



Office of Fossil Energy

Carbon Sequestration Newsletter

AUGUST 2012

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build more efficient electrical grids, and advance clean energy research and development (R&D). The new action plan also places a greater emphasis on energy efficiency. Accomplishments to date under the CED include: (1) completing the final phase of the Weyburn-Midale Carbon Dioxide Monitoring and Storage Project, which focuses on best practices for the safe and permanent storage of carbon dioxide (CO₂) used in enhanced oil recovery (EOR); and (2) the North American Carbon Storage Atlas (NACSA), which is the first atlas to map the potential CO₂ storage resource in North America. Action Plan II will include new and ongoing initiatives, such as projects to permanently store CO₂ in geological formations; clarify U.S. and Canadian regulatory authorities for deployment of offshore renewable energy and technologies; and investigate the potential of power storage technologies. The CED was established in 2009 to encourage the development of clean energy technologies to reduce greenhouse gases (GHGs) and address potential climate change. (See [Recent Publications section for a write-up and a link to the “U.S.-Canada Clean Energy Dialogue Action Plan II.”](#)) June 21, 2012, <http://energy.gov/articles/united-states-canada-announce-next-phase-us-canada-clean-energy-dialogue>.

Fossil Energy Techline, “DOE-Sponsored Project Begins Demonstrating CCUS Technology in Alabama.”

A Southeast Regional Carbon Sequestration Partnership (SECARB) project sponsored by DOE has initiated CO₂ injection using CO₂ from Alabama Power’s 2,657-MW Barry Electric Generating Plant. The “Anthropogenic Test” demonstrates carbon



capture, utilization, and storage (CCUS) by diverting and capturing flue gas, and transporting CO₂ approximately 12 miles to the Citronelle Dome. The injection spans two years at a rate of up to 550 metric tons of CO₂ per day, and monitoring technologies will track the CO₂ plume, measure the pressure front, evaluate trapping mechanisms, and ensure that CO₂ remains in the formation. The formation is more than 9,000 feet underground and overlain by multiple geologic confining units. After three years of post-injection monitoring, the site will be closed and the wells either plugged or abandoned per state regulations or re-permitted for CO₂-EOR and CO₂ storage operations. August 22, 2012, http://www.fossil.energy.gov/news/techlines/2012/12037-CO2_Injection_Begins_in_Alabama.html.



INTRODUCTION

This Newsletter is created by the National Energy Technology Laboratory and represents a summary of carbon sequestration news covering the past month. Readers are referred to the actual article(s) for complete information. It is produced by the National Energy Technology Laboratory to provide information on recent activities and publications related to carbon sequestration. It covers domestic, international, public sector, and private sector news.

HIGHLIGHTS

U.S. Department of Energy News Release, “United States, Canada Announce Next Phase of U.S.-Canada Clean Energy Dialogue.”

On June 21, 2012, the U.S. Department of Energy (DOE) and Environment Canada released the U.S.-Canada Clean Energy Dialogue (CED) Action Plan II, renewing their commitment to collaborate on carbon capture and storage (CCS) technologies,

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SEQUESTRATION IN THE NEWS

United Press International, "Canada Gives Nod to CCS Project," and *The Chronicle Herald*, "Alberta Board Approves First Plan to Store Gas Emissions Underground."

Canadian regulators have conditionally approved the first proposal to inject emissions from Alberta's oil sands. Shell Canada received approval for its \$1.35 billion Quest underground carbon project, which calls for the permanent storage of up to 1.2 million metric tons of CO₂ a year from its Scotford upgrader. The project's plan is to pipe liquefied CO₂ to injection wells north of the upgrader and permanently and safely store it more than two kilometers underground, beneath multiple layers of rock and mineral formations, beginning in 2015. The province said its goal is to reduce CO₂ emissions by 5 million metric tons per year by 2015. The provincial regulator, the Energy Resources Conservation Board, attached 23 provisions to its consent, the majority of which relate to data collection, analysis, and reporting. July 12, 2012, http://www.upi.com/Business_News/Energy-Resources/2012/07/12/Canada-gives-nod-to-CCS-project/UPI-80471342102377/?spt=hs&or=er, and July 12, 2012, <http://thechronicleherald.ca/business/116297-alberta-board-approves-first-plan-to-store-gas-emissions-underground>.

Billings Gazette, "Wyoming Oil Field Latest Reborn with CO₂ Flooding."

Elk Petroleum and Denbury Resources were granted environmental clearance from the Bureau of Land Management to begin pumping CO₂ into an oil field near Casper, Wyoming. The two companies plan to use the CO₂ flooding to extract up to 24 million additional barrels of oil from the Grieve Oil Field, which they co-own, through the practice of EOR. Crews will construct a three-mile supply pipeline that connects the Grieve site, located approximately 50 miles west of Casper, to an already-existing Anadarko CO₂ pipeline. Construction is expected to be completed by October and in operation by November. July 31, 2012, http://billingsgazette.com/news/state-and-regional/wyoming/wyoming-oil-field-latest-reborn-with-co-flooding/article_c5c71b4b-8803-5a62-a800-aac1857d1e8e.html.

Wyoming Business Report, "CO₂ Pipeline Back Underway."

