**DOE/NETL HIGHLIGHTS**

**DOE/FE Funding to Include CCUS.**

The U.S. Department of Energy’s (DOE) Office of Fossil Energy (FE) announced the availability of financial assistance for cost-shared research and development (R&D) projects under a Funding Opportunity Announcement (FOA) that supports the initial engineering and design of carbon capture, utilization, and storage (CCUS) projects. Projects selected under the CCUS-focused Area of Interest (AOI) for this FOA will support the completion of an initial design of a commercial-scale CCUS-direct air capture system that separates, stores, or utilizes a minimum of 1,000 metric tons of carbon dioxide (CO₂) per year from the air. The National Energy Technology Laboratory (NETL) will manage the projects, which will support DOE’s Carbon Capture Program. Responses are due by March 5, 2021. From energy.gov. January 2021.

**ANNOUNCEMENTS**

**DOE Announces FOA in Support of CO₂ Utilization.**

DOE/FE will make available federal funding for cost-shared research, development, and testing of technologies that can utilize CO₂ from power systems for bio-mediated uptake by algal systems to create valuable products and services. The FOA, which supports DOE’s Carbon Utilization Program, will seek applications that aim to perform engineering-scale testing and validation of algae-based technologies and bioproducts. Responses are due March 2, 2021.

**DOE Announces Funding to Help Decarbonize Energy and Commodity Production.**

DOE/FE announced that federal funding is available for cost-shared R&D to help recalibrate the nation’s fossil fuel and power infrastructure for decarbonized energy and commodity production. The funding is aimed at developing technologies for the production, transport, storage, and utilization of fossil-based hydrogen, with progress toward net-zero emissions. Projects selected under the FOA will be managed by NETL. Responses are due March 1, 2021.

**RGGI Secondary Market Report Made Available.**


**Industry Research Report on CO₂-EOR Market Released.**

A research report on the global CO₂-enhanced oil recovery (EOR) market was released by a research and consulting services company. The report offers qualitative and quantifiable information on factors affecting or influencing market dynamics and market growth, including sections on global CO₂-EOR market growth drivers, market trends, and market opportunities. (Purchase may be required.)

**Report Outlines Potential Approaches to Reduce CO₂ Emissions.**

University of Colorado’s (Boulder) Renewable and Sustainable Energy Institute (USA) released a report outlining steps the United States can take to reduce CO₂ emissions. “Accelerating the U.S. Clean Energy Transition: Challenges and Solutions by Sector” describes low- and zero-carbon solutions across a variety of sectors, laying out policy options for each. The report also provides an overview of technologies that have the potential to reduce CO₂ levels.
PROJECT and BUSINESS DEVELOPMENTS

Full-Scale CCS Facility to Be Installed in Norway.

A full-scale carbon capture and storage (CCS) facility will be installed at a cement plant in Brevik, Norway. The HeidelbergCement Norcem project is expected to capture and store 400,000 tons of CO₂ per year. Work on the facility is projected to begin in 2021, with the goal of beginning CO₂ separation from the cement process in later years. The outcome is expected to be a 50% reduction of emissions produced at the plant. From The Baltic Course. December 2020.

MOU Signed to Further Develop CCUS Value Chain

Equinor Energy and Mitsubishi Heavy Industries signed a Memorandum of Understanding (MOU) for a low-carbon technology collaboration. Under the MOU, both companies will develop and use technology to reduce the CO₂ footprint of oil and gas operations. The companies will look to further develop the hydrogen and CCUS value chains. From Mitsubishi Heavy Industries News Release. December 2020.

Norwegian CO₂ Storage, Transport Project to Proceed.

The Norwegian government has voted to fund the Northern Lights CO₂ transport and storage project, enabling it to proceed. The Northern Lights project will be an open and available infrastructure that enables the transport of CO₂ from industrial capture sites to a terminal in Øygarden for intermediate storage before being transported by pipeline for permanent storage in an underground reservoir. The project is the transport and storage component of Longship, the Norwegian government’s full-scale CCS project. From Carbon Capture Journal. December 2020.

LEGISLATION and POLICY

Bill Introduced to Support CO₂ Storage.

