Carbon Storage Newsletter

July 2015

What's Inside?

Highlights

"DOE-Funded Project Testing Laser CO_2 Monitoring at Carbon Storage Site."

A multipoint, laser-based carbon dioxide (CO_2) monitoring system was installed at an operational carbon storage site in Decatur, Illinois, USA, as part of a National Energy Technology Laboratory (NETL)-managed project. Developed by Exelis, the system, called GreenLITE, runs autonomously and provides real-time updates of two-dimensional atmospheric CO_2 concentrations over a 0.25 square-kilometer area at the storage site, which is located adjacent to an ethanol production facility where 1 million metric tons of CO_2 have been captured over the past three years and transported for storage. The Midwest Geological Sequestration Consortium (MGSC), one of seven regional partnerships in NETL's Regional Carbon Sequestration Partnership (RCSP) Program, began large-scale CO_2 injection at the Decatur site in 2011. From *Energy.gov* on June 3, 2015.

Announcements

NETL Releases Carbon Storage Project Portfolio.

The U.S. Department of Energy's (DOE) NETL released the 2015 Carbon Storage Portfolio, which provides a comprehensive overview of the NETL Carbon Storage Program's current and recently completed work. The portfolio includes Storage Division personnel contact information, technology area introductions, project communication products, papers and technical reports, Best Practices Manuals (BPMs), and access to all archived projects.

NETL-Sponsored Demonstration Project Reaches Milestone.

In a DOE/NETL-sponsored project at a hydrogen production facility in Port Arthur, Texas, USA, Air Products and Chemicals Inc. captured and stored 2 million metric tons of CO_2. The project, supported through DOE's Industrial Carbon Capture and Storage (ICCS) Program, demonstrates vacuum swing adsorption (VSA) to capture the CO_2, and also looks to help verify CO_2-enhanced oil recovery (EOR) as an effective method for permanent geologic CO_2 storage.

Magellan Provides Project Updates.

Magellan Petroleum Corporation announced the completion of a reservoir engineering study using data from the Poplar CO_2-EOR pilot project. The results of the study estimated that approximately 80 to 100 million barrels of oil equivalent (MMboe) may be recoverable from the Charles formation at Poplar using CO_2-EOR over approximately 40 years.

Announcements (Continued)

ETI Seeks CCS Partners.

The Energy Technologies Institute (ETI) in the United Kingdom (UK) is seeking a concept for new power generation capacity fitted with carbon capture and storage (CCS). The investment is expected to support development of an investable, low-cost, low-carbon power scheme, and is designed to take advantage of new CCS infrastructure. The Request for Proposal (RFP) will close on September 15, 2015. The deadline for notification of intention to submit a proposal is August 14, 2015.

Technical Session on Engineering Geologic CO_2 Storage Systems.

The American Institute of Chemical Engineers' (AIChE) Annual Meeting, scheduled for November 8-13, 2015, in Salt Lake City, Utah, USA, will include a technical session, titled, "Engineering Geologic Carbon Dioxide Storage Systems." Research presentations will cover the science and technology of carbon storage, as well as field demonstrations of CO_2 injection.

2015 Carbon Management Technology Conference (CMTC 2015).

This conference is scheduled for November 17-19, 2015, at the Sugar Land Marriott Town Square in Sugar Land, Texas, USA. The conference will focus on carbon capture, storage, and utilization technologies that are being performed at large scale and provide options for low greenhouse gas (GHG) emissions while maintaining fuel diversity for sustainable growth.

Dutch Government to Speed Up GHG Reductions.

The Dutch government will work to reduce their GHG emissions by at least 25 percent compared to 1990 levels by 2020, per a district court order. Current government policy has the Netherlands on pace for an approximate 17 percent reduction by 2020.

Carbon Storage in the News

"Green Light for Peterhead Carbon Capture and Storage Proposal."

Aberdeenshire council approved plans for the Peterhead CCS project being developed by Shell and Scottish and Southern Energy (SSE). According to Shell, up to 10 million metric tons of CO_2 emissions could be captured over a 10- to 15-year lifecycle from the Peterhead Power Station and transported offshore, via pipeline, for long-term storage in depleted gas wells under the North Sea. The Peterhead CCS Project was chosen as one of two CCS demonstration projects to progress to the next stage of the UK Government's CCS Commercialization Competition funding. From *Daily Record* on June 18, 2015.

