CSN CARBON STORAGE NEWSLETTER

JANUARY 2016

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:

HIGHLIGHTS

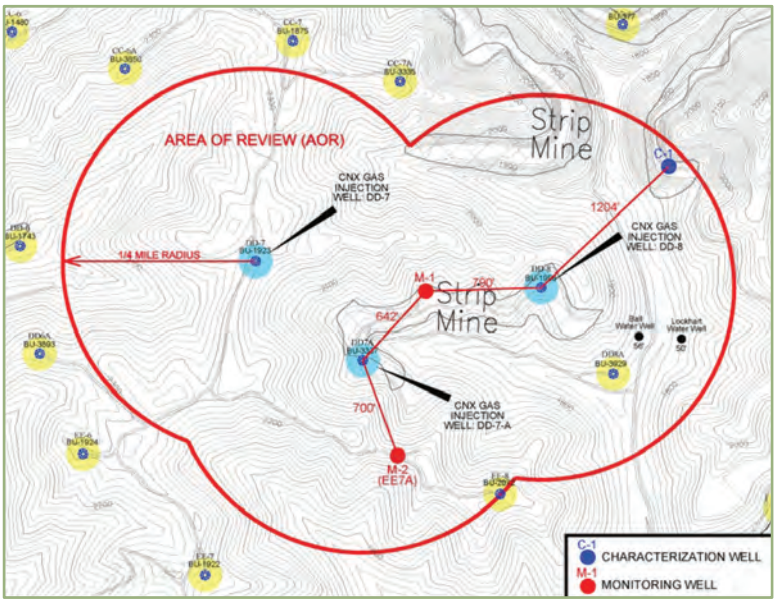
"Secretary Moniz Announces New CO_2 Storage Network at Multinational Carbon Sequestration Forum." The U.S. Department of Energy (DOE) announced the formation of an international initiative to facilitate collaborative testing of advanced carbon capture and storage (CCS) technologies in a real-world, saline storage environment.

The ***Carbon Sequestration Leadership Forum's (CSLF)*** Large-Scale Saline Storage Project Network will form a global network of large-scale carbon dioxide (CO_2) injection sites that can share best practices, operational experience, and key lessons to advance the deployment of CCS. The collaboration builds on the CO_2 Capture Test Center Network, which has been chaired by Norway since 2013; the United States will chair the capture center in 2016. From *energy.gov* on November 4, 2015.

ANNOUNCEMENTS

Final Call for Abstracts - GHGT-13.

The Greenhouse Gas Control Technologies 13 (GHGT-13) conference call for papers closes on February 10, 2016. Technical themes include: advances in capture technology development; developments in CO_2 geological storage; developments in other storage options for CO_2; CCS for industrial sources (non-power); CO_2 transport and infrastructure development; towards negative CO_2 emissions; CO_2 utilization options; demonstration projects and major national and international CCS research, developments and demonstration programs; CCS technology assessment, cost and system integration; perceptions of CCS and education activities; energy, climate change and CCS policies; legal and regulatory aspects of CCS and long term liability of CO_2; and abatement of non-CO_2 greenhouse gases from geological activities.



Underground CO_2 Storage, Natural Gas Recovery Targeted by Virginia Tech/NETL Researchers.

Researchers from DOE's *National Energy Technology Laboratory (NETL) and Virginia Polytechnic Institute and State University (Virginia Tech)* are investigating the feasibility of permanently and safely storing CO_2 underground while simultaneously recovering natural gas. Virginia Tech's Virginia Center for Coal and Energy Research (VCCER) initiated the injection of up to 20,000 tons of CO_2 into a coalbed methane field in Virginia, USA. Researchers will use a state-of-the-art monitoring, verification, and accounting (MVA) program to monitor and collect data as the CO_2 is injected into the coal seams.

DOE-Funded Research Yields U.S. Patent for Use of CO_2 in Concrete Curing.

The United States Patent and Trademark Office issued a patent for a new process, funded by DOE's NETL, which uses CO_2 to cure pre-cast concrete. The process uses CO_2 instead of water to cure pre-cast concrete, reducing curing time to less than 24 hours. For more information, visit *NETL's Carbon Use and Reuse Webpage*.

