NETL the ENERGY lab

Carbon Sequestration Newsletter

A Call for Papers

see page 3

October 2011

What's Inside?

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

***CSLF News Release*, "World-Class Carbon Capture and Storage Projects Honored by International Body."**

The Carbon Sequestration Leadership Forum (CSLF) selected three projects pioneering carbon capture and storage (CCS) technologies at a large commercial scale to receive its Global Achievement Award. Each of the three projects reached milestones with sustained operation demonstrating capture, injection, and storage of several million tonnes of carbon dioxide (CO_2). The three recipients of the award are: the In Salah CO_2 Storage Project in Algeria; the Sleipner CO_2 Project in the North Sea; and the Weyburn-Midale CO_2 Project in Canada. In addition to providing scientific research opportunities, the projects are also being recognized as exemplary global models for their willingness to share their experiences in implementing CCS technologies. The CSLF is a ministerial-level international climate change initiative marshalling worldwide resources to develop improved, cost-effective technologies for the separation, capture, transport, and long-term storage of CO_2 from power plants and industrial facilities. It is comprised of 25 nations that account for approximately 60 percent of the world's population, 76 percent of the world's anthropogenic CO_2 emissions, 75 percent of the world's energy consumption, and 70 percent of the world's energy production. To learn more about CSLF, visit: www.cslforum.org. September 21, 2011, http://www.cslforum.org/pressroom/publications/beijing_cslf_awards.pdf.

***CSLF News Release*, "Energy Ministers Endorse CCUS as Key to Combating Climate Change."**

In an official announcement made by member country ministers and heads of delegation, the CSLF endorsed carbon capture, utilization, and storage (CCUS) technologies as a significant component of international plans to combat climate change. The CSLF member nations affirmed CCUS as an important element of any effective response to climate change and suggested an increase in the number of worldwide demonstrations in order to enable commercial deployment of CCUS by the end of the decade. CCUS, a group of technologies for capturing CO_2 emissions from power plants or industrial facilities for enhanced oil and gas recovery (EOR/EGR) and safe and permanent underground storage, is believed to be an essential part of effective management and reduction of CO_2 emissions. September 22, 2011, http://www.cslforum.org/pressroom/publications/beijing_communique_92211.pdf.

Sequestration in the News

***Fossil Energy Techline*, "Innovative Texas Clean Coal Project Takes Major Step Forward as DOE Issues Record of Decision."**

A DOE-issued Record of Decision (ROD), along with a cooperative agreement between DOE's Office of Fossil Energy (FE) and Summit Texas Clean Energy, LLC (STCE), states that Federal funding will be used to help build the Texas Clean Energy Project west of Midland-Odessa, Texas.

National Energy
Technology Laboratory

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

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

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

1450 Queen Avenue SW
Albany, OR 97321-2198

2175 University Ave. South, Suite 201
Fairbanks, AK 99709

John T. Litynski
412-386-4922
john.litynski@netl.doe.gov

Dawn M. Deel
304-285-4133
dawn.deel@netl.doe.gov

Visit the NETL website at:
www.netl.doe.gov

Customer Service:
1-800-553-7681

Sequestration in the News (Continued)

The 400-megawatt (MW), environmentally clean, coal-based power plant will combine integrated gasification combined cycle (IGCC) power generation, urea production, and CCUS technology. The National Energy Technology Laboratory (NETL)-managed project will be partially funded with $450 million from DOE's Clean Coal Power Initiative (CCPI), with $211 million coming from the American Recovery and Reinvestment Act (ARRA) funds for CCPI. Approximately 90 percent of the CO_2 will be captured from the plant's syngas (about 3 million tons per year); while a portion of the captured CO_2 will be used to produce urea for fertilizer, the majority will be transported to the oilfields of the west Texas Permian Basin via existing regional pipelines and used for EOR operations.
The project is expected to create approximately 1,000 jobs during construction and 300 during operations. To read DOE's ROD, click: http://www.netl.doe.gov/publications/others/nepa/ROD-EIS-0444.pdf. To learn more about DOE's Clean Coal Technology Program, visit: http://www.fossil.energy.gov/programs/powersystems/cleancoal/index.html. September 27, 2011, http://www.fossil.energy.gov/news/techlines/2011/11053-Texas_Clean_Coal_Project_Moves_For.html.

