NATIONAL ENERGY TECHNOLOGY LABORATORY

CSN

CARBON STORAGE NEWSLETTER

VOL. 21, NO. 10

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

DOE/FECM/NETL HIGHLIGHTS

DOE Funding to Support Carbon Management Technologies.

U.S. DEPARTMENT OF ENERGY | Fossil Energy and Carbon Management

The U.S. Department of Energy's (DOE) *Office of Fossil Energy and Carbon Management (FECM)* announced funding for four national public power associations to help increase regional- and state-level engagement in carbon management. In one award, the National Association of Regulatory Utility Commissioners will promote learning and discussion among its members on topics such as carbon capture, utilization, and storage (CCUS). In another award, the National Association of State Energy Officials will research, analyze, and develop educational information on topics such as new developments in carbon management, including CCUS. DOE's National Energy Technology Laboratory (NETL) will serve as the contracting authority for the cooperative agreements issued with the awards. From *FECM*. September 2021.

ANNOUNCEMENTS

2021 DOE/NETL Carbon Management and Oil and Gas Research Project Review Meeting Conference Proceedings Available.

Conference proceedings are available for the DOE/NETL 2021 *Carbon Management and Oil and Gas Research Project Review Meeting*, which was held in August 2021 through a series of virtual meetings. The project review meeting enabled researchers to present results from more than 250 projects funded through a variety of program areas, including carbon storage and utilization.

Consortium Backs CO_2 Storage Project.

The Greensand carbon dioxide (CO_2) storage project will continue to Phase II of the pilot project. A grant application will be filed with Denmark's Energy Technology Development and Demonstration Program; if the application is successful, work on the project could begin as soon as late-2021, with the offshore injection pilot starting in late-2022.

Publication Highlights CCUS in Wyoming.

Enhanced Oil Recovery Institute

The Enhanced Oil Recovery Institute published a StoryMap highlighting CCUS in Wyoming. "*Wyoming is CCUS Ready!*" highlights the state's infrastructure, geology, and tax incentives as they relate to CCUS, as well as the financial and environmental benefits.

RGGI Releases Report on Secondary Market.

RGGI Inc.

The states participating in the Regional Greenhouse Gas Initiative (RGGI) released the "Report on the Secondary Market for RGGI CO_2 Allowances: Second Quarter 2021." Prepared by independent market monitor Potomac Economics, the report found no evidence of anticompetitive conduct in the RGGI CO_2 allowance secondary market.

NASA's CO_2 Conversion Challenge Winners Announced.

NASA

The National Aeronautics and Space Administration (NASA) *CO_2 Conversion Challenge* sought the development of novel synthesis technologies that use CO_2 as the sole carbon source to generate molecules that can be used to manufacture a variety of products for use in microbial bioreactors. The three teams that received awards demonstrated prototype systems capable of converting CO_2 from the air into glucose and other useful sugars.

ANNOUNCEMENTS *(cont.)*

UK Launches Net-Zero Research Program.

The United Kingdom's (UK) Department for Business, Energy, and Industrial Strategy launched a research program to help the UK reach climate goals. *CS-N0W* will produce research and advice, digital data, and tools to help inform the UK government's low-carbon efforts.

Department for Business, Energy & Industrial Strategy

Australian Government Outlines Incentive Options for Reducing Emissions, Establishing Credit Market.

The Australian Department of Industry, Science, Energy, and Resources published a discussion paper outlining options to incentivize emissions reductions and establish a carbon credit market. The paper expands on recommendations made in *a February 2020 report* that detailed how the country's *Safeguard Mechanism* can be adapted to encourage emissions reductions.

UKCCSRC Grants Funding for Carbon Capture.

The UK Carbon Capture and Storage Research Center (UKCCSRC) granted funding to study new materials for carbon capture. Scientists from Swansea University's Energy Safety Research Institute will collaborate with the University of Pisa and Immaterial Ltd to scale-up new materials and prepare industrial testing of the materials through the *Reducing Industrial Carbon Emissions (RICE) project*.