Construction is underway on the 232-mile Greencore pipeline north of Casper, Wyoming. The construction started in August 2011 and was suspended in November; construction is only permitted by the Federal government between August and November due to wildlife protection. The 20-inch pipeline will carry CO₂ from ConocoPhillips' gas plant at Lost Cabin in eastern Fremont County and head toward Campbell County and north to Montana's Bell Creek field. The CO₂ will also be used in the Cedar Creek Anticline field. The Greencore pipeline has a capacity of more than 700 million cubic feet of CO₂ a day and will cost an estimated \$275 million to \$325 million to complete. Pipeline construction will result in more than 200 jobs in the Casper area. Greencore is a subsidiary of Denbury Resources, headquartered in Plano, Texas. August 7, 2012, <http://www.wyomingbusinessreport.com/article.asp?id=63703>.

ANNOUNCEMENTS

DOE Advances Innovative CCS Polygeneration Plant.

DOE and the California Energy Commission (CEC) are working together to advance an innovative CCS plant simultaneously through both the Federal National Environmental Policy Act (NEPA) review and a complementary California Energy Quality Act process. Part of DOE's Clean Coal Power Initiative (CCPI), the new polygeneration plant will incorporate CCS and utilize CO₂ for EOR. For more information on DOE's CCPI, visit: <http://www.fossil.energy.gov/programs/powersystems/cleancoal/index.html>.

2012 MGSC Annual Meeting and Workshop.

The Midwest Geological Sequestration Consortium (MGSC) Annual Meeting and Workshop will be held September 17-19, 2012, at the I Hotel and Conference Center in Champaign, Illinois. The agenda includes a full day of presentations on the Illinois Basin Decatur Project (IBDP), covering all aspects of MGSC Phase II research activities; a Sequestration Training and Education Program (STEP)-sponsored workshop; and an optional tour of the IBDP site. For more information, visit the MGSC website at: <http://www.sequestration.org/>.

DOE-Funded Project to Capture CO₂ Launched in Ohio.

A novel method to capture CO₂ from flue gas and produce biofuels has been formally launched in the second phase of a DOE project at a nursery in Ohio. The successful application of the process could eventually help reduce GHG emissions and provide a source of liquid biofuels and biogas. More information is available at: http://www.fossil.energy.gov/news/techlines/2012/12035-Bioconversion_Pilot_Plant_Launched.html.

Latest Fossil Energy Today Newsletter Now Available.

DOE's FE has released the latest edition of "Fossil Energy Today," a free quarterly digital newsletter that provides up-to-date information on important activities, progress, and other developments within FE. For subscription information and to download the latest issue, click: <http://www.fossil.energy.gov/news/energytoday.html>.

NETL Publication Earns National Communications Award.

NETL received a National Association of Government Communicators (NAGC) 2012 first-place award for superior government communications for the Carbon Sequestration Atlas of the United States and Canada (Atlas III). The annual Blue Pencil & Gold Screen awards recognize communications pieces produced by government agencies that are particularly high quality and effective. Atlas III received top honors in the Technical or Statistical Report category. Atlas III can be viewed at: http://www.netl.doe.gov/technologies/carbon_seq/refshelf/atlasIII/2010atlasIII.pdf.

DOE Manual Features Strategies for Carbon Storage Wells.

NETL released its latest best practices manual (BPM), titled, "Carbon Storage Systems and Well Management Activities." The BPM covers the planning, permitting, design, drilling, implementation, and decommissioning of CO₂ storage wells. The BPM is available at: http://www.netl.doe.gov/technologies/carbon_seq/refshelf/BPM-Carbon-Storage-Systems-and-Well-Mgt.pdf.

SCIENCE

***NYDailyNews*, "Nepal Snow Leopard Threatened by Climate Change."**

According to scientists from the World Wildlife Fund, the habitat of Nepal's snow leopards is under threat due to potential climate change. By using computer climate models and on-the-ground tracking of snow leopards' movements, the scientists discovered that the changing weather patterns are pushing forests further into the leopard's territory, which could potentially reduce their hunting grounds by approximately 40 percent by the end of the century. The species live in high alpine areas (above the tree line, but generally below 16,500 feet) where they are able to track their prey. Experts believe that as few as 500 adults currently inhabit Nepal's Himalayas. Under a "worst-case" scenario, scientists also predicted the leopards' 7,700 square-mile territory would be reduced to 4,500 square-miles by the end of the century. July 17, 2012, <http://india.nydailynews.com/newsarticle/50057c86c3d4cacd3500002/nepal-snow-leopard-threatened-by-climate-change>.

***ScienceDaily*, "Humpback Whales Staying in Antarctic Bays Later Into Autumn."**

A new study conducted by Duke University researchers has found that a large number of humpback whales are remaining in bays along the Western Antarctic Peninsula long after their annual migrations to distant breeding grounds were believed to begin. According to the study, the humpback whales are staying in the Antarctic bays to feast on shrimp-like krill late into the austral autumn due to the increasingly delayed arrival and reduced extent of annual winter sea ice cover, believed to be a result of potential climate change. Published in the journal "Endangered Species Research," the study provides the first density estimates for humpback whales in both open and enclosed habitats along the peninsula in late autumn. The highest densities of whales were found in narrow, enclosed sections of Wilhelmina Bay, Andvord Bay, and the Errera Channel. The lowest densities (as low as .02 whales per square kilometer) were found in the open water of the adjacent Gerlache Strait. July 30, 2012, <http://www.sciencedaily.com/releases/2012/07/120730155059.htm>.

POLICY

Carbon Capture Journal, “CCS Roadmap for Romania Launched.”

