NATIONAL ENERGY TECHNOLOGY LABORATORY

NOVEMBER 2021

CARBON CAPTURE NEWSLETTER

U.S. DEPARTMENT OF ENERGY | OFFICE OF FOSSIL ENERGY AND CARBON MANAGEMENT | 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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DOE Invests Funding to Decarbonize the Natural Gas Power and Industrial Sectors Using CCS

The U.S. Department of Energy (DOE) announced funding for projects to advance point-source carbon capture and storage (CCS) technologies that can capture at least 95% of carbon dioxide (CO_2) emissions generated from natural gas power and industrial facilities. The 12 projects were selected by DOE's Office of Fossil Energy and Carbon Management (FECM) as part of DOE's efforts to deploy a portfolio of innovative solutions to help achieve the Biden-Harris administration's goals of net-zero carbon emissions by 2050 and a 100% clean electricity sector by 2035. Descriptions of selected projects and their associated areas of interest (AOIs) can be found here.

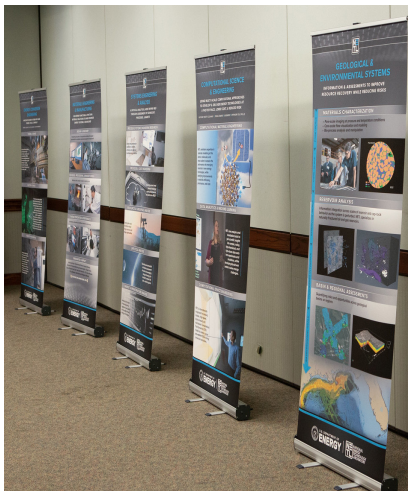
Interagency News and Updates

U.S. DOE Announces Funding for Direct Air Capture and Storage for Low Carbon Energy Sources

DOE released a Funding Opportunity Announcement (FOA) to leverage existing low-carbon energy to scale-up direct air capture (DAC) technology combined with reliable carbon storage. DAC is considered a growing and necessary field that still requires significant investments to create a cost-effective and economically viable technology that can be deployed at scale in the commercial CO_2 market. Advancing the deployment of DAC approaches is critical to combatting the current climate crisis and achieving net-zero emissions by 2050. The FOA "Direct Air Capture Combined With Dedicated Long-Term Carbon Storage, Coupled to Existing Low-Carbon Energy" is focused on front-end engineering design (FEED) studies of advanced DAC systems capable of removing a minimum of 5,000 metric tons per year net CO_2 from air based on a life cycle analysis, suitable for long duration carbon storage or CO_2 conversion/utilization. The studies will provide detailed information on the operation of these systems and potential investment costs that will allow DOE to accelerate research and development for existing DAC technologies, co-located with domestic low-carbon thermal energy sources, such as nuclear power plants, geothermal resources and industrial plants. "DOE announces funding for cost-shared research and development projects under DE-FOA-0002560 "Direct Air Capture Combined With Dedicated Long-Term Carbon Storage, Coupled to Existing Low-Carbon Energy." Read the full FOA here.

2021 UCFER Annual Technical Review Meeting (Virtual) Proceedings Available

National Energy Technology Laboratory (NETL) leadership and experts, including NETL Director Brian Anderson, joined representatives from 11 universities as they gathered virtually Oct. 5–6, 2021, to discuss project successes during the 2021 University Coalition for Fossil Energy Research (UCFER) Annual Technical Review Meeting. The meeting included remarks from NETL management and principal investigators from active UCFER subawards in Carbon Capture, Carbon Storage, Crosscutting Research, Advanced Coal Processing, Coal Beneficiation, Gasification Systems and Coal & Coal-Biomass to Liquids, Natural Gas Technologies, Fuel Cell Technologies, Natural Gas Technologies, and Rare Earth Elements.



NETL Displays Latest in FECM Tech at 2021 International Pittsburgh Coal Conference

NETL Director Brian Anderson joined NETL Carbon Capture Technology Manager Dan Hancu at the 2021 International Pittsburgh Coal Conference to discuss how to cost-effectively implement CCS. NETL-led presentations highlighted a comprehensive, multi-pronged approach to the research and development (R&D) of advanced carbon capture technologies for today's fossil fuel-based power platforms. The success of this research will enable cost-effective implementation of CCS technologies throughout the power generation sector and ensure the United States will continue to have access to safe, reliable, and affordable energy generation while meeting the goals of carbon neutrality by 2035.

