CSN CARBON STORAGE NEWSLETTER

MARCH 2021

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

CARBON STORAGE PROGRAM DOCUMENTS and REFERENCE MATERIALS

NATIONAL ENERGY TECHNOLOGY LABORATORY

DOE/NETL HIGHLIGHTS

NRAP Releases Draft Recommended Practices for Geologic Carbon Storage Sites.

NRAP National Risk Assessment Partnership

Researchers from the U.S. Department of Energy's (DOE) National Risk Assessment Partnership (NRAP) released two draft reports providing recommendations to support quantitative assessment and management of subsurface environmental and induced seismicity risks at geologic carbon storage sites. The draft reports—"*NRAP Recommended Practices for Containment Assurance and Leakage Risk Quantification*" and "*NRAP Recommended Practices for Managing Induced Seismicity Risk Associated with Geologic Carbon Storage*"—are available through the National Energy Technology Laboratory's (NETL) Energy Data eXchange (EDX). Public comment is sought through May 7, 2021. The reports are organized as a set of conceptual workflows that progress through the various stages of the geologic carbon storage project lifecycle. Recommendations are intended to support stakeholder decision-making related to site characterization, area of review, post-injection site care, and monitoring intensity and duration. NRAP is a collaboration of five U.S. national laboratories focused on quantifying and managing subsurface environmental risks to support implementation of safe and secure large-scale geologic carbon storage.

NRAP Releases Dataset and Tools.

EDX Energy Data eXchange

DOE's *NRAP released FutureGen 2.0 data* to the public on NETL's EDX. Stemming from a federally funded research and multi-year preservation effort, the release makes this dataset available to the carbon storage community for model simulation development and validation and for future machine learning/artificial intelligence applications in carbon storage analysis. In addition, NRAP *released the Passive Seismic Monitoring Tool*, which is used for optimal design of passive seismic monitoring networks using surface or borehole geophones.

DOE's SMART Initiative Generates Dataset for CO_2 Injection Site and Develops an LIP Framework.

SMART

DOE's National Energy Technology Laboratory's (NETL) Science-Informed Machine Learning for Accelerating Real-Time Decisions in Subsurface Applications (SMART) Team *generated a comprehensive synthetic dataset for a realistic carbon dioxide (CO_2) injection site*. In addition, the SMART Real-Time Forecasting Team is *developing a learning-based inversion-free prediction (LIP) framework* that has the potential to produce real-time forecasting with uncertainty quantification informed by streaming observation data through parallel forward simulations. Funded by DOE's *Carbon Storage* and Upstream Oil and Gas Programs, the SMART Initiative is a 10-year, multi-organizational effort with the goal of transforming data analysis and predictive capabilities for subsurface applications and significantly improving efficiency and effectiveness of carbon storage and unconventional oil and gas field operations.

ANNOUNCEMENTS

NETL-Supported Project to be Field-Tested.

An NETL-supported project to develop a transformational CO_2 capture technology will be field-tested at Norway's Technology Centre Mongstad (TCM). The Non-Aqueous Solvent technology is being developed by RTI International with support from DOE's Office of Fossil Energy (FE) and NETL.

Norway's Technology Centre Mongstad

ANNOUNCEMENTS *(cont.)*

DOE Announces Funding for Clean Energy Research.

DOE announced funding for transformative clean energy research and development (R&D) via the Advanced Research Projects Agency-Energy (ARPA-E). DOE will also participate in the National Climate Task Force's Climate Innovation Working Group, which will coordinate federal efforts to help achieve net-zero economy-wide emissions by 2050.

RGGI Secondary Market Report Made Available.

The independent market monitor for the Regional Greenhouse Gas Initiative (RGGI) released a report on the secondary market for RGGI CO_2 allowances, including future prices, market activity, and allowance holdings. Potomac Economics' "Report on the Secondary Market for RGGI CO_2 Allowances: Fourth Quarter 2020" addresses the period from October through December 2020. The report is part of Potomac's ongoing monitoring of the RGGI auctions and secondary markets.

Report Examines CCS Potential to Address CO_2 Emissions.