According to a report by the environmental non-governmental organization (NGO) Bellona Foundation, Romania has the potential to become CO₂ negative by generating CO₂ neutral electricity from biomass and absorbing already emitted CO₂ from the atmosphere. The report, titled “Our future is carbon negative – A CCS Roadmap for Romania,” models the Romanian electricity system until 2050 by considering current energy plans, with more or less CCS added. In addition, the report presents recommendations for policymakers and investors. To download the report, go to: <http://bellona.org/ccs/ccs-news-events/publications/article/our-future-is-carbon-negative-a-ccs-roadmap-for-romania.html>. June 26, 2012, <http://www.carboncapturejournal.com/displaynews.php?NewsID=965&PHPSESSID=9ajj2n8hhu0brc2eckfo8eojul>.

“A literature review of economic studies on carbon pricing and Australian wholesale electricity markets.”

The following is the Abstract of this article: “With the ongoing development of Australian anthropogenic climate change mitigation policies, there has been a steady increase in modeling studies undertaken to estimate Australian carbon prices and their impact on existing electricity markets. This article summarizes some of the more prominent studies completed by many of Australia’s foremost economic modeling firms. [The authors] developed a simple approach for testing the consistency of these studies and their findings in relation to carbon pass-through. Unfortunately, [the authors] have established that the studies are entirely inconsistent in their estimation of carbon pass-through. Furthermore, [the authors] were unable to establish why the estimation of carbon pass-through varies so significantly. This has important implications for policy makers given much of the compensation to be paid to households and businesses under the Clean Energy Future package is predicated on simple assumptions of carbon pass-through. Based upon [the authors’] analysis of these economic studies, [the authors’] conclusion is that Australian policy makers are best guided by relying upon the numerous a posteriori estimations of pass-through in the European Union Emissions Trading Scheme (ETS) rather than Australian a priori studies.” **Tim Nelson, Simon Kelley, and Fiona Orton**, *Energy Policy*, Available online July 11, 2012, doi:10.1016/j.enpol.2012.05.075, <http://www.sciencedirect.com/science/article/pii/S0301421512004880>. (Subscription may be required.)

“Informed public opinion in the Netherlands: Evaluation of CO₂ capture and storage technologies in comparison with other CO₂ mitigation options.”

The following is the Abstract of this article: “In this study, 995 respondents in a representative sample of the Dutch general population are set in the situation of policymakers: they are faced with the issue of fulfilling the Dutch demand for energy in 2030 in such a way that emissions of [CO₂] will be reduced by 50 [percent]. In the Information-Choice Questionnaire (ICQ) that was developed for this, respondents evaluated information from experts on seven options for CO₂ emission reduction and their consequences. Two CCS options were compared to two energy efficiency options, a wind energy option, a biomass

energy option, and a nuclear energy option. Results show that people are not that enthusiastic regarding the two CCS options. These are evaluated 5.3 and 5.9 on average on a scale of 1–10 and not often chosen as one of the three preferred options, but they are also rarely rejected. Most of the other options in the questionnaire were evaluated rather positively, except nuclear energy and the more ambitious efficiency option. Analysis shows that the evaluation of the information regarding consequences moderately influences how options are evaluated overall. The results further indicate that the CCS options are evaluated less positively due to the comparison with other options.” **Marjolein de Best-Waldhober, Dancker Daamen, Andrea Ramirez Ramirez, André Faaij, Chris Hendriks, and Erika de Visser**, *International Journal of Greenhouse Gas Control*, Available online July 9, 2012, doi:10.1016/j.ijggc.2012.05.023, <http://www.sciencedirect.com/science/article/pii/S1750583612001260>. (Subscription may be required.)

GEOLOGY

“Hydrogeochemical numerical simulation of impacts of mineralogical compositions and convective fluid flow on trapping mechanisms and efficiency of carbon dioxide injected into deep saline sandstone aquifers.”

The following is the Abstract of this article: “A series of numerical simulations, which consider density-dependent (convective) groundwater and CO₂ flow, is performed using a multiphase hydrogeochemical reactive transport numerical model to evaluate impacts of mineralogical compositions on the trapping mechanisms and efficiency of CO₂ injected into a deep saline sandstone [formation] (reservoir rock). The results of the numerical simulations show that the mineralogical compositions of the sandstone [formation] have significant impacts on hydrogeochemical behavior of injected CO₂ and thus its trapping mechanisms and efficiency. Injected CO₂ is accumulated as a free fluid phase beneath the caprock (i.e., hydrodynamic trapping), then dissolved as aqueous phases such as bicarbonate and carbonate anions into groundwater (i.e., solubility trapping), and finally precipitated as carbonate minerals (i.e., mineral trapping). Mineral trapping of injected CO₂ takes place as precipitation of a primary carbonate mineral such as calcite and secondary carbonate minerals such as dawsonite, siderite, ankerite, and magnesite. The patterns of hydrogeochemical reactions depend significantly on the initial presence and absence of chlorite in the sandstone [formation]. For mineral trapping of injected CO₂, ankerite is the most dominant mineral when chlorite is initially present, whereas dawsonite is the most dominant mineral when chlorite is initially absent in the sandstone aquifer. Mg²⁺ and Fe²⁺, which are essential chemical components of such secondary carbonate minerals (i.e., siderite, ankerite, and magnesite) for mineral trapping of injected CO₂, are mainly supplied by dissolution of chlorite. As a result, the precipitation amounts of the secondary carbonate minerals and thus the efficiency of mineral trapping of injected CO₂ increase significantly as the volume fraction of chlorite increases in the sandstone [formation]. A series of additional numerical simulations, which consider density-independent (non-convective) multiphase fluid flow, is also performed using the same numerical model, and then its results are compared with those of the above-mentioned numerical simulations, which consider density-dependent (convective) multiphase fluid flow, to evaluate impacts of convective fluid flow on the trapping mechanisms and efficiency of injected

