

FEBRUARY 2021

# CARBON CAPTURE NEWSLETTER

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



## 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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## National Carbon Capture Center Achieves Milestone

The National Carbon Capture Center (NCCC) announced the “first fire” of its new natural gas infrastructure, paving the way for the first test runs of carbon capture technologies using actual natural gas-derived flue gas in January 2021. The news marks a significant milestone for the U.S. Department of Energy’s (DOE) National Energy Technology Laboratory (NETL)-sponsored facility as it expands its ability to evaluate carbon capture technologies for natural gas power plants. The natural gas carbon capture infrastructure will offer significant advantages for carbon capture technology developers to demonstrate and scale-up technologies, including expanded testing windows and more flexibility. **DECEMBER 2020**



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# Interagency News and Updates

## DOE Announces \$15 Million in Funding Opportunities for Direct Air Capture Technologies

DOE's Office of Fossil Energy (FE) announced up to \$15 million in federally funded financial assistance for cost-shared R&D projects under the funding opportunity announcement (FOA) [DE-FOA-0002402, Carbon Capture R&D: Bench-Scale Testing of Direct Air Capture Components \(TRL 3\) and Initial Engineering Design for Carbon Capture, Utilization and Storage Systems from Air \(TRL 6\)](#). The NETL-managed projects will develop lower-cost, scalable technologies for CO<sub>2</sub> capture from air and support DOE's Carbon Capture Program. The FOA focuses on two areas of interest (AOI): **AO1: Bench-Scale Testing of Structured Material Systems or Component Designs for Optimized Direct Air Capture** and **AO2: Initial Engineering Design of Carbon Capture Utilization and Storage Systems for Direct Air Capture**. DOE anticipates selecting up to eight projects for this FOA.



## DOE Announces Funding for Projects to Improve Fossil-Based Hydrogen Production, Transport, Storage, and Utilization

DOE FE announced the availability of federal funding to help recalibrate the nation's fossil-fuel and power infrastructure for decarbonized energy and commodity production under the FOA [DE-FOA-0002400, "Fossil Energy Based Production, Storage, Transport and Utilization of Hydrogen Approaching Net-Zero or Net-Negative Carbon Emissions."](#) NETL will manage the projects. Of particular interest to carbon capture is **AOI 7: Initial Engineering Design of Advanced CO<sub>2</sub> Capture from Hydrogen Production**. The objective of this AOI is to complete the initial design of a commercial-scale, advanced carbon capture, utilization, and storage (CCUS) system that separates, stores, and utilizes more than 100,000 metric tons of CO<sub>2</sub> a year, with more than 90% carbon capture efficiency, from a steam reforming or autothermal reforming plant to produce 99.97% hydrogen from natural gas.



## Energy Policy Act Signals Inclusive, Innovation-Focused Future for DOE

The Energy Act of 2020, passed in the year-end legislative package, builds on more than five years' work on an energy reauthorization bill led by the U.S. Senate Committee on Energy and Natural Resources. The final bill signals a "down payment" on a transition toward a future for DOE focused on innovation, technology commercialization, emissions reductions, renewables, and domestic manufacturing. New programs authorized by the bill will support R&D for energy storage, reducing emissions from the industrial and manufacturing sectors, technology demonstration, and commercial-scale carbon-capture. **JANUARY 2021**

## NETL-Morgantown Focuses on Carbon Capture and Conversion

Several intensive R&D projects are currently underway at NETL-Morgantown, with scientists and engineers working on making the energy sector more efficient. The majority of NETL's projects from the past, present, and future revolve around carbon, and how it can be used or transformed to better develop energy. NETL's R&D projects fall under one of five core competencies: (1) geological and environmental systems, which includes CO<sub>2</sub> storage and enhanced natural gas recovery; (2) energy conversion engineering, which utilizes NETL-Morgantown's Reaction Analysis and Chemical Transformation (ReACT) facility; (3) computational science and engineering, which makes use of NETL's supercomputer—Joule 2.0 (one of the top 100 supercomputers in the world); (4) material science—dealing with structural materials and functional materials; and (5) systems engineering and analysis, which focuses on process optimization and analysis, as well as the design of the future of energy systems. **DECEMBER 2020**

