

NETL'S CARBON TRANSPORT AND STORAGE NEWSLETTER

ANNUAL INDEX

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October 2022 – September 2023



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NETL'S CARBON TRANSPORT AND STORAGE NEWSLETTER **ANNUAL INDEX – FY 2023**

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This Annual Index is a compilation of the National Energy Technology Laboratory's (NETL) monthly Carbon Transport and Storage Newsletters (CTSNs) published from October 2022 to September 2023. The CTSN is produced by NETL to provide information on activities and publications related to carbon transport and storage. It covers domestic, international, public sector, and private sector news. Duplicative stories have been removed; stories/news are included verbatim from the respective time of publication.

Note that links were active at the time of publication.

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DOE/FECM/NETL HIGHLIGHTS



October 2022 (Vol. 22 No. 10)

DOE Invests in Programs that Fund CCS Projects.

The U.S. Department of Energy's (DOE) Office of Fossil Energy and Carbon Management (FECM) announced funding for [18 projects](#) to conduct early-stage research and development (R&D) of decarbonization technologies and environmental remediation and develop strategies to enhance the engagement of minority-serving institutions on FECM-related research at eligible U.S. colleges and universities. The investment includes nine projects through the University Coal Research (UCR) Program and nine projects through the Historically Black Colleges and Universities and Other Minority Institutions (HBCU-OMI) Program. Both the UCR and HBCU-OMI Programs, which comprise FECM's [University Training and Research \(UTR\) Program](#), will fund projects that explore biomass feedstocks blended with waste coal and coupled with carbon capture and storage (CCS) and address the reclamation and remediation of legacy environmental impacts of coal-based production and generation.

From [energy.gov](#). August 2022.

DOE Announces Funding to Advance CCS.

DOE/FECM announced an investment to advance CCS for natural gas power and industrial sectors. The funding will go to 10 projects to develop carbon capture technologies capable of capturing at least 95% of carbon dioxide (CO₂) emissions from natural gas power plants, waste-to-energy power plants, and industrial applications. Deploying these technologies in the power and industrial sectors at a commercial scale will help advance the Biden-Harris administration's goal of a carbon pollution-free power sector by 2035 and a net-zero greenhouse gas (GHG) economy by 2050. DOE's National Energy Technology Laboratory (NETL) will manage [the projects](#), which will support the development and testing of transformational carbon capture materials, equipment, and processes for applications in natural gas combined cycle (NGCC), waste-to-energy power generation, and the industrial sector. Other projects will perform front-end engineering design (FEED) studies for industrial plants and NGCC power plants integrated with carbon capture systems.

From [energy.gov](#). August 2022.

November 2022 (Vol. 22 No. 11)

DOE Announces Set of FOAs to Manage and Store CO₂.

The U.S. Department of Energy (DOE) announced a set of funding opportunities to bolster investments in the carbon management industry and to reduce carbon dioxide (CO₂) emissions released into the atmosphere through power generation and industrial operations. The three Funding Opportunity Announcements (FOAs) will be supported by Bipartisan Infrastructure Law (BIL) funding to help drive the demonstration and deployment of carbon capture systems, along with carbon transport and storage infrastructure. The [Carbon Storage Validation and Testing](#) FOA supports the [Carbon Storage Assurance Facility Enterprise \(CarbonSAFE\) Initiative](#) and provides up to \$2.25 billion to support the development of new and expanded large-scale, commercial carbon storage projects with capacities to store 50 or more million metric tons of CO₂, along with associated CO₂ transport infrastructure. The [Carbon Capture Demonstration Projects Program](#) FOA provides up to \$2.54 billion to develop six integrated carbon capture, transport, and storage demonstration projects that can be readily replicated and deployed at fossil energy power plants and major industrial sources of CO₂ and certain types of chemical production facilities. The [Carbon Dioxide Transport Engineering and Design](#) FOA provides up to \$100 million to design regional CO₂ pipeline networks to safely transport captured CO₂ from key sources to centralized locations.

From [energy.gov](#). September 2022.

December 2022 (Vol. 22 No. 12)

DOE Accepting Letters of Interest for Loans Under CO₂ Transportation Infrastructure Finance and Innovation Program.

The U.S. Department of Energy (DOE) is accepting Letters of Interest from applicants for loans under a \$2.1 billion Carbon Dioxide Transportation Infrastructure Finance and Innovation (CIFIA) Program. Enacted under the Bipartisan Infrastructure Law (BIL), CIFIA offers funding for large-capacity, shared carbon dioxide (CO₂) transportation projects located in the United States. Appropriated annually through 2026, CIFIA will support shared infrastructure projects that connect anthropogenic sources of carbon with endpoints for its storage or utilization. The program is administered jointly by DOE's Loan Programs Office (LPO) and the Office of Fossil Energy and Carbon Management (FECM). Additional details on eligibility, priority considerations, and financial terms and conditions are available on the [CIFIA website](#).

From [energy.gov](#). October 2022.

January 2023 (Vol. 23 No. 1)

DOE Issues Two RFIs on Implementing and Developing Carbon Transport and Storage Programs.

The U.S. Department of Energy's (DOE) Office of Fossil Energy and Carbon Management (FECM) issued two Requests for Information (RFIs) on the implementation of Future Growth Grants under the Carbon Dioxide (CO₂) Transportation Infrastructure Finance and Innovation (CIFIA) Program and the development of field laboratories at carbon storage facilities through the Carbon Storage Technology Operations and Research (CarbonSTORE) Initiative. For the [CIFIA Future Growth Grants RFI](#), FECM and DOE's Loan Programs Office are working together to provide direct loans and loan guarantees ([CIFIA Loans](#)) and Future Growth Grants that will support the development of regional and national CO₂ transport infrastructure to accelerate the deployment and development of carbon capture and storage (CCS) projects. (Comments are due on January 17, 2023). The [CarbonSTORE RFI](#) seeks input on the best approaches and options for developing field laboratories, whether at [Carbon Storage Assurance Facility Enterprise \(CarbonSAFE\)](#) Initiative project sites or other sites, to catalyze the rapid development and field-testing of technologies that would support a safe and affordable CCS industry. (Comments are due on January 9, 2023.)

From [Office of Fossil Energy and Carbon Management](#). December 2022.

February 2023 (Vol. 23 No. 2)

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 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 (CO₂). 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.

March 2023 (Vol. 23 No. 3)

DOE Invests Funding to Lower Nation's Carbon Pollution

The U.S. Department of Energy (DOE) announced \$131 million for 33 research and development projects to advance the wide-scale deployment of carbon management technologies to reduce carbon dioxide (CO₂) pollution. The projects will address the technical challenges of capturing CO₂ from power plants and industrial facilities or directly from the atmosphere and assess potential CO₂ storage sites, increasing the number of sites progressing toward commercial operations. DOE is investing \$38 million in 22 projects awarded under the "Carbon Management" funding opportunity that will develop technologies to capture CO₂ from utility and industrial sources or directly from the atmosphere and transport it either for geologic storage or conversion into valuable products such as fuels and chemicals. DOE is investing \$93 million in 11 projects awarded under the "CarbonSAFE: Phase II - Storage Complex Feasibility" funding opportunity that will improve procedures to safely, efficiently, and affordably assess onshore and offshore CO₂ project sites within a storage complex at commercial scale. Projects were selected under DOE's Carbon Storage Assurance Facility Enterprise (CarbonSAFE) initiative, which focuses on developing commercial-scale geologic storage sites each with the potential to store 50 million metric tons or more of CO₂ over a 30-year period.

From *NETL.doe.gov*. January 2023.

DOE Invests Funding in CCS Technologies

DOE's Office of Fossil Energy and Carbon Management (FECM) is funding three CO₂ storage projects and two carbon conversion projects selected under the Accelerating Carbon Capture and Storage Technologies (ACT) initiative's fourth call for projects. The ACT is a multi-national program to facilitate international collaboration on research and development and technology innovation to accelerate the global deployment of carbon capture and storage (CCS) and carbon conversion technologies. The three selected CO₂ storage projects will explore options for geologic storage sites, and solutions for CO₂ transport, injection, and monitoring and include PERBAS, a team led by German-based GEOMAR, with DOE's Lawrence Berkeley National Laboratory (LBNL), the Colorado Schools of Mines, and other partners from Germany, India, and Norway; SPARSE, a team led by Norwegian-based SINTEF, with LBNL, and other partners from Norway and Canada; AMIGO, a team led by Canadian-based Repsol, with NETL and other partners from Canada and the United States.

From *Energy.gov* February 2023.

NETL Project Partner Demonstrates CO₂ Capture from Ethanol Production and Its Deep Geologic Storage in Mount Simon Sandstone

Archer Daniels Midland (ADM), with support from NETL, demonstrated an integrated system of processing CO₂ and transporting it from an ethanol plant to the Mt. Simon Sandstone saline reservoir for geologic storage. This is the largest demonstration of its kind in the United States. The system, demonstrated by ADM at the company's Agricultural Processing and Biofuels Plant in Decatur,

Illinois, collected CO₂ produced as a byproduct of processing corn into fuel-grade ethanol. ADM CCS is the first geologic storage project to operate with the U.S. Environmental Protection Agency's (EPA) Class VI injection well permit. Under this Class VI permit, the cumulative amount of CO₂ injected into the Mt. Simon Sandstone saline reservoir was over 2.8 million metric tons.

From *NETL.doe.gov*. January 2023.

Funding Opportunities Issued for Carbon Capture Large-Scale Pilot Projects and Carbon Capture Demonstration Projects Program

DOE's Office of Clean Energy Demonstrations (OCED), in collaboration with FECM and NETL, will provide up to \$2.52 billion to fund two carbon capture programs needed to reduce carbon emissions from the electricity generation and industrial sectors. Funded by President Biden's Bipartisan Infrastructure Law, the two programs—*Carbon Capture Large-Scale Pilots* and *Carbon Capture Demonstration Projects*—aim to significantly reduce CO₂ emissions from electricity generation and hard-to-abate industrial operations, an effort critical to addressing the climate crisis and meeting the President's goal of a net-zero emissions economy by 2050. Read the full Funding Opportunity Announcements [here](#) and [here](#).

From *energy.gov*. February 2023.

April 2023 (Vol. 23 No. 4)

DOE Announces Funding for Carbon Management Programs.

The U.S. Department of Energy (DOE) announced funding for two carbon management programs to catalyze investments in transformative carbon capture systems and carbon transport and storage technologies. Funded by the Bipartisan Infrastructure Law (BIL), the two programs—*Carbon Capture Large-Scale Pilots* and *Carbon Capture Demonstration Projects Program*—aim to reduce carbon dioxide (CO₂) emissions from electricity generation and industrial operations. The *Office of Clean Energy Demonstrations (OCED)*, in collaboration with the *Office of Fossil Energy and Carbon Management (FECM)* and the *National Energy Technology Laboratory (NETL)*, will manage the programs. OCED is charged with accelerating deployment of carbon management technologies by de-risking these transformational technologies at scale and catalyzing private sector investment through public-private cost-share agreements. Read the full Funding Opportunity Announcements (FOAs) [here](#) and [here](#).

From *energy.gov*. February 2023.

May 2023 (Vol. 23 No. 5)

NETL to Expand BIL-Funded Carbon Storage Validation and Testing Program.

The U.S. Department of Energy's (DOE) Office of Fossil Energy and Carbon Management (FECM) is implementing the Bipartisan Infrastructure Law (BIL) Section 40305 (Carbon Storage Validation and Testing) through its Carbon Storage Assurance Facility Enterprise (CarbonSAFE) Initiative. Previously, the *Funding Opportunity Announcement (FOA)* DE-FOA-00002711 accepted applications for later phases only (Phases III, III.5, and IV). In advance of the second deadline for full applications, the National Energy Technology Laboratory (NETL) may modify the FOA to add a new Area of Interest (AOI) to accept applications for projects that meet the objectives of CarbonSAFE Phase II (Storage Complex Feasibility). If the FOA is amended, applicants will be able to apply to four AOIs: AOI 1: Phase III – Site Characterization and Permitting; AOI 2: Phase III.5 – National Environmental Policy Act (NEPA), Front-End Engineering Design (FEED) Studies, and Storage Field Development Plan; AOI 3: Phase IV – Construction; and AOI 4: Phase II – Storage Complex Feasibility.

From *NETL*. March 2023.

NETL, ORNL Collaborate to Accelerate Decarbonization.

NETL is teaming with Oak Ridge National Laboratory (ORNL) to explore a range of technology innovations for carbon capture and utilization and strategies for economic development and sustainable energy transitions in the Appalachian region. Representatives of NETL and UT-Battelle, operator of ORNL, signed an official Memorandum of Understanding (MOU) during a ceremony held at NETL's Morgantown, West Virginia, site in March 2023. Under the MOU, NETL and ORNL intend to jointly explore the development and demonstration of materials and technologies for carbon capture and utilization; develop best practices for carbon dioxide (CO₂) removal; conduct research, development, demonstration, and commercialization of sustainable technologies for production, extraction, separation, and use of critical minerals; create alternative uses for coal; develop technologies; and develop and implement strategies to enable economic development and sustainable energy transitions in the Appalachian region.

From *energy.gov*. March 2023.

DOE Using BIL Funding to Decarbonize the Economy.

Using BIL funds, DOE's FECM, NETL, and Office of Clean Energy Demonstrations (OCED) are helping to establish four new regional direct air capture (DAC) hubs throughout the United States to help achieve a net-zero greenhouse gas (GHG) economy by 2050 in a cost-effective, reliable, and efficient manner. DAC technology uses chemical reactions to remove CO₂ from the air independent of point sources. After being separated from ambient air and extracted in a pure, compressed form, the CO₂ is then delivered for storage or conversion to valuable products.

From *NETL*. March 2023.

June 2023 (Vol. 23 No. 6)

NETL Researchers Launch Airborne Technology at Commercial-Scale CO₂ Storage Site.

A team led by National Energy Technology Laboratory (NETL) researchers launched airborne technology at a commercial-scale carbon dioxide (CO₂) geologic storage site in Mississippi to complete a first-of-its-kind electromagnetic survey and to collect data needed to monitor greenhouse gas (GHG) stored in the subsurface. The researchers tested a superconducting quantum interference device (SQUID) magnetometer at the Kemper Carbon Storage Assurance Facility Enterprise (CarbonSAFE) site. The SQUID magnetometer can detect magnetic fields of extremely low magnitude. Detection and analysis of this measured geophysical data can help researchers identify geologic features and document changes when CO₂ is injected. The testing completed in Mississippi will also help determine if airborne electromagnetic surveys offer an effective, lower-cost solution for monitoring carbon storage sites. If successful, the technology will verify previous subsurface characterization efforts and develop baseline measurements and subsurface representations. In addition, the airborne surveys may assist operators of underground storage sites in their efforts to monitor CO₂ plume movement.

From *NETL*. May 2023.

NETL Data Portal to Help Accelerate CO₂ Storage Application Process.

NETL released a set of spatial data layers representing geologic, geophysical, structural, hydrologic, and contextual data designed to help users find suitable storage reservoirs and to support the initial preparations for a U.S. Environmental Protection Agency (EPA) Underground Injection Control (UIC) Class VI permit. This set of data layers, known as the *Class VI Data Support Tool Geodatabase*, leverages public domain information from the Energy Data eXchange (EDX), the U.S. Geological Survey (USGS), State geological surveys, and other sources to indicate subsurface conditions. Upgrades to the geodatabase are planned; by December 2023, it will be integrated into a data visualization dashboard tool that will enable users to interact with the data in a virtual environment, and easily pull relevant spatial data and information into maps for a Class VI permit application without having to download the data to their local computer.

From *NETL*. April 2023.

DOE Announces Investment to Expand Infrastructure to Support CO₂ Transport and Storage.

The U.S. Department of Energy (DOE) announced an investment of \$251 million to support 12 selected projects across seven states that will bolster the nation's carbon management capabilities. Funded by the Bipartisan Infrastructure Law (BIL), the projects will expand CO₂ transportation and storage infrastructure to help reduce CO₂ emissions from power generation and industrial operations. In addition, DOE announced the second opening of the \$2.25 billion Carbon Storage Validation and Testing *Funding Opportunity Announcement (FOA)*, which has been modified to accept applications under a broader scope, including storage complex feasibility in addition to the site characterization, permitting, and construction stages of project development. It also expands the definition of large-scale storage to allow for additional storage options.

From *energy.gov*. May 2023.

July 2023 (Vol. 23 No. 7)

DOE Announces Selections for CCS Systems FEED Studies.

The U.S. Department of Energy's (DOE) Office of Clean Energy Demonstrations (OCED) selected eight integrated front-end engineering design (FEED) studies for award negotiations to support the development of community-informed integrated carbon capture, transport, and storage (CCS) systems. The *eight FEED studies*, which represent five different U.S. states and one tribal nation, will address the design of integrated CCS projects and support the buildout of CCS capacity toward achieving a clean and equitable energy economy. The FEED studies are funded through OCED's *Carbon Capture Demonstration Projects Program*, which seeks to address the urgent need to deploy carbon management technologies. The goal of the Carbon Capture Demonstration Projects Program is to accelerate the implementation of integrated CCS technologies and catalyze significant follow-on investments from the private sector to mitigate carbon emissions sources in industries across America.

From *energy.gov*. May 2023.

DOE Makes Funding Available to Aid Carbon, Transport, and Storage Industry.

DOE's Office of Fossil Energy and Carbon Management (FECM) announced up to \$45.5 million in funding available to advance carbon dioxide (CO₂) capture technologies and help establish the foundation for a successful carbon transport and storage industry in the United States. Projects selected under the *Funding Opportunity Announcement (FOA)* will focus on two areas: (1) developing lower-cost, highly efficient technologies for carbon capture from power and industrial facilities that will capture CO₂ for geologic carbon storage or for conversion into long-lasting products like concrete, and (2) accelerating the deployment of multi-modal transport of CO₂ through the creation of transportation hubs. The application deadline is July 18, 2023.

From *energy.gov*. June 2023.

August 2023 (Vol. 23 No. 8)

NETL Using BIL Funding to Accelerate Commercialization of CO₂ Storage Technologies.

Supported by funding from President Biden's Bipartisan Infrastructure Law (BIL), the National Energy Technology Laboratory's (NETL) development of computational models and software applications is poised to accelerate the commercialization of technologies to safely inject and store hundreds of years of carbon dioxide (CO₂) in the subsurface. Tools to receive BIL funding include the Energy Data eXchange for Carbon Capture and Sequestration (*EDX4CCS*) project, which provides an advanced, strategic, carbon capture and storage (CCS)-specific data infrastructure system to drive the efficient and rapid deployment of CCS efforts.

From *NETL*. June 2023.

September 2023 (Vol. 23 No. 9)**DOE Announces Projects to Provide Regional Technical Assistance to Advance CCS Deployment**

The U.S. Department of Energy (DOE) announced that 16 projects across 14 states will receive funding to provide locally tailored technical assistance and enhanced stakeholder engagement around carbon management technologies. The projects aim to connect carbon management developers with local communities to foster collaboration and education toward the advancement of commercial deployment of carbon capture, transport, and storage technologies across the United States. The funding will enable organizations with extensive experience and unique skill sets in carbon capture, transport, and storage to provide technical information and procedural assistance to industry and business partners with a vested interest in commercial-scale carbon management. DOE's National Energy Technology Laboratory (NETL), under the purview of DOE's Office of Fossil Energy and Carbon Management (FECM), will manage the [selected projects](#).

From *NETL*. July 2023.

NETL Using BIL Funding to Develop Database to Support CO₂ Storage Site Selection

The CO₂-Locate database—a centralized platform that enables users to obtain data quickly and accurately—is now published on NETL's [Energy Data eXchange \(EDX\)](#). Developed with [Bipartisan Infrastructure Law \(BIL\)](#) funding, the database is designed to support more efficient and effective carbon capture and storage (CCS) site selection, risk analysis, and other key stakeholder needs, and includes the start of an integrated national well dataset representing open-source wellbore data from disparate state and federal entities. Leveraging existing NETL research and development (R&D) technologies, CO₂-Locate's high-level analytics will give researchers a better understanding of the age, total vertical depth, and status of wells across the country, allowing them to make informed site-selection decisions.

From *NETL*. July 2023.

PROJECT AND BUSINESS DEVELOPMENTS



October 2022 (Vol. 22 No. 10)

Industrial Partners Begin CCS Feasibility Project.

Three industrial partners are collaborating on a study to explore the feasibility of an open-access CO₂ storage and liquefaction hub in the Ghent part of North Sea Port, Belgium. The partners—Fluxys, ArcelorMittal Belgium, and North Sea Port—initiated the collaboration to decarbonize several industry sectors. Set for commissioning in 2027, the Ghent Carbon Hub will enable the transport and liquefaction of CO₂ from emitters and provide buffer storage and loading of liquefied CO₂ onto ships for storage.

From *Gasworld*. August 2022.

Proposed CCS Ammonia Plant Announced.

CF Industries Holdings Inc. announced plans for a blue ammonia production facility in Ascension Parish, Louisiana (USA). Developed in conjunction with Mitsui & Co. Ltd, the proposed facility would qualify as a “blue” process by employing CCS, reducing the carbon emissions of the ammonia production process compared to conventional ammonia processes. A FEED study is expected to be conducted once the site and technology providers are finalized, with a final investment decision by the companies expected in 2023.

From *Louisiana Governor Newsroom*. August 2022.

Wyoming Carbon Storage Project Receives Federal Approval.

The U.S. Department of Interior’s Bureau of Land Management approved a proposal to store CO₂ underground in Lincoln and Sweetwater Counties, Wyoming (USA). ExxonMobil’s proposal includes a CO₂ disposal well pad and pipeline, which once completed will allow for underground storage of CO₂ produced along with natural gas at the existing ExxonMobil Shute Creek Plant (located in Lincoln County, Wyoming). The disposal well will store approximately 60 million cubic feet of CO₂ daily at a depth of approximately 18,000 feet in the water leg of the Madison formation, which is an approved disposal zone.

From *Bureau of Land Management Press Release*. August 2022.

BP Drilling Appraisal Wells for CCS.

BP has begun drilling appraisal wells in Texas (USA) for CCS operations, with oil and gas company Linde planning to build a site on the Texas coast for the storage of CO₂ produced by their manufacturing facility in Houston. BP’s role will be to build and handle the permit for geologic storage wells, while Linde will utilize its carbon separation, capture, and compression technologies. The joint Linde-BP project is scheduled to open in 2026.

From *Carbon Herald*. August 2022.

Project Receives Grant to Assess CCS Resources.

The Nebraska Environmental Trust awarded a grant to a University of Nebraska–Lincoln (USA) project to assess CCS resources. The project objective is to assess CO₂ storage resources and opportunities in the study area (which covers several counties in Nebraska) and near the Nebraska Public Power District’s Gerald Gentleman Station. The researchers will use laboratory tests and simulations to determine various physical and mechanical parameters, such as porosity, permeability, strength, stiffness, and storage coefficient.

From *University of Nebraska–Lincoln, Nebraska Today*. August 2022.

MOU to Advance Global Market Using Korea-Developed CCUS Technologies.

DL E&C Co., an engineering, procurement, and construction company, signed an MOU with KEPRI Korea Electric Power Research Institute (KEPRI) to advance the global CCUS market. Under the MOU, the companies will cooperate on the mutual exchange of technologies to enter overseas CCUS markets. DL E&C intends to adopt KEPRI’s carbon capture technology when expanding the CCUS market from Korea to other countries.

From *Business Wire*. August 2022.

Companies Agree to Expand CCUS Efforts.

BKV Corporation and *Verde CO₂ CCS LLC* have agreed to expand CCUS and GHG emissions reduction efforts through CCUS project identification and evaluation. BKV will leverage Verde’s CCUS experience to equip its *CCUS business line*, BKV Carbon Ventures, with the resources needed to evaluate CCUS projects and build a pipeline of feasible projects moving forward. BKV’s initial CCUS project, in partnership with EnLink Midstream, is expected to come online in 2023.

From *BKV News Release*. August 2022.

Mantel Announces Investment for Industrial CCUS.

Mantel announced an investment to accelerate their technology development, prototype testing, and initial deployment of their high-temperature, liquid-phase carbon capture system solution. Mantel’s molten salts selectively absorb CO₂ and regenerate a pure stream of CO₂ that can be stored or utilized. According to the company, combining liquid-phase materials with high operating temperatures can lead to a more than 60% reduction in energy losses and an approximately 50% reduction in costs.

From *Gasworld*. August 2022.

November 2022 (Vol. 22 No. 11)

EPA Approves MRV Plan for CO₂ Storage.

Stakeholder Midstream received approval from the U.S. Environmental Protection Agency (EPA) for its monitoring, reporting, and verification (MRV) plan to store CO₂ in its injection well in Yoakum County, Texas (USA). The well currently injects more than 70,000 metric tons of CO₂ per year but had a permitted capacity of more than 375,000 metric tons. The well is located near several interstate CO₂ pipelines.

From *Midland Reporter-Telegram*. September 2022.

Large-Scale DAC Project Launched in Wyoming.

CarbonCapture announced the launch of a large-scale direct air capture (DAC) project in Wyoming (USA). Project Bison is expected to be operational by the end of 2023, and is expected to be capable of capturing and storing 5 million tons of CO₂ per year by 2030.

From *Reuters*. September 2022.

Collaboration to Provide Support for CCS Projects.

The International CCS Knowledge Centre and energy consulting firm GLJ signed a teaming agreement to support the development of large-scale CCS/CCUS projects. The two Canadian companies will identify opportunities for collaboration as Canada develops a national strategy for CCS, including the implementation of an investment tax credit.

From *International CCS Knowledge Centre Media Release*. September 2022.

Energy Companies to Develop Technologies to Reduce Emissions.

Offshore energy companies in Brazil have entered into a joint research and technology development project focused on developing technologies to reduce carbon emissions. The project, named i-Concept JIP Phase 2, will address subsea factory and advanced subsea processing systems, enhanced oil recovery (EOR) by injection of CO₂, and CCUS. The participants include Repsol Sinopec Brasil, Shell Brasil Petróleo, and Deep Seed Solutions, among others.

From *Offshore Energy*. September 2022.

North Sea CCS Monitoring Pilot Project Completed.

Magseis Renewables completed a high-resolution, 3D seismic data acquisition offshore Norway over a CCS area. The company utilized its extended high-resolution acquisition technology, combined with ocean bottom nodes, to provide imaging of the targeted carbon storage reservoir and the overburden.

From *Offshore Energy*. September 2022.

December 2022 (Vol. 22 No 12)

CCS Project to Be Developed in Nebraska.