GEOLOGY (CONTINUED)

fluid flow on the trapping mechanisms and efficiency of injected CO₂. The comparison of the results of both numerical simulations shows that convective fluid flow also has significant impacts on hydrogeochemical behavior of injected CO₂ and thus its trapping mechanisms and efficiency. Convective fluid flow reduces the free fluid phase of CO₂ (i.e., hydrodynamic trapping) and thus enhances the aqueous and solid phases of CO₂ (i.e., initially solubility trapping and then mineral trapping).” **Jung-Hwi Kihm, Jun-Mo Kim, Sookyun Wang, and Tianfu Xu**, *Journal of Geophysical Research*, Available online June 12, 2012, doi:10.1029/2011JB008906, <http://www.agu.org/pubs/crossref/2012/2011JB008906.shtml>. (Subscription may be required.)

“Hydro-mechanical analysis of CO₂ storage in porous rocks using a critical state model.”

The following is the Abstract of this article: “A numerical model is presented to simulate the hydro-mechanical [behavior] of the porous rocks that form the deep saline [formations] which are currently being considered as potential CO₂ storage reservoirs. The model has taken into account the equations of state regulating the [behavior] of CO₂, in both the supercritical state in which will be injected, and under atmospheric conditions. Whilst the flow model is founded on a ‘conventional’ advective/diffusive formulation, the geomechanical constitutive model used is a critical state model that includes a non-linear hypoelastic law, and a brittle/ductile yield which takes into account mechanical degradation and the effect of partial saturation caused by the CO₂ flow. With this model, it will be possible to analyze the [localization] of the deformation which may occur when a dilatant brittle yield is reached, and thus to analyze the role played by the preferential flow paths associated with this localization. A partial differential equation solver based on the finite element method, which adopts a multiphysics simulation environment, has been used. After some examples of validation, the simulation of a synthetic example that highlights the capacities of the model is presented.” **J. Alonso, V. Navarro, B. Calvo, and L. Asensio**, *International Journal of Rock Mechanics and Mining Sciences*, Available online June 7, 2012, doi:10.1016/j.ijrmmms.2012.05.016, <http://www.sciencedirect.com/science/article/pii/S1365160912000962>. (Subscription may be required.)

TECHNOLOGY

“Energy consumption reduction in CO₂ capturing and [storage] of an LNG plant through process integration and waste heat utilization.”

The following is the Abstract of this article: “Liquefied natural gas (LNG) plants are energy intensive. As a result, the power plants operating these LNG plants emit high amounts of CO₂. To mitigate global warming that is caused by the increase in atmospheric CO₂, CCS using amine absorption is proposed. However, the major challenge of implementing this CCS system is the associated power requirement, increasing energy consumption by about 15–20 [percent]. In order to reduce such energy consumption, innovative process integration and waste heat utilization is proposed. Four waste heat

sources and six potential uses were uncovered. A new integrated CCS configuration is proposed, which integrates the APCI LNG plant and the driver cycle with the CCS plant. HYSYS simulation software was used to simulate the CO₂ capture cycle using monoethanolamine solvent, natural gas combined cycles, CO₂ compression cycle and CO₂ liquefaction cycles. The developed models were validated against experimental data from the literature with good agreement. Net available power enhancement in one of the proposed CCS configuration is 26.3 MW, which is 16.31 [percent] more than the conventional CCS configuration. Pinch analysis method was used to compare the utility cooling and utility heating of the proposed and conventional CCS configurations. The result of the pinch analysis shows that the proposed CCS configuration requires 23.86 [percent] less utility cooling than the conventional CCS configuration.” **Abdullah Alabdulkarem, Yunho Hwang, and Reinhard Radermacher**, *International Journal of Greenhouse Gas Control*, Available online July 17, 2012, doi:10.1016/j.ijggc.2012.06.006, <http://www.sciencedirect.com/science/article/pii/S1750583612001326> (Subscription may be required.)

“Imaging Wellbore Cement Degradation by Carbon Dioxide under Geologic Sequestration Conditions Using X-ray Computed Microtomography.”

The following is the Abstract of this article: “X-ray microtomography (XMT), a nondestructive three-dimensional imaging technique, was applied to demonstrate its capability to visualize the mineralogical alteration and microstructure changes in hydrated Portland cement exposed to [CO₂] under geologic [storage] conditions. Steel coupons and basalt fragments were added to the cement paste in order to simulate cement-steel and cement-rock interfaces. XMT image analysis showed the changes of material density and porosity in the degradation front (density: 1.98 g/cm³, porosity: 40 [percent]) and the carbonated zone (density: 2.27 g/cm³, porosity: 23 [percent]) after reaction with CO₂-saturated water for [five] months compared to unaltered cement (density: 2.15 g/cm³, porosity: 30 [percent]). Three-dimensional XMT imaging was capable of displaying spatially heterogeneous alteration in cement pores, calcium carbonate precipitation in cement cracks, and preferential cement alteration along the cement-steel and cement-rock interfaces. This result also indicates that the interface between cement and host rock or steel casing is likely more vulnerable to a CO₂ attack than the cement matrix in a wellbore environment. It is shown here that XMT imaging can potentially provide a new insight into the physical and chemical degradation of wellbore cement by CO₂ [release].” **Hun Bok Jung, Danielle Jansik, and Wooyong Um**, *Environ. Sci. Technol.*, Available online July 23, 2012, doi:10.1021/es3012707, <http://pubs.acs.org/doi/abs/10.1021/es3012707>. (Subscription required.)