PROJECT and BUSINESS DEVELOPMENTS

CCS Drilling Study Investigates Feasibility of Storing CO_2.

A carbon capture and storage (CCS) drilling study concluded that more than 2 million metric tons of CO_2 per year can be stored underground at two ethanol plants in California. Commissioned by Aemetis Inc. (a renewable natural gas and renewable fuels company) and conducted by Baker Hughes (a global energy services company), the study estimated that 1 million metric tons of CO_2 per year can be stored in saline formations located at or near the Aemetis Keyes ethanol plant site, and that up to 1.4 million metric tons of CO_2 per year could be injectable at or near the Aemetis Riverbank ethanol plant site. From *Yahoo! Finance*. August 2021.

Initial Phase of Carbon Storage and Soil Health Pilot Program Completed.

A group of U.S. farmers completed the initial benchmarking phase of a carbon storage and soil health pilot program. Rabo AgriFinance is facilitating the pilot program, which will see participating farmers receive compensation for implementing regenerative agricultural practices that enrich their fields' soils while capturing CO_2 from the air. Participants receive compensation based on the amount of carbon stored, measured, and monitored over time. The initial stage of the pilot is focused on learning which practices result in the best soil health and carbon capture in a variety of conditions and crops. From *Business Wire*. August 2021.

Companies Collaborate on CCS Project.

TGS, a global subsurface data company, and Magseis Renewables, a subsidiary of the surveying services company Magseis Fairfield, agreed to collaborate on a CCS pilot project in Norway. The project will employ high-resolution 3D seismic acquisition offshore Norway at a potential carbon storage area to demonstrate detailed imaging of the full section, from the seabed to the target storage reservoir. The imaging software and high-resolution acquisition configurations will be combined to determine the resolution needed by CCS developers. From *Offshore Magazine*. August 2021.

CO_2 Storage Project Planned in South Africa.

Geologic mapping at a CCS site in South Africa has begun, according to the Council for Geoscience (a National Science Council of South Africa). The project will be based around the town of Leandra, Mpumalanga province, in South Africa's northeast. The project plans to link a pipeline transporting compressed CO_2 from emitting sources to the injection point. According to researchers, South Africa has approximately 150 metric gigatons of potential storage capacity. From *Reuters*. August 2021.

Companies Sign Purchase Agreement for DAC and Storage of CO_2.

Swiss Re, a reinsurance provider, and Climeworks, a CO_2 air capture specialist, signed a partnership for a purchase agreement for direct air capture (DAC) and CO_2 storage. The agreement also includes collaboration on developing risk management knowledge and risk transfer solutions. From *Swiss Re News Release*. August 2021.

Offshore CCS Project Launched in South China Sea.

The China National Offshore Oil Corporation (CNOOC) launched an offshore CCS project. According to CNOOC, the project is expected to store more than 1.46 million metric tons of CO_2. Located in the Pearl River Mouth basin of the South China Sea, the project is designed to reinject up to 300,000 metric tons of CO_2 per year into seabed reservoirs. From *Reuters*. August 2021.

LEGISLATION and POLICY

Canada to Review Calls for CCUS Studies.

Natural Resources Canada sought *expressions of interest* to support CCUS across Canada. Funded under Canada's Energy Innovation Program, the call supported front-end engineering and design studies that have the potential to reduce the impact of carbon emissions. Following the review process, successful applicants will be invited to submit full project proposals later this year. As part of their 2021 budget, the Canadian federal government is investing in research, development, and demonstrations to advance the commercial viability of CCUS technologies. From *Natural Resources Canada News Release*. August 2021.

Australian Government to Fund Carbon Storage Projects.

