

## CSN

CARBON STORAGE  
NEWSLETTER

AUGUST 2018

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:

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## DOE/NETL HIGHLIGHTS

*DOE Invests in Technologies that Assess Subsurface Stress for Carbon Storage.*

The U.S. Department of Energy's (DOE) Office of Fossil Energy (FE) has selected five projects to receive Federal funding for cost-shared research and development (R&D) through FE's *Carbon Storage Program*. The projects, supported through Funding Opportunity Announcement (FOA) DE-FOA-0001826 "Developing Technologies to Advance the Understanding of State of Stress and Geomechanical Impacts within the Subsurface," will provide tools for measuring, estimating, and understanding underground stress impacts that may occur in carbon storage activities. The National Energy Technology Laboratory (NETL)-managed projects were selected under two Areas of Interest (AOI): AOI 1 – Tools and Methods for Determining Maximum Principal Stress in the Deep Subsurface, and AOI 2 – Methods for Understanding Impact of Vertical Pressure Migration Due to Injection on State of Subsurface Stress. From *energy.gov* on July 25, 2018.

## ANNOUNCEMENTS

*FE Appoints New Head of Clean Coal and Carbon Management.*

DOE's FE announced the appointment of Lou Hrkman as the new Deputy Assistant Secretary (DAS) for Clean Coal and Carbon Management, where he will oversee research, development, and demonstration of advanced coal-based power systems.

*Commitments Made to Reducing GHG Emissions.*

At the *China-U.S. High-Level Dialogue on Energy and Climate Change*, held in San Francisco, California (USA), U.S. and Chinese experts discussed several cooperative mechanisms in existence between the two countries and pledged to continue dialogue. In addition, *officials from China and the European Union (EU)* also reaffirmed their commitment, releasing a *joint statement* at the *20<sup>th</sup> EU-China Summit*, held in Beijing, China. In the joint statement, the two sides committed to policies and measures to limit greenhouse gases (GHGs).

*CCUS Taskforce Sets Out Recommendations for the United Kingdom (UK).*

The Carbon Capture Utilization and Storage (CCUS) Taskforce presented a report to the UK government, detailing recommendations, opportunities, and the importance of CCUS technology. Among the recommendations is the development of at least two CCUS clusters (incorporating capture plants and carbon dioxide [CO<sub>2</sub>] stores) that are operational from the mid-2020s. The CCUS Cost Challenge Taskforce was established in January 2018 with the remit of informing and proposing a strategic plan for supporting the development of CCUS in the UK.

*Dutch Policy Measures.*

The Dutch government has committed to reducing their national CO<sub>2</sub> emissions by 49 percent by 2030 compared with 1990 levels. In addition to other policy measures, the Netherlands is also considering a national carbon price floor.



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## PROJECT and BUSINESS DEVELOPMENTS

### *DOE and NPPD to Study Carbon Storage.*

The Nebraska Public Power District (NPPD) has agreed to be part of a DOE Carbon Storage Assurance Facility Enterprise (CarbonSAFE) study that will look to safely, permanently, and economically store commercial-scale quantities of CO<sub>2</sub>. NPPD is currently working to complete a final report on a pre-feasibility study for a commercial-scale CO<sub>2</sub> geologic storage complex, and on the integrated CO<sub>2</sub> capture facility design for Gentleman Station Unit 2 (the design work is expected to be completed in 2019). *DOE's CarbonSAFE Initiative* projects focus on the development of geologic storage sites for the storage of CO<sub>2</sub> from industrial sources. From *The News Tribune* on July 20, 2018.

### *MOU to Develop Bio-Energy Combined with CCS.*

Researchers, scientists, and experts from Indonesia and Austria signed a Memorandum of Understanding (MOU) for a joint research project that will focus on bio-energy with carbon capture and storage (BECCS). Under the MOU, the Bandung Institute of Technology (ITB) and the International Institute for Applied Systems Analysis (IIASA) will also develop scientific publications and provide academic staff for research participation in seminars and conferences. In addition, the MOU allows for the possibility of graduate student exchanges and sharing access to relevant databases. From *OpenGovAsia* on July 30, 2018.