A bill was introduced in the U.S. House of Representatives that supports the buildout of the infrastructure necessary to transport CO₂ from where it is captured to where it could be stored. The Storing CO₂ and Lowering Emissions (SCALE) Act would also authorize DOE to provide grants for procuring carbon utilization products for infrastructure projects, as well as build upon DOE’s Carbon Storage Assurance Facility Enterprise (CarbonSAFE) projects. Under the bill, increased funding would also enable the U.S. Environmental Protection Agency to review permit applications for Class VI CO₂ storage wells in a timely manner and provide grants for states to establish and operate their own Class VI permitting programs. From Ethanol Producer. December 2020.

Companies to Collaborate on CCUS Projects in India.

Carbon Clean and Veolia announced a joint venture to develop two CCUS projects in India. The newly established company, Veolia Carbon Clean, will finance, design, build, and operate the projects, as well as research the opportunity for other projects in India. From Carbon Clean. December 2020.

Locations Being Investigated for Storage, Liquefaction of CO₂ in Sweden.

Five energy companies in Sweden will collaborate in a pre-study to investigate infrastructure for capturing and storing CO₂. One location being studied by representatives of the Carbon Infrastructure Capture (CinfraCap) project is the Energy Terminal at the Port of Gothenburg (Sweden), where they are looking to identify a suitable location for intermediate storage and possible liquefaction of CO₂. From Port of Gothenburg News Release. December 2020.

Carbon Storage Consulting Services Contract Awarded.

Oxy Low Carbon Ventures was awarded a contract to provide carbon storage consulting services for Minnkota Power Cooperative’s Project Tundra. Oxy Low Carbon Ventures, a carbon management company, will advise Minnkota on the design and overall requirements of the project’s carbon storage facility. Minnkota is currently conducting front-end engineering and design studies. From Yahoo! December 2020.

UK Government to Fund CO₂ Reduction Projects.

Six projects across the United Kingdom (UK) were awarded funding from the UK government to form a “net-zero industrial zone.” Among the projects is the Humber Industrial Cluster Plan, which will examine how hydrogen and CCS technology can be scaled up to help achieve net-zero emissions by 2040. From Energy Live News. January 2021.

IRS Finalizes Carbon Capture Tax Credits.

The U.S. Internal Revenue Service (IRS) and the U.S. Treasury Department released final regulations for businesses seeking to claim carbon capture tax credits under section 45Q. The final rules aim to help businesses understand how the tax credit for qualified carbon oxide storage can benefit companies claiming carbon capture credits. From Accounting Today. January 2021.

New York State Establishes GHG Emissions Cap.

New York State adopted a regulation that requires statewide greenhouse gas (GHG) emissions limits. Under the New York Climate Leadership and Community Protection Act, emissions limits in the state are required to reflect a 40% reduction in statewide GHG emissions by 2030 and an 85% reduction by 2050 (both based on 1990 levels). From Lexology. December 2020.

Agreement on Bill to Reduce CO₂ Emissions Reached.

Agreement was reached on a Massachusetts bill to reduce the state’s CO₂ emissions by at least 85% below 1990 levels by 2050. The bill (S. 2995) would establish a net-zero GHG emissions limit for 2050, as well as statewide emissions limits every five years over the next three decades. From Milford Daily News. January 2021.
LEGISLATION and POLICY (cont.)

Researchers Produce CCUS Study.
Researchers from the University of Wyoming, the West Virginia University School of Law, and the U.S. Energy Association published a study identifying regulatory shortcomings that may impact the deployment of CCUS technologies in the United States. The study identified legal and regulatory obstacles to CCUS deployment, such as land, mineral, pore space, or water rights; eminent domain; or pipeline or CO₂ storage regulations. The U.S. Energy Association conducted a webinar outlining the results of the study. From Casper Star-Tribune. December 2020.

UK Oil and Gas Strategy Includes Support for CCS Projects.
The UK Oil and Gas Authority submitted a revised strategy in the UK Parliament that supports the government’s net-zero targets. Under the revised strategy, industry is encouraged to collaborate with the supply chain and actively support CCS projects. From Carbon Capture Journal. December 2020.