Rystad Energy's monthly "Energy Transition Report" found that carbon capture and storage (CCS) technology has the potential to address approximately 62% of global CO_2 emissions. The assessment adds that direct air capture (DAC) and bioenergy carbon capture and storage (BECCS) technology will also be needed to reach this level.

Database to Support North Sea CCS Operators.

Applied Petroleum Technology compiled a new database of CO_2 properties at various pressures and temperatures for the North Sea to support operators considering offshore CO_2 storage. The database includes more than 950 data points.

CCS Project Update.

Porthos, a CCS project in Rotterdam, Netherlands, *announced* it is on schedule to store approximately 2.5 million metric tons of CO_2 per year in gas fields beneath the North Sea.

IEA to Produce Net-Zero Roadmap.

The International Energy Agency (IEA) will produce a report that details the steps governments, companies, investors, and citizens can take for the energy sector to reach net-zero emissions by 2050. "The World's Roadmap to Net Zero by 2050" is expected to be released in 2021.

PROJECT and BUSINESS DEVELOPMENTS

Companies to Explore CCS Solutions.

LafargeHolcim and Schlumberger New Energy announced a partnership to explore the development of CCS solutions. The two companies will study the feasibility of capturing CO_2 from two LafargeHolcim cement plants—based in North America and Europe—using Schlumberger's carbon storage technology. From *The Maritime Executive*. February 2021.

ExxonMobil to Invest in CCS.

ExxonMobil announced the creation of a business to commercialize its low-carbon technology portfolio, with an initial focus on CCS technologies. According to the company's press release, ExxonMobil Low Carbon Solutions will advance plans for more than 20 new CCS opportunities worldwide to enable large-scale emissions reductions. ExxonMobil also plans to invest in lower-emissions energy solutions. From *ExxonMobil News Release*. February 2021.

EOR Pipeline Project Approved.

The Bureau of Land Management (USA) approved the Wyoming Pipeline Corridor Initiative, designating approximately 1,100 miles of federal land for potential future pipeline development. The proposal identifies routes across Wyoming that could be utilized for enhanced oil recovery (EOR). From *Wyoming Tribune News*. January 2021.

Chevron Invests in CCUS Startup.

Chevron plans to invest in Blue Planet, a startup that uses captured CO_2 to produce carbonate aggregates that can be used for building materials. The two companies signed a letter of intent to collaborate on potential pilot projects and commercial opportunities. Blue Planet's CO_2 capture process does not require that CO_2 be purified and enriched before use, which has the potential to reduce energy and cost compared to other CO_2 utilization technologies. The technology could also be used to store CO_2 in building materials at a significant scale. From *The Chemical Engineer*. January 2021.

Feasibility Study Underway for India CCUS Project.

Datsur, Air Liquide, and the Bureau of Economic Geology at the University of Texas at Austin (USA) have been selected to conduct a feasibility study for a carbon capture, utilization, and storage (CCUS) project in India. The project will be conducted at Indian Oil Corporation Ltd.'s Koyali refinery near Vadodara, Gujarat, which has the potential to capture more than 5,000 tons of CO_2 per day for large-scale EOR. The project will examine the technical viability, economic cost, and feasibility of capturing CO_2; develop technical specifications, designs, and plans; review and identify necessary approvals and permits required; and analyze the environmental benefits of the CCUS project. From *Chemical Engineering*. January 2021.

CCS Project Awards Contract.

Subsea 7—a subsea company servicing the offshore energy industry—and Aibel—a service company within the oil, gas, and offshore wind industries—were awarded contracts for the *Northern Lights Project*, which is part of the Norwegian full-scale CCS project. Through an engineering, procurement, construction, and installation (EPCI) contract, Subsea 7 will lay the pipeline that will transport CO_2 from the intermediate storage site to the injection well in the North Sea. Aibel was awarded an EPCI contract for the Northern Lights subsea control system. The scope of work includes upgrades to the platform to operate the system that will connect it to the Northern Lights subsea facilities. From *Carbon Capture Journal*. February 2021.

Companies Sign MOU to Develop Integrated CO_2 Capture Solution.

