



U.S. DEPARTMENT OF  
**ENERGY**



NATIONAL  
ENERGY  
TECHNOLOGY  
LABORATORY

# CTSN CARBON TRANSPORT and STORAGE NEWSLETTER

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This newsletter was compiled by the National Energy Technology Laboratory to provide information on recent activities and publications related to carbon transport and storage. It covers domestic, international, and public and private sector news in the following areas:

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## DOE/FECM/NETL HIGHLIGHTS



### DOE Announces Funding to Accelerate Deployment of Carbon Capture, Transport, Conversion, and Storage Technology.

The U.S. Department of Energy's (DOE) Office of Fossil Energy and Carbon Management (FECM) and the National Energy Technology Laboratory (NETL) announced available funding for projects that will improve stakeholder access to region-specific information and technical assistance regarding the commercial deployment of carbon capture, transport, conversion, and storage technologies throughout the United States. The overall objective of this Funding Opportunity Announcement (FOA) is to accelerate the safe and socially equitable deployment of carbon capture and storage (CCS) by establishing technical teams possessing both the expertise and experience in carbon transport and geologic storage and the capability to offer technical and community support services and information-sharing to CCS and storage-based carbon dioxide removal (CDR) stakeholders. Another objective of this FOA is to enhance geologic data gathering, analysis, and sharing in areas where individual or hub-scale storage facilities are likely to emerge. [Responses](#) are due February 20, 2023.

From *NETL News*. December 2022.



## DOE/FECM/NETL HIGHLIGHTS (cont.)



## DOE Announces CDR Funding.

DOE announced the launch of four programs that will help build a commercially viable, just, and responsible CDR industry in the United States. The programs, funded with \$3.7 billion from the Bipartisan Infrastructure Law (BIL), will help accelerate private-sector investment, spur advancements in monitoring and reporting practices for carbon management technologies, and provide grants to state and local governments to procure and use products developed from captured carbon emissions. In addition to BIL funding, President Biden's Inflation Reduction Act (IRA) features adjustments to the federal Section 45Q tax credit for the capture and geologic storage of carbon dioxide (CO<sub>2</sub>). The new BIL efforts are the Direct Air Capture (DAC) Commercial and Pre-Commercial Prize, Regional DAC Hubs, Carbon Utilization Procurement Grants, and the BIL Technology Commercialization Fund.

From *energy.gov*. December 2022.

## ANNOUNCEMENTS



## 2023 AIChE Annual Meeting Call for Abstracts Open.



The Call for Abstracts for the 2023 American Institute of Chemical Engineers (AIChE) Annual Meeting, which will be held November 5–10, 2023, in Orlando, Florida (USA), is open. NETL is chairing a session on carbon transport and storage titled “**Engineering Geologic Carbon Dioxide Storage Systems**.” Abstracts are due on April 3, 2023. [Click here](#) for more information regarding abstract criteria and submission.

## Well Decommissioning Guidelines for Carbon Storage Launched.

Offshore Energies UK introduced guidelines that will support the industry in decommissioning North Sea oil and gas wells so that reservoirs can be repurposed for offshore carbon storage. The guidelines, commissioned by the UK's Department of Business, Energy, and Industrial Strategy (BEIS), support the verification process and permitting procedures for carbon storage developers.



Department for  
Business, Energy  
& Industrial Strategy

## Agreement on Carbon Storage Project Reached.



California Resources Corporation announced a carbon dioxide management agreement between TerraVault JV Holdco LLC and Lone Cypress Energy Services LLC to store 100,000 metric tons of CO<sub>2</sub> per year from a newly constructed blue hydrogen plant at the Elk Hills Field in Kern County,

California (USA). The Lone Cypress Hydrogen Project has the potential to store up to 200,000 metric tons of CO<sub>2</sub> per year if expanded.

CO<sub>2</sub> Monitoring Consortium Formed.

A group of U.S. industry leaders is forming a CO<sub>2</sub> monitoring consortium, combining knowledge and perspective from across the carbon value chain, from capture to storage. The collective (Denbury Inc., IMA Financial Group Inc., Enerflex Ltd., Wolf Carbon Solutions U.S., Advanced Resources International, and Project Canary) will match existing frameworks and requirements through Project Canary's digital platform into measurement, reporting, and verification for CCS.