***Wyoming Business Report*, "Drilling Complete at CO_2 Storage Study Site."**

The University of Wyoming Carbon Management Institute (CMI) and its industry partner Baker Hughes have completed drilling and collecting data at a 12,810-foot-deep stratigraphic test well in southwestern Wyoming. The data collected from the $16.9-million Wyoming Carbon Underground Storage Project (WY-CUSP) will be used to aid researchers in evaluating the Rock Springs Uplift as a potential geologic CO_2 storage site. WY-CUSP researchers will perform additional analyses on the 912 feet of core recovered from the well, focusing on any fractures in the rock formations. In addition, researchers will also study a comprehensive wire line log suite from the test well, which will provide information about the characteristics of the storage and sealing formations at the site; analyze fluid samples collected from the potential CO_2 storage reservoirs for trace elements, alkalinity, hardness, and other parameters; and study the results of testing of the storage reservoirs and primary sealing formation, which will allow CMI to evaluate the strength of the rock layers comprising the various formations. The project, which began in December 2009 and is scheduled for completion in December 2012, is expected to produce a detailed characterization of two saline formations in the Rock Springs Uplift for potential pilot- and commercial-scale CO_2 storage. Preliminary data indicates that the Rock Springs Uplift could store approximately 26 billion tons of CO_2 over 50 years. September 20, 2011, http://www.wyomingbusinessreport.com/article.asp?id=59938.

***Bellona*, "Alstom and Datang to Develop Two Carbon Dioxide Capture Projects in China."**

China Datang Corporation and Alstom have signed a Memorandum of Understanding (MOU) for a partnership to jointly develop two CCS demonstration projects in two oilfields. Under the terms of the MOU, a 350-

Sequestration in the News (Continued)

MW coal-fired power plant located in Daqing, Heilongjiang province, will be equipped with Alstom's oxy-firing technology, and a 1,000-MWe coal-fired power plant located in Dongying, Shandong province, will also be equipped with one of Alstom's CO_2 capture technologies. Both projects are expected to be completed and operating by 2015, with each capable of capturing more than 1 million tonnes of CO_2 per year. Due to their close proximity to oilfields, the projects are expected to provide cost-effective CO_2 transport, utilization, and storage, as well as serve as an effective tool for EOR operations. September 26, 2011, http://www.bellona.org/news/news_2011/Alstom_and_Datang_projects.

Announcements

DOE's Carbon Storage Program Infrastructure Annual Review Meeting.

DOE's 2011 Annual Review Meeting, featuring the Regional Carbon Sequestration Partnerships (RCSPs), will be held at the Sheraton Station Square Hotel in Pittsburgh, Pennsylvania, on November 15-17, 2011. This meeting highlights DOE's carbon storage infrastructure projects, which include the efforts of DOE's RCSPs; however, it is now expanding to include other U.S. and international projects that are working to characterize CO_2 storage capacity through exploration and injection operations. An interactive reception and poster sessions will be held to highlight geologic CO_2 storage and characterization work being performed by ARRA-supported Regional Carbon Sequestration Training Centers, DOE's National Laboratories, RCSP subcontractors, and other organizations. For more information, go to: http://www.netl.doe.gov/events/11conferences/Carbon%20storage%20program/index.html.

Call for Papers.

Abstracts are now being accepted for the 11th International Conference on Greenhouse Gas Control Technologies (GHGT-11), to be held November 18-22, 2012, at the Kyoto International Conference Center in Kyoto, Japan. Technical themes include: CO_2 capture technology development, geologic CO_2 storage, CCS for industrial sources, CO_2 transport and infrastructure development, commercial issues, CCS system integration, public perception and acceptance of CCS, energy and climate change policies, legal and regulatory aspects of CCS, and CO_2 storage liability. Abstracts are due no later than Friday, February 20, 2012. For more information, click: http://www.ghgt.info/docs/docs/GHGT-11/GHGT_11_CFP_FINAL_web.pdf.