“MCFC-based CO₂ capture system for small scale CHP plants.”

The following is the Abstract of this article: “Carbon dioxide emissions into the atmosphere are considered among the main reasons of the greenhouse effect. The largest share of CO₂ is emitted by power plants using fossil fuels. Nowadays there are several technologies to capture CO₂ from power plants’ exhaust gas but each of them consumes a significant part of the electric power generated by the plant. The Molten Carbonate Fuel Cell (MCFC) can be used as concentrator of CO₂, due to the chemical reactions that occurs in the cell stack: [CO₂] entering into the cathode side is transported to the anode side via CO₃⁼ ions and is finally

TECHNOLOGY (CONTINUED)

concentrated in the anodic exhaust. MCFC systems can be integrated in existing power plants (retro fitting) to separate CO₂ in the exhaust gas and, at the same time, produce additional energy. The aim of this study is to find a feasible system design for medium scale cogeneration plants which are not considered economically and technically interesting for existing technologies for carbon capture, but are increasing in numbers with respect to large size power plants. This trend, if confirmed, will increase number of medium cogeneration plants with consequent benefit for both MCFC market for this application and effect on global CO₂ emissions. System concept has been developed in a numerical model, using AspenTech engineering software. The model simulates a plant, which separates CO₂ from a cogeneration plant exhaust gases and produces electric power. Data showing the effect of CO₂ on cell voltage and cogenerator exhaust gas composition were taken from experimental activities in the fuel cell laboratory of the University of Perugia, FCLab, and from existing CHP plants. The innovative aspect of this model is the introduction of recirculation to optimize the performance of the MCFC.” **Umberto Desideri, Stefania Proietti, Paolo Sdringola, Giovanni Cinti, Filippo Curbis**, *International Journal of Hydrogen Energy*, Available online July 28, 2012, doi:10.1016/j.ijhydene.2012.05.048, <http://www.sciencedirect.com/science/article/pii/S0360319912011913>. (Subscription may be required.)



TERRESTRIAL

“A sustainable agricultural landscape for Australia: A review of interlacing carbon sequestration, biodiversity and salinity management in agroforestry systems.”

The following is the Abstract of this article: “Transformation of the southwestern Australian landscape from deep-rooted woody vegetation systems to shallow-rooted annual cropping systems has resulted in the severe loss of biodiversity and this loss has been exacerbated by rising ground waters that have mobilized stored salts causing extensive dry land salinity. Since the original plant communities were mostly perennial and deep rooted, the model for sustainable agriculture and landscape water management invariably includes deep rooted trees. Commercial forestry is however only economical in higher rainfall (>700 mm yr⁻¹) areas whereas much of the area where biodiversity is threatened has lower rainfall (300–700 mm yr⁻¹). Agroforestry may provide the opportunity to develop new agricultural landscapes that interlace ecosystem services such as carbon mitigation via carbon [storage] and biofuels, biodiversity restoration, watershed management while maintaining food production. Active markets are developing for some of these ecosystem services, however a lack of predictive metrics and the regulatory environment are impeding the adoption of several ecosystem services. Nonetheless, a clear opportunity exists for four major issues – the maintenance of food and fiber production, salinization, biodiversity decline and climate change mitigation

– to be managed at a meaningful scale and a new, sustainable agricultural landscape to be developed.” **S.J. George, R.J. Harper, R.J. Hobbs, and M. Tibbett**, *Agricultural, Ecosystems & Environment*, Available online July 31, 2012, doi:10.1016/j.agee.2012.06.022, <http://www.sciencedirect.com/science/article/pii/S0167880912002496>. (Subscription may be required.)

TRADING

“Pricing emission permits in the absence of abatement.”

The following is the Abstract of this article: “If emissions are stochastic and firms are unable to control them through abatement, the cap in a permit market may be exceeded, or not be reached. [The author derived] a binary options pricing formula that expresses the permit price as a function of the penalty for noncompliance and the probability of an exceeded cap under the assumption of no abatement. [The author applied a] model to the EU ETS, where the rapid introduction of the market made it difficult for firms to adjust their production technology in time for the first phase. The model fits the data well, implying that the permit price may have been driven by firms hedging against stochastic emissions.” **Beat Hintermann**, *Energy Economics*, Available online June 7, 2012, doi:10.1016/j.eneco.2012.06.005, <http://www.sciencedirect.com/science/article/pii/S0140988312001119>. (Subscription may be required.)

“Tradable credits system design and cost savings for a national low carbon fuel standard for road transport.”