## RGGI Releases Report on Secondary Market.

The states participating in the Regional Greenhouse Gas Initiative (RGGI) released the “**Report on the Secondary Market for RGGI CO<sub>2</sub> Allowances: Third Quarter 2022**.” Prepared by independent market monitor Potomac Economics, the report found no evidence of anticompetitive conduct in the RGGI CO<sub>2</sub> allowance secondary market.



## Belgium CCUS Plant Inaugurated.

ArcelorMittal inaugurated its carbon capture, utilization, and storage (CCUS) project at its steel plant in Belgium. Using carbon recycling technology, the “Steelanol” project uses biocatalysts to transform carbon-rich waste gases from the steelmaking process and waste biomass into advanced ethanol, which can then be used as a building block to produce a variety of chemical products.



## Companies to Collaborate on CCS.

Aramco and Shandong Energy are exploring collaboration on integrated refining and petrochemical opportunities in China. The scope of the Memorandum of Understanding (MOU) extends to cooperation on technologies related to hydrogen, renewables, and CCS.

## CCUS MOU Signed in India.

ONGC and Shell will collaborate on a joint CO<sub>2</sub> storage study and enhanced oil recovery (EOR) screening assessment for key basins in India. The MOU is aimed at developing CCUS/CCS as an emissions mitigation tool.



## PROJECT AND BUSINESS DEVELOPMENTS

### CO<sub>2</sub> Storage Site to be Developed in Mississippi.

Denbury Inc. and Weyerhaeuser Company agreed to evaluate and potentially develop a CO<sub>2</sub> storage site in Mississippi (USA). The site is located adjacent to Denbury's NEJD Pipeline, approximately 35 miles south of the company's Jackson Dome field. Denbury is planning to use the site to store industrial CO<sub>2</sub> in geologic formations. According to Denbury, the site will have a total estimated storage capacity of 275 million metric tons of CO<sub>2</sub>.

From *Business Wire*. December 2022.

### Construction of Offshore CCS Project Underway.

Malaysia Marine and Heavy Engineering secured a contract from Petronas Carigali to undertake engineering, procurement, construction, installation, and commissioning services for the Kasawari CCS project off the coast of Sarawak, Malaysia. Once completed, the Kasawari CCS project will be capable of capturing up to 3.3 million metric tons of CO<sub>2</sub> per year. It is scheduled to start by the end of 2025 and will be part of the overall Kasawari Gas Development Project.

From *Rigzone*. November 2022.

### Oil and Gas Producer Expands CCS in Denmark.

Wintershall Dea is teaming up with other companies to expand CCS activities around a hub near Hirtshals on Denmark's northern North Sea coast. The hub will be linked to the Danish Greensand CCS project. Greenport Scandinavia will serve as a collection point for approximately 1.5 million metric tons of CO<sub>2</sub> generated from biogas in the region and countries on the Baltic Sea. It will then be shipped to Greensand for storage in depleted oil fields. The first injections of CO<sub>2</sub> test volumes at Greensand are planned for 2023, with a goal of reaching 4–5 million metric tons of CO<sub>2</sub> storage annually by 2030.

From *Reuters*. December 2022.



wintershall dea

### UK CCS Project Receives Planning Consent.

SSE Thermal and Equinor's Keadby Three plant in North Lincolnshire received its development consent order, which could provide financial backing to help deploy technology to connect with the dual pipeline plans for hydrogen and emissions storage. According to officials, the power station would "become the first power CCS project in the UK to receive planning consent."

From *MSN*. December 2022.

### Carbon Hub Receives EU Funding.

The European Union (EU) Commission awarded funding for the study of the Ghent Carbon Hub project—an open-access, multi-modal CO<sub>2</sub> storage and liquefaction terminal in North Sea Port. Fluxys Belgium, North Sea Port, and ArcelorMittal Belgium will receive the funding through the Connecting Europe Facility for Energy Funding Program. Ghent Carbon Hub is set up as an open-access infrastructure, which includes a CO<sub>2</sub> storage and liquefaction terminal and a pipeline network collecting CO<sub>2</sub> from emitters. The liquefied CO<sub>2</sub> will be loaded onto ships for offshore storage.

From *MarketScreener*. December 2022.