Carbon America and Bridgeport Ethanol LLC agreed to develop a CCS project at the Bridgeport Ethanol facility in Nebraska (USA). Carbon America will install carbon capture equipment that will extract CO₂ from the ethanol production process and transfer the gas via a CO₂ pipeline to a storage site near the plant. Once fully operational, the Bridgeport CCS project is expected to capture and store approximately 175,000 tons of CO₂ annually (equivalent to 95% of total emissions from the ethanol plant's fermentation operations).

From *Ethanol Producer Magazine*. October 2022.

Large-Scale CCS Project Announced in Louisiana.

CF Industries, ExxonMobil, and EnLink Midstream will collaborate on a potential business prototype for industrial-scale CCS projects. The companies entered into a commercial agreement to capture CO₂ emissions from CF Industries' Ascension Parish manufacturing complex, transport it through EnLink's transportation network, and store it on property owned by ExxonMobil in Vermilion Parish in Louisiana (USA). The companies estimate the project to be capable of capturing and storing up to 2 million metric tons of CO₂ annually. The start-up for the project is scheduled for 2025.

From *Louisiana Governor John Bel Edwards News Release*. October 2022.

North Sea Carbon Storage Trial Set to Begin.

Belgium and Denmark agreed to allow cross-border transport of captured CO₂ from industrial operations to the reservoirs being developed as part of the Greensand CCS project. The deal will allow CO₂ collected at sites in Belgium to be transported across the border into the Danish waters that host the storage site. For the trial project, CO₂ will be captured at a Belgian ethylene plant run by Ineos Oxide and shipped to Ineos' Nini West oil platform, located off the coast of Denmark, where it will be injected into the former oilfield.

From *Upstream*. October 2022.

Approval Sought for CCS Hub in the USA.

Gulf Coast Sequestration (GCS) initiated the process for obtaining a Class VI Underground Injection Control permit from the U.S. Environmental Protection Agency for a CCS project in Lake Charles, Louisiana (USA). The site is expected to be capable of storing 2.7 million metric tons of CO₂ per year.

From *Gasworld*. October 2022.

Companies Sign Letter of Intent for CCUS Projects.

Energy company Western Midstream and an Occidental Petroleum subsidiary signed a Letter of Intent to collaborate on CCUS projects. The target regions for the potential projects are the Colorado DJ Basin and the Delaware Basin. The focus of the Letter of Intent is the delivery of low-carbon oil and natural gas products to end consumers, with the CO₂ being transported for storage, EOR, or utilization.

From *Carbon Herald*. October 2022.

January 2023 (Vol. 23 No. 1)

PA DCNR Announces CCUS Research Facility.

Pennsylvania's (USA) Department of Conservation and Natural Resources (DCNR) outlined plans for a \$6 million carbon capture, utilization, and storage (CCUS) research and storage facility to house their collection of core samples and drill cuttings. DCNR's Geological Survey has developed a repository of rock core and drill cuttings generated through exploration into oil and gas-bearing and other formations across the state. The library currently has limited space at the Pennsylvania Geological Survey headquarters.

From *Pennsylvania Government Press Room*. November 2022.

CO₂ Storage Capacity Confirmed for Northern Lights Project.

The Northern Lights Project concluded drilling operations for a CO₂ injection well and a contingent injection well within its CO₂ storage license in the North Sea, with preliminary results confirming the storage capacity of at least 5 million metric tons of CO₂ per year. The Northern Lights project—a joint venture created by Equinor, Shell, and TotalEnergies—plans to ship the CO₂ to an onshore terminal on the Norwegian west coast and, from there, transport the liquefied CO₂ by pipeline to a subsea storage location in the North Sea.

From *Offshore Energy*. November 2022.

MOU to Explore East China CCUS Development.

Shell, Sinopec, China Baowu Steel Group, and BASF signed a non-binding Memorandum of Understanding (MOU) to explore the feasibility of developing an open-source CCUS project in the East China region. The parties intend to conduct a joint study to assess the technical solutions and develop a commercial model for the project, as well as to explore the potential establishment of low-carbon product supply chains and propose enabling policies.

From *Oil and Gas Journal*. November 2022.

NET Power Launches Large-Scale Plant with CCS.

A consortium led by NET Power will develop and build a utility-scale natural gas-fired power plant near Odessa, Texas (USA), with near-zero atmospheric emissions that fully integrates power production with the transportation and storage of CO₂. The plant will be built near Occidental's Permian Basin operations and is expected to be online in 2026. The project will transport captured CO₂ to a storage location through Occidental's existing Permian CO₂ handling infrastructure and operations.

From *Carbon Capture Journal*. November 2022.

Companies Sign Lease Agreement to Develop CO₂ Storage Hub.

Occidental Petroleum subsidiary 1PointFive signed a lease agreement with King Ranch, an agricultural company, to support large-scale DAC projects for dedicated CO₂ storage in Texas (USA). The agreement provides access to land with the potential to remove up to 30 million metric tons of CO₂ per year through DAC and pore space estimated to store up to 3 billion metric tons of CO₂ in geologic reservoirs.

From *Oil and Gas Journal*. November 2022.

Pertamina, ExxonMobil to Develop CCS Technology in Indonesia.

Indonesia's state-owned PT Pertamina and ExxonMobil signed a Heads of Agreement (HOA) to develop CCS technology. The HOA is in line with a previous joint study that found up to 1 billion metric tons of CO₂ storage capacity in Pertamina's oil and gas fields. By strengthening their collaboration, Pertamina and ExxonMobil will finalize and prepare a commercial model design for the development of a regional CCS hub in the working area of PT Pertamina Hulu Energi, which is tasked with managing Pertamina's upstream oil and gas assets in the Kalimantan region.

From *S&P Global*. November 2022.

CCS Hub to Be Built in Saudi Arabia.

Saudi Aramco, SLB, and Linde signed a Joint Development Agreement to establish a CCS hub in Jubail on the east coast of Saudi Arabia. The hub will have the potential to store up to 9 million metric tons of CO₂ per year by 2027, according to company officials, with the goal of contributing to the kingdom's plans to capture 44 million metric tons by 2035.

From *Reuters*. November 2022.

Companies Agree to Promote CCUS Development.

GS Caltex signed an MOU with eight other companies to cooperate on and promote the development of CCUS. GS Caltex, an energy-producing company, will oversee defining the business extent of CCUS for each participating company.

From *Korea JoongAng Daily*. November 2022.

February 2023 (Vol. 23 No. 2)**CO₂ Storage Site to be Developed in Mississippi.**

Denbury Inc. and Weyerhaeuser Company agreed to evaluate and potentially develop a CO₂ 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 CO₂ in geologic formations. According to Denbury, the site will have a total estimated storage capacity of 275 million metric tons of CO₂.

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 CO₂ 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 CO₂ 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 CO₂ test volumes at Greensand are planned for 2023, with a goal of reaching 4–5 million metric tons of CO₂ storage annually by 2030.

From *Reuters*. December 2022.

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 CO₂ 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 CO₂ storage and liquefaction terminal and a pipeline network collecting CO₂ from emitters. The liquefied CO₂ 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 CO₂ from South Korea to the CCS hub within Sarawak. They will also study CO₂ 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.

March 2023 (Vol. 23 No. 3)**U.S. Department of State, Bezos Earth Fund, and Rockefeller Foundation Announce Next Steps on Energy Transition Accelerator**

The U.S. Department of State, The Rockefeller Foundation, and the Bezos Earth Fund announced the next steps in developing the Energy Transition Accelerator (ETA), a joint initiative to catalyze private capital to accelerate the transition to clean power in developing countries. The three partners introduced the broad outlines of the ETA at the United Nations Climate Change Conference (COP) 27 in November 2022 in Sharm el-Sheikh, Egypt, intending to undertake an inclusive process to fully design the initiative in the lead-up to COP 28 this December in Dubai.

From *PR Newswire*. January 2023.

California Resources Corporation Announces Agreement for Carbon Storage Project

California Resources Corporation announced a Carbon Dioxide Management Agreement between Carbon TerraVault Holdings, LLC, and Grannus, LLC, to store 370,000 metric tons of CO₂ per year at CTV III from a new blue ammonia and hydrogen plant to be constructed in Northern California (USA). The Grannus Blue Ammonia and Hydrogen Project aims to be California's first blue ammonia and hydrogen facility producing 150,000 metric tons per year of blue ammonia and 10,000 metric tons per year of blue hydrogen. The blue ammonia facility will use Grannus' patented process.

From *Business Wire*. January 2023.

Fourth Developer Seeks to Capture and Store Carbon from Ethanol Plants in U.S. Midwest

A developer and an ethanol plant are seeking regulatory approval to store CO₂ in Randolph County, Indiana. The request was listed as "pending" on EPA's website as of Jan. 25, 2023. At least three other developers are planning interstate pipeline networks in nearby states to off-take the CO₂ emissions of ethanol plants. Two of the companies plan to pipe the CO₂ to Illinois for underground storage. A third developer would pipe the emissions to North Dakota, one of the states with regulatory authority over Class VI wells.

From *S&P Global*. January 2023.

Altera Infrastructure Applies for CO₂ Storage License

Altera Infrastructure and partner Wintershall Dea have applied for a license to store CO₂ in the North Sea as part of the Havstjerne project. Altera's Stella Maris CCS system will collect, transport, inject, and store 10 million metric tons of CO₂ per year using collection hubs and large CO₂ carriers for transport and offshore storage. The company is in discussions with large emitters and land-based industry clusters across Europe.

From *Riviera*. January 2023.

Novel Monitoring Technology Undergoing Tests at Danish CO₂ Storage Project

Magseis Fairfield reported that it had mobilized its MASS III nodes and modular source for testing a new CO₂ monitoring technique developed by SpotLight. Monitoring is said to take place by placing seabed nodes at 16 selected points on the seabed. By comparing collected data with previous images of the sandstone reservoir, Project Greensand can uncover the location of the CO₂. The work is part of the project's pilot phase and is being carried out by Esvagt Innovator.

From *Offshore Energy*. December 2022.

April 2023 (Vol. 23 No. 4)

Companies Sign MOU to Develop CCS in Norway.

Horisont Energi and Neptune Energy signed a Memorandum of Understanding (MOU) with E.ON to develop a European CCS value chain. The companies will develop a land-based CO₂ terminal in Norway, a subsea pipeline, and a seabed liquid CO₂ distribution and injection system connected to the offshore underground storage. The MOU covers development, financing, and funding for handling CO₂. The companies are using the collaboration to help link CO₂ projects on the Norwegian Continental Shelf with development of Europe's CO₂ removal market, with the potential to open a commercial carbon removal market.

From *Offshore Magazine*. February 2023.

Large-Scale, Cross-Border Carbon Storage Project Announced.

CapEOmega and Neptune Energy announced they have begun working on NoordKaap—a large-scale concept for cross-border carbon storage that would allow industrial companies to store CO₂. RWE is also reported to be involved and plans to explore how the project can ship CO₂ from its biomass Eemshaven plant to store the gas in the Dutch North Sea. The joint project is expected to become operational in 2028 and adopt a network-based approach to CCS, aimed at reducing costs and scaling the infrastructure. The project will involve utilizing vessels that can both transport CO₂ from and to terminals, as well as possessing the capability to inject the CO₂ at offshore sites.

From *Carbon Herald*. February 2023.

Saudi Aramco Identifying Fields for EOR.

The Saudi Arabian Oil Company, Saudi Aramco, is identifying fields whose production can be boosted with enhanced oil recovery (EOR) when a new carbon capture hub at the industrial complex of Jubail comes online in 2027. The carbon capture hub in the Red Sea-facing industrial city of Jubail is being developed as part of Aramco's plans to reach net-zero by 2050.

From *S&P Global*. February 2023.

Carbon Capture Project Aims to Remove CO₂ from Distilleries.

United Kingdom-based Carbon Capture Scotland, aiming to remove 1 million metric tons of CO₂ from the distillery industry by 2030, will source its carbon-removal technology from Danish supplier Airco Process Technology. The project will capture CO₂ from the fermentation processes association with distilleries, with the CO₂ captured being utilized or for geologic storage.

From *Gasworld*. February 2023.

Linde to Supply Clean H₂ by Storing CO₂.

Linde will supply clean hydrogen to OCI's blue ammonia plant in Texas by capturing and storing more than 1.7 million metric tons of CO₂ emissions each year. Linde will build, own, and operate an onsite complex at the OCI plant, which will include autothermal reforming with carbon capture, plus a large air separation plant.

From *Reuters*. February 2023.

May 2023 (Vol. 23 No. 5)

Norway Receives Five Applications for Carbon Storage Permits.

Five companies applied for carbon storage permits in the Norwegian Continental Shelf. The location of the storage sites is in the North Sea's Trudvang area and will be the destination of CO₂ released by large European and UK industry companies. To date, Norway has awarded licenses for four storage locations; it will review this set of applications (from Equinor, Neptune Energy Norge, Storegga Norge, Sval Energi, and Wintershall Dea Norge) with the goal of providing a verdict by July 2023.

From *Carbon Herald*. March 2023.

Denmark Inaugurates Cross-Border CO₂ Storage Site.

Project Greensand achieved cross-border CCS by shipping CO₂ from Belgium and injecting it into a depleted oil field under the Danish North Sea. The project aims to store up to 8 million metric tons of CO₂ every year by 2030 (the equivalent of 40% of Denmark's emissions reduction target and more than 10% of the country's annual emissions).

From *Euractiv*. March 2023.

MOU to Explore CCS Projects in US and Australia.

Chevron and Japanese power generation company JERA Co., Inc. signed an MOU that provides a framework for their collaboration on CCS projects located in the United States and Australia. The MOU has the potential to expand the companies' current liquified natural gas relationship and further their collaboration in the lower carbon space.

From *Chevron Newsroom*. March 2023.

CCS Project Expands CO₂ Storage Footprint.

A CCS project located along the Texas Gulf Coast expanded its CO₂ storage footprint by acquiring nearly 100,000 acres onshore in Chambers and Jefferson Counties, Texas. The Bayou Bend CCS project—a joint venture between Chevron and Talos Energy—now encompasses nearly 140,000 acres of pore space for CO₂ storage. Bayou Bend CCS was the [winning bidder](#) in August 2021 for the Texas General Land Office's Jefferson County, Texas, carbon storage lease, located in state waters offshore Beaumont and Port Arthur, Texas.

From *Offshore Energy*. March 2023.

Feasibility Study to Begin in Stockholm.

Ports of Stockholm will begin a feasibility study to establish a node for CO₂ at Stockholm Norvik Port, the goal of which is to increase the possibilities for emission reduction and negativeS emissions by establishing a regional, sustainable, and cost-efficient CO₂ infrastructure in eastern Sweden. The feasibility study will provide support for future decision-making by Ports of Stockholm and other stakeholders about the possibilities to further the planning for a regional CO₂ hub at Stockholm Norvik.

From *Carbon Capture Journal*. March 2023.

June 2023 (Vol. 23 No. 6)**University, Texas Port Partner to Store CO₂ with DOE-Funded Grant.**

Scientists at the Bureau of Economic Geology at the University of Texas Jackson School of Geosciences are helping the Port of Corpus Christi determine if it can store CO₂ from industrial operations at the port beneath the seafloor of the Gulf of Mexico. Funded by a DOE grant, the feasibility study will last two years and include a study of the best methods to transport CO₂ from the port to an offshore storage site.

From *The University of Texas at Austin, Jackson School of Geosciences*. March 2023.

LOI Signed for CCS Project.

Milestone Carbon signed a Letter of Intent (LOI) to evaluate approximately 46,000 acres for CCS in Louisiana's Terrebonne Parish. The carbon storage company plans to use the land to dispose of CO₂ emissions in geologic formations with the potential to store hundreds of millions of tons of CO₂. Milestone Carbon will also evaluate the land's potential for multiple EPA Class VI injection wells to support the decarbonization efforts of existing and planned industrial facilities in southeastern Louisiana.

From *Business Wire*. March 2023.

Pre-FEED Phase of CCS Project Completed.

COWI, an engineering and architecture consulting group, and Viridor, a renewable energy and waste management company, announced the [completion of the pre-front-end engineering design \(pre-FEED\) stage](#) of the Runcorn CCS project. The energy-from-waste facility will be retrofitted with CCS technology and is expected to remove 450,000 metric tons of atmospheric CO₂ annually. The project, which [was shortlisted](#) for the final stage of the United Kingdom (UK) government's industrial carbon capture sequencing process, will next move to a transition phase ahead of FEED, with the CCS technology expected to be deployed by 2025.

From *Carbon Capture Journal*. April 2023.

Partnership to Develop Carbon-Neutral Cement Plant.

Heidelberg Materials and the Government of Canada signed a Memorandum of Understanding (MOU) on a full-scale CCS facility for the cement industry. The Government of Canada committed to invest in the construction of the facility, which is part of Heidelberg Materials' Edmonton, Alberta, plant. The facility is scheduled to be operational by late-2026 and is expected to capture more than 1 million metric tons of CO₂ annually.

From *Heidelberg Materials Press Release*. April 2023.

Linde, ExxonMobil Agree to Transport, Store CO₂.

Linde and ExxonMobil signed a long-term agreement for the off-take of CO₂ associated with Linde's clean hydrogen production in Beaumont, TX. Under the terms of the agreement, ExxonMobil will transport and store up to 2.2 million metric tons of CO₂ a year from Linde's hydrogen production facility.

From *Linde Press Release*. April 2023.

Temporary CO₂ Storage Tank Placed for Northern Lights CCS Project.

Progress is being made with the first temporary CO₂ storage tank for the Northern Lights CCS project—a joint venture of energy companies Shell, Equinor, and TotalEnergies developing an open and flexible infrastructure to store CO₂ from industries across Europe. The tank, lifted and placed at the project's CO₂-receiving facility in Øygarden in western Norway, is the first of 12 for the first phase of the project's CO₂ storage development. When in operation, the facility is expected to handle 1.5 million metric tons of CO₂ per year; for the second phase, the facility will look to expand its capacity to more than 5 million metric tons per year.

From *Offshore Energy Today*. April 2023.

July 2023 (Vol. 23 No. 7)**Collaboration to Accelerate CCUS in the United States.**

Carbon America and Svante Technologies Inc. announced a collaboration on the commercial deployment of CCUS projects in the United States. The companies will work together to identify and deploy projects that can rapidly reduce U.S. greenhouse gas (GHG) emissions. The collaboration leverages Svante's novel solid sorbent carbon capture technology and Carbon America's experience in CCUS project development.

From *Svante Press Release*. May 2023.

Drax, C-Zero Sign MOU for Sale of CDR Credits from BECCS Facility.

Drax and C-Zero Markets agreed to a Memorandum of Understanding (MOU) concerning the sale of CDR credits from Drax's U.S. bioenergy with carbon capture and storage (BECCS) facility. Under the terms of the MOU, C-Zero will buy 2,000 metric tonnes of CO₂ from Drax's BECCS facility for \$300 per metric tonne. Drax aims to deliver 12 million metric tonnes of CO₂ per year using BECCS by 2030.

From *Drax Press Release*. May 2023.

Aker Carbon Capture, Carbfix Extend CCS MOU.

Aker Carbon Capture and Carbfix extended their partnership aimed at exploring full CCS value chains. Under the two-year MOU, the two Nordic companies will work together on point source capture and storage volumes between 100,000 to 1 million metric tons of CO₂ per year from industries such as cement, gas-to-power, and waste-to-energy.

From *Aker Carbon Capture News*. May 2023.

Companies to Collaborate on Cement CCS.

Air Liquide and Holcim agreed to collaborate on Holcim's cement CCS project under development in Belgium. Using Air Liquide's Cryocap™ technology, Holcim expects to reduce CO₂ emissions by up to 1.1 million tons per year. Air Liquide intends to build and operate a unit of its proprietary Cryocap Oxy technology to capture and purify up to 95% of the CO₂ generated from Holcim's production unit in Obourg. The captured CO₂ will then be managed through [Antwerp@C CO₂ Export Hub](#), where it will be transported, liquefied, and loaded onto CO₂ ships for offshore storage.

From *Carbon Capture Journal*. May 2023.

MOU to Advance CCS Solutions.

Wood, an engineering and consulting company, and Computer Modelling Group Ltd. (CMG), a software company that produces reservoir simulation software for the oil and gas industry, signed an MOU specializing in CCS projects. Under the MOU, Wood will combine its surface, fluids transport, and pipeline engineering experience with CMG's subsurface software and services to provide an integrated and connected approach to CCS project development.

From *Wood Press Release*. April 2023.

Santos Signs Four Agreements for CO₂ Storage.

Australian energy company Santos [executed deals](#) with potential customers for CO₂ storage at the Bayu-Undan CCS project offshore Timor-Leste. The deals are with potential upstream gas and liquefied natural gas projects offshore the Northern Territory and in Darwin, and a South Korean energy and industrial conglomerate. The Bayu-Undan CCS project is situated within Santos' Darwin and Bayu-Undan Hub, which is part of the company's three-hub CCS strategy (also includes the under-construction Moomba CCS project).

From *Offshore Technology*. May 2023.

Ørsted Selected for Denmark's Full-Scale CCS Project.

The Danish Energy Agency awarded Ørsted Bioenergy & Thermal Power with a 20-year contract for Denmark's first CCS project. The Ørsted Kalundborg Hub project, expected to capture and store 430,000 metric tons of CO₂ per year from 2026, will see Ørsted establish carbon capture at its wood chip-fired Asnæs Power Station in Kalundborg in western Zealand and the Avedøre Power Station's straw-fired boiler in the Greater Copenhagen area. Approximately 150,000 metric tons of biogenic CO₂ per year will be captured from the straw-fired unit at Avedøre Power Station; the CO₂ will initially be transported by lorry to Asnæs Power Station until a shared pipeline infrastructure across Zealand is established. Ørsted will capture 280,000 metric tons of biogenic CO₂ per year from the wood chip-fired unit at Asnæs Power Station, which will also function as a CO₂ hub, handling and shipping biogenic carbon from both the Avedøre and Asnæs combined heat and power stations to the Northern Lights storage reservoir in the Norwegian portion of the North Sea.

From *Offshore Energy*. May 2023.

Collaboration on CO₂ Storage in Denmark.

Gas Storage Denmark and Fidelis New Energy will collaborate on Fidelis' development, delivery, and operations of an onshore CO₂ system in Denmark. The Norne Carbon Storage Hub will provide CO₂-emitting companies the opportunity to access cost-effective and safe decarbonization options and will help Denmark and other countries achieve 2030 and 2050 climate goals. The CO₂ storage network will be capable of receiving CO₂ from local CO₂ sources via pipeline and international CO₂ sources via shipborne transport at multiple receiving facilities.

From *Victorian Advocate*. May 2023.

August 2023 (Vol. 23 No. 8)

Sweetwater Carbon Storage Hub in Southwestern Wyoming.

The [University of Wyoming's School of Energy Resources](#), in partnership with Frontier Carbon Solutions Holdings, was selected to negotiate a [Financial Assistance award by DOE's Carbon Storage Assurance Facility Enterprise \(CarbonSAFE\) Initiative](#) to further develop the Sweetwater Carbon Storage (SCS) Hub. The SCS Hub spans more than 45,000 acres in southwestern Wyoming and will provide a carbon management solution for industrial emitters across the Mountain West. When fully developed, the SCS Hub is expected to store more than 350 million metric tons of CO₂ in geologic reservoirs.

From *PR Newswire*. June 2023.

Halliburton Wins Well Completions Contract for CCS Project.

Halliburton was awarded a contract to provide completions, liners, and monitoring solutions for the CCS system within the HyNet project. The [HyNet North West](#) project in Liverpool Bay in the UK will apply CCS to reduce carbon emissions by transporting CO₂ captured from industrial sources and storing it in depleted reservoirs underneath the bay.

From *BusinessWire*. June 2023.

Aalborg Portland and Fidelis New Energy Sign Letter of Intent.

Aalborg Portland, a Danish cement producer, signed a letter of intent with Fidelis New Energy to supply more than 400,000 metric tons of CO₂ to the [Norne Carbon Storage Hub](#) via pipeline by 2030. The Norne Carbon Storage Hub, a large-scale facility for handling captured CO₂, was announced by Fidelis in May 2023.

From *CemNet.com*. June 2023.

Japan's JOGMEC Selects Seven CCS Projects.

The Japan Organization for Metals and Energy Security (JOGMEC) selected seven projects to address business scale and cost reduction in CCS. The projects, from various industries including electric power generation, oil refining, and steelmaking, are expected to start operation by 2030 and capture and store approximately 13 million metric tons of CO₂ per year. Early in 2023, Japan's industry ministry set a target annual CO₂ storage capacity of 6–12 million metric tons by 2030 under a long-term roadmap for CCS.

From *Reuters*. June 2023.

Companies Sign MOU to Establish CCS Value Chain in Japan.

Japanese industries Japan Petroleum Exploration Co., JGC Holdings Corporation, Kawasaki Kisen Kaisha (K LINE), and JFE Steel Corporation signed a memorandum of understanding (MOU) to conduct a collaborative evaluation to establish a CCS value chain rooted in Japan. The evaluation includes CO₂ separation and capture at JFE's steelworks in Japan and marine transportation of liquefied CO₂ (LCO₂) to receiving point(s) in Malaysia. The valuation will also include an estimation of required facilities and costs.

From *Offshore Energy*. June 2023.

Partnership to Develop Floating Carbon Storage and Injection Unit.

Navigator Holdings, a specialist in liquefied natural gas carriers, and floating infrastructure operator Bumi Armada Berhad signed an MOU to develop a floating carbon storage and injection unit. The Bluestreak CO₂ joint venture aims to create a value chain of shuttle tankers that will transport captured CO₂ emissions to a floating storage and injection facility in the UK.

From *Carbon Herald*. June 2023.

Mining Partnerships to Capture, Store CO₂.

Arca, a carbon mineralization company, is collaborating with several global nickel producers to use its technology to capture and store CO₂ in mine tailings. The technology accelerates the natural process of carbon mineralization, helping companies to utilize their mine waste to capture and store CO₂ directly from the air.

From *Sustainable Biz*. June 2023.

CO₂ Shipping and Storage Solution for Offshore Australia.

Australian oil and gas company Pilot Energy and Norway's Knutsen NYK Carbon Carriers will collaborate to develop an integrated solution for marine transportation and offshore injection of CO₂. The solution will utilize the Cliff Head CCS Project to enable large-scale industrial emitters to transport, via ship, ambient temperature LCO₂ for injection and offshore storage near the coast of Perth, Australia.

From *Marine Link*. June 2023.