The following is the Abstract of this article: “This research examines the economic implications of different designs for a national low carbon fuel standard (NLCFS) for the road transportation sector. A NLCFS based on the average Carbon Intensity (CI) of all fuels sold generates an incentive for fuel suppliers to reduce the measured CI of their fuels. The economic impacts are determined by the availability of low carbon fuels, estimates of which can vary widely. Also important are the compliance path, reference level CI, and the design of the credit system, particularly the opportunities for trading and banking. To quantitatively examine the implications of a NLCFS, [the authors] created the Transportation Regulation and Credit Trading (TRACT) Model. With TRACT, [the authors] model a NLCFS credit trading system among profit maximizing fuel suppliers for light- and heavy-duty vehicle fuel use for the United States from 2012 to 2030. [The authors] find that credit trading across gasoline and diesel fuel markets can lower the average costs of carbon reductions by an insignificant amount to 98 [percent] depending on forecasts of biofuel supplies and carbon intensities. Adding banking of credits on top of trading can further lower the average cost of carbon reductions by [five to nine percent] and greatly reduce year-to-year fluctuations in credit prices.” **Jonathan Rubin and Paul N. Leiby**, *Energy Policy*, Available online June 11, 2012, doi:10.1016/j.enpol.2012.05.031, <http://www.sciencedirect.com/science/article/pii/S0301421512004430>. (Subscription may be required.)

TRADING (CONTINUED)

“Evaluating the application of different pricing regimes and low carbon investments in the European electricity market.”

The following is the Abstract of this article: “The EU-ETS is the first measure initiated by the EU to contribute to the decarbonization of the European energy sector. It is a cap and trade system that requires industries participating to the program to procure allowances to cover their emissions. Electricity Intensive Industries (EIIs) have complained that the system put their European

plants at disadvantage compared to facilities located outside the EU. They have asked for actions to mitigate this effect; one of them is to have access to long term contracts with electricity suppliers, ideally with those operating carbon free plants. This paper presents and illustrates a method for assessing the impact of this measure on EIIs participating to the EU cap and trade system. [The authors] model a power market segmented in two consumer groups EIIs and the rest of the market (N-EIIs).” **Giorgia Oggioni and Yves Smeers**, *Energy Economics*, Available online June 7, 2012, doi.org/10.1016/j.eneco.2012.06.012, <http://www.sciencedirect.com/science/article/pii/S0140988312001181>. (Subscription may be required.)

RECENT PUBLICATIONS

“Carbon Capture and Storage Legal and Regulatory Review – Edition 3.”

The following is from this document: “The International Energy Agency (IEA) considers CCS a crucial part of worldwide efforts to limit global warming by reducing GHG emissions. The IEA estimates that emissions can be reduced to a level consistent with a 2°C global temperature increase through the broad deployment of low-carbon energy technologies – and that CCS would contribute about one-fifth of emission reductions in this scenario. Reaching that goal, however, requires that approximately 100 CCS projects be implemented by 2020 and over 3,000 by 2050. Achieving such rapid expansion requires that regulatory frameworks, or a lack thereof, do not unnecessarily impede environmentally safe demonstration and deployment of CCS, so in 2008 the IEA established the IEA International CCS Regulatory Network (Network) as a forum for sharing knowledge amongst regulators and policy makers. This publication, the IEA *Carbon Capture and Storage Legal and Regulatory Review (CCS Review)*, was launched in October 2010 in response to a suggestion made at the Network’s second meeting that the IEA produce a regular review of CCS regulatory progress worldwide. The *CCS Review* aims to help countries develop their own regulatory frameworks by documenting and analyzing recent CCS legal and regulatory developments. It also identifies steps taken towards the legal and regulatory goals in the 2009 IEA *Technology Roadmap: Carbon capture and storage*. The *CCS Review* is produced approximately every 12 months, to provide an up-to-date snapshot of CCS regulatory developments in contributing jurisdictions.” The full IEA publication is available at: http://www.iea.org/publications/freepublications/publication/CCS_Review_3rd%20edition_FINAL.pdf.

“Carbon Storage Systems and Well Management Activities.”

The following is from the Executive Summary of this document: “The purpose of this report is to share lessons learned regarding site-specific management activities for carbon storage well systems. This manual builds on the experiences of the Regional Carbon Sequestration Partnerships and acquired knowledge from the petroleum industry and other private industries that have been actively drilling wells for more than 100 years. Specifically, this manual focuses on management activities related to the planning, permitting, design, drilling, implementation, and decommissioning of wells for geologic storage projects. A key lesson and common theme reiterated throughout the seven DOE [BPMs] is that each project site is unique. This means that each CCS project needs to be designed to address specific site characteristics, and should involve an integrated team of experts from multiple technical (e.g., scientific and engineering) and nontechnical (e.g., legal, economic, communications) disciplines. Additionally, works during the characterization, siting, and implementation phases of projects are iterative; the results from previously completed tasks are analyzed and used to make decisions going forward. This means that as data comes in, the conceptual model of the site is revised and updated to allow better future decisions.” The complete NETL BPM is available for download at: http://www.netl.doe.gov/technologies/carbon_seq/refshelf/BPM-Carbon-Storage-Systems-and-Well-Mgt.pdf.

“Global Status of Large-Scale Integrated CCS Projects: June 2012 Update.”

The following is the Introduction of this document: “The Global CCS Institute tracks the global status of large-scale integrated CCS projects (LSIPs), through a regular review of news reports and updates from Institute representatives around the world. The public data set on LSIPs, maintained by the Institute, is amended on a weekly basis to reflect changes to the status and details of projects. The Institute is currently [finalizing] its 2012 Annual Survey of LSIPs... The purpose of this paper is to [summarize] the present status of LSIPs and provide information on changes that have occurred since the publication of the Institute’s *December 2011 Update*. Additional charts are provided in Appendix 1, and all changes made to the Institute’s LSIP listing since the release of the *Global Status of CCS: 2011* report in October 2011 are listed in Appendix 2.” The complete document is available for download at: <http://cdn.globalccsinstitute.com/sites/default/files/publications/41146/globalstatusoflargescaleintegratedprojectsjune2012update.pdf>.

