CSN CARBON STORAGE NEWSLETTER

JANUARY 2020

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

NETL Develops Flexible CCUS Analysis Tools and Resources.

National Energy Technology Laboratory (NETL) researchers developed a first-of-its-kind suite of tools that enables better decision-making regarding the economic challenges of carbon capture, utilization, and storage (CCUS). The publicly available tools and resources can evaluate CCUS costs during each step in the value chain. NETL researchers are also developing techno-economic models for offshore carbon dioxide (CO_2) saline storage, onshore CO_2 enhanced oil recovery (EOR), and offshore CO_2 EOR. The flexibility and adaptability of NETL's CCUS tools and resources are critical for addressing challenges and acclimating to the changing factors that influence CCUS implementation. More information is available on *NETL's Energy Analysis page*. NETL's work supports the U.S. Department of Energy's (DOE) mission to advance the national, economic, and energy security of the United States. From *NETL Press Release* on December 19, 2019.

ANNOUNCEMENTS

New US Secretary of Energy Sworn In.

Dan Brouillette was sworn in as the 15th U.S. Secretary of Energy on December 11, 2019. Secretary Brouillette has three decades of experience in both the public and private sector and most recently served as the Deputy Secretary of Energy.

Report Documents CCS Milestones.

The Global CCS Institute released a report that documents milestones for carbon capture and storage (CCS) over the past 12 months. The 2019 Global Status of CCS report provides detailed information and analysis of the global CCS facility pipeline, policy, CO_2 storage, and the legal and regulatory environment.

CCUS-Supporting Project Launches.

A European Union (EU)-funded project to accelerate the widespread deployment of CCUS *unveiled its new website*. Building on international collaboration and work already undertaken, LAUNCH, an international consortium of academic and industry partners, will investigate barriers to implementing CCUS.

Study Shows World Has Sufficient CO_2 Storage Capacity.

According to a study conducted by the University of Texas at Austin, there is enough storage capacity in the world's nearshore continental margins to meet CO_2 storage goals. The study, *published in Nature Scientific Reports*, shows the role CCS has in reaching targets.

Indonesia Drafting Regulations for Sale of Carbon Credits.

Indonesia is drafting regulations for the sale of carbon credits for carbon reserves stored in peatlands, rain forests, and mangroves. Officials expect the sales to generate up to $100 billion a year, which could be used to help Indonesia preserve its rain forests, mangrove forests, and peatlands.

Report Highlights Roles of CCS, BECCS in UK.

According to a report *published in Petroleum Geoscience*, advances and investment in CCS and bioenergy with carbon capture and storage (BECCS) can play a key role in helping the United Kingdom advance towards its emission targets.

PROJECT and BUSINESS DEVELOPMENTS

North Dakota Company Advances Carbon Storage Project.

A North Dakota (USA) ethanol company is preparing to store its CO_2 emissions underground. Red Trail Energy plans to drill a test well on its property to examine the geology in which it intends to store its CO_2. The North Dakota Industrial Commission approved the CCS project in 2019. If tests confirm the practicality of CCS operations, Red Tail Energy could begin injection in 2021. From *Casper Star Tribune* on December 11, 2019.

Companies Commit to CCS.

ExxonMobil, Shell, Air Liquide, and Air Products signed an agreement with Porthos, a CCS project organization, to commit to work in parallel on preparations for the capture, transport, and storage of CO_2 from their refineries and hydrogen production facilities in Rotterdam, Netherlands. Porthos has begun technical preparations for transporting and storing CO_2 beneath the North Sea. From *Carbon Capture Journal* on December 9, 2019.

Seismic Data to Be Used in CCS Project.

The CCUS Net Zero Teesside project planned for North East of England purchased seismic datasets to verify the suitability for CO_2 storage in offshore reservoirs located in the Permian Gas Basin in the southern North Sea. The seismic datasets were purchased from TGS-NOPEC Geophysical Company (TGS), which provides geoscience data to oil and gas companies. From *TGS Press Release* on December 5, 2019.

Proposals Sought for CCS Pilot.

The University of Wyoming (UW) Energy Resources Council is seeking proposals for a coal-based pilot project for capturing at least 75% of CO_2 from coal power plants. The call for proposals was posted by *UW's School of Energy Resources (SER)* on behalf of the Wyoming State Legislature. The Wyoming State Legislature appropriated $5 million for the program during its 2019 session; final submissions of proposals are due February 14, 2020. From *Carbon Capture Journal* on December 15, 2019.