The Australian government plans to fund carbon storage activities in the southwest land division of Western Australia. The Western Australian Carbon Farming and Land Restoration Program will provide funding to projects that utilize agriculture's potential to store carbon in the landscape and contribute to the growth of the Western Australian carbon farming market. Funding amounts will be determined after assessing the expressions of interest, which were accepted through September 2021. From *business.gov.au*. September 2021.

EMISSIONS TRADING

Québec and California Hold Joint GHG Auction.

Québec (Canada) and California held the 28th joint auction of greenhouse gas (GHG) emission units. In total, 71,261,536 current vintage emission units were sold at $23.30 and 8,306,250 2024 vintage emission units were sold at $23.69. The summary of the auction results is available on the *Québec Ministry website*. The next auction is scheduled for November 17, 2021. From *Newswire*. August 2021.

Carbon Credits Program Established on State Forest Land.

Michigan's Department of Natural Resources and DTE Energy agreed to establish a carbon credits program on state forest land, leveraging the carbon storage capacity of their trees. The *Bluesource/Michigan DNR Big Wild Forest Carbon Project* offers a portfolio of carbon offset credits generated from sustainable forest management activities on more than 100,000 acres of the Pigeon River Country State Forest in the northern Lower Peninsula. From *Midland Daily News*. August 2021.

Six Carbon Credit Indices Launched.

S&P Global Platts, an information provider for the commodities and energy markets, announced the launching of six carbon credit indices with environmental technology company Viridios AI. The CARBEX™ carbon credit indices reflect the value of different types of voluntary carbon credits. From *PR Newswire*. August 2021.

Indonesian Government Plans Carbon Tax.

The Government of Indonesia is drafting an emissions reduction scheme that would regulate the carbon trade, provide payments based on performance in reducing GHGs, and impose a levy on carbon emissions. The draft Presidential Regulation on Instruments of Carbon Economic Value for Nationally Determined Contributions could be finalized by the end of 2021. From *Lexology.* August 2021.

SCIENCE

DOT Partnering with Port of San Diego in Carbon Storage Study.

The U.S. Department of Transportation (DOT) and the Port of San Diego announced a partnership to study bay wide eelgrass carbon storage. According to the port and DOT's Maritime Administration (MARAD), eelgrass can capture and store large amounts of CO_2 in the plants and soils. MARAD awarded the port a cooperative agreement for a study to assess how much CO_2 is stored in San Diego Bay's eelgrass, as well as how much CO_2 eelgrass could continue to capture in the future. From *Times of San Diego*. August 2021.

Researchers to Study Feasibility of Using Quantum Gravity Sensors to Monitor CCS Sites.

A research project will consider the feasibility of using quantum gravity sensors to monitor CCS sites. With funding from the UKCCSRC, researchers at the *Quantum Technology* Hub will research how the sensors can contribute to detecting and monitoring CO_2. The project will model the gravity gradient signals of the CO_2 to determine the ability of the cold atom sensors to detect and monitor its migration. The work will investigate how an existing portable cold atom gravity gradiometer could be used to monitor a planned injection of CO_2 at the GeoEnergy Test Bed at the University of Nottingham's Sutton Bonington campus, a facility with multi-sensor technology for CO_2 monitoring research. From *Carbon Capture Journal*. August 2021.

Study Finds Volcanoes Play Role in Atmospheric CO_2.

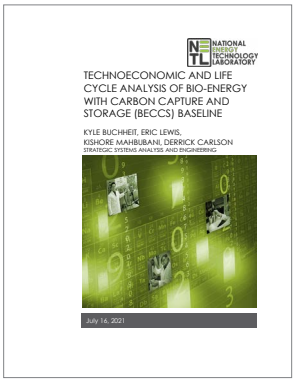
Using machine learning (ML) to model Earth's systems, scientists studied the role of volcanoes in the Earth's carbon life cycle. Researchers from the University of Southampton, the University of Sydney, Australian National University, the University of Ottawa, and the University of Leeds used ML algorithms and plate tectonic reconstructions to model interactions within the Earth and how they may have changed over time. Their findings, published in the journal *Nature Geoscience*, found that when fragments of these volcanoes break off and reach the oceans, they trap CO_2 in the atmosphere. According to their research, this means that volcanoes play a balancing act between emitting large amounts of CO_2 while also removing CO_2 through erosion processes. From *Siliconrepublic.com*. August 2021.