### *New Oil and Gas Program to Seek Safe CO<sub>2</sub> Storage Technologies.*

The Oil & Gas Technology Centre announced the launch of the TechX Ventures Program, which combines science with engineering to create start-up companies with technologies that lead to a sustainable future in a low-carbon economy. A partnership with Deep Science Ventures, the program will seek to create new technologies that will allow the safe storage and conversion of CO<sub>2</sub> to useful products. From *The Oil & Gas Technology Centre* on July 30, 2018.



Photograph from Southern States Energy Board's ECO<sub>2</sub>S Project as part of the CarbonSAFE Initiative ([FE0029465](#)).

## LEGISLATION and POLICY

### *Carbon Tax Bill Introduced.*

A *bill introduced by a member of the U.S. House of Representatives* would create a tax on CO<sub>2</sub> emissions while also limiting the U.S. Environmental Protection Agency's (EPA) authority to regulate GHG emissions from stationary sources under the Clean Air Act. The legislation, referred to as the "*MARKET CHOICE Act*," would establish a \$24/metric ton tax on CO<sub>2</sub>-equivalent emissions beginning in 2020. The tax would rise at an annual rate of two percent above inflation or more if specific emissions reduction targets are not achieved. From *S&P Global Platts* on July 23, 2018.

### *UK to Require Companies to Report CO<sub>2</sub> Emissions.*

The British government announced plans to require companies to report energy use, CO<sub>2</sub> emissions, and energy efficiency measures in their annual reports. The new framework will streamline reporting requirements while looking to improve energy efficiency by at least 20 percent by 2030. From *Reuters* on July 18, 2018.

### *Liverpool Bids to Become "Climate-Positive City."*

Liverpool Council (England, UK) announced a partnership with a blockchain non-profit to make Liverpool a "climate-positive city" by the end of 2020. As part of the deal, Poseidon Foundation will integrate its blockchain-powered platform into Liverpool city council's day-to-day operations in an effort to help further reduce emissions impacts through offsetting. Liverpool city council is currently committed to cut its overall CO<sub>2</sub> emissions by 40 percent by 2030 against 1990 levels. From *Business Green* on July 20, 2018.

## EMISSIONS TRADING

### *RGGI Initiates Auction Process.*

The states participating in the Regional Greenhouse Gas Initiative (RGGI) released the Auction Notice and application materials for their 41<sup>st</sup> quarterly auction of CO<sub>2</sub> allowances, to be held September 5, 2018. The "[Auction Notice for CO<sub>2</sub> Allowance Auction 41](#)" provides the information needed for potential participants to indicate their intent to bid on the 13,590,107 CO<sub>2</sub> allowances offered for sale at a minimum reserve price of \$2.20. In addition, the RGGI states will also make available a 10 million CO<sub>2</sub> allowance cost containment reserve (CCR), which will be accessed if the interim clearing price exceeds the CCR trigger price of \$10.25. From *RGGI News Release* on July 10, 2018.

### *Partnership to Launch Transparent Carbon Credit Trading Market.*

Xarbon Sustainability Limited and the United Nations Office for Project Service (UNOPS) have entered into a strategic partnership to support low-carbon economy development. Xarbon, a Hong Kong-based sustainability technology company, uses blockchain technology to improve carbon credit trading market transparency. UNOPS focuses on supporting low-carbon economy development by establishing digitalized carbon, aiming to improve education, awareness-raising, and social impact. From *Asia One* on July 18, 2018.

## RGGI Inc.



### *Carbon Tax Plan Unveiled.*

The Canadian province of Manitoba unveiled details of its "Made-in-Manitoba" plan, which includes a cap-and-trade style carbon tax for certain industries. Most companies in the province will pay a \$25/metric ton tax, but larger industrial emitters will be exempt up to a certain benchmark, which will be individually established by Manitoba's Climate and Energy Branch. When a company exceeds their benchmark, they can either pay the \$25/metric ton tax or purchase carbon credits from other companies; those who do not reach their benchmark can accumulate carbon credits, which can be sold on an open market or used to offset future taxes. Only companies that release more than 50,000 metric tons of CO<sub>2</sub> annually will qualify for the output-based pricing system framework. From *CBC News* on July 30, 2018.