### MOU Includes Collaboration on CCS in Malaysia.

Petroleum Sarawak Bhd (Petros) and Posco Group signed an MOU to collaborate on the development of a CCS business in Sarawak (Malaysia). The companies will conduct a joint study of potential carbon storage sites in Sarawak, as well as the potential transportation of CO<sub>2</sub> from South Korea to the CCS hub within Sarawak. They will also study CO<sub>2</sub> injection and storage; solutions to reduce, mitigate, and/or avoid greenhouse gas emissions arising from CCS opportunities; and the technical and commercial feasibility of the CCS business.

From *The Edge Markets*. December 2022.

### Cooperative Agreement to Advance CCS.

CEMEX and RTI were awarded a cooperative agreement to advance CCS in cement manufacturing. The team will conduct a front-end engineering design (FEED) study of a post-combustion carbon capture system at a Texas (USA) cement plant. CEMEX and RTI are also conducting a second CCUS study at CEMEX's Victorville, California (USA), cement plant. The study, backed by a separate grant, is examining the costs associated with the implementation of a non-aqueous solvent carbon capture system with a modular design.

From *Carbon Capture Journal*. December 2022.

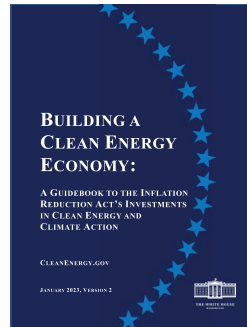
## LEGISLATION AND POLICY



### White House Releases IRA Guidebook for Clean Energy and Climate Programs.

The White House released the first edition of a new resource that provides descriptions of the IRA's tax incentives and funding programs to build a clean energy economy, lower energy costs, address climate change, and reduce harmful pollution. ***Building a Clean Energy Economy: A Guidebook to the Inflation Reduction Act's Investments in Clean Energy and Climate Action*** creates a roadmap for the clean energy and climate funding available under the law at the program level.

From *The White House*. December 2022.



### EU Draft Regulation Focuses on Carbon Removals.

The European Commission published plans for establishing a Carbon Removal Certification Framework (CRCF) to quantify, certify, and monitor carbon removals and outlined how the corresponding governance system will operate. If approved, the draft regulation will result in the formation of a government-backed voluntary certification scheme for carbon removals. For project developers in Europe, the CRCF would provide a route to market for projects related to soil carbon storage, kelp forest carbon storage, and DAC.

From *Lexology*. December 2022.

## EMISSIONS TRADING



### RGGI States Initiate Auction Process for Auction 59.

The RGGI-participating states released materials for their 59th quarterly CO<sub>2</sub> allowance auction, scheduled for March 8, 2023. As indicated in the ***Auction Notice for CO<sub>2</sub> Allowance Auction 59***, 21,522,877 CO<sub>2</sub> allowances will be offered for sale at a minimum reserve price of \$2.50 in 2023. There is an 11,245,778 CO<sub>2</sub> allowance cost containment reserve (CCR) available (will be accessed if the interim clearing price exceeds the CCR trigger price of \$14.88) in addition to an emissions containment reserve (ECR) of 10,616,464 allowances (available to be withheld if the interim clearing price is less than the ECR trigger price of \$6.87).

From *RGGI News Release*. January 2023.



### India Passes Bill to Promote Carbon Trading.

A bill seeking to mandate the use of non-fossil energy sources and promoting renewable energy and the development of a domestic carbon market was passed by the Parliament of India. The Energy Conservation (Amendment) Bill, 2022, aims to introduce new concepts, such as carbon trading, to support the decarbonization of the Indian economy and help achieve sustainable development goals.

From *Money Control*. December 2022.

## SCIENCE



### Companies Collaborate on Mineralization Process that Stores CO<sub>2</sub>.

Sulzer Chemtech and Blue Planet are working to develop CCUS technology. The two companies are collaborating to commercialize a mineralization process that stores CO<sub>2</sub> emissions released by emissions-heavy industries in aggregate form, which can then be used to offset the CO<sub>2</sub> footprint of cement, producing carbon-negative concrete. The new strategic agreement follows the announcement of a technical collaboration between the two companies in 2021.

From *Construction Week Online*. December 2022.

