U.S. DEPARTMENT OF ENERGY | OFFICE OF FOSSIL ENERGY | NATIONAL ENERGY TECHNOLOGY LABORATORY

CSN CARBON STORAGE NEWSLETTER

JULY 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:

CARBON STORAGE PROGRAM DOCUMENTS and REFERENCE MATERIALS

NATIONAL ENERGY TECHNOLOGY LABORATORY

DOE/NETL HIGHLIGHTS

DOE Selects Carbon Storage Projects to Receive Federal Funding.

Three projects have been selected by the U.S. Department of Energy's (DOE) Office of Fossil Energy (FE) to receive funding for cost-shared research and development (R&D) under Phase II of Funding Opportunity Announcement (FOA) *DE-FOA-0001450, Carbon Storage Assurance Facility Enterprise (CarbonSAFE): Storage Complex Feasibility*. Projects selected under this FOA will determine the feasibility for commercial-scale storage complexes that can hold 50+ million metric tons (MMT) of carbon dioxide (CO_2). The projects, to be managed by the National Energy Technology Laboratory (NETL), were selected as part of the *Carbon Storage Program* and will help inform the characterization and permitting of a commercial-scale complex with at least one storage site, ultimately demonstrating the potential for safe and secure storage in time for the anticipated deployment of transformative carbon capture technologies in the 2025 timeframe. From *energy.gov* on May 24, 2018.

DOE Launches CCUS Initiative.

DOE launched the *Carbon Capture, Utilization, and Storage (CCUS)* Initiative, which will focus on strengthening the framework for building collaborative partnerships on CCUS between the public and private sectors. The initiative will complement existing CCUS efforts led by the Carbon Sequestration Leadership Forum (CSLF), the International Energy Agency (IEA), the IEA's Greenhouse Gas R&D Programme (IEAGHG), Mission Innovation, and the Global CCS Institute. The announcement was made at the 9th Clean Energy Ministerial (CEM9) in Copenhagen, Denmark. From *energy.gov* on May 24, 2018.

Petra Nova in Texas (USA) is the world's largest post-combustion carbon capture system, capturing CO_2 produced by burning coal for use in enhanced oil recovery (EOR).

ANNOUNCEMENTS

Carbon Storage and Oil Natural Gas Programs Annual Meeting.

DOE/NETL's "2018 Mastering the Subsurface Through Technology Innovation, Partnerships, and Collaboration: Carbon Storage and Oil and Natural Gas Technologies Review Meeting" will be held August 13-16, 2018, in Pittsburgh, Pennsylvania. This project review meeting will allow researchers to present results from projects funded through DOE's Carbon Storage and Oil and Natural Gas Programs.

SPE Releases CO_2 Storage Resources Management System Document.

The Society of Petroleum Engineers (SPE) released the "CO_2 Storage Resources Management System (SRMS)," developed by a subcommittee of SPE's CCUS Technical Section, which engages in collaboration, knowledge sharing, and activities dedicated to the advancement of CCUS and the decarbonization of the petroleum industry. The document establishes technically based capacity and resources evaluation standards.

SPE International®
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ANNOUNCEMENTS *(cont.)*

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.

UK Government Plans Full-Scale CCS Scheme in 2030s.

According to United Kingdom (UK) government officials, Scottish companies are on track to launch full-scale carbon capture and storage (CCS) projects in the 2030s. The UK Department for Business, Energy, and Industrial Strategy (BEIS) announced that a CCS cross-challenge taskforce report will be published that will discuss steps to achieve cost-effective CCS.

Tokyo Announces Sustainability Plan Towards Zero Carbon.

The Tokyo Organizing Committee of the Olympic and Paralympic Games published its Sustainability Plan Version 2. One of the plan's five themes focuses on "Towards Zero Carbon," which refers to efforts to reduce CO_2 emissions generated during preparations and operation of the 2020 Games.

Countries Release Declaration of Ambition on International Policy.

A group of 23 participating countries have committed to exploring the possibilities of enhancing their targets and developing implementation guidelines at the 24th Conference of the Parties (COP24) to the United Nations Framework Convention on Climate Change (UNFCCC), to be held in December 3-14, 2018, in Katowice, Poland.

RGGI Report on Secondary Market.