## CLIMATE and SCIENCE NEWS

### *Acidic Oceans May Cause Fish to Lose Their Sense of Smell.*

A new study shows evidence that fish's ability to smell may be affected by potentially elevated levels of CO<sub>2</sub> in the ocean. When CO<sub>2</sub> is absorbed by seawater, the water becomes more acidic, which affects the ability of fish to detect odors. Fish would become vulnerable, as they use their sense of smell to find food, safe habitats, avoid predators, and find suitable spawning grounds. The study, titled "[Near-future CO<sub>2</sub> levels impair the olfactory system of a marine fish](#)," appeared in the journal *Nature Climate Change* and was led by the University of Exeter (England, UK). From *Phys.Org* on July 23, 2018.

### *Report Shows Missouri Farms Carbon Storage Potential.*

A research report conducted by Climate Central analyzed the extent to which the use of conservation farming practices can reduce carbon emissions in Missouri (USA). The report, titled "[Soil Solutions: Carbon-Smart Farming in the Show Me State](#)," found that the estimated total annual carbon storage potential for the entire state, with the adoption of conservation practices, is equivalent to twice the annual total GHG emissions of Columbia, Missouri. From *Climate Central* on July 18, 2018.

## JOURNAL ARTICLES

### *Detecting subsurface fluid leaks in real-time using injection and production rates.*

The following is the Abstract of this article: "[Carbon dioxide] injection into geologic formations for either enhanced oil recovery or carbon storage introduces a risk for undesired fluid leakage into overlying groundwater or to the surface. Despite decades of subsurface CO<sub>2</sub> production and injection, the technologies and methods for detecting CO<sub>2</sub> leaks are still costly and prone to large uncertainties. This is especially true for pressure-based monitoring methods, which require the use of simplified geological and reservoir flow models to simulate the pressure behavior as well as background noise affecting pressure measurements. In this study, [the authors] propose a method to detect the time and volume of fluid leakage based on real-time measurements of well injection and production rates. The approach utilizes analogies between fluid flow and capacitance-resistance modeling. Unlike other leak detection methods (e.g. pressure-based), the proposed method does not require geological and reservoir flow models to simulate the behavior that often carry significant sources of uncertainty; therefore, with [the authors'] approach the leak can be detected with greater certainty. The method can be

applied to detect when a leak begins by tracking a departure in fluid production rate from the expected pattern. The method has been tuned to detect the effect of boundary conditions and fluid compressibility on leakage. To highlight the utility of this approach [the authors] use [their] method to detect leaks for two scenarios. The first scenario simulates a fluid leak from the storage formation into an above-zone monitoring interval. The second scenario simulates intra-reservoir migration between two compartments. [The authors] illustrate this method to detect fluid leakage in three different reservoirs with varying levels of geological and structural complexity. The proposed leakage detection method has three novelties: i) requires only readily-available data (injection and production rates), ii) accounts for fluid compressibility and boundary effects, and iii) in addition to detecting the time when a leak is activated and the volume of that leakage, this method provides an insight about the leak location, and reservoir connectivity. [The authors] are proposing this as a complementary method that can be used with other, more expensive, methods early on in the injection process. This will allow an operator to conduct more expensive surveys less often because the proposed method can show if there are no leaks on a monthly basis that is cheap and fast." **Harpreet Singh and Nicolas J. Huerta**, *Advances in Water Resources*. (Subscription may be required.)