### Whales Could Be Valuable Carbon Sinks.

Research published in ***Trends in Ecology and Evolution*** explores how whales can contribute to carbon storage and the overall reduction of atmospheric CO<sub>2</sub>. According to the study, whales, which can weigh more than 150 tons and live for more than 100 years, make up one of the largest living carbon pools in the pelagic ocean (the part of the marine system that is responsible for storing 22% of Earth's total carbon).

From *ScienceDaily*. December 2022.





## PUBLICATIONS

### Evaluation of the impact of CO<sub>2</sub> geological storage on tight oil reservoir properties.

The following is from the abstract of this article: “Carbon capture, utilization, and storage (CCUS) is an emerging methodology to mitigate CO<sub>2</sub> emissions. When injected into the subsurface, there are potential interactions between CO<sub>2</sub>, pore fluids, and the reservoir rock. To determine analyzed the effect of CO<sub>2</sub> on the physical properties of geological reservoirs, the pore structure, and mineral composition of cores before and after CO<sub>2</sub> static soaking. The samples were analyzed using nuclear magnetic resonance (NMR), X-ray diffraction (XRD), scanning electron microscope (SEM), and energy dispersive spectrometer (EDS). This study found that the pore size of tight sandstone core samples increases with time under the same formation water condition. At the same time, the pore changes of tight sandstone samples are different under different CO<sub>2</sub>-formation water immersion. The experimental results show that the degree of dissolution of minerals with CaCl<sub>2</sub> formation water is negligible. Often, When CO<sub>2</sub> injection, two phenomena usually occur. First, mineral dissolution enlarges pores. Second, the diagenetic crystallization of salt and illite divides the pores will increase the pore size. The results of the CO<sub>2</sub>–NaHCO<sub>3</sub> static immersion show experiments that within seven days, due to salt diagenesis and mineral precipitation than mineral dissolution, the pores decrease. With the further strengthening of mineral dissolution, the pores increase during 7–12 days. In addition, in CO<sub>2</sub>–CaCl<sub>2</sub> type formation water, only pore size decreases within the reaction time of 12 days, indicating that precipitation is more excellent than dissolution in this water environment. The comprehensive analysis shows that the effect of CO<sub>2</sub> on pore enlargement is not unidirectional but first inhibits and then promotes pore size. After CO<sub>2</sub> injection into the formation, it is dissolved in formation water with different chemical properties, influencing reservoir rocks. Compared with CO<sub>2</sub>–CaCl<sub>2</sub> formation water, CO<sub>2</sub>–NaHCO<sub>3</sub> formation water has a noticeable effect of increasing porosity, which has the potential of improving oilfield tight reservoir conditions to a certain extent.”

**Yuting Dai, Fengpeng Lai, Jun Ni, Yisheng Liang, Hao Shi, and Gongshuai Shi,** *Journal of Petroleum Science and Engineering.* (Subscription may be required.)

### Characterizing the Value of Single Source CO<sub>2</sub> Intermediate Storage (CIS) to Optimize Pipeline Utilization/Economics.

The following is from the Executive Summary of this DOE/NETL report: “One of the main hurdles facing the wide-spread implementation of carbon capture, utilization, and storage (CCUS) is the ability to capture and transport large quantities of carbon dioxide (CO<sub>2</sub>) from anthropogenic sources at prices low enough to be competitive with alternative sources of CO<sub>2</sub>. Full utilization of CO<sub>2</sub> pipelines is an important strategy to decrease the total cost of utilizing the CO<sub>2</sub> from these sources. Sources with low capture capacity factors and high peak rates of capture can more fully utilize smaller pipelines and provide sustained CO<sub>2</sub> supply to the downstream end-user by incorporating CO<sub>2</sub> intermediate storage (CIS) – sending CO<sub>2</sub> at larger volumes to the intermediate storage reservoirs during periods of peak capture. Then, CO<sub>2</sub> can be produced from intermediate storage during periods of capture or source downtime to continue to fully utilize the smaller diameter pipeline. The feasibility of CIS is determined in this report based on the economic value that maximizing pipeline utilization between CIS and storage represents in the CCUS value chain. This report investigates the economics and details of matching CIS with different CO<sub>2</sub>



sources to begin to inform future CCUS discussions about the feasibility of re-production of temporarily stored CO<sub>2</sub>. High-level screening of all four types of potential CIS reservoirs [steel tanks, saline aquifers, depleted oil and gas reservoirs, and salt caverns] showed impacts on economic returns for CIS. Multiple withdrawal and injection cycles per year in typical applications and the relatively large capital required only realizes positive economic returns in the current CCUS economic environment for the lowest cost salt cavern CIS reservoirs prominent along the coast of the Gulf of Mexico.”