The independent market monitor for the Regional Greenhouse Gas Initiative (RGGI) released a report containing information on the secondary market for RGGI CO_2 allowances, including future prices, market activity, and allowance holdings. Potomac Economics' "Report on the Secondary Market for RGGI CO_2 Allowances: First Quarter 2018" addresses the period from January through March 2018.

PROJECT and BUSINESS DEVELOPMENTS

Demonstration of Geologic Carbon Storage Verified.

A DOE-funded project successfully verified geologic CO_2 storage, according to a joint announcement by WellDog, Virginia Tech, and Carbon GeoCycle. The test involves injecting more than 13,000 tons of CO_2 into stacked unmineable coal seems for enhanced oil recovery (EOR) in Buchanan County, Virginia, USA. The verification revealed that CO_2, injected over the last two years, successfully flowed into all of the targeted coal seams. From *Oil & Gas 360* on June 27, 2018.

CO_2-EOR Project Approved.

Denbury Resources announced the approval of a CO_2-EOR project at Cedar Creek Anticline (CCA), a geologic feature that covers parts of Montana, North Dakota, and South Dakota (USA). The 125-mile-long CAA is estimated to hold up to 5 billion barrels of original oil in place. The project has the potential to recover more than 400 million barrels, with initial tertiary production expected by late 2021 or early 2022. Phase I of the project targets 30 million barrels of estimated recoverable oil in the Red River formation at East Lookout Butte and Cedar Hills South fields, and Phase II will target approximately 100 million barrels of recoverable oil in the Interlake, Stony Mountain, and Red River formations at Cabin Creek field. Future phases will be developed based on CO_2 availability and other factors. From *Denbury Press Release* on June 18, 2018.

Feasibility of CCUS Project to Be Studied.

Occidental Petroleum Corporation and White Energy have agreed to evaluate the economic feasibility of a CCUS project that would capture CO_2 at White Energy's ethanol facilities in Hereford and Plainview, Texas, USA. The CO_2 captured would then be transported to the Permian Basin, where Occidental Petroleum would use it for EOR operations. The engineering study is expected to last six months and will examine the costs of building a carbon capture facility. If deemed economically feasible, operations could begin as soon as 2021. The project would be designed to be eligible for 45Q tax credits and California's (USA) Low-Carbon Fuel Standard CCS protocol. From *Occidental Petroleum News Release* on June 19, 2018.

Chevron's CCS Project to Begin in 2018.

Chevron is expected to start a CCS project at the Gorgon liquified natural gas (LNG) facility in Australia in 2018. Australia approved the project on the condition that Chevron committed to storing 80 percent of the CO_2 emitted from Gorgon over a five-year period. The LNG facility is located off the coast of Western Australia. From *The Chemical Engineer* on July 2, 2018.

LEGISLATION and POLICY

Massachusetts Senate Authorizes Carbon Pricing.

The Massachusetts State Senate (USA) passed a bill authorizing a carbon pricing program that approves revenue-neutral fees as a carbon pricing option. The bill will next be debated in the Massachusetts House and, if signed into law, would have a deadline for carbon pricing in the transportation sector by 2020, commercial and industrial building and processes by the end of 2021, and residential buildings by the end of 2022. From *U.S. State Senator Mike Barrett Press Release* on June 14, 2018.

Netherlands Proposes Emissions Cut.

A draft law proposed in the Netherlands would set a 49 percent greenhouse gas (GHG) emission reduction target by 2030, compared to 1990 levels, and a 95 percent reduction by 2050. Other features of the proposal include a carbon neutral electricity system, as well as the establishment of an annual day in which the Dutch Ministry of Energy and Climate will give a progress update on achieving targets. In addition, beginning in 2019, future Dutch governments would be required to present updated plans every five years. From *Climate Change News* on June 27, 2018.

Zimbabwe Releases Climate Policies.

Zimbabwe released three policies designed to help meet its pledges to reduce CO_2 emissions. The "Child Friendly Climate Policy" will educate the youth, and the "Climate Smart Agriculture Policy" will promote farming practices. In addition, the country's first "National Climate Policy" will create legal structures to help businesses meet Zimbabwe's emission-reduction targets. From *Economic Times* on June 26, 2018.

EMISSIONS TRADING

RGGI States Announce Results of 40th Auction.