Chart Industries and Svante signed a Memorandum of Understanding (MOU) to develop an integrated CO_2 capture and storage solution to make high-purity CO_2 products from industrial flue gas streams. The facilities will employ Svante's solid-sorbent technology to capture CO_2 directly from post-combustion flue gases to produce pipeline-grade CO_2 for transportation and storage. From Gasworld. February 2021.

LEGISLATION and POLICY

Carbon Market Bill Passes State Senate Natural Resources Committee.

A bill to establish a voluntary carbon market in Indiana (USA) passed the Indiana Senate Natural Resources Committee. *Senate Bill 373* would establish a carbon market program that facilitates carbon market trading in Indiana, as well as a "Climate-Friendly Farming and Forestry Registration Program" that registers technical advisers and creates an advisory council. The bill will next head to the full Senate for consideration. From *Indiana Environmental Reporter*. February 2021.

Bill Aims for Tax Exemption to Support CO_2 Storage.

Legislation to create a tax exemption for storage of CO_2 was passed in the North Dakota (USA) Senate. North Dakota already exempts CO_2 used for EOR from sales and use tax; the legislation, *Senate Bill 2152*, provides clarification that the same tax treatment can be extended to CO_2 used for geologic storage. The bill will next go to the North Dakota House. From *Ethanol Producer Magazine*. January 2021.

New Mexico Emissions Reduction Bill Passes First Step.

Legislation focused on reducing greenhouse gas (GHG) emissions in New Mexico (USA) passed the House Energy and Natural Resources Committee. House Bill 9, "The Climate Solutions Act," would establish carbon emissions reduction targets and incentivize businesses to find solutions to meet the targets. A key element of the bill includes the establishment of statewide GHG emissions standards, with goals of reaching a 50% reduction in GHGs by 2030 and net-zero emissions by 2050. The bill will be heard next by the New Mexico House State Government, Elections, and Indian Affairs Committee. From *Los Alamos Reporter.* February 2021.

EMISSIONS TRADING

RGGI to Conduct Program Review.

The RGGI-participating states intend to initiate a program review in 2021, as stated in their *Principles to Accompany Model Rule Amendments*. To date, two program reviews have been conducted, which considered program design and outcomes, as well as potential changes or new program elements. The RGGI-participating states intend to publish a preliminary program review schedule later in 2021, including a public engagement plan to solicit input to inform the review process. From *RGGI News Release*. February 2021.

EU Carbon Auction Clears at Record High Price.

A February 2021 CO_2 carbon allowance auction under the European Union (EU) Emissions Trading System (ETS) cleared at the highest auction price since the EU ETS launched in 2005, according to auction host European Energy Exchange. From *S&P Global*. February 2021.

ICE to Move EU Carbon Trading to Netherlands.

The Intercontinental Exchange (ICE), which provides price transparency within energy markets, announced that it will move its trading of European carbon futures and options from London to its Netherlands-based exchange in Amsterdam. The date of the move has not been announced, but it is expected to take place later in 2021. From *Nasdaq*. February 2021.

SCIENCE

New Carbon Storage Studies Launched.

Agronomic research trials and field demonstrations are being conducted to help farmers add carbon storage to their operations. AGCO—an agricultural machinery and solutions company—will conduct research trials in Africa, Switzerland, Denmark, and the United States, focusing on best practices to maximize carbon stores. From *No-Till Farmer*. February 2021.

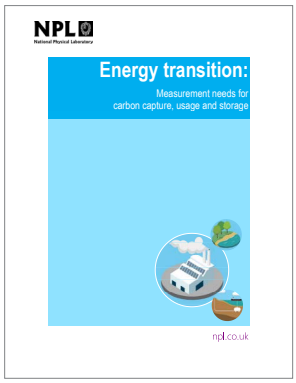
New Method Could Boost CO_2 Storage Rates.

Researchers from the Massachusetts Institute of Technology (MIT; USA) developed a method that could boost the performance of systems that use catalytic surfaces to enhance the rates of carbon-storing electrochemical reactions. In such catalytic systems, the movement of a stream of gas containing CO_2 is typically sluggish, slowing down the rate of CO_2 conversion. Results of the study, *published in the journal Cell Reports Physical Science*, show that the new design ensures the CO_2 stream stays concentrated, nearly doubling the performance of the system. From *Carbon Capture Journal*. January 2021.