## Coal Plants of the Future

This DOE video highlights the reliability of coal for power, usefulness of coal byproducts, and vast coal resources available in the United States, as well as the economic benefit of coal use. **NOVEMBER 2020**

# U.S. and International Events

## 15th International Conference on Carbon Dioxide Capture and Storage Technologies and Applications

The 15th International Conference on Carbon Dioxide Capture and Storage Technologies and Applications (to be held February 18–19, 2021, in Rome, Italy) aims to bring together academic scientists, researchers, and research scholars to exchange and share their experiences and research on all aspects of CO<sub>2</sub> capture and storage technologies and applications. It also provides an interdisciplinary platform for researchers, practitioners, and educators to present and discuss recent innovations, trends, and concerns, as well as practical challenges encountered and solutions adopted in the fields of CO<sub>2</sub> capture and storage technologies and applications.

## 15th International Greenhouse Gas Control Technologies Conference

The International Energy Agency Greenhouse Gas R&D Programme (IEAGHG) is the guardian of the Greenhouse Gas Control Technologies (GHGT) conference series and has signed an agreement with Khalifa University for the university to host the 15th International Greenhouse Gas Control Technologies Conference (GHGT-15) in Abu Dhabi. Due to the ongoing global pandemic, the conference dates have been revised and the event will now take place March 15–18, 2021.

## Westminster Energy, Environment, & Transport Forum

The Westminster Energy, Environment, & Transport Forum, titled “Next steps for carbon capture, usage and storage in the UK—market development, regulation, and the low-carbon economic recovery policy agenda,” will be held virtually March 16, 2021. The forum will discuss the next steps for developing the CCUS market in the United Kingdom (UK). Expected speakers and attendees will include senior government and regulatory officials, as well representatives from power generation, energy retail, heat production and energy networks, heavy industry, construction and infrastructure firms, science and innovation platforms, investors, legal and consultancy groups, environmental and sustainability groups, and researchers in academia and higher education.

## Gordon Research Conference: Permanently Removing CO<sub>2</sub> from Our Emissions and Atmosphere

The fourth installation of the CCUS Gordon Research Conference series, to be held May 30–June 4, 2021, in Waterville Valley, New Hampshire, will examine the following questions: (1) can the United States decarbonize safely and with a variety of approaches appropriate for the variety of power and industrial challenges?; and (2) can the United States develop methods to clean up the atmosphere in time to keep within reasonable temperature limits?

## Carbon Capture Technology Conference & Expo

The Carbon Capture Technology Conference & Expo is a two-day event to be held June 9–10, 2021, in Stuttgart Messe, Germany. Experts from around the world will discuss the latest advances in new technology for carbon capture, storage, and transport, as well as unique ways of utilizing CO<sub>2</sub> to produce net-zero fuels and for other manufacturing processes.

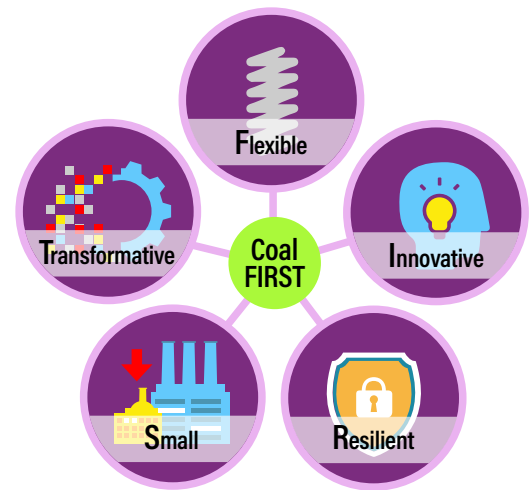
## Trondheim CCS Conference

Trondheim CCS Conference (TCCS) is a global scientific carbon capture, transport, and storage (CCS) technology conference. The conference typically has 150 oral presentations, five or six parallel sessions, more than 100 posters, and keynote speakers. The 11th conference, TCCS-11, will be held June 21–23, 2021, in Trondheim, Norway. The objective of TCCS-11 is to bring forward, present, and discuss work undertaken within R&D institutions, universities, and industry.

