NETL the ENERGY lab

Carbon Storage Newsletter

DECEMBER 2015

WHAT'S INSIDE?

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

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 Buchanan County, Virginia, USA, in July 2015. 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.

RGGI Completes 30th Auction of CO_2 Allowances.

The Regional Greenhouse Gas Initiative's (RGGI) 30th auction of CO_2 allowances was completed, with 15,374,274 CO_2 allowances selling at the clearing price of $7.50. This was the fourth and final auction of 2015 and generated $115.3 million for reinvestment in strategic programs, such energy efficiency and greenhouse gas (GHG) abatement programs. In addition, the states participating in RGGI also released the "Report on the Secondary Market for RGGI CO_2 Allowances: Third Quarter 2015."

6th Carbon Sequestration Leadership Forum Minister's Meeting Held in Saudi Arabia.

The 6th CSLF Ministerial Meeting, co-hosted by the United States and Saudi Arabia, was held in Riyadh, Saudi Arabia. The meeting focused on the role of CCS technologies.

Announcements (Continued)

CSLF Recognizes CO_2 Capture Project for Work in CCS.

CSLF recognition for the CO_2 Capture Project (CCP) includes a Global Achievement Award for the third phase of the CCP Program (CCP3 – 2009-2014), as well as Recognized Project Status for its current, fourth phase of the program (CCP4 – 2014-2018).

Sembcorp Joins Industrial CCS Scheme.

Sembcorp Utilities UK, an industrial energy and water services provider, has joined the Teesside Collective, an industrial CCS scheme. The first phase of the scheme could be up and running by 2024.

Carbon Storage in the News

"Shell Launches Quest Carbon Capture and Storage Project."

Shell's Quest CCS project initiated commercial operations in Alberta, Canada. Designed to capture and safely store more than 1 million metric tons of CO_2 per year, Quest will capture one-third of the CO_2 emissions from Shells' Scotford Upgrader, transport it through an approximately 40-mile pipeline, and inject it more than 1 mile underground. Quest is now operating at commercial scale after successful testing that saw more than 200,000 metric tons of CO_2 captured and stored earlier in 2015. From *Shell Media Release* on November 6, 2015

"CO_2 Solutions Completes Operation of Demonstration Plant."

CO_2 Solutions, Inc., announced the completion of its demonstration plant in Valleyfield, near Montreal, Québec, Canada, after logging more than 2,500 operational hours since CO_2 capture began in June 2015. Data and results from the project, which are currently being validated and analyzed, will allow for the completion of detailed engineering and costing models for commercial units at various scales. From *CO_2 Solutions Press Release* on November 10, 2015.

"Saudi Pilot Carbon Storage Project May Boost Recovery Rates at Giant Oilfield."

According to officials, Saudi Arabia's first CCS project has the potential to increase oil recovery rates by 20 percent. The CCS project is located at the Ghawar oilfield, which has been in operation since 1951 and produces more than 5 million barrels of oil per day. Under the project, 40 million cubic feet of CO_2 will be captured at the Hawiyah gas recovery plant and piped approximately 53 miles to the Uthmaniyah area, where it will be used in enhanced oil recovery (EOR) operations. Saudi Aramco, the national oil firm that developed the project, estimates it has the potential to store approximately 800,000 metric tons of CO_2 per year. From *Reuters* on November 5, 2015.

"Climeworks AG Builds First Commercial Scale CO_2 Capture Plant."

Climeworks AG will operate an industrial-scale CO_2 capture plant in Hinwil (Canton of Zurich, Switzerland) with the capacity to capture 900 tons of CO_2 per year. The plant, which will be operational by mid-2016, is part of a three-year pilot and demonstration project supported by the Swiss Federal Office of Energy (SFOE). The project will utilize Climeworks' Direct Air Capture (DAC) technology and continuously operate an industrial-scale plant that captures CO_2 from ambient air. From *Climeworks' Press Release* on October 21, 2015.

"Test Begins to Store Carbon Dioxide Under Seabed Off Hokkaido."

A Japanese government-backed trial operation for the capture and undersea storage of CO_2 emissions at a facility in Hokkaido, Japan, has been initiated. According to project officials, emissions will be transported via pipeline into a CO_2 separation and collection device, where they will be absorbed by a liquid solution that will raise the CO_2 concentration to more than 99 percent. The concentrated CO_2 will then be transported to two wells that are approximately 1.8 and 2.7 miles off the coast and 0.7 to 1.9 miles deep, respectively. Beginning in April 2016, the project will transfer in the range of 100,000 to 200,000 tons of CO_2 per year for three years, monitoring the temperature and pressure in the process. From *Japan Times* on November 20, 2015.