LCO₂-Storage Vessels Receive Approval.

Vessel designs to carry and store LCO₂ have received approval in principle from the American Bureau of Shipping (ABS). Designs for the LCO₂ floating storage and offloading unit and the LCO₂ carrier were reviewed per the latest ABS Rules. *ABS is a classification society for gas carriers.*

From *The Maritime Executive*. June 2023.

September 2023 (Vol. 23 No. 9)

ExxonMobil Acquires CCS Solutions Company

ExxonMobil entered into a definitive agreement to acquire Denbury Inc.—a developer of CCS solutions and enhanced oil recovery. The acquisition provides ExxonMobil with a U.S. CO₂ pipeline network of 1,300 miles, as well as 10 strategically located onshore storage sites. In addition to Denbury's CCS assets, the acquisition includes Gulf Coast and Rocky Mountain oil and natural gas operations, which consist of proved reserves totaling more than 200 million barrels of oil equivalent, providing near-term optionality for CO₂ offtake and execution of the CCS business.

From *ExxonMobil*. July 2023.

Indiana Facility Receives Carbon Storage Injection Well Permits

The U.S. Environmental Protection Agency intends to issue two carbon storage injection well permits for Wabash Valley Resources' (WVR) planned ammonia production facility in Indiana. The WVR project, which has received funding from DOE's FECM to develop and validate technologies that enable cost-effective and safe geologic storage, will liquefy, inject, and store CO₂ in subsurface rock formations at depths of nearly a mile.

From *ICIS*. July 2023.

Occidental, ADNOC to Evaluate Carbon Management Projects

Occidental and ADNOC signed an MOU to evaluate investment opportunities in DAC infrastructure and CO₂ storage hubs in the United States and the United Arab Emirates (UAE). Under the terms of the MOU, ADNOC may evaluate participation in DAC plants and CO₂ storage hubs under development in the United States by Occidental subsidiary 1PointFive. Occidental and ADNOC may also evaluate jointly developing one or more UAE-located CO₂ storage hubs and consider beginning feasibility and pre-front-end engineering design studies for a 1 million metric ton/year DAC plant. The agreement is enabled by the *UAE-US Partnership for Accelerating Clean Energy (PACE)*, which was launched in November 2022 and is expected to mobilize clean energy and carbon management projects, including CCS and DAC, by 2035.

From *Oil & Gas Journal*. August 2023.

MOU to Explore Integrated CCS Solutions

Fluor Corp. and Carbfix signed a memorandum of understanding (MOU) to pursue integrated CCS solutions. Under the MOU, the companies will look for ways to help decarbonize industries with high GHG emissions (i.e., steel, aluminum, and cement). In addition, the MOU also enables the two companies to pursue CO₂-removal projects such as DAC and bioenergy carbon capture and storage.

From *Chemical Engineering Online*. July 2023.

Companies to Explore Integrated CCS Hub in Asia Pacific Region

A group of companies agreed to explore joint development of an integrated CCS effort in Malaysia for industries in the Asia-Pacific region. Petronas, TotalEnergies, and Mitsui & Co. will target all aspects of CCS development, including evaluating storage in maturing and depleted fields and in saline aquifers, as well as identifying potential customers and establishing the necessary commercial and legal frameworks.

From *Journal of Petroleum Technology*. July 2023.

Deals to Explore CCS, CCUS in Indonesia

Indonesia's state energy company PT Pertamina signed four agreements to study and explore potential developments of CCS and CCUS in Indonesia. Pertamina signed the agreements with Mubadala Energy, Japan Petroleum Exploration Co. Ltd, Japan Organization for Metals and Energy Security, and POSCO International. According to Pertamina, Indonesia has the potential to store up to 400 gigatonnes of CO₂ in its depleted oil and gas reservoirs and saline formations.

From *Reuters*. July 2023.

Companies Create Pact to Explore CCS Value Chain

Sharjah National Oil Corporation (SNOC) and Japan's Sumitomo Corporation signed an initial agreement to explore a carbon capture project in the Emirate of Sharjah, part of the United Arab Emirates. According to SNOC, the companies will conduct a feasibility study covering the entire CCS value chain, including transport, storage, business models, and assessment of regulatory aspects.

From *The National News*. July 2023.

UK Government Announces CCUS Cluster Selections

The United Kingdom (UK) government announced its selection for its next two CCUS clusters. The Acorn project is a CO₂ transportation and storage system that will reuse legacy oil and gas infrastructure to transport captured industrial CO₂ emissions from the Scottish cluster for storage under the North Sea. The Viking project has more than 300 million metric tons of initial storage capacity, with eight discrete reservoirs situated beneath the seabed. The clusters are slated for completion by 2030.

From *edie.net*. July 2023.

LEGISLATION AND POLICY



October 2022 (Vol. 22 No. 10)

Incentives Under IRA Could Impact Deployment of Carbon Storage.

New incentives under the 2022 Inflation Reduction Act (IRA) could impact the deployment of carbon storage and clean fuel development. The IRA extends the available Section 45Q tax credit to any carbon capture, DAC, or carbon utilization project that begins construction before January 1, 2033. In addition, the IRA increases the value of those credits up to (per metric ton) \$85 for captured and stored CO₂ and \$60 for CO₂ that is reused.

From *JD Supra*. August 2022.

Australian Government Releases Consultation Paper to Reduce Emissions.

The Australian government—through its Department of Climate Change, Energy, the Environment and Water—released a [consultation paper](#) setting out how to reform its [safeguard mechanism](#), which was introduced in 2016 to address industrial emissions. Proposed changes include having the large-emitting facilities covered by the scheme either reduce emissions onsite or purchase carbon credits. According to the consultation paper, the annual rate of emissions cuts is expected to be 3.5–6%. The paper proposes a path to turn the safeguard mechanism into a form of a carbon trading scheme.

From *The Guardian*. August 2022.

Australian Government Approves Offshore GHG Storage Areas.

The Australian government granted two new offshore GHG storage permits to explore the potential of CCS in Australia. The first permit was issued to Woodside Energy in the Browse Basin off the coast of the Kimberley in Western Australia's north. The second was issued to a joint venture among INPEX, Woodside Energy, and TotalEnergies in the Bonaparte Basin off the coast of the Northern Territory. Three more permits are expected to be issued later.

From *Australian Broadcasting Corporation (ABC)*. August 2022.

Projects Shortlisted for BEIS CCUS Cluster Process.

The UK Department for Business, Energy, and Industrial Strategy (BEIS) announced a list of 20 projects shortlisted for the next stage of the CCUS cluster process. The UK government's [Ten Point Plan for a Green Industrial Revolution](#) sets a goal of deploying CCUS in two industrial clusters by the mid-2020s and in two more by 2030. In November 2021, the HyNet cluster in Northwest England and North Wales and the East Coast Cluster in the Teesside and Humber were selected as Track 1 clusters (for deployment by the mid-2020s) and will be considered for support under the UK government's CCUS Program. The shortlisted projects will also be considered for government funding support.

From *UK BEIS News Release*. August 2022.

November 2022 (Vol. 22 No. 11)

California Bill to Create Regulatory Framework for CCUS.

Passed by the California state legislature, [S.B. 905](#) requires the California Air Resources Board (CARB) to establish a Carbon Capture, Removal, Utilization, and Storage Program. In addition, the bill requires CARB to adopt regulations for a unified permit application for the construction of CCUS projects, develop a centralized database to track the deployment of CCUS and CDR technologies and the development of CCUS projects, adopt protocols to support additional and new methods of CO₂ utilization or storage, and adopt financial responsibility regulations applicable to CCUS projects.

From *JD Supra*. September 2022.

Legislation Spurs Plans for CCS Plant in WV.

Competitive Power Ventures Inc. announced plans to build a natural gas power plant in West Virginia (USA) with CCS technology. The IRA expanded the 45Q tax credit for industry and power, increasing the credit from \$50 to \$85 per metric ton of CO₂ stored through geologic storage, and from \$35 to \$60 per metric ton of CO₂ stored via EOR.

From *E&E News*. September 2022.

EPA Conducting Outreach on Power Plant Carbon Regulations.

EPA opened a non-regulatory [docket](#) to collect written input from “a broad group of stakeholders,” seeking their input on how to write rules to address power plant carbon emissions. EPA held a series of virtual meetings with stakeholders earlier this year to solicit advice on structuring standards for new and existing fossil fuel power plants under a specific section of the Clean Air Act. EPA plans to release proposals to limit carbon from new and existing coal and natural gas power plants in 2023.

From *E&E News*. September 2022.

Australia Passes Law for Net-Zero Emissions by 2050.

Australia's parliament passed government legislation pledging to reduce CO₂ emissions by 43% by 2030 and to net zero by 2050. The emissions reduction target for 2030 is 50% more than previous targets.

From *Reuters*. September 2022.

December 2022 (Vol. 22 No. 12)

New CCUS Bill Signed in Indiana.

A CCUS bill signed into law in Indiana (USA) addresses common issues affecting carbon storage regulations, including pore space ownership, liability, permitting, monitoring, and mineral rights primacy. The legislation is designed to address regulatory uncertainty, attract potential stakeholders for CCUS projects, and establish a path to the deployment of commercial-scale CCUS projects for owners and operators of large-scale carbon emitters in Indiana.

From *JD Supra*. October 2022.

January 2023 (Vol. 23 No. 1)

EU Invests ETS Revenue in Clean Tech Projects.

The European Commission launched its third call for large-scale projects under the European Union (EU) Innovation Fund with revenue from the EU Emissions Trading System (ETS). The call will fund projects covering general decarbonization, seeking those in renewable energy, energy-intensive industries, energy storage, or CCUS. The EU Innovation Fund is focused on the demonstration and commercialization of innovative low-carbon technologies.

From *Carbon Capture Journal*. November 2022.

EU Legislation to Expand National Carbon Sinks.

The European Parliament and European Council agreed on legislation that expands the EU's forests, marshes, and other natural carbon sinks, with the goal of raising its target for reducing net carbon emissions. The [Land Use, Land-Use Change, and Forestry](#) legislation sets regulations and binding targets for removing 310 million metric tons of CO₂-equivalent by 2030 through the use of soil, trees, plants, biomass, and timber. The law currently calls for EU countries to ensure they compensate emissions from land use and forestry with at least an equivalent amount of carbon removal. The new law will, from 2026, require the removal of CO₂ to exceed emissions.

From *Carbon Herald*. November 2022.

February 2023 (Vol. 23 No. 2)**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, help forest carbon storage, and DAC.

From *Lexology*. December 2022.

March 2023 (Vol. 23 No. 3)**Alaska Governor Outlines Carbon Management Bill Package**

The Governor of Alaska outlined a Carbon Management Bill Package previewing legislation creating statutory and regulatory structures needed to capitalize on the carbon markets. The State of Alaska is proposing legislation for maximum flexibility to participate in the evolving industry. Under this legislation, the Department of Natural Resources would be authorized to promote and provide two main categories of carbon management: geologic and biologic storage.

From *State of Alaska*. January 2023.

Norway and France to Cooperate on CCS

Norway and France have signed a letter of intent to promote cooperation on the development and deployment of CCS to help prevent global warming. Norway plans to use CCS to store emissions from European industry and has designated geological formations deep beneath its seabed as reservoirs for CO₂.

From *Reuters*. December 2022.

TIER Amendments Provide Price Certainty and Incentivize CCS

Amendments to Alberta, Canada's Technology, Innovation, and Emissions Reduction Regulation (TIER) went into effect on January 1, 2023. The amendments align TIER with the federal Greenhouse Gas Pollution Pricing Act, facilitate TIER participation by the proponents of CCS projects, provide price certainty, and seek to address a potential surplus of provincial carbon credits in the coming years.

From *Lexology*. January 2023.

West Virginia Passes Bills on Carbon Storage and Hydrogen Hubs

West Virginia (USA) passed two bills that are intended to attract CCS projects and hydrogen hubs, making it easier for such projects to either lease or buy state-owned land. In addition to bringing in investment, the bills will help West Virginia curb its CO₂ emissions.

From *Carbon Herald*. January 2023.

April 2023 (Vol. 23 No. 4)**Carbon Capture and Utilization Parity Act Introduced.**

A bill intended to create parity between the value for utilization and storage in the 45Q carbon capture tax credit was introduced in the U.S. Senate. *The Carbon Capture and Utilization Parity Act of 2023* would establish parity between 45Q carbon capture tax credits for utilization and storage, support industry investment in carbon-neutral products, and contribute to emissions reductions and a circular economy.

From *U.S. Senator Sheldon Whitehouse Press Release*. February 2023.

Germany Developing CCS Strategy.

The German government is developing a Carbon Management Strategy for CO₂ storage and utilization. According to projections, approximately 30 million tons of CO₂ will have to be captured, transported, reused, or disposed of by 2045 for the country to become carbon neutral. The focus of the strategy will be on industrial processes and waste, and it will include possible locations of capture plants, capture and utilization hubs, and transport pipelines for CO₂.

From *Energy Post*. February 2023.

CCUS Legislation Reintroduced in Pennsylvania.

Legislation on establishing the legal and regulatory framework for potential CCUS in Pennsylvania is being reintroduced. As part of the legislative package, one of the bills would direct the Commonwealth to apply for primary enforcement authority from the U.S. Environmental Protection Agency (EPA) for CO₂ underground injection wells (Class VI wells). Several other states seeking to facilitate CCUS and its associated jobs and investment have secured primacy, which streamlines the permitting process.

From *Senator Gene Yaw News Release*. February 2023.

May 2023 (Vol. 23 No. 5)**CCS Legislation Advances in Illinois.**

Legislation that would create a clearer regulatory framework to establish CCS in Illinois was passed out of a House committee. House Bill 2202 reflects on a recent study by the University of Illinois Urbana-Champaign's Prairie Research Center that noted deploying CCUS at a larger scale in Illinois to combat climate change and decarbonize the global economy will require "robust governance." The bill also further develops drilling regulations, injection permit procedures, and application processes with the Illinois Department of Natural Resources.

From *The Telegraph*. March 2023.

PA Looks to Regulate CO₂ Injection Wells.

The Pennsylvania Department of Environmental Protection (DEP) gave notice to the U.S. Environmental Protection Agency (EPA) that the state plans to apply for primacy as it looks to regulate CO₂ injection wells within its boundaries. If the application process succeeds, it would put Pennsylvania's DEP in charge of permitting and overseeing the geologic CO₂ storage industry.

From *The Bradford Era*. March 2023.

EU Lawmakers Approve Climate Legislation.

The European Parliament gave final approval to *updated national targets* to reduce CO₂ emissions and to *expand carbon sinks* in natural ecosystems. The two laws are part of a package of climate change legislation passing through the European Union's (EU) policymaking process, designed to help the 27-country bloc reduce its GHG emissions by 55% by 2030 (from 1990 levels).

From *Reuters*. March 2023.

UK Provides Springboard to CCUS Industry.

The UK government confirmed Spring Budget 2023 funding for the UK's CCUS program, kick-starting early investment in the industry. According to the [Carbon Capture and Storage Association \(CCSA\)](#)—the trade body for the CCUS industry in Europe—the budget will unlock “private investment and job creation across the UK...”.

From *CCSA*. March 2023.

Indonesia Passes New Legislation to Boost CCS in Oil and Gas Sector.

The government of Indonesia announced new legislation that aims to boost the use of CCS in the oil and gas sector. The guidance will help encourage fossil fuel companies to equip their operations with CCUS facilities to curb emissions. Under the regulation, companies in the oil and gas sector will be incentivized to install the technology through carbon credits. Indonesia has set a target of achieving *net-zero emissions by 2060*.

From *Carbon Herald*. March 2023.

June 2023 (Vol. 23 No. 6)

Australian Government Report Highlights Importance of Carbon Storage.

The Australian government's Climate Change Authority released an Insights Report to help policymakers and stakeholders better understand how carbon storage can be scaled up, accelerated, and used responsibly. “*Reduce, remove and store: The role of carbon sequestration in accelerating Australia's decarbonisation*” contains 23 policy insights as part of a “deep dive” into carbon storage, including recommending that the Australian government's net-zero plan and Climate Change Authority's Annual Progress Reports include storage; recommending the pursuit of policies that help ensure there is an adequate supply of carbon storage to meet demand; and suggesting Australia prioritize carbon storage approaches that make optimum use of resources for the volume of carbon stored.

From *Australian Government Climate Change Authority Media Release*. April 2023.

Pact Between Britain and Oklahoma to Focus on CCUS.

The British trade minister signed a trade and economic MOU with Oklahoma that will focus on boosting green trade, particularly in CCUS. According to officials, the deal is aimed at boosting the \$215.6 million worth of goods British companies exported to Oklahoma in 2022 and generating more jobs for UK exporters.

From *Reuters*. April 2023.

July 2023 (Vol. 23 No. 7)

Legislation Introduced to Boost Carbon Removal Solutions.

The Carbon Removal and Emission Storage Technologies (CREST) Act, which directs DOE and the U.S. Department of the Interior to establish new research programs and evaluate the feasibility of carbon removal and storage pathways, quantify the net impact of carbon removal solutions, and establish a pilot reverse auction purchasing program to accelerate carbon removal market commercialization, was introduced in the U.S. Senate. Title I of *the CREST Act* builds upon previously authorized carbon removal R&D programs to include carbon removal pathways that can store CO₂ or use CO₂ to produce valuable products such as biofuels and other products. Title II creates a pilot carbon removal purchasing program that utilizes an innovative reverse auction mechanism to find the cheapest pathways for carbon removal solutions that meet specified performance metrics.

From *U.S. Senator Susan Collins Press Release*. May 2023.

Carbon Credit Bill Passes State Senate in Alaska.

The Alaska State Senate passed a carbon credit bill allowing the state to seek extra revenue via the carbon credits market and essentially leave vast amounts of carbon-absorbing areas, such as forests, undisturbed. The Alaska Department of Natural Resources also [issued a report](#) projecting that carbon credit pilot projects in three areas (the Haines, Tanana Valley, and Matanuska-Susitna Valley areas) could earn approximately \$5 million concurrently, beginning as soon as 2024.

From *Juneau Empire*. May 2023.

UK Government to Develop North Sea Carbon Storage Map.

Britain's government intends to develop a map of the UK North Sea's subsurface geology showing the potential for CCS. Companies already working on CCS technology and licensed to drill in the region will be obliged to report their findings to the regulator, with the government using the information to quantify the potential for CCS in certain areas.

From *Offshore Magazine*. May 2023.

Dutch Government Allocates Funds to CCS Projects.

The Dutch government announced the allocation of funds—the bulk of which are for CCS projects through the SDE+++ scheme—that provide subsidies for the use of techniques to generate renewable energy and reduce carbon emissions. Of the €12 billion (\$13.04 billion) budget, €6.7 billion (\$7.28 billion) will be allocated for CCS projects. The budget for the SDE+++ scheme has increased due to the pricing of the European Union Emissions Trading Scheme being higher than previously expected.

From *ICIS*. April 2023.

August 2023 (Vol. 23 No. 8)

Carbon Offset Legislation Signed into Law in Alaska.

Carbon offset legislation giving the state authority to develop carbon management projects on state lands, sell carbon offset credits, and lease state lands for carbon management purposes was signed into law in Alaska. SB 48 is expected to generate new revenue for the state, enable more active forest management, and ensure public access and use of state lands. In addition to establishing the framework for carbon offset projects, the bill also gives the Alaska Oil and Gas Conservation Commission the authority to pursue primary authority over Class VI underground injection wells. (Class VI wells are used for geologic storage of CO₂.)

From *Office of Governor Mike Dunleavy*. May 2023.

EU Plans Strategy to Scale Up Investment in CCS.

In a public consultation, the European Commission announced plans to scale up its investment in capturing and storing CO₂ emissions. According to the Commission, infrastructure to capture and store CO₂ underground, or to use it in industry, was not developing fast enough. To boost the industry, the Commission will produce a European Union (EU) strategy that could include 2040 and 2050 targets for CO₂ storage infrastructure, or EU-wide standards on CO₂ quality and access to carbon capture infrastructure.

From *Reuters*. June 2023.

Carbon Capture, Storage Bill Advances in Louisiana.

House Bill 571, which would give local lawmakers a percentage of the revenue from carbon stored under state land or water bottoms, was advanced by Louisiana lawmakers. Under the bill, 30% of revenues from carbon storage under state land or water bottoms would go to local governments. The bill now lies with Louisiana Gov. John Bel Edwards.

From *Iowa Capital Dispatch*. June 2023.

CCUS-Boosting Legislation Introduced.

The bipartisan Carbon Removal, Efficient Agencies, Technology Expertise (CREATE) Act was introduced in the U.S. Senate. The legislation would create a comprehensive federal initiative for CDR by creating a new interagency group on Large-Scale Carbon Management; establish four working groups within the Large-Scale Carbon Management interagency group to pursue a technological and detailed CDR research and demonstration initiative across several federal agencies; and require that the working groups focus on carbon removal in the oceans, atmosphere, and land using both natural and technological approaches.

From *U.S. Senate Committee on Environment and Public Works*. June 2023.

Pennsylvania Senate Committee Advances CCS Legislation.

The Pennsylvania Senate Environmental Resources and Energy Committee advanced two bills addressing CCS and reporting requirements. Senate Bill 831 would establish a legal and regulatory framework for potential CCS in Pennsylvania. Senate Bill 286 would direct the Environmental Quality Board to establish reporting obligations for accidental discharges or spills that could enter the water.

From *Pennsylvania Business Report*. June 2023.

September 2023 (Vol. 23 No. 9)

EU Awards Grants to Carbon Management Projects

The European Commission [announced 41 projects](#) that will receive grants as part of the latest call for funding for large-scale projects from the European Union (EU) Innovation Fund. A funding vehicle for the deployment of net-zero and carbon management technologies, the EU Innovation Fund is financed by proceeds from the EU Emissions Trading System. Of the 41 projects, 10 are in carbon management, covering topics such as CCS.

From *Carbon Herald*. July 2023.

Legislation to Catalyze Carbon Storage Introduced

Bipartisan legislation that will improve our understanding of soil carbon storage was introduced in the U.S. Senate. The [Advancing Research on Agricultural Climate Impacts Act](#) will catalyze soil carbon storage by directing the U.S. Department of Agriculture (USDA) to develop consistent and standardized soil carbon measurement methodologies; leverage the Agriculture and Food Research Initiative to develop new tools to measure, monitor, report, and verify GHG emissions and carbon storage; conduct farm demonstrations to improve producer understanding and adoption of soil carbon storage practices; establish a Soil Carbon Inventory and Analysis Network; and develop modeling tools that enable users to estimate changes in soil carbon and GHG emissions resulting from implementing conservation management practices.

From *U.S. Senator Tina Smith Press Release*. July 2023.

EMISSIONS TRADING



October 2022 (Vol. 22 No. 10)

ICE to Launch UK Carbon Emissions Options.

Subject to regulatory approval, Intercontinental Exchange Inc. (ICE) plans to launch UK carbon emissions allowance options in 2022. ICE expects to list UK options out to March 2024. ICE launched UK carbon allowance futures in May 2021, alongside the launch of emissions auctions on behalf of the UK government as part of the UK's new ETS.

From *Yahoo! Finance*. August 2022.

Nigeria Initiates National Emissions Framework.

Nigeria initiated the development of a national emissions framework, their government announced. Nigeria's Emission Trading Framework seeks to align itself to international mechanisms such as the EU ETS. According to government officials, Nigeria has "legal framework provided in the Climate Change Act of 2021 for the reduction of [GHG] emissions through a cap and trade-based emissions trading schemes..."

From *Vanguard*. August 2022.

Carbon Credit Platform Launched.

The International Finance Corporation, Cultivo, Aspiration, and Chia Network launched the Carbon Opportunities Fund—a global investment platform for trading carbon credits. According to the companies, the fund will seek to leverage investments in the voluntary carbon markets and broaden access to finance for certified, nature-based projects. Carbon credit companies Cultivo and Aspiration will lead the fund's strategy and execution, while the fund's carbon credits will be tracked by the World Bank's Climate Warehouse, which was launched on Chia's public blockchain.

From *Sustainability Magazine*. August 2022.

Collaboration to Accelerate Deployment of Natural Carbon Sink Solutions.

Two companies are working together to accelerate the deployment of natural carbon sink solutions. Through the collaboration, Pledge—a London-based integrated carbon offsetting platform—will offer soil carbon storage credits from Grassroots Carbon—a San Antonio (USA)-based company offering certified soil carbon storage credits. Grassroots Carbon links buyers of carbon credits with landowners interested in employing regenerative practices to store CO₂ in soil.

From *Carbon Herald*. August 2022.

November 2022 (Vol. 22 No. 11)

RGGI Auction Results Announced.

The states participating in the Regional Greenhouse Gas Initiative (RGGI) announced the results of the 57th RGGI auction of CO₂ allowances. A total of 22,404,023 CO₂ allowances were sold at a clearing price of \$13.45 (bids ranged from \$2.44 to \$20.00 per allowance). None of the 11.61 million cost containment reserve (CCR) allowances made available were sold, nor were any of the 10.96 million emissions containment reserve (ECR) allowances. (The CCR is a fixed additional supply of allowances made available for sale if an auction's interim clearing price exceeds \$13.91. The ECR is a designated quantity of allowances to be withheld if an auction's interim clearing price is below \$6.42.) Additional details are available in the [Market Monitor Report for Auction 57](#).

From *RGGI Press Release*. September 2022.

December 2022 (Vol. 22 No 12)

Nova Scotia to Replace Cap-and-Trade System.

Nova Scotia is proposing legislation for an emissions-reduction plan that would replace its cap-and-trade system for large industrial greenhouse gas (GHG) emitters. According to officials, the proposed changes to the Environment Act would create a pricing system based on GHG output. The Canadian province's current cap-and-trade system expires at the end of 2022. The new system, which still needs approval from the federal cabinet, would begin on January 1, 2023.

From *Canada's National Observer*. October 2022.

India to Launch National Carbon Trading Market.

In a [recent energy bill](#), the Indian government approved the creation of a national carbon market. According to the bill, the government will issue carbon credits to entities that choose to register under the carbon credit trading scheme. The carbon market will be voluntary at first, with plans to eventually roll out a mandatory cap-and-trade system.

From *Energy Monitor*. October 2022.

Singapore, Vietnam Sign Carbon Credits MOU.

Singapore and Vietnam signed a Memorandum of Understanding (MOU) to support decarbonization efforts in both countries by collaborating on energy and carbon credits. The MOU also includes collaboration on research, development, and deployment of low-carbon energy technologies.

From *Carbon Herald*. October 2022.