CARBON STORAGE in the NEWS

"Statoil to Conduct CCS Feasibility Studies in North Sea Fields."

At the request of the Norwegian government, Statoil will conduct new carbon storage studies on the Norwegian continental shelf. According to Statoil, the feasibility studies will be carried out at three locations in the Norwegian sector of the North Sea and are targeted for completion in 2016. The Norwegian government has previously stated a goal of at least one full-scale CCS demonstration plant by 2020. From *Reuters* on January 4, 2016.

"CO_2 Capture Technology Picked… for Commercial-Scale Use in Cement Production."

Aker Solutions will use its advanced carbon capture technology to conduct a feasibility study on the development of a commercial-scale carbon capture facility for use in cement production. Picked by Norcem to conduct the study, Aker Solutions will look at capturing as much as 400,000 tons of CO_2 a year at Norcem's cement plant in Brevik, Norway. Aker Solutions' technology was successfully tested for 18 months at the cement plant and showed to be cost-effective, robust, and flexible during various operating conditions. The work is part of a feasibility study that will be submitted to Gassnova and the Norwegian Ministry of Petroleum and Energy. From *Aker Solutions' Press Release* on November 17, 2015.

"Seismos Announces… CO_2 EOR Surveillance Platform."

Seismos, Inc., a provider of subsurface fluid-flow imaging technology for the oil and gas industry, announced a new surveillance platform for enhanced oil recovery (EOR) operations. The platform focuses on increasing CO_2-EOR production by providing continuous, real-time information on the subsurface movement of CO_2 and areas of unswept oil. The platform is currently installed in oilfields in Texas and New Mexico, USA. From *PR Newswire* on January 6, 2016.

SCIENCE

"Sea Plankton Rise Could be Due to Increased Carbon Dioxide: Research."

According to researchers from John Hopkins University, rises in CO_2 levels in the Atlantic Ocean may have led to a nearly 10-times increase in the marine alga concentration during the last few decades. Published in the journal "Science," the study analyzed Continuous Plankton Recorder survey data from the North Atlantic Ocean and North Sea since the mid-1960s, finding that higher CO_2 levels in the oceans may be causing an increase in the population of single-celled coccolithophores. Previous studies believed that increased ocean acidity due to higher CO_2 levels would lead to a decline in the number of plankton species. The Abstract of the study, titled "Multidecadal increase in North Atlantic coccolithophores and the potential role of rising CO_2," is available below. From *Northern Californian* on November 29, 2015.

"Multidecadal increase in North Atlantic coccolithophores and the potential role of rising CO_2."

The following is the Abstract of this article: "As anthropogenic CO_2 emissions acidify the oceans, calcifiers generally are expected to be negatively affected. However, using data from the Continuous Plankton Recorder, [the authors] show that coccolithophore occurrence in the North Atlantic increased from ~2 to more than 20 [percent] from 1965 through 2010. [The authors] used random forest models to examine more than 20 possible environmental drivers of this change, finding that CO_2 and the Atlantic Multidecadal Oscillation were the best predictors, leading [the authors] to hypothesize that higher CO_2 levels might be encouraging growth. A compilation of 41 independent laboratory studies supports [the authors'] hypothesis. [The authors'] study shows a long-term basin-scale increase in coccolithophores and suggests that increasing CO_2 and temperature have accelerated the growth of a phytoplankton group that is important for carbon cycling." **Sara Rivero-Calle, Anand Gnanadesikan, Carlos E. Del Castillo, William M. Balch, and Seth D. Guikema**, *Science*. (Subscription may be required.)

"Living Shorelines Blunt Effects of Climate Change, Study Shows."