Science

"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. Developed by Solidia Technologies, Inc., the process uses CO_2 instead of water to cure pre-cast concrete, reducing curing time to less than 24 hours (water-based curing could take weeks). According to Solidia, the new process may reduce the carbon footprint of concrete curing by approximately 30 percent compared to traditional methods. In addition, Solidia's analysis claims that combining it with their patented CO_2-enriched cement process could reduce CO_2 emissions associated with concrete product fabrication by 60 percent, while slashing water use by 90 percent. Applied industry-wide, the two technologies combined have the potential to reduce CO_2 emissions by 1,920 million metric tons per year. For more information, visit NETL's Carbon Use and Reuse Webpage. From *energy.gov* on November 10, 2015.

Science (Continued)

"Halifax Firm Injects CO_2 into Concrete and Reduces Carbon Footprint."

A company in Nova Scotia has developed a concrete technology in which captured CO_2 emissions are injected and stored into the concrete, lowering its carbon footprint by up to 15 percent. According to the developer, CarbonCure Technologies, the CO_2 mineralizes during the process, becoming limestone calcium carbonate, and creates a stronger, faster-setting concrete. From *CBC News* on November 30, 2015.

"Porous Liquid Holds Promise for CO_2 Capture."

Scientists have created a porous liquid with the ability to dissolve large amounts of gas, which could potentially be used for carbon capture applications. Researchers from the School of Chemistry and Chemical Engineering at Queen's University Belfast led the three-year research project, which found that large amounts of gas can be absorbed into the "holes" of their newly invented liquid. The study, titled "Liquids with permanent porosity" and published in the journal "Nature," also involved the University of Liverpool and universities in France, Germany, and Argentina. From *Carbon Capture Journal* on November 15, 2015.

Policy

"[The United States] and China Advance Policies to Limit Carbon Emissions."

According to the U.S. Energy Information Administration (EIA), the United States and China have advanced policies to limit CO_2 emissions. In its intended nationally determined contributions (INDCs), the United States proposes to bring emissions 26 to 28 percent below 2005 levels by 2025. China's INDC proposes to peak its CO_2 emissions around 2030, furthermore proposing 20 percent non-fossil energy use, also by 2030. From *Energy Voice* on November 18, 2015

"DNV GL Conducts Largest Ever Controlled Release of CO_2 from an Underwater Pipeline."

DNV GL announced it will conduct a controlled release of CO_2 from an underwater pipeline at its full-scale Spadeadam Testing and Research Center in Cumbria, United Kingdom (UK). Scheduled in begin in January 2016, the planned underwater release is part of an international Joint Industry Project (JIP) called "Sub-C-O2," the goal of which is to develop safety guidelines on the use of offshore CO_2 pipelines. This marks the project's second experimental phase and is expected to run for three months and involve releases in an approximately 130-foot-diameter, 39-foot-deep pond at Spadeadam. From *DNV GL* on November 23, 2015.

"A benchmarking framework to evaluate business climate change risks: A practical tool suitable for investors decision-making process."

The following is the Abstract of this article: "A fundamental concern for the investor community is to identify techniques which would allow them to evaluate and highlight the most probable financial risks that could affect the value of their asset portfolio. Traditional techniques primarily focus on estimating certain conventional social-economic factors and many fail to cover an array of climate change risks. A limited number of institutional documents present, to a somewhat limited extent, some general-defined types of business climate change risks, which are deemed most likely to influence the value of an investors' portfolio. However, it is crucial that stakeholders of businesses and scholars consider a wider range of information so as to assist investors in their decision making. This paper aims at establishing a new framework to operationalize and quantify an array of business climate change risks to provide more comprehensive and tangible information on non-traditional risks. This framework relies on the benchmarking – scoring systems and Global Reporting Initiative (GRI) guidelines, and is applied to various Greek businesses that are certified by Environmental Management and Audit Scheme (EMAS)." **Nikolaos Demertzidis, Thomas A. Tsalis, Glykeria Loupa, Ioannis E. Nikolaou**, *Climate Risk Management*. (Subscription may be required.)