January 2023 (Vol. 23 No. 1)

EU Reaches Deal on National CO₂ Reduction Targets.

The EU agreed to a law that sets national targets to reduce overall carbon emissions by the end of the decade. The legislation, called the Effort Sharing Regulation (ESR), sets national targets for emission reductions from road transport, domestic maritime transport, heating of buildings, agriculture, small industrial installations, and waste management—all included in the EU ETS. ESR is part of the overall EU plan to reduce net emissions by 55% from 1990 levels by 2030 and to achieve climate neutrality by 2050.

From *Reuters*. November 2022.

RGGI Auction Results Announced.

The states participating in the Regional Greenhouse Gas Initiative (RGGI) announced the results of the 58th RGGI auction of CO₂ allowances. A total of 22,233,203 CO₂ allowances were sold at a clearing price of \$12.99 (bids ranged from \$2.44 to \$22.00 per allowance). None of the 11.61 million cost containment reserve (CCR) allowances made available were sold, nor were any of the 10.96 million emissions containment reserve (ECR) allowances. (The CCR is a fixed additional supply of allowances made available for sale if an auction's interim clearing price exceeds \$13.91. The ECR is a designated quantity of allowances to be withheld if an auction's interim clearing price is below \$6.42.) Additional details are available in the [Market Monitor Report for Auction 58](#).

From *RGGI Press Release*. December 2022.

February 2023 (Vol. 23 No. 2)**RGGI States Initiate Auction Process for Auction 59.**

The RGGI-participating states released materials for their 59th quarterly CO₂ allowance auction, scheduled for March 8, 2023. As indicated in the [Auction Notice for CO₂ Allowance Auction 59](#), 21,522,877 CO₂ allowances will be offered for sale at a minimum reserve price of \$2.50 in 2023. There is an 11,245,778 CO₂ 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.

March 2023 (Vol. 23 No. 3)**Preliminary Agreement to Include Shipping in the EU's ETS from 2024**

The European Union's (EU) legislative bodies reached an agreement on including shipping in their Emission Trading System (ETS). Subject to final adoption, ships above 5,000 gigatons transporting cargo or passengers for commercial purposes in the EU will be required to acquire and surrender emission allowances for their CO₂ emissions from 2024. Offshore ships will be included from 2027.

From *Hellenic Shipping News Worldwide*. January 2023.

April 2023 (Vol. 23 No. 4)**Indonesia Launches Carbon Trading Mechanism.**

Indonesia launched the first phase of carbon trading for coal power plants. The first stage covers 99 power plants with a total installed capacity of 33.6 gigawatts connected to power grids owned by state utility Perusahaan Listrik Negara (PLN). Indonesia's carbon trade applies to power plants with a capacity of at least 100 megawatts; however, according to officials, it will later be rolled out to smaller coal plants and other fossil-fueled power plants, as well as power plants not connected to PLN's grid.

From *Reuters*. February 2023.

EU Carbon Price Reaches High Mark.

Allowances traded under the European Union's emissions trading system (EU ETS) hit an all-time high in February 2023. The price of carbon credits in the system has risen fivefold in the past three years.

From *Financial Times*. February 2023.

May 2023 (Vol. 23 No. 5)**RGGI CO₂ Auction Results Announced.**

The states participating in the Regional Greenhouse Gas Initiative (RGGI) announced the results of their 59th auction of CO₂ allowances. A total of 21,522,877 CO₂ allowances were sold at a clearing price of \$12.50 (bids ranged from \$2.50 to \$17.57 per allowance). None of the 11.25 million cost containment reserve (CCR) allowances made available were sold (the CCR is

a fixed additional supply of allowances that are made available for sale if an auction's interim clearing price exceeds \$14.88). None of the 10.62 million emissions containment reserve (ECR) allowances made available were withheld (the ECR is a designated quantity of allowances to be withheld if an auction's interim clearing price is below \$6.87). The auction generated \$269 million for states to reinvest in strategic programs, including energy efficiency, renewable energy, direct bill assistance, and GHG abatement programs. Additional details are available in the [Market Monitor Report for Auction 59](#).

From *RGGI News Release*. March 2023.

RGGI Program Review: Public Meeting.

The RGGI-participating states conducted their third program review meeting on March 29, 2023, to review the successes, impacts, and design elements of their CO₂ budget trading programs. [During the public meeting](#), the RGGI member states provided an update on program review considerations to date and sought feedback on assumptions and a proposed framework for conducting electricity sector analyses.

From *RGGI News Release*. March 2023.

June 2023 (Vol. 23 No. 6)**RGGI States Initiate Auction Process for Auction 60.**

The states participating in the Regional Greenhouse Gas Initiative (RGGI) released the Auction Notice and application materials for their 60th quarterly CO₂ allowance auction, to be held June 7, 2023. As indicated in the [Auction Notice for CO₂ Allowance Auction 60](#), a total of 22,026,639 CO₂ allowances will be offered for sale at a minimum reserve price of \$2.50. Also available will be an 11,245,778 CO₂ allowance cost containment reserve (CCR to be accessed if the interim clearing price exceeds the CCR trigger price of \$14.88), as well as 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*. April 2023.

European Parliament Approves Upgrade of Carbon Market.

The European Parliament approved reforms to European Union (EU) climate change policies, including an upgrade of the bloc's carbon market. Parliament voted to approve a deal agreed to [last year](#) by negotiators from EU countries and Parliament to reform the carbon market to reduce emissions by 62% from 2005 levels by 2030. Under the upgrade, factories will lose the free CO₂ permits they currently receive by 2034, and shipping emissions will be added to the CO₂ market from 2024.

From *Reuters*. April 2023.

July 2023 (Vol. 23 No. 7)**RGGI Annual 2022 Market Monitoring Report Available.**

The states participating in the Regional Greenhouse Gas Initiative (RGGI) released the [Annual Report on the Market for RGGI CO₂ Allowances: 2022](#). Prepared by independent market monitor Potomac Economics, the report evaluates activity in the market for RGGI CO₂ allowance auctions in 2022, focusing on allowance prices, trading and acquisition of allowances in the auctions and the secondary market, participation in the market by individual firms, and market monitoring. The report found no evidence of anti-competitive conduct.

From *RGGI*. May 2023.

India Set to Develop Carbon Trading Scheme.

According to the Union Ministries of Power and Environment, Forests, and Climate Change, India is set to develop a carbon trading scheme for decarbonization that is designed to enhance the country's energy transition by pricing GHG emissions. The Indian Carbon Market will create a national framework aimed at decarbonizing the Indian economy through GHG trading. A voluntary mechanism would also be developed concurrently to encourage GHG reduction from non-obligated sectors. The scheme will establish guidelines for verification and institutional and governance structures.

From *The Economic Times*. May 2023.

Vietnam Announces Plans to Launch Exchange for Carbon Emissions Trading.

Vietnam is expected to establish a market for trading CO₂ emissions in 2028 to enhance the exchange of carbon credits between local and international markets. Under the plan, proposed by the Ministry of Natural Resources and Environment, Vietnam is preparing to develop regulations on carbon credit management and the exchange of GHG emissions quotas and carbon credits. The process is due to be completed in 2027.

From *Xinhua*. May 2023.

August 2023 (Vol. 23 No. 8)

RGGI States Announce Results of CO₂ Allowance Auction.

The RGGI states announced the results of their 60th auction of CO₂ allowances, during which 22,026,639 allowances were sold at a clearing price of \$12.73. Auction 60 generated \$280.4 million for states to reinvest in strategic programs, including energy efficiency, renewable energy, direct bill assistance, and greenhouse gas abatement. None of the 11.25 million cost containment reserve (CCR) allowances made available were sold (CCR allowances are made available for sale if an auction's interim clearing price exceeds a certain level [\$14.88 in 2023]). In addition, none of the 10.62 million emissions containment reserve (ECR) allowances were withheld (ECR allowances are withheld if the auction's interim clearing price is below an established price level [\$6.87 in 2023]). Additional details are available in the [Market Monitor Report for Auction 60](#).

From *RGGI Press Release*. June 2023.

Oklahoma to Start Issuing Carbon Storage Permits.

A bill signed by Governor Kevin Stitt is a step toward Oklahoma gaining delegation authority from the U.S. Environmental Protection Agency (EPA) over the permitting process for Class VI wells in the state. The wells are used by industry to inject captured carbon deep underground into rock formations for permanent storage. North Dakota and Wyoming are the only states with primacy for all well classes (I, II, III, IV, V, and VI). According to the news release, the legislation sets in motion a review of the Oklahoma Carbon Capture and Geologic Sequestration Act that was adopted in 2009.

From *Carbon Herald*. June 2023.

Marketplace for Carbon Credits Unveiled.

CarbonKerma launched a [blockchain-based marketplace for carbon credits](#) derived from the use of CCUS technology. The platform is designed to provide companies that capture carbon with an efficient means of selling carbon credits to companies and consumers seeking to offset their carbon footprints. The platform utilizes the immutability characteristics of blockchain technology to ensure the integrity and traceability of the carbon that is sunk, traded, and retired. Each sunk metric ton of CO₂ is represented as a digital token on a one-for-one basis.

From *Yahoo Finance*. June 2023.

Zimbabwe to Regulate Voluntary Carbon Offset Trading.

According to its environment minister, Zimbabwe's government will regulate voluntary carbon offset trading in a bid to curb greenwashing and ensure benefits for local communities. Zimbabwe says organizations operating carbon credit projects in the country were largely unregulated, meaning there is no reliable data on the size of Zimbabwe's carbon market.

From *Reuters* May 2023.

Singapore, Mongolia to Collaborate on Carbon Credits.

The governments of Singapore and Mongolia signed an MOU to identify potential carbon projects that can yield carbon credits supporting the two countries' climate ambitions. The MOU will be implemented by an interagency working group between Singapore's Ministry of Sustainability and the Environment and Mongolia's Ministry of Environment.

From *The Business Times*. June 2023.

September 2023 (Vol. 23 No. 9)

Qatar, Japan Agree to Study Carbon Credits

Qatar's Ministry of Environment and Climate Change and Japan's Mitsubishi Research Institute signed an agreement to conduct a study on carbon credits. The agreement will analyze Qatar's carbon credits plan, which pertains to initiatives and strategies aimed at reducing GHG emissions and promoting sustainable practices to combat climate change. The research project will enable Qatar to study possible climate change options, enhance current provisions on sustainability efforts, and achieve the goals of reducing emissions.

From *Arab News*. July 2023.

Companies Investing in Carbon Credits in Tanzania

Tanzania announced that it has attracted more than 20 companies to invest in carbon credits. The country introduced its first piece of legislation on carbon trading—the Environmental Management (Control and Management of Carbon Trading) Regulations—in October 2022. The legal framework issued in the country on carbon trading aims to provide for the control and management of carbon credits projects in Tanzania.

From *Carbon Herald*. July 2023.

SCIENCE**October 2022 (Vol. 22 No. 10)****Study Reveals Changeable Tendency of SOC in Dryland.**

Researchers from the Northwest Institute of Eco-Environment and Resources of the Chinese Academy of Sciences studied the dynamics of soil organic carbon (SOC) and soil total nitrogen (STN) in drylands. The results, published in *Journal of Environmental Management*, showed that climate factors in the dryland north of China were the main factors affecting SOC and STN. According to the study, dryland should be considered a potential region for carbon storage.

From *phys.org*. August 2022.

Restoring Dried-Out Wetlands Could Increase CO₂ Storage Potential.

Restoring dried-out wetlands could avoid emissions equivalent to more than 100 billion metric tons of CO₂ by the end of the century, according to researchers. The amount of GHGs emitted by wetlands depends on the amount of water in them; when wetland soil is covered in water, it emits methane, when dry, it emits less methane but instead releases CO₂ and nitrous oxide. By studying 3,704 records of water levels and emissions from wetlands throughout the world, the researchers calculated the precise water level at which wetlands produce the fewest net emissions. The results, *published in the journal Nature Geoscience*, found that the amount of carbon stored in wetlands offset nearly all the methane emitted when the water level was a few centimeters beneath the surface.

From *New Scientist*. August 2022.

Scientists Discover Process to Gauge CO₂ Storage in Plants.

Scientists from the University of Western Australia School of Molecular Sciences discovered a previously unknown process that determines how much CO₂ plants release into the atmosphere. *Published in the journal Nature Plants*, the study focused on plant respiration and proposed a new process to slow it down in plants, and thus reduce their release of CO₂. By blocking pyruvate pathways, the scientists hope to prioritize energy sources within plants that limit the release of CO₂, redirecting the carbon into biomass instead of CO₂.

From *phys.org*. August 2022.

New York DEC to Fund CCS Research Project.

The New York (USA) Department of Environmental Quality (DEC) awarded a grant to a Cornell professor to study how small bodies of water contribute to CCS. The study will be conducted in ponds and wetlands in Ithaca and surrounding areas, aiming to quantify how much carbon the small bodies of water can store in their sediment. The goal is to find sustainable ways to implement carbon-friendly ponds, either naturally or artificially.

From *The Cornell Daily Sun*. August 2022.

Ohio State University to Lead Carbon Farming Project.

Ohio State University (USA) is leading a project to study carbon farming as a potential climate change solution. Funded in part by a grant from the Foundation for Food & Agriculture Research, the project will measure how much organic and inorganic carbon gets stored in the soil under different farming practices in key regions across the western hemisphere. The project, titled "Enhanced Soil Carbon Farming as a Climate Solution," will measure carbon storage on croplands, rangelands, and grasslands, including soils used to produce a wide and representative range of crops and animals, as well as soils being managed through both traditional and enhanced carbon-farming methods.

From *Ohio State University News*. August 2022.

November 2022 (Vol. 22 No. 11)**NETL Research Finds Some Rock Formations Could "Self-Heal" Fractures in Presence of CO₂.**

Using unique laboratory equipment, NETL researchers were able to determine that certain rock formations can self-seal fractures in the presence of stored CO₂, meaning igneous rock intrusions in the eastern United States could potentially store CO₂ underground. The results of the research were *published in an NETL report* and an article in *the Geological Society of London*. The primary objective of the study was to characterize core from depth with methods not available to most researchers. The study provides a baseline set of measurements to examine the reactivity of the cores when exposed to CO₂.

From *NETL News*. September 2022.

EU Briefing on Soil Carbon.

The European Environment Agency published a briefing on soil carbon based on information extracted from 2021 national GHG inventories. The briefing also provides an overview of the status of soil carbon pools across Europe.

From *European Environment Agency*. September 2022.

Report Details CO₂ Storage in NWT of Canada.

According to a *previously published report* by Natural Resources Canada, forests in the Northwest Territories (NWT) of Canada stored more CO₂ than the entire territory released in 25 of the 30 years studied. The purpose of the report was to provide baseline information about NWT forests that can be used to measure future changes, such as those caused by climate change. The report also includes details about carbon stored in the natural environment.

From *CBC*. September 2022.

University of Sydney Soil Research Projects to Benefit Carbon Storage.

The University of Sydney received a federal grant from the Australian government to fund soil research projects to build a new knowledge base to support practices and improve productivity, profitability, and climate resilience for Australian farmers. One of the projects will provide an understanding of the role soil viruses play in promoting and maintaining soil health, carbon storage, and nutrient cycling. Another project will explore the interaction of various components in soils to better understand their linkages and benefits to soil carbon storage.

From *The University of Sydney*. September 2022.

Researchers Develop Kelp Aquaculture Model to Maximize Carbon Storage.

Researchers from the University of Maine (USA), in collaboration with Conscience Bay Research, have developed a kelp aquaculture model for the Gulf of Maine that maximizes carbon storage and cost-effectiveness as a carbon sink. Using 18 different variables, the researchers created a model for kelp aquaculture in the region and were able to reduce the cost of carbon storage through kelp aquaculture from \$17,048 per ton of CO₂ equivalent to \$1,257. The study was *published in Frontiers of Marine Science*.

From *The University of Maine*. September 2022.

December 2022 (Vol. 22 No 12)**Vibrating Trucks Used to Search for CO₂ Storage Sites.**

University of Copenhagen researchers are using vibrating trucks to study the CO₂ storage potential of deep soil layers in northwest Zealand. The vibrations send powerful sound waves into the earth, which are reflected from the soil, registered by geophones, and transformed into a detailed image. The collected images are used to form an underground map that helps researchers find suitable locations for CO₂ storage.

From *Mirage News*. October 2022.

Scientists Study Conversion of CO₂ to Solid Minerals for Storage.

Pacific Northwest National Laboratory (PNNL) researchers studied how CO₂ converts from a gas to a solid in ultrathin films of water on underground rock surfaces, publishing their scientific review article in the journal *Nature Reviews Chemistry*. The review discussed how mineralization work can lead to practical CO₂ storage systems.

From *phys.org*. October 2022.

Antarctic Krill Valuable as Carbon Sink.

According to a report by the World Wide Fund for Nature, krill found in waters around the Antarctic Peninsula and Scotia Sea, which sits between Antarctica and South America, are worth an estimated \$15.2 billion each year in carbon storage. The report calculated the value of the krill as a carbon sink based on the estimated “social cost of carbon,” or the price, in U.S. dollars, of releasing an extra metric ton of CO₂ after factoring in the net damages from its impact on global climate change.

From *The West Australian*. October 2022.

January 2023 (Vol. 23 No. 1)**Australia, Google to Research Seagrass Mapping.**

Google and the Australian government's Commonwealth Scientific and Industrial Research Organisation (CSIRO) and Department of Foreign Affairs and Trade are partnering to conduct coastal research for a blue carbon project in the Indo-Pacific that will inform climate-smart decision-making. Delivered through Australia's Science and Technology for Climate Partnership, the initiative aims to learn more about how seagrass ecosystems absorb and store CO₂. As part of the project, imagery of seagrass and marine fauna will be collected using machine learning so that researchers can map and model data and insights. Previously, researchers relied on manual image analysis based on data from remote geospatial and aerial sensing platforms to assess the carbon stored by coastal and marine areas.

From *The Mandarin*. November 2022.

Datasets Used to Estimate Wetland Soil Carbon Stock.

National-scale maps of carbon stored in wetland soil across interior and coastal settings were created from harmonized public datasets. The datasets represent a revised national-scale estimate of wetland soil carbon stock assessments by improving soil organic carbon densities. Scientists created 3-D maps of soil carbon stored across the conterminous United States in inland and tidal wetlands of the U.S. Geological Survey's National Land Cover Database and National Oceanic and Atmospheric Administration's Coastal Change Analysis Program. The resulting maps identify (1) wetland soil carbon storage at high resolution, (2) issues of spatial bias among approaches used for different public datasets, and (3) strategic approaches to improve the assessment of the vulnerability of wetland carbon storage. The approach provides more accurate estimates of carbon storage for national- and regional-scale computer models and can be applied to other wetland soil datasets by region, or updated as new data becomes available.

From *U.S. Geological Survey*. November 2022.

Greenland Investigating Geologic CO₂ Storage.

The government of Greenland is investigating whether the Greenlandic land, specifically the ground in Disko and Nuussuaq, can be used to store CO₂. Together with the Icelandic company Carbic, the Greenlandic Ministry for Raw Materials has begun tests where they use old drill cores from oil exploration on the Nuussuaq peninsula. This process is called carbon capture mineralization storage and examines the extent to which drill cores from Nuussuaq can bind CO₂.

From *High North News*. November 2022.

February 2023 (Vol. 23 No. 2)**Companies Collaborate on Mineralization Process that Stores CO₂.**

Sulzer Chemtech and Blue Planet are working to develop CCUS technology. The two companies are collaborating to commercialize a mineralization process that stores CO₂ emissions released by emissions-heavy industries in aggregate form, which can then be used to offset the CO₂ 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 CO₂. 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.

March 2023 (Vol. 23 No. 3)**Scientists Discover a New Pathway for the Movement of Carbon-Rich Materials from Productive Arctic Coastal Waters to the Deep Ocean**

Every year, the transfer of carbon-rich particles across the shelf in the Barents and Kara Sea could trap as much as 3.6 million metric tons of CO₂ in the deep Arctic Ocean for thousands of years. According to researchers from the Alfred Wegener Institute and other institutions, this previously unknown transport route uses the biological carbon pump and ocean currents to absorb atmospheric CO₂ on a scale equivalent to Iceland's total annual emissions. The researchers recently published *their findings* in the journal *Nature Geoscience*. Ref.: Carbon dioxide sink in the Arctic Ocean from cross-shelf transport of dense Barents Sea water, Rogge, et. al., *Nat. Geosci.* (2022) doi: 10.1038/s41561-022-01069-z

From *SciTechDaily*. January 2023.

NASA Space Missions Pinpoint Sources of CO₂ Emissions on Earth

A recent case study involving Europe's largest coal-fired power plant shows space-based observations can be used to track CO₂ emissions at the source. A duo of Earth-observing missions enabled researchers to detect and track CO₂ emission changes from a single facility using the world's fifth-largest coal-fired power plant as a test case. In the study, researchers used space-based measurements from the National Aeronautics and Space Administration's (NASA) Orbiting Carbon Observatory 2 and 3 missions to quantify the CO₂ discharged hundreds of miles below at Bełchatów Power Station in Poland.

From *NASA JPL*. January 2023.

Scientists Unveil Carbon Capture System

Scientists at DOE's Pacific Northwest National Laboratory (PNNL) cleared a new milestone in their efforts to make carbon capture more affordable and widespread—creating a new system that captures CO₂ and converts it into one of the world's most widely used chemicals: methanol. As [described](#) in the journal *Advanced Energy Materials*, the new system is designed to fit into coal-, gas-, or biomass-fired power plants, as well as cement kilns and steel plants. Using a PNNL-developed capture solvent, the system seizes CO₂ molecules before they are emitted, then converts them into useful, sellable substances. Ref.: Jiang, et. al, Energy-effective and low-cost carbon capture from point-sources enabled by water-lean solvents, *J. of Cleaner Production* (2023), <https://doi.org/10.1016/j.jclepro.2022.135696>.

From *ScienceDaily*. January 2023.

April 2023 (Vol. 23 No. 4)

Scientists Study Role of Salt in CO₂ Storage.

According to a new study led by researchers at The University of Texas at Austin's Bureau of Economic Geology, salt could play a large role in the transition to lower-carbon energy sources. Specifically, the [study](#) (Duffy et al., *Tektonika* [2023]) describes how large underground salt deposits could serve as hydrogen holding tanks, conduct heat to geothermal plants, and influence CO₂ storage.

From *University of Texas at Austin Jackson School of Geosciences*. February 2023.

Study Desired to Investigate Biochar, Plugging Oil and Gas Wells.

Colorado lawmakers want to commission a study to see if biochar, a carbon-rich substance similar to charcoal, can be used to plug hundreds of deserted oil and gas wells across the state, storing carbon in the process. If passed, the bill would help scientists assess whether biochar in wells is a viable form of carbon storage. The measure would direct Colorado State University to review current research and run new tests on the efficacy of biochar's filtration properties, the tonnage of carbon that could be stored, and how the substance would interact with its subterranean environment.

From *CBS News Colorado*. February 2023.

May 2023 (Vol. 23 No. 5)

Underwater Waves May Affect Ocean's Ability to Store CO₂.

According to new research, waves deep below the ocean's surface may affect how the ocean stores heat and CO₂. A team of researchers, led by the University of Cambridge, the University of Oxford, and the University of California – San Diego, quantified the effect of these waves and other forms of underwater turbulence in the Atlantic Ocean, finding that their importance is not being accurately reflected in climate models. The results, published in the journal *AGU Advances* (Laura Cimoli et al., Significance of Diapycnal Mixing Within the Atlantic Meridional Overturning Circulation, *AGU Advances* [2023]), show that turbulence in the interior of oceans is more important for the transport of carbon and heat than previously imagined.

From *Pyhs.Org*. March 2023.

Global Ecosystem at Risk of Losing Carbon Storage Ability: Study.

A recent study found that several regions of the world are at risk of losing their ability to store carbon. Published in the journal *Nature*, the study (Fernández-Martínez, M., Peñuelas, J., Chevallier, F. et al. Diagnosing destabilization risk in global land carbon sinks. *Nature* [2023]) reviewed the productivity of carbon storage of global ecosystems between 1981 and 2018, finding that many fluctuated greatly from year to year; so much so, that some parts of the world are at risk of turning into scrubland that is unable to host forests and other ecosystems that act as carbon sinks.

From *Mongabay*. March 2023.

June 2023 (Vol. 23 No. 6)

Study Maps Carbon in the Arctic.

As reported [in a study](#) in the journal *Geophysical Research Letters*, scientists have mapped a woody deposit of the Mackenzie River Delta in Nunavut, Canada, that stores approximately 3.1 million metric tons of carbon. The 20-square-mile (51-square-kilometer) pileup of fallen trees stack up as the river twists and turns, resulting in long-term carbon storage. According to the study's authors, driftwood hidden by living vegetation or buried underground couldn't be counted using their method, meaning the delta's driftwood potentially stores at least twice as much carbon as their work found. (Sendrowski, A., et al., (2023). Wood-based carbon storage in the Mackenzie River Delta: The world's largest mapped riverine wood deposit. *Geophysical Research Letters*, 50, e2022GL100913.)

From *SciTechDaily*. April 2023.

Catalyst Promotes CO₂ Utilization.

A catalyst capable of converting CO₂ into useful methanol at room temperature and low-pressure conditions has been found. Researchers from the Tokyo Institute of Technology, Japan, developed an active and stable catalyst for CO₂ hydrogenation at room temperature that can be synthesized via a simple process. The results of their study were published in the *Journal of the American Chemical Society*. (Hironobu Sugiyama, et al., Room-Temperature CO₂ Hydrogenation to Methanol over Air-Stable hcp-PdMo Intermetallic Catalyst. *Journal of the American Chemical Society*, 2023; DOI: 10.1021/jacs.2c13801.)

From *ScienceDaily*. April 2023.

July 2023 (Vol. 23 No. 7)

Technology Pulls Seawater from Ocean for Carbon Storage.

Scientists from the University of California at Los Angeles Institute for Carbon Management invented a technology that pulls seawater from the ocean and precipitates out the calcium carbonate in it via an electrochemical process—essentially “zapping” the seawater to remove and store carbon. Researchers project that the technology, called SeaChange, could pull approximately 10 pounds of CO₂ from the atmosphere per metric ton of seawater processed, with the pilot project designed to process more than 50 metric tons a day during the trial. (Storing 1 metric ton of CO₂ requires processing 220 metric tons of seawater. For comparison, from *NETL's Direct Air Capture (DAC) Sorbent Study*, storing 1 metric ton of CO₂ from the air requires processing 2,700 tonnes of air.)