The RGGI-participating states released the results of their 40th auction of CO_2 allowances, in which 13,771,025 CO_2 allowances were sold at a clearing price of $4.02. Bids ranged from $2.20 to $6.00 per allowance. None of the 10 million cost containment reserve (CCR) allowances were sold (CCR is a fixed additional supply of allowances only available for sale if CO_2 allowance prices exceed certain price levels [$10.25 in 2018]). Auction 40, the second auction of the fourth control period, generated $55.4 million for reinvestment in strategic programs, such as energy efficiency, renewable energy, and GHG abatement programs. To date, proceeds from all RGGI CO_2 allowance auctions have generated $2.94 billion. From *RGGI News Release* on June 15, 2018.

CLIMATE and SCIENCE NEWS

Researchers Study Safety of CO_2 Storage.

A new study shows that captured CO_2 can be safely stored underground through injection into the microscopic pore spaces of common rocks. Researchers from the Universities of Aberdeen and Edinburgh used computer simulations to model the storage of CO_2 for 10,000 years into the future, combining information from natural CO_2 and methane accumulations and hydrocarbon industry experience (e.g., engineered gas storage, decades of borehole injection, and laboratory experiments). The results of the study were *published in the journal Nature Communications*. From *SCCS News* on June 12, 2018.

Victoria's Inland Wetlands CO_2 Storage Potential.

Victoria's inland wetlands have the potential to store approximately 3 million tons of CO_2 a year, according to research conducted by the Deakin School of Life and Environmental Sciences' Blue Carbon Lab. Funded by Victoria, Australia's Department of Environment, Land, Water and Planning, the study analyzed soil samples from more than 100 different wetlands across Victoria. The results, *published in the journal Global Change Biology*, estimated that Victoria's inland wetlands had a soil carbon stock of 68 million tons. From *Blue Carbon Lab* on June 25, 2018.

Catalyst Improves CO_2-to-Methanol Process.

Researchers from Penn State University claim to have made improvements to the process of converting CO_2 to methanol, according to a study *published in the journal ACS Catalysis*. Integrated experimental and computational research showed the benefit of a new catalyst that uses a specific formulation of palladium and copper. Researchers found that combining the metals in the new formulations increased the rate of methanol formation by three times over palladium alone and by four times over copper alone, representing an improvement over previous methods. From *Penn State University* on June 28, 2018.

JOURNAL ARTICLES

Developing CCS in the UK and Beyond: Insights from the UK CCS Research Centre.

The following is the Abstract of this article: "The UK Carbon Capture and Storage Research Centre coordinates a programme of research covering all aspects of CCS in support of basic science and UK government efforts on energy and climate change. This paper will present progress and 'lessons learned' from the Centre's activities, with a particular focus on the development and use of pilot scale facilities and encouraging industrial and other stakeholder engagement in research. It will also highlight key features of an extensive programme of international engagement activities undertaken by the Centre, identifying added value for both the UK CCS community and global development of CCS." Ciara O'Connor, Hannah Chalmers, Steph Wright, Bruce Adderley, and Jon Gibbins, *Energy Procedia*. (Subscription may be required.)

The Neglected Importance of Corporate Perceptions and Positions for the Long-term Development of CCS.

The following is the Abstract of this article: "Many companies that produce fossil fuels or fossil fuel-derived products show a strong belief in a large and continuing role for fossil fuels in the global economy up to 2050 and beyond. These companies are generally expected to be amongst the primary consumers of CCS technology. So far, however, fossil fuel companies have shown only moderate interest in CCS. Whilst a lot of potential operational barriers to CCS adoption have been identified in the literature, the value of CCS from a corporate strategy perspective has sometimes been assumed, but rarely explored. This paper asks the following question: What are the perceptions and positions of fossil fuel companies on CCS and how does this inform their decision-making on CCS investment and advocacy? This paper addresses this issue by presenting the results of in-depth interviews with high-level CCS experts from major multinational oil and gas companies and major coal mining firms. The results indicate that CCS would require a significant change within the business strategy of fossil fuel companies. This is contrary to the common argument that CCS is attractive because the technology is regarded as not being very disruptive to the incumbent energy system as it leaves most of the existing infrastructure, actor constellations and institutions intact. While fossil fuel companies engage in CCS development, it is often to [familiarize] themselves with technologies that might have future value if markets for these technologies take off. In several cases, CCS engagement has served the strategic need to weaken the link between fossil fuel extraction and climate change, build up shareholder trust, and improve public perception. However, there is little evidence that these companies engage in CCS to develop a strategic insurance against climate policy risks to their core businesses." Lukas Braunreiter and Simon J. Bennett, *Energy Procedia*. (Subscription may be required.)