"Royal Dutch Shell Seeks Funding for Carbon Capture Project."

According to a report from the Financial Times, Royal Dutch Shell is seeking funds to develop a CCS project at an abandoned offshore natural gas power station. Shell officials believe that if successful, the project, located at Goldeneye, an abandoned offshore natural gas production platform connected to the Scottish coast via a 100-kilometer pipeline, can serve as an example for other similar projects. From *Bidness Etc* on June 29, 2015.

"Canada's SaskPower Opens Carbon Capture Test Facility."

SaskPower opened its Carbon Capture Test Facility (CCTF) in Estevan, Saskatchewan, Canada. Built in partnership with Mitsubishi Hitachi Power Systems, Ltd., CCTF is a laboratory that uses flue gas from the neighboring Shand Power Station and allows researchers to test equipment, chemical innovation, and engineering designs. Individual parts can be isolated, modified, and operated to test carbon capture technologies at CCTF, allowing companies to track how they react under commercial operating conditions. The launch was attended by member countries of the Carbon Sequestration Leadership Forum (CSLF). From *POWER Magazine* on June 18, 2015.

Science

"New Calculations to Improve Carbon Dioxide Monitoring From Space."

A team of climate scientists have developed calculations that predict how light of different colors is absorbed by CO_2, helping to interpret GHG emissions data collected from satellites and ground stations. Published in the journal "Physical Review Letters," the scientists' study shows how the fundamental laws of quantum mechanics can be used to make the predictions, how it will aid in learning how CO_2 evolves in the atmosphere, and where CO_2 is being produced. By improving the understanding of how much light the CO_2 absorbs, the group of researchers, led by the University College London (UCL), believe that uncertainties in some models can be reduced. According the study, the new calculations give an accuracy of 0.3 percent, while previous methods were accurate to approximately 5 percent. From *R&D Magazine* on June 15, 2015.

Science (Continued)

"Enhancing North Sea Oil Recovery Can Store More CO_2 Much Faster," *and* "Carbon Capture Could Provide Lifeline to North Sea Oil, Report Says."

According to a new report, synergy between CO_2-EOR and CCS could aid in the development of both technologies in the UK continental shelf. The study, conducted by researchers from Edinburgh University, states that storing CO_2 from industry in spaces left by oil extraction under the North Sea has the potential to stimulate exploration in the area, while also helping the UK meet its international targets for reducing CO_2 emissions. According to the report, projects that combined carbon capture with subsea exploration could extend the life of North Sea oil fields. From *Gas World* on June 16, 12015, and *Chronicle Live* on June 16, 2015.

"Increased Carbon Dioxide Levels in Air Restrict Plants' Ability to Absorb Nutrients."

According to a study conducted by researchers from the University of Gothenburg, potentially rising levels of atmospheric CO_2 may affect plants' ability to absorb nutrients. Published in the journal "Global Change Biology," the study examined various ecosystems using large-scale field experiments conducted in eight countries on four continents. The data revealed that the concentration of nitrogen (a nutrient that impacts crop growth in terrestrial ecosystems) in plants' tissue was lower in air with high levels of CO_2. As a result, a potential rise in CO_2 levels in the atmosphere could result in crops having a reduced nitrogen content. An abstract of the study, titled, "Constraints to nitrogen acquisition of terrestrial plants under elevated CO_2," is available in the "Terrestrial" section of this newsletter. From *Scicasts* on June 15, 2015.

Policy

"Administration Announces More Than $4 Billion in Private-Sector Commitments and Executive Actions to Scale-Up Investment in Clean Energy Innovation."

The White House announced a series of executive actions to encourage clean energy innovation. Under one of the executive actions, DOE will launch a Clean Energy Impact Investment Center. Among other purposes, the center will share relevant research and analysis by DOE and its National Laboratories, and collect and make available existing, public information on entities currently engaged in partnerships with DOE, as well as information about energy and climate programs at other government agencies. From *The White House Press Release* on June 16, 2015.

"United Stated and China Strengthen Climate Change."