From *The Economic Times*. May 2023.

Tools Help Cities Assess Carbon Storage.

Researchers from Aalto University in Espoo, Finland, have developed a tool to help keep urban development plans in line with climate goals, providing a metric that planners can use to improve carbon-neutral planning of urban growth. The new metric, called the carbon storage factor, indicates how much carbon can be captured in planned urban developments. According to the researchers, urban growth commonly encroaches on forested areas and agricultural land, meaning that cities consume carbon sinks as they grow, making it harder for municipalities and countries to reach net-zero emissions targets. The research was [published in *Environmental Research Letters*](#) (Ilmari Talvitie, et al. 2023 *Environ. Res. Lett.* 18 044029).

From *Science Daily*. May 2023.

August 2023 (Vol. 23 No. 8)

Climate Change Releases Carbon Stocks Deep Underground: Study.

According to a study conducted by the University of Zurich's Department of Geography, in the Sierra Nevada National Forest, global warming could be accelerating the decomposition of soil humus and affecting the compounds that help plants store carbon, which were previously thought to be stable. According to the study, [published in the journal *Nature Geoscience*](#), the warming climate is causing the loss of organic compounds that help plants store carbon in their leaves and roots. Previously, scientists had assumed that complex polymers were able to withstand natural decomposition for longer and thus store carbon in the soil. However, the study found that the compound lignin—which gives plants their stiffness—was reduced by 17%, while waxy compounds called cutin and suberin—which protect plants from pathogens and are found in leaves, stems, and roots—were down 30%.

From *phys.org*. June 2023.

Researcher Receives NSF Award to Study Carbon Storage.

An Indiana University researcher was awarded [\\$736,000 from the National Science Foundation](#) to address gaps in the understanding of CO₂-water-rock interactions that naturally remove CO₂ from the atmosphere. The research team is particularly interested in investigating basalt-CO₂-water interactions, which have shown potential for rapid, long-term carbon storage.

From *Newswise*. June 2023.

September 2023 (Vol. 23 No. 9)

Fiber-Optic DAS Employed to Track CO₂ Injection

A [study published in *Seismological Research Letters*](#) highlights the pioneering use of fiber optic distributed acoustic sensing (DAS) by researchers at a field site in Victoria, Australia, for precise monitoring of induced seismicity resulting from a small-scale CO₂ injection. The CO₂CRC Otway Project in Victoria serves as a research test site for exploring subsurface CO₂ storage.

From *Newswise*. July 2023.

Study Highlights CCUS Potential in the North Sea

A research study led by the University of Aberdeen identified areas of a North Sea gas “super basin” with the greatest potential for storing industrial carbon emissions. Scientists from the University's Center for Energy Transition used subsurface data and techniques usually employed in oil and gas exploration to produce a detailed technical study of the Anglo-Polish Super Basin in the Southern North Sea to determine its suitability for CCUS. Their results confirm the potential of the area as a future CCUS hub where industrial emissions can be stored in former gas fields and other geologic formations.

From *phys.org*. July 2023.

PUBLICATIONS



October 2022 (Vol. 22 No. 10)

Fracture Adjacent Matrix Permeability: Insights from a Direct Experimental Approach.

The following is from the Introduction of this DOE/NETL product: "Characterizing the permeability of a rock matrix immediately adjacent to a fracture is critical for understanding migration of fluids (gases and liquids) as this zone undergoes reaction/mechanical degradation during storage and production. The issue with traditional approaches is that they are designed on the premise of using a cylindrical core sample where pressure or flow is measured across the entire sample, rather than adjacent to or immediately on a fracture plane. Measuring across the entire sample means that heterogeneity, and thus the anisotropic nature of permeability in mudrocks, is integrated into one permeability measurement and fails to capture how fluids migrate in and out of the matrix along the primary flow path, be it in fractures or bedding planes. The measurement of permeability in shale and mudrock has been conducted using a variety of techniques and methods; with resulting typical absolute permeability values ranging from 0.001 to 1 uD. The more successful attempts have occurred in fractured media, which lends itself well to traditional core flood experiments that use Darcy flow approximations when describing the physics of flow. In the non-fractured cases, methods have generally centered around the principle of pressure pulse decay, whereby a pressure differential is induced across a core plug and the rate at which the upstream and downstream pressure equilibrates is used to calculate permeability. The pressure pulse decay methodology is well documented and generally accepted as the best approach to experimentally derive permeability in tight, unfractured systems."

Global Carbon Capture and Storage Market Research Report with Opportunities and Strategies to Boost Growth- COVID-19 Impact and Recovery.

The following is a description of this document: "Carbon capture and storage (CCS) is the process of capturing and storing carbon dioxide (CO₂) before it is released into the atmosphere. The technology can capture up to 90% of the CO₂ released by burning fossil fuels in electricity generation and industrial processes such as cement production. Growing concerns about the detrimental effect of carbon emissions on the environment have driven the adoption of carbon capture and storage (CCS) technology. Several governments are encouraging the implementation of the technology through pilot projects in various industries due to the ability of carbon capture and storage technology to serve as a large-scale solution to achieve CO₂ emission reduction and climate control goals. A2Z Market Research announces the release of the Carbon Capture and Storage Market research report. The market is predicted to grow at a healthy pace in the coming years. Carbon Capture and Storage Market 2022 research report present an analysis of market size, share, growth, trends, cost structure, and statistical and comprehensive data of the global market. The report gives a clear picture of the current market circumstance [...] As analytics have become an inherent part of every business activity and role, form a central role in the decision-making process of companies these days is mentioned in this report. In the next few years, the demand for the market is expected to substantially rise globally, enabling healthy growth of the Carbon Capture and Storage Market is also detailed in the report. This report highlights the manufacturing cost structure includes the cost of the materials, labor cost, depreciation cost, and the cost of manufacturing procedures. Price analysis and analysis of equipment suppliers are also done by the analysts in the report."

Integration of supply chain management of hybrid biomass power plant with carbon capture and storage operation.

The following is from the abstract of this article: "Bioenergy Carbon Capture and Storage (BECCS) is thought to be one of the most important technologies to realize the deep carbon emission reduction. An integrated model that combines biomass inventory management and carbon capture and storage (CCS) construction is built to analyze the operation management of BECCS plants. Biomass supply level and structure, operation costs, warehousing scale, and application restrictions are considered in the inventory management. The operation costs, learning effects, investment path, and capture efficiency of CCS are considered in the process of CCS construction. These two processes are integrated to maximize the total profit for biomass power plants under inter-temporal conditions. Jiangsu Province is selected for numerical simulation. The results show that the supply level of biomass has a great influence on the results, and the corresponding CCS technology needs to fully consider this factor for expansion. In addition, under strict carbon emission constraints, to avoid the high cost of CCS, policymakers are more inclined to achieve emission reduction targets by reducing power generation levels. Therefore, appropriate policy subsidies are needed to ensure the development of BECCS at this time."

Jian-Xin Guo, Xianchun Tan, Baihe Gu, and Kaiwei Zhu, *Renewable Energy*. (Subscription may be required.)

Heat pulse testing at monitoring wells to estimate subsurface fluid velocities in geological CO₂ storage.

The following is from the abstract of this article: "Monitoring the injected CO₂ during geological CO₂ storage (GCS) is essential to assure containment and identify CO₂ leakage. In this work, a new approach is introduced to estimate the evolution of the downhole fluid velocity at a monitoring well and identify CO₂ arrival time using in-well heat pulse/tracer test. The proposed technique involves using a downhole heater to generate a series of heat pulses and measuring their corresponding temperature response. The surface temperature of the downhole heater is controlled by the supplied electrical power and the heat loss by convection to the surroundings. Convective heat transfer is well described using Newton's law of cooling in which the temperature difference between the heater and the surrounding fluids drives the heat transfer, for which the convection heat transfer coefficient (h) controls the magnitude of heat loss. Among various factors that control h , it depends on the type of the flowing fluid and its velocity. Through analyzing the measured temperature at different heat pulses, the changes in h - due to mobilization of the in-situ brine or CO₂ arrival - can be estimated. Consequently, the velocity of the flowing fluid across the heater can be obtained. Since heat transfer by convection is sensitive to the type of the surrounding fluid, intrusion of CO₂ can be detected from the relatively higher surface temperature obtained at CO₂ arrival. Churchill and Bernstein (1977)'s correlation is adopted to estimate the change of fluid velocity in terms of the change in h . To demonstrate the validity of the proposed technique, the results are applied and validated against those of COMSOL Multiphysics simulation tool for single-phase brine (before CO₂ arrival) and single-phase CO₂ (after CO₂ arrival). The observed temperature heating is sensitive to the flowing fluid velocity and fluid type. The temperature signal observed at CO₂ arrival is large and easily detectable using temperature monitoring tool which provides reliable indication for tracking CO₂ arrival at monitoring wells compared with passive temperature monitoring. The results obtained using the proposed technique agree very well with the numerical results obtained from the simulation tool with a maximum estimation error of 7 percent."

Refaat G. Hashish and Mehdi Zeidouni, *Journal of Petroleum Science and Engineering*. (Subscription may be required.)

Effect of the carbon emissions trading policy on the co-benefits of carbon emissions reduction and air pollution control.

The following is from the abstract of this article: "Achieving the co-benefits of carbon emissions reduction and air pollution control is significant for pursuing a sustainable and low-carbon economy in China. This study applies the difference-in-differences method to explore the local and spillover impact of the carbon emissions trading policy (2011) on China's carbon emissions and air quality, based on city-level data. The results show that the carbon emissions trading policy significantly affects the co-benefits of the total carbon emissions reduction and air quality improvement. In addition to this direct effect, the carbon emissions trading policy could indirectly affect carbon emissions and air quality by changing the innovation ability of cities and location choice of local industries. Though the policy does not significantly affect the overall carbon emissions intensity in China, it is seen to be effective for Central China. [The authors'] further spatial analysis indicates that the policy increases the carbon emissions in neighboring cities, which supports the 'pollution haven hypothesis.' Thus, this study contributes to the existing climate policy literature and provides a more comprehensive picture of the policy effect by integrating the co-benefits of the carbon emissions reduction and air pollution control, estimating both local and spillover effects and exploring the underlying mechanisms."

Zhaoyingzi Dong, Chuyu Xia, Kai Fang, and Weiwen Zhang,
Energy Policy. (Subscription may be required.)

November 2022 (Vol. 22 No. 11)

CO₂ Intermediate Storage (CIS) Concept Overview.

The following is from the Introduction of this DOE/NETL report: "...Several studies and feedback from industry stakeholders have proposed CO₂ intermediate storage (CIS) as one strategy that could buffer variations in anthropogenic CO₂ supply and demand...The objective of this overview is to provide a comprehensive set of qualitative considerations to inform future quantitative technical and economic CIS analyses. This overview focuses on CO₂ EOR as the end-user for CCUS supply chains that might implement CIS. CO₂ EOR is currently the most common end-use for anthropogenic CO₂. Worldwide, CO₂ EOR currently utilizes approximately 78 percent of all anthropogenic CO₂ captured; in the United States (U.S.), 95 percent of all anthropogenic CO₂ captured is utilized by CO₂ EOR end-users. Beside the environmental benefit, CO₂ EOR promotes U.S. energy independence through oil production and offsets CCUS CAPEX and OPEX with earnings from oil sales. This overview will add a comprehensive discussion of CIS-related topics to existing literature to provide a reference for future assessments, models, and analyses of subsurface CIS within CCUS supply chains."

Carbon Capture, Usage and Storage: A Government Response on potential business models for Carbon Capture, Usage and Storage.

The following is from the Executive Summary of this U.K. Department for Business, Energy & Industrial Strategy document: "Carbon Capture, Usage and Storage (CCUS) can play an essential role in reaching net zero. It can be an engine to drive cleaner, sustainable growth, transforming [the UK's] industrial heartlands. It can also unlock new jobs and innovative businesses, raising productivity and competitiveness across the UK. [The UK is] committed to deploying CCUS this decade. [The UK is] determined to realise the key strategic opportunities of CCUS in a way that is affordable and value of money for the consumer and taxpayer. Alongside the CCS Infrastructure Fund, announced at Budget, [the UK] will continue to develop and implement new CCUS business models. The consultation, 'Business Models for Carbon Capture, Usage and Storage', published in 2019, was a necessary first step in this process. It sought views on possible new business models for CCUS and outlined government's work in developing potential business models for low carbon hydrogen production."

What are the potential paths for carbon capture and storage in Sweden? A multi-level assessment of historical and current developments.

The following is from the abstract of this article: "Carbon capture and storage (CCS), including bioenergy with carbon capture and storage (BECCS), could contribute to climate change mitigation strategies. However, the 2020s is not the first time that CCS is high on the agenda. This study explores the differences between the past and current developments of CCS and discusses how incumbent actors' experiences can inform the understanding of potential future energy system transitions in Sweden. For this purpose, a multi-level perspective (MLP) analysis was conducted based on documents, interviews and focus groups with key actors. Since the 2000s, increased urgency of climate change has further pushed policy makers into action. In addition, there is a new framing of CCS that underscores the potential of BECCS to provide negative carbon dioxide (CO₂) emissions, as well as prospects for offshore storage of CO₂ in Norway and other territories. As such, this study shows that Sweden could be on a transformation pathway towards implementing CCS alongside other mitigation measures."

Adrian Lefvert, Emily Rodriguez, Mathias Fridahl, Stefan Grönkvist, Simon Haikola, and Anders Hansson,
Energy Research & Social Science.
(Subscription may be required.)

New line-source solution and scaling relations for diffusive leakage of brine from an infinite aquifer-caprock composite domain during geological storage of CO₂.

The following is from the abstract of this article: "Diffusive leakage of heat or chemical species from the storage layers is ubiquitous in engineering systems. Understanding the measure of diffusive fields around the target layer may be used to better design a prospective engineering system and characterize anomalies in the observed pressure, chemicals, and temperature. [The authors] report a novel analytical solution to a widely occurring yet unsolved diffusion type problem where a storage layer with a line-source at the inner boundary is embedded in an infinite medium. The analytical difficulty posed by two-dimensional flow and mutual interaction between surrounding formations and storage layer is handled by successively applying Hankel and Laplace transforms. The obtained solution was verified analytically and compared with the classical Theis solution. Afterwards, [the authors] focus [their] discussion around CO₂ storage problem and analyze the pressure perturbation behavior, temporally and spatially, to identify the degree of dependency of model parameters. [The authors] identify that the diffusive leakage rate scales with the square root of nondimensional time. The distance to the maximum local radial leakage (R_{max}) is found to be nonvariant to the model parameters and scales with the square root of the nondimensional time. It was found that more than 99% of the total leakage takes place within $5R_{max}$ radius from the injection point..."

Ayon Kumar Das, Morteza Dejam, and Hassan Hassanzadeh,
International Journal of Greenhouse Gas Control. (Subscription may be required.)

Effects of CO₂ adsorption on molecular structure characteristics of coal: Implications for CO₂ geological sequestration.

The following is from the abstract of this article: “With a series of global problems such as greenhouse effect caused by the gradual increase of atmospheric CO₂ concentration, CO₂ geological storage has become one of the effective measures. To study the influence of the interaction between CO₂ and coal on the molecular structure characteristics of coal, three coals of different ranks were selected for CO₂ adsorption and were subjected to X-ray diffraction, Raman spectroscopy and Fourier transform infrared spectroscopy experiments. The results indicate that with increasing of CO₂ pressure: 1) Due to the solubility differences of different minerals, the contents of quartz in the coal samples gradually increases, while the contents of calcite, pyrite and kaolinite decreases; 2) The average number of the aromatic layers gradually decreased indicates that some aromatic layers are destroyed and order degree is lowered in the coal microcrystalline structure, resulting in a gradual increase of the inter-layer spacing between aromatic layers, the stacking of aromatic layers; 3) The concentration of aromatic rings gradually decreases leading to the intermolecular structural defects are obvious and the gradual evolution of the microcrystalline structure into the more disordered crystal structure; 4) The hydroxyl groups are predominated by oxidation reactions in long-flame coal and lean coal, while they are mainly governed by swelling in anthracite; 5) The ratio between aliphatic and total hydrogen atoms (H_a/H), aliphatic structure (I_a) and ‘A’ factor values of the anthracite reveal a slight increase, while the aromaticity 2 (AR2) and degree of condensation 2 (DOC2) values display a decreasing trend. These values of long-flame coal and lean coal only slightly change. The influence of CO₂ intrusion on coal properties due to the changes of molecular structure and CO₂ trapping mechanisms are discussed. [The authors’] research contributes to understand deeply the geological sequestration of CO₂ in coal seams and higher CO₂ injection pressures should be adopted.”

Xiaolei Wang, Huihui Liu, Dongming Zhang, Xiuzhu Yuan, Ping Zeng, and Hao Zhang, *Fuel*. (Subscription may be required.)

Pore fluid substitution effects on elastic wave propagation in Berea sandstone: Implication to seismic monitoring of CO₂ geologic storage.

The following is from the abstract of this article: “This study presents an experimental demonstration of seismic monitoring of CO₂ geologic storage based on the observation of pore fluid substitution effects on elastic wave propagation along a core sample of Berea sandstone. Two-phase core flooding of distilled water (H₂O) and supercritical carbon dioxide (scCO₂) was characterized with ultrasonic measurements along a sample in subsurface conditions (750–800 m depth). [The authors’] experimental results show that the compressional (P) wave propagation was clearly sensitive to the pore fluid substitutions between CO₂ and H₂O; however, the shear (S) wave was not. The dynamic bulk modulus of water-saturated samples was considerably higher than that of dry or CO₂-saturated samples with ~22% porosity, whereas little variation was seen in the dynamic shear modulus, regardless of pore fluids. Changes in P-wave velocity, amplitude, and phase were observed during the gradual substitutions of pore fluids; however, no clear changes were seen in the S-wave. Hysteresis in the P-wave characteristics occurred between drainage and imbibition, which was likely due to the different wettability of the two fluids. The characteristics also depend on the distribution (parallel or serial) of the two fluids in the sample as well as the volumetric fractions of the fluids. Thus, no unique relationship exists between the seismic characteristics and the CO₂ saturation degree, rather it also depends on the capillary pressure and the compressibility ratio of the two fluids. [The authors’] results suggest that time-lapse seismic records are satisfactory for detecting subsurface CO₂ plume appearance and migration, however, supplementary data are required for quantitative prediction of CO₂ volumetric distribution in the plume.”

Aryoung Yun and Insun Song, *International Journal of Greenhouse Gas Control*. (Subscription may be required.)

Low carbon optimal operation of integrated energy system based on carbon capture technology, LCA carbon emissions and ladder-type carbon trading.

The following is from the abstract of this article: “Facing the problem of the exhaustion of fossil energy and the low-carbon requirements of the power industry, low-carbon technology cooperates with market mechanisms to achieve low-carbon operation of the integrated energy system (IES). This paper establishes an IES considering carbon capture technology (CCT). Life cycle assessment (LCA) analysis the greenhouse gas emissions of different energy chains in IES. The normalized carbon emission coefficient is calculated. The carbon emission coefficient and the reward and punishment ladder-type carbon trading mechanism are used to calculate the carbon trading cost. And the economic benefits of carbon capture power plants are evaluated. Based on the constraints of the system’s operating mechanism, with the optimal economic cost as the objective function, a low-carbon economic operating model is established in an integrated energy system that considers carbon capture technology. The model is analyzed through an example. In the example results, the total cost of the model is slightly increased by 3.2%. And the carbon emissions are greatly reduced by 72.66%. It proves that the reasonable planning of the carbon trading market and the transformation of high-carbon power plants can effectively promote the low-carbon development of IES.”

Rutian Wang, Xiangyun Wen, Xiuyun Wang, Yanbo Fu, and Yu Zhang, *Applied Energy*. (Subscription may be required.)

Study on the basic physical conditions of CO₂ geologic sequestration reservoir in the Majiagou Formation in the Ordos Basin.

The following is from the abstract of this article: “Carbon dioxide capture and storage is one of the important ways to achieve large-scale CO₂ emission reduction and enhance the oil recovery. The site selection and potential assessment of CO₂ geological storage requires a systematic study of the basic physical conditions of the geological storage layer in the storage area, and the site selection and storage potential evaluation of CO₂ geological storage first require a systematic study of the basic physical conditions in the areas for CO₂ storage. Because of the insufficient research on the basic physical conditions of the Majiagou Formation in the Ordos Basin, this study mainly studies the top burial depth, ground temperature, formation pressure, and the density of CO₂ of the Majiagou Formation in the Ordos Basin. The research shows: (1) The top burial depth of the Majiagou Formation is a simple slope with high in the east and low in the west in the Ordos Basin. The temperature on the top of the Majiagou Formation gradually increases from 66–73°C in the east to 132–140°C. The pressure on the top of the Majiagou Formation gradually increased from 20–30 Mpa in the east to 30–40 Mpa in the west, which indicates that the modern underground pressure field of the Majiagou Formation belongs to the normal pressure system, and the temperature field belongs to the medium-low temperature system, which provides favorable geotemperature and pressure conditions for CO₂ injection and storage. (2) The CO₂ density on the top of the Majiagou Formation gradually rose from 740–790 kg/m³ in the east to 950–1000 kg/m³ in the west, which provides data support for CO₂ storage potential evaluation and provides methodology for the study of basic physical conditions of other CO₂ geological storage layers.”

Ping Lu, Zun-sheng Jiao, Zhi-Zhan Wang, Yu-Ze Nan, Yong Bai, and Yan Ma, *Energy Reports*. (Subscription may be required.)

December 2022 (Vol. 22 No 12)**CO₂ Pipeline risk assessment and comparison for the midcontinent United States.**

The following is from the abstract of this article: “A comprehensive quantitative risk assessment for the construction and operation of CO₂ transportation networks considered for the Midcontinent United States was conducted. The results showed risks associated with CO₂ pipelines were significantly less than those of other pipeline types. The assessment used four conceptual pipelines of different lengths to discuss risks operators may see. The assessment evaluated the risk associated with construction and operation using data from the US Occupational Safety Health Administration to determine the risk of injury or death for pipeline workers and data from the US Pipeline and Hazardous Materials Safety Administration for CO₂, natural gas distribution, natural gas transmission/gathering, and non-CO₂ hazardous liquid pipelines to develop quantitative likelihood and severity values leading to risk values. The data for the assessment covered incidents from 2010 to 2017 for CO₂ pipelines. The average risk for construction and 30 years of operation for four CO₂ pipeline configurations ranging between 79 and 1,546 miles in length was found. The construction and operational risk averaged between \$1,400,521 (approximately \$0.02/tonne of CO₂) for the shorter pipeline (79 miles) and \$27,481,939 (approximately \$0.10/tonne of CO₂) for a longer pipeline (1,546 miles). The largest risks of fatality for CO₂ pipelines comes from vehicle transport. The largest operational risk to the pipeline was due to leakage. Public pipeline opposition is also a significant risk; it was not quantified but is addressed.”

Andrew Duguid, Jared Hawkins, and Laura Keister, *International Journal of Greenhouse Gas Control*. (Subscription may be required.)

Sequestering CO₂ as CO₂ hydrate in an offshore saline aquifer by reservoir pressure management.

The following is from the abstract of this article: “CO₂ has been successfully sequestered in aquifers at shallow water depth as supercritical CO₂. However, at a water depth larger than 630 m in tropical regions, there exists a hydrate stability zone (HSZ) extending below the seafloor where CO₂ and water can exist as solid CO₂ hydrate. It is generally believed that CO₂ cannot be stored inside the HSZ as formation of CO₂ hydrate will impair CO₂ injectivity. In this study, [the authors] investigate the feasibility of storing CO₂ inside this HSZ by reservoir pressure management vis-à-vis the CO₂ hydrate formation pressure through the use of water producers and CO₂ injectors. [The authors] carry out simulations to investigate CO₂ storage in three aquifers in tropical waters each with an area of 94 km² (9.7 km × 9.7 km), thickness of 50 m, porosity of 30% and permeability of 3,000 md. Three confined aquifers are compared. Aquifer 1 is a shallow water aquifer without a HSZ. It has a water depth of 300 m and buried depth of 830 mbsf. Aquifer 2, straddling (60% inside and 40% outside) the HSZ, has a water depth of 800 m and buried depth of 70 mbsf. Aquifer 3, residing inside the HSZ, has a water depth of 800 m and buried depth of 30 mbsf. The reservoir pressure is managed by four corner wells which function either as CO₂ injectors or water producers. [The authors] simulate CO₂ injection into these aquifers with the help of water production to manage the reservoir pressure to stay below either the reservoir fracture pressure or the hydrate formation pressure.”

Kai Zhang and Hon Chung Lau, *Energy*. (Subscription may be required.)

Data-driven offshore CO₂ saline storage assessment methodology.

The following is from the abstract of this article: “The world produces approximately 50 billion tonnes of greenhouse gases annually. This is measured in CO₂-equivalents, and geologic CO₂ storage has the potential to advance decarbonization and mitigate greenhouse gas emissions. New technologies to assess offshore carbon storage are needed to address resource, regulatory, and commercial needs. Although most efforts to assess storage resources focus on onshore criteria, offshore reservoirs offer significant storage potential and distinct development challenges. Potential advantages of offshore carbon storage include being further from human population centers and less potential to interact with groundwater. The U.S. Department of Energy's method for evaluating storage capacity in non-oil-bearing saline reservoirs has been enhanced to support assessments for offshore environments in the Offshore CO₂ Saline Storage methodology (OCSS). This methodology applies data-driven capabilities to estimate saline storage capacity while accounting for features specific to offshore reservoirs. Features include changes in CO₂ density and sedimentary differences that impact estimates of permanence and capacity. The Offshore CO₂ Saline Storage Calculator mechanizes OCSS to estimate storage capacity. This paper presents the methodology and estimates for 18 geologic domains in the Gulf of Mexico. Potential storage distributions, sensitivity analyses, and the incorporation of spatial data and tools to support safe site selection are also discussed.”

Lucy Romeo, Randal Thomas, MacKenzie Mark-Moser, Andrew Bean, Jennifer Bauer and Kelly Rose, *International Journal of Greenhouse Gas Control*. (Subscription may be required.)

Numerical Trend Analysis for Factors Affecting EOR Performance and CO₂ Storage in Tight Oil Reservoirs.