Researchers Develop Fuel Tank to Capture, Store CO_2 on Ships.

Researchers from Northwestern University developed a CO_2-capturing solid oxide fuel cell that captures traditional carbon-based fuels for storage or recycling into renewable hydrocarbon fuel. To store and reuse this CO_2, the researchers invented a patent-pending dual-chamber storage tank. After the carbon emissions are captured by the tank, they would then be offloaded as carbon to be stored at each destination port. From *Interesting Engineering*. August 2021.

PUBLICATIONS

Technoeconomic and Life Cycle Analysis of Bio-Energy with Carbon Capture and Storage (BECCS) Baseline.



The following is from the product description of this NETL document: "Bio-Energy with Carbon Capture and Storage (BECCS) is an attractive option from an environmental standpoint, as biomass regrowth removes CO_2 from the atmosphere, which offsets the emissions produced by burning the biomass. When combined with carbon capture, this produces a system that is capable of zero or even negative greenhouse gas (GHG) emissions. This study examines the performance, environmental impact, and economics of co-firing biomass in pulverized coal (PC) power plants. The analysis is based on various plant configurations (with and without carbon dioxide [CO_2] capture) using hybrid poplar biomass at three levels of co-fire (20, 35, and 49 weight percent) with Illinois No. 6 coal. This study is an analysis of the overall performance and economics of the plant, which was used to determine the levelized cost of electricity (LCOE) and to perform a full environmental life cycle analysis (LCA) of greenfield PC plants co-firing biomass."

Global Carbon Capture and Storage Market 2021–2025.

The following is from a summary of this market research: "The analyst has been monitoring the carbon capture and storage market and it is poised to grow by 64.05 mn tons during 2021-2025, progressing at a CAGR of almost 21% during the forecast period. [The authors'] report on the carbon capture and storage market provides a holistic analysis, market size and forecast, trends, growth drivers, and challenges, as well as vendor analysis covering around 25 vendors. The report offers an up-to-date analysis regarding the current global market scenario, latest trends and drivers, and the overall market environment. The market is driven by the dependence on fossil fuels for generation of electricity and the need to adhere to stringent environmental regulations. In addition, the dependence on fossil fuels for generation of electricity is anticipated to boost the growth of the market as well. The carbon capture and storage market analysis includes application, technology, and end-user segments and geographic landscape."

Risk-based monitoring designs for detecting CO_2 leakage through abandoned wellbores: An application of NRAP's WLAT and DREAM tools.

The following is from abstract of this article: "As geologic CO_2 storage (GCS) moves towards industrial-scale deployment, strategies must be developed to ensure long-term environmental risks related to potential leakage are managed. One approach to is to perform risk-based subsurface monitoring targeting early leak detection. Early detection is particularly important to address the risk associated with leakage along legacy wells. The challenge in risk-based monitoring is that leakage impacts are expected to be small in comparison with the footprint of the stored CO_2 plume and could occur over considerable depths, ranging from the storage formation up to surficial aquifers. Here [the authors] demonstrate the application workflow of two of the National Risk Assessment Partnership's (NRAP) computational tools, WLAT (Wellbore Leakage Analysis Tool) and DREAM (Designs for Risk Evaluation and Management), to a hypothetical CO_2 storage site based on a study area in the Midwestern United States. By incorporating site specific wellbore integrity analyses, results show how fluid leakage may be estimated, evaluated, and monitored in terms of risk. For the selected site, three monitoring wells were ultimately needed to detect all possible CO_2 leaks and six monitoring wells were needed to minimize time to leak detection. Such analyses inform stakeholders about long-term liability and monitoring costs of GCS projects." **C. Yonkofski, G. Tartakovskly, N. Huerta, and A. Wentworth,** *International Journal of Greenhouse Gas Control*. (Subscription may be required.)