Interagency News and Updates (continued)

DOE Announces Funding for Basic Research to Advance the Frontiers of Science

DOE announced funding for a range of research opportunities to support its clean energy, economic, and national security goals. The funding will advance the priorities of DOE's Office of Science and its major programs, including Advanced Scientific Computing Research, Basic Energy Sciences, Biological and Environmental Research, Fusion Energy Sciences, High-Energy Physics, Nuclear Physics, Isotope R&D and Production, and Accelerator R&D and Production. The DOE Funding Opportunity Announcement (FOA), informally known as the "Open Call," is issued annually at the beginning of each fiscal year.

NETL Carbon Capture and Hydrogen Power Research Showcased at Shale Insight 2021

NETL Director Brian Anderson joined DOE Principal Deputy Assistant Secretary for FECM Jennifer Wilcox in highlighting the lab's research into CCS and hydrogen power technologies during the 2021 Shale Insight conference. Speaking to shale industry leaders during technical breakout sessions on Sept. 30, 2021, Anderson detailed NETL's recent research and application of CCS in conjunction with the latest developments in hydrogen power.

NETL Direct Air Capture (DAC) Computational Research Demonstrated During Manufacturing Day

NETL presented the computational research of one of its Mickey Leland Energy Fellowship (MLEF) research associates during the High-Performance Computing for Energy Innovation Manufacturing Day, held virtually Oct. 1, 2021. MLEF research associate Tiernan Baucom presented "Computational Study of MOFs for Direct Air Capture Using Flexible Force Fields." The key objectives of Baucom's project were to derive a flexible model for a certain metal organic framework (MOF) called "MAF-2" using the QuickFF software package, carry out CO_2 adsorption calculations using the flexible model potential, and ascertain the ability of the flexible model to reproduce the experimentally measured CO_2 sorption data. Baucom's study showed the flexible model was far more successful than the rigid model in predicting the CO_2 adsorption properties of the MAF-2.

ASME ACES Highlighted Hydrogen Power, Carbon Capture

The Advanced Clean Energy Summit (ACES), held Sept. 21–22, 2021, showcased sustainable energy technology and practices, such as hydrogen power and carbon capture. The event, hosted by the American Society of Mechanical Engineers (ASME) and organized with support from NETL, brought together perspectives and expertise from around the globe as participants learned and networked in a collaborative, open forum to foster the sustainable energy landscape of the future. NETL organized a panel during the event on advances in hydrogen power, which are being developed to deliver an abundant fuel source from the nation's fossil energy resources while generating net-zero carbon emissions when paired with CCS technologies.

DOE Announces Prize to Support Diversity in Innovation

DOE launched the Inclusive Energy Innovation Prize that will award cash prizes to groups and organizations that support entrepreneurship and innovation in communities historically underserved in climate and energy technology funding. Through the Inclusive Energy Innovation Prize, DOE will deliver resources to ensure applicants from all backgrounds have an equal opportunity to apply for and receive DOE funding.

U.S. and International Events

2021 Appalachian Hydrogen & Carbon Capture Conference

The Appalachian Hydrogen & Carbon Capture Conference (co-sponsored by DOE), to be held Nov. 4, 2021, at Hilton Garden Inn Pittsburgh Southpointe, explores issues surrounding hydrogen use and CCS in the unique context of the Appalachian region.

2021 AIChE Annual Meeting

The American Institute of Chemical Engineers (AIChE) Annual Meeting will be held in-person at the Hynes Convention Center, Sheraton Boston and Marriott Boston Copley Place, Nov. 7–11, 2021, and virtually Nov. 15–19, 2021. The AIChE Annual Meeting is the forum for chemical engineers interested in innovation and professional growth. Experts will cover a wide range of topics relevant to cutting-edge research, new technologies, and emerging areas in the field.

Climate Change 2021: The Push to Carbon Neutrality, Adaptation, and Resiliency

Air & Waste Management Association's Climate Change 2021 conference, to be held virtually Dec. 1–2, 2021, will address emerging policies and strategies for tackling climate change impacts, including mitigation, adaptation, and resiliency. Other topics will include global greenhouse gas policies and initiatives, innovative technologies, and solutions for mitigation and adaptation efforts.