LEGISLATION and POLICY

Coal-to-Products Bill Introduced to Establish Program Within DOE.

U.S. Senators introduced legislation to establish a dedicated program within DOE that focuses on advancing the research and promotion of coal-derived carbon products. Enactment of the *Creating Opportunities and Leveraging Technologies for Coal Carbon Act (COAL TeCC Act)* is expected to enhance ongoing work at DOE, being carried out through NETL, to utilize coal as a precursor for value-added products. The COAL TeCC Act also directs DOE to establish a pilot and demonstration program in Appalachia to help coal-derived carbon products reach the commercialization phase. From *U.S. Senator Shelley Moore Capito Press Release* on December 13, 2019.

Drax to Use BECCS to Become Carbon-Negative.

British electrical power generation company Drax announced plans to become carbon-negative by 2030 through the use of BECCS technology. Drax is planning to scale-up the use of CO_2 capture technologies in its power plant in Yorkshire, England, to remove more CO_2 from the atmosphere than it produces in advance of CCS-related government policy and investment framework. From *Business Green* on December 10, 2019.

US Senators Introduce Legislation with Potential to Increase CO_2 Storage

A group of U.S. Senators introduced legislation that addresses reforestation, which could potentially increase the natural storage of CO_2 emissions. The Reforestation Act of 2019 provides funding to the U.S. Forest Service to carry out projects in forests affected by events such as wildfires, insect infestations, and disease. Among other activities, reforestation includes the replanting of forests, which is expected to increase natural carbon storage. From *U.S. Senator Tom Udall Press Release* on December 19, 2019.

EMISSIONS TRADING

Results of 46th RGGI Auction Released.

The states participating in the Regional Greenhouse Gas Initiative (RGGI) announced the results of their 46th auction of CO_2 allowances. A total of 13,116,444 CO_2 allowances were sold at a clearing price of $5.61, with bids ranging from $2.26 to $8.00 per allowance. In addition, none of the 10 million cost containment reserve (CCR) allowances made available were sold. (The CCR is a fixed additional supply of allowances made available if CO_2 allowance prices exceed certain price levels [$10.51 in 2019].) Auction 46 generated $73.6 million for states to reinvest in strategic programs, including energy efficiency and greenhouse gas (GHG) abatement programs. Additional details are available in the *Market Monitor Report for Auction 46.* From *RGGI News Release* on December 6, 2019.

Switzerland, EU Link Emissions Trading Systems.

Switzerland formally linked its GHG emissions trading system with the European Union Emissions Trading System in January 2020. The agreement to link cap-and-trade systems has the potential to increase the availability of reduction opportunities and enhance the cost efficiency of emissions trading. From *Council of the EU Press Release* on December 9, 2019.

SCIENCE NEWS

Geologic Capacity Exists to Store Large Quantities of CO_2.

A study *published in Nature Scientific Reports* indicates the existence of geologic formations on Earth suitable for storing enough CO_2 to provide a 13% reduction of worldwide emissions by 2050. The study states that drilling approximately 12,000 carbon storage wells has the potential to store 6 to 7 billion tons of CO_2 a year by 2050. Conducted by researchers from the Norwegian Institute of Science and Technology and the University of Texas, the study identified locations worldwide that could store CO_2. From *Yale Environment 360* on December 26, 2019.

Scientists Develop New Material for Absorbing CO_2.

Swedish scientists developed a new material for capturing CO_2 that may enhance CCUS technologies. The new material is a bio-based hybrid foam infused with CO_2 zeolites, which has an elevated ability to absorb CO_2. Results of the Swedish joint research study, conducted by scientists from Chalmers University of Technology and Stockholm University, were *published in the journal ACS Applied Materials & Interfaces*. From *Chalmers University of Technology* on December 9, 2019.

Study Identifies Carbon Storage Potential of Western US Forests.

Oregon State University researchers identified forests in the western United States that have carbon storage potential. The five-year study, which was supported by the U.S. Department of Agriculture, identified and targeted forests with high carbon storage potential; low vulnerability to drought, fire, and beetles; and high biodiversity value. The findings of the study were *published in the journal Ecological Applications*. From *Oregon State University Newsroom* on December 9, 2019.

JOURNAL ARTICLES

Estimating the pressure-limited dynamic capacity and costs of basin-scale CO_2 storage in a saline formation.