The following is from the abstract of this article: “Improved oil recovery from tight oil reservoirs to fulfill the fossil fuel requirements and the CO₂ storage to meet the net carbon zero objectives are the two motivations of this work. CO₂ is a major anthropogenic greenhouse gas and its emission to [...] plants' atmosphere is hazardous, particularly causing global warming. Therefore, its injection in the sub-surface oil-bearing formations not only improves the oil recovery but also reduces the carbon footprint from the planet. In this study, a mechanistic numerical simulation model is built using typical U.S. tight oil reservoir rock and fluid properties. The reservoir model is equipped with a hydraulically fractured single horizontal well that is subjected to multiple sensitivities using the huff-n-puff technique. Detailed CO₂ trapping and diffusivity mechanisms at the nanopore scale are discussed that numerically define the CO₂ solubility in formation oil and its trapping phenomenon into the nanopore spaces. The results show that CO₂ injection works predominantly to achieve significant incremental oil recovery. Also, the reservoir with lighter in-situ fluid composition and higher reservoir pressure further enhances the oil recovery due to improved diffusivity and the solubility of CO₂ into the reservoir fluid. It is also found that the increased number of huff-n-puff cycles and the incremental CO₂ injection volume in each cycle not only enhance the oil recovery performance but likewise help to trap a larger volume of CO₂ into a reservoir. A few diagnostic contour plots are also presented in this study to demonstrate the simultaneous effect of multiple hydraulic fracture parameters and the CO₂ injection volume for the directional EOR and CO₂ trapping performance. The findings of this study can help for a better understanding of designing EOR operations in tight oil reservoirs to achieve both goals concurrently.”

Fahad Iqbal Syed, Temoor Muther, Vuong Pham Van, Amirmasoud Kalantari Dahaghi, and Shahin Negahban, *Fuel*. (Subscription may be required.)

Heat pulse testing at monitoring wells to estimate subsurface fluid velocities in geological CO₂ storage.

The following is from the abstract of this article: “Monitoring the injected CO₂ during geological CO₂ storage (GCS) is essential to assure containment and identify CO₂ leakage. In this work, a new approach is introduced to estimate the evolution of the downhole fluid velocity at a monitoring well and identify CO₂ arrival time using in-well heat pulse/tracer test. The proposed technique involves using a downhole heater to generate a series of heat pulses and measuring their corresponding temperature response. The surface temperature of the downhole heater is controlled by the supplied electrical power and the heat loss by convection to the surroundings. Convective heat transfer is well described using Newton’s law of cooling in which the temperature difference between the heater and the surrounding fluids drives the heat transfer, for which the convection heat transfer coefficient (h) controls the magnitude of heat loss. Among various factors that control h , it depends on the type of the flowing fluid and its velocity. Through analyzing the measured temperature at different heat pulses, the changes in h - due to mobilization of the in-situ brine or CO₂ arrival - can be estimated. Consequently, the velocity of the flowing fluid across the heater can be obtained. Since heat transfer by convection is sensitive to the type of the surrounding fluid, intrusion of CO₂ can be detected from the relatively higher surface temperature obtained at CO₂ arrival. Churchill and Bernstein (1977)’s correlation is adopted to estimate the change of fluid velocity in terms of the change in h . To demonstrate the validity of the proposed technique, the results are applied and validated against those of COMSOL Multiphysics simulation tool for single-phase brine (before CO₂ arrival) and single-phase CO₂ (after CO₂ arrival). The observed temperature heating is sensitive to the flowing fluid velocity and fluid type. The temperature signal observed at CO₂ arrival is large and easily detectable using temperature monitoring tool which provides reliable indication for tracking CO₂ arrival at monitoring wells compared with passive temperature monitoring. The results obtained using the proposed technique agree very well with the numerical results obtained from the simulation tool with a maximum estimation error of 7 percent.”

Refaat G. Hashish and Mehdi Zeidouni, *Journal of Petroleum Science and Engineering*. (Subscription may be required.)

DAS signature of reservoir pressure changes caused by a CO₂ injection: Experience from the CO₂CRC Otway Project.

The following is from the abstract of this article: “Distributed Acoustic Sensing (DAS) is a fast-developing technology and is being actively used in geophysical monitoring applications. DAS technology is based on continuous measurements along a fibre-optic cable and can record seismic waves/signals that induce axial strain in the cable. Most DAS systems are designed to measure signals higher than 1 Hz; however some DAS systems are sensitive to low-frequency (< 1 Hz) signals such as reservoir pressure variations. At the time of CO₂ injection within the CO₂CRC Otway Project, pressure related strain-rate DAS signals were observed in two monitoring wells. These signals are highly correlated with the pressure signals measured by borehole pressure gauges above the perforations in monitoring wells. Comparison of DAS measurements and pressure measurements shows a linear relationship between the two datasets. Analysis of data shows that DAS is able to detect reservoir pressure variations higher than 10–4 psi/s. Analysis of pressure variations and strain calculated from DAS strain rate values allows estimation of the elastic modulus of the reservoir formation. Obtained results show that DAS systems can be utilised not only as seismic sensors, but also as continuous pressure sensors that can help track possible CO₂ leakages into the overburden. In contrast to traditional pressure gauges, DAS is also capable of tracking the pressure profile along the entire well. DAS pressure sensing capabilities open up many new applications to complement subsurface reservoir pressure monitoring, CCUS and hydrogeological studies.”

Evgenii Sidenko, Konstantin Tertyshnikov, Boris Gurevich, and Roman Pevzner, *International Journal of Greenhouse Gas Control*. (Subscription may be required.)

Fundamental study and utilization on supercritical CO₂ fracturing developing unconventional resources: Current status, challenge and future perspectives.

The following is from the abstract of this article: “Under the fact that considerable exploration and production of unconventional resources and worsening global climate, reducing carbon emission and rationally utilizing carbon resources have been drawn increasing attention. Supercritical CO₂ (SC-CO₂) has been proposed as anhydrous fracturing fluid to develop unconventional reservoirs, since its advantages of reducing water consumption, reservoir contamination etc. Well understanding of SC-CO₂ fracturing mechanism and key influencing factors will exert significant impact on the application of this technology in the field. In this paper, the fundamental studies on SC-CO₂ fracturing from the aspects of laboratory experiment and simulation are reviewed. The fracturing experimental setups, fracture monitoring and characterizing methods, unconventional formation categories, numerical simulation approaches, fracturing mechanism and field application etc., are analyzed. The fundamental study results indicate that compared with conventional hydraulic fracturing, SC-CO₂ fracturing can reduce fracture initiation pressure and easily induce complex fracture networks with multiple branches. The field test further verifies the application prospect and the possibility of carbon storage. However, due to the limitation of reservoir complexity and attributes of SC-CO₂, massive challenges will be encountered in SC-CO₂ fracturing. According to the current research status, the limitations in basic research and field application are summarized, and the future development direction of this technology and relevant suggestions are proposed.”

Bing Yang, Hai-Zhu Wang, Gen-Sheng Li, Bin Wang, Liang Chang, Gang-Hua Tian, Cheng-Ming Zhao. And Yong Zheng, *Petroleum Science*. (Subscription may be required.)

Tracer analysis in flow channel characterization and modelling of gas and CO₂ injection EOR in unconventional reservoirs.

The following is from the abstract of this article: “A large amount of unproduced oil remains in unconventional shale reservoirs. In this paper [the authors] present the use of water and oil tracers as a key factor in flow channel characterization and in constructing a viable numerical model to forecast oil and gas recovery by depletion drive and enhancing oil recovery (EOR) by hydrocarbon gas or CO₂ injection in Niobrara and Codell formations in the Denver-Julesburg (DJ) Basin. First, a dual-porosity compositional model was built based on seismic interpretation results, well logs, and core analysis. Two hydraulic fracture scenarios, (1) uniform dimensions and (2) variable dimensions, were included in the static rock frame of the numerical model. Production performance matching demonstrated that the use of variable length and height for hydraulic fractures led to a more realistic representation of the reservoir performance. On another front, injection of water and oil tracers and flowback analysis provided the means to better quantify the fracture network distribution, flow communication between wells, and hydraulic fracture performance in each well. Finally, two ‘huff-and-puff’ (injection, shut-in, production) cycles of lean gas and CO₂ injection into the reservoir were modeled to assess EOR potential of cyclic gas injection. With identical gas injection rates, lean gas produced more oil than CO₂; however, CO₂-EOR modeling results indicated that a substantial amount of CO₂ was stored in the reservoir. The net carbon stored after CO₂-EOR was approximately 13% of the injected CO₂ and CO₂ utilization was 39,000 scf per incremental oil barrel produced which is much larger than the average CO₂ utilization of about 12,000 scf per incremental oil barrel produced in conventional reservoirs. However, the produced CO₂ from unconventional reservoir EOR operation can be recycled to achieve complete storage of CO₂ — rendering CO₂-EOR an effective means of decarbonization. Finally, transmissibility analysis of an existing major fault zone in the study area indicated that CO₂ did not leak via a major fault in the study area nor via the associated nearby natural fractures in the study area.”

Yanrui Ning, Hossein Kazemi, Ali Tura, and T.L. Davis, *Journal of Petroleum Science and Engineering*. (Subscription may be required.)

January 2023 (Vol. 23 No. 1)

Evaluating the Impacts of the Bipartisan Budget Act of 2018 45Q Tax Credit on CCS Network Costs.

The following is from the Executive Summary of this DOE/NETL document: "This study evaluates the impact of the Bipartisan Budget Act of 2018 (BBA)-amended 45Q tax credit on integrated carbon capture and storage (CCS) networks for source types and geologic storage reservoirs common to the north-central U.S. The integrated CCS networks evaluated were chosen to closely replicate those in the forthcoming National Energy Technology Laboratory (NETL) central U.S. CCS cost options study's Northwest CCS Network Regional Impact Area (Northwest Impact Area). The Northwest Impact Area covers portions of Montana, North Dakota, South Dakota, Nebraska, and Wyoming, and includes the Williston Basin, Wind River Basin, Powder River Basin, and Denver Basin. Each network includes a single CO₂ source, a dedicated pipeline transport component, and a single saline storage reservoir. CCS-related costs are estimated from the perspective of a source that is capturing CO₂ and paying fees for its transport and storage. The three CO₂ sources assessed include a cement plant in South Dakota that produces 0.99 million metric tons per annum (Mtpa) of Portland cement, and captures 0.97 Mtpa of CO₂, and two 650 megawatt (MW) supercritical pulverized coal (SCPC) plants that capture 4.33 Mtpa of CO₂ each; one is located in North Dakota and the other in Wyoming..."

NETL 45Q Addendum to the CO₂U LCA Guidance Toolkit.

The following is from the Introduction of this DOE/NETL document: "26 CFR § 1.45Q-4 (hereby referred to as 45Q) requires a life cycle analysis (LCA) to be performed to document the amount of qualified carbon oxide for the utilization tax credit. Under the Internal Revenue Service's (IRS) regulations, LCAs must be prepared and documented in conformance with certain ISO standards. The Treasury Department and the IRS noted in its final rule that the Department of Energy (DOE) National Energy Technology Laboratory (NETL) CO₂ Utilization Guidance Toolkit is consistent with the ISO standards and directed taxpayers in the final rule to use such guidance when submitting LCAs under 45Q. This toolkit, which includes the Carbon Dioxide Utilization Life Cycle Analysis Guidance for the U.S. DOE Office of Fossil Energy and Carbon Management (hereby referred to as the NETL CO₂U LCA Guidance Document), was originally written to guide projects in performing LCAs as part of their laboratory-funded project... The purpose of this addendum [is] to guide applicants on how to use the NETL CO₂U LCA Guidance Document when preparing LCAs under 45Q. This document outlines requirements for conforming with the NETL CO₂U LCA Guidance Document only. Requirements for qualifying for a tax credit under 45Q are contained in IRS's regulations at 26 CFR Part 1. All sections contained in this addendum are meant to serve as either direct replacement for the corresponding section in the toolkit or provide recommendations on how to use the section for the purposes of 45Q..."

Policy incentives for Greenhouse Gas Removal Techniques: the risks of premature inclusion in carbon markets and the need for a multi-pronged policy framework.

The following is from the abstract of this article: "Almost all modelled emissions scenarios consistent with the Paris Agreement's target of limiting global temperature increase to well below two degrees include the use of greenhouse gas removal (GGR) techniques. Despite the prevalence of GGR in Paris-consistent scenarios, and indeed the UK's own net-zero target, there is a paucity of regulatory support for emerging GGR techniques. However, the role of carbon pricing is one area that has experienced more attention than others, including discussion about the future inclusion of GGR in carbon markets. Here [the authors] identify three risks associated with using carbon markets as the sole, or main, policy lever to encourage the deployment of GGR techniques. [The authors'] categorization of risks stems from discussions with policymakers in the UK and a review of the broader literature on carbon markets and GGR. [The authors] present a three-pronged risk assessment framework to highlight the dangers in doing so. First, treating emissions

removals and emissions reductions as entirely fungible allows for undesirable substitution. Second, carbon markets may provide insufficient demand pull to drive currently more-costly GGR techniques to deployment at commercial scales. Third, opening up a carbon market for potentially lower-cost GGR (such as nature-based solutions) too early could exert downward pressure on the overall market-based price of carbon, in the absence of adjustments to emissions caps or other safeguards..."

Joshua Burke and Ajay Gambhir, *Energy and Climate Change*.
(Subscription may be required.)

Hydromechanical impact of basement rock on injection-induced seismicity in Illinois Basin.

The following is from the abstract of this article: "The common explanation of observed injection-induced microseismicity is based on the measured stress state at the injection interval and the assumption that it remains the same in the vicinity. [The authors] argue here that representing the stress state in different geologic formations over the injection site with the single Mohr's circle is insufficient due to local stratigraphic features and contrast in compressibilities of the involved formations. The role of hydromechanical coupling in the microseismic response is also crucial for the proper assessment of the problem. Thoroughly monitored Illinois Basin Decatur Project revealed the majority of CO₂ injection-associated microseismic events being originated in the crystalline basement. Even though basement faults can serve as the conduits for fluid flow—the predicted pressure increase seems to be insufficient to trigger seismicity. To address this issue, accurate laboratory measurements of rock properties from the involved formations are conducted. The pre-injection stress state and its evolution are evaluated with the hydromechanically coupled numerical model. It appears that the presence of an offset in a stiff competent layer affects the stress state in its vicinity. Therefore, both the pre-injection stress state and its evolution during the fluid injection should be addressed during the induced seismicity assessment."

Nikita Bondarenko, Yuri Podladchikov, and Roman Makhnenko, *Nature*.
(Subscription may be required.)

CO₂ zonal injection rate allocation and plume extent evaluation through wellbore temperature analysis.

The following is from the abstract of this article: "Temperature analysis during a pause in injection operations, known as warmback analysis, has been used in the petroleum industry for evaluating the injection conformance and estimating the location of the flooded front in applications, such as waterflooding oil reservoirs. In this work, methods are introduced to extend the application of temperature warmback analysis to estimate the zonal CO₂ injection rate and zonal CO₂ plume extent during geologic CO₂ storage in a saline aquifer. First, novel analytical solutions are developed to model transient temperature in the aquifer during the injection and subsequent shut-in periods considering two-phase flow (gaseous CO₂ and aqueous brine) conditions in the aquifer. The solution involves a discretization of the aquifer into regions; the energy and mass conservation equations for the regions are solved simultaneously considering appropriate boundary conditions at the interfaces. Two solutions techniques are presented: multi-region and three-region solutions. Inverse models are developed accordingly to evaluate the injection profile and estimate the extent of the plume front in the reservoir during the injection period. The multi-region solution results in an inversion approach that requires regression analysis. However, the three-region formulation results in a simple graphical technique for inverse modeling. The analytical solutions are validated against a thermally coupled reservoir simulation tool using different synthetic cases for CO₂ injection in deep saline aquifers. The results of the developed solutions provide a good match with numerical results during forward and inverse modeling."

Rafaat G. Hashish and Mehdi Zeidouni, *Advances in Water Resources*.
(Subscription may be required.)

Integration of energy storage systems based on transcritical CO₂: Concept of CO₂ based electrothermal energy and geological storage.

The following is from the abstract of this article: “Energy storage systems are crucial for the massive deployment of renewable energy at a large scale. This paper presents a conceptual large-scale thermoelectrical energy storage system based on a transcritical CO₂ cycle. The concept is developed through the analysis of three high-efficiency systems: renewable energy storage using a thermoelectric energy storage system based on a reversible heat pump; a CO₂ storage system; and novel integration of energy storage using a reversible heat pump and geological injection of CO₂. The latter system efficiently integrates energy and CO₂ storage, taking advantage of the synergies between the operational requirements of both systems. The system uses CO₂ captured in stationary sources as a working fluid to store energy from renewables. The energy is stored and recovered in geological formation and heat/cold tanks, with energy storage based on sensible or latent heat of ice and water. A fraction of the CO₂ is expected to be permanently sequestered in the geological formation. The analysis of the time evolution of the system, under different operation profiles, shows the interest of the concept as a feasible integration for energy storage and CO₂ capture based on renewable energy, with an electric-to-electric efficiency varying between 40 and 50 %.”

A. Carro, R. Chacartegui, C. Ortiz, J. Carneiro, and J.A. Becerra, *Energy*. (Subscription may be required.)

Carbon Emission Trading Scheme in the shipping sector: Drivers, challenges, and impacts.

The following is from the abstract of this article: “The aim of this study is to review, identify and synthesize the drivers, challenges and impacts of implementing a Carbon ETS in the shipping sector. PRISMA is adopted to review relevant articles selected from Scopus and Web of Science databases. The review uncovers three categories of drivers, seven categories of challenges, and two categories of impacts. The drivers are (1) limitations of existing technical and operational solutions; (2) promise of market-based solutions; and (3) attitudes of stakeholders. Challenges are about (1) geographical coverage; (2) sectoral coverage; (3) free emissions quota percentage and the carbon trading price; (4) conflict between common but differentiated responsibilities and equal treatment; (5) management difficulties; (6) jurisdiction under international law; and (7) opposition from the shipping sector. Impacts are (1) environmental and economic impacts and (2) optimal abatement strategy. This study offers some implications and recommendations for relevant stakeholders on implementing carbon ETS.”

Min Wu, Kevin X. Li, Yi Xiao, and Kum Fai Yuen, *Marine Policy*. (Subscription may be required.)

Print media representations of carbon capture utilization and storage (CCUS) technology in China.

The following is from the abstract of this article: “Carbon Capture Utilization and Storage (CCUS) technology is an essential component to decarbonize society and reach carbon neutrality. Its success depends on not only technological advances but also people’s reaction to it. This study applied traditional content analysis to uncover the CCUS reporting landscape and employed the Socio-Political Evaluation of Energy Deployment (SPEED) framework to explore how different aspects of the CCUS value chain were discussed in Chinese newspapers. A total of 492 news items from November 21st 2002 to May 8th 2021 were identified and analyzed. Results showed that news coverage of CCUS technology in China started in 2005. The media explained the nature and sources of carbon dioxide (CO₂), framed CCUS by various terms, for example, ‘greengen’ and ‘a clean energy technology’, as well as demonstrated various tones in CCUS. The analysis found 71.3% (N = 351) of newsletters took an affirmative stance towards CCUS. It was also revealed that environmental frames appeared in almost every article, while much less attention was paid to other issues. Moreover, this research demonstrated that CCUS-related policies were driving media coverage closely year by year. However, current news presentations were inadequate due to technical misperceptions and a lack of comprehensive coverage. Therefore, this research proposed a science-for-the-community communication strategy that involved several key factors such as policy guidance, newspaper functions at different levels, journalist training, direct engagement of the public as well as student education.”

Kai Jiang, Peta Ashworth, Shiyi Zhang, and Guoping Hu, *Renewable and Sustainable Energy Reviews*. (Subscription may be required.)

CO₂ Pipeline risk assessment and comparison for the midcontinent United States.

The following is from the abstract of this article: “A comprehensive quantitative risk assessment for the construction and operation of CO₂ transportation networks considered for the Midcontinent United States was conducted. The results showed risks associated with CO₂ pipelines were significantly less than those of other pipeline types. The assessment used four conceptual pipelines of different lengths to discuss risks operators may see. The assessment evaluated the risk associated with construction and operation using data from the US Occupational Safety Health Administration to determine the risk of injury or death for pipeline workers and data from the US Pipeline and Hazardous Materials Safety Administration for CO₂, natural gas distribution, natural gas transmission/gathering, and non-CO₂ hazardous liquid pipelines to develop quantitative likelihood and severity values leading to risk values. The data for the assessment covered incidents from 2010 to 2017 for CO₂ pipelines. The average risk for construction and 30 years of operation for four CO₂ pipeline configurations ranging between 79 and 1,546 miles in length was found. The construction and operational risk averaged between \$1,400,521 (approximately \$0.02/tonne of CO₂) for the shorter pipeline (79 miles) and \$27,481,939 (approximately \$0.10/tonne of CO₂) for a longer pipeline (1,546 miles). The largest risks of fatality for CO₂ pipelines comes from vehicle transport. The largest operational risk to the pipeline was due to leakage. Public pipeline opposition is also a significant risk; it was not quantified but is addressed.”

Andrew Duguid, Jared Hawkins, and Laura Keister, *International Journal of Greenhouse Gas Control*. (Subscription may be required.)

February 2023 (Vol. 23 No. 2)**Evaluation of the impact of CO₂ 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 CO₂ emissions. When injected into the subsurface, there are potential interactions between CO₂, pore fluids, and the reservoir rock. To determine analyzed the effect of CO₂ on the physical properties of geological reservoirs, the pore structure, and mineral composition of cores before and after CO₂ 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 CO₂-formation water immersion. The experimental results show that the degree of dissolution of minerals with CaCl₂ formation water is negligible. Often, When CO₂ 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 CO₂-NaHCO₃ 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 CO₂-CaCl₂ 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 CO₂ on pore enlargement is not unidirectional but first inhibits and then promotes pore size. After CO₂ injection into the formation, it is dissolved in formation water with different chemical properties, influencing reservoir rocks. Compared with CO₂-CaCl₂ formation water, CO₂-NaHCO₃ 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 CO₂ 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 (CO₂) from anthropogenic sources at prices low enough to be competitive with alternative sources of CO₂. Full utilization of CO₂ pipelines is an important strategy to decrease the total cost of utilizing the CO₂ from these sources. Sources with low capture capacity factors and high peak rates of capture can more fully utilize smaller pipelines and provide sustained CO₂ supply to the downstream end-user by incorporating CO₂ intermediate storage (CIS) – sending CO₂ at larger volumes to the intermediate storage reservoirs during periods of peak capture. Then, CO₂ 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 CO₂ sources to begin to inform future CCUS discussions about the feasibility of re-production of temporarily stored CO₂. 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 CO₂ 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 CO₂ 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 CO₂ at low-cost and on large-scale, supercritical CO₂ long-distance transportation, greatly enhancing oil recovery and storage rate, and CO₂ 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, Tiya ZHOU, Zemin JI, and Haishui HAN, *Petroleum Exploration and Development.* (Subscription may be required.)

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 9.62×10^{10} kgCO_{2-eq} and 1.94×10^{11} kgCO_{2-eq}, 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 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.)

March 2023 (Vol. 23 No. 3)

Appalachian Hydrogen Infrastructure Analysis

The following is a description of this NETL product: “...This report highlights the potential for the Appalachian region to develop a hydrogen economy with fossil-derived hydrogen with CCS production (hydrogen from natural gas with carbon capture and storage). Specifically, the report provides hydrogen transport and storage infrastructure pathways in support of a broader hydrogen economy. These pathways are consistent with existing and potential technologies and regulations and provide valuable guidance for the investment and research and development potential for transportation and storage of hydrogen in Appalachia.”

Hartej SINGH, Luke CLAHANE, Amanda HARKER STEELE, Clare CALLAHAN, Travis WARNER, and Robert WALLACE, March 2022.

The impact of policies on profit-maximizing rates of reliance on carbon capture for storage versus cleaner production

The following is from the abstract of this article: “Based on techno-economic analysis, previous studies compare the short and long-term average cost of [CCS] with cleaner production technologies such as renewable energy (RE) generation. This study proposes scenarios where power generators choose to invest in CCS, RE, or both based on profit-maximization goals in the presence of policy instruments such as carbon tax and subsidies. We characterize profit-maximizing rates of reliance on CCS and RE and examine the impact of policies on a power generator's optimal choice. The model, implemented on data obtained from 53 electric power companies, suggests that electric generators could adopt both CCS and RE profitably in the presence of policy incentives...”

Mahelet G. FIKRU, *Journal of Cleaner Production*, December 2022. (Subscription may be required.)

Characteristics of CO₂ foam plugging and migration: Implications for geological carbon storage and utilization in fractured reservoirs

The following is from the abstract of this article: “Fractured reservoirs exhibit heterogeneity and high conductivity, posing challenges to the application of low-carbon and clean production technologies. In this study, the flow and plugging characteristics of CO₂ foam in fractured cores were analyzed in physical fracture cores and visual slab fracture models. The influence of surface roughness and fracture openings on foam flow and plugging efficiency were studied. Results show that polymer-enhanced foam displays a higher-pressure drop in a single core with a small fracture opening. With increasing fracture opening, the plugging capacity of the polymer-enhanced foam gradually decreases to that of ordinary foam. In parallel fractures of different openings, ordinary foam is better able to regulate the flow, whereas the conformance control of polymer-enhanced is more robust. Prolonged foam flow in the fractures leads to foam collapse, especially for small fracture openings and high roughness... Foam flow in the fracture is analyzed in terms of the forces acting on the foam. Understanding foam flow resistance is a key to preventing gas channeling, expanding sweep range and improving the oil washing efficiency.”

Zhengxiao XU, Zhaomin LI, Zhiliang LIU, Binfei LI, Qifeng ZHANG, Lei ZHENG, Yongjin SONG, and Maen M. HUSEIN, *Separation and Purification Technology*, August 2022. (Subscription may be required.)

Environmental trade-offs of direct air capture technologies in climate change mitigation toward 2100

The following is from the abstract of this article: “Direct air capture (DAC) is critical for achieving stringent climate targets, yet the environmental implications of its large-scale deployment have not been evaluated in this context. Performing a prospective life cycle assessment for two promising technologies in a series of climate change mitigation scenarios, we find that electricity sector decarbonization and DAC technology improvements are both indispensable to avoid environmental problem-shifting. Decarbonizing the electricity sector improves the sequestration efficiency, but also increases the terrestrial ecotoxicity and metal depletion levels per metric ton of CO₂ sequestered via DAC. These increases can be reduced by improvements in DAC material and energy use efficiencies. DAC exhibits regional environmental impact variations, highlighting the importance of smart siting related to energy system planning and integration. DAC deployment aids the achievement of long-term climate targets, its environmental and climate performance however depend on sectoral mitigation actions, and thus should not suggest a relaxation of sectoral decarbonization targets.”

