 66 Company	Rodeo refinery (green field)	Rodeo, CA	Active
Deer Park Energy Center NGCC Carbon Capture System FEED Study	Calpine Texas CCUS Holdings	Calpine's Deer Park Energy Center	Deer Park, TX	Active	Engineering Study of Svante's Solid Sorbent Post-Combustion CO2 Capture Technology at a Linde Steam Methane Reforming H2 Plant	Linde, Inc.	Linde SMR plant	Port Arthur, TX	Active
FEED for a CO2 Capture System at Calpine's Delta Energy Center	ION Clean Energy Inc.	Calpine's Delta Energy Center	Pittsburg, CA	Active	Engineering Design of a Polaris Membrane CO2 Capture System at a Cement Plant	Membrane Technology and Research, Inc.	CEMEX Balcones cement plant	New Braunfels, TX	Active
Retrofittable Advanced Combined Cycle Integration for Flexible Decarbonized Generation	GE Company – GE Gas Power	Southern Company's Plant Barry –Unit 6	Bucks, AL	Active	Initial Engineering and Design for CO2 Capture from Ethanol Facilities	University of North Dakota Energy and Environmental Research Center	RTE Ethanol plant	Richardton, ND	Completed
CO2 Capture at Louisville Gas & Electric Cane Run Natural Gas Combined Cycle Power Plant	Electric Power Research Institute (EPRI)	LG&E-KU Cane Run #7 NGCC unit	Jefferson County, KY	Active	LH CO2MENT Colorado Project	Electricore, Inc.	LafargeHolcim's Portland cement plant	Florence, CO	Completed
FEED: Project Tundra Carbon Capture System	Minnkota Power Cooperative, Inc.	Square Butte Electric Cooperative's Milton R. Young Station, Unit 2	Center, ND	Active	Engineering Design of a Linde-BASF Advanced Post-Combustion CO2 Capture Technology at a Linde Steam Methane Reforming H2 Plant	Praxair, Inc.	Linde SMR plant	St James Parish, LA	Completed
UKY-CAER Heat-Integrated Transformative CO2 Capture Process for Pulverized Coal Power Plants	University of Kentucky Research Foundation	Wyoming Integrated Test Center (w/ support from Basin Electric Dry Fork Station)	Gillette, WY	Completed	Initial Engineering Design of a Post-Combustion CO2 Capture System for Duke Energy's East Bend Station Using Membrane-Based Technology	Electric Power Research Institute (EPRI)	Duke Energy's East Bend Station	Boone County, KY	Completed
Commercial Carbon Capture Design and Costing: Part Two (C3DC2)	ION Clean Energy, Inc.	NPPD's Gerald Gentleman Station	Sutherland, NE	Completed	ION Engineering Commercial Carbon Capture Design and Costing (C3DC)	ION Engineering, LLC	NPPD's Gerald Gentleman Station	Sutherland, NE	Completed
Full-Scale FEED Study for Retrofitting the Prairie State Generating Station with an 816 MWe Capture Plant Using MHIA's PCC Technology	University of Illinois	Prairie State Generation Company's Station	Marissa, IL	Completed	Initial Engineering, Testing, and Design of a Commercial-Scale, Post-Combustion CO2 Capture System on an Existing Coal-Fired Generating Unit	University of North Dakota	Milton R. Young Station	Center, ND	Completed
FEED Study for Retrofit Post-Combustion Carbon Capture on a NGCC Power Plant	Electric Power Research Institute	California Resources Corporation's Elk Hills Power Plant	Kern County, CA	Completed					
Piperazine Advanced Stripper (PZAS) FEED	The University of Texas at Austin	Golden Spread Electric Cooperative's Mustang Station	Denver City, TX	Completed					
Commercial-Scale FEED Study for MTR's Membrane CO2 Capture Process	Membrane Technology & Research, Inc.	Basic Electric's Dry Fork Station	Gillette, WY	Completed					
Large-Scale Commercial Carbon Capture Retrofit of the San Juan Generating Station	Enchant Energy LLC	Public Service Company of New Mexico's San Juan Generating Station	Waterflow, NM	Completed					
FEED of Linde-BASF Advanced Post-Combustion CO2 Capture Technology at a Southern Company Natural Gas-Fired Power Plant	Southern Company Services, Inc.	Mississippi Power's Plant Daniel, Unit 4	Moss Point, MS	Completed					
FEED Study for a Carbon Capture Plant Retrofit to a Natural Gas-Fired Gas Turbine Combined Cycle Power Plant	Bechtel National Inc.	Sherman Generating Station	Sherman, TX	Completed					

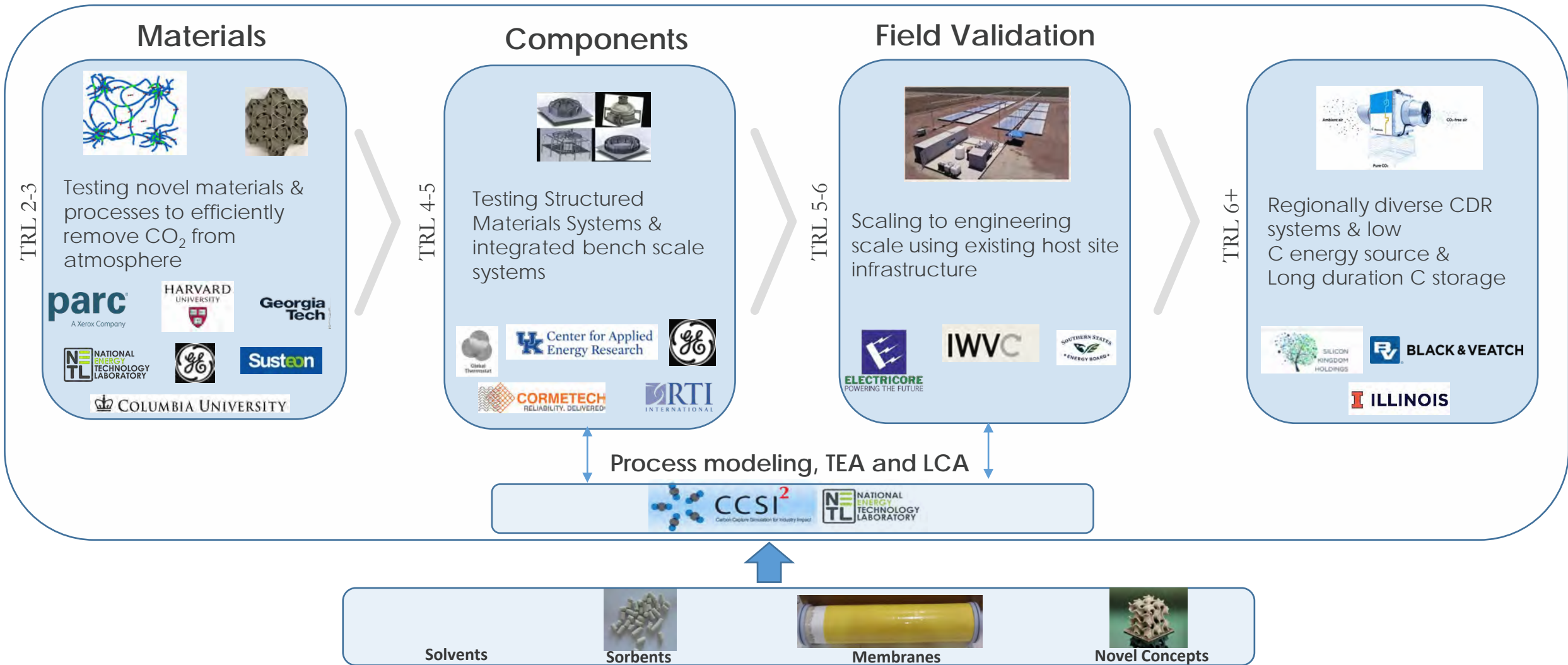
Large-scale Carbon Capture Pilot Studies



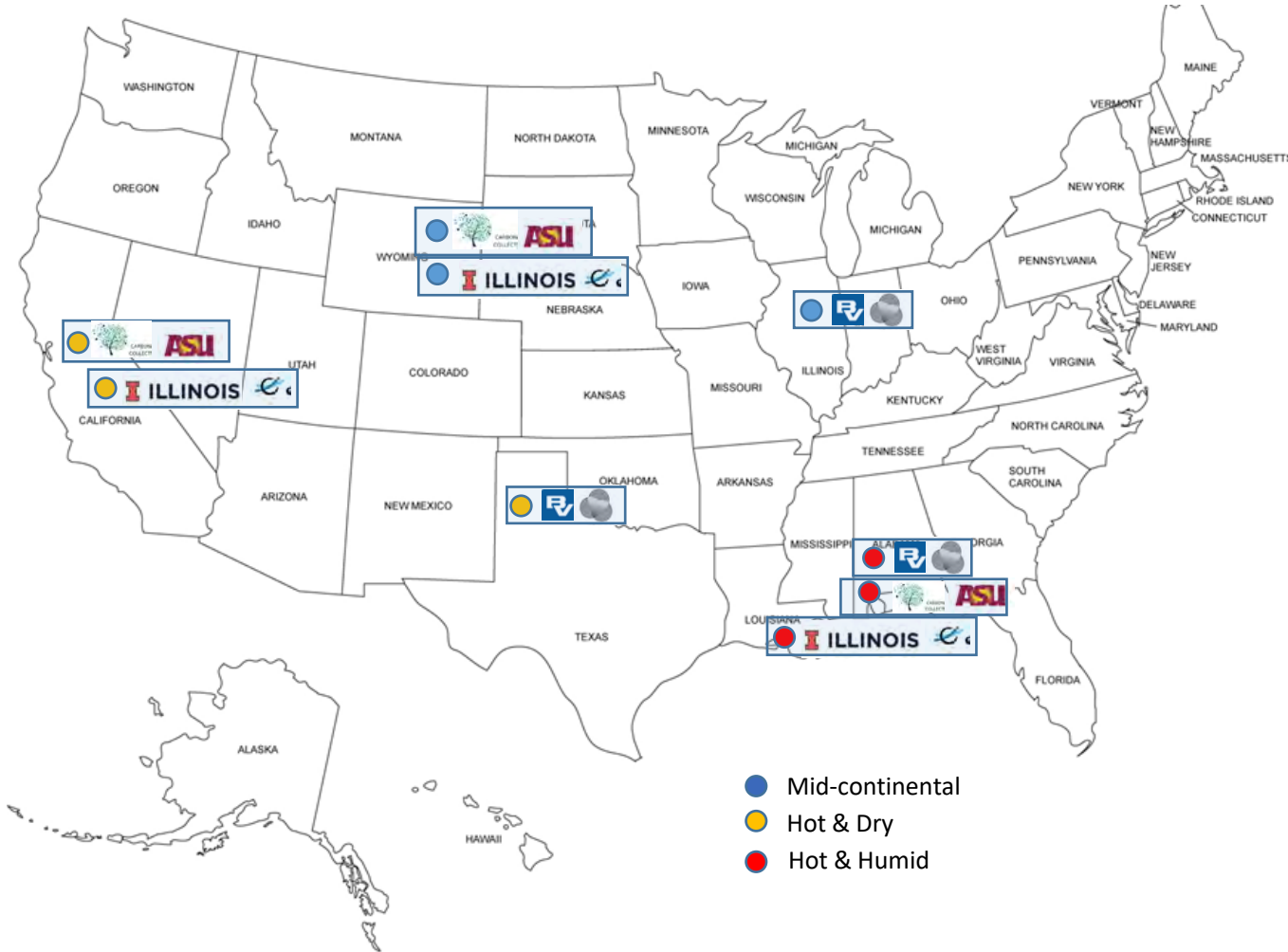
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Large Pilot Testing of Linde-BASF Advanced Post-Combustion CO2 Capture Technology at a Coal-Fired Power Plant	University of Illinois	City, Water, Light, and Power Dallman Power Plant	Springfield, IL
Engineering Scale Testing of Transformational Non-Aqueous Solvent-Based Carbon Dioxide Capture Process at Technology Centre Mongstad	Research Triangle Institute	Technology Centre Mongstad	Mongstad, Norway



Carbon Dioxide Removal... Program Structure



Pre-FEEDs (TRL 6+)... Gen 1 DAC Systems



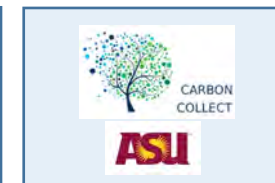
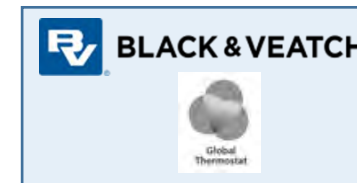
Input:

- DAC Technology (TRL 6), 100,000 tpy net CO₂
- 3 host sites from the pre-defined geographical areas

Output:

Pre-FEEDs for **three individual** case studies including:

- Energy source integration
- CO₂ storage pathways
- Business case analysis (i.e., LCFS / 45Q credits)
- TEA, LCA



PSC and CDR.. Program Outreach



CARBON CAPTURE NEWSLETTER
JUNE 2022

U.S. DEPARTMENT OF ENERGY | OFFICE OF FOSSIL ENERGY AND CARBON MANAGEMENT | NATIONAL ENERGY TECHNOLOGY LABORATORY

Reduce CO₂ emissions

HIGHLIGHTS

- The newsletter is compiled by the National Energy Technology Laboratory to provide information on recent activities and publications related to carbon capture.
- To subscribe, click here.

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Biden-Harris Administration Announces Investment to Reduce CO₂ Emissions

The U.S. Department of Energy (DOE) announced more than \$2.3 billion for efforts to advance diverse carbon management approaches that reduce carbon dioxide (CO₂) emissions, address the impacts of potential climate change, and create good-paying jobs while prioritizing community engagement and environmental justice. The first effort is a Notice of Intent for \$2.25 billion, funded by the Bipartisan Infrastructure Law (BIL), to accelerate geologic carbon storage projects capable of storing at least 50 million metric tons of captured CO₂, each. In addition, DOE issued two funding opportunities: the \$45 million "CarbonSAFE: Phase II - Storage Complex Feasibility" Funding Opportunity (DE-FOA-0002610) aiming to improve procedures to safely, efficiently, and affordably define and assess onshore and offshore CO₂ storage sites at a commercial scale, and the \$46 million "Carbon Management" Funding Opportunity (DE-FOA-0002614) aiming to develop technologies to remove, capture, and convert or store CO₂ from utility and industrial sources or the atmosphere.

2020 CARBON CAPTURE PROGRAM R&D COMPENDIUM of CARBON CAPTURE TECHNOLOGY

MAY 2020

U.S. DEPARTMENT OF ENERGY | NATIONAL ENERGY TECHNOLOGY LABORATORY

POINT SOURCE CARBON CAPTURE PROGRAM

Notice of Intent (DE-FOA-0002684) to Issue DE-FOA-0002614, titled "Carbon Management"

Notice of Intent

Advancing technologies for the capture of CO₂ from power sources, such as natural gas power and industrial facilities, with minimum cost and energy penalty.

The U.S. Department of Energy/National Energy Technology Laboratory's (DOE/NETL) Point Source Capture (PSC) Program is developing the next generation of advanced carbon dioxide (CO₂) capture technology to support the United States in achieving ambitious goals for a greenhouse gas (GHG) neutral economy by 2050. A carbon capture technology that can be used to reduce CO₂ emissions from existing and new power and industrial plants, such as CO₂ capture from fossil energy and carbon management (PSCM) has become a comprehensive, multi-pronged approach for carbon management that involves the coupling of carbon capture methods to a PSC for fossil fuel-based power generation and industrial processes, and capitalizing on advanced CO₂ technologies in tandem with low-carbon energy resources with strong, diverse capabilities in CO₂ utilization and conversion into high-value products. The PSC Program is accelerating commercially viable solutions that can be scaled to a wide spectrum of CO₂ emission sources, including facilities that produce power, chemicals, ethanol, cement, or steel. Program goals range from conceptual engineering and materials design to laboratory and bench-scale technology demonstration, and, finally, pilot-scale testing and full-scale engineering and design (FEED) studies (DOE, 6/7/16) to lower both capital and operating costs and improve the economics of PSC.

Point Source Carbon Capture:

- Capture from Power Generation Sources:** Power source CO₂ capture in fossil fuel-based power production separates CO₂ emissions from the plant's exhaust gas or steam stream. The PSC Program is focused on advancing novel carbon capture materials, equipment, processes, or a combination thereof for applications in power generation cycle (PCC) power generation. BIL is intended to support testing of highly efficient component designs, material systems, and/or integrated processes and to conduct FEED studies for commercial-scale CO₂ capture at existing PCC power plants.
- Capture from Industrial Sources:** Point source CO₂ capture from industrial facilities, such as mineral production (cement and lime plants), iron and steel manufacturing (blast furnaces, hydrogen), ethanol plants, and ethanol plants - in which CO₂ emissions may be present at a higher concentration than from fossil fuel-based plants - is a vital aspect in reducing CO₂ emissions. BIL is supporting the development of advanced capture technologies for industrial carbon capture and to conduct full-scale engineering design and FEED studies for commercial-scale capture systems that separate CO₂ emissions at industrial facilities.

Explore the Site

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- Activities
- Accountants

Technology Area Contact: Robbie.Jones@nlsl.gov (301-905-1051)

CARBON DIOXIDE REMOVAL PROGRAM

DOE Announces Additional \$6M in Funding for Four Direct Air Capture Projects

Key Technology Areas:

- Science:** Select-based CO₂ capture involves chemical or physical absorption of CO₂ from air into a liquid carrier. The absorption fluid is regenerated by increasing temperature or reducing pressure to release the captured CO₂. Solid Carbon Dioxide capture is a variation with continuously circulating chemical absorption systems. However, these systems require significant amounts of energy for regeneration. R&D objectives include advanced materials (e.g., water-based sorbents, phase-change sorbents, high-performance functional sorbents) that show a lower regeneration energy requirement than existing solid systems combined with high CO₂ absorption capacity. System advancement includes process intensification techniques, methods to integrate sorbent circulation with sorption and heat recovery approaches.
- Systems:** Select-based CO₂ capture involves the chemical absorption of CO₂ from air using a solid carbon dioxide sorbent, which is regenerated by increasing temperature or reducing pressure to release the captured CO₂. In addition, system-level objectives include advanced process monitoring, R&D objectives include advanced process monitoring, R&D objectives include advanced process monitoring, R&D objectives include advanced process monitoring.
- Materials:** Membrane-based CO₂ capture uses permeable polymeric membranes that allow for the selective transport and retention of CO₂ from air. Membrane processes offer potential advantages for having a lower regeneration energy requirement than existing solid-based systems. Membrane-based CO₂ capture also provides an opportunity for advanced process monitoring, R&D objectives include advanced process monitoring, R&D objectives include advanced process monitoring.
- Electrochemical:** Electrochemical-based CO₂ capture uses electrochemical processes to separate CO₂ from air. Electrochemical processes can be easily integrated with renewable power sources to reduce the cost and improve the efficiency of CO₂ capture systems. The challenge with electrochemical processes includes the design of electrochemical cells and gas-liquid interfaces for large-scale applications. R&D objectives include the identification of electrochemical reactions, membrane materials, and testing to quantify the performance and to optimize reactor configurations.

Explore the Site

- News Stories
- Event Information
- CCP
- Systems Analysis
- Conference Proceedings
- Publications
- Activities
- Accountants

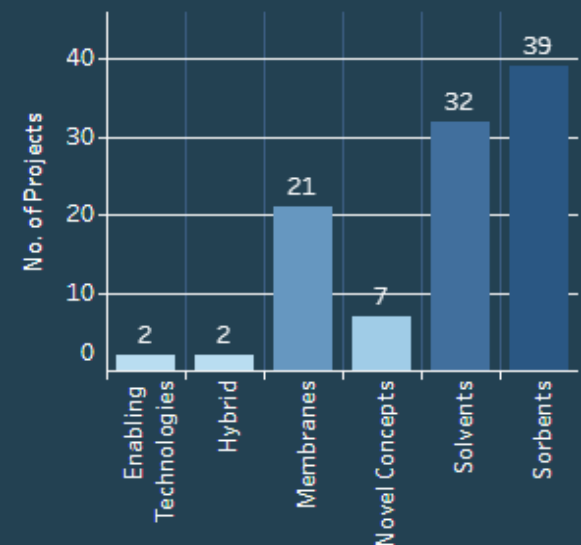
Carbon Capture Newsletter

Carbon Capture Program R&D Compendium

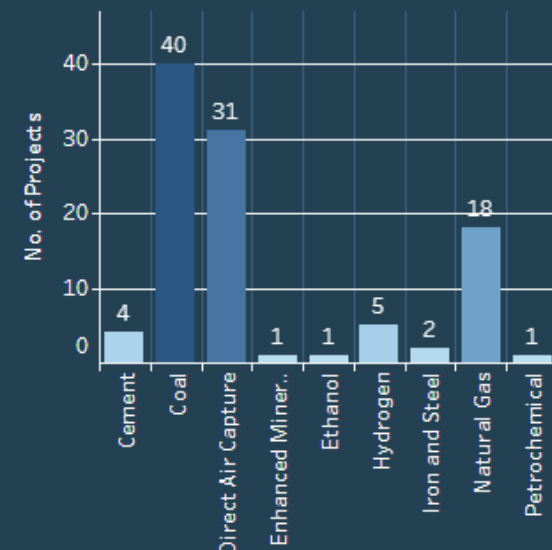
Point Source Carbon Capture Program Website

Carbon Dioxide Removal Program Website

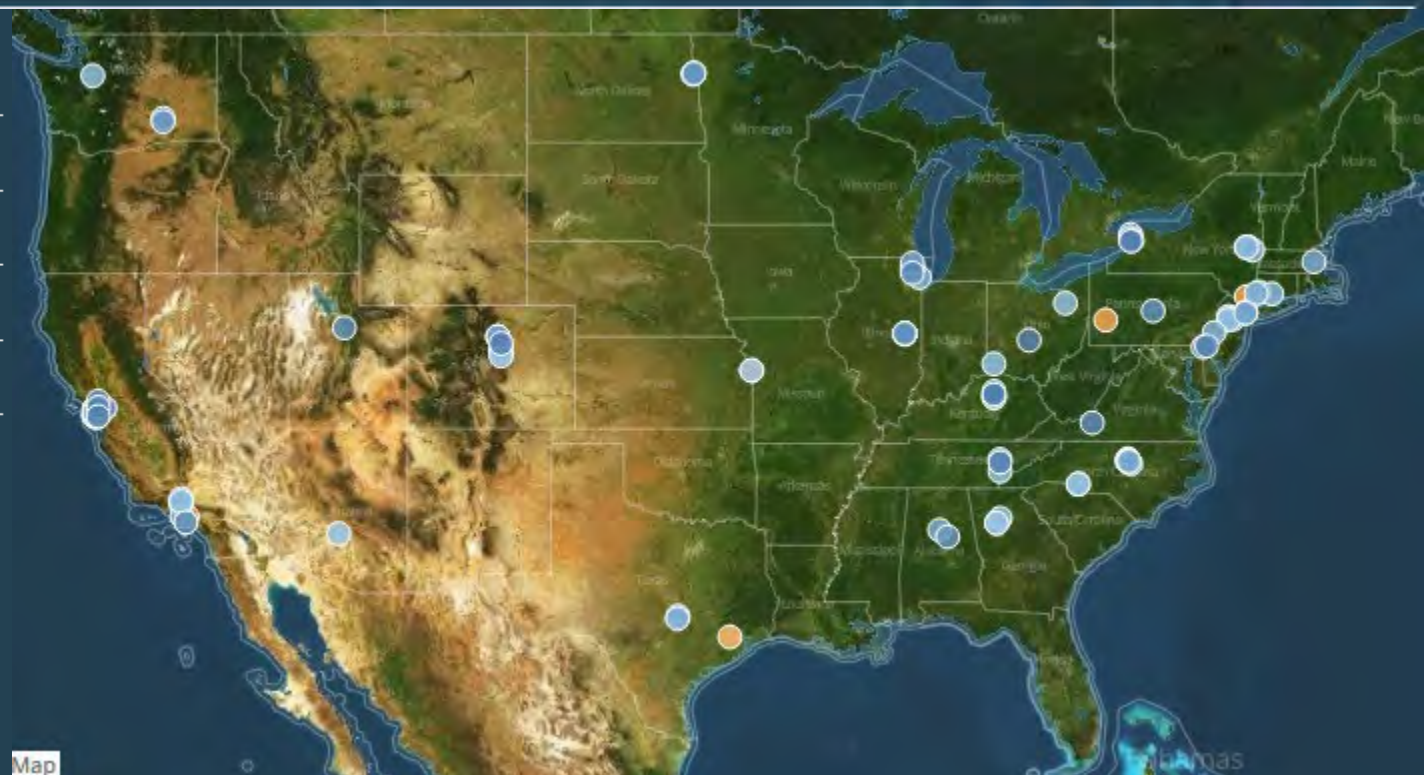
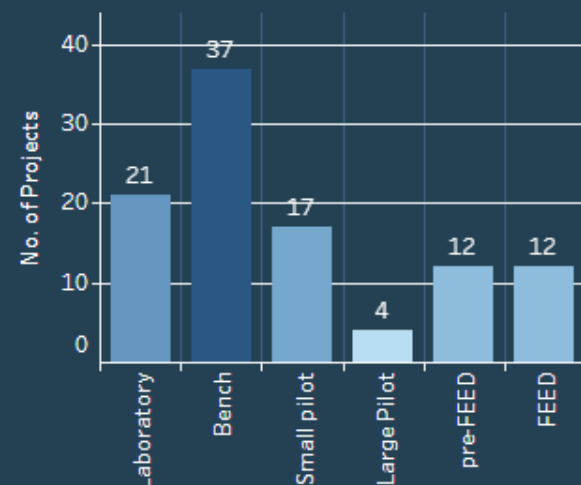
Key Technology



Application Type

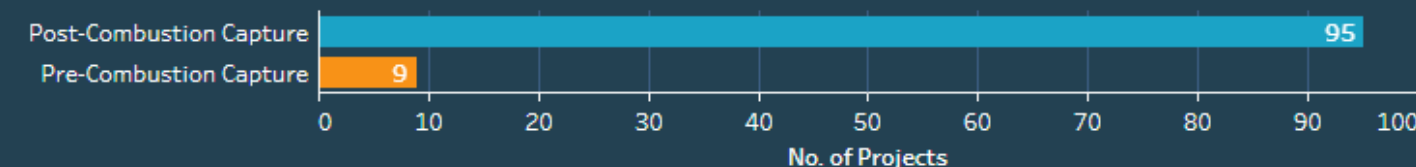


Ending Scale



Map

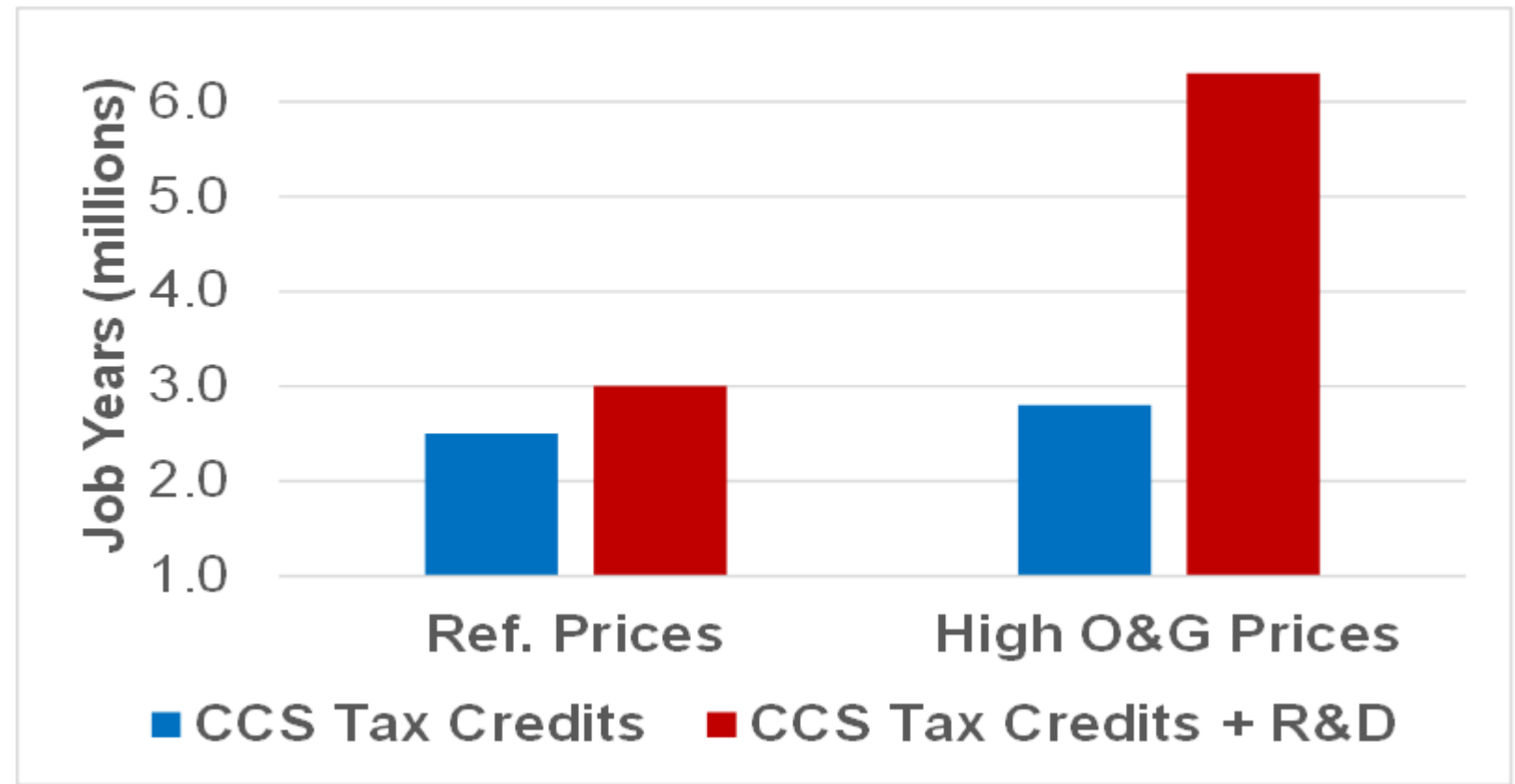
Technology Area



Assessing the impacts of Capture R&D

By comparing model runs without and with inputs from R&D, metrics such as employment impacts can be assessed

Marginal Jobs Impacts of CCS Tax Credits and DOE/NETL R&D Program, 2020-50



Infrastructure Investment and Jobs Act (IIJA) - Bipartisan Infrastructure Law (BIL)

❖ BIL: Carbon Capture Demonstration Projects Program

FOA 1

- FOA 2738 “FEED Studies for Integrated Carbon Capture, Transport, and Storage Systems” - [released September 22, 2022](#)
- \$189M; up to 20 projects

FOA 2

- FOA 2962 - [released February 23, 2023](#)
- Letters of Intent due 3/28; Applications due 5/23 @ 5pm
- \$1.7B; ~6 projects (transformational domestic, commercial-scale, integrated CCS, demonstration projects)
 - 2 projects at new or existing coal electric generation facilities
 - 2 projects at new or existing natural gas electric generation facilities
 - 2 projects at new or existing industrial facilities not purposed for electric generation

❖ BIL: Carbon Capture Large-Scale Pilot Program

- FOA 2963 - [released February 23, 2023](#)
- \$820M; up to 10 projects (transformational carbon capture technologies applied to existing coal or natural gas electric generation facilities and existing industrial facilities)

❖ BIL: Carbon Dioxide Removal Provisions

- \$3.5B Four Regional Clean Direct Air Capture Hubs