“Our future is carbon negative: A CCS roadmap for Romania.”

The following is from the Executive Summary of this document: “Implementing a cost effective and reliable energy system has many

RECENT PUBLICATIONS (CONTINUED)

challenges, including energy security, technology choice, utilization of indigenous resources and transnational cooperation. The added requirement of meeting the ever-tightening CO₂ emissions of the European Trading Scheme (ETS) adds to these challenges. Policy choices taken today will affect the development of the wider economy for at least a generation. This report assesses these interlinking factors, and provides stakeholders with an insight into future possible liabilities, opportunities, costs and risks. The document proposes specific recommendations on how to limit such risks and secure a cost-effective energy supply for the future. The report also assesses the impact of climate change legislation on major Romanian industries, cataloguing emissions, CCS applicability and actions necessary.” The full report is available for download at: <http://cdn.globalccsinstitute.com/sites/default/files/publications/41086/fil-romania-final2-opt.pdf>.

“Valuation of Potential Risks Arising from a Model, Commercial-Scale CCS Project Site.”

The following is the Abstract of this document: “A diverse group of organizations from industry, government, and the environmental community jointly sponsored Industrial Economics (IEc), an expert in environmental economics and natural resource damage assessment, to develop and test a model approach for valuing the economic damages arising from a well-sited and well-managed CCS project. These damages included environmental and human health impacts arising from a range of potential events such as pipeline ruptures and subsurface [release]. They do not address potential impacts from facility construction or routine operation, nor do they address potential impacts to workers, business interruption, facility repair or similar ‘private’ costs internal to the operator. The model was successfully developed and applied to a ‘realistic’ project based on the publicly available risk assessment for a site from the FutureGen 1.0 site selection process. The project was planned to inject 50 million metric tons of CO₂ over 50 years and to have a 50 year post-injection period (for a 100-year analysis period). This site-specific application of the model showed that the ‘most likely’ (50th percentile) estimated damages arising from CO₂ totaled approximately \$7.3 million and ‘upper end’ (95th percentile) estimated damages totaled approximately \$16.9 million. On a per metric ton basis, these results translate into ‘most likely’ (50th percentile) estimated damages of \$0.15 per metric ton and ‘upper end’ (95th percentile) estimated damages of \$0.34 per metric ton. When combined, the estimated damages for CO₂ and hydrogen sulfide (H₂S) were roughly 10-15 [percent] higher. It is important to note that the range of damage estimates is highly sensitive to site-specific data. The sponsor group concludes that the tools exist to estimate prospective financial damages. Further, the sponsor group has developed insight into the magnitude and timing of dollar amounts that are likely to be at risk and the conditions under which they may be at risk at a well-selected and well-managed CCS project. This analytic approach is based on generally accepted practices within the financial and insurance industries, and can be applied, with adjustment for location, to CCS projects around the world.” To download the full report, go to: <http://cdn.globalccsinstitute.com/sites/default/files/publications/40831/iec2012valuationofpotentialrisks.pdf>.

“Project Pioneer: Transporting CO₂: A non-confidential report.”

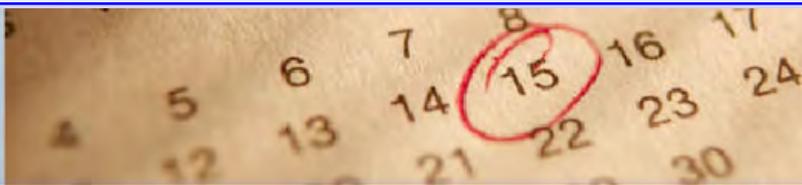
The following is from the Introduction to the project: “Project Pioneer would have been one of the first CCS projects to utilize an integrated approach for CCS, and was expected to serve as a prototype for the long-term, commercial-scale application and integration of CCS technologies to achieve reductions in [GHG] emissions. The partners in Project Pioneer were TransAlta Corporation (TransAlta), Capital Power L.P. (CPLP), Enbridge Inc. (Enbridge), the Alberta provincial and Canadian federal governments, and the Global CCS Institute as a Knowledge Sharing Partner. Project Pioneer was proposed to capture 1 million metric tons of CO₂ annually from a coal fired power plant and transport the CO₂ by pipeline to a [storage] site or to be utilized for EOR in a depleted oil/gas field. The key components of Project Pioneer were: carbon capture facility (CCF), pipeline from the CCF to the [storage] site, pipeline from the CCF to the EOR site, [and] saline formation [storage] site.” The full document is available at: <http://cdn.globalccsinstitute.com/sites/default/files/publications/40766/nonconfidentialreporttransportingco22012-opt.pdf>.

LEGISLATIVE ACTIVITY

Congressman Jim McDermott News Release, “McDermott Bill: Addresses Climate Change, Protects Consumers and Reduces Deficit.”

