CSN CARBON STORAGE NEWSLETTER

JUNE 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

DOE Leads International Forum to Develop Net-Zero Emissions Strategies.

The U.S. Department of Energy (DOE) is leading the creation of a new international forum dedicated to developing long-term strategies, such as carbon capture and storage (CCS), to reach global net-zero emissions. The Net-Zero Producers Forum includes Canada, Norway, Qatar, Saudi Arabia, and the United States, which collectively represent 40% of global oil and gas production. DOE, along with other governments, also *announced several other initiatives* to expand international cooperation in addressing potential climate issues and enhance clean energy innovation. The efforts were coordinated by DOE's Office of International Affairs in support of *President Biden's Leaders Summit on Climate*. From *DOE's Office of Fossil Energy and Carbon Management*. April 2021.

ANNOUNCEMENTS

DOE Announces Funding to Enhance Safety, Security of CO_2 Storage.

DOE announced funding for four research and development (R&D) projects to enhance the safety and security of carbon dioxide (CO_2) storage. The selected projects will look to address challenges related to long-term, commercial-scale storage of CO_2, working to improve the tools to monitor the seal integrity of caprocks used in CO_2 storage complexes and identify and reduce the risk of potential seismic activity. The projects will be managed by DOE's Office of Fossil Energy and Carbon Management's (FECM) National Energy Technology Laboratory (NETL) and will support the goals of the *Advanced Storage R&D* technology development area in *DOE's Carbon Storage Program*.

NETL FY 2020 Science and Technology Accomplishments Book Available.

NETL's FY 2020 Science & Technology Accomplishments book is available. These demonstrated accomplishments, which represent a selection of NETL researchers' achievements, characterize NETL's six Core Competencies: Computational Science and Engineering, Energy Conversion Engineering, Geological and Environmental Sciences, Materials Engineering and Manufacturing, Program Execution and Integration, and Systems Engineering and Analysis.

In Case You Missed It, Office of Fossil Energy and Carbon Management.

DOE's FECM reported on highlights from the first quarter of 2021, including Principal Deputy Assistant Secretary Jennifer Wilcox—who is also Acting Assistant Secretary for Fossil Energy—speaking about the importance of CCS and direct air capture technologies at several virtual events.

NETL-Supported Technology Wins Global Competition.

An NETL-supported technology won a global competition for the development of an eco-friendly process that infuses concrete with CO_2 emissions directly captured from industrial facilities. The University of California, Los Angeles (UCLA) CarbonBuilt Team won the grand prize in the NRG COSTIA Carbon XPRIZE global competition's track for technologies related to coal-fired power generation. The project was supported by *DOE's Carbon Utilization Program*.

CARBON UTILIZATION

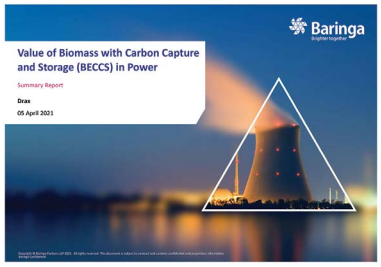
ANNOUNCEMENTS *(cont.)*

Partnership Formed to Accelerate CCUS.

Battelle and Catahoula Resources will jointly develop solutions for the capture, transport, and storage of CO_2 produced at ethanol facilities in Nebraska (USA). The companies, paired with private investment firm The Energy and Minerals Group, plan to design and build multiple low-cost storage options either onsite or close to existing ethanol plants where the geology proves to be favorable.

Report on BECCS Potential at Drax.

Energy consultancy Baringa released a report evaluating the impact of deploying bioenergy with carbon capture and storage (BECCS) technology at the Drax Power Station in North Yorkshire, England. Commissioned by the Drax Group, *the report* also found that with investment from the United Kingdom (UK) government, work to build two BECCS units could begin in 2024.



Carbontech Initiative Announces First Participants.