A comprehensive thermodynamic performance assessment of CO_2 liquefaction and pressurization system using a heat pump for carbon capture and storage (CCS) process.

The following is from the abstract of this article: "CO_2 compression process significantly contributes to the overall efficiency penalty resulting from carbon capture and storage (CCS) process. In this study, heat-pump (HP)-assisted CO_2 compression configurations are examined using first and second laws of thermodynamics to reduce power consumption during CO_2 compression. The performance is quantified in terms of net electric power consumption and compared with the conventional multi-stage compression. The input boundary conditions required for the proposed configurations modeling such as captured CO_2 pressure, CO_2 required pressure, the number of stages or the pressure ratio during CO_2 compression, and cooling temperature depend on the plant configuration, location, and compression chain characteristics. This study emphasizes that the variability in boundary conditions can significantly impact the optimum thermodynamic route of CO_2 pressurization. A thorough parametric investigation is thus performed to clarify the impact of these parameters on the overall power consumption. CO_2 pumping or compression near the critical point was shown to play a key role in optimizing CO_2 pressurization routes. Additionally, a high CO_2 captured pressure and a low target pressure, number of stages, and cooling temperature were shown to enhance system performance. Furthermore, the second law analysis illustrated that the point of minimum net power consumption corresponds to the minimum exergy destruction. Finally, the optimization of the proposed system using a genetic algorithm allowed for a 7.77% electric power saving and 68.02% exergetic efficiency using the proposed system." **Hafiz Ali Muhammad, Chulwoo Roh, Jongjae Cho, Zabdur Rehman, Haider Sultan, Young-Jin Baik, and Beomjoon Lee,** *Energy Conversion and Management*. (Subscription may be required.)

Modeling and economic evaluation of carbon capture and storage technologies integrated into synthetic natural gas and power-to-gas plants.

The following is from the abstract of this article: "The production of synthetic natural gas from coal and biomass gasification made it possible to obtain a product that can be used to replace easily the standard natural gas in the existing infrastructures. This paper follows and presents a study that was conducted on a synthetic natural gas plant integrated with carbon capture and storage technologies. The recent growth in the use of energy coming from renewable sources requires that balancing measures be taken for electricity grids, which, as can be easily imagined, is best accomplished by using multiple energy storage technologies. In particular, the power-to-gas technology allows renewable electrical energy to be transformed into methane via electrolysis and subsequent methanation. Moreover, the production of synthetic natural gas can be enhanced by using concentrated CO_2 emitted by synthetic natural gas plants, coupling the coal gasification and methanation processes within the same plant. This paper compares and evaluates two distinct process configurations and their implementation with power-to-gas technology in Aspen Plus v.8. During the study, it was analyzed how the introduction of carbon capture and storage technologies affect the overall energy balance, as well as the individual performances of each configuration. The two cases proved to have similar efficiency; it was also observed that the integration of and carbon capture and storage technologies resulted in a negligible reduction in the efficiency of the system (approximately 1%). The integration of power-to-gas technologies led to a decrease in the efficiency of the system up to 30%. Based on the current emission allowances specified in the rules of the regulated market of CO_2, it was also assessed how such technologies

PUBLICATIONS *(cont.)*

would be sustainable in terms of costs derived from the production of gas. An analysis was in fact performed to estimate the costs associated with this type of plant and the results showed that the introduction of carbon capture and storage technologies in synthetic natural gas plants had a lower impact on the costs related to both the plant and the synthetic natural gas. In this respect, a sensitivity analysis of the most influent factors was performed as well. The results showed that, when it comes to the production of gas in in the power-to-gas process, the specific cost strongly depends on the price of electricity and the operating hours." **Claudia Bassano, Paolo Deiana, Giorgio Vilardi, and Nicola Verdone,** *Applied Energy*. (Subscription may be required.)