The cost of getting CCS wrong: Uncertainty, infrastructure design, and stranded CO_2.

The following is the Abstract of this article: "CCS infrastructure will require industry—such as fossil-fuel power, ethanol production, and oil and gas extraction—to make massive investment in infrastructure. The cost of getting these investments wrong will be substantial and will impact the success of CCS technology. Multiple factors can and will impact the success of commercial-scale CCS, including significant uncertainties regarding capture, transport, and injection-storage decisions. Uncertainties throughout the CCS supply chain include policy, technology, engineering performance, economics, and market forces. In particular, large uncertainties exist for the injection and storage of CO_2. Even taking into account upfront investment in site characterization, the final performance of the storage phase is largely unknown until commercial-scale injection has started. [The authors] explore and quantify the impact of getting CCS infrastructure decisions wrong based on uncertain injection rates and uncertain CO_2 storage capacities using a case study managing CO_2 emissions from the Canadian oil sands industry in Alberta. [The authors] use SimCCS, a widely used CCS infrastructure design framework, to develop multiple CCS infrastructure scenarios. Each scenario consists of a CCS infrastructure network that connects CO_2 sources (oil sands extraction and processing) with CO_2 storage reservoirs (acid gas storage reservoirs) using a dedicated CO_2 pipeline network. Each scenario is analyzed under a range of uncertain storage estimates and infrastructure performance is assessed and quantified in terms of cost to build additional infrastructure to store all CO_2. [The authors] also include the role of stranded CO_2, CO_2 that a source was expecting to but cannot capture due substandard performance in the transport and storage infrastructure. Results show that the cost of getting the original infrastructure design wrong are significant and that comprehensive planning will be required to ensure that CCS becomes a successful climate mitigation technology. In particular, [the authors] show that the concept of stranded CO_2 can transform a seemingly high-performing infrastructure design into the worst case scenario." Richard S. Middleton and Sean Yaw, *International Journal of Greenhouse Gas Control*. (Subscription may be required.)

Cost-optimal design of pressure-based monitoring networks for carbon sequestration projects, with consideration of geological uncertainty.

The following is the Abstract of this article: "Leakage from geologic faults and abandoned wells represents one of the major risks to industrial-scale CCS projects. Current CCS regulations and best practice guidance suggest that operators emplace risk-informed monitoring, verification, and accounting (MVA) plans to protect public safety and reduce property and environmental damage. Deep subsurface pressure monitoring is regarded as one of the most cost-effective technologies for early leakage detection in CCS projects. In practice, however, the number of deep pressure monitoring wells that an operator can deploy often remains limited because of the high costs associated with drilling, instrumenting, and operating these wells. Thus, optimal design of the pressure monitoring network is essential to minimizing monitoring and liability costs and gaining public support. In this work, [the authors] present a general, binary integer programming approach to solve an optimal monitoring well network design problem under multiple constraints. Specifically, [the authors'] approach helps a CCS operator to design a cost-optimal monitoring network that covers all potentially leaky locations (in a worst-case-scenario sense) while satisfying a prescribed CO_2 storage performance criterion and considering geological uncertainty. Instead of using cost surrogates as has been done in many other studies, [the authors'] formulation allows the user to directly assess total costs in terms of monitoring costs and potential economic losses associated with brine and CO_2 leakage. [The authors'] numerical examples demonstrate that a cost-optimal monitoring network may save millions of dollars in total costs, including well construction and leakage costs. Factors exerting the most impact on the cost-optimal monitoring network design are unit leakage damage costs, pressure threshold for leakage detection, and geological uncertainty." Hoonyoung Jeong, Alexander Y. Sun, and Xiaodong Zhang, *International Journal of Greenhouse Gas Control*. (Subscription may be required.)

JOURNAL ARTICLES *(cont.)*

MRI study on CO_2 capillary trap and drainage behavior in sandstone cores under geological storage temperature and pressure.