Natural Gas CCS Forum.

The American Clean Skies Foundation (ACSF) is hosting a one-day public forum, titled, "CCS for Gas – A Bridge and Destination?," on November 4, 2011, at the Hotel Monaco in Washington, D.C. This CCS leadership forum for natural gas-fired power plants provides the opportunity to discuss CCS technology; research, design, and demonstration (RD&D); and policy. Attendees include experts from the electric utility industry, manufacturers, government agencies, and the environmental community. To learn more, visit: http://www.cleanskies.org/ccsforum/.

CCS in the Iron and Steel Industry.

The International Energy Agency Greenhouse Gas R&D Program (IEAGHG) is hosting a workshop, titled, "Challenges and Opportunities of CO_2 Capture and Storage in the Iron and Steel Industry," on November 8-9, 2011, at the Steel Industry VDEh Auditorium in Düsseldorf, Germany. Topics to be discussed include the difficulties of CCS implementation in the iron and steel industry and the various issues and factors in the evaluation of the cost of CO_2 capture in an integrated steel mill. For more information, visit: http://www.ieaghg.org/index.php?/20110609257/ccs-in-the-iron-and-steel-industry.html.

New UK CCS Training Academy Announced.

CCS TLM and The National Center for CCS (NCCCS) have launched an academy offering training courses in CCS. The academy will develop and run a series of short two to three day courses aimed at improving knowledge and understanding of the CCS business. The courses will be aimed at personnel in industry and other stakeholders who may be involved in CCS in the future, or those who need to have a technical overview about CCS but are unable to undertake lengthy periods of training. The first academy is planned for early December 2011. For more information, visit: http://www.ccstlm.com/news.aspx?id=162.

New GHG Measurement Standards Released.

On October 4, 2011, the Greenhouse Gas Protocol (GHG Protocol) launched two new standards that allow businesses to better measure, manage, and report their greenhouse gas emissions. Developed by the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD), the Corporate Value Chain (Scope 3) and Product Life Cycle Standards enable companies to save money, reduce risks, and gain competitive advantage. The standards are available at: http://www.wri.org/publication/greenhouse-gas-protocol-corporate-value-chain-accounting-and-reporting-standard and http://www.wri.org/publication/greenhouse-gas-protocol-product-life-cycle-accounting-and-reporting-standard, respectively.

Science

***USA Today*, "Study: Climate Change to Impact Where Wine Grapes Can Grow."**

According to climate scientists at Stanford University, premium wine growing areas in the United States could shrink within 30 years as a result of potential climate change. The research, published in the journal *Environmental Research Letters*, was based on a 2009 Federal report that found that average U.S. temperatures could increase by two to four degrees by 2020 compared to 1970's averages. Following their 2006 climate study, which projected that as much as 81 percent of premium U.S. wine grape acreage could become unsuitable for some varieties by the end of the century, the researchers found that the amount of land suitable for premium wine cultivation could shrink by 50 percent in high-value areas of Northern California by 2040. In addition, the study found that potential climate change could also lead to cooler areas, such as parts of Oregon and Washington state, seeing an increase in premium grape-growing acreage. To read the Stanford University news release, visit: http://news.stanford.edu/news/2011/june/wines-global-warming-063011.html. October 6, 2011, http://www.usatoday.com/weather/climate/story/2011-10-06/climate-change-could-impact-wine-growing-regions/50682188/1.

***Science Daily*, "Unexpected Effect of Climate Change on Body Size for Many Different Species."**

According to a study conducted by researchers at the National University of Singapore, potential climate change is causing a reduction in size for many different species across the world, which could affect food webs and biodiversity. The study, which was published in the online journal *Nature Climate Change*, found that increasing temperatures have had broad effects on various species, from plants to predators, and that many organisms are already shrinking in size, with more organisms likely to follow. Researchers claim that the reductions in size have varying effects on different species, which could potentially upset ecosystems and food webs, as not all organisms are adapting to their new sizes in the same manner. October 17, 2011, http://www.sciencedaily.com/releases/2011/10/111017092029.htm.