Yang QIU, Patrick LAMERS, Vassilis DAILOU, Noah MCQUEEN, Harmen-Sytze DE BOER, Mathijs HARMSSEN, Jennifer WILCOX, André BARDOW, and Sangwon SUH, *Nature Communications*, June 2022. (Subscription may be required.)

Decarbonising the refinery sector: A socio-technical analysis of advanced biofuels, green hydrogen and carbon capture and storage developments in Sweden

The following is from the abstract of this article: "...This paper draws on expert interviews and combines the Technological Innovation Systems (TIS) and Multi-level Perspective (MLP) frameworks to examining the niche level development of three emerging technologies in the context of deep decarbonisation of refinery. This research finds that the development of the three decarbonisation technologies shares some of the challenges and opportunities and exhibits technology interdependency to some extent. Among the three TISs, advanced biofuel is the most mature in terms of knowledge base, actor-network, legislation framework and market function. Green hydrogen and CCS encounter stronger momentum than before and can benefit from possible synergies across various sectors. However, the analysis also reveals the lack of market formation, mainly due to the lack of policy instruments for niche markets. Here, policy recommendations for accelerating deep decarbonisation of the oil refinery industry are discussed. Finally, we contribute to the sustainability transitions literature by exploring the dynamics of emerging TISs for industrial decarbonisation."

Anissa NURDIAWATI and Frauke URBAN, *Energy Research & Social Science*, February 2022.

Lessons Learned for Rapid Decarbonization of Power Sectors

The following is from the abstract of this article: "This report covers key lessons learned for the rapid decarbonization of power sectors, emphasizing best practices in planning, building, and operating electricity systems. Decarbonization covers all greenhouse gases, including CO₂ and methane. The intended audience of this report consists of energy ministers and other high-level energy sector decisionmakers."

Prateek JOSHI and Jeff LOGAN, September 2022.

Intermountain West Energy Sustainability & Transitions Initiative: CO₂ Transport and Geologic Storage Modeling Results

The following is from the introduction of this report: "Analysis was performed for the [I-WEST] initiative that utilized [DOE] models...to analyze various business cases given changes in technical and financial assumptions for the I-WEST region to see how these assumptions influence CO₂ transport and storage costs. Also, NETL-developed models were used to see the effect of changing oil prices on the viability of CO₂-EOR [enhanced oil recovery] and the mass of CO₂ stored via CO₂-EOR. This supplementary documentation provides a detailed overview on the models, assumptions, and parameters used in the modeling and example results."

David MORGAN, Allison GUINAN, Travis WARNER, Derek VIKARA, and R. Taylor VACTOR, October 2022.

Computed Tomography Scanning and Geophysical Measurements of the Wellington 1-32 Core

The following is from the abstract of this report: "The computed tomography (CT) facilities and the Multi-Sensor Core Logger (MSCL) at [NETL] in Morgantown, West Virginia were used to characterize core from the Wellington 1-32 well (API 15-191-22591), a small-scale field test site in the Wellington Field, in Sumner County, Kansas. Wellington 1-32 was drilled in association with the Kansas Geologic Survey's (KGS) Phase I pre-feasibility study under the [CarbonSAFE] program, with the goal of utilizing the Arbuckle Group as a reservoir for CO₂ storage and the potential for stacked reservoir enhanced oil recovery from Mississippian reservoirs."

T. PARONISH, R. SCHMITT, N. MITCHELL, S. BROWN, D. CRANDALL, J. MOORE, F. HASIUK, N. POTTER, and Y.E.C. HOLUBNYAK, October 2022.

Application of unsupervised deep learning to image segmentation and in-situ contact angle measurements in a CO₂-water-rock system

The following is from the abstract of this article: "Rock surface wettability is a critical property that regulates multiphase flows in porous media, which can be quantified using the surface contact angle (CA). X-ray micro-computed tomography (μCT) provides an effective approach to in-situ measurements of surface CAs. However, the CA measurement accuracy depends significantly on the quality of CT image segmentation, which is the clustering of CT pixels into separate phases. Inspired by this, we developed a deep learning (DL)-based CA measurement workflow. Motivated by the recent tremendous progress in unsupervised learning techniques and aiming to avoid expensive manual data annotations, an unsupervised DL pipeline for CT image segmentation was proposed and implemented, which includes unsupervised model training and post-processing...The workflow has been proven an efficient tool for pore-scale wettability characterization, which has a wide range of applications in fundamental studies of multiphase flows in natural porous media, which have critical implications to geological carbon sequestration, hydrocarbon energy recovery, and contaminant transport in groundwater."

Hongsheng WANG, Laura DALTON, Ruichang GUO, James MCCLURE, Dustin CRANDALL, and Cheng CHEN, *Advances in Water Resources*, March 2023. (Subscription may be required.)

Pore Scale Modeling on Wettability Heterogeneity of Rocks

The following is from the introduction of this presentation: "Recent in-situ measurements of wettability on natural rocks suggest that wettability heterogeneity of a natural rock is at a sub-pore scale and wettability has a wide range. This work is to introduce a new model on heterogeneous wettability and the implications of pore-scale wettability heterogeneity on immiscible displacement in a sandstone."

Laura E. DALTON, Hongsheng WANG, James MCCLURE, Dustin CRANDALL, and Cheng CHEN, December 2022.

Strategies for Achieving the DOE Hydrogen Shot Goal Thermal Conversion Approaches

The following is from the introduction of this report: "In this initial screening, the current and target performance and cost of several...thermal conversion technologies are explored. For commercial technologies, cost reduction is heavily focused on factors outside of the scope of the plant such as feedstock price assumptions, by-product sales, etc. For advanced technologies, the cost reduction pathways are made up of a combination of technology developments and external factors that reduce cost."

Shannon MCNAUL, Charles WHITE, Robert WALLACE, Travis WARNER, H. Scott MATTHEWS, Jinliang MA, Massood RAMEZAN, and Eric LEWIS, January 2023.

April 2023 (Vol. 23 No. 4)

N. Wijaya, D. Vikara, K. Bello, R. T. Vactor, M. Tarhoni, T. Grant, D. Morgan and L. Cunha, “*Exploratory Analysis of Offshore CO₂ Storage Pilot Project in the Gulf of Mexico: Geologic, Infrastructure, and Cost Considerations*,” *National Energy Technology Laboratory*, Pittsburgh, December 9, 2022.

Di He, Ruina Xu, Tiancheng Ji, Peixue Jiang, “*Experimental investigation of the mechanism of salt precipitation in the fracture during CO₂ geological sequestration*,” *International Journal of Greenhouse Gas Control*, Volume 118, July 2022.

K.A. Titus, D.E. Dempsey, R.A.M. Peer, “*Carbon negative geothermal: Theoretical efficiency and sequestration potential of geothermal-BECCS energy cycles*,” *International Journal of Greenhouse Gas Control*, Volume 122, January 2023.

Saulo B. de Oliveira, Haline V. Rocha, Colombo C.G. Tassinari, “*3D geochemical characterization of organic-rich shales of the Irati Formation, Paraná Sedimentary Basin: New perspective for CO₂ geological storage in southeastern Brazil*,” *International Journal of Greenhouse Gas Control*, Volume 114, February 2022.

Yanli Meng, Li Wang, Yigang Wei, Zhijun Shi, Ziqian Luo, “*Time-frequency dynamics, co-movement and causality among returns of global carbon emissions trading schemes (ETSS): A tale of four markets*,” *Journal of Cleaner Production*, Volume 363, August-2022.

**May 2023 (Vol. 23 No. 5)–September 2023
(Vol. 23 No 9)**

Beginning in May 2023, the CTSN discontinued this section.

ANNOUNCEMENTS



October 2022 (Vol. 22 No. 10)

Conference Proceedings from DOE/NETL's 2022 Carbon Management Project Review Meeting Available.

Conference proceedings from the DOE/NETL 2022 Carbon Management Project Review Meeting, held in Pittsburgh, Pennsylvania (USA), August 15–19, 2022, are [available online](#). The meeting included a mixture of plenary and parallel sessions and poster presentations providing updates on DOE/NETL-funded carbon capture, utilization, and storage (CCUS) research projects being conducted to advance carbon management technologies and ensure a sustainable clean energy future for the nation.

DOE Issues NOI for Carbon Storage FOA.

DOE issued a Notice of Intent (NOI) for an FOA titled “*Regional Initiative to Accelerate Carbon Management Deployment: Technical Assistance for Large-Scale Storage Facilities and Regional Carbon Management Hubs*.” The objective of the planned FOA is to establish a consistent, effective mechanism for providing technical assistance to develop multiple large-scale carbon storage facilities and regional carbon management hubs that could store hundreds of millions of tons of CO₂ and inject more than 5 million metric tons of CO₂ per year.

DOE/FECM Selects Winner of SMART VP Prize Challenge.

DOE/FECM announced the Phase II winner of its *Science-Informed Machine Learning to Accelerate Real Time (SMART)* Visualization Platform (VP) Prize Challenge. Clean energy technology company Petrolern LLC will receive the prize award for their work in developing the web-based GeoDeck platform, which is a tool to help transform the interaction with the subsurface by providing real-time visualizations of subterranean fluid flows, fractures, and other features. Such visualizations can enhance decision-making for safer subsurface operations, including CO₂ storage.

NETL Tool Attracts International Attention.

An NETL tool for estimating geologic environments for CO₂ storage is attracting attention from institutions of higher education and governments from more than 90 nations, including Norway, Spain, France, South Korea, India, Australia, Mexico, and the United Kingdom (UK). NETL's *CO₂-SCREEN* was created to provide a robust, user-friendly tool to estimate CO₂ storage efficiency in a variety of geologic environments, including saline formations, shale formations, and residual oil zones.

Drax, British Steel Sign MOU to Support BECCS Development.

Renewable energy company Drax and British Steel signed a Memorandum of Understanding (MOU) to support the development of bioenergy with carbon capture and storage (BECCS). Through the MOU, the companies will explore opportunities for steel to be used to help build Drax's BECCS project, which will be part of the East Coast Cluster—a consortium of Zero-Carbon Humber and Net-Zero Teesside.

Climeworks Wins Award for Innovative Technology at Capture and Storage Plant.

Climeworks received the *Innovation in Vacuum Busch Award* for its advanced use of vacuum technology at its Ocrá direct air capture (DAC) and storage plant. Located in Iceland, the plant can capture 4,000 metric tons of CO₂ per year.

Global CCS Market Report.

According to a report by Research and Markets, the global CCS market could reach \$4.9 billion by 2026. The report, “Carbon Capture and Storage – Global Market Trajectory & Analysis,” states that the CCS market in the United States is estimated at \$1.1 billion in 2022, accounting for a 33.5% share of the global market. (Purchase may be required to access the report.)

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 CO₂ Allowances: Second Quarter 2022.” Prepared by independent market monitor Potomac Economics, the report found no evidence of anticompetitive conduct in the RGGI CO₂ allowance secondary market.

EU Carbon Credits Reach New High.

Carbon allowance prices under the European Union Emissions Trading Scheme (EU ETS) reached an all-time high of approximately \$99 per metric ton of CO₂ equivalent in August 2022.

November 2022 (Vol. 22 No. 11)

DOE Accepting LOIs for Loans Under CO₂ Transportation Infrastructure Finance and Innovation Program.

DOE is accepting Letters of Interest (LOIs) from applicants for loans under a new \$2.1 billion Carbon Dioxide Transportation Infrastructure Finance and Innovation (CIFIA) Program. Enacted under the BIL, CIFIA offers funding for large-capacity, shared CO₂ transportation projects located in the United States. Appropriated annually through 2026, CIFIA will support shared infrastructure projects that connect anthropogenic sources of carbon with endpoints for its storage or utilization. The program is administered jointly by DOE's Loan Programs Office (LPO) and Office of Fossil Energy and Carbon Management (FECM). Additional details on eligibility, priority considerations, and financial terms and conditions are available on the [CIFIA website](#).

DOE Invests in Projects and Programs to Advance CCS.

DOE/FECM *invested more than \$6 million* to support the University Coal Research (UCR) Program and the Historically Black Colleges and Universities and Other Minority Institutions (HBCU-OMI) Program. Both programs will fund projects that explore biomass feedstocks blended with waste coal and coupled with carbon capture and storage (CCS). DOE/FECM also *invested more than \$31 million* to advance CCS for the natural gas power and industrial sectors. The selected projects will develop carbon capture technologies capable of capturing at least 95% of CO₂ emissions from natural gas power plants, waste-to-energy power plants, and industrial applications.

White House Establishes Office of Clean Energy Innovation and Implementation.

The White House announced the establishment of the White House Office on Clean Energy Innovation and Implementation within the Executive Office of the President. The office will help implement the Inflation Reduction Act of 2022 (IRA).

NETL Explores CO₂ Capture Retrofit Costs for Industrial Sources.

The National Energy Technology Laboratory (NETL) published “*Cost of Capturing CO₂ From Industrial Sources*,” an update to a 2014 study that examines the costs of retrofitting a variety of industrial processes with state-of-the-art CO₂ capture systems. The report is accompanied by NETL's Industrial Sources *Carbon Capture Retrofit Database (CCRD)*, a tool that enables users to estimate the cost of capture for a given industrial plant or an entire industrial sector using either study assumptions or user inputs.

DOE Announces Funding for CDR and Carbon Conversion.

DOE/FECM announced funding for research and development (R&D) projects to advance carbon dioxide removal (CDR) and carbon conversion technologies. Direct air and ocean capture of CO₂, with storage of the captured CO₂ in geologic formations or converted to value-added products, has a critical role in helping the United States achieve the Biden-Harris administration's goal of net-zero greenhouse gas (GHG) emissions by 2050.

FY 2022 Carbon Transport and Storage Newsletter Annual Index Available.

The FY 2022 Carbon Transport and Storage Newsletter Annual Index is available. The document is a compilation of NETL's Carbon Transport and Storage Newsletters published from October 2021 through September 2022.

NETL Releases 2022 Compendium of Carbon Capture Technology.

Compiled biannually to provide a technical summary of CO₂ capture technology R&D sponsored by DOE/NETL's *Point Source Capture* (PSC) and *Carbon Dioxide Removal* (CDR) Programs, *NETL's 2022 Compendium of Carbon Capture Technology* presents 124 projects in a single document, all of which were active between October 1, 2019, and October 1, 2021.

USDA Investment Includes Carbon Storage Project.

The U.S. Department of Agriculture (USDA) announced investments under the *Partnerships for Climate-Smart Commodities* funding opportunity, which will create market opportunities for American commodities produced using climate-smart production practices. USDA anticipates that these projects will result in more than 50 million metric tons of CO₂-equivalent stored over the life of the projects.

PA Holds Informational Briefing on CCUS.

Government and industry officials conducted an informational briefing about Pennsylvania's (USA) potential as a carbon capture, utilization, and storage (CCUS) hub. Earlier this year, a co-sponsorship memo was circulated to establish the Pennsylvania Geologic Storage of Carbon Dioxide Act, which would create a legal and regulatory framework for CCS projects in the state.

NREL Strategies for 100% Clean Energy.

A team of National Renewable Energy Laboratory (NREL) researchers studied tradeoffs of six possible technology strategies to get from 90% to 100% carbon-free electricity in the United States. The study was *published in the online journal Joule*.

Summit Carbon Solutions Achieves Milestone.

Summit Carbon Solutions has secured easement agreements for more than half of the proposed route for a planned carbon capture, transport, and storage project in Iowa (USA). The 1,400 easement agreements with 800 Iowa landowners total nearly 350 miles.

BECCS Market Projected to Grow.

According to a report by Research and Markets, the global bioenergy with carbon capture and storage (BECCS) market is projected to grow throughout 2023–2027. "*Bioenergy With Carbon Capture And Storage Market – Global Industry Size, Share, Trends, Opportunity and Forecast, 2017-2027 Segmented By End Use, By Technology, By Form of Energy, By Application, By Region*" outlines the demand for biofuels and the production of biofuels to obtain energy from biomass.

Companies to Assess CCS for Maritime.

BASF and Samsung Heavy Industries will collaborate on CCS onboard maritime vessels by conducting a feasibility assessment of BASF's OASE[®] blue technology for flue gas applications. The scope of the Memorandum of Understanding includes a marinization study, as well as engineering design and construction of a carbon capture unit.

December 2022 (Vol. 22 No 12)

Company Offers Corrosion Testing for CCS Developments.

Welltec opened a new test flow loop facility in Esbjerg, Denmark, that will provide corrosion testing for carbon capture and storage (CCS) developments. The center is expected to replicate extreme environmental conditions, ensuring materials planned for storing CO₂ in a subsurface reservoir provide the necessary levels of durability and wear resistance.

Carbon Storage Evaluation Agreement Reached.

TC Energy and Pembina Pipeline entered into a carbon storage evaluation agreement with the Government of Alberta to further evaluate an Area of Interest for storing carbon from industrial emissions in Alberta (Canada). The agreement will allow the Alberta Carbon Grid to move into the next phase of the province's carbon capture, utilization, and storage (CCUS) process.

Report: CCS Capacity Rises.

The capture capacity of CCS projects in the project pipeline has risen from 169 million metric tons per year in 2021 to 244 million metric tons per year currently, according to the Global CCS Institute. In addition, the *Global Status of CCS 2022* report also found that the U.S. legislation *Inflation Reduction Act (IRA)* could increase the deployment of CCS 13-fold by 2030 compared to existing policy.

RGGI Auction 58.

The states participating in the Regional Greenhouse Gas Initiative (RGGI) plan to host their 58th quarterly auction of CO₂ allowances on December 7, 2022. Auction 58 will offer allocation year 2021 and 2022 CO₂ allowances (initial offering) and allow for activation of an Emissions Containment Reserve (ECR) or a Cost Containment Reserve (CCR). The CCR contains several CO₂ allowances, in addition to the initial offering, that will be offered for sale when the interim clearing price exceeds a threshold. The ECR represents several CO₂ allowances that will be withheld from the initial offering when the interim clearing price falls below a threshold.

Increase in EOR Creating Demand for CO₂ Market.

A report published by the market research company Maximize Market Research shows that increasing utilization of CO₂ for enhanced oil recovery (EOR) has created a demand for the CO₂ market. Maximize Market Research's "Carbon Dioxide Market 2022" found that the global CO₂ market size is expected to reach ~\$12 billion by 2029, at a compound annual growth rate of ~4.8%.

Scaled-Up Technology Addresses CCUS Economics.

Schlumberger and RTI International entered into an agreement to accelerate the industrialization and scale-up of RTI's non-aqueous solvent technology, which addresses the efficiency of absorption-based carbon capture and the overall economics of CCUS projects, according to the company.

January 2023 (Vol. 23 No. 1)

NETL Case Study Explores Solvent-Based DAC for Removal of Atmospheric CO₂.

A *case study* conducted by DOE's National Energy Technology Laboratory (NETL) examined the performance and cost of solvent-based direct air capture (DAC). DAC is an emerging CO₂ removal (CDR) technology that concentrates CO₂ found in the ambient air rather than a power plant or industrial facility flue gas, thereby addressing both current and legacy emissions. Atmospheric concentrations of CO₂ (~415 parts per million) are much lower than those found in effluent streams from power plants or industrial facilities, presenting greater technical and cost challenges for technologies to concentrate the CO₂ to the degree necessary for storage or utilization.

DOE to Issue CO₂ MRV Lab Call.

DOE's Office of Technology Transitions, in partnership with FECM, intends to issue a lab call on CDR measurement, reporting, and verification (MRV) best practices and capabilities. The lab call is funded by the Bipartisan Infrastructure Law (BIL) and aims to support the development of MRV tools and protocols that are necessary to enable CDR commercialization at scale.

DOE/FECM Hosted Carbon Management Day Webinar.

DOE/FECM celebrated its second annual Carbon Management Day, recognizing the essential role carbon management has in meeting the nation's goal of net-zero emissions by 2050. (Carbon Management Day is celebrated on December 1, because 12.01 is the atomic mass of carbon.) As part of the celebration, FECM *hosted a webinar* to gather stakeholders throughout industry, academia, and communities to provide updates on key initiatives, take a closer look at FECM-funded carbon management projects, and inform stakeholders on how to get involved.

Carbon Management Collegiate Competition.

DOE/FECM is funding the Carbon Management Collegiate Competition, which tasks students to propose a regional carbon transport network. The competition seeks a diverse range of participants, with consideration given to disadvantaged communities and underrepresented minorities in science, technology, engineering, and mathematics (STEM) fields to advance carbon management technologies and achieve net-zero greenhouse gas (GHG) emission goals in a just and sustainable way.

NETL Researchers' Impact Recognized.

A recent *analysis* by Stanford University (USA) listed 25 current and former NETL researchers as being in the top 2% of scientists worldwide. The analysis comprised lists according to career-long impact and single-year impact.

NETL Celebrates the First Anniversary of BIL.

NETL celebrated the first anniversary of the BIL and its contributions to building a more resilient future in the United States. Highlights of NETL's BIL support include providing an advanced, strategic, CCS-specific data infrastructure system to drive the efficient and rapid deployment of CCS efforts.

DOE/NETL SMART Technical Advisory Group Member Publishes Book.

A member of the DOE/NETL Science-informed Machine Learning for Accelerating Real-Time Decisions in Subsurface Applications (SMART) Technical Advisory Group is the lead author of a new book titled "Artificial Intelligence and Data Analytics for Energy Exploration and Production." The book aims to help unleash the power of artificial intelligence and data analytics for faster and more cost-effective exploration and production, involving subsurface characterization, carbon storage, and reservoir monitoring.

Japan's Mitsui Hunts for Carbon Storage Sites in Asia-Pacific.

Mitsui & Co. plans to secure sites in the Asia-Pacific region and other areas to store CO₂ produced at Japanese factories and power plants, with plans to obtain rights for storing 15 million metric tons yearly by 2035. After securing storage rights, Mitsui intends to debut a CCS service for Japanese companies and others as early as 2030.

Series of Documents Supporting CCS Deployment Published.

The consortium implementing the CCS Roadmap for Central and Eastern Europe (CCS4CEE) project released a series of documents that support CCS deployment across the CEE region. The CCS4CEE project aims to renew the discussion on the long-term deployment of CCS in the CEE region, leading to new policies and joint projects. It covers Croatia, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, Slovenia, and Ukraine. Included in the documents is a *summary of national CCS roadmaps*.

Denbury Announces CO₂ Transport and Storage Agreement.

Denbury Carbon Solutions LLC executed a CO₂ Services Agreement with Clean Hydrogen Works, under which it will transport and store CO₂ captured from Clean Hydrogen's planned hydrogen-ammonia complex in Parish, Louisiana (USA). The complex is expected to be built less than two miles from Denbury's existing CO₂ pipeline network.

Chevron, MOL to Study CO₂ Shipping.

Chevron and Mitsui O.S.K. Ltd. (MOL) signed a Joint Study Agreement (JSA) on the feasibility of transporting liquified CO₂ from Singapore to storage locations offshore Australia. Under the JSA, the companies will explore the technical and commercial feasibility of initially transporting up to 2.5 million metric tons of liquified CO₂ per year by 2030.

UK Company Unveils New CO₂ Management Platform.

The United Kingdom (UK)-based Aquaterra Energy unveiled a new CO₂ management platform for long-term monitoring and sustained integrity of underwater CCS sites. The integrated solution is said to provide monitoring of both subsurface fiberoptic seismic arrays and dissolved CO₂ gas detection via solar- or wave-powered remote data transmission nodes between the seabed and the surface.

February 2023 (Vol. 23 No. 2)

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.

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 CO₂ 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 CO₂ per year if expanded.

CO₂ Monitoring Consortium Formed.

A group of U.S. industry leaders is forming a CO₂ 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 CO₂ Allowances: Third Quarter 2022*." Prepared by independent market monitor Potomac Economics, the report found no evidence of anticompetitive conduct in the RGGI CO₂ 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 CO₂ 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.

March 2023 (Vol. 23 No. 3)

DOE Announces CDR Funding

DOE announced the launch of four programs (Direct Air Capture Commercial and Pre-Commercial Prize, Regional Direct Air Capture Hubs, Carbon Utilization Procurement Grant, and Carbon Utilization Procurement Grant) that will help build a commercially viable, just, and responsible Carbon Dioxide Removal (CDR) industry in the United States. The Bipartisan Infrastructure Law-funded programs 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.

December 2022.

DOE Provided CCS Expertise to I-WEST Report

DOE's Strategic Systems Analysis and Engineering (SSAE) team contributed to the Phase I Final Report from the Intermountain West Energy Sustainability and Transition (I-WEST) Initiative. Funded by DOE and led by Los Alamos National Laboratory, the I-WEST Initiative targets the development of a regional, stakeholder-informed technology roadmap for transitioning the Intermountain West region into a carbon-neutral and economically sustainable energy system. The chapter on CO₂ storage and utilization leveraged discussions with regional stakeholders and subject matter experts. An opportunity case for carbon capture, utilization, and storage in the region was outlined using strengths, weaknesses, opportunities, and threats analysis as well as gap analysis.

December 2022.

DOE Tests Storage Evaluation System

At the recent CO₂ Conference in Midland, Texas, DOE's director of carbon transport and storage stated that DOE is interested in testing the CO₂ Storage Resources Management System (SRMS) developed by SPE International's CO₂ Storage Resources Committee. SRMS is competing for acceptance with other proposed systems for evaluating, planning, and classifying storage systems.

Report on CDR Released

A new report, "The State of Carbon Dioxide Removal," defines CDR as human efforts to capture CO₂ from the atmosphere and store it durably on land, in the seas, or in products. Examples include reforestation, bioenergy with carbon capture and storage, and direct air carbon capture and storage.

January 2023.

Managing Carbon in the Midwest Workshop Report

Argonne National Laboratory held a workshop on June 14, 2022, that convened key industrial, academic, and government stakeholders with bases in and near Illinois (USA) to share information on capabilities in carbon capture, utilization, and storage. The linked report summarizes the workshop discussion on the science and technology needed to unlock the potential of carbon management in a clean energy and industrial economy.

December 2022.

Voluntary Carbon Trades to Start in 2023

India's carbon trading framework may be released, and the market for voluntary carbon trading will open during the year. The Bureau of Energy Efficiency (BEE) will assist the ministries of Power and Environment, which will separately generate notifications on the carbon market; an inter-ministerial body will take the final decision on the framework. The current Perform, Achieve, and Trade (PAT) scheme will be transitioned to the compliance market. PAT is a BEE program under the National Mission for Enhanced Energy Efficiency operated as a regulatory instrument to reduce energy consumption in energy-intensive industries.