The Carbon to Value Initiative (C2V Initiative)—a program aimed at commercializing technologies that capture, convert, and store CO_2—announced the selection of 10 companies for the first cohort of the program. The startups will participate in a program with members from the C2V Initiative's Carbontech Leadership Council.

International Consortium to Develop Electricity-Based CCS.

An international consortium plans to investigate the potential of CCS technology to reduce CO_2 industrial emissions. "ConsenCUS – CarbOn Neutral cluSters through Electricity-based iNnovations in Capture, Utilisation and Storage" aims to scale up technological innovations and conduct socio-economic research to investigate electrochemical CO_2 emissions reduction.

Pre-Study of CCS Project Complete.

The Carbon Infrastructure Capture Project (CinfraCap) in western Sweden completed a pre-study, which included proposals for optimizing CCS and identifying potential risks. *CinfraCap*—a collaboration project among Göteborg Energi, Nordion Energi, Preem, St1, Renova, and the Gothenburg Port Authority—is focused on the transport of captured CO_2.

Brief Surveys U.S. Federal CCS Policy Landscape.

The Global CCS Institute released a brief detailing the CCS-related bills introduced in the U.S. House of Representatives and the U.S. Senate in 2021. The brief examines the CCS policies that support the advancement of the technology in the United States and provides a history of CCS policy.

GLOBAL CCS INSTITUTE

PROJECT and BUSINESS DEVELOPMENTS

DOE-Funded Project Completed.

The University of Illinois announced the completion of the Illinois Basin—Decatur Project (IBDP). Primarily funded through DOE/NETL's Midwest Geological Sequestration Consortium (MGSC), IBDP was designed to evaluate and test CCS technology at commercial scale, with the goal of confirming the ability of the Mt. Simon Sandstone to store 1 million metric tons of CO_2 over three years. The Illinois State Geological Survey designed, implemented, and monitored the project, which was hosted and operated by ADM. From *ADM News Release*. May 2021.

Companies Seek CCUS Opportunities.

A Memorandum of Understanding (MOU) between Italian oil company Eni and Australian energy company Santos could lead to the development of carbon capture, utilization, and storage (CCUS) facilities. Under the MOU, the companies plan to look at potential optimizations, synergies, and sharing of infrastructure; the potential expansion of a liquified natural gas field; and possibly developing CCUS facilities. From *Offshore Engineer*. May 2021.

Dutch Government Grants Subsidies for CCS Project.

The Dutch government granted subsidies to a consortium for the Port of Rotterdam CCS project. The project aims to capture CO_2 in the Rotterdam port area and store it in gas fields in the North Sea. The CCS subsidies are a means to cover the cost(s) of capturing CO_2 by the consortium, which includes Royal Dutch Shell, ExxonMobil, Air Liquide, and Air Products. The project is expected to be operational by 2024. From *Reuters*. May 2021.

Companies Further Collaboration on CCS.

Aker Carbon Capture and SINTEF entered into an MOU to advance CCS solutions. The two companies have collaborated on CCS development for more than a decade, and currently collaborate on several R&D projects. The MOU is intended to advance ongoing and future work in the CCS field. From *Business Insider*. May 2021.

Australian University Announces CCS Partnership.

Researchers at the University of Newcastle (Australia) announced a partnership to further their work on capturing CO_2 for either storage or utilization. The university's Global Innovation Centre for Advanced Nanomaterials will explore the conversion of halloysite nanotubes into advanced nanomaterials that can be utilized as novel adsorbent systems and catalysts for CO_2 capture and conversion processes. From *University of New Castle*. April 2021.

Additional Locations for CCS Project Announced.

Green Plains Inc.—a biorefining company based in Omaha, Nebraska (USA)—and Summit Carbon Solutions (SCS)—an affiliate of Summit Agricultural Group—entered into a long-term carbon offtake agreement as part of a pipeline expansion of SCS's CCS project. The project expansion allows for the development of infrastructure to capture and transport CO_2 for long-term storage. From *Green Plains Press Release*. April 2021.