Government officials from the United States and China announced cooperation on potential climate change and clean energy through the U.S.-China Climate Change Working Group at the seventh U.S.-China Strategic and Economic Dialogue (S&ED). The cooperation builds upon the November 2014 Joint Announcement on Climate Change in which the two countries pledged to commit to work together to achieve a global climate agreement and transition to low-carbon economies. The Working Group highlighted, among other outcomes of the meeting, the announcement of a "Climate-Smart/Low-Carbon Cities Summit," to be held later this year; a bilateral, industry-led working group to develop pilot projects demonstrating energy efficiency in industrial and commercial buildings; an industrial boiler emission control program; and two joint carbon capture, utilization, and storage pilot projects. From *The U.S. Department of State* on June 24, 2015.

"U.S.-Brazil Joint Statement on Climate Change."

The United States and Brazil have launched a Joint Initiative on Climate Change, to be implemented through a high-level U.S.-Brazil Climate Change Working Group. The new Working Group will look to enhance bilateral cooperation on issues relating to land use, clean energy, and adaption, as well as policy dialogues on domestic and international climate issues. The first meeting of the Working Group will occur in October. From *The White House Press Release* on June 30, 2015.

"Carbon dioxide emission standards for U.S. power plants: An efficiency analysis perspective."

The following is the Abstract of this article: "On June 25, 2013, [the United States] announced [a] plan to introduce [CO_2] emission standards for electricity generation. This paper proposes an efficiency analysis approach that addresses which emission rates (and standards) would be feasible if the existing generating units adopt best practices. A new efficiency measure is introduced and further decomposed to identify different sources' contributions to emission rate improvements. Estimating two Data Envelopment Analysis (DEA) models – the well-known joint production model and the new materials balance model – on a dataset consisting of 160 bituminous-fired generating units, [the authors] find that the average generating unit's electricity-to-[CO_2] ratio is 15.3 [percent] below the corresponding best-practice ratio. Further examinations reveal that this discrepancy can largely be attributed to non-discretionary factors and not to managerial inefficiency. Moreover, even if the best practice ratios could be implemented, the generating units would not be able to comply with the U.S. Environmental Protection Agency's (EPA) recently proposed [CO_2] standard." **Benjamin Hampf and Kenneth Løvold Rødseth**, *Energy Economics*. (Subscription may be required.)

Geology

"Permeability characteristics of mudstone cap rock and interlayers in bedded salt formations and tightness assessment for underground gas storage caverns."

The following is the Abstract of this article: "Permeability of nonsaline cap rock and interlayers is a key parameter for the assessment of the tightness of gas storage caverns in bedded salt formations. X-ray Diffraction, permeability tests, Scanning Electron Microscope studies and theoretical analyses have been performed for the mudstone cap rock and interlayers of a potential cavern in a bedded salt formation. The results show that the permeability of cap rock and interlayers is in the range of 10^{-18}–10^{-20} m^2, whereas the interface in between salt

Geology (Continued)

and interlayer behaves as if impervious. Applied confinement conditions significantly affect the permeability. The higher the applied hydrostatic pressure, the lower the permeability. Permeability decreases more than one order of magnitude with hydrostatic pressure increases, up to a certain 'compression threshold pressure'. Permeability remains virtually constant, at an extremely low magnitude, once the hydrostatic pressure exceeds this 'compression threshold pressure'. The intrinsic reasons for the low permeability have been revealed by SEM studies, and are as follows: (1) the grains making up the bulk of the mudstone are very small and extremely tightly cemented; secondary minute clay minerals completely fill the pores and fissures between grains of quarts and feldspar, etc., resulting in very little residual void space and reducing connectivity for fluid penetration; and (2) the boundaries between quartz, feldspar and other grains are mainly plate-shape cracks that are poorly interconnected while the finer matrix is very tight and crack-free. The mechanical compaction investigation shows that the plate-shape cracks are much easier to be compacted than sphere-shape pores, which contributes significantly to the decrease in permeability. A capillary tube model suggests that permeability decreases very rapidly in the initial stages of compaction, but decreases extremely slowly in subsequent stages. So the permeability obviously behaves differently before and after the 'compression threshold pressure'. By comparison with previous studies, the research [the authors] launched demonstrates that the cap rock and interlayers are characterized by extremely low permeability in compression regions. Hence the requirements of tightness (except for the possible presence of Excavation Disturbed Zones) are basically guaranteed. Also, a recommendation is expressed as: to ensure higher tightness and safety, reasonable design and operating programs should be adopted to reduce the EDZs as much as possible." **Wei Liu, Yinping Li, Chunhe Yang, Jaak J.K. Daemen, Yun Yang, and Guimin Zhang**, *Engineering Geology*. (Subscription may be required.)