The following is the Abstract of this article: "Capillary pressure is an important parameter to characterize the core properties in CO_2 geological storage applications, and it is necessary to study the CO_2 drainage behavior to predict the potential and ensure the safety of storage. In this work, [the authors] conducted CO_2 drainage experiments in two types of sandstone cores (Berea sandstone and synthetic sandstone) under reservoir conditions (800m underground) and measured the capillary pressure using an MRI system. The drainage experiments were repeated in a capillary number range from 5.22×10^{-9} to 5.5×10^{-7} by varying the injection rate. The entry pressure and pore size distribution index were calculated by fitting a straight line on a log-log curve of the effective saturation versus capillary pressure. Relative permeability curves were plotted using the calculated entry pressure and pore size distribution index. The curves were consistent with the properties of the sandstone cores. The capillary desaturation curves gave the irreducible brine saturations for different permeability, wettability, injection pressure and injection direction conditions as a function of capillary number." **Ying Teng, Lanlan Jiang, Yu Liu, Dayong Wang, and Yongchen Song,** *International Journal of Heat and Mass Transfer*. (Subscription may be required.)

Modelling and optimization of a manufacturing/remanufacturing system with storage facility under carbon cap and trade policy.

The following is the Abstract of this article: "Due to rigorous environmental legislations and competitive economics worldwide, a growing number of companies are devoted to recovering and remanufacturing used products. Consequently, over the past few decades, the management of manufacturing/remanufacturing systems has been receiving increasing attention from researchers and companies leaders. Most of the existing research papers in the literature considered that remanufactured products have the same quality and price as new ones. However, in practice, the market perceives new items as higher quality products rather than remanufactured items. This paper aims to bridge the gap in research on manufacturing/remanufacturing supply chain, by investigating an optimal storage and manufacturing/remanufacturing planning, while taking into consideration the difference between new and remanufactured items, random machine failures, carbon constraints and distinct random customer demands for both items types. Furthermore, to make our system more realistic, it is assumed that the return rate of used items depends on the sales in the past periods, machine repair time is stochastic and set-up time period is not negligible. In this study, two models are developed, considering carbon emissions or not, to determine the optimal values of the manufacturing/remanufacturing period lengths and serviceable stock capacities of new and remanufactured items. Numerical results are provided to illustrate the impact of set-up cost, percentage of returned used items, machine availability, carbon cap and carbon trading price on the optimal storage and production planning. Moreover, the influences of carbon cap, carbon trading price and percentage of returned used items on carbon emissions have been analyzed. The results reveal that set-up cost, percentage of returned used items and machine availability have significant impact on storage and production planning of new and remanufactured items. In addition, the results indicate that a lower carbon cap and/or a high carbon trading price, induce the producer to collect and remanufacture used items and curb carbon emissions." **Sadok Turk, Christophe Sauvey, and Nidhal Rezg,** *Journal of Cleaner Production*. (Subscription may be required.)

How to optimize the development of carbon trading in China—Enlightenment from evolution rules of the EU carbon price.

The following is the Abstract of this article: "This paper explores the optimization scheme of carbon trading in China based on a novel energy-saving and emission-reduction (ESER) system with carbon price constraints. With the aid of nonlinear dynamics theory, the dynamics behavior of the novel system is discussed. Genetic algorithm and back propagation neural network is used to identify the quantitative coefficients according to the statistical data of the second period in European Union (EU). Taking the actual situation in EU for instance, the variables which are sensitive to carbon trading [are researched]. Enlightened by the EU's experience, an optimal road of China's carbon trading is put forward. The results show that carbon emissions could be controlled by carbon trading. The investment to carbon trading hampers economic growth in the near future, and ESER technical progress is negatively correlated with carbon trading in the long run. Demand and supply relationship is closely related to carbon price, both are the important issues in carbon trading system. Excessive government control and extortionate carbon price will deliver the opposite effect and even fatal influence on carbon trading system." **Guochang Fang, Lixin Tian, Menghe Liu, Min Fu, and Mei Sun,** *Applied Energy*. (Subscription may be required.)

Carbon trading's impact on California's real-time electricity market prices.