## JOURNAL ARTICLES *(cont.)*

### *Long-term viability of carbon sequestration in deep-sea sediments.*

The following is the Abstract of this article: "Sequestration of [CO<sub>2</sub>] in deep-sea sediments has been proposed for the long-term storage of anthropogenic CO<sub>2</sub> that can take advantage of the current offshore infrastructure. It benefits from the negative buoyancy effect and hydrate formation under conditions of high pressure and low temperature. However, the multiphysics process of injection and postinjection fate of CO<sub>2</sub> and the feasibility of subseabed disposal of CO<sub>2</sub> under different geological and operational conditions have not been well studied. With a detailed study of the coupled processes, [the authors] investigate whether storing CO<sub>2</sub> into deep-sea sediments is viable, efficient, and secure over the long term. [The authors] also study the evolution of multiphase and multicomponent flow and the impact of hydrate formation on storage efficiency. The results show that low buoyancy and high viscosity slow down the ascending plume and the forming of the hydrate cap effectively reduces permeability and finally becomes an impermeable seal, thus limiting the movement of CO<sub>2</sub> toward the seafloor. [The authors] identify different flow patterns at varied time scales by analyzing the mass distribution of CO<sub>2</sub> in different phases over time. [The authors] observe the formation of a fluid inclusion, which mainly consists of liquid CO<sub>2</sub> and is encapsulated by an impermeable hydrate film in the diffusion-dominated stage. The trapped liquid CO<sub>2</sub> and CO<sub>2</sub> hydrate finally dissolve into the pore water through diffusion of the CO<sub>2</sub> component, resulting in permanent storage. [The authors] perform sensitivity analyses on storage efficiency under variable geological and operational conditions. [The authors] find that under a deep-sea setting, CO<sub>2</sub> sequestration in intact marine sediments is generally safe and permanent." **Yihua Teng and Dongxiao Zhang**, *Science Advantages*. (Subscription may be required.)

### *Air quality co-benefits of carbon pricing in China.*

The following is the Abstract of this article: "Climate policies targeting energy-related CO<sub>2</sub> emissions, which act on a global scale over long time horizons, can result in localized, near-term reductions in both air pollution and adverse human health impacts. Focusing on China, the largest energy-using and CO<sub>2</sub>-emitting nation, [the authors] develop a cross-scale modelling approach to quantify these air quality co-benefits, and compare them to the economic costs of climate policy. [The authors] simulate the effects of an illustrative climate policy, a price on CO<sub>2</sub> emissions. In a policy scenario consistent with China's recent pledge to reach a peak in CO<sub>2</sub> emissions by 2030, [the authors] project that national health co-benefits from improved air quality would partially or fully offset policy costs depending on chosen health valuation. Net health co-benefits are found to rise with increasing policy stringency." **Mingwei Li, Da Zhang, Chiao-Ting Li, Kathleen M. Mulvaney, Noelle E. Selin, and Valerie J. Karplus**, *Nature Climate Change*. (Subscription may be required.)

### *Assessment of two-phase flow on the chemical alteration and sealing of leakage pathways in cemented wellbores.*

The following is the Abstract of this article: "Wellbore leakage tops the list of perceived risks to the long-term geologic storage of CO<sub>2</sub>, because wells provide a direct path between the CO<sub>2</sub> storage reservoir and the atmosphere. In this paper, [the authors] have coupled a two-phase flow model with [the authors'] original framework that combined models for reactive transport of carbonated brine, geochemistry of reacting cement, and geomechanics to predict the permeability evolution of cement fractures. This addition makes the framework suitable for field conditions in geological storage sites, permitting simulation of contact between cement and mixtures of brine and supercritical CO<sub>2</sub>. Due to lack of conclusive experimental data, [the authors] tried both linear and Corey relative permeability models to simulate flow of the two phases in cement fractures. The model also includes two options to account for the inconsistent experimental observations regarding cement reactivity with two-phase CO<sub>2</sub>-brine mixtures. One option assumes that the reactive surface area is independent of the brine saturation and the second option assumes that the reactive surface area is proportional to the brine saturation. [The authors] have applied the model to predict the extent of cement alteration, the conditions under which fractures seal, the time it takes to seal a fracture, and the leakage rates of CO<sub>2</sub> and brine when damage zones in the wellbore are exposed to two-phase CO<sub>2</sub>-brine mixtures. Initial brine residence time and the initial fracture aperture are critical parameters that affect the fracture sealing behavior. [The authors] also evaluated the importance of the model assumptions regarding relative permeability and cement reactivity. [The authors'] results illustrate the need to understand how mixtures of [CO<sub>2</sub>] and brine flow through fractures and react with cement to make reasonable predictions regarding well integrity. For example, a reduction in the cement reactivity with two-phase CO<sub>2</sub>-brine mixture can not only significantly increase the sealing time for fractures but may also prevent fracture sealing." **Jaisree Iyer, Stuart D.C. Walsh, Yue Hao, and Susan A. Carroll**, *International Journal of Greenhouse Gas Control*. (Subscription may be required.)