"Pore network quantification of sandstones under experimental CO_2 injection using image analysis."

The following is the Abstract of this article: "Automated-image identification and quantification of minerals, pores and textures together with petrographic analysis can be applied to improve pore system characterization in sedimentary rocks. [The authors'] case study is focused on the application of these techniques to study the evolution of rock pore network subjected to super critical CO_2-injection. [The authors] have proposed a Digital Image Analysis (DIA) protocol that guarantees measurement reproducibility and reliability. This can be summarized in the following stages: (i) detailed description of mineralogy and texture (before and after CO_2-injection) by optical and scanning electron microscopy (SEM) techniques using thin sections; (ii) adjustment and calibration of DIA tools; (iii) data acquisition protocol based on image capture with different polarization conditions (synchronized movement of polarizers); (iv) study and quantification by DIA that allow (a) identification and isolation of pixels that belong to the same category: minerals vs. pores in each sample and (b) measurement of changes in pore network, after the samples have been exposed to new conditions (in [the authors'] case: SC–CO_2-injection). Finally, interpretation of the petrography and the measured data by an automated approach were done. In [the authors'] applied study, the DIA results highlight the changes observed by SEM and microscopic techniques, which consisted in a porosity increase when CO_2 treatment occurs. Other additional changes were minor: variations in the roughness and roundness of pore edges, and pore aspect ratio, shown in the bigger pore population. Additionally, statistic tests of pore parameters measured were applied to verify that the differences observed between samples before and after CO_2-injection were significant." **Edgar Berrezueta, Luís González-Menéndez, Berta Ordóñez-Casado, and Peter Olaya**, *Computers & Geosciences*. (Subscription may be required.)

Technology

"CO_2 foam flooding for improved oil recovery: Reservoir simulation models and influencing factors."

The following is the Abstract of this article: "A mechanistic model of CO_2 foam that allows for direct simulation of foam generation, propagation, coalescence and collapse was described in this study. The controlling parameters, such as reaction rate factors for foam generation, coalescence and collapse in presence of oil, the viscosity of foaming components and surfactant adsorption, were adjusted to match the experimental results of CO_2 foam coreflooding. A three dimensional heterogeneous conceptual reservoir model was then built to study the mechanisms of CO_2 foam flooding based the foam model. The simulation results show that CO_2 foam flooding can improve oil recovery through a combination of various mechanisms, including selective blocking and conformance control, gas up-flow effect, reservoir energy support, and the improvement of displacement efficiency. The sensitivity and the effect of different influencing factors on the performance of CO_2 foam flooding were investigated via the simulation models on various scenarios. [Carbon dioxide] foam flooding can achieve a better oil recovery in comparison with water flooding, CO_2 flooding and WAG (water alternating gas) processes. Early CO_2 foam injection is conducive to the improvement of oil recovery and the success of the project. [Carbon dioxide] foam flooding technique can be applied in a wide range of complex reservoirs, especially for highly heterogeneous reservoirs with high permeability channels, and reservoirs with different sedimentary sequences." **Yang Zhang, Yuting Wang, Fangfang Xue, Yanqing Wang, Bo Ren, Liang Zhang, and Shaoran Ren**, *Journal of Petroleum Science and Engineering*. (Subscription may be required.)

"Well completion and integrity evaluation for CO_2 injection wells."

The following is the Abstract of this article: "[Storage] of CO_2 in depleted oil and gas reservoirs, coal seams and saline [formations] is one important means of mitigating greenhouse effect on the environment and enhancing oil and gas recovery. The collected CO_2 is injected via injection wells into the underground space. Due to the characteristics of supercritical CO_2, e.g., corrosive, low temperature, the well design and completion for CO_2 injection purposes requires more considerations. This paper introduces the basic challenges of designing a CO_2 injection well, reviews the famous CO_2 injection cases around the world, and proposes well completion criteria, including completion scheme design, materials selection and so on. Well integrity tests in use are reviewed and evaluated in terms of their pros and cons. Well integrity evaluation using numerical simulation is conducted as well to study the influences of CO_2 injection on well integrity in a pilot area in Germany.