Geomechanical properties will constrain CO_2 injection into the lower Ordovician Rose Run sandstone deep saline reservoir, Appalachian Basin, Kentucky, USA.

The following is from the abstract of this article: "The Kentucky Geological Survey (KGS) 1 Hanson Aggregates stratigraphic research well, Carter County, Kentucky, USA, was drilled to a total depth of 1474 m as a field-scale test of potential CO_2 storage reservoir properties in the Central Appalachian Basin. Geomechanical properties of the Rose Run sandstone (upper Ordovician Knox group) were tested for its suitability as a storage reservoir. A 9.8-m thick section of the Rose Run was penetrated at 1000 m drilled depth and a whole-diameter core and rotary sidewall cores were taken. Average porosity and permeability measured in core plugs were 9.1% and 44.6 mD, respectively. Maximum vertical stress gradient calculated in the wellbore was 26 MPa/km. Wellbore fractures in dolomites underlying and overlying the Rose Run follow the contemporary N53°E Appalachian Basin stress field. The Rose Run elastic geomechanical properties were calibrated to values measured in core plugs to evaluate its fracturing risk as a CO_2 storage reservoir. Mean Young's modulus and Poisson's ratio values of the Rose Run were 45 GPa and 0.23, respectively, whereas Young's modulus and Poisson's ratio values were 77.1 GPa and 0.28, respectively, in the overlying Beekmantown dolomite, suggesting the Rose Run may fracture if overpressured during CO_2 injection but be confined by the Beekmantown. Triaxial compressive strength measured in core plugs found the Rose Run and Beekmantown fractured at mean axial stresses of 156.5 MPa and 282.2 MPa, respectively, confirming the Beekmantown as suitable for confining CO_2 injected into the Rose Run. A step-rate test was conducted in a mechanically-isolated 18.6-m interval bracketing the Rose Run. Static Rose Run reservoir pressure was 9.3 MPa, and fracture gradient under injection was 13.6 MPa/km, suggesting step-rate testing before CO_2 injection, and subsequent pressure monitoring to ensure confinement. As the region around the KGS 1 Hanson Aggregates well is underpressured and adjacent to faulted Precambrian basement, further research is needed to evaluate its induced seismicity risk during CO_2 injection." **John Richard Bowersox, Stephen F. Greb, Junfeng Zhu, and David C. Harris,** *Journal of Rock Mechanics and Geotechnical Engineering*. (Subscription may be required.)

A coupled thermo-hydro-mechanical model for simulating leakoff-dominated hydraulic fracturing with application to geologic carbon storage.

The following is from the abstract of this article: "A potential risk of injecting CO_2 into storage reservoirs with marginal permeability ($\lesssim$ 10 mD (1 mD = 10^{-15} m^2)) is that commercial injection rates could induce fracturing of the reservoir and/or the caprock. Such fracturing is essentially fluid-driven fracturing in the leakoff-dominated regime. Recent studies suggested that fracturing, if contained within the lower portion of the caprock complex, could substantially improve the injectivity without compromising the overall seal integrity. Modeling this phenomenon entails complex coupled interactions among the fluids, the fracture, the reservoir, and the caprock. [The authors] develop a simple method to capture all these interplays in high fidelity by sequentially coupling a hydraulic fracturing module with a coupled thermal-hydrological-mechanical (THM) model for nonisothermal multiphase flow. The model was made numerically tractable by taking advantage of self-stabilizing features of leakoff-dominated fracturing. The model is validated against the PKN solution in the leakoff-dominated regime. Moreover, [the authors] employ the model to study thermo-poromechanical responses of a fluid-driven fracture in a field-scale carbon storage reservoir that is loosely based on the In Salah project's Krechba reservoir. The model reveals complex yet intriguing behaviors of the reservoir-caprock-fluid system with fracturing induced by cold CO_2 injection. [The authors] also study the effects of the in situ stress contrast between the reservoir and caprock and thermal contraction on the vertical containment of the fracture. The proposed model proves effective in simulating practical problems on length and time scales relevant to geological carbon storage." **Xin Ju, Pengcheng Fu, Randolph R. Settegast, and Joseph P. Morris,** *International Journal of Greenhouse Gas Control*. (Subscription may be required.)