# Business and Industry News

## CONSOL Hoping to Build Coal-Fired Plant with Zero Emissions

CONSOL Energy Inc. plans to construct a 300-MW coal-fired plant at or near its Pennsylvania Mining Complex in Washington and Greene counties and to have the plant operating by 2028. CONSOL views coal as an ally that could be used at a plant that would result in zero carbon emissions (and potentially negative emissions). According to the company, wet waste coal from its mining complex would be the primary fuel at this plant. Emissions also would be captured at the facility, whose development could spark construction of an underground hub to store CO<sub>2</sub>. CONSOL's project was one of four selected through *DOE's Coal FIRST (Flexible, Innovative, Resilient, Small, Transformative) Initiative*, which will support the development of the coal plant of the future to provide secure, stable, and reliable power. JANUARY 2021



## Membrane-Based System for Low-Cost CO<sub>2</sub> Capture to Be Demonstrated at Engineering Scale

A new membrane technology for separating CO<sub>2</sub> from exhaust gas will be scaled up for real-world testing under an NETL-funded project to evaluate low-cost CO<sub>2</sub> capture at a coal-fired power plant. Design and testing of an engineering-scale CO<sub>2</sub>-capture system will be jointly overseen by GTI and The Ohio State University. The project aims to conduct tests on coal flue gas at the Wyoming Integrated Test Center. The CO<sub>2</sub>-selective membrane, developed by Ohio State researchers, consists of a layer of non-volatile, amino-group-containing compounds coated onto a nanoporous polymer support. When CO<sub>2</sub>-containing flue gas contacts the membrane, CO<sub>2</sub> molecules absorb into the membrane by binding reversibly with the amino groups in the membrane to form protonated amine cations and bicarbonate anions. The ions are transported across the membrane via two separate routes in a "facilitated transport" mechanism. Carbon dioxide is released to the low-pressure side of the membrane when it desorbs from the amino sites, leaving them in the membrane. JANUARY 2021

## Mining the sky for CO<sub>2</sub> with metal trees, towers, and pumps

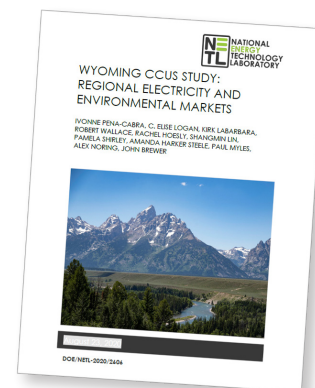
Four companies are forming commercial partnerships to reduce CO<sub>2</sub> around the globe. Carbon Engineering plans to build a commercial-size plant for direct air capture (DAC) in 2022 in the oil-rich Permian Basin in the southwestern United States, where it would capture 1 million tons of CO<sub>2</sub> and store it permanently underground. Global Thermostat is working with two German companies and partnering with Exxon on a pilot project in the Magallanes province of Chile in an area that has unusually strong winds. The idea is to use wind turbines to make electricity to split hydrogen out of water to make methanol, which can be converted into "climate-neutral" gasoline. Climeworks is building a plant near Reykjavík, Iceland, designed to store 4,000 tons of CO<sub>2</sub> underground each year by mixing it with water and injecting into an underground formation where it will eventually be absorbed into stone. (4) Silicon Kingdom Holdings bought the rights to develop the "mechanical tree," a product of a DOE physicist, which is described as being much more efficient at storing CO<sub>2</sub> than real trees. The company expects to be deploying small modules initially and reach an annual capacity to capture up to 3.8 million tons of CO<sub>2</sub> before the end of the decade. JANUARY 2021



# Publications

## Wyoming CCUS Study: Regional Electricity and Environmental Markets

ALEX NORING, AMANDA HARKER-STEELE, BOB WALLACE, C. ELISE LOGAN, IVONNE A. PENA-CABRA, JOHN BREWER, KIRK LABARBARA, PAMELA SHIRLEY, PAUL MYLES, RACHEL HOESLY, SHANGMIN LIN, NETL TECHNICAL REPORT, DOE/NETL-2020/2606, AUGUST 26, 2020.