Technology (Continued)

The results show that the materials selected for CO_2 injection well shall adapt to the low-temperature environment, and the cement should have a high tensile strength and resist corrosion. Under the impact of salt rock creep, the cement cracks resulting from temperature decrease during injection tend to heal. At the end of the paper for the wells with loss of integrity, a remedial work needs to be done, e.g., cement repair, and for this a thorough review of cement repair experiences is performed." **Mingxing Bai, Jianpeng Sun, Kaoping Song, Lili Li, and Zhi Qiao**, *Renewable and Sustainable Energy Reviews*. (Subscription may be required.)

"Field measurement of residual carbon dioxide saturation using reactive ester tracers."

The following is the Abstract of this article: "As part of the CO2CRC Otway Residual Saturation and Dissolution Test, a series of field tests were conducted at their project site in Victoria, Australia, with the primary goal of developing and assessing methods for quantifying residual CO_2 saturation in a saline [formation]. This paper reports the outcome of one of these tests, a single-well 'push–pull' tracer test that uses novel reactive esters (i.e., propylene glycol diacetate, triacetin and tripropionin). For this tracer test, the ester is injected (pushed) into the reservoir where residual saturation has been established using CO_2, and maintained by pushing with CO_2 saturated water (to prevent changes in saturation due to CO_2 dissolution). The ester is partially [hydrolyzed] by the formation water to yield multiple compounds (i.e., the corresponding alcohol and acid generated from the ester). During water production (pull) from the same well, these compounds will partition differentially between the residual supercritical CO_2 phase and water phase, leading to chromatographic separation. By modelling the concentration profiles of these tracers in production water samples and using the experimentally determined partition coefficients, [the authors] generate two consistent residual saturation estimates using two separate modelling techniques, one a simple finite difference simulation of the tracer velocity field and the other a standard multiphase simulation code." **Matthew Myers, Linda Stalker, Tara La Force, Bobby Pejcic, Christopher Dyt, Koon-Bay Ho, and Jonathon Ennis-King**, *Chemical Geology*. (Subscription may be required.)

Terrestrial

"Constraints to nitrogen acquisition of terrestrial plants under elevated CO_2."

The following is the Abstract of this article: "A key part of the uncertainty in terrestrial feedbacks on climate change is related to how and to what extent nitrogen (N) availability constrains the stimulation of terrestrial productivity by elevated CO_2 (eCO_2), and whether or not this constraint will become stronger over time. [The authors] explored the ecosystem-scale relationship between responses of plant productivity and N acquisition to eCO_2 in free-air CO_2 enrichment (FACE) experiments in grassland, cropland and forest ecosystems and found that: (i) in all three ecosystem types, this relationship was positive, linear and strong (r^2 = 0.68), but exhibited a negative intercept such that plant N acquisition was decreased by 10 [percent] when eCO_2 caused neutral or modest changes in productivity. As the ecosystems were markedly N limited, plants with minimal productivity responses to eCO_2 likely acquired less N than ambient CO_2-grown counterparts because access was decreased, and not because demand was lower. (ii) Plant N concentration was lower under eCO_2, and this decrease was independent of the presence or magnitude of eCO_2-induced productivity enhancement, refuting the long-held hypothesis that this effect results from growth dilution. (iii) Effects of eCO_2 on productivity and N acquisition did not diminish over time, while the typical eCO_2-induced decrease in plant N concentration did. [The authors'] results suggest that, at the decennial timescale covered by FACE studies, N limitation of eCO_2-induced terrestrial productivity enhancement is associated with negative effects of eCO_2 on plant N acquisition rather than with growth dilution of plant N or processes leading to progressive N limitation." **Zhaozhong Feng, Tobias Rütting, Håkan Pleijel, Göran Wallin, Peter B. Reich, Claudia I. Kammann, Paul C.D. Newton, Kazuhiko Kobayashi, Yunjian Luo, and Johan Uddling**, *Global Change Biology*. (Subscriptions may be required.)

Trading

"CO_2 Allowances Sold for $5.50 in 28th RGGI Auction."