### Carbon Capture Utilization and Storage Market worth \$7.7 billion by 2026 - Exclusive Report by MarketsandMarkets™.

The following is from a description of this report: “The carbon Capture, Utilization, and Storage market is expected to reach USD 4.9 billion by 2027, at a CAGR of 15.1%. The demand from the construction industry is expected to drive the growth of the market during the forecast period between 2022 to 2027. However, factory shutdowns, interrupted supply chains, and reduced demand from end-use industries has negatively affected the carbon capture, utilization, and storage market...”

### Progress and prospects of carbon dioxide capture, EOR-utilization and storage industrialization.

The following is from the abstract of this article: “Carbon dioxide capture, EOR-utilization and storage (CCUS-EOR) are the most practical and feasible large-scale carbon reduction technologies, and also the key technologies to greatly improve the recovery of low-permeability oil fields. This paper sorts out the main course of CCUS-EOR technological development abroad and its industrialization progress. The progress of CCUS-EOR technological research and field tests in China are summarized, the development status, problems and challenges of the entire industry chain of CO<sub>2</sub> capture, transportation, oil displacement, and storage are analyzed. The results show a huge potential of the large-scale application of CCUS-EOR in China in terms of carbon emission reduction and oil production increase. At present, CCUS-EOR in China is in a critical stage of development, from field pilot tests to industrialization. Aiming at the feature of continental sedimentary oil and gas reservoirs in China, and giving full play to the advantages of the abundant reserves for CO<sub>2</sub> flooding, huge underground storage space, surface infrastructure, and wide distribution of wellbore injection channels, by cooperating with carbon emission enterprises, critical technological research and demonstration project construction should be accelerated, including the capture of low-concentration CO<sub>2</sub> at low-cost and on large-scale, supercritical CO<sub>2</sub> long-distance transportation, greatly enhancing oil recovery and storage rate, and CO<sub>2</sub> large-scale and safe storage. CCUS-EOR theoretical and technical standard system should be constructed for the whole industrial chain to support and promote the industrial scale application, leading the rapid and profitable development of CCUS-EOR emerging industrial chain with innovation.”

**Shiyi YUAN, Desheng MA, Junshi LI, Tiyao ZHOU, Zemin JI, and Haishui HAN,** *Petroleum Exploration and Development.* (Subscription may be required.)

**PUBLICATIONS** (cont.)**Life cycle assessment of a carbon capture utilization and storage supply chain in Italy and Germany: Comparison between carbon dioxide storage and utilization systems.**

The following is from the abstract of this article: “The main purpose of this work is to verify that the CCUS supply chains at large scale that were developed in previous studies for Italy and Germany effectively reduce carbon emissions. The methodology of life cycle analysis was applied. Results showed that the annual global warming potential (GWP) for these supply chains in Italy and Germany are respectively  $9.62 \times 10^{10}$  kgCO<sub>2-eq</sub> and  $1.94 \times 10^{11}$  kgCO<sub>2-eq</sub> which would help enable these countries to achieve the carbon dioxide reduction target fixed by European environmental policies. Overall emissions in Italy and Germany are 249 Mtonne/year and 640 Mtonne/year, respectively. Sensitivity analysis results show that, for the supply chain in Germany, the GWP increases when, for a fixed amount of emissions captured, more carbon dioxide is sent to utilization: storage is then important to achieve the environmental target. Other impact categories decrease, increase or remain constant. On the other hand, for the supply chain in Italy, results showed that a lower environmental impact can be obtained by increasing the carbon utilization rate for methane production via a power to gas system. If this is implemented then this utilization system would be a better solution from an environmentally point of view than the storage option with other utilization processes.”

**Grazia Leonzio, I. David L. Bogle, and Pier Ugo Foscolo**, *Sustainable Energy Technologies and Assessments*. (Subscription may be required.)