PUBLICATIONS

Energy transition: Measurement needs for carbon, capture, usage and storage.

The following is from the Introduction of this United Kingdom (UK) National Physical Laboratory (NPL) document: "In 2019, the UK became the first major economy to pass legislation that committed to a target of net zero greenhouse gas (GHG) emissions by the year 2050, and by 2045 in Scotland… As of September 2020, the global average CO_2 content in the atmosphere was around 411 parts per million (ppm), which is 'higher than at any point in at least the past 800,000 years'. However, there are uncertainties in the scale, timeline and geographical nature of the impacts of climate change on society and hence in the relative value of differing mitigation strategies. These uncertainties mean that the consequences for society, in both action and inaction, are dramatic and far-reaching. CCUS provides an effective transitionary tool to deal with these uncertainties and to enable progress towards net zero whilst allowing the economy to time to adapt."



Carbon Capture and Storage Market: Technology Innovations and Analysis Till 2030.

The following are key highlights of this Prophecy Market Insights report: "The global carbon capture and storage market accounted for US$ 1.4 billion in 2018 and is projected to register a moderate CAGR of 9.30% over the forecast period. The market report has been segmented on the [capture] technology, end-user industry, and region. By technology, pre-combustion is dominating the segment, due to increased energy generation, newly developed advanced amine systems. By end-user industry, the oil and gas industry is dominating the segment, as carbon capture and storage (CCS), is aiding the oil and gas industry to mitigate greenhouse gases out of the atmosphere. By region, North America is projected to lead the global carbon capture and storage market and is expected to remain dominant during the forecast period, owing to the growing demand for clean technology."

CO_2 storage potential in sedimentary basins of Kazakhstan.

The following is from the Abstract of this article: "The terms of the Paris Agreement oblige Kazakhstan to decrease its Greenhouse Gas (GHG) emissions by 2030. Annual GHG emissions of the country already went beyond the limit set by the Paris agreement in 2014 and this number is expected to increase with a growing economy showing that current measures of GHG mitigation in the country are insufficient. Despite the energy sector of the country being heavily dependent on its coal and substantial land resources, CCS was not featured in the 'Green Economy' plan of the country. To investigate the applicability of this technology, six selected Kazakhstan sedimentary basins (the Precaspian, Mangyshlak, South-Torgay, Ustyurt, Chu-Sarysu, and Zaysan basins) were evaluated and ranked for geologic CO_2 storage deployment in terms of containment, capacity, and feasibility. The effective CO_2 storage capacities in oil reservoirs, gas reservoirs, and saline aquifers were estimated for each basin using the Carbon Sequestration Leadership Forum (CSLF) and USDOE methods. The evaluations revealed that the Precaspian Basin is the most suitable for geological CO_2 storage, followed by the Mangyshlak, South Torgay, and Ustyurt basins. The total effective CO_2 storage capacity of the country is estimated to be ~583 Gt, of which ~539 Gt corresponds to the abovementioned four suitable basins where most of injected CO_2 is expected to be stored in the hydrodynamic traps. The results suggest that four sedimentary basins identified in this study have prospectivity to reduce GHG emissions of Kazakhstan significantly and thus enable the decarbonization of national economy to achieve the goals set by the Paris Agreement." **Yerdaulet Abuov, Nurlan Seisenbayev, and Woojin Lee,** *International Journal of Greenhouse Gas Control*. (Subscription may be required.)

Recent advances in carbon dioxide utilization.