The following is from the abstract of this article: "Deployment of carbon capture and storage (CCS) could be necessary to be able to satisfy baseload electricity demand, maintain diversity in the energy mix, and achieve mitigation of carbon dioxide (CO_2) emissions at lowest cost (IPCC, 2015; U.S. DOE, 2016). If basin-, regional- or national-scale deployment of CCS is needed, it may be possible to store only a small fraction of the captured CO_2 in oil and natural gas reservoirs. The vast majority would likely have to be stored in saline formations. Pressure buildup as a result of injecting CO_2 into such reservoirs is expected to be an important source of risk associated with CO_2 storage, and could constrain dynamic storage capacities (maximum injection rates) to be far below estimates based on access to theoretical storage resources. Estimates of CO_2 storage costs based on an assumption of practical availability of the theoretical storage resource could lead to underestimation of the costs of CO_2 storage. In this study, simulation results suggest that the pressure-limited dynamic CO_2 storage capacity of the Mount Simon Sandstone could be less than 4% of the theoretical storage resource in this saline formation, and storage costs could be an order of magnitude higher than recent estimates. However, consideration of the geologic heterogeneity in this deep saline formation allowed definition of a high injectivity zone, and estimated costs of CO_2 storage in this 'sweet spot' of the reservoir approached recent estimates that did not include costs for pressure management." **Steven T. Anderson and Hossein Jahediesfanjani,** *International Journal of Greenhouse Gas Control*. (Subscription may be required.)

Characterization of local capillary trap clusters in storage aquifers.

The following is from the abstract of this article: "Local capillary trapping occurs when buoyant CO_2 moves upward in a saline aquifer during geologic carbon sequestration. The volumetric capacity of local capillary traps (LCTs) is controlled by reservoir geological heterogeneity. These traps are thus intrinsic to heterogeneous storage aquifers; their volumetric capacities are however largely unknown. To address this issue, this work employs an easily calculated criterion that requires only a static geologic model to estimate the properties of LCT clusters, including size, frequency, and extent. Specifically, this work quantitatively analyzes: i) the properties of the largest LCT cluster; and ii) the impact of reservoir heterogeneity on cluster properties. The key finding of this work is that spatially-correlated reservoir heterogeneity in the horizontal direction causes the largest LCT cluster to laterally span across a given domain even when the horizontal correlation length is small (only 1/25th) compared to the domain width. The overall work sheds useful insights of the dependence of LCT clusters on reservoir heterogeneity and its implication for CO_2 trapping quantification." **Bo Ren and Luca Trevisan,** *Energy*. (Subscription may be required.)

Modeling of ex-situ dissolution for geologic sequestration of carbon dioxide in aquifers.

The following is from the abstract of this article: "Underground carbon dioxide (CO_2) sequestration is considered to be one of the main methods to mitigate greenhouse gas (GHG) emissions. In this technology, pure CO_2 is injected into an underground geological formation and since it is less dense than residual fluids, there is always a risk of leakage to the surface. To increase security of underground CO_2 disposal, ex-situ dissolution can be implemented. When CO_2 is dissolved in brine before injection, it significantly reduces the risks of leakage. In this approach, pure CO_2 is dissolved on the surface before injection. Surface dissolution could be achieved in a pipeline operating under the pressure of a target aquifer into which the CO_2 is injected. In a pipeline, CO_2 droplets are dissolved being dispersed in a brine turbulent flow. In this paper, a comprehensive model of droplet dissolution along a pipeline is presented. The model accounts for droplet breakup and coalescence processes and is validated against available experimental data." **Federico Cao, Dmitry Eskin, and Yuri Leonenko,** *Journal of Petroleum Science and Engineering*. (Subscription may be required.)

JOURNAL ARTICLES *(cont.)*

Prediction leakage channels of CO_2 injection wells.

The following is from the abstract of this article: "During CO_2 injection, a microannulus will be generated, leading to the transmission of gas through the cement behind the casing or before the formation when thermal stress exceeds bond strength. In this work, leakage channel prediction model was developed to predict the leakage channel of CO_2 injection wells. The prediction results indicate that the thermal stresses first decreased and then increased with increasing well depth; decreased with increasing radial distance; and increased with increasing injection time. The cement sheath of a production casing is more likely to form a leakage channel than other cement sheaths during long-duration CO_2 injection." **Bin Yuan, Yongqing Wang, Shuqiang Shi, and Yibo Feng,** *Energy Procedia.* (Subscription may be required.)