UK Energy White Paper Builds on CCS Development.
The UK government released an Energy White Paper that outlines plans to support a transition to net-zero. The white paper builds on the Ten-Point Plan, which includes funding for the development of four CCS hubs and clusters. From Global CCS Institute. December 2020.

EMISSIONS TRADING

RGGI States Initiative Auction Process for Auction 51.
The RGGI-participating states initiated the auction process for their 51st quarterly CO₂ auction, scheduled for March 3, 2021. Auction 51 will offer 23,467,261 CO₂ allowances for sale at a minimum reserve price of $2.38. An 11,976,778 CO₂ allowance cost containment reserve (CCR) will also be made available (the CCR will be accessed if the interim clearing price exceeds the CCR trigger price of $13.00). From RGGI News Release. January 2021.

Daily Carbon Credit Assessment Launched.

SCIENCE

Research Partnership to Use CCUS Technology.
A research partnership to use CCUS technology to produce plastic was formed. Braskem, a polyolefins producer, and the University of Illinois Chicago (UIC) (USA) will develop a new method for producing ethylene—a raw material used to make thermoplastic resins—that will utilize CCUS technology. The project will use the CCUS technology under development at UIC to connect the capture and conversion of waste CO₂ streams with the production of sustainable feedstock for making plastic. Braskem will assist with scale-up of the technology and help validate the theoretical and experimental studies produced by UIC. From Braskem News Release. December 2020.

Scientific Development Could Improve CO₂ Capture.
Researchers from Swansea University (UK) developed a new way of producing carbon spheres that has the potential to improve carbon capture technologies. According to scientists, carbon spheres play an important role in gas adsorption and storage. The Swansea team adapted an existing method of creating carbon spheres (chemical vapor deposition) by using pyromellitic acid as both a carbon and oxygen source and applied the method at different temperatures. From Swansea University Press Release. December 2020.

Scientists Convert CO₂ into Jet Fuel.
Scientists from Oxford University successfully converted CO₂ into jet fuel using a technique that reverses the process of burning fuel by relying on the organic combustion method. By heating a mix of citric acid, hydrogen, and an iron-manganese-potassium catalyst, the team was able to convert CO₂ into a liquid fuel capable of powering jet aircraft. According to the scientists, the technique has the potential to make conventionally powered aircrafts with net-zero CO₂ emissions. From Yahoo/December 2020.
Scaling Up the CCS Market to Deliver Net-Zero Emissions.

The following is from the Executive Summary of this Global CCS Institute report: “Understanding how the carbon capture and storage (CCS) market is likely to develop over the coming years is of interest to a wide range of stakeholders. It can help inform the timing and design of policies introduced by governments, the scale of the market for potential investors, and the challenges associated with meeting long-term climate targets. This report aims to inform the discussion on these topics by providing an overview of the near-term and longer-term developments in the CCS market. It reviews the current CCS facility pipeline, and how that could change in the next few years given project lead-in times. It then considers how this compares to projections of the number of CCS facilities needed to meet long-term climate goals. Throughout the report the number of CCS facilities deployed is used as a proxy for the size of the CCS market. The current CCS facility pipeline provides a relatively robust indicator of the CCS market in the next few years, particularly given it takes around 6-8 years for projects to progress through the full development cycle. There are currently 51 large-scale CCS facilities in the CCS facility pipeline, with 19 in operation, 4 under construction, 10 in advanced development and 18 in early development. Most of the large-scale facilities in operation are in North America, with the remainder in Norway, China, Brazil, Saudi Arabia, Australia and the UAE. The projects tend to be concentrated in industries where the unit cost of capturing CO₂ is low, such as natural gas processing, fertiliser and ethanol production.”

A knowledge-data framework and geospatial fuzzy logic-based approach to model and predict structural complexity.