A National Oceanic and Atmospheric Administration (NOAA) study found that "living shorelines" may help reduce atmospheric CO_2. The study, published in the journal "PLOS One," measured carbon storage in the coastal wetlands and the fringing marshes of living shorelines in North Carolina, USA. Researchers found that the living shorelines stabilize shorelines using natural materials, such as plants, sand, and rock, which may reduce CO_2 emissions in the atmosphere and help to mitigate potential climate change. An Abstract of the study, titled "Living Shorelines: Coastal Resilience with a Blue Carbon Benefit," is available below. From *Environmental Protection* on December 23, 2015.

"Living Shorelines: Coastal Resilience with a Blue Carbon Benefit."

The following is the Abstract of this article: "Living shorelines are a type of estuarine shoreline erosion control that incorporates native vegetation and preserves native habitats. Because they provide the ecosystem services associated with natural coastal wetlands while also increasing shoreline resilience, living shorelines are part of the natural and hybrid infrastructure approach to coastal resiliency. Marshes created as living shorelines are typically narrow (< 30 m) fringing marshes with sandy substrates that are well flushed by tides. These characteristics distinguish living shorelines from the larger meadow marshes in which most of the current knowledge about created marshes was developed. The value of living shorelines for providing both erosion control and habitat for estuarine organisms has been documented but their capacity for carbon [storage] has not. [The authors] measured carbon [storage] rates in living shorelines and sandy transplanted Spartina alterniflora marshes in the Newport River Estuary, North Carolina. The marshes sampled here range in age from 12 to 38 years and represent a continuum of soil development. Carbon [storage] rates ranged from 58 to 283 g C m^{-2} yr^{-1} and decreased with marsh age. The pattern of lower [storage] rates in older marshes is hypothesized to be the result of a relative enrichment of labile organic matter in younger sites and illustrates the importance of choosing mature marshes for determination of long-term carbon [storage] potential. The data presented here are within the range of published carbon [storage] rates for S. alterniflora marshes and suggest that wide-scale use of the living shoreline approach to shoreline management may come with a substantial carbon benefit." **Jenny L. Davis, Carolyn A. Currin, Colleen O'Brien, Craig Raffenburg, and Amanda Davis**, *PLOS One*. (Subscription may be required.)

POLICY

"New Zealand Meets Kyoto Climate Target."

The New Zealand government released three reports indicating its target has been met for reducing emissions under the first commitment period of the Kyoto Protocol. The reports, which also show that the country is on track to meet its 2020 target, were published by the New Zealand Ministry for the Environment as part of their international climate change reporting obligations. The reports are available via the above link. From *New Zealand Government News Release* on December 17, 2015.

"Japan to Release New Climate Policy Plan..."

The Japanese government announced plans to develop a new climate change policy plan by early 2016. The new climate plan, which will be developed by a panel from the Ministry of Economy, Trade, and Industry (METI) and a panel from the Ministry of Environment, will aim to meet Japan's target of reducing greenhouse gas (GHG) emissions to 26 percent below 2013 levels by 2030. Due for publication in 2016, the policy plan will also consider the possibility of implementing an emissions trading scheme (ETS). From *Carbon Pulse* on December 22, 2015.

"Recent advances in risk assessment and risk management of geologic CO_2 storage."

The following is the Abstract of this article: "This paper gives an overview of the advances made in the field of risk assessment and risk management of geologic CO_2 storage (GCS), since the publication of the IPCC Special Report on Carbon Capture and Storage in 2005. Development and operation of a wide range of demonstration projects coupled with development of new regulations for safe injection and storage of CO_2 have led to development and deployment of a range of risk assessment approaches. New methods and tools have been developed for quantitative and qualitative risk assessment. These methods have been integrated effectively with monitoring and mitigation techniques and deployed in the field for small-scale field tests as well as large-scale commercial projects. An important development has been improved definition of risks, which can be broadly classed as site performance risks, long-term containment risks, public perception risks and market risks. Considerable experience has now been gained on understanding and managing site performance risks. Targeted research on containment risks and induced seismicity risks has led to improved understanding of parameters and processes influencing these risks

as well as identifying key uncertainties that need to be targeted. Finally, significant progress has been made to effectively integrate communication strategies with risk management approaches to increase stakeholder confidence in effectiveness of deployed risk management approaches to manage risks." **Rajesh J. Pawar, Grant S. Bromhal, J. William Carey, William Foxall, Anna Korre, Philip S. Ringrose, Owain Tucker, Maxwell N. Watson, and Joshua A. White**, *International Journal of Greenhouse Gas Control*. (Subscription may be required.)

"An examination of geologic carbon [storage] policies in the context of [release] potential."

The following is the Abstract of this article: "Carbon dioxide injected into geologic reservoirs for long-term [storage], or the brine it displaces, may [release] through natural or manmade pathways. Using a [release] estimation model, [the authors] simulated fluid [release] from a storage reservoir and its migration into overlying formations. The results are discussed in the context of policies that seek to assure long-term [storage] and protect groundwater. This work is based on a case study of CO_2 injection into the Mt. Simon sandstone in the Michigan sedimentary basin, for which [the authors] constructed a simplified hydrologic representation of the geologic formations. The simulation results show that (1) CO_2 [release] can reach [a formation] containing potable water, but numerous intervening stratigraphic traps limit the rate to be orders of magnitude less than the rate of [release] from the storage reservoir; (2) [DOE] guidelines for storage permanence allow for more [release] from larger injection projects than for smaller ones; (3) well [release] permeability is the most important variable in determining [release] processes and substantial [release] requires that numerous wells [releasing] with the anomalously high permeability of 10^{-10} m^2; and (4) [release] can reduce the U.S. Environmental Protection Agency's Area of Review." **Jeffrey M. Bielicki, Catherine A. Peters, Jeffrey P. Fitts, and Elizabeth J. Wilson**, *International Journal of Greenhouse Gas Control*. (Subscription may be required.)

GEOLOGY

"Capillary trapping for geologic carbon dioxide storage – From pore scale physics to field scale implications."

The following is the Abstract of this article: "A significant amount of theoretical, numerical and observational work has been published focused on various aspects of capillary trapping in CO_2 storage since the IPCC Special Report on Carbon Dioxide Capture and Storage (2005). This research has placed capillary trapping in a central role in nearly every aspect of the geologic storage of CO_2. Capillary, or residual, trapping – where CO_2 is rendered immobile in the pore space as disconnected ganglia, surrounded by brine in a storage [formation] – is controlled by fluid and interfacial physics at the size scale of rock pores. These processes have been observed at the pore scale in situ using X-ray microtomography at reservoir conditions. A large database of conventional centimetre core scale observations for flow modelling are now available for a range of rock types and reservoir conditions. These along with the pore scale observations confirm that trapped saturations will be at least 10 [percent] and more typically 30 [percent] of the pore volume of the rock, stable against subsequent displacement by brine and characteristic of water-wet systems. Capillary trapping is pervasive over the extent of a migrating CO_2 plume and both theoretical and numerical investigations have demonstrated the first order impacts of capillary trapping on plume migration, [immobilization] and CO_2 storage security. Engineering strategies to [maximize] capillary trapping have been proposed that make use of injection schemes that [maximize] sweep or enhance imbibition. National assessments of CO_2 storage capacity now incorporate modelling of residual trapping where it can account for up to 95 [percent] of the storage resource. Field scale observations of capillary trapping have confirmed the formation and stability of residually trapped CO_2 at masses up to 10,000 tons and over time scales of years. Significant outstanding uncertainties include the impact of heterogeneity on capillary [immobilization] and capillary trapping in mixed-wet systems. Overall capillary trapping is well constrained by laboratory and field scale observations, effectively modelled in theoretical and numerical models and significantly enhances storage integrity, both increasing storage capacity and limiting the rate and extent of plume migration." **Samuel Krevor, Martin J. Blunt, Sally M. Benson, Christopher H. Pentland, Catriona Reynolds, Ali Al-Menhali, and Ben Niu**, *International Journal of Greenhouse Gas Control*. (Subscription may be required.)

"Petrological characterization and reactive transport simulation of a high-water-cut oil reservoir in the Southern Songliao Basin, Eastern China for CO_2 [storage]."

The following is from the Abstract of this article: "[Carbon dioxide] geological [storage] (CGS) in depleted or high-water-cut oil reservoirs is a viable option for reducing anthropogenic CO_2 emissions and [EOR]. The Upper Cretaceous Qingshankou Formation in the central Changling (fault) Depression, Songliao Basin, East China is the selected site for a pilot injection of the CO_2 INJECTION project. The target reservoir depth is about 2400–2500 m. Lithologic features and diagenetic minerals of the reservoir and [caprocks] have been investigated by optical microscopy, scanning electron microscopy (SEM), and X-ray diffraction (XRD). In the Qingshankou Formation, the reservoir rock is a typical arkose with moderately to good sorting, and very fine to fine grain sizes. Mineralogically it is dominated by quartz (19–31 vol.%), plagioclase (19–28 vol.%), and K-feldspar (2–26 vol.%). Calcite and ankerite constitute the most common diagenetic minerals. The lithology of the [caprock] is mainly silty mudstone and composed of quartz (average of 12.9–27.0 wt.%), albite (14.2–35.5 wt.%), K-feldspar (1.3–2.7 wt.%), mixed-layer illite/smectite (24.9–68.8 wt.%), chlorite (3.15–14.7 wt.%) and some kaolinite. The main antigenic minerals in the CO_2 INJECTION well are made up of albite (average of 29.7 wt.%), K-feldspar (average of 4.5 wt.%), calcite (average of 7.5 wt.%) and ankerite (average of 9.1 wt.%)." **Zhichao Yu, Li Liu, Keyu Liu, Siyu Yang, and Yongzhi Yang**, *International Journal of Greenhouse Gas Control*. (Subscription may be required.)

"Carbon dioxide storage in subsurface geologic medium: A review on capillary trapping mechanism."

The following is the Abstract of this article: "Carbon dioxide (CO_2) storage in subsurface geologic medium is presently the most promising option for mitigating the anthropogenic CO_2 emissions. To have an effective storage in immobile phase, however, it is necessary to determine the distribution of CO_2 in a medium, which mainly depends on three trapping mechanisms known as capillary, dissolution and mineral mechanisms. Previous studies have emphasized on these mechanisms individually in different aspects, particularly by considering the [formation] system. The purpose of this review is to give a comprehensive discussion on the advancement made toward capillary trapping in terms of effective and non-effective factors. It also throws light into the importance of capillary trapping in depleted hydrocarbon reservoir. Considering various factors and their impacts on capillary trapping, it is suggested to carry out an integrated study for the assessment of the major and minor influential parameters for better modeling and understanding of capillary trapping in any storage medium." **Arshad Raza, Reza Rezaee, Chua Han Bing, Raoof Gholami, Mohamed Ali Hamid, and Ramasamy Nagarajan**, *Egyptian Journal of Petroleum*. (Subscription may be required.)

TECHNOLOGY

"Numerical analyses of the effects of nitrogen on the dissolution trapping mechanism of carbon dioxide geological storage."

The following is the Abstract of this article: "Numerical simulations are carried out to investigate the effects of impurity on geological storage of CO_2, in the context of [CCS] which has been considered as one of the primary options for significantly reducing anthropogenic emissions of [GHGs] into the atmosphere. The CO_2 streams captured from power plants or other large industrial processes contain a variety of impurities. This study investigates the effects of nitrogen (N_2) on the dissolution trapping mechanism, which occurs when the injected CO_2 mixture dissolves into the formation fluids. The density of the formation water/brine at the two-phase interface would increase in response to the dissolution of CO_2. At favorable conditions, convection would be triggered and could greatly accelerate the dissolution rate of CO_2. This density-driven convection process is beneficial for both storage security and permanence. However, N_2 would lead to a density reduction of the aqueous phase when dissolved into the formation water/brine. The onset of convection would be delayed and the dissolution rate may be affected when co-injecting CO_2 with N_2. In addition, the spatial distribution of CO_2 in the aqueous phase would also be different with varying amounts of N_2 in the CO_2 streams." **Didi Li, Xi Jiang, Qingliang Meng, and Qiyuan Xie**, Computers & Fluids. (Subscription may be required.)

"Geochemical modeling of a sustained shallow [formation] CO_2 [release] field study and implications for [release] and site monitoring."

The following is the Abstract of this article: "A geochemical numerical modeling study was conducted to constrain processes occurring in field and laboratory experiments, simulating CO_2 [release] from geological storage on shallow potable [formations]. A [release] was previously physically simulated in a shallow potable [formation] at Vrøgum plantation, Western Denmark by injection of 1600 kg of gas phase CO_2 over 72 days. Here, a 1-dimensional reactive transport model was constructed based on field and laboratory results and subsequently used to explore the contributions of various geochemical processes to explain observed results from the carbonate free system. Finite gibbsite derived Al^{3+} driven cation exchange is able to explain the majority of water chemistry change observed at Vrøgum including: a pulse like effect showing a fast peak and return toward background levels for alkalinity and dissolved ion concentrations; and increasing and persistent acidification via buffering exhaustion. Model processes were supported further by simulation of a batch experiment conducted on the Vrøgum glacial sand, employing the same processes and sediment parameters. The fitted reactive transport model was subsequently used to extend predictions and explore various scenarios. Extended predictions suggest the pulse of elevated ions travels with advective flow succeeded by a zone of increasing acidification. Model runs at higher P_{CO2} (implying greater depths) suggest amplification of effects, i.e., greater peaks and more rapid and severe acidification. Calcite limits acidification, however, induces additional Ca driven ion exchange giving rise to more significant chemistry change. Although a site specific model, results have significant implications for risks posed to water resources from CCS [release] and implementation of [MVA] programs." **Aaron G. Cahill and Rasmus Jakobsen**, *International Journal of Greenhouse Gas Control*. (Subscription may be required.)

TERRESTRIAL

"Freshwater Sources Allow Escape for Terrestrial Carbon."

A new study published in the "Proceedings of the National Academy of Sciences" claims large amounts of CO_2 may be escaping from forest soil to freshwater sources. According to researchers, freshwater rivers and streams transport more than 220 billion pounds of CO_2 per year, which based on previous approximations may indicate that the current assessments of carbon storage in terrestrial landscapes may be overestimated by almost 30 percent. The data used for the study, titled *"Aquatic carbon cycling in the conterminous United States and implications for terrestrial carbon accounting,"* was the result of four years' worth of countrywide carbon assessment, where researchers gathered carbon data from freshwater rivers, lakes, and reservoirs around the United States. From *R&D Magazine* on December 28, 2015.

TRADING

"China Sets CO_2 Reporting Standards Ahead of Market Launch."

As part of their plan to launch a national carbon market by 2017, China has issued national standards for industrial firms to report their GHG emissions. Issued by the National Development and Reform Commission (NDRC), the standards will enable China to create a statistical system for GHG emissions and support the establishment of a national carbon trading scheme. The reporting rules cover 10 industries, including power generation and grids. By approximately 2030, China has pledged to reduce its carbon intensity from the 2005 level. From *The Business Times* on December 23, 2015.

"S. Korea, China Agree to Expand Cooperation in Carbon Trading."

Seoul's carbon trading market operator announced plans for South Korea and China to expand their cooperation on emissions trading, including joint efforts to link their carbon trading markets. Under the Memorandum of Understanding (MOU) signed by the Korea Exchange (KRX) and the China Beijing Environment Exchange (CBEEX), the sides will exchange market information and share their experiences. The KRX launched their carbon trading system in 2015; China, which currently has seven operators of regional carbon trading markets, plans to launch their nationwide scheme in 2017. From *Yonhap News* on December 21, 2015.

RECENT PUBLICATIONS

"Carbon Capture and Storage – The vital role of CCS in an effective COP21 agreement."