**Modeling the operational flexibility of natural gas combined cycle power plants coupled with flexible carbon capture and storage via solvent storage and flexible regeneration.**

The following is from the abstract of this article: “In electricity systems with high shares of variable renewable energy resources, the capability to flexible alter power output can increase the economic value of natural gas combined cycle (NGCC) power plants equipped with carbon capture and sequestration (CCS) and enhance their competitiveness as firm low-carbon resources. Here [the authors] examine NGCC power plants w/CCS (NGCC-CCS) coupled with solvent storage to enable flexible operation. [The authors] present a modular and detailed modeling formulation to represent these systems in a computationally efficient and accurate manner and to evaluate the operating patterns and system value of flexible CCS designs. The proposed framework breaks down NGCC-CCS plants into major subcomponents and uses linear constraint formulations to enforce energy and mass balances. In addition, thermal power plants are subjected to unit commitment (UC) constraints that are generally time-consuming to solve via conventional methods, which use binary decision variables for start-up and shut-down decisions. [The authors] thereby investigate whether the linear relaxation of discrete UC decision variables coupled with a generator clustering method are applicable to model flexible CCS subcomponents. Finally, [the authors] integrate this novel flexible CCS formulation into a power system unit commitment and economic dispatch model to present a case study that shows the hourly operating patterns of NGCC-CCS subcomponents and impacts on power system environmental and economic performance...”

**Fangwei Cheng, Neha Patankar, Sambuddha Chakrabarti, and Jesse D. Jenkins**, *International Journal of Greenhouse Gas Control*. (Subscription may be required.)

## About DOE'S CARBON TRANSPORT and STORAGE PROGRAM

The **Carbon Transport and Storage Program** at the National Energy Technology Laboratory (NETL) is focused on developing and advancing technologies to enable safe, cost-effective, permanent geologic storage of CO<sub>2</sub>, both onshore and offshore, in different geologic settings. The technologies being developed will benefit both industrial and power sector facilities that will need to mitigate future CO<sub>2</sub> emissions. The program also serves to increase the understanding of the effectiveness of advanced technologies in different geologic reservoirs appropriate for CO<sub>2</sub> storage—including saline formations, oil reservoirs, natural gas reservoirs, unmineable coal seams, basalt formations, and organic-rich shale formations—and to improve the understanding of how CO<sub>2</sub> behaves in the subsurface. These objectives are necessary to increasing public confidence in safe, effective, and permanent geologic CO<sub>2</sub> storage.

The [Carbon Transport and Storage Program Overview](#) webpage provides detailed information of the program's structure, as well as links to the webpages that summarize the program's key elements.

### Carbon Transport and Storage Program Resources

Newsletters, program fact sheets, best practices manuals, roadmaps, educational resources, presentations, and more information related to the Carbon Transport and Storage Program is available on [DOE's Energy Data eXchange \(EDX\) website](#).

#### Get Social with Us

There are several ways to join the conversation and connect with NETL's Carbon Transport and Storage Program:



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## About NETL'S CARBON TRANSPORT and STORAGE NEWSLETTER

Compiled by the National Energy Technology Laboratory, this newsletter is a monthly summary of public and private sector carbon transport and storage news from around the world. The article titles are links to the full text for those who would like to read more (note that all links were active at the time of publication).

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1450 Queen Avenue SW  
**Albany, OR** 97321-2198  
541-967-5892

3610 Collins Ferry Road  
**Morgantown, WV** 26507-0880  
304-285-4764

626 Cochran Mill Road  
**Pittsburgh, PA** 15236-0940  
412-386-4687

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

**CUSTOMER SERVICE:** 1-800-553-7681

[www.netl.doe.gov](http://www.netl.doe.gov)

## CONTACTS

If you have questions, feedback, or suggestions for NETL's Carbon Transport and Storage Newsletter, please contact:

**Carbon Transport and Storage Newsletter Support** at [CTSNFeedback@netl.doe.gov](mailto:CTSNFeedback@netl.doe.gov)

#### Mark McKoy

Technology Manager  
Advanced Carbon Storage R&D  
304-285-4426

[Mark.McKoy@netl.doe.gov](mailto:Mark.McKoy@netl.doe.gov)

#### William Aljoe

Technology Manager  
Carbon Storage Infrastructure  
412-386-6569

[William.Aljoe@netl.doe.gov](mailto:William.Aljoe@netl.doe.gov)