The following is from the abstract of this article: “Prediction of structural complexity for geohazard and subsurface resource applications requires constraining and interpreting data that are often ambiguous or lack key information. Moreover, structural complexity is a subjective term, requiring context for quantification. Recognizing this, a new knowledge-data framework and a geospatial fuzzy logic method is developed to represent and predict structural complexity in the subsurface. A conceptual model for known structural complexity serves as a basis for associating geospatial representations with types of damage zones. A second conceptual model for zones of structural complexity facilitates its prediction, notably in areas with limited explicit structural data. For each conceptual model, a fuzzy logic inference model is developed to incorporate geospatial data and estimate structural complexity potential. This approach is demonstrated using several public geospatial datasets within the state of Oklahoma. Explicit fault and earthquake location data were integrated using a fuzzy model of known structural complexity to train topographic, lithologic, and geophysical proxy datasets, applied to a fuzzy model to predict structural complexity, and evaluated with Receiver Operating Characteristic analyses and error classification. The final model output, displayed in maps and cross sections, offers comparison with interpreted structural data for validation. Together, these results demonstrate the effectiveness and limitations of the new approach as a screening tool for predicting structurally complex areas.”

Devin Justman, C. Gabriel Creason, Kelly Rose, and Jennifer Bauer, Journal of Structural Geology. (Subscription may be required.)
Carbon sequestration and vegetation properties across the age of community managed exclosures in Northern Ethiopia.

The following is from the abstract of this article: “Exclosure management is becoming a common approach to rehabilitate and increase net biomass productivity of extremely degraded areas in Northern Ethiopia. However, the effect of age of exclosures on vegetation and soil property of communal lands is not yet well studied. In this study, the effect of land exclusion and age of exclosure on plant species richness, diversity, density and dominance, herbaceous standing biomass, woody biomass, woody biomass carbon, soil organic carbon (SOC) and other soil properties were assessed. To study the above listed variables, exclosures in three age classes (5–7, 12–15 and >20 years) and adjacent free grazing areas were selected. [The authors] replicate each age class three times considering agroecological similarity. From each exclusion and free grazing area, six larger plots (10m × 20m) each having five small quadrats were taken. Totally, 72 larger plots and 360 small quadrats were sampled. The result of this study indicates that exclusion of communal lands significantly improved species richness, diversity, biomass, woody biomass carbon, SOC, total nitrogen (TN) and total potassium (TK). Similarly, the density of perennial species and the density of grass species were found increased with the age of exclosure. Herbaceous species richness, diversity and annual species density were higher in the young-aged exclosures than in the older exclosures. Woody species richness, diversity, density, biomass, and woody biomass carbon were highest in the older exclosures. Besides, age of exclosure increases the content of SOC, TN and TK. Furthermore, it was found that young-aged exclosures stored more biomass carbon (267 %) and SOC (37.66 %) than the young-aged exclosures. The study indicates the benefits of land exclosure for permanent carbon storage, which is vital to reduce atmospheric greenhouse gas concentration.” Gebrehaweria Kidane Reda, Teame Gebrehiwot Kebede, Shishay Tekklay Kahsay, and Berhane Hagos Gebrehiwot, Journal for Nature Conservation. (Subscription may be required.)

Carbon dioxide wettability of South West Hub sandstone, Western Australia: Implications for carbon geo-storage.

The following is from the abstract of this article: “CO₂-rock wettability is a key factor which determines the fluid dynamics and CO₂ geo-storage capacity. However, the full understanding of real reservoir CO₂-wettability is yet to be gained. [The authors] thus systematically analysed the wettability of CO₂-brine/ South West Hub sandstones at various pressures (0.1 MPa, 5 MPa, 10 MPa, 15 MPa, and 20 MPa) at 334 K. A new procedure based on organic carbon isotope tracking (13Corg) was proposed to eliminate the effect of artificial organic matter introduced by drilling mud penetration. The results indicate that the advancing (θₐ) and receding (θₜ) water contact angles for the CO₂-brine/ South West Hub sandstone system increase with increase in pressure (ranging from 71° to 118° and 66° to 111°). It can thus be suggested that the system is weakly water-wet to intermediate-wet. When the samples were treated with dichloromethane, a slight decline in organic content was observed leading to slight decrease in water contact angles (i.e. TOC decreased from 0.019% to 0.003% for core C, and the corresponding θₐ and θₜ decreased from 118° to 110° and 111° to 104°, respectively, at 20 MPa and 334 K). This wettability analysis demonstrates that (a) the contact angle is very sensitive to the amount of organic matter and therefore care should be taken to remove artificial organic matter from the sample, and that (b) this condition prevails in a real proposed CO₂-storage site. This analysis thus has important implications for assessing the feasibility of long-term CO₂ storage and enabling large-scale industrial carbon geological storage projects.” Cut Aja Fauziah, Ahmed Z. Al-Yaseri, Nilesh Kumar Jha, Christopher Lagat, Hamid Roshan, Ahmed Barifcani, and Stefan Iglauer, International Journal of Greenhouse Gas Control. (Subscription may be required.)
**Sustainable utilization and storage of carbon dioxide: Analysis and design of an innovative supply chain.**