### *Estimates of carbon storage in grassland ecosystems on the Loess Plateau.*

The following is the Abstract of this article: "Grassland ecosystems play an important role in the carbon (C) balance of arid and semi-arid regions. These ecosystems provide C for grass growth and soil microbial activities and represent one of the main sources of atmospheric C. In this study, [the authors] estimated the C density and storage of 223 sampling sites in grassland ecosystems on the Loess Plateau using elevation, vegetation indexes, precipitation, air temperature, day and night land surface temperature (LSTd and LSTn, respectively), evapotranspiration (ET), percent tree cover and the non-vegetated area to build decision regression tree and generalized linear regression models (GLMs). The results showed that the C density decreased from south to north and ranged from 0.22 to 29.29 kg C/m<sup>2</sup>. The average amount of C stored in the ecosystems was 1.46 Pg. The typical steppe and forest steppe stored the most C, and the steppe desert stored the least. The soil (0–1 m) stored most of the organic C, accounting for > 90%, and the belowground biomass (BGB) contained > 3 times the amount of C as the aboveground biomass (AGB). This study provides reference information for the loss of C and associated mitigation strategies on the Loess Plateau." **Yinyin Wang, Lei Deng, Gaolin Wu, Kaibo Wang, and Zhouping Shangquan**, *CATENA*. (Subscription may be required.)

## JOURNAL ARTICLES *(cont.)*

### *Impact of inner reservoir faults on migration and storage of injected CO<sub>2</sub>.*

The following is the Abstract of this article: “[Carbon dioxide] geological storage (CGS) is an effective way to mitigate [GHG] emissions, and geological security is one of the most important issues in CGS. The faults distributed in geological formations make multi-layered reservoirs interconnected systems. A three-dimensional (3D) numerical model was established to evaluate the effects of inner reservoir faults on the CO<sub>2</sub> migration and storage capacity of an actual CGS demonstration project in the Ordos Basin of China. The results show that the faults in the layered reservoir system could significantly affect the migration of injected CO<sub>2</sub>. The cross-layer faults at the bottom of the faulted reservoir could act as preferential passages between the upper and lower geological formations, causing the CO<sub>2</sub> in the reservoir formation to move upward to adjacent layers rather than to lateral migration. CO<sub>2</sub> migration along the inner-layer faults widely occurred at the top of the reservoir formation, decreasing the pressure accumulation and CO<sub>2</sub> saturation around the injection well. Based on the simulation, CO<sub>2</sub> will have migrated into the Heshanggou Formation after 300 years, and most of the CO<sub>2</sub> will be trapped in the bottom sub-layers, with no CO<sub>2</sub> intruding into the upper caprock. The spatial and temporal evolution of the injected CO<sub>2</sub> was well presented for the faulted reservoir system, suggesting that the faults inside the multi-layered reservoir are beneficial to CGS.” **Zhijie Yang, Tianfu Xu, Fugang Wang, Yanlin Yang, Xufeng Li, and Ningning Zhao**, *International Journal of Greenhouse Gas Control*. (Subscription may be required.)