CCUS Research Project Completes Injection Phase.

CO2CRC
Building a low emissions future

Australian CCUS research organization CO2CRC announced the completion of CO_2 injection beneath the Otway International Test Center (OITC) in Nirranda South, Victoria. The injection marks the end of field operations for the Otway Stage 3 Project, which is developing next-generation subsurface CO_2 monitoring and verification technologies for application in commercial CCS projects. More than 95,000 metric tons of CO_2 have been stored at OITC since operations began in 2007. From *CO2CRC News Release*. April 2021.

PROJECT and BUSINESS DEVELOPMENTS *(cont.)*

Carbfix to Build CO_2 Storage Hub.

Iceland startup Carbfix announced that preparations to build an onshore CO_2 mineral storage facility are underway. Based in the bay of Straumsvik in southwestern Iceland, the CO_2 Mineral Storage Terminal would receive CO_2 emissions from industries in Northern Europe by ship; Carbfix would then inject the CO_2 into basaltic bedrock. According to company officials, the preparation phase will begin later this year with the engineering and permitting processes. Drilling of the first wells is planned for 2022, with the aim of starting operations in 2025 and reaching full-scale operations by 2030. From *High North News*. April 2021.

MOU to Explore Feasibility of CCS Solutions.

Borg CO_2—a joint project between 18 industry partners and the port of Borg—and Northern Lights—a Norwegian transport and storage company—signed an MOU to explore the feasibility of CO_2 capture, transport, and storage solutions for industrial partners in the Fredrikstad region. Under the MOU, captured CO_2 would be transported to a CO_2 loading terminal hosted by Borg CO_2, where it would then be loaded onboard a Northern Lights-operated ship for transport to Øygarden on the Norwegian west coast for underground injection. From *Carbon Capture Journal*. April 2021.

Deal Struck in Acorn CCS Project.

Oil and gas firms Shell and Harbour Energy reached a deal with clean energy firm Storegga on the Aberdeenshire Acorn CCS project. The "Acorn Development Agreement" formalizes their relationship and helps to guide the firms through a final investment decision, construction, and operation. The project is expected to be operational in the mid-2020s. From *Energy Voice*. April 2021.

MOU Signed on Australian CCUS Project.

China Huaneng Group—an energy and technology company—and Glencore—a natural resource company—signed an MOU to cooperate on CCUS technology, beginning with the CTSCo Project at Millmerran power station in Australia. Glencore's CTSCo Project is an onshore CCUS project that aims to demonstrate CCUS at industrial scale. From *Carbon Capture Journal*. April 2021.

LEGISLATION and POLICY

Roadmap Aims to Maximize CCUS Potential in UK Through Government, Industry Collaboration.

The UK's Department for Business, Energy & Industrial Strategy released a roadmap that outlines how the UK government and industry can collaborate to create an industrialized UK CCUS supply chain. "*CCUS Supply Chains: a roadmap to maximise the UK's potential*" is organized across four crosscutting activities: supply chain mapping, capability development, skills and innovation, and finance and trade. From *Carbon Capture Journal*. May 2021.

EMISSIONS TRADING

Australia Seeks Partners to Help Develop Carbon Exchange.

Australia's Clean Energy Regulator *sought partner(s)* to facilitate the development of a domestic exchange market for carbon offset units. According to officials, the carbon exchange would complement the current Australian over-the-counter market and accelerate Australia's emissions reduction. From *Regulation Asia*. May 2021.

SCIENCE

Startup Uses Kelp to Store CO_2.

A company based in Maine (USA) is farming kelp to capture and store CO_2 beneath the ocean floor. Running Tide Technologies grows the kelp in a hatchery and then moves it to biodegradable buoys once matured. According to the scientists, kelp—a type of seaweed—captures CO_2 at one of the fastest rates of any species in the world. As the plant grows, it eventually sinks to the bottom of the ocean floor. Running Tide is working with scientists and universities to collect data to monitor the CCS potential. From *CNN*. May 2021.