The following is a description of this document: "The report 'Carbon Capture and Storage – the vital role of CCS in an effective COP21 agreement' provides an overview of the road so far and calls for key policy initiatives to support the greater global deployment of CCS technology. Key [World Coal Association (WCA)] policy recommendations include: [1] Policy parity - CCS must receive the same policy support that has benefitted renewable technologies in recent decades. This is vital to facilitate the lowest cost pathway to [decarbonization]. [2] Governments must articulate how they plan to drive CCS deployment beyond the demonstration phase towards [commercialization]. [3] Solutions to reducing emissions will require global action, CCS deployment requires international incentives."

"Carbon Capture and Storage: A vital low carbon technology that can deliver on economic development, energy security, and climate goals."

The following is from the Executive Summary of this document: "The global energy landscape is changing and policy makers have important choices to make. Energy markets are in transition with technology innovations tapping unconventional oil supplies, improving efficiency, and generating lower carbon electricity, but not at a rate fast enough to seriously address climate concerns. Energy investments are shifting from developed countries to emerging economies with rapid energy demand growth. Yet, reliance on fossil fuels continues. At present, around 80 [percent] of the world's primary energy and 65 [percent] of global electricity generation is supplied from fossil fuels and they are projected to dominate for decades. As part of a portfolio of low carbon emissions technologies, CCS, a vital technology that can address large-scale cuts in CO_2 emissions from fossil fuel power plants and industrial facilities, can deliver on climate goals and in many countries simultaneously meet energy security and sustainable economic development goals. Given these potential benefits, policy makers must take urgent action to accelerate commercial deployment and build on the successes of the past two decades."

"North Sea to the Rescue: The commercial and industrial opportunities of CO_2 storage in the North Sea."

The following is from the Introduction of this document: "CCS delivers very substantial CO_2 reductions from large industrial and energy facilities. CCS is not a peripheral [decarbonization] technology. CCS is an indispensable component of national and global [decarbonization] pathways as [recognized] by the IPCC, the IEA, and the European Commission. The EU 2050 Energy Roadmap relies heavily on the deployment of CCS to meet EU wide [decarbonization] goals. CCS deployment provides a huge opportunity for Europe to meet its energy, climate and societal goals, in particular to achieve its GHG emissions reduction targets at lower cost while satisfying energy security. The North Sea has a critical role in the permanent storage of CO_2 from many of Europe's emitters. The North Sea has immense secure CO_2 storage capacity and indigenous offshore industries with the capability to develop and operate CO_2 storage complexes. The development and operation of transport and storage infrastructure has the potential to become a new industry for the North Sea, eclipsing declining hydrocarbon production. Countries that act now to remove commercial barriers and [incentivize] the sectors development will foster highly skilled employment attract industrial activity and enable the development of technology and service sectors. Using estimates of the CO_2 required to be stored in the North Sea for Europe to reach its 2050 [decarbonization] objectives, Bellona has estimated the size of the future North Sea CO_2 storage sector. [Carbon dioxide] storage will require the characterization of storage sites, the drilling of appraisal and injection wells, the emplacement of CO_2 platforms, along with engineering, fabrication and logistics. [Carbon dioxide] storage requires many of the same skills and infrastructure now underemployed or to be decommissioned. The CO_2 storage sector has the potential to become a major North Sea enterprise, employing 22,000 people by 2030. Countries surrounding the North Sea basin must act to encourage the sectors development and to enable Europe to [decarbonize] effectively."

LEGISLATIVE ACTIVITY

"[California Announces Climate Legislation at COP21]."

At the 21st Conference of Parties (COP21) meeting in Paris, France, the California delegation announced a climate change proposal that will set targets to achieve, among other targets, a 50 percent reduction in black carbon emissions in the state of California by 2030. The *"Short-Lived Climate Pollutant Reduction Act of 2016"* will require the California Air Resources Board (CARB) to approve and implement, by January 1, 2018, a strategy to reduce statewide emissions of short-lived climate pollutants to achieve a reduction in emissions of methane by 40 percent, F-gases by 40 percent, and black carbon by 50 percent below 2013 levels by the year 2030. The legislation is expected to be formally introduced in early 2016. From *U.S. Senator Ricardo Lara Press Release* on December 8, 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 CO2 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*.

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.

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