The following is from the abstract of this article: "Carbon dioxide (CO_2) is the major contributor to greenhouse gas (GHG) emissions and the main driver of climate change. Currently, CO_2 utilization is increasingly attracting interest in processes like enhanced oil recovery and coal bed methane and it has the potential to be used in hydraulic fracturing processes, among others. In this review, the latest developments in CO_2 capture, utilization, conversion, and sequestration are examined through a multi-scale perspective. The diverse range of CO_2 utilization applications, including mineralization, biological utilization, food and beverages, energy storage media, and chemicals, is comprehensively presented. We also discuss the worldwide research and development of CO_2 utilization projects. Lastly, we examine the key challenges and issues that must be faced for pilot-scale and industrial applications in the future. This study demonstrates that CO_2 utilization can be a driver for the future development of carbon capture and utilization technologies. However, considering the amount of CO_2 produced globally, even if it can be reduced in the near-to mid-term future, carbon capture and storage will remain the primary strategy and, so, complementary strategies are desirable. Currently, the main CO_2 utilization industry is enhanced oil and gas recovery, but considering the carbon life cycle, these processes still add CO_2 to the atmosphere. In order to implement other CO_2 utilization technologies at a large scale, in addition to their current technical feasibility, their economic and societal viability is critical. Therefore, future efforts should be directed toward reduction of energy penalties and costs, and the introduction of policies and regulation encouraging carbon capture, utilization and storage, and increasing the public acceptance of the strategies in a complementary manner." **Zhien Zhang, Shu-Yuan Pan, Hao Li, Jianchao Cai, Abdul Ghani Olabi, Edward John Anthony, and Vasilije Manovic,** *Renewable and Sustainable Energy Reviews*. (Subscription may be required.)

Evolution patterns of bioenergy with carbon capture and storage (BECCS) from a science mapping perspective.

The following is from the abstract of this article: "Negative emissions technologies (NETs), which remove and isolate carbon dioxide from the atmosphere, are expected to play a significant role in mitigating climate change. As one of the most promising NETs, bioenergy with carbon capture and storage (BECCS) methods, which captures carbon dioxide (CO_2) emissions from bioenergy plants and then stores them in geological reservoirs, are being widely used in climate change scenarios. With the increased focus on mitigating solutions, several concerns have been raised regarding the deployment of BECCS. As no science mapping analyses of evolutionary BECCS patterns have yet been made, this study sought to determine these evolution patterns using a systematic analysis approach based on science mapping and visualization analyses. Under a longitudinal framework, the conceptual BECCS evolutionary track was determined using SciMAT to elucidate the structure and dynamic aspects of the associated scientific research. The co-word network and thematic evolutionary analysis revealed five main BECCS related themes. While this study provides a systematic study of BECCS research and development, further research should continue to focus on techno-economic analyses and the ecological and environmental impacts (land-use, water, diversity, and bioenergy crops) of BECCS. An increased research focus on the emerging biochar and hydrogen production themes is expected." **Meihui Li, Yi Lu, and Mengjiao Huang,** *Science of The Total Environment*. (Subscription may be required.)

PUBLICATIONS *(cont.)*

The value of hydrogen and carbon capture, storage and utilisation in decarbonising energy: Insights from integrated value chain optimisation.

The following is from the abstract of this article: "There is increasing interest in carbon capture, utilisation and storage (CCUS) and hydrogen-based technologies for decarbonising energy systems and providing flexibility. However, the overall value of these technologies is vigorously debated. Value chain optimisation can determine how carbon dioxide and hydrogen technologies will fit into existing value chains in the energy and chemicals sectors and how effectively they can assist in meeting climate change targets. This is the first study to model and optimise the integrated value chains for carbon dioxide and hydrogen, providing a whole-system assessment of the role of CCUS and hydrogen technologies within the energy system. The results show that there are opportunities for CCUS to decarbonise existing power generation capacity but long-term decarbonisation and flexibility can be achieved at lower cost through renewables and hydrogen storage. Methanol produced from carbon capture and utilisation (CCU) becomes profitable at a price range of £72–102/MWh, compared to a current market price of about £52/MWh. However, this remains well below existing prices for transport fuels, so there is an opportunity to displace existing fuel demands with CCU products. Nonetheless, the scope for decarbonisation from these CCU pathways is small. For investment in carbon capture and storage to become attractive, additional drivers such as decarbonisation of industry and negative emissions policies are required. The model and the insights presented in this paper will be valuable to policymakers and investors for assessing the potential value of the technologies considered and the policies required to incentivise their uptake." **Christopher J. Quarton and Sheila Samsatli,** *Applied Energy*. (Subscription may be required).

Freight consolidation and containerization strategy under business as usual scenario & carbon tax regulation.