Company to Store CO_2 as Ocean Bicarbonate.

The UK-based company Cquestr8 secured funding to develop carbon capture technology using natural processes to store CO_2 as stable ocean bicarbonate. The *Cquestr8* process will store CO_2 while also providing ocean ecosystem co-benefits through the deployment of marine bicarbonate. Cquestr8 targets decarbonization of the cement, lime, and steel production sectors. From *Carbon Capture Journal*. April 2021.

Startup Unveils CCS Technology.

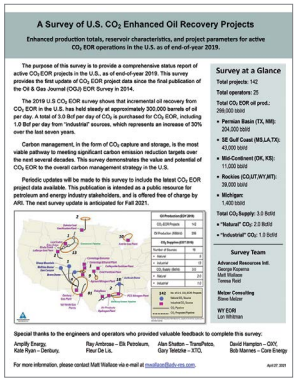
High Hopes launched a CCS technology that uses high-flying balloons to capture CO_2 emissions at high altitudes. The captured CO_2 is then brought down to the ground for either underground storage or re-use. According to the company, low temperatures and constant winds save most of the energy required for the process. From *Power Engineering International*. April 2021.

Mangrove Loss Could Create CO_2 Hotspots—Study.

A study led by Australia's Griffith University identified six mangrove-rich regions that could become future "hotspots" of CO_2 emissions due to the potential loss of mangroves. The study, *published in the journal Global Change Biology*, integrated global datasets for carbon stocks, mangrove distribution, deforestation rates, and land-use change drivers into a predictive model of mangrove CO_2 emissions, allowing the researchers to project CO_2 emissions and soil carbon storage potential. According to the study, mangroves have high carbon densities and can store large amounts of CO_2 for long periods. From *Scroll.in*. May 2021.

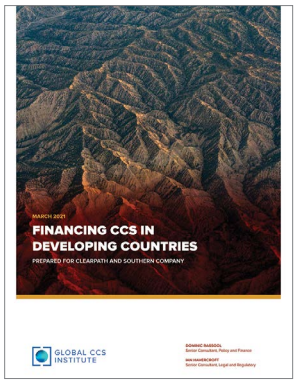
PUBLICATIONS

A Survey of U.S. CO_2 Enhanced Oil Recovery Projects.



The following is description of this Advanced Resources International survey: "The purpose of this survey is to provide a comprehensive status report of active CO_2 EOR projects in the U.S., as of end-of-year 2019. This survey provides the first update of CO_2 EOR project data since the final publication of the Oil & Gas Journal (OGJ) EOR Survey in 2014. The 2019 U.S CO_2 EOR survey shows that incremental oil recovery from CO_2 EOR in the U.S. has held steady at approximately 300,000 barrels of oil per day. A total of 3.0 Bcf per day of CO_2 is purchased for CO_2 EOR, including 1.0 Bcf per day from 'industrial' sources, which represents an increase of 30% over the last seven years. Carbon management, in the form of CO_2 capture and storage, is the most viable pathway to meeting significant carbon emission reduction targets over the next several decades. This survey demonstrates the value and potential of CO_2 EOR to the overall carbon management strategy in the U.S."

Financing CCS in Developing Countries.



The following is a description of this Global CCS Institute publication: "For CCS to fulfill its potential in reducing significant global emissions, this technology must be deployed in all parts of the world. Yet there are currently very few CCS projects in developing countries. This report was commissioned by ClearPath and Southern Company to examine the role of climate finance in supporting CCS project development in developing countries. It investigates: The support afforded to existing CCS facilities; Reasons for the lack of deployment in developing countries; How to overcome CCS investment risks; and Relevant global climate finance mechanisms to support the deployment of more facilities. It was found that while there is a very high need for CCS in several developing countries, their level of readiness for CCS deployment is low. Climate finance has an important role to play in both, improving their level of readiness as well as closing the funding gap in developing CCS projects."