### *Adaption, mitigation and risk-taking in climate policy.*

The following is the Abstract of this article: “The future consequences of climate change are highly uncertain and estimates of economic damages differ widely. Governments try to cope with these risks by investing in mitigation and adaptation measures. In contrast to most of the existing literature, [the authors] explicitly model the decision of risk averse governments on mitigation and adaptation policies. [The authors] also consider the interaction of the two strategies in presence of uncertainty. Mitigation efforts of a single country trigger crowding out as other countries will reduce their mitigation efforts. This may even lead to lower mitigation on the global scale. In contrast, a unilateral commitment to large adaptation efforts benefits the single country and can reduce the global risk from climate change at the expense of other countries.” **Heike Auerswald, Kai A. Konrad, and Marcel Thum**, *Journal of Economics*. (Subscription may be required.)

### *The role of revenue sharing and first-mover advantage in emission abatement with carbon tax and consumer environmental awareness.*

The following is the Abstract of this article: “In this study, [the authors] explore the role of revenue sharing and first-mover advantage in manufacturer's carbon emission abatement effort and the firms' profitability in a linear demand setting, where the government might impose some carbon emission charges and consumers may have environmental awareness. [The authors] consider a supply chain system, consisting of a manufacturer and a retailer. Either of them can move first to offer the other firm a wholesale price contract (WP) or a revenue sharing contract (RS), which is termed as ‘abatement level promise strategy’ (PR) and ‘abatement level requirement strategy’ (RQ), respectively. [The authors'] analysis shows that under both PR and RQ, there exists a unique abatement level maximizing the manufacturer's profit in WP and RS, respectively. Moreover, both firms' incentives for abatement are perfectly aligned under PR, but are misaligned under RQ when the marginal abatement cost is large. Contrary to conventional wisdom, RS does not necessarily dull the manufacturer's effort in abatement, it depends on whether she possesses first-mover advantage and whether consumers have environmental awareness. Further, with consumer environmental awareness (numerically) or without, both firms always prefer to possess first-mover advantage, but the system's profit under RQ is smaller than that under PR (numerically). Surprisingly, whether a greater share of revenue benefits a firm depending on whether the firm possesses first-mover advantage (numerically). Finally, under both RQ (numerically) and PR, RS fails to coordinate the system.” **Huixiao Yang, Jianwen Luo, and Haijun Wang**, *International Journal of Production Economics*. (Subscription may be required.)

### *Decentralized optimal multi-energy flow of large-scale integrated energy systems in a carbon trading market.*

The following is the Abstract of this article: “This paper proposes a novel decentralized optimal multi-energy flow (OMEF) of large-scale integrated energy systems (IES) in a carbon trading market, to fully exploit economic and environmental advantages of the system considering difficulties of information collection from subareas. The decentralized OMEF is solved by three decentralized optimization algorithms, including auxiliary problem principle (APP), block coordinates down (BCD), and approximate Newton directions (AND). Moreover, a dynamic parameter adjustment is developed for APP and BCD to ensure convergence. So that a cooperative optimization among subareas can be achieved through utilizing only the local information and the boundary information. Finally, case studies of a two-area IES with 8 energy hubs and a three-area IES with 33 energy hubs are carried out to deeply compare the performance of the three decentralized algorithms, together with a thorough analysis about the effect of carbon trading price on the system.” **Kaiping Qu, Tao Yu, Linni Huang, Bo Yang, and Xiaoshun Zhang**, *Energy*. (Subscription may be required.)