Nanosilica-latex reduction carbonation-induced degradation in cement of CO_2 geological storage wells.

The following is from the abstract of this article: "Carbon capture and storage (CCS) is a promising solution for reducing carbon dioxide concentration in the atmosphere. Wellbore integrity (in particular, the durability of the cement) is critical for ensuring the long-term viability and safety of CCS projects. The ordinary Portland cement (OPC) currently used in CCS wells has been shown to be unstable in CO_2-rich environments. Therefore, this study investigated amorphous-nanosilica-latex (ANL) modified oil well cement and studied its carbonation-induced degradation resistance properties. [The authors] observed that the modified cement had lower original permeability, higher compressive strength, and smaller penetration depth than existing OPC, even after carbonation degradation. For example, the initial permeability of 6 wt % for the ANL-modified cement was seven times smaller than that of OPC, while after 90 days of carbonation degradation, the carbonation penetration depth was more than 15.7 times smaller than OPC. ANL also reacted with hydroxide ($Ca(OH)_2$) to generate products with low calcium silicon ratios (such as tobermorite) and reduced the pH of the cement. ANL-modified cement showed superior degradation resistance due to (i) a decrease in permeability because of film formation effect of latex and filling effect of nano-particles, and (ii) the reacted with $Ca(OH)_2$ to generate longer chains of calcium silicate hydrate." **Bihua Xu, Bin Yuan, Yongqing Wang, Shunpeng Zeng, and Yuhao Yang,** *Journal of Natural Gas Science and Engineering.* (Subscription may be required.)

The impact of environmental innovation on carbon dioxide emissions.

The following is from the abstract of this article: "This paper examines the effects of environmental innovation on carbon dioxide emissions in the EU-27 countries between 1992 and 2014. [The authors] utilize the Generalized Method of Moments in a dynamic panel setting. Patent counts of environmental patent applications are used as indicator for environmental innovation. [The authors] find that environmental innovation did contribute to reductions of carbon dioxide emissions, while general innovative activity does not cause decreases in emissions. However, this effect is found to be comparatively small to the effects of increased economic activity. Further, [the authors] find the effect of innovation to differ across countries, with less developed economies showing a higher level of heterogeneity." **Daniel Töbelmann and Tobias Wendler,** *Journal of Cleaner Production.* (Subscription may be required.)

Knowledge spillover efficiency of carbon capture, utilization, and storage technology: A comparison among countries.

The following is from the abstract of this article: "This study examines the carbon capture, utilization, and storage research performance of 31 countries from the knowledge spillover perspective. Knowledge spillover efficiency—operationally defined as the level of academic and practical influence of research and development outputs—is measured using the output-oriented constant return to scale, variable returns to scale, and super efficiency models using data envelopment analysis. [The authors] consider the number of patents and research articles from 2000 to 2016 as input variables, while the number of research article citations, patent citations, and registration of triadic patent families as of 2017 are the three output variables. The samples for measuring efficiency were obtained by collecting patents and research articles using Wintelips and Scopus database, respectively. The results of the super-efficiency data envelopment analysis were used to examine each country's position in terms of knowledge spillover. More specifically, the US, European countries, Japan, Australia, and New Zealand showed relatively high efficiency, which might be characteristic of their R&D policies and environmental factors. Moreover, the returns to scale analysis provide implications for R&D resource allocation as to whether to encourage the quantitative or qualitative expansion of R&D outputs to improve efficiency. This study can provide meaningful information to policymakers to identify ex post R&D activities and planning." **Junhee Bae, Yanghon Chung, Jaewook Lee, and Hangyeol Seo,** *Journal of Cleaner Production.* (Subscription may be required.)

Impacts of China's emissions trading schemes on deployment of power generation with carbon capture and storage.