Application of three-dimensional fault stress models for assessment of fault stability for CO_2 storage sites.

The following is from the abstract of this article: "Carbon Capture and Storage (CCS) is a key technology for a low-carbon energy future and will have an important role on the economic future of the UK Continental Shelf (UKCS). The East Irish Sea Basin (EISB) is a prospective area for CCS in the western UKCS. 3D seismic from the EISB were used in this study to characterise the fault network and potential fault reactivation risks associated with CO_2 injection. Two main structural domains are present: a Northern domain with NW-SE faults, and a Southern domain with faults following a N-S orientation. The main storage sites consist of structural closures in Triassic strata of the Sherwood Sandstone Formation (SSF), overlain by alternations of mudstones and evaporites of the Triassic Mercia Mudstone Group (MMG). The closures occur predominantly at fault-bounded horsts, with adjacent grabens filled by thick sequences of the Triassic Mercia Mudstone Group (MMG). The fault framework was used to test, in 3D, the stress model published for the EISB and assess the fault reactivation risk associated with CO_2 storage. Slip tendency values were predominantly below 0.6, suggesting the presence of stable structures in the EISB. Under the tested conditions, faults are capable of withstanding pressure increases between 3 MPa and 10 MPa before the onset of slip. The limited fault reactivation risk suggests CCS operations are suitable prospects for the EISB. This work demonstrates the additional value gained from integration of accurately constrained fault geometries in 3D stress models." **Davide Gamboa, John D.O. Williams, Michelle Bentham, David I. Schofield, and Andrew C. Mitchell,** *International Journal of Greenhouse Gas Control*. (Subscription may be required.)

Utilization of CO_2 to reduce environmental impact of diluted bitumen transportation and improve economics of CCS operations.

The following is from the abstract of this article: "Environmental impact and economics of Carbon Dioxide (CO_2) and bitumen transportation are among the major challenges of oil sands operations. [The authors] propose and assess a new approach to address these important challenges by using diluted bitumen (DilBit) as a carrier for large-scale CO_2 transportation. The proposed approach provides a unique prospect to significantly reduce the cost of CO_2 transportation from the carbon capture and storage (CCS) value chain, facilitate more efficient detection of DilBit spills from pipelines, utilize CO_2, and improve public perception of both oil sands and CCS operations. These opportunities will offer the possibility of sustaining access to oil resources while reducing environmental impact and improving the economics of CCS and oil sands operations. Through experimental measurements, [the authors] have shown that 80–200 kg of CO_2 per m^3 of DilBit can be dissolved and transported. [The authors] also report simulation results from the simultaneous transportation of DilBit and CO_2 and DilBit spill detection through monitoring concentration of leaked CO_2." **Ali Zirahi, Ali Haddadnia, Mohammadjavad Mohammadi, Bahareh Azinfar, Mohsen Zirrahi, Hassan Hassanzadeh, and Jalal Abedi,** *International Journal of Greenhouse Gas Control*. (Subscription may be required.)

Effects of grazing management on spatio-temporal heterogeneity of soil carbon and greenhouse gas emissions of grasslands and rangelands: Monitoring, assessment and scaling-up.