The 28th auction of CO_2 allowances conducted by the nine states participating in the Regional Greenhouse Gas Initiative (RGGI) was completed, with 15,507,571 CO_2 allowances selling at the auction clearing price of $5.50. The auction generated a total of $85 million for reinvestment in strategic programs, including energy efficiency, renewable energy, direct bill assistance, and GHG abatement programs. To date, all RGGI CO_2 allowance auctions have generated a total of $2.1 billion. Additional details of the auction are available in the Market Monitor Report for Auction 28. From *RGGI Press Release* on June 5, 2015.

"China Climate Change Plan Unveiled."

China officials announced details of its climate action plan, aiming to reduce CO_2 emissions by 60 to 65 percent, based on 2005 levels, by 2030. The carbon intensity target builds upon a previous plan to reduce carbon intensity by 40 to 45 percent by 2020. In addition, the new climate plan calls for an increase in the share of non-fossil fuels in its primary energy consumption to approximately 20 percent by 2030. From *BBC News* on June 30, 2015.

"Carbon pricing versus emissions trading: A supply chain planning perspective."

The following is the Abstract of this article: "Carbon pricing (taxes) and carbon emissions trading are two globally practiced carbon regulatory policy schemes. This paper presents an analytical supply chain planning model that can be used to examine the supply chain performance at the tactical/operational planning level under these two policy schemes. Model implementation and analyses are completed using actual data from a company operating in Australia, where these environmental regulatory policies are practiced. Numerical results provide important

Trading (Continued)

managerial and practical implications and policy insights. In particular, the results show that there are inflection points where both carbon pricing and trading schemes could influence costs or emissions reductions. An erratic nonlinear emissions reduction trend is observed in a carbon pricing scheme as the carbon price increases steadily; whereas emissions reduction in a carbon trading scheme follows a relatively linear trend with a nonlinear cost increase. Overall, a carbon trading mechanism, although imperfect, appears to result in better supply chain performance in terms of emissions generation, cost, and service level; even though a carbon tax may be more worthwhile from an uncertainty perspective as emissions trading costs depend on numerous uncertain market conditions." **Atefe Zakeri, Farzad Dehghanian, Behnam Fahimniab, and Joseph Sarkis**, *International Journal of Production Economics*. (Subscription may be required.)

Recent Publications

"CO_2 storage and Enhanced Oil Recovery in the North Sea: Securing a low-carbon future for the UK."

The following is from the Introduction of this document: "Production of oil from a North Sea oilfield typically leaves 55 [percent] of the oil underground. Decreasing North Sea production, combined with consistent oil consumption in the UK, results in increasing quantities of oil being imported from elsewhere in the world. This has a high opportunity cost, due to lost employment in the UK offshore, and in the lost GDP of money paid out. Compared to North Sea oils, the imported oils have a similar carbon emission of [GHG] to the atmosphere when used, but can have 50 [percent] to 100 [percent] greater embedded carbon used in their extraction compared to domestic oil. It is sensible to consider the three questions of: (1) Can additional UK oil be produced profitably with CO_2–EOR? (2) Can the [GHG] emissions of UK CO_2–EOR oil be reconciled with a transition to a low carbon economy? (3) Can a mutually beneficial link between CCS and CO_2–EOR be made? [The authors] conclude that the answer to these three questions is 'yes.' Development of CO_2–EOR creates an additional market pull, to use CO_2 from the CCS projects, and eliminates costs and transport and storage for CCS projects. That can rapidly enable and accelerate the [utilization] of North Sea deep geology as a profitable business for CO_2 storage. That helps to rapidly reduce [GHG] emissions in the UK, and starts a revolution in sustainable offshore employment and offshore technology. The North Sea can become a commercially proven and guaranteed, secure site for storage of CO_2 received from across the European Union."

"Building the UK Carbon capture and storage sector by 2030 – Scenarios and actions."

The following is the Introduction of this document: "The ETI's work has shown that a successful UK CCS sector could save tens of billions of pounds ([approximately one percent] of GDP) from the annual costs of low carbon energy by the 2040s: a huge potential saving by any standards. Apart from providing low carbon electricity, CCS can capture industrial emissions, help deliver low carbon gas and deliver 'negative emissions' in combination with Bioenergy. The first two key projects (Peterhead and White Rose) are currently being taken forward under the Government's CCS [Commercialization Program]. But what else is needed to build a substantial CCS sector by 2030? What practical steps are needed on the ground, and how much will it cost? This report [summarizes] work that [has been] done to examine these questions. It extends previous modelling-based analysis, using three ambitious but deliverable scenarios to illustrate how the CCS sector [can be built] by 2030."