The following is from the abstract of this article: "With the increase of greenhouse gasses and climate change, international regulators faced a challenging task in determining carbon footprint regulations. With global greenhouse gas emissions from maritime logistics accounts for about 2.5%, this study would take to account for shipment containerization strategies under carbon tax regulation to explore the influence of carbon tax regulation on maritime logistics carbon emission reduction. The motivation of this study comes from a real case example of freight consolidation and containerization problem (FCCP) in Indonesia. This study tries to model an actual problem faced by a third-party logistics provider in consolidating goods into various sizes of containers while keeping the total transportation costs as low as possible. The most significant contributions of this study are to incorporate environmental factors into the FCCP model and to illustrate the impacts of various carbon footprints schemes on both cost and carbon emissions. Therefore, shipment containerization strategies under various carbon footprints schemes are formulated to minimize the transportation costs, as well as to lower the amount of carbon emission from maritime and land transport modes. The methodology used is a case-based approach; it depicts product delivery activities from one origin hub in Kaohsiung, Taiwan, to the biggest retailer stores in Jakarta, Indonesia. The aim is to incorporate environmental factors and illustrate how the proposed policy balances both cost and carbon emissions. Under the proposed policy, a new mixed-integer programming model is introduced considering the freight consolidation and containerization problem. Based on the different groups of numerical results, [the authors] found that the shipment containerization strategy under carbon tax regulation gives a better outcome in terms of total transportation cost and total carbon emissions compared with the business as usual policy." **Sunil Tiwari, Hui Ming Wee, Yanjie Zhou, and Leonardo Tjoeng,** *Journal of Cleaner Production*. (Subscription may be required.)

Ex-post investigation of cost pass-through in the EU ETS – an analysis for six industry sectors.

The following is from the abstract of this article: "In the discussion on the potential risk of carbon leakage related to the EU ETS and the effect of safeguard measures, the scope for passing through carbon costs into final product prices is considered a key issue. This study investigates whether and to what extent ETS-related carbon costs have been passed through into product prices by EU industry. Literature on the issue of carbon cost pass-through in industry, other than electric power generation, is relatively sparse and [the authors] therefore aim to add to the knowledge gathered in this area so far. [The authors] investigate a number of products in six industry sectors in several European countries and regions and provide estimates for carbon cost pass-through for more than 50 product/country pairs. In line with the literature, [the authors'] econometric results imply significant cost pass-through for a number of products, with results being most conclusive for the cement, iron and steel, and refineries sectors. The extent of the estimated pass-through rates diverges between products and countries/regions. These findings are aimed at informing discussions about carbon leakage protection for industries covered by the EU ETS." **Johanna Cludius, Sander de Bruyn, Katja Schumacher, and Robert Vergeer,** *Energy Economics*. (Subscription may be required.)

No-tillage did not increase organic carbon storage but stimulated N_2O emissions in an intensively cultivated sandy loam soil: A negative climate effect.