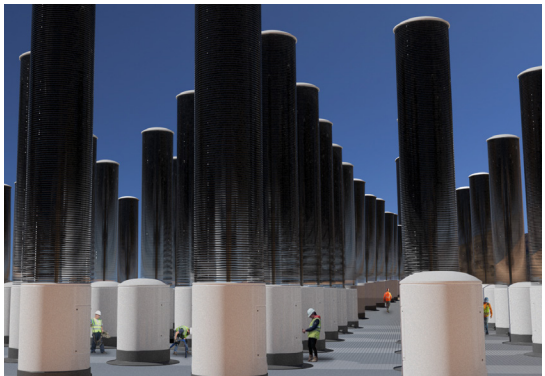
IEA Bioenergy Triannual Online Conference 2021

The International Energy Agency's (IEA) Triannual Online Conference features a series of online sessions spread over two weeks between Nov. 29 and Dec. 9, 2021. The central theme is the role of biomass in the transition toward a carbon-neutral society.

Business and Industry News

Carbon Collect's MechanicalTree selected for DOE Award

A passive carbon capture system, based on the research of Klaus Lackner (Arizona State University) and commercialized by Carbon Collect Inc., is among six DOE-funded projects targeting CCS technologies. The project will focus on designing "carbon farms" located in three distinct geographical locations using a commercial-scale passive DAC system. With the help of proprietary technology developed by Lackner, the MechanicalTree is significantly more efficient at removing CO_2 from the air than a normal tree. The "mechanical trees" allow the captured gas to be stored or sold for reuse in a variety of applications, such as synthetic fuels, enhanced oil recovery, or in food, beverage, and agriculture industries.



Artist's Impression of Carbon Collect's MechanicalTree farm

Business and Industry News (continued)

Black & Veatch to extract 100,000 metric tons of CO_2 Emissions Annually with DAC Technology

Black & Veatch has been awarded DOE funding to support work on a new DAC system that will be able to capture 100,000 metric tons of CO_2 emissions from the atmosphere annually. DOE's support will allow Black & Veatch to develop an initial engineering design (Technology Readiness Level 6) for a large-scale DAC system to be placed in three locations: Odessa, Texas; Bucks, Alabama; and Goose Creek, Illinois. The company will serve as the prime contractor, responsible for project management and balance of plant engineering.

Lessons Learned from Carbon-Removal Efforts

A team of Microsoft staff working on the company's carbon-negative program and research scientists who analyze carbon reduction and removal strategies have written an article, published by Nature Magazine, that summarizes the lessons learned from Microsoft's recent carbon-removal efforts, along with carbon-removal efforts of the U.S.-Irish financial-infrastructure company Stripe. The team highlights three issues with the current system (inconsistent definitions of net zero, poor measurement and accounting of carbon, and an immature market in CO_2 removal and offsets) and suggests solutions.

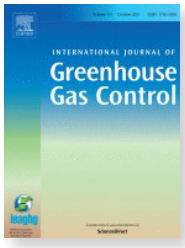
Publications

En Route to Zero Emissions for Power and Industry with Amine-Based Post-combustion Capture

DAVID DANACI, MAI BUI, CAMILLE PETIT, NIALL MAC DOWELL, ENVIRONMENTAL SCIENCE & TECHNOLOGY, VOLUME 55, ISSUE 15, PAGES 10619–10632, JULY 9, 2021. (SUBSCRIPTION MAY BE REQUIRED.)

Deep CCS: Moving Beyond 90% Carbon Dioxide Capture

MATTHEW N. DODS, EUGENE J. KIM, JEFFREY R. LONG, SIMON C. WESTON, ENVIRONMENTAL SCIENCE & TECHNOLOGY, VOLUME 55, ISSUE 13, PAGES 8524–8534, JUNE 23, 2021. (SUBSCRIPTION MAY BE REQUIRED.)