Geology

"Eocene atmospheric CO_2 from the nahcolite proxy."

The following is the Abstract of this article: "Estimates of the atmospheric concentration of CO_2, $[CO_2]_{atm}$, for the 'hothouse' climate of the early Eocene climatic optimum (EECO) vary for different proxies. Extensive beds of the mineral nahcolite ($NaHCO_3$) in evaporite deposits of the Green River Formation, Piceance Creek Basin, Colorado, USA, previously established $[CO_2]_{atm}$ for the EECO to be >1125 ppm by volume (ppm). Here, [the authors] present experimental data that revise the sodium carbonate mineral equilibria as a function of $[CO_2]$ and temperature. Co-precipitation of nahcolite and halite (NaCl) now establishes a well-constrained lower $[CO_2]_{atm}$ limit of 680 ppm for the EECO. Paleotemperature estimates from leaf fossils and fluid inclusions in halite suggest an upper limit for $[CO_2]_{atm}$ in the EECO from the nahcolite proxy of – 1260 ppm. These data support a causal connection between elevated $[CO_2]_{atm}$ and early Eocene global warmth, but at significantly lower $[CO_2]_{atm}$ than previously thought, which suggests that ancient climates on Earth may have been more sensitive to a doubling of $[CO_2]_{atm}$ than is currently assumed." **Elliot A. Jagniecki, Tim K. Lowenstein, David M. Jenkins, and Robert V. Demicco**, *Geology*. (Subscription may be required.).

"Analysis of CO_2 trapping capacities and long-term migration for geological formations in the Norwegian North Sea using MRST-co2lab."

The following is the Abstract of this article: "MRST-co2lab is a collection of open-source computational tools for modeling large-scale and long-time migration of CO_2 in conductive [formations],

Geology (Continued)

combining ideas from basin modeling, computational geometry, hydrology, and reservoir simulation. Herein, [the authors] employ the methods of MRST-co2lab to study long-term CO_2 storage on the scale of hundreds of [million tons]. [The authors] consider public data sets of two [formations] from the Norwegian North Sea and use geometrical methods for identifying structural traps, percolation-type methods for identifying potential spill paths, and vertical-equilibrium methods for efficient simulation of structural, residual, and solubility trapping in a thousand-year perspective. In particular, [the authors] investigate how data resolution affects estimates of storage capacity and discuss workflows for identifying good injection sites and optimizing injection strategies." **Halvor Møll Nilsen, Knut-Andreas Lie, and Odd Andersen**, *Computers & Geosciences*. (Subscription may be required.)

Technology

"Geomechanical stability of CO_2 containment at the South West Hub Western Australia: A coupled geomechanical-fluid flow modelling approach."

The following is the Abstract of this article: "An area in the Southern Perth Basin has been selected as a potentially suitable site for CO_2 injection and storage as a part of the South West Hub Project (SW Hub), due to its proximity to major CO_2 emission sources and the presence of potentially suitable geology. This 3D modelling study attempts to assess the geomechanical stability of faults and intact host rocks during CO_2 injection at the SW Hub. The stratigraphy and fault structure of the 3D model are based on the architecture of an E–W cross section in a pre-existing 3D geological model that represents a comprehensive synthesis of seismic, stratigraphic and structural data. In the models, the rocks and faults are simulated as Mohr–Coulomb elastic–plastic materials, and their geomechanical and hydrological properties are based on experimental data from the Harvey-1 drill core samples and also information from literature. A series of models are performed to assess five injection scenarios with injection rates of 1–5 million tonnes per year over a period of 20 years. The results show that the simulated CO_2 injection scenarios would not lead to fault reactivation or breach the overlying Yalgorup or Eneabba Shale formations in the area. Some small smooth uplifts are recorded as a result of injection. In the models assuming weak faults, average ground surface uplifts are 0.4–1.8 cm for the injection rates of 1–5 million tonnes per year, over an area of approximately 2.5 km radius around the hypothetical injection site. Uplifts are marginally smaller when assuming strong faults." **Y. Zhang, L. Langhi, P.M. Schaubs, C. Delle Piane, D.N. Dewhurst, L. Stalker, and K. Michael**, *International Journal of Greenhouse Gas Control*. (Subscription may be required.)

"Modelling CO_2 migration in [formations]; considering 3D seismic property data and the effect of site-typical depositional heterogeneities."