Policy

***Carbon Capture Journal*, "IEA Reports Progress on CCS Regulation."**

The International Energy Agency (IEA) released the second edition of the IEA Carbon Capture and Storage Legal and Regulatory Review, providing an up-to-date snapshot of global CCS regulatory developments. The second edition reflects the ongoing progress toward comprehensive CCS legal and regulatory frameworks at national and regional levels. Examples of progress discussed in the review include: in the United States, the Environmental Protection Agency (EPA) finalized two Federal rules related to geologic storage; in Canada, Alberta became the first Canadian jurisdiction to finalize its regulatory framework; in Europe, four guidance documents have been released by the European Commission in addition to the European Union (EU) CCS Directive; and in Australia, the Federal government finalized secondary legislation to support offshore geologic CO_2 storage. The review also reflects progress being made in other countries that are implementing or considering CCS regulation, including Malaysia, South Africa, Vietnam, Mexico, and Indonesia. In addition to providing national-level updates of progress, the review also addresses long-term liability for stored CO_2, developments made by the international CCS community in advancing CCS deployment through amendments to international marine treaties and in the context of the United Nations Framework Convention on Climate Change (UNFCCC) framework, and the process behind developing CCS regulatory frameworks. October 9, 2011, http://www.carboncapturejournal.com/displaynews.php?NewsID=850.

"Managing private and public adaptation to climate change."

The following is from the Abstract of this article: "Adaptation to climate change is already being delivered by public and private actors, yet there has been little analysis of the relationships between the providers and beneficiaries of adaptation. This paper reviews the type of actors that are supplying adaptation services and their motivations. [The authors] then focus on a specific, under-explored case of adaptation: that of privately provided adaptation public goods and services, the realization of which is contingent on the individual management of private goods and private risks. Following the work of Olson (1965) [the authors] find that the benefits of the privately provided adaptation public good do not necessarily accrue back to the (same) individuals who are the providers. The characteristics of this particular form of public good pose specific institutional challenges. In this paper [the authors]: (1) explore the characteristics and defining features of these privately provided adaptation public goods; (2) argue that this form of adaptation provisioning is increasingly recognized as a feature in climate change adaptation (and/or social transformation) problems; (3) review existing cases of effective/ineffective management of these public goods; and (4) outline the institutions that may be required to facilitate the management of these public goods for adaptation." **Emma L. Tompkins and Hallie Eakin**, *Global Environmental Change*, Available online October 12, 2011, doi:10.1016/j.gloenvcha.2011.09.010, http://www.sciencedirect.com/science/article/pii/S0959378011001452. (Subscription required.)

Geology

"The effects of sub-critical and super-critical carbon dioxide adsorption-induced coal matrix swelling on the permeability of naturally fractured black coal."

The following is from the Abstract of this article: "Swelling of the coal matrix with the adsorption of CO_2 is one of the leading problems for CO_2 [storage] in deep coal seams as it causes coal seam permeability to be significantly reduced. The main objective of this study was to investigate the effect of coal mass swelling on the permeability of naturally fractured black coal. A series of permeability tests were conducted using a newly developed tri-axial

Geology (Continued)

apparatus on 38 mm by 76 mm naturally fractured black coal specimens. These tests were carried out for CO_2 and N_2 injections at 2-20 MPa injection pressures under 10 to 24 MPa confining pressures at 33°C. Each coal specimen was then allowed to swell under sub-critical and super-critical CO_2 adsorption and the corresponding effects on CO_2 and N_2 permeabilities were examined. Results indicate that the permeability of naturally fractured black coal is significantly reduced due to matrix swelling, which starts as quickly as within 1 h of CO_2 injection. A further reduction is then observed, and the maximum swelling rate occurs within the first 3-4 h of CO_2 adsorption. The amount of coal matrix swelling due to CO_2 adsorption clearly depends on the phase condition of the CO_2, and super-critical CO_2 adsorption-induced swelling is about two times higher than that induced by sub-critical CO_2 adsorption. Interestingly, although a fractured coal specimen which has already fully swelled under sub-critical CO_2 adsorption can swell significantly more under super-critical CO_2 adsorption, after swelling under super-critical CO_2 adsