

NOVEMBER 2023

# CARBON CAPTURE NEWS LETTER



## HIGHLIGHTS

The newsletter is compiled by the National Energy Technology Laboratory to provide information on recent activities and publications related to carbon capture.

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## DOE Announces Funding for Innovations in CDR

The U.S. Department of Energy's (DOE) Office of Fossil Energy and Carbon Management (FECM) announced 13 semifinalists to receive a total of \$1.3 million for commercialization programs that support technologies to reduce carbon dioxide (CO<sub>2</sub>) emissions by removing CO<sub>2</sub> directly from the atmosphere. The [Direct Air Capture \(DAC\) Energy Program for Innovation Clusters \(EPIC\) Prize](#) is one of several prize competitions hosted by DOE and funded by the Bipartisan Infrastructure Law (BIL) to support breakthrough DAC technologies that demonstrate strong potential to accelerate economic support and expand domestic carbon removal. The DAC EPIC Prize sponsors incubator teams that provide creative and impactful solutions that support entrepreneurs and innovators in the DAC space. From mentorship and networking to prototyping assistance and intellectual property management, incubators can accelerate economic development, strengthen innovation, and expand domestic carbon dioxide removal (CDR) technology development and manufacturing.

# Interagency News and Updates

## Proceedings from the 2023 FECM/NETL Carbon Management Research Project Review Meeting Available

Proceedings from the 2023 FECM/NETL Carbon Management Research Project Review Meeting are now available, organized by NETL program: PSCC, CDR, Carbon Conversion, and Carbon Transport and Storage.



2023 FECM / NETL  
**Carbon Management**  
Research Project Review Meeting

## NETL Launches Multidisciplinary Project to Advance DAC Technology

DOE's National Energy Technology Laboratory (NETL) initiated a four-year plan to advance a DAC process based on an innovative sorbent developed at NETL that integrates expertise from the laboratory's extensive materials design, computational materials design, computation fluid dynamics, and process system design research portfolios to evolve an innovative technology that will remove CO<sub>2</sub> from the atmosphere. Advanced modeling support helps to guide DAC technology development through the creation of rigorous, optimized property models. This will allow developers to understand the impact of sorbent regeneration protocols on the cost of the process, guiding advancement of the technology and reducing the risk associated with scale-up.

## DAC Commercial CDR Purchase Pilot Prize Open to CDR Technology Pathways

The DAC Commercial CDR Purchase Pilot Prize marks the first initiative by the U.S. Federal Government to directly purchase CDR from domestic providers. Through this prize, DOE will establish precedent for the level of rigor required to successfully evaluate CDR technologies and demonstrate how CDR purchase contracts can catalyze innovation while strengthening America's CDR objectives. The application deadline is November 30, 2023. Read the official rules [here](#).



## Chemical Engineer Quickly Makes Impact to Address Climate Change

During Mariah Young's brief time at NETL, she has been recognized for advancing innovative projects to reduce emissions of CO<sub>2</sub>. In 2022, she and her colleagues received the Chairperson's Excellence in Government Gold Award and the Outstanding Small Team Gold Award from the Pittsburgh Federal Executive Board for their work overseeing the development and commercialization of more than 120 projects to address climate change. Young recently discussed her responsibilities at NETL, the path that brought her to the laboratory, and the exciting life she shares with her husband.



NETL's Mariah Young

# Interagency News and Updates (continued)

## NETL'S José Figueroa Coordinating Multi-Agency New GHG Reduction Efforts

José Figueroa, senior management and technical advisor for the Technology Development Center (TDC) at NETL, is helping facilitate new efforts in greenhouse gas (GHG) reduction by coordinating a methane emissions reduction program that supports the statutory requirements of the Methane Emissions Reduction Program, adding to his long history of service with the laboratory. Since being promoted to senior management and technical adviser, one of Figueroa's most important responsibilities is coordinating efforts between the U.S. Environmental Protection Agency, DOE, and NETL by offering technical and financial assistance that helps companies, including oil and gas owners and operators, to monitor and reduce methane emissions from leaks and daily operations.



*José Figueroa, senior management and technical advisor for the TDC at NETL*

## NETL Researchers on List of Best Scientists in the World

Four NETL researchers have been recognized by Research.com as being among the best scientists in the world in the fields of chemistry, earth science, engineering, and technology. NETL's Dan Sorescu, Ranjani Siriwardane, Ray Boswell, and Mehrdad Massoudi appear in the second edition of Research.com's rankings. Research.com conducted a detailed study of 166,880 scholars determined from a variety of bibliometric data sources. According to its website, the objective of the ranking is to inspire scholars, businesspeople, and administrative bodies around the world to investigate where top experts are heading and to offer a way for the entire scientific community to learn about the leading experts in specific areas of study in different countries or within research institutions.



*NETL researchers, left to right, Dan Sorescu, Ranjani Siriwardane, Ray Boswell and Mehrdad Massoudi*

## NETL Collaborates with U.S. Steel to Capture GHG at Edgar Thomson Plant

NETL and U.S. Steel Corporation plan to evaluate an advanced membrane technology to capture CO<sub>2</sub> emissions generated by steelmaking operations at the company's Edgar Thomson Plant, located in Braddock, Pennsylvania. The project is part of NETL's Point Source Carbon Capture (PSCC) Program. Compared to other separation technologies, such as solvents and sorbents, polymer membranes offer a comparatively simple CO<sub>2</sub> separation process.

Membranes require few moving parts and no CO<sub>2</sub> regeneration step, resulting in potential cost savings. Additionally, the simplicity of membrane-based processes offers the advantage of reduced capital and maintenance costs.



# Interagency News and Updates (continued)

## NETL Co-Hosted Post-Combustion Capture Conference in Pittsburgh

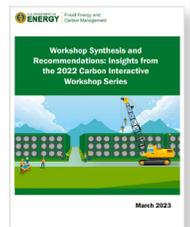
NETL joined DOE and the International Energy Agency (IEA) Greenhouse Gas Research and Development (R&D) Programme (IEAGHG) in welcoming researchers and scientists from around the globe to Pittsburgh in September 2023 to discuss the state of the art in post-combustion carbon capture technology at the Seventh IEAGHG Post-Combustion Capture Conference.



NETL's David C. Miller, deputy director and chief research officer, gave a plenary address on the first day of the conference to provide a high-level overview of NETL's accomplishments and research on post-combustion capture. Other experts from the laboratory, Timothy Fout and Krista Hill, led session chairs on process modeling and environmental impacts, respectively. Additionally, Sarah Forbes—FECM deputy director, Carbon Management Technologies—and Dan Hancu—FECM division director, PSCC Program—delivered keynote addresses.

## Carbon Interactive Workshop Series

In November and December 2022, DOE embarked with federal partners on a pilot program of interactive workshops on carbon management. The aims were (1) for DOE and other government agencies to learn about community priorities, concerns, and ideas related to carbon projects, including how community members would like to be involved in projects moving forward, and (2) for community members to learn about the potential carbon projects that might be a fit for their area, the rationale for these projects, and opportunities for public participation along the lifespan of a project. A summary of the series is now available in the report, "[Workshop Synthesis and Recommendations: Insights from the 2022 Carbon Interactive Workshop Series](#)"



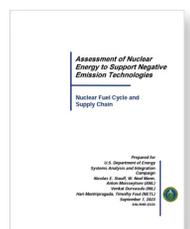
## Health Benefits of Carbon Capture Quantified in Landmark Study

Installing technologies designed to capture CO<sub>2</sub> emissions from industrial and power facilities has the potential to result in billions of annual health benefits nationwide. These health benefits are directly tied to the reduction of other air pollutants that would also be removed in a carbon capture system, according to a first-of-its-kind study, "[Carbon Capture Co-benefits: Carbon Capture's Role in Removing Pollutants and Reducing Health Impacts](#)," from the Great Plains Institute and Carbon Solutions, LLC. The analysis found that reducing nitrogen oxides, sulfur dioxide, and particulate matter as part of an amine-based carbon capture system led to positive health benefits across all sectors and regions.



## Could Advanced Reactors Make Carbon Capture Systems More Viable?

A new [DOE report](#) finds promise in pairing nuclear reactors with CDR technologies, including DAC. According to the study, advanced reactors could lower the levelized cost of certain DAC technologies by up to 13% over non-nuclear-powered systems. The pairing could also boost their performance and market feasibility. The "[Assessment of Nuclear Energy to Support Negative Emission Technologies](#)" report is an initial exploration into the role nuclear power plants could play in supporting a variety of negative emissions technologies. Researchers found DAC to be an especially promising partner. The study focused on pairing low-temperature solid sorbent and high-temperature liquid solvent DAC systems with three advanced reactor types—an advanced pressurized water reactor, a sodium-cooled fast reactor, and a very high-temperature reactor.



# Interagency News and Updates (continued)

## Biden-Harris Administration Announces Funding as Part of Investing in America Agenda to Support Research for mCDR Solutions

The U.S. Department of Commerce and National Oceanic and Atmospheric Administration (NOAA) announced \$24 million for projects that will research marine CDR (mCDR) strategies, as part of President Biden's Investing in America agenda. A total of \$14 million from the Inflation Reduction Act (IRA) will go toward 10 projects that examine how effectively and safely strategies like enhancing ocean alkalinity or sinking seaweed remove carbon from the atmosphere. Seven more mCDR research projects will be supported by an additional \$10 million in funding provided by NOAA's appropriation for the National Oceanographic Partnership Program; NOAA's Ocean Acidification Program; NOAA's Global Ocean Monitoring and Observing Program; FECM; DOE's Water Power Technologies Office (WPTO); the Office of Naval Research; the U.S. National Science Foundation; and the ClimateWorks Foundation.

## Fact Sheet Available: Inflation Reduction Act and Carbon Management Opportunities In North Dakota

A new FECM fact sheet provides a quick background of the IRA and a short discussion of the potential for carbon management and emissions reductions for North Dakota.



## New System Uses Seawater to Capture and Store CO<sub>2</sub>

A new system has begun removing acid from seawater at DOE's Pacific Northwest National Laboratory (PNNL) facility in Sequim, Washington, allowing seawater to absorb CO<sub>2</sub> from the atmosphere. The system represents a crucial step in research about ways to mitigate climate change and ocean acidification. The technology behind the CDR system was developed by start-up company Ebb Carbon, which is partnering with PNNL; NOAA's Pacific Marine Environmental Laboratory; the NOAA Cooperative Institute for Climate, Ocean, and Ecosystem Studies; and the Salish Sea Modeling Center. Funding was provided by NOAA's Ocean Acidification Program as well as WPTO and the ClimateWorks Foundation.

## DOE Announces Funding to Advance H<sub>2</sub> Technology that Converts Waste to Clean Energy

FECM announced up to \$19 million in funding for research that will develop innovative technology solutions to make clean hydrogen (H<sub>2</sub>) a more available and affordable fuel for electricity generation, industrial decarbonization, and transportation. The funding opportunity will focus on using H<sub>2</sub> systems to convert various waste materials into clean energy. The funding opportunity solicits applications in three areas of interest: (1) advancing toward commercialization viable gasification energy systems that convert varied waste feedstock materials such as coal waste, biomass, waste plastics, municipal solid waste, and industrial waste into clean energy; (2) improving the performance of gasification-based systems that use waste feedstock materials through wireless sensing technology; and (3) developing technology components that advance monitoring, detection, and security for integrated H<sub>2</sub>-based systems with carbon capture.



# Interagency News and Updates (continued)

## DOE Announces Funding to Advance Technologies that Capture Carbon Emissions to Decarbonize Industrial Processes and Produce Valuable Products

FECM announced up to \$17.5 million in funding to advance technologies that capture CO<sub>2</sub> from industrial facilities and power plants and convert those CO<sub>2</sub> emissions into valuable products. Advancing the development of these technologies will help establish the foundation for a successful carbon capture and carbon conversion industry in the United States and will help meet the Biden-Harris administration's climate goals of achieving a carbon neutral power sector by 2035 and net-zero GHG emissions by 2050. Read more details about the funding [here](#).



## Membrane-Based CO<sub>2</sub> Capture Pilot Now Under Construction at Wyoming Coal Plant

Membrane Technology and Research (MTR) Carbon Capture has begun construction of a pilot project to capture CO<sub>2</sub> from Basin Electric Power Cooperative's Dry Fork coal-fired power plant. MTR Carbon Capture will operate out of the Wyoming Integrated Test Center, a carbon capture and utilization testing facility at the Dry Fork plant in Gillette, Wyoming. The testing facility allows CO<sub>2</sub> capture technology companies access to the flue gas that would otherwise be released from the plant. MTR Carbon Capture will use its proprietary Polaris polymeric membrane to capture more than 150 metric tons of CO<sub>2</sub> each day at Dry Fork Station.

## DOE STEM Portal

DOE is building pathways for a diverse workforce to pursue science, technology, engineering, and math (STEM) careers. DOE seeks to engage learners at all levels to promote STEM and energy literacy and to attract, inspire, and develop a STEM identity and a sense of belonging in STEM. DOE is committed to promoting and supporting people from all backgrounds and perspectives, including individuals and communities that have been historically underrepresented in STEM fields and activities at DOE.

## Career Opportunities at NETL

At the core of NETL's success is its commitment to hiring the right people for the right positions. DOE's only government-owned and government-operated national laboratory offers exciting federal careers in research and engineering, technical project management, procurement, finance and budget, legal, and administrative support. Learn more at [NETL Careers](#).

## Bipartisan Infrastructure Law Hub

The BIL represents the most dramatic changes to DOE since its founding in 1977. In the next few years, the BIL will stand up 60 new DOE programs, including 16 demonstration and 32 deployment programs, and expand funding for 12 existing research, development, demonstration, and deployment programs. NETL's

[BIL Hub](#) provides information on the BIL, including links to the Guidebook, DOE's Clean Energy Corps, DOE's Applicant Portal, and DOE's Grid Resilience Program, as well as information on solicitations and funding opportunities.



# U.S. and International Events

## 2023 AIChE Annual Meeting

The 2023 American Institute of Chemical Engineers (AIChE) Annual Meeting, to be held Nov. 5–10, 2023, in Orlando, Florida, is an educational forum for chemical engineers interested in innovation and professional growth. Academic and industry experts will cover a wide range of topics relevant to innovative research, modern technologies, and emerging growth.



## 2023 NCCC & Expo

The 2023 National Carbon Capture Conference (NCCC) & Expo, to be held Nov. 7–8, 2023, in Des Moines, Iowa, is a two-day event designed for companies and organizations advancing technologies and policy that support removal of CO<sub>2</sub> from all sources, including fossil fuel-based power plants, ethanol production plants, and industrial processes, as well as directly from the atmosphere. The program will focus on research, data, trends, and information on all aspects of carbon capture, utilization, and storage (CCUS) with the goal of helping companies build knowledge, connect with others, and better understand the market and carbon utilization.

## Carbon Management Community Summit

The Carbon Management Community Summit, to be held Nov. 16–17, 2023, in Houston, Texas, will feature a series of presentations, discussions, and workshops designed to inform and engage the local public on the topic of carbon management, and to spur collaboration in project planning and development across stakeholder groups. The summit is sponsored by DOE and hosted by Climate Now, in partnership with Rice University and the City of Houston.

## Appalachian Hydrogen & Carbon Capture Conference 2023

The Appalachian Hydrogen & Carbon Capture Conference, to be held Nov. 30, 2023, in Canonsburg, Pennsylvania, will feature several speakers who collaborate closely with DOE and understand the workings of both the government and the oil and gas industry.

## UNFCCC COP 28

The 2023 United Nations Climate Change Conference (UNFCCC), to be held Nov. 30–Dec. 12, 2023, in Dubai, United Arab Emirates, will comprise the 28th meeting of the Conference of the Parties (COP 28); the fifth meeting of the COP serving as the Meeting of the Parties to the Paris Agreement; the 18th meeting of the COP serving as the Meeting of the Parties to the Kyoto Protocol; the 59th meeting of the Subsidiary Body for Implementation; and the 59th meeting of the Subsidiary Body for Scientific and Technological Advice.



## 2023 CO<sub>2</sub> Conference

The 2023 CO<sub>2</sub> Conference, to be held Dec. 4–7, 2023, in Midland, Texas, provides a forum for highlighting the best practices the industry utilizes in all CO<sub>2</sub> applications, emphasizing plenary technical and business sessions. The agenda includes presentations covering CO<sub>2</sub> enhanced oil recovery, CCUS/carbon management, CO<sub>2</sub> reservoir cyclic injection, and residual oil zone exploitation.

## PowerGen International

PowerGen International, to be held Jan. 23–25, 2024, in New Orleans, Louisiana, is a networking and business hub for power generation professionals and solution providers.

Bringing together power producers, utilities, consultants, manufacturers, and large-scale energy users, it serves as a platform to explore innovative solutions amid the shift toward cleaner and more sustainable energy sources.



# Business and Industry News

## Bubbling Salt and Excess Carbon from Earth's Ocean

Katherine Hornbostel, the principal investigator on a multi-institution proposal and assistant professor of mechanical engineering and materials science at the University of Pittsburgh Swanson School of Engineering, recently received a \$1.4 million award from NOAA and Office of Naval Research to develop new membranes that can simultaneously perform desalination and direct ocean capture. The team includes members from Arizona State University, University of California-Irvine, and the National Renewable Energy Laboratory.

## ION Clean Energy Heads Back to TCM

ION Clean Energy and Technology Centre Mongstad (TCM) have come to terms on an agreement to bring ION's groundbreaking ICE-31 solvent technology to TCM



for further validation of the technology's performance over parametric and steady-state testing that will demonstrate the ION solvent's stability and prove that there is no significant solvent degradation as the technology is scaled up. The initiative is part of ION's commercial development program and will take the ICE-31 solvent's Technology Readiness Level (TRL) from TRL 6 to TRL 7 with a successful campaign.

## Berkeley Engineers Partner with Siemens Energy on DOE Project to Explore DAC

DOE awarded a \$3.7 million grant to explore the feasibility of a multi-technology DAC hub that will extract CO<sub>2</sub> directly from the air to help combat climate change to Siemens Energy Inc. and partners Constellation Energy; University of California, Berkeley; and Battelle. The Teras DAC hub setup will include a physical installation in the Midwest, while the analysis, design, and digital twin simulations will be performed at University of California, Berkeley. The DAC system will be anchored around Siemens Energy's large-scale solid sorbent capture technology, with smaller deployments of next-generation capture technologies planned.

## TCM Strengthens Cooperation with the U.S.

The 2023 FECM/NETL Carbon Management Research Project Review Meeting in Pittsburgh, Pennsylvania, provided an opportunity for TCM to showcase their state-of-the-art testing facilities and expertise in CO<sub>2</sub> capture. DOE/NETL is dedicated to driving R&D efforts that contribute to reducing CO<sub>2</sub> emissions, including the capture and storage of CO<sub>2</sub>. DOE has been actively involved in funding several test campaigns at TCM.

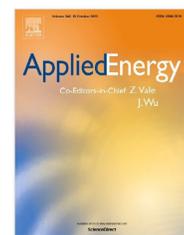
## NETL Team Converts CO<sub>2</sub> Into Acetate: Project Can Reduce GHG While Supplying Useful Commercial Raw Material

A three-person team of researchers at NETL found a means to turn CO<sub>2</sub> into a useful commercial product—acetate—and are working to grow their discovery to commercial scale. Djuna Gulliver, federal principal investigator; Sam Flett, research associate with the Oak Ridge Institute for Science and Education; and research engineer Dan Ross, with NETL's Leidos Research Support Team, explained their work and provided a tour of their Pittsburgh laboratory. Their discovery of turning CO<sub>2</sub> gas into liquid acetate was a happenstance, involving the intervention of microorganisms that function as biocatalysts. NETL has filed for a patent on the technology.

# Publications

## Beyond price taker: Conceptual design and optimization of integrated energy systems using machine learning market surrogates

JORDAN JALVING, JAFFER GHOUSE, NICOLE CORTES, XIAN GAO, BERNARD KNUEVEN, DAMIAN AGI, SHAWN MARTIN, XINHE CHEN, DARICE GUITTET, RADHAKRISHNA TUMBALAM-GOOTY, LUDOVICO BIANCHI, KEITH BEATTIE, DANIEL GUNTER, JOHN D. SIIROLA, DAVID C. MILLER, ALEXANDER W. DOWLING, APPLIED ENERGY, VOLUME 351, DEC. 1, 2023. (SUBSCRIPTION MAY BE REQUIRED.)

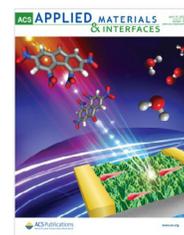


## Integrated carbon capture and conversion: A review on C2+ product mechanisms and mechanism-guided strategies

ASMITA JANA, ETHAN J. CRUMLIN, JIN QIAN, SETH W. SNYDER, IDAHO NATIONAL LABORATORY, FEBRUARY 2023.

## Chemical Feedback in the Self-Assembly and Function of Air–Liquid Interfaces: Insight into the Bottlenecks of CO<sub>2</sub> Direct Air Capture

UVINDUNI I. PREMADASA, DENG PAN DONG, DIANA STAMBERGA, RADU CUSTELCEAN, SANTANU ROY, YING-ZHONG MA, VERA BOCHAROVA, VYACHESLAV S. BRYANTSEV, BENJAMIN DOUGHTY, ACS APPL. MATER. INTERFACES, VOLUME 15, ISSUE 15, MARCH 21, 2023. (SUBSCRIPTION MAY BE REQUIRED.)



## Cost and Life Cycle Emissions of Ethanol Produced with an Oxyfuel Boiler and Carbon Capture and Storage

JOHN DEES, KAFAYAT OKE, HANNAH GOLDSTEIN, SEAN T. MCCOY, DANIEL L. SANCHEZ, A. J. SIMON, WENQIN LI, ENVIRON. SCI. TECHNOL., VOLUME 57, ISSUE 13, MARCH 21, 2023.

## 3D printed triply periodic minimal surfaces as advanced structured packings for solvent-based CO<sub>2</sub> capture

NATHAN C. ELLEBRACHT, PRATANU ROY, THOMAS MOORE, ALDAIR E. GONGORA, DIEGO I. OYARZUN, JOSHUAH K. STOLAROFF, DU T. NGUYEN, ENERGY & ENVIRON. SCI., ISSUE 4, 2023.



## Leveraging the bioeconomy for carbon drawdown

JOHN P. DEES, WILLIAM JOE SAGUES, ETHAN WOODS, HANNAH M. GOLDSTEIN, A. J. SIMON, DANIEL L. SANCHEZ, GREEN CHEMISTRY, ISSUE 8, 2023.

## About DOE Carbon Capture:

DOE/NETL is developing the next generation of advanced CO<sub>2</sub> capture technologies through NETL's Point Source Carbon Capture Program (PSCC) and advancing a diverse set of CDR approaches to directly remove CO<sub>2</sub> emissions from the atmosphere through NETL's Carbon Dioxide Removal Program.



The Digital Compendium of Carbon Capture Technology provides a technical summary of the DOE/NETL's Carbon Capture Program, assembling carbon dioxide capture technology research and development (R&D) descriptions in a searchable database.



## Carbon Capture Reference Materials

- Point Source Carbon Capture Program Fact Sheet
- Carbon Dioxide Removal Program Fact Sheet
- Carbon Capture Infographics
- Interactive Project Maps: PSCC and CDR
- Compendium of Carbon Capture Technology
- Carbon Dioxide Capture Handbook
- CCSI<sup>2</sup>
- Systems Analysis
- Conference Proceedings
- Accomplishments Posters: PSCC and CDR

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