The following is from the abstract of this article: "The establishment of an emissions trading scheme (ETS) in China creates the potential for a 'least cost' solution for achieving the greenhouse gas (GHG) emissions reductions required for China to meet its Paris Agreement pledges. China has pledged to reduce CO_2 intensity by 60–65% in 2030 relative to 2005 and to stop the increase in absolute CO_2 emissions around 2030. In this series of studies, [the authors] enhance the MIT Economic Projection and Policy Analysis (EPPA) model to include the latest assessments of the costs of power generation technologies in China to evaluate the impacts of different potential ETS pathways on deployment of carbon capture and storage (CCS) technology. This paper reports the results from baseline scenarios where power generation prices are assumed to be homogeneous across the country for a given mode of generation. [The authors] find that there are different pathways where CCS might play an important role in reducing the emission intensity in China's electricity sector, especially for low carbon intensity targets consistent with the ultimate goals of the Paris Agreement. Uncertainty about the exact technology mix suggests that decision makers should be wary of picking winning technologies, and should instead seek to provide incentives for emission reductions. While it will be challenging to meet the CO_2 intensity target of 550 g/kWh for the electric power sector by 2020, multiple pathways exist for achieving lower targets over a longer timeframe. [The authors'] initial analysis shows that carbon prices of 35–40$/$tCO_2$ make CCS technologies on coal-based generation cost-competitive against other modes of generation and that carbon prices higher than 100$/$tCO_2$ favor a major expansion of CCS. The next step is to confirm these initial results with more detailed modeling that takes into account granularity across China's energy sector at the provincial level." **Jennifer Morris, Sergey Paltsev, and Anthony Y. Ku,** *Energy Economics.* (Subscription may be required.)

ELEGANCY: The Interdisciplinary Approach of the German Case Study to Enable a Low Carbon Economy by Hydrogen and CCS.

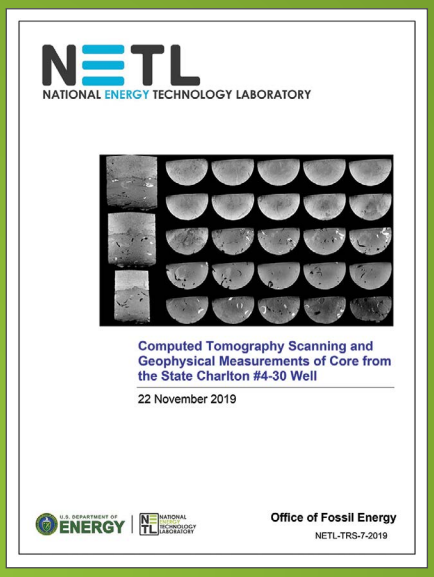
The following is from the abstract of this article: "The goal of the multinational ACT project ELEGANCY is to accelerate the decarbonisation of the European energy system by exploiting synergies between carbon capture and storage (CCS) and hydrogen (H_2). The introduction of CCS is delayed due to lack of business models, the widespread use of H_2 is hindered by the cost and availability of large quantities of clean hydrogen. The five participating countries Norway, England, Netherlands, Switzerland and Germany want to investigate and evaluate the combination of a hydrogen infrastructure with CCS in case studies and develop a planning tool. The Ruhr-University Bochum is working interdisciplinarily with five institutes within the framework of the Research Department Closed Carbon Cycle Economy (RD-CCCE). Thus, in addition to the technical part, social, macroeconomic and legal aspects are considered in the German case study. This interdisciplinary approach is presented in this paper, describing the practices of the different disciplines." **Stefan Flamme, Daniel Benrath, Sabrina Glanz, Franziska Hoffart, Christian Pielow, Michael Roos, Roland Span, Hermann-Josef Wagner, and Anna-Lena Schönauer,** *Energy Procedia.* (Subscription may be required.)

Soil organic matter decomposition and carbon sequestration in temperate coniferous forest soils affected by soluble and insoluble spruce needle fractions.

The following is from the abstract of this article: "Temperate forest soils are important carbon (C) sinks, where the C-stock is largely determined by the balance of leaf inputs and losses through respiration. However, studies dealing with leaf inputs to coniferous forest soils are limited although coniferous forests are widespread through the Northern temperate zone. In this study, [the authors] focused on the effects of soluble, insoluble and whole-tissue coniferous needle fractions on soil organic matter (SOM) decomposition and C storage in soil fractions. In addition, the effect of future increased C input was tested by applying a doubled amount of the soluble fraction (whole-tissue + soluble fraction). ^{13}C-labelled needles were produced from spruce seedlings in growth chambers and needle fractions were added to the coniferous forest soil in laboratory microcosms. CO_2 respired during incubation from the microcosms was partitioned into needle- and SOM-derived components. After seven months, soils were destructively harvested and analyzed for C content in soil fractions and microbial community composition…" **Veronika Jílková, Kateřina Jandová, Allan Sim, Barry Thornton, and Eric Paterson,** *Soil Biology and Biochemistry.* (Subscription may be required.)

REPORTS and OTHER PUBLICATIONS

Computed Tomography Scanning and Geophysical Measurements of Core from the State Charlton #4-30 Well.