The following is the from the abstract of this article: "Grazing lands provide many goods and ecosystem services, such as forage, livestock, soil carbon (C) storage, biodiversity, and recreational opportunities. Ensuring the long-term sustainability of grazing lands requires optimal management to simultaneously balance livestock productivity for sustaining human food and nutritional demands while reducing environmental impacts, such as greenhouse gases (GHG) emissions and soil degradation. In this paper, [the authors] revisit grazing management in grazing lands exposed to different grazing systems […] review parameterization and multi-faceted goals for sustainability of grazing systems considering broader sustainability from economic to environmental aspects […] discuss the inconsistencies between grazing researchers and ranchers' practices […] review the separate experimental data to examine the impacts of multi-paddock rotational grazing on soil carbon, nutrient and GHGs [and] present status and upcoming challenges in monitoring and upscaling of grazing ecosystem research and management. In [this paper], new concepts of multiple source monitoring networks are presented that enable the analysis of scale-dependent processes. Finally, [this paper points] out future directions for monitoring and assessment of managing soil C and GHG emissions from grazing lands. The results show that the inconsistences are essentially due to (1) effects of spatiotemporal scales on both economic and ecological outcomes, and (2) simplistic representations of multi-faceted grazing systems and sustainability. The development of multi-faceted monitoring systems needs to be further parametrized and standardized to make consistent for meaningful and comparable assessment of grazing management impacts on SOC and GHGs." **Junye Wang, Yumei Li, Edward W. Bork, Goetz M. Richter, Changchun Chen, Syed Hamid Hussain Shah, and Symon Mezbahuddin,** *Journal of Cleaner Production*. (Subscription may be required.)

PUBLICATIONS *(cont.)*

Impacts of wetland dieback on carbon dynamics: A comparison between intact and degraded mangroves.

The following is from the abstract of this article: "Mangroves are effective blue carbon sinks and are the most carbon rich ecosystems on earth. However, their areal extent has declined by over one-third in recent decades. Degraded mangrove forests result in reduced carbon captured and lead to release of stored carbon into the atmosphere by CO_2 emission. The aim of this study was to assess changes in carbon dynamics in a gradually degrading mangrove forest on Bonaire, Dutch Caribbean. Remote sensing techniques were applied to estimate the distribution of intact and degraded mangroves. Forest structure, sediment carbon storage, sediment CO_2 effluxes and dissolved organic and inorganic carbon in pore and surface waters across intact and degraded parts were assessed. On average intact mangroves showed 31% sediment organic carbon in the upper 30 cm compared to 20% in degraded mangrove areas. A loss of 1.51 $MgCO_2$ ha^{-1} yr^{-1} for degraded sites was calculated. Water samples showed a hypersaline environment in the degraded mangrove area averaging 93 which may have caused mangrove dieback. Sediment CO_2 efflux within degraded sites was lower than values from other studies where degradation was caused by clearing or cutting, giving new insights into carbon dynamics in slowly degrading mangrove systems. Results of water samples agreed with previous studies where inorganic carbon outwelled from mangroves might enhance ecosystem connectivity by potentially buffering ocean acidification locally. Wetlands will be impacted by a variety of stressors resulting from a changing climate. Results from this study could inform scientists and stakeholders on how combined stresses, such as climate change with salinity intrusion may impact mangrove's blue carbon sink potential and highlight the need of future comparative studies of intact versus degraded mangrove stands." **D.F. Senger, D.A. Saavedra Hortua, S. Engel, M. Schnurawa, N. Moosdorf, and L.G. Gillis,** *Science of The Total Environment*. (Subscription may be required.)

On the theoretical carbon storage and carbon sequestration potential of hempcrete.

The following is from the abstract of this article: "Hempcrete is a natural insulation material that is well known for exhibiting favorable thermal properties and low manufacturing emissions. Hempcrete is a biocomposite, consisting of hemp shiv and a lime-based binder composed of hydrated lime and either a hydraulic (*e.g.*, natural hydraulic lime and ordinary portland cement) or pozzolanic binder (*e.g.*, metakaolin). While long-term biogenic carbon storage can be achieved via utilization of hemp shiv in hempcrete, additional carbon storage can be achieved via carbonation of the binder. This study advances previous carbonation modeling approaches by deriving a theoretical model based on the fundamentals of cement hydration and carbonation chemistry to quantify the total theoretical *in situ* CO_2e sequestration potential of hempcrete binders. To estimate the percentage of manufacturing CO_2e emissions that can be recovered through *in situ* binder carbonation, the model is implemented in life cycle assessments of 36 hempcrete formulations of various binder contents and densities using an equivalent functional unit (FU) of a 1 m^2 wall assembly with a U-value of 0.27 W/(m^2K). [The authors'] model estimates between 18.5% and 38.4% of initial carbon emissions associated with binder production can be sequestered through *in situ* carbonation. Considering biogenic carbon storage, [the authors] predict that the total life cycle CO_2e emissions of hempcrete can be negative, with a minimum of –16.0 kg CO_2e/FU for the hempcrete mixture formulations considered herein. However, [the authors] estimate that some hempcrete formulations can exhibit net-positive emissions, especially high-density mixes (>300 kg/m^3) containing portland cement, thereby illustrating the importance of materials selection and proportioning in designing carbon-storing hempcrete." **Jay H. Arehart, William S. Nelson, and Wil V. Srubar III,** *Journal of Cleaner Production*. (Subscription may be required.)