## REPORTS and OTHER PUBLICATIONS

***Feasibility of Biogeochemical Sealing of Wellbore Cements: Lab and Simulation Tests.***

The following is from the Executive Summary of this DOE/NETL document: “A critical facet of a successful CO<sub>2</sub> storage program in geologic formations—a major component of the DOE Fossil Energy portfolio—necessitates prevention of CO<sub>2</sub> leakage from cement and its interface with host lithologies. To ensure permanence of CO<sub>2</sub> stored in a geologic formation it is essential to maintain the wellbore integrity to prevent leakage of gas to the surface or surficial aquifers. This study builds on advances on the current understanding of behavior of cement under high pressure/temperature and CO<sub>2</sub> conditions and recent reports on the bioprecipitation of calcium carbonate by *Sporosarcina pasteurii* (*S. pasteurii*) in the presence of supercritical CO<sub>2</sub>, to test the feasibility of microbially-mediated sealing of a leaking wellbore. This study used a Portland cement, Mt. Simon sandstone cores (to be supplied by [Pacific Northwest National Laboratory [PNNL] researchers), and a synthetic Illinois Basin brine as the model geologic materials. The Mt. Simon formation has been targeted for supercritical CO<sub>2</sub> injection as a part of the DOE’s FutureGen project, and as one of the U.S. DOE-NETL Phase III Regional Partnership programs. The growth rate of *S. pasteurii* on cement and sandstone in various temperature and pressure conditions were measured. For the aqueous experiments, this study focused on the aqueous population of *S. pasteurii* as it allowed a quantitative evaluation of community growth. However, it was also qualitatively evaluated whether this species was able to grow on cement or sandstone that was previously collected from the Mt. Simon formation. It was found that the species grew best at 30°C compared to 40°C, the latter being among the lowest temperatures likely to occur in the Mt. Simon formation. The species was able to have temporarily stable population for a in the brine at 30°C, but failed after 40°C. This study inoculated a brine solution overlaying cement/sandstone ‘cement samples’ and incubated them at 30°C in the brine with urea augmented. The results demonstrated that the species grew well on the sandstone, and on the cement with an apparent preference for the later.”

***Role of CCUS in a below 2 degrees scenario.***

The following is from the Executive Summary of this European Zero Emission Technology and Innovation Platform (ZEP) document: “The world’s economy is built on energy, 80% of which still came from fossil fuels in 2016. The growth in use of fossil fuels worldwide is still far higher in absolute terms than the growth of non-CO<sub>2</sub> emitting energies, so far employed. In Europe, the EU Commission’s 2016 reference scenario for primary energy consumption showed similar levels of demand for natural gas and oil in 2050 as in 2010. Meanwhile, the Paris Agreement commits the world to net-zero emissions in the second half of the century, balancing remaining sources with sinks to achieve neutrality. In a European context, the recently agreed Regulation on Governance of the Energy Union commits the EU to meeting net-zero ‘as soon as possible’. The EU’s Long-term strategy for [GHG] emissions reduction, to be presented at COP 24 in November, will assess how to reach net-zero by 2050. Although a major source for global GHG emissions, the industry sector has largely been shielded from contemporary climate action, postponing relevant measures into the far future. Cash and investment constrained European industry will not make changes to reduce CO<sub>2</sub> emissions without a strong positive business case, which so far is lacking. Within a 32 year timeframe Europe cannot rely on potential breakthrough technologies and fundamental changes in consumer [behavior], but needs to deploy real solutions that are available today to reduce industry emissions. [CCS], along with [utilization] of CO<sub>2</sub> where appropriate (CCUS), is available, scalable, cost effective and suitable to deeply reduce emissions from industrial processes and heat.”



## ABOUT DOE'S CARBON STORAGE PROGRAM

The **Carbon Storage Program** advances the development and validation of technologies that enable safe, cost-effective, permanent geologic storage of CO<sub>2</sub>. The Carbon Storage Program also supports the development of best practices for CCS that will benefit projects implementing CCS at a commercial scale, such as those being performed under NETL's Clean Coal Power Initiative and Industrial Carbon Capture and Storage Programs. The technologies being developed and the small- and large-scale injection projects conducted through this program will be used to benefit the existing and future fleet of fossil fuel power-generating facilities by developing tools to increase our understanding of the behavior of CO<sub>2</sub> in the subsurface and identifying the geologic reservoirs appropriate for CO<sub>2</sub> 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 are available via the [Carbon Storage Program Publications webpage](#).

Get answers to your carbon capture and storage questions at NETL's [Frequently Asked Questions webpage](#).

## 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.



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