The following is from the abstract of this DOE/NETL document: "The computed tomography (CT) facilities and the Multi-Sensor Core Logger (MSCL) at the National Energy Technology Laboratory (NETL) in Morgantown, West Virginia were used to characterize core of the Bass Island, Bois Blanc, and Amherstburg Formations from a vertical well (State Charlton #4-30) from Otsego County, Michigan at depths 3,030.0 to 3,090.0 ft and 3,400.0 to 3,520.5 ft. The primary impetus of this work is a collaboration between the Michigan Geological Survey (MGS) and NETL to characterize core to better understand the potential of carbon dioxide (CO_2) sequestration within formations in the Michigan Basin. As part of this effort, bulk CT scans of core were obtained from the State Charlton #4-30 well, provided by the MGS. This report, and the associated scans generated, provide detailed datasets not typically available for researchers to analyze. The resulting datasets are presented in this report and can be accessed from NETL's Energy Data eXchange (EDX) online system…All equipment and techniques used were non-destructive, enabling future examinations and analyses to be performed on the cores. Low-resolution CT images obtained with the NETL medical CT scanner were obtained for the entire core and high-resolution CT images acquired with the NETL industrial CT scanner were obtained for selected sections of the core. Qualitative analysis of the medical CT images coupled with X-ray fluorescence (XRF) measurements from the MSCL were useful in identifying zones of interest for more detailed analysis. The ability to quickly identify key areas for more detailed study with higher resolution will save time and resources in future studies. The combination of methods used provides a multi-scale analysis of this core and descriptions of the core that are relevant for many subsurface examinations that have traditionally been performed at NETL."

Carbon Dioxide Enhanced Oil Recovery Life Cycle (CELiC) Model.

The following is the description of this DOE/NETL product: "The Carbon Dioxide (CO_2) Enhanced Oil Recovery (EOR) Life Cycle (CELiC) Model calculates life cycle greenhouse gas (GHG) emissions for a CO_2-EOR system, where the user can select one of three sources of the injected CO_2: (1) extracted from a natural dome, (2) captured from a coal-fired power plant, or (3) captured from a natural gas power plant. The model has several parameters and options to allow the assessment of the system for a wide-array of products—electricity, pipeline CO_2, crude oil, and refined fuels. The model is also capable of deterministic (i.e., point estimate) and stochastic (i.e., probabilistic) analyses and finally a deterministic time-series analysis that shows the changing GHG emissions for the CO_2-EOR system over time."

FE/NETL CO_2 Transport Cost Model.

The following is the description of this DOE/NETL product: "The FE/NETL CO_2 Transport Cost Model is a spreadsheet-based tool that calculates the net present value for a project that transports liquid CO_2 by pipeline. The model includes the capital costs, operating costs, financing costs and revenues for the project. The model can calculate the break-even first year price (or cost) for transporting a tonne of CO_2 by finding the price that yields a net present value of zero for the project. The user provides a variety of inputs including the annual mass of CO_2 to be transported, the pipeline length, the years of operation and financial parameters."

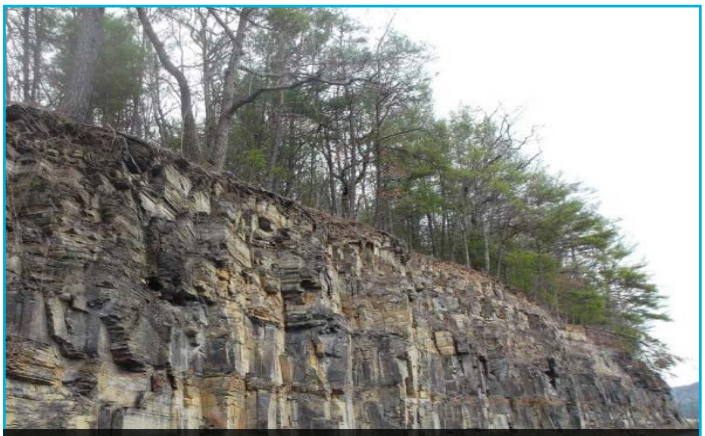
ABOUT DOE'S CARBON STORAGE PROGRAM

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*.



Parallel, vertical, orthogonal natural fracture faces (joint sets) in an outcrop of organic-rich Millboro Shale (Marcellus equivalent), Clover Creek, VA. Photo by Dan Soeder, 2014.

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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NATIONAL ENERGY TECHNOLOGY LABORATORY

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