The following is the Abstract of this article: "Geological [storage] is one proposed measure for [GHG] mitigation; and deep, saline [formations] are considered to hold large storage potentials for CO_2. The Johansen Formation has been suggested by Norwegian authorities as a potential reservoir candidate due to its relative proximity to land and point sources for CO_2. Reservoir evaluations must consider the given premise of zero interference with ongoing gas production in the Troll Field, providing geographical constraints. Recent data contributions; new 3D seismic data, attribute analyses, and revision of the depositional model form the basis of this modelling study. Porosity distributions were generated from quantified relations with acoustic impedance. The reservoir quality varies according to sedimentary facies, and differentiated relative permeability curves were assigned accordingly. Effects of directional anisotropy and site-typical geological heterogeneities were considered through scenario-modelling. The potential for dissolution and residual trapping of CO_2 varies according to migration paths; and was estimated to 50–80 [percent] of injected CO_2 after 150 years. [Immobilization] was more efficient with increased sweep through reservoir zones with high irreducible gas fractions, and in scenarios where plume separation occurred. The main determinant, however, for improving trapping efficiency is the well location and injection scheme." **Anja Sundal, Rohaldin Miri, Trude Ravn, and Per Aagaard**, *International Journal of Greenhouse Gas Control*. (Subscription may be required.)

Terrestrial

"Hydraulics are a first-order control on CO_2 efflux from fluvial systems."

The following is the Abstract of this article: "Evasion of CO_2 from fluvial systems is now recognized as a significant component of the global carbon cycle. However, the magnitude of, and controls on, this flux remains uncertain, and improved understanding of both is required to refine global estimates of fluvial CO_2 efflux. [Carbon dioxide] efflux data show no pattern with latitude suggesting that catchment biological productivity is not a primary control and that an alternative explanation for intersite variability is required. It has been suggested that increased flow velocity and turbulence enhance CO_2 efflux, but this is not confirmed. Here using contemporaneous measurements of efflux (range: 0.07–107 $\mu mol\, CO_2\, m^{-2}\, s^{-1}$), flow hydraulics (mean velocity range: 0.03–1.39 $m\, s^{-1}$), and pCO_2 (range: 174–10712 μatm) at six sites, [the authors] find that flow intensity is a primary control on efflux across two climatically different locations (where pH is not a limiting factor) and that the relationship is refined by incorporating the partial pressure of CO_2 (pCO_2) of the water. A remaining challenge is how to upscale from point to reach or river basin level. Remote imaging or river surface may be worth exploring if subjectivity in interpreting surface state can be overcome." **Hazel Long, Leena Vihermaa, Susan Waldron, Trevor Hoey, Simon Quemin, and Jason Newton**, *Journal of Geophysical Research*. (Subscription may be required.)

Trading

"First California Cap-and-Trade Compliance Period Ends with 99 Percent Compliance."

The California Air Resources Board announced a 99 percent compliance rate for the first compliance period of the state's cap-and-trade program. The program was initiated under the California Global Warming Solutions Act of 2009 (AB 32), which aims to reduce GHG emissions back to 1990 levels by 2020. From *California Environmental Protection Agency Air Resource Board News Release* on November 4, 2015.

"World Bank Launches $500 [Million] Carbon Market Scheme."

The World Bank, with pledges from Germany, Norway, Sweden, and Switzerland, has launched a $500 million carbon market scheme designed to help developing countries pay for CO_2 emission reductions and address potential climate change. According to the bank, the scheme will reward countries for reducing emissions by paying a fee for each ton of CO_2 reduced. The price-per-ton paid to the countries will be set on a case-by-case basis. From *Reuters* on November 30, 2015.

"China to Start Nationwide Emissions Trading Market in 2017."

Following the successful operation of seven pilot-scale schemes across the country, Chinese officials announced intentions to start a nationwide CO_2 emissions trading market in 2017. According to China's INDCs, the country is looking to cut CO_2 emissions per unit of gross domestic product (GDP) by 60 to 65 percent from the 2005 level by 2030. From *Xinhua News* on November 19, 2015.

"Modeling the impacts of alternative emission trading schemes on international shipping."