The following is the Abstract of this article: "What is the extent of a real-time electricity market's pass-through of the marginal cost of CO_2 emissions due to a cap-and-trade (C&T) program? This is an important policy question, as an incomplete pass-through would suggest the program's limited effectiveness in achieving efficient pricing of electricity. To answer the question, [the authors] perform a regression analysis of California's electricity market data for a 65-month period of [January 1, 2011, through May 31, 2016]. Based on this newly constructed large sample, [the authors] find that the California Independent System Operator's real-time market prices contain a CO_2 premium that closely tracks the marginal cost of CO_2 emissions of California's natural-gas-fired generation units, which are often at margin that determines the power prices. While the CO_2 premium provides much needed incentives for renewable energy development, it does little to improve the incentive for natural-gas-fired generation investment in California. Hence, procurement of dispatchable generation capacity via long-term contracts continues to be useful for the state to meet the mandatory criteria for resource adequacy and system reliability." **C.K. Woo, Y. Chen, J. Zarnikau, A. Olson, J. Moore, and T. Ho,** *Energy*. (Subscription may be required.)

REPORTS and OTHER PUBLICATIONS

Experimental and Numerical Modeling Approach to Elucidating Damage Mechanisms in Cement-Well Casing-Host Rock Settings for Underground Storage of CO_2.

NRAP Technical Team

The following is from the Executive Summary of this National Risk Assessment Partnership (NRAP) document: "This research project was completed during an ambitious 12-month period encompassing both experimental and modeling efforts to elucidate the potential for damage mechanisms in Class H Portland cement exposed to high temperature, pressure and supercritical CO_2 or carbon dioxide-oxygen cycle (CO_2-O_2). One key goal of this work was to decouple the effects of these three influences to determine which, if any, had the most profound impact on integrity of Class H cement. Experimental work was completed at both Oregon State University (OSU) and NETL-Albany. Modeling work was done at OSU. The results of the experimental work showed that mechanical properties, specifically compressive strength and modulus of rupture were most affected (decreased over the control) at high temperatures (85°C), high pressure (4,200 psi) and in the presence of super-critical CO_2 or CO_2-O_2. The influence of low (23°C) or intermediate temperature (50°C) as well as exposure to a synthetic brine or saturated limewater had negligible effects on mechanical properties. Cement exposed to supercritical CO_2 and CO_2-O_2 were shown to alter the cement specimens from the exterior of paste samples inward as the carbonation front lead to distinct zones of amorphous silica, calcite deposited, calcium depleted, and finally the unaltered cement closer inward toward the center of the sample. While total alteration depths were similar between both sets of exposed samples (CO_2 or CO_2-O_2) the amount of alteration within the altered zone varied between the different exposures, qualitatively. Pore solution analysis reflected the alteration process showing that the concentrations of alkalis (from the Portland cement) reduced over time as the concentration of calcium increased. Inversely, aqueous calcium decreased in the bulk solution. It was also found that sulfate was drawn preferentially at high temperature (85°C). Perhaps the most important finding was verification that the introduction of O_2 into the gas stream resulted in rapid corrosion of the Alloy-20 metal on the interior of the autoclaves used for high pressure, temperature and gas exposure experiments. This represents a significant concern for the long-term sequestration of co-sequestration of CO_2 once oxygen is introduced into the system. The wellbore casing, being made of stainless steel, is subject to deterioration and this could represent a potential leakage pathway."

Clean Air, Clean Industry, Clean Growth: How Carbon Capture Will Boost the UK Economy.

The following is from the Executive Summary of this document: "This Study into the value of CCS investments along the East Coast of the [UK], represents a new approach to evaluating the economic and societal benefits associated with the deployment of CCS. The results provide a robust basis for advancing CCS in the UK. The Study considers a phased evolution of CCS Investments providing essential [decarbonization] options with discrete investment/decision points along the way. The CCS Investments considered are sized and timed to align with the Committee on Climate Change ("CCC") projections for UK carbon emissions reductions targets with each investment demonstrating a significant net positive impact on the UK economy. Successive investments in CCS projects and infrastructure are envisaged that evolve over time into a CCS network. Each phase of East Coast CCS investments is considered as discrete but with each phase building on and using the infrastructure implemented in the previous phases. For modelling purposes, the phases are divided into 5 year periods i.e. the same as parliamentary terms and climate budget periods in the UK. This approach is adopted [recognizing] that policy may change from time to time and technology does not stand still. Options can therefore be maintained and adjusted for UK [decarbonization] policy as circumstances evolve, with successive phases of investment only proceeding if the case for them stands up over time. There is no requirement for investors, the UK and/or Scottish governments to commit to the whole series of investments upfront."

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_2. 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_2 in the subsurface and identifying the geologic reservoirs appropriate for 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 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.

National Energy Technology Laboratory

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