April 2023 (Vol. 23 No. 4)

DOE Invests Funding in CCS Technologies.

DOE/FECM is funding three CO₂ storage projects and two carbon conversion projects selected under the Accelerating Carbon Capture and Storage Technologies (ACT) initiative's fourth call for projects. The ACT is a multi-national program to facilitate international collaboration on research and development (R&D) and technology innovation to accelerate the global deployment of carbon capture and storage (CCS) and carbon conversion technologies. The three selected CO₂ storage projects will explore options for geologic storage sites and solutions for CO₂ transport, injection, and monitoring.

From *energy.gov*. February 2023.

DOE/FECM Releases FY 2023 TCF to Support Partnerships Between Industry and National Labs.

DOE/FECM announced funding under its Fiscal Year (FY) 2023 *Technology Commercialization Fund (TCF)* Base Annual Appropriations National Laboratory Call for FECM Program-Led Topics. The solicitation offers an opportunity for private industry to partner with DOE's national labs to advance lab-developed intellectual property (IP) toward commercialization in technology areas covered by FECM's strategic vision.

From *energy.gov*. March 2023.

NETL, Supercomputing Center Pioneer CFD Simulation Announced.

Cerebras Systems announced the simulation of a real-time natural convection computational fluid dynamics (CFD) simulation in partnership with DOE/NETL. The simulation has the potential to help improve and accelerate projects like carbon storage.

From *Newswise*. February 2023.

NETL FY 2022 Accomplishments Report Available.

NETL Annual Accomplishments 2022 contains project posters that showcase the results NETL scientists, engineers, project managers, and partners have achieved to help ensure America's security and prosperity by addressing its energy and environmental challenges through transformative science and technology solutions. The accomplishments demonstrate the impact made possible through research aligned with DOE/FECM's research, development, demonstration, and deployment priorities.

From *NETL*. February 2023.

NETL Uses Microwaves to Reduce Costs of DAC Technologies.

NETL researchers have reported the successful use of microwaves to accelerate sorbent regeneration—results that can lead to the reduction of expensive water and energy requirements of some direct air capture (DAC) technologies. The research team published their work in the January 2023 issue of *Materials Today Sustainability*, and discussed their work on a *Spotify podcast*.

From *NETL*. March 2023.

GPI Publishes DAC Atlas.

The Great Plains Institute (GPI) published *An Atlas of Direct Air Capture: Opportunities for Negative Emissions in the United States*. The atlas examines key factors that impact regional suitability for developing DAC technology and associated infrastructure, including transporting and storing CO₂.

From *Better Energy*. March 2023.

CO₂ Storage License Applied for in the North Sea.

Sval, Storegga, and Neptune applied for a CO₂ storage license in the Norwegian North Sea. The project, called Trudvang, has the potential to store up to 225 million metric tons of CO₂. The application comes after the Norwegian Ministry of Petroleum and Energy announced (in January 2023) a new area in the North Sea for applications related to CO₂ injection and storage.

From *Key Facts Energy*. February 2023.

Carbon Storage Platform Licensed.

TGS licensed its *Carbon AXIOM* platform and associated well data products for carbon capture, utilization, and storage (CCUS). The platform, which now includes detailed analysis of saline aquifer potential in offshore Galveston, Texas, enables the assessment of depleted oil and gas reservoirs for CCUS purposes along the Texas, Louisiana, and Mississippi Gulf Coast regions.

From *energy-pedia*. February 2023.

RGGI Reports Available.

The states participating in the Regional Greenhouse Gas Initiative (RGGI) released the “*Report on the Secondary Market for RGGI CO₂ Allowances: Fourth Quarter 2022*.” Prepared by independent market monitor Potomac Economics, the report found no evidence of anticompetitive conduct in the RGGI CO₂ allowance secondary market. RGGI also made available the *2022 Interim Compliance Summary Report*, which contains data regarding CO₂ allowances provided by CO₂ budget sources to meet their 2022 interim control period compliance obligation. (RGGI’s fifth three-year control period took effect on January 1, 2021, and extends through December 31, 2023.)

From *RGGI*. February 2023.

UW’s EORI Launches Dashboard.

The University of Wyoming’s (UW) Enhanced Oil Recovery Institute (EORI) launched a dashboard offering information on EORI’s current project locations and descriptions, as well as a chart depicting project types and their frequencies. In addition, *the dashboard* also contains a list of EORI’s downloadable publications and a link to EORI’s library of publications and presentations.

From *University of Wyoming*. February 2023.

Capture Status of Arab Carbon Storage Facilities Announced.

According to the Arab Monetary Fund, three carbon storage facilities in Saudi Arabia, the United Arab Emirates, and Qatar capture 10% of the world’s CO₂ annually (around 40 million tons in 2020). Numerous Arab countries have set goals for renewable energies to be achieved in the 2030–2050 timeframe, while also aiming to reduce fossil energy sector emissions.

From *Arab News*. February 2023.

May 2023 (Vol. 23 No. 5)

FECM’s Role in Call to Action on Carbon Management.

President Biden *invited countries* to join the United States in participating in the Carbon Management Challenge, a global initiative to accelerate the deployment of carbon management technologies. For the U.S. government, DOE’s FECM is investing more than \$12 billion allocated by the BIL toward the research, development, and commercial demonstration of carbon capture, DAC, and carbon conversion technologies, as well as the buildout of carbon transport and storage infrastructure around the country. Governments participating in the Carbon Management Challenge will announce contributing measures and specific goals at the *United Nations Conference of the Parties (COP 28) meeting* later this year in Dubai, United Arab Emirates.

From *energy.gov*. April 2023.

Updated DOE Carbon Transport Website.

DOE’s Carbon Transport website has been updated. The Carbon Transport program area is designed to identify technical gaps, prioritize research needs, and develop tools to facilitate and optimize a robust, national-scale CO₂ transport infrastructure. The near-term goal is to expand the nation’s capability to transport 65 million metric tons of CO₂ per year. The long-term goal, aligned with a net-zero carbon emissions strategy by the midcentury, is to ensure the capability to transport 1 gigatonne of CO₂ per year.

NETL Report on Offshore GOM CO₂ Storage Pilot Study.

An NETL report, “*Exploratory Analysis of Offshore CO₂ Storage Pilot Project in the Gulf of Mexico: Geologic, Infrastructure, and Cost Considerations*,” evaluates several design, infrastructure, and cost considerations for conceptual pilot-scale CO₂ saline storage in offshore Gulf of Mexico (GOM). The study (N. Wijaya et al., NETL, Pittsburgh, December 9, 2022) includes site selection and geologic storage screening for offshore storage sites and aims to assess the cost magnitude associated with developing green or brownfield storage options. The analysis presents the evaluation under two scenarios: a focus on the GOM Outer Continental Shelf federal waters and another on Texas state waters. The analysis intends to offer insight into the convergence of design, cost, and site-selection considerations, which can be used to support the planning of future carbon capture and storage (CCS) development in the offshore GOM.

From *NETL*. December 2022.

CCUS and Canada’s Energy Strategy.

A Canadian international corporate law firm released a video analyzing carbon capture, utilization, and storage (CCUS) as a key element in the country’s industrial and governmental energy transition strategy. Part of a larger series of videos and webinars, Torsys LLP’s video takes a cross-jurisdictional look at the strategies being employed in Alberta and Ontario, highlighting the key regulatory hurdles of CCUS, how potential liabilities are being handled, and how governments are supporting adoption with subsidies and tax credits.

From *Lexology*. March 2023.

IEA CCUS Projects Explorer.

The International Energy Agency’s (IEA) CCUS Projects Database tracks CO₂ capture, transport, storage, and utilization projects worldwide that have been commissioned since the 1970s. The *data set* includes projects with a clear emissions reduction scope and excludes CO₂ capture for utilization pathways that bring low climate benefits (e.g., food and beverages) or that are part of a conventional industrial process (e.g., internal use for urea production).

From *International Energy Agency*. March 2023.

Humber Industrial Cluster Plan Launched.

After detailed analysis, modeling, and interviews, the Humber Industrial Cluster Plan has been launched by a consortium of companies and organizations in the United Kingdom (UK). First proposed in 2019 to drive sustainable growth and reduce carbon emissions in the Humber region, the plan highlights several key decarbonization projects, some of which feature the development of CCS technology.

From *Carbon Capture Journal*. March 2023.

June 2023 (Vol. 23 No. 6)

2023 FECM/NETL Carbon Management Research Project Review Meeting.

The 2023 Office of Fossil Energy and Carbon Management's (FECM) and NETL's Carbon Management Research Project Review Meeting will take place August 28–September 1, 2023, in Pittsburgh, PA. Representatives for more than 150 DOE-sponsored research and development (R&D) projects will share the knowledge and insights gained from their projects funded by the following FECM R&D programs: [Point Source Carbon Capture](#), [Carbon Dioxide Removal](#), [Carbon Conversion](#), and [Carbon Transport and Storage](#). A mixture of plenary and program-specific sessions will span 4 1/2 days. Oral presentations, along with an interactive poster session one evening, aim to share research results and provide opportunities for discussion and collaboration on the subject research efforts, both domestic and international. The meeting will be co-located with the United States Energy Association's inaugural [Carbon Management Technology Showcase](#) (CMTS).

NETL Develops CCS Pipeline Route Planning Database.

NETL has created an expansive and accessible Carbon Capture and Storage (CCS) Pipeline Route Planning Database to guide decisions on safely transporting CO₂ from capture sources to underground storage sites and conversion facilities. The [CCS Pipeline Route Planning Database](#), available through NETL's EDX, provides a comprehensive, national, big data resource to accelerate the country's energy transition. The publicly available database provides critical insights into the complex social, environmental, and regulatory variables that will be encountered during CCS deployment projects.

From *NETL*. May 2023.

DOE Releases Fourth "Pathways to Commercial Liftoff" Report in Carbon Management.

DOE released its fourth [Pathways to Commercial Liftoff report](#), focused on carbon management. The report discusses the whole carbon management ecosystem, including point-source carbon capture, utilization, and storage (CCUS) and carbon dioxide removal (CDR) technologies. According to the report, industry is poised to allocate billions of dollars in capital toward carbon management technologies, driven by industries with attractive economics for CCUS. The report also discusses solvable barriers to carbon management technology deployment at scale, including breaking through near-term bottlenecks in transport and storage.

From *energy.gov*. April 2023.

NETL CCUS Research Explained at National Event.

NETL researchers participated in the [CCUS Conference](#) at the University of Houston in Texas, detailing NETL's key research on point source carbon capture, CO₂ removal, CO₂ conversion into products, reliable CO₂ storage, blue hydrogen production, and critical mineral production from industrial and mining waste. The work presented at the event demonstrated the ongoing need for skilled petroleum engineers, geologists, geophysicists, and other types of engineers to help define the future of carbon management.

From *NETL*. April 2023.

White House CEQ Announces Members of Task Force to Inform CCUS Deployment.

The White House Council on Environmental Quality (CEQ) announced members of two new task forces that will provide input to inform the responsible deployment of CCUS. The task forces (the *Carbon Dioxide Capture, Utilization, and Sequestration Federal Lands and Outer Continental Shelf Permitting Task Force* and the *Carbon Dioxide Capture, Utilization and Sequestration Non-Federal Lands Permitting Task Force*) will provide recommendations to the federal government on how to ensure that CCUS projects, including CO₂ pipelines, are permitted efficiently, reflect the input and needs of a wide range of stakeholders, and deliver benefits rather than harms to local communities.

From *The White House*. March 2023.

DOE/FECM Invests in Upgrading NETL Research Sites.

DOE/FECM announced \$150 million in Inflation Reduction Act (IRA) funding to support the site-wide infrastructure and laboratory modernization upgrades at three of its NETL research sites. The IRA investment will be used to enhance core strengths at NETL's complexes in Pittsburgh, PA; Morgantown, WV; and Albany, OR, which include providing resources to apply artificial intelligence and machine learning to visualize and monitor the movement of CO₂ stored underground to address potential challenges for CCS.

From *energy.gov*. April 2023.

DOE/FECM Fact Sheets on Carbon Management and IRA Opportunities.

DOE/FECM released two fact sheets detailing how the IRA's commitment to energy and climate action has the potential to support the development of carbon management projects and infrastructure to benefit the economy and communities in [Alaska](#) and [Western energy-producing Tribal Nations](#), while also delivering deep reductions in carbon emissions.

From *energy.gov*. April 2023.

NETL to Co-Host Seventh IEAGHG Post-Combustion Capture Conference.

NETL and DOE will co-host the International Energy Agency Greenhouse Gas R&D Program's (IEAGHG) [Seventh Post-Combustion Capture Conference \(PCCC7\)](#), to be held September 25–28, 2023, in Pittsburgh, Pennsylvania. [PCCC events](#) are dedicated to sharing and publicizing the progress on all aspects of capture technology, including reports from commercial CCS plants in operation.

From *NETL*. April 2023.

Revamped Carbon Negative Shot Webpage.

DOE updated and redesigned its [Carbon Negative Shot webpage](#) to be a resource for information on CO₂ removal and to highlight the pathways DOE is pursuing under this [Earthshot](#).

From *energy.gov*. April 2023.

NETL Study Assesses Appalachian Region, Cites CCS.

The Appalachian region is well suited to be one of the nation's clean energy hydrogen hubs because of its natural gas resources, infrastructure, storage capacity, workforce, and industrial demand, according to a [recently released report conducted by NETL](#) (H. Singh, et al., "Appalachian Hydrogen Infrastructure Analysis," NETL, Pittsburgh, March 20, 2022). According to the authors, the study "demonstrates that Appalachia has the resources and infrastructure in and around its borders to lead a clean energy revolution by using natural gas with [CCS] to produce and store hydrogen."

Navigating CCUS Strategy Guide.

Decarbonfuse released a *7-Point CCUS Strategy Guide*, which is an excerpt from their Navigating CCUS Workshop—a comprehensive full-day briefing to gain commercial and carbon development insights into CCUS projects.

From *Decarbonfuse*. April 2023.

Webinar Focused on Proving CO₂ Storage.

Finding Petroleum event organizers hosted a webinar titled “Monitoring of Offshore CO₂ Storage Sites—How can we be sure that it is staying there.” The webinar explored what a solid “operating model” for how CO₂ storage should be monitored and verified would look like.

July 2023 (Vol. 23 No. 7)

NETL Scientists, Researchers Chairing Topical Session on Carbon and Hydrogen Storage in Geologic Systems.

Scientists and Researchers from NETL are chairing a Topical Session at The Geological Society of America Connects 2023 Meeting, to be held October 15–18, 2023, in Pittsburgh, PA. The session, *Carbon and Hydrogen Storage in Geologic Systems (T5)*, will bring together researchers and stakeholders to discuss the underlying research challenges associated with management of geologic storage formations. Interested speakers are invited to submit an abstract by visiting [the meeting website](#). (Abstract submissions are due by July 25, 2023.)

From *The Geological Society of America*. July 2023.

FACT SHEET: President Biden to Catalyze Global Climate Action Through MEF.

President Biden convened leaders of the Major Economies Forum on Energy and Climate (MEF), highlighting new steps the United States is taking to meet its 1.5°C-aligned goal of reducing emissions by 50–52% in 2030. Among the key areas discussed were the advancement of carbon management and partnering with other countries to accelerate carbon capture, removal, use, and storage technologies through a COP 28 Carbon Management Challenge. (COP 28 is the 28th session of the Conference of Parties, to be held in the United Arab Emirates from November 30 to December 12, 2023.)

From *The White House*. April 2023.

FACT SHEET: Biden-Harris Administration Outlines Priorities for Building America's Energy Infrastructure Faster, Safer, and Cleaner.

The Biden-Harris administration announced a suggested set of priorities for Congress to pass as part of bipartisan permitting reform legislation, including addressing the siting of hydrogen and CO₂ pipelines and storage infrastructure and providing federal siting authority for such infrastructure.

From *The White House*. May 2023.

DOE Announces Winners of First Annual Carbon Management Collegiate Competition.

DOE's FECM announced the winners of the American-Made *Carbon Management Collegiate Competition*, with the winning teams having the opportunity to present their winning proposals at DOE's annual *Carbon Management Research Project Review Meeting* in August 2023. The competition challenged students to help shape the future of carbon management by proposing regional carbon networks capable of transporting at least 1 million metric tons of CO₂ per year from industrial sources (e.g., power plants or ethanol production facilities) to locations that either use the CO₂ to manufacture products or for permanent storage.

From *energy.gov*. June 2023.

IEA Report Highlights Importance of CCS, CDR.

The International Energy Agency (IEA) released a report on the key actions needed to keep the Paris Agreement's target of limiting the global temperature rise to 1.5°C within reach. Among the pillars mentioned, the report, “*Credible Pathways to 1.5°C: Four pillars for action in the 2020s*,” highlights the importance of CCS and CDR.

From *Carbon Capture Journal*. April 2023.

A Guide to CCS and EPA's Power Plant Rule.

In light of the proposed *U.S. Environmental Protection Agency (EPA) power plant rule*, E&E News provided answers to common questions about CCS and power plants.

From *E&E News*. May 2023.

Podcast Discusses CCUS Regulatory Frameworks in Canada.

The Canadian government introduced two fiscal and regulatory levers—carbon pricing and an investment tax credit—to support the broad adoption of carbon capture, utilization, and storage (CCUS) in Canada. The Oxford Institute for Energy Studies (OIES) released a podcast discussing this and other topics related to the development of CCUS in Canada.

From *OIES*. May 2023.

Australian Industry Releases Carbon Roadmap for Net-Zero Future.

The Australian Petroleum Production and Exploration Association released a roadmap for a net-zero emissions future. *The report* proposes establishing nine “Net-Zero Zones” across Australia, with shared infrastructure for gas, renewables, CCUS, and hydrogen production.

From *Energy World*. May 2023.

MRCI Participates in Science Festival.

The DOE-funded Midwest Regional Carbon Initiative (MRCI) hosted an interactive display at the Center of Science and Industry (COSI) Big Science Celebration 2023 in Columbus, Ohio. The display included three interactive stations focused on the geology of CCS, and it was complimented with signage explaining CCS and the goal of the program. CCS Rock Kits were distributed, which directed attendees to NETL's webpage.

From *MRCI*. June 2023.

August 2023 (Vol. 23 No. 8)

DOE/NETL Panel Discusses EDX disCO₂ver.

NETL and DOE were represented on a panel called “*Bridging the Digital Divide with EDX disCO₂ver*.” Held on July 20, 2023, by the non-profit American Council for Technology-Industry Advisory Council (ACT-IAC), the discussion focused on the purpose and future of *EDX disCO₂ver*, and why there is a need to provide a digital infrastructure to accelerate safe CCS practices.

From *NETL*. July 2023

DOE Awards \$3.9 Million to Advance High-Performance Computing for Energy Innovation.

DOE announced a \$3.9 million federal investment for *13 projects* that will tap into the DOE National Laboratories' high-performance computing resources to connect with industry partners. These short-term, collaborative projects will address key manufacturing challenges and accelerate the development and deployment of clean energy technologies to advance the Biden-Harris administration's goal of net-zero carbon emissions by 2050.

From *energy.gov*. June 2023.

Senate Confirms DOE Under Secretary for Infrastructure.

David Crane was confirmed by the U.S. Senate to serve as Under Secretary for Infrastructure. The office focuses on deploying clean energy infrastructure and includes the Carbon Capture Demonstration Projects Program that targets demonstrating commercial-scale carbon capture technologies integrated with CO₂ transportation and geologic storage infrastructure.

From *energy.gov*. June 2023.

RGGI States Release Reports.

The states participating in the Regional Greenhouse Gas Initiative (RGGI) released two reports. The *Report on the Secondary Market for RGGI CO₂ Allowances: First Quarter 2023*, prepared by Potomac Economics, contains information on future prices, market activity, and allowance holdings from January through March 2023. The RGGI states also *released* the *Investment of RGGI Proceeds in 2021* report, which tracks investments of RGGI proceeds in 2021, providing state-specific success stories and program highlights.

From *RGGI Press Release*. June 2023.

2023 MRCI Stakeholders and Partners Meeting.

The 2023 Midwest Regional Carbon Initiative (MRCI) Stakeholder and Partners Meeting is scheduled for October 3–5, 2023, in Morgantown, WV. The DOE-funded MRCI will share the work it has been conducting to accelerate carbon capture, utilization, and storage (CCUS) acceptance and deployment in the Midwest, Northeast, and Mid-Atlantic regions of the United States.

Carbon Capture, CO₂ Removal to Play Key Decarbonization Role.

The Sustainability Research team of S&P Global Ratings reports that carbon capture and CO₂ removal will play a key decarbonization role. The credit ratings firm sampled 25 of the highest-revenue oil and gas companies and found that they all plan to use at least one of the options of CCS, CDR, or carbon credits to meet decarbonization goals.

From *Rigzone*. June 2023.

Offshore Carbon Storage Project in Danish North Sea Receives Safety Approval.

Project Greensand, an offshore carbon storage project in the Danish North Sea, received official safety approval from *DNV*. The safety verification covers everything from fabrication by the individual subcontractors to the actual offshore installation. For this pilot project, the CO₂ was transferred from Belgium aboard a platform supply vessel, transferred to the Noble Resolve jack-up rig, injected into a depleted reservoir at the Nini field, and stored at a depth of about 1,800 meters below the seabed.

From *OE Offshore Engineer*. June 2023.

Report on Unforeseen Variances in Norway CCS Projects.

The Institute for Energy Economics and Financial Analysis (IEEFA) released a report on CO₂ storage in the Sleipner and Snøhvit subsea fields. “*Norway’s Sleipner and Snøhvit CCS: Industry models or cautionary tales?*” focuses on subsurface geology and is based on literature reviews of technical studies and academic papers.

From *IEEFA*. June 2023.

OMB Regulatory Agenda Outlines Upcoming CCS-Related Rulemakings.

The *Spring 2023 Unified Agenda and Regulatory Plan*, published by the White House Office of Management and Budget, includes CCS-related items. Released twice per year, the agenda outlines actions federal agencies plan to issue in both the near and long term.

From *Ethanol Producer Magazine*. June 2023.

September 2023 (Vol. 23 No. 9)

DOE Funds DAC Facilities

DOE announced funding to advance the development of two commercial-scale direct air capture (DAC) facilities in Texas and Louisiana. The projects are expected to remove more than 2 million metric tons of CO₂ emissions from the atmosphere each year.

From *energy.gov*. August 2023.

DOE Announces Funding to Speed Up Adoption of Carbon Management Technologies

DOE announced the availability of funding to support states, local governments, and public utilities in purchasing products derived from converted carbon emissions. The funding is aimed at speeding up the adoption of advanced carbon management technologies, creating a market for environmentally sustainable alternatives in fuels, chemicals, and building products sourced from captured emissions from industrial and power generation facilities.

From *energy.gov*. July 2023.

Announced DOE Funding to Help Understand Impacts of Geologic Storage

DOE’s Office of Fossil Energy and Carbon Management (FECM) and *Office of Technology Transitions (OTT)* announced funding for four national laboratory-led projects supporting carbon management and resource sustainability. One of the projects, led by Lawrence Berkeley National Laboratory, will develop a tool that will lead to a better understanding of the impacts of geologic carbon storage.

From *energy.gov*. July 2023.

NETL, Partners Develop Technology to Help Realize Effective Carbon Storage

NETL and partner organizations developed and demonstrated a suite of embedded sensor technologies enabled with sensing materials for subsurface wellbore integrity monitoring—technology that can help realize effective geologic carbon storage. Work began in April 2018, with NETL (project lead) and partner organizations including the Illinois State Geological Survey, Intelligent Optical Systems, University of California at Los Angeles, University of Pittsburgh, and Carnegie Mellon University.

From *NETL*. August 2023.

DOE Announces Intent to Launch Responsible Carbon Management Initiative

DOE’s FECM *announced its intent* to launch a “Responsible Carbon Management Initiative,” aimed at encouraging and recognizing project developers and others in the industry to pursue the highest levels of safety, environmental stewardship, accountability, community engagement, and societal benefits in carbon management projects.

From *energy.gov*. August 2023.

DOE Invests in Carbon Management Technologies and Applications

DOE’s FECM announced funding for 23 projects to support R&D for carbon management technologies and applications that reduce carbon dioxide (CO₂) emissions. The projects will be led by universities and private sector companies throughout the United States to advance technologies toward commercial deployment that will capture CO₂ from sources such as industrial facilities or power plants, or directly from the air and oceans, and convert it into valuable products such as fuels, chemicals, and building materials.

From *energy.gov*. August 2023.

U.S., India Partnership to Collaborate on CCUS

During the third ministerial meeting of the U.S.-India Strategic Clean Energy Partnership (launched in September 2021), the sides renewed their commitment to work toward a just, orderly, and sustainable energy transition, prioritizing access to a reliable, affordable, and clean energy supply. In addition, the sides agreed to spur partnership in the area of carbon capture, utilization, and storage (CCUS).

From *energy.gov*. August 2023.

USDA Announces Investments to Improve Monitoring of GHG Emissions and Carbon Storage

The U.S. Department of Agriculture (USDA) announced new investments to improve the measurement, monitoring, reporting, and verification of greenhouse gas (GHG) emissions and carbon storage in climate-smart agriculture and forestry. The investments, made possible by the Inflation Reduction Act (IRA), will advance priorities set by the broader *Federal Strategy to Advance Greenhouse Gas Measurement and Monitoring for the Agriculture and Forest Sectors*, which was released as a draft for public input and outlines a strategic framework and priority actions for improving accuracy and reducing uncertainty of GHG estimates.

From *USDA*. July 2023.

MRCI 2023 Partners and Stakeholders Meeting

The DOE-funded *Midwest Regional Carbon Initiative (MRCI)* will hold its 2023 Partners and Stakeholders Meeting, October 3–5, 2023, in Morgantown, West Virginia. The meeting will include updates on the work MRCI has been doing to accelerate CCUS acceptance and deployment in its *20-state region*, as well as updates from DOE, reports on commercial progress from the region, and an overview of research in the Illinois, Michigan, and Appalachian basins.

From *MRCI*. June 2023.

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 CO₂, 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 CO₂ emissions. The program also serves to increase the understanding of the effectiveness of advanced technologies in different geologic reservoirs appropriate for CO₂ 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 CO₂ behaves in the subsurface. These objectives are necessary to increasing public confidence in safe, effective, and permanent geologic CO₂ 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](#).



Rig drilling a site characterization well at the Craig Power Station in Colorado, USA. Photo Source: Schlumberger Carbon Services

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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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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