Zero- and negative-emissions fossil-fired power plants using CO_2 capture by conventional aqueous amines

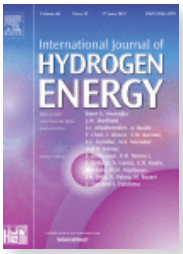
YANG DU, TIANYU GAO, GARY T. ROCHELLE, ABHOYJIT S. BHOWN, INTERNATIONAL JOURNAL OF GREENHOUSE GAS CONTROL, VOLUME 111, ARTICLE 103473, OCTOBER 1, 2021. (SUBSCRIPTION MAY BE REQUIRED.)

Publications (continued)

BAT Review for New-Build and Retrofit Post-Combustion Carbon Dioxide Capture Using Amine-Based Technologies for Power and CHP Plants Fuelled by Gas and Biomass as an Emerging Technology under the IED for the UK

JON GIBBINS, MATHIEU LUCQUIAUD, UK CCS RESEARCH CENTRE REPORT, VERSION 1.0, JULY 2021.

Technoeconomic analysis for hydrogen and carbon Co-Production via catalytic pyrolysis of methane



JARRETT RILEY, CHRIS ATALLAH, RANJANI SIRIWARDANE, ROBERT STEVENS, INTERNATIONAL JOURNAL OF HYDROGEN ENERGY, VOLUME 46, ISSUE 39, 17 JUNE 17, 2021, PAGES 20338-20358. (SUBSCRIPTION MAY BE REQUIRED.)

Synthesis and Quantum Metrology of Metal–Organic Framework-Coated Nanodiamonds Containing Nitrogen Vacancy Centers

ROMAN A. SHUGAYEV, SCOTT E. CRAWFORD, JOHN P. BALTRUS, NATHAN A. DIEMLER, JAMES E. ELLIS, KI-JOONG KIM, AND PATRICIA C. CVETIC, CHEM. MATER. VOLUME 33, ISSUE 16, PAGES 6365−6373, AUGUST 12, 2021. (SUBSCRIPTION MAY BE REQUIRED.)

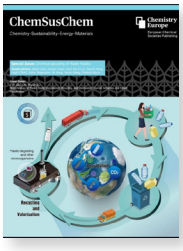
Cryogenic Carbon Capture™ Technoeconomic Analysis

HOEGER, CHRISTOPHER; BURT, STEPHANIE; BAXTER, LARRY, DOE FECM, APR. 5, 2021.

Analysis of energetics and economics of sub-ambient hybrid post-combustion carbon dioxide capture

STEPHEN J. A. DEWITT, ROHAN AWATI, HÉCTOR OCTAVIO RUBIERA LANDA, JONGWOO PARK, YOSHIAKI KAWAJIRI, DAVID S. SHOLL, MATTHEW J. REALFF, RYAN P. LIVELY, AICHE, 17 AUGUST 17, 2021. (SUBSCRIPTION MAY BE REQUIRED.)

Integrated Capture and Conversion of CO_2 to Methane Using a Water-lean, Post-Combustion CO_2 Capture Solvent



DR. JOTHEESWARI KOTHANDARAMAN, DR. JOHNNY S. LOPEZ, DR. YUAN JIANG, DR. ERIC D. WALTER, DR. SARAH D. BURTON, ROBERT A. DAGLE, DR. DAVID J. HELDEBRANT, CHEMSUSCHEM, AUGUST 21, 2021. (SUBSCRIPTION MAY BE REQUIRED.)

Carbon Capture, Utilization, and Storage: Overview and Considerations for State Planning

RODNEY SOBIN, NATIONAL ASSOCIATION OF STATE ENERGY OFFICIALS, AUGUST 6, 2021.

About DOE's Carbon Capture Program

NETL's Carbon Capture Program is developing the next generation of advanced carbon dioxide (CO_2) capture technologies. The U.S. Department of Energy's (DOE) Office of Fossil Energy and Carbon Management has adopted a comprehensive multi-pronged approach for the research and development of advanced CO_2 capture technologies that have the potential to provide step-change reductions in both cost and energy requirements as compared to currently available technologies.

The 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 single document.

Carbon Capture Reference Materials

- Carbon Capture Program Factsheet
- Carbon Capture Infographics
- Compendium of Carbon Capture Technology
- Carbon Dioxide Capture Handbook
- $CCSI^2$
- Systems Analysis
- Conference Proceedings
- Accomplishments Posters
- Fossil Energy Techlines

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Program staff are also located in **Houston, Texas** and **Anchorage, Alaska**

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