The following is the Abstract of this article: "Various market-based measures have been proposed to reduce CO_2 emissions from international shipping. One promising mechanism under consideration is the Emission Trading Scheme (ETS). This study analyzes and benchmarks the economic implications of two alternative ETS mechanisms, namely, an open ETS compared to a Maritime only ETS (METS). The analytical solutions and model calibration results allow [the authors] to quantify the impacts of alternative ETS schemes on the container shipping sector and the dry bulk shipping sector. It is found that an ETS, whether open or maritime only, will decrease shipping speed, carrier outputs and fuel consumption for both the container and dry bulk sectors, even in the presence of a 'wind-fall' profit to shipping companies. Under an open ETS, the dry bulk sector will suffer from a higher proportional reduction in output than the container sector, and will thus sell more emission permits or purchase fewer permits. Under an METS, container carriers will buy emission permits from the dry bulk side. In addition, under an METS the degree of competition within one sector will have spill-over effects on the other sector. Specifically, when the sector that sells (buys) permits is more collusive (competitive), the equilibrium permit price will rise. This study provides a framework for identifying the moderating effects of market structure and competition between firms on emission reduction schemes, and emphasizes the importance of understanding the differential impacts of ETS schemes on individual sectors within an industry when considering alternative policies." **Kun Wang, Xiaowen Fu, and Meifeng Luo**, *Transportation Research Part A: Policy and Practice.* (Subscription may be required.)

Recent Publications

"Leveling the Playing Field: Policy Parity for Carbon Capture and Storage Technologies."

The following is from the Executive Summary of this document: "Federal energy and environmental policy has severely tilted the energy playing field. Secretary Moniz has requested the National Coal Council (NCC) make recommendations to level the playing field for CCS and provide 'policy parity.' Existing incentives for CCS are simply too small to 'bridge the chasm' – as the NCC put it earlier this year – between the cost and risk of promising but immature CCS technologies and other technology alternatives. While CCS is commercially deployed in some industrial sectors and technically demonstrated at electric power plants, power generation with CCS remains expensive today compared to other technologies such as natural gas combined cycle (NGCC) or heavily subsidized renewables. DOE has stewarded a successful research and development program to spur early development of CCS technologies, but without sufficient government support and incentives, commercial CCS deployment has lagged. Absent commercial-scale deployment, developers have no history to understand technical risks, frequency and duration of down time, and other critical factors that become known only with operation. Today, the world's first and only operating commercial-scale power plant with CCS has successfully achieved a capture rate of 80 [percent] of the plant's CO_2, but has been unable to maintain that level of performance and has been operational just 40 [percent] of the time because of technical complications. With broad deployment, technological experience and confidence will rise, and costs will decline. Policy parity is essential to this progress. Coal and other fossil fuel use will keep rising globally as the world adds, per the United Nations, three billion more people to cities in the next 40 – 50 years. To achieve climate goals and address fossil emissions, the world must have CCS. Commercializing CCS requires a level playing field. Cross-functional experts within the NCC's working groups have rigorously assessed the incentives and policies needed to level the playing field. There is consensus among them that the recommendations in this report will bring needed advances to development and deployment of CCS technologies…"

Recent Publications (Continued)

"Power sector scenarios for the fifth carbon budget."

The following is from the Executive Summary of this document: "This report sets out scenarios for the power sector in 2030 as an input to [the authors] advice on the fifth carbon budget, which [will be published] in November. The fifth carbon budget will set a limit on UK emissions of [GHGs] over the period 2028 to 2032. It marks the halfway point from the first carbon budget (2008-12) to the UK's statutory target for 2050 to reduce emissions by at least 80 [percent] across the economy relative to 1990, as set out in the Climate Change Act. [The authors] are publishing these scenarios ahead of [their] November advice given the importance of the power sector to meeting the economy-wide emissions targets. It has been a common finding of [the authors'] previous work that meeting the 2050 target will require that emissions from energy use – power, heat and transport – are almost eliminated. To achieve this it is important to have low-carbon sources of energy that are low cost, secure, acceptable to the public and attractive to investors. A [decarbonized] power sector can provide that low-carbon energy source. [The authors'] scenarios set out possible futures for the UK power sector. They are not intended to set out a prescriptive path. The scenarios provide a tool for the Committee to verify that its advice can be achieved with manageable impacts for the criteria in the Climate Change Act, including competitiveness, affordability and energy security. [The authors] welcome comments and input on this analysis."

"The Global Status of CCS: 2015 Summary Report."

The following is a description of this document: "The Global Status of CCS: 2015 Summary Report provides an overview of the key findings contained in the package of Volumes and Reports that comprises The Global Status of CCS: 2015 release, as well as a set of actions that can accelerate the deployment of CCS globally."