Congressman Jim McDermott has introduced a bill proposing an approach to reduce carbon emissions, titled, “The Managed Carbon Price Act of 2012” (MCP). The bill is an updated version of legislation introduced in 2009 that incorporates suggestions from the energy industry, environmental advocates, policy experts, and economists. MCP would create a market incentive to reduce carbon emissions by placing a price on emissions that would increase over time. Proceeds from MCP would go into a newly created Energy and

Economic Security Trust Fund, with 25 percent of the revenue going towards deficit reduction and 75 percent going back to the public to offset any price increases. According to a recent report from the Brookings Institution, if the starting price were set at \$15 per ton, MCP would raise an estimated \$80 billion, rising to \$170 billion in 2030 and \$310 billion by 2050. Within 42 years of enactment, MCP would reduce CO₂ emissions by 80 percent of 2005 levels. To view the MCP fact sheet, click: <http://mcdermott.house.gov/images/pdf/MCP%20-%20Fact%20Sheet%20final.pdf>. The bill is available at: <http://mcdermott.house.gov/images/pdf/MPC%20-%20Section-by-Section%20Final.pdf>. August 2, 2012, http://mcdermott.house.gov/index.php?option=com_content&view=article&id=624:mcdermott-bill-addresses-climate-change-protects-consumers-a-reduces-deficit&catid=25:press-releases&Itemid=20.



EVENTS

September 4-6, 2012, **Carbon Capture & Storage: A Field-Based Masterclass**, *Springfield County Hotel, Stoborough, Wareham, Dorset, UK*. This three-day course follows the path of CO₂ from extraction from ancient rocks in the subsurface, through its use, to the capture and safe storage back into the rocks. The training experience will combine classroom sessions, case studies, and field visits. For more information, download the course flyer at: http://www.cestlm.com/content_189_.

September 14-15, 2012, **International Conference on Biodiversity & Sustainable Energy Development**, *Hyderabad International Convention Center, Hyderabad, India*. This conference brings together researchers from academia and corporate, activists, ecosocial organizations, and NGOs to discuss, among other topics, biodiversity, energy systems, and environmental sustainability; governance and sustainable development; and biodiversity in Earth science and potential climate change. For more information, click: <http://www.omicsonline.org/biodiversity2012/>.

October 15-18, 2012, **29th Annual Pittsburgh Coal Conference**, *David L. Lawrence Convention Center, Pittsburgh, Pennsylvania, USA*. This conference will focus on environmental emissions issues and technologies surrounding the continued use of coal, as well as the development of future coal-based energy plants. Among the topics to be discussed in the sessions are combustion, gasification, sustainability, carbon management, coal-derived products, coal science, clean coal demonstration and commercial projects, and coal mining and coal gas. For more information, visit the conference website at: http://www.engineering.pitt.edu/Coal_Conference/2012_Conference.aspx.

October 17-18, 2012, **ImechE Carbon Capture and Storage – Ready, Steady, Go!**, *Institution of Mechanical Engineers, London, UK*. The Institution of Mechanical Engineers' (ImechE) 6th international conference aims to prepare companies for commercial-scale CCS technologies by covering, among other topics, the latest in European Union (EU) and UK government CCS decisions, funding for CCS research and project development, CCS business development and investment opportunities, and legal and regulatory issues surrounding the development market. To download the brochure, visit the seminar's website at: <http://events.imeche.org/EventView.aspx?EventID=1442>.

October 21-23, 2012, **National CCS Conference**, *Burswood Entertainment Complex, Perth, Australia*. The theme of this conference, which is the major event of National CCS Week (an Australian-based event focusing on CCS as an essential part of the global GHG mitigation portfolio), is "Advancing CCS: Progress and Achievements." The aim of the conference will be to facilitate knowledge sharing and networking opportunities between CCS stakeholders and to raise awareness of CCS among the community. To learn more about the conference and Australia's National CCS Week, visit: <http://www.nationalccs.com.au/information/?IntCatId=43>.

November 5-6, 2012, **1st International Conference on Urban Sustainability and Resilience**, *University College London, London, UK*. Experts from engineering, science, and social science disciplines will come together at this international conference to discuss the current state of knowledge in the field of urban sustainability and resilience. Among the central themes of the conference will be the development of a low-carbon urban environment. To learn more, go to: <http://www.usar-conference-2012.org/>.

November 5-9, 2012, **CLIMATE 2012**. This online climate conference will focus on the latest scientific findings on the social, economic, and political aspects of potential climate change. New projects and innovative initiatives in both industrialized and developing countries by universities, scientific institutions, government bodies, NGOs, and other stakeholders will be covered. For more information, visit the conference website at: <http://www.climate2012.de/>.

November 18-22, 2012, **International Conference on Greenhouse Gas Technologies 11 (GHGT-11)**, *Kyoto International Conference Center, Japan*. This will be the second visit to Kyoto by the GHGT conference series, with more than 1,600 delegates expected to attend. The call for papers has expired. Visit: <http://www.ghgt.info/index.php/Content-GHGT11/ghgt-11-overview.html> for more details. Registration is available at: <http://www.ghgt.info/index.php/Content-GHGT11/ghgt-11-conference-registration.html>.

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Please visit <http://listserv.netl.doe.gov/mailman/listinfo/sequestration>, enter your email address, and create a password. This will enable you to receive a pdf version of the Carbon Sequestration Newsletter at no cost.

To view an archive with past issues of the newsletter, see: http://www.netl.doe.gov/technologies/carbon_seq/refshelf/subscribe.html.

To learn more about DOE's Carbon Sequestration Program, please contact John Litynski at john.litynski@netl.doe.gov, or Dawn Deel at dawn.deel@netl.doe.gov.