"Delivering CCS: Essential infrastructure for a competitive, low-carbon economy."

The following is from the Introduction of this document: "Developing a domestic CCS industry promises to be a significant prize for the UK economy. There is clear evidence that CCS will be an essential tool to reduce CO_2 emissions at the lowest cost to the UK economy. For example, the ETI has calculated through its energy systems modelling that without CCS the cost of reaching the UK [decarbonization] goals in 2050 could double, costing the UK economy an additional approximately $50.4 billion per year or [one percent] of GDP in 2050. No other technology has such a dramatic impact on the costs of achieving a low-carbon economy. As well as keeping energy bills as low as possible, the development of CCS can help to maintain the future competitiveness of UK industry e.g. steel, cement and chemicals, as it is the only technology available to [decarbonize] these essential sectors. To deliver the considerable economic benefits of CCS it is necessary to institute a progressive build-out of CCS so that by 2030 the UK has in the region of 10GW of power stations fitted with CCS and between 40 – 10 $MtCO_2$ being captured from energy intensive industries every year. At this scale a total of between 40 – 50 Mtpa of UK CO_2 emissions will be abated by 2030, making a material contribution to meeting UK carbon budgets. Development of enabling transport and storage infrastructure of sufficient capacity is essential to provide early investor confidence that can underpin the required investment in CO_2 capture facilities. In particular early appraisal of multiple storage sites, which have an inherently long lead-time and require significant investment, must be facilitated over the life of this parliament."

Legislative Activity

"Proposed Market Stability Reserve to Stabilize European Carbon Trading."

The European Parliament and the European Council reached an informal agreement to establish and operate a Market Stability Reserve (MSR) for the European Union Emissions Trading Scheme (EU-ETS). The legislative proposal seeks to address a potential oversupply of CO_2 allowances and stabilize the carbon price. According to the compromise package, the MSR will be established in 2018 and become fully operational on January 1, 2019. The originally proposed auction from 2014 to 2016 has been rescheduled to 2019 to 2020, with "backloaded" allowances placed in the market reserve; unallocated allowances will be included in the MSR in 2020. From *Global CCS Institute* on Jun 19, 2015.

About DOE's Carbon Storage Program

The Carbon Storage Program is implemented by the U.S. Department of Energy's Office of Fossil Energy and managed by the National Energy Technology Laboratory. The program is developing technologies to capture, separate, and store CO_2 in order to reduce greenhouse gas emissions without adversely influencing energy use or hindering economic growth. NETL envisions having a technology portfolio of safe, cost-effective, carbon dioxide capture, transport, and storage technologies that will be available for commercial deployment.

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

The **National Energy Technology Laboratory's CCS Database** includes active, proposed, and terminated CCS projects worldwide. The information is taken from publically available sources to provide convenient access to information regarding efforts by various industries, public groups, and governments towards development and eventual deployment of CCS technology. NETL's CCS Database is available as a Microsoft Excel spreadsheet and also as a customizable layer in Google Earth.

Newsletters, program fact sheets, best practices manuals, roadmaps, educational resources, presentations, and more are available via the Carbon Storage Reference Shelf.

Get answers to your carbon capture and storage questions at NETL's Frequently Asked Questions webpage.

There are several ways to join the conversation and connect with NETL's Carbon Storage Program:

NETL RSS Feed

NETL on Facebook

NETL on Twitter

NETL on LinkedIn

NETL on YouTube

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.

National Energy Technology Laboratory

The National Energy Technology Laboratory (NETL), part of DOE's national laboratory system, is owned and operated by the U.S. Department of Energy (DOE). NETL supports DOE's mission to advance the national, economic, and energy security of the United States.

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

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

13131 Dairy Ashford Road, Suite 225
Sugar Land, TX 77478

420 L Street, Suite 305
Anchorage, AK 99501

1450 Queen Avenue SW
Albany, OR 97321-2198

Contacts

Traci Rodosta
304-285-1345
traci.rodosta@netl.doe.gov

Disclaimer