"World Energy Outlook 2015."

The following is a description of this document: "The precipitous fall in oil prices, continued geopolitical instability and the ongoing climate negotiations are witness to the dynamic nature of energy markets. In a time of so much uncertainty, understanding the implications of the shifting energy landscape for economic and environmental goals and for energy security is vital. The World Energy Outlook 2015 (WEO-2015) presents updated projections for the evolution of the global energy system to 2040, based on the latest data and market developments, as well as detailed insights on the prospects for fossil fuels, renewables, the power sector and energy efficiency and analysis on trends in CO_2 emissions and fossil-fuel and renewable energy subsidies."

"The CarbonNet Project: integrity of wells in the near-shore area Gippsland Basin Victoria."

The following is the Abstract of this document: "The CarbonNet Project is investigating CO_2 storage sites in the nearshore area of the Gippsland Basin of Victoria, Australia. The project objective is to provide permanent and safe storage for 25 to 125 Mt of CO_2. The integrity of legacy or existing wells (which includes abandoned, production, injection, mineral/water bores and Measurement, Monitoring and Verification [MMV] wells) is [recognized] around the world as one of the most significant operational risks to CO_2 storage projects. The number of wells and quality of completions can vary significantly in different basins and jurisdictions. Furthermore, the drilling and completion requirements for onshore and offshore wells are subject to various regulatory, industry and operator standards and practices. The Gippsland Basin has been an active oil and gas production province since the 1960's and there is a reasonable database of well data and parameters to assess well integrity. In the nearshore area of the Gippsland Basin, the integrity of fourteen wells has been assessed by CarbonNet and risks were identified. The assessment was based on existing documentation lodged with the regulator under Australia's comprehensive offshore petroleum legislation. The assessment concludes that the risk of [release] to surface from the fourteen legacy wells reviewed is very low. At an intraformational level, some wells are less securely completed and therefore appropriate mitigation measures are proposed – generally, to avoid intraformational storage concepts at these sites and locations. Ultimately for any CO_2 storage project, there is a requirement to demonstrate how to safely monitor legacy wells. In an Australian regulatory context, the requirement is to demonstrate they are not active [release] pathways and to outline plans for remediation of wells if they are shown to have problems. Options are discussed for completion and monitoring of future petroleum wells and other boreholes to avoid any new risks."

Legislative Activity

"[Senators] Introduce Bill to Help Finance Carbon Capture and Storage Projects."

The Carbon Capture Improvement Act of 2015 was introduced to help power plants and industrial facilities finance the purchase of CCS equipment by allowing businesses to use tax-exempt private activity bonds (PABs) to finance the upfront capital costs associated with installation of the equipment. In addition to making CCS projects more economically feasible through the use of PABs, the bill will also look to boost oil production through EOR operations. From *U.S. Senator Rob Portman Press Release* on November 19, 2015.

Legislative Activity (Continued)

"[Irish] Government to Introduce Legislation to [Address] Climate Change – Taoiseach."

The Irish government announced it will introduce legislation to address potential climate change. According to government officials, the climate bill would set out plans in four areas (agriculture, energy, buildings, and transport), as well as increase financial contributions to developing nations. From *independent.ie* on November 30, 2015.

"Russia Lays Foundations for Carbon Regulation…"

Russia's Ministry of Natural Resources and Environment has published a draft law that introduces a baseline for controlling CO_2 emissions by creating a legal definition of GHGs and setting rules on how to measure, regulate, and report CO_2 emissions. From *Reuters* on November 5, 2015.

"The political economy of passing climate change legislation: Evidence from a survey."

The following is from the Abstract of this article: "Climate change is now a major aspect of public policy. There are almost 500 identified climate change laws in the world's leading economies. This paper reviews the main domestic factors that drive this legislation. The analysis is based on a unique dataset of climate legislation in 66 national jurisdictions for the period 1990–2013. [The authors] find that the passage of new climate laws is influenced by several factors. One important factor is the quantity and quality of previous legislation: the propensity to pass more laws decreases non-linearly with the stock of existing legislation, but increases in the presence of a strategic 'flagship law' that sets an overall framework for climate policy. Contrary to widespread belief, political orientation is not a decisive factor…" **Sam Fankhauser, Caterina Gennaioli, and Murray Collins**, *Global Environmental Change.* (Subscription may be required.)

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:

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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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