The following is from the abstract of this article: "Although numerous studies have been conducted on the effects of no-tillage on carbon (C) sequestration in agricultural systems, there is still no consensus on the balance between the potential of C sequestration and nitrous oxide (N_2O) or nitric oxide (NO) emissions. A no-tillage field experiment in the North China Plain was established in 2006 and the influence of no-tillage on N_2O and NO emissions was monitored under an annual wheat-maize cropping system. The study included four treatments: no-tillage (NT) and conventional tillage (CT) soils amended with N fertilizer at a rate of 225 kg N ha^{-1} for wheat and 195 kg N ha^{-1} for maize (NTN and CTN) and without N fertilizer (NT0 and CT0). Three years of no-tillage significantly ($p < 0.05$) increased soil organic C (SOC) content by 12.2% in the 0–5 cm soil layer, possibly due to the surface aggregation of organic C derived from crop roots and exudates, but did not alter SOC pool in the 0–30 cm profile. Annual N_2O emissions in the NT0 and CT0 treatments were 0.53 and 0.57 kg N_2O-N ha^{-1}, respectively, and were significantly ($p < 0.05$) increased to 0.96 kg N_2O-N ha^{-1} in CTN and to 1.23 kg N_2O-N ha^{-1} in NTN. Remarkable differences in N_2O emissions between CTN and NTN were observed during the maize growing season. In contrast, NO emissions were not affected by the tillage regimes regardless of N fertilization. The mean ratios of NO/N_2O fluxes in N-unfertilized plots were 0.26–0.29 and 1.79–2.11 for the maize and wheat season, respectively, indicating that both NO and N_2O were primarily derived from denitrification during the maize growing season and from nitrification under wheat cultivation. Under N-fertilized plots, the ratios increased to 1.44–2.02 and 5.00–6.03 for the maize and wheat season, respectively, with significantly ($p < 0.05$) lower values in NTN plots than in CTN plots. The N_2O emission factors for N applied in the wheat-maize rotation system were 0.16% and 0.09% for NTN and CTN, respectively, which was far lower than the IPCC Tier 1 default value (1.0%), primarily due to the absence of irrigation after fertilization in maize season and low temperature in wheat season. The results suggest that the 3-year no-tillage regime with residue removal did not substantially increase C storage in the 0–30 cm profile, but stimulated N_2O emissions primarily by increasing denitrification." **Yuhui Niu, Yanjiang Cai, Zengming Chen, Jiafa Luo, Hong J Di, Hongyan Yu, Anning Zhu, and Weixin Ding,** *Soil and Tillage Research*. (Subscription may be required.)

PUBLICATIONS *(cont.)*

First report on carbon storage in a warm-temperate mangrove forest in South Africa.

The following is from the abstract of this article: "Carbon (C) storage by vegetated coastal habitats (mangroves, salt marshes and seagrasses) is globally recognized as a critical ecosystem service. Research efforts have therefore focused on quantifying C stored in these 'blue carbon' ecosystems but a notable knowledge gap still exists for certain geographical regions. This study aimed to provide the first comprehensive assessment of C storage in South African warm temperate mangroves by quantifying the C storage in aboveground biomass and soil C pools associated with the mangrove forest at the Nxaxo Estuary. C storage variability was also related to mangrove forest structure and soil environmental variables. C storage was quantified using standardized protocols for aboveground (live trees, leaf litter, pneumatophores) and soil C pools at five *Avicennia marina* sites. The results showed soil C storage to be spatially variable while aboveground C pools were similar between intertidal zones within the sites. The soil C pool made the largest contribution to total C storage at each site and ranged from 176.91 ± 4.5MgC.ha^{-1} to 262.53 ± 18.8 MgC.ha^{-1}. Of the aboveground carbon pools, live trees made the largest contribution and ranged from 2.25 ± 1.0 MgC.ha^{-1} to 9.56 ± 3.6 MgC.ha^{-1}. Across all sites, average C storage for all pools was 234.9 ± 39.16 MgC.ha^{-1}, which falls within the range reported for mangroves at other southern hemisphere range limits. Variability in soil C was linearly related to soil organic matter but this relationship was inconsistent between different soil depth intervals that were sampled. Total C storage was inversely related to mangrove tree density. This study confirms the need for more blue carbon studies to quantify C storage in under-represented geographical areas and to investigate factors that drive variability in C storage at different spatial scales." **Jaime L. Johnson, Jacqueline L. Raw, and Janine B. Adams,** *Estuarine, Coastal and Shelf Science*. (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 CO_2, 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 CO_2 emissions. The program also serves to increase the understanding of the effectiveness of advanced technologies in different geologic reservoirs appropriate for CO_2 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 CO_2 behaves in the subsurface. These objectives are key to increasing confidence in safe, effective, and permanent geologic CO_2 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*.

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

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).

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

3610 Collins Ferry Road
P.O. Box 880
Morgantown, WV 26507-0880
304-285-4764

626 Cochrans Mill Road
P.O. Box 10940
Pittsburgh, PA 15236-0940
412-386-4687

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

CUSTOMER SERVICE: 1-800-553-7681

www.netl.doe.gov

Contacts

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

Carbon Storage Newsletter Support
CSNFeedback@netl.doe.gov

Mark McKoy
Technology Manager
Carbon Storage
304-285-4426
Mark.McKoy@netl.doe.gov

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