A hard-to-keep promise: Vegetation use and aboveground carbon storage in silvopastures of the Dry Chaco.

The following is from the abstract of this article: "In dry woodland regions, silvopastures have emerged as a promising option to balance cattle production, carbon storage and biodiversity. However, one of the major challenges in these systems, particularly when implemented in a matrix of natural vegetation, is the preservation of tree populations in the face of management actions implemented by ranchers to control woody encroachment. Here, [the authors] investigate the extent of that tradeoff by analyzing the impact of woody encroachment control practices on carbon storage in silvopastures of the Argentine Dry Chaco. First, [the authors] analyze tree density and carbon storage in aboveground woody biomass for silvopastures and woodlands at 24 sites in five properties across the Argentine Dry Chaco. Then, [the authors] characterize vegetation management goals and actions of ranchers who have adopted silvopastures in that same region, combining field assessments, high-resolution imagery analysis, characterization of site history, and surveys. [The authors] find that woody biomass in silvopastures retains an average of 64 % of the carbon present in aboveground biomass in intact woodlands (28.8 Mg C ha^{-1}). However, [the authors] also find that this storage capacity decreases by 12 % with each woody encroachment control intervention, due to these interventions' negative effects on tree density. Ranchers expressed concern about tree mortality, but also indicated low profitability of wood products and highlighted woody encroachment as a major issue for livestock production. Therefore, ranchers feel they have no choice but to continue preventing woody encroachment, even if this implies the gradual depletion of tree populations. Understanding how ranchers manage silvopastures, and how that management affects the provision of ecosystem services, is essential and will require more careful long-term monitoring and evaluation. This is particularly true in agricultural frontiers such as the Argentine Dry Chaco, where silvopastoral systems have the potential to mitigate the seemingly irremediable conflict between commodity production and nature conservation." **Pedro D. Fernández, Yann le Polain de Waroux, Estéban G.Jobbágy, Dante E. Loto, and N. Ignacio Gasparri,** *Agriculture, Ecosystems $ Environment*. (Subscription may be required.)

Application of computed tomography (CT) in geologic CO_2 utilization and storage research: A critical review.

The following is from the abstract of this article: "Computed tomography (CT) is a useful sample characterization and analysis technique to better understand complicated reactive transport processes in geologic CO_2 utilization and storage (GCUS) conditions. According to previous studies, [the authors] have identified four major challenges that hinder the application of CT scanning in GCUS-related sample characterization: (1) lack of registration, segmentation, noise/artifact-reducing and model selection algorithms; (2) great uncertainty in mineral composition characterization; (3) low resolution to characterize caprock with nanopores, and (4) limited real-time CT imaging capacity. To tackle these challenges, future R&D directions regarding CT applications in GCUS research are proposed." **Manguang Gan, Liwei Zhang, Xiuxiu Miao, Sergey Oladyshkin, Xiaowei Cheng, Yan Wang, Yutong Shu, Xuebin Su, and Xiaochun Li,** *Journal of Natural Gas Science and Engineering*. (Subscription may be required.)

ABOUT DOE/NETL'S CARBON STORAGE PROGRAM

The **Carbon Storage Program** at the U.S. Department of Energy's (DOE) 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 *DOE/NETL 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.

DOE/NETL Carbon Storage Program Resources

Newsletters, program fact sheets, best practices manuals, roadmaps, educational resources, presentations, and more information related to the DOE/NETL 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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