The following is from the abstract of this article: “A mixed integer linear programming model is developed for the optimal design of carbon capture utilization and storage supply chain in Germany. A sensitivity analysis shows that for the optimal supply chain the total costs are 97.9 billion €/year with a NPV of 675 billion € and a PB of 2.71 years: the economic profitability is ensured only due to the use carbon tax. Also, 160 MtonCO₂ year are captured to produce methanol, concrete, wheat, lignin, polyurethane, calcium carbonate, urea and concrete by red mud. It is found that the selection of capture material/technology depends on CO₂ composition, flue gas flow rate and CO₂ final use. The high flow rate of flue gases with a CO₂ composition between 13 mol% and 22 mol%, is most effectively captured by absorption technology. A Monte Carlo simulation is carried out to evaluate the uncertainties regarding the selling price and national demand of compounds.” Grazia Leonzio, Pier Ugo Foscolo, and Edwin Zondervan, Computers & Chemical Engineering. (Subscription may be required.)

**Zeolite and fly ash in the composition of oil well cement: Evaluation of degradation by CO₂ under geological storage condition.**

The following is from the abstract of this article: “The performance of cement class G used in cementation of oilfield wellbores with addition of pozzolans was evaluated under geological carbon storage conditions. Two commercial synthetic zeolites types (4A-1 and 4A-2) and fly ash from a coal-fired plant were used as pozzolanic materials in amounts of 5 and 10% in weight replacing the cement. After curing, the cement samples were submitted to degradation tests in CO₂-saturated water at 15 MPa and 90°C for 7 and 14 days. The cement chemical degradation by CO₂ was investigated using scanning electron microscopy (SEM), X-ray diffraction (XRD) and compressive strength tests. The chemically altered layer thickness was averaged 3.46 mm for standard cement after 14 days of exposure to CO₂. On the other hand, cement systems with 10% wt. of pozzolanic material varied from 1.70 to 5.50 mm depending on the type of pozzolan and level of cementitious matrix porosity related to pozzolanic particle clustering. In general, 4A-1 zeolite presented better performance in terms of resistance to CO₂ attack and higher compressive strength after 14 days when compared to 4A-2 zeolite. The results showed that the addition of fly ash improved the compressive strength of the samples but increased the chemically altered layer due to CO₂ diffusion. SEM and XRD analyses showed that the portlandite was consumed and carbonation occurred in the chemical modified layer due to cement reaction with aqueous CO₂. Most cement systems with and without pozzolanic material exhibited no expressive loss on compressive strength after being exposed to CO₂-rich environment up to 14 days. On the contrary, some cement systems with 4-A1 zeolite and fly ash exhibited a mechanical resistance increase due to the carbonation process.” Roger Braun Ledesma, Natáliia Feijó Lopes, Katryanne Georg Bacca, Martimiano Krusciel de Moraes, Giovanni dos Santos Batista, Marçal Rodrigues Pires, and Eleani Maria da Costa, Journal of Petroleum Science and Engineering. (Subscription may be required.)
ABOUT DOE’S CARBON STORAGE PROGRAM

The Carbon 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 depositional environments. 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, basalt formations, and organic-rich shale basins—and to improve the understanding of how CO₂ behaves in the subsurface. These objectives are key to increasing confidence in safe, effective, and permanent geologic CO₂ storage.

The Carbon 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 Storage Program Resources

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

ABOUT NETL’S CARBON STORAGE NEWSLETTER

Compiled by the National Energy Technology Laboratory, this newsletter is a monthly summary of public and private sector carbon 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). Click here to manage your Carbon Storage Newsletter subscription options or to unsubscribe.

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