 - [DE-FOA-0002735](#) issued on December 13, 2022
- \$100M Commercial Direct Air Capture Technology Prize Competition
- \$15M Pre-Commercial Direct Air Capture Prize Competitions

\$369B for Clean Energy and Climate Provisions For Carbon Management: Enhanced 45Q

- *Direct Pay Option*
- *Broadens Qualifying Facilities: Capture Thresholds*
- *Extends Commence Construction Date to 2033*
- *Increases 45Q Credit Values (\$35/\$50 previously)*
 - *\$60/metric ton for point source capture and utilization*
 - *\$85/metric ton for point source capture and carbon storage in saline formations*
 - *\$130/metric ton for Direct Air Capture and utilization*
 - *\$180/metric ton for DAC and Saline Geologic Storage*

Questions

<http://www.netl.doe.gov/research/coal/carbon-capture>

Ron Munson

Technology Manager
Point Source Carbon Capture
U.S. Department of Energy
National Energy Technology
Laboratory
520-709-8983
Ronald.Munson@netl.doe.gov

Dan Hancu

Senior Program Manager
Point Source Capture Division
U.S. Department of Energy
Office of Fossil Energy and
Carbon Management
240-220-1186
Dan.Hancu@hq.doe.gov



NETL RWFI Energy 101

Thank you for your Participation



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

NETL RWFI Home Page – www.netl.doe.gov/rwfi

E-Note: netl.rwfi@netl.doe.gov

Economic & Workforce Development Roundtable Discussion

Discussion topics include the potential economic and workforce development opportunities that successful research into these topics and their related challenges.