## Energy Technology Perspectives 2020

INTERNATIONAL ENERGY AGENCY, ENERGY TECHNOLOGY PERSPECTIVES, 2020. (SUBSCRIPTION MAY BE REQUIRED.)

## A single-component water-lean post-combustion CO<sub>2</sub> capture solvent with exceptionally low operational heat and total costs of capture – comprehensive experimental and theoretical evaluation

RICHARD F. ZHENG, DUSHYANT BARPAGA, PAUL M. MATHIAS, DEEPIKA MALHOTRA, PHILLIP K KOECH, YUAN JIANG, MUKUND BHAKTA, MARTY LAIL, ARAVIND V. RAYER, GREG A. WHYATT, CHARLES J. FREEMAN, ANDY J. ZWOSTER, KARL K. WEITZA, DAVID J. HELDEBRANT, ENERGY & ENVIRONMENTAL SCIENCE, ISSUE 11, 2020. (SUBSCRIPTION MAY BE REQUIRED.)

## Subtle changes in hydrogen bond orientation result in glassification of carbon capture solvents

JOSÉ LEOBARDO BAÑUELOS, MAL-SOON LEE, MANH-TUONG NGYUEN, DIFAN ZHANG, DEEPIKA MALHOTRA, DAVID C. CANTU, VASSILIKI-ALEXANDRA GLEZAKOU, ROGER ROUSSEAU, THOMAS F. HEADEN, ROBERT M. DALGLIESH, DAVID J. HELDEBRANT, TRENT R. GRAHAM, KEE SUNG HAN, STEVEN R. SAUNDERS, PHYSICAL CHEMISTRY CHEMICAL PHYSICS, ISSUE 34, 2020. (SUBSCRIPTION MAY BE REQUIRED.)

## Cost and Life-Cycle Greenhouse Gas Implications of Integrating Biogas Upgrading and Carbon Capture Technologies in Cellulosic Biorefineries

MINLIANG YANG, NAWA RAJ BARAL, AIKATERINI ANASTASOPOULOU, HANNA M. BREUNIG, CORINNE D. SCOWN, ENVIRON. SCI. TECHNOL., VOLUME 54, ISSUE 20, PAGES 12810–12819, OCTOBER 8, 2020. (SUBSCRIPTION MAY BE REQUIRED.)

## Carbon-Negative Biofuel Production

SEUNGDO KIM, XUESONG ZHANG, ASHWAN DARAM REDDY, BRUCE E. DALE, KURT D. THELEN, CURTIS DINNEEN JONES, ROBERTO CESAR IZAURRALDE, TROY RUNGE, CHRISTOS MARAVELIAS, ENVIRON. SCI. TECHNOL., VOLUME 54, ISSUE 17, PAGES 10797–10807, AUGUST 4, 2020. (SUBSCRIPTION MAY BE REQUIRED.)

# About DOE's Carbon Capture Program

NETL's [Carbon Capture Program](#) is developing the next generation of advanced carbon dioxide (CO<sub>2</sub>) capture technologies. The U.S. Department of Energy's (DOE) Fossil Energy Program has adopted a comprehensive multi-pronged approach for the research and development of advanced CO<sub>2</sub> capture technologies that have the potential to provide step-change reductions in both cost and energy requirements as compared to currently available technologies. The success of this research will enable cost-effective implementation of carbon capture technologies that can be applied to the existing fleet of fossil fuel-fired plants, new plants, industrial facilities, and the removal of CO<sub>2</sub> from the atmosphere. Cost-competitive carbon capture technologies have the potential to support the fossil sector while advancing U.S. leadership in high efficiency, low-emission generation technologies.

## Carbon Capture Reference Materials

- [Carbon Capture Program Factsheet](#)
- [Carbon Capture Infographics](#)
- [Compendium of Carbon Capture Technology](#)
- [Carbon Dioxide Capture Handbook](#)
- [CCSI<sup>2</sup>](#)
- [Systems Analysis](#)
- [Conference Proceedings](#)
- [Accomplishments Posters](#)
- [Fossil Energy Techlines](#)

Carbon Capture Infographics contain visual representations of the program and its associated technologies. These are designed to help convey program highlights in a compact and shareable form. [Check out the latest!](#)



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