Dynamic interactive effect and co-design of SO_2 emission tax and CO_2 emission trading scheme.

The following is from the abstract of this article: "To solve the different environmental problems caused by the over-use of fossil fuels, multiple environmental policies currently coexist. How these environmental policies interact with each other and how to optimise them are a few issues that need to be resolved urgently in practice. [The authors] established an environmental dynamic stochastic general equilibrium model (E-DSGE) to analyse the dynamic interactive effects of the SO_2 emission tax and CO_2 emission trading in China and the optimal design of these two environmental policies. [The authors] have calibrated the model based on China's actual data. The results indicate that synergistic emission reduction effects have led to an overlap between the two policies, because both SO_2 and CO_2 emissions share a common root—fossil fuels. Currently there is no obvious conflict between them. When the SO_2 emission tax is levied at 12.6 CNY/kg, the CO_2 emission cap should be lower than 76.1%. Second, the synergistic emission reduction effect between CO_2 emission trading and the SO_2 emission tax can enhance the automatic stabilisation function of both. Third, [the authors] suggest to optimise both policies pro-cyclically. However, if either of these two policies is ineffective, the optimal SO_2 emission tax will be counter-rather than pro-cyclical." **Bowen Xiao, Ying Fan, and Xiaodan Guo,** *Energy Policy*. (Subscription may be required.)

Assessing the potential of soil carbonation and enhanced weathering through Life Cycle Assessment: A case study for Sao Paulo State, Brazil.

The following is from the abstract of this article: "Enhanced silicate rock weathering for long-term carbon dioxide sequestration has considerable potential, but depends on the availability of suitable rocks coupled with proximity to suitable locations for field application. In this paper, [the authors] investigate the established mining industry that extracts basaltic rocks for construction from the Paraná Basin, Sao Paulo State, Brazil. Through a Life Cycle Assessment, [the authors] determine the balance of carbon dioxide emissions involved in the use of this material, the relative contribution of soil carbonation and enhanced weathering, and the potential carbon dioxide removal of Sao Paulo agricultural land through enhanced weathering of basalt rock. [The authors'] results show that enhanced weathering and carbonation respectively emit around 75 and 135 kg carbon dioxide equivalent per tonne of carbon dioxide equivalent removed (considering a quarry to field distance of 65 km). [The authors] underline transportation as the principal process negatively affecting the practice and uncover a limiting road travel distance from the quarry to the field of 540 ± 65 km for carbonation and 990 ± 116 km for enhanced weathering, above which the emissions offset the potential capture. Regarding Sao Paulo State, the application of crushed basalt at 1 t/ha to all of the State's 12 million hectares of agricultural land could capture around 1.3 to 2.4 Mt carbon dioxide equivalent through carbonation and enhanced weathering, respectively. This study suggests a lower sequestration estimate than previous studies and emphasizes the need to consider all process stages through a Life Cycle Assessment methodology, to provide more reliable estimates of the sequestration potential of greenhouse gas removal technologies." **David Lefebvre, Pietro Goglio, Adrian Williams, David A.C. Manning, Antonio Carlos de Azevedo, Magda Bergmann, Jeroen Meersmans, and Pete Smith,** *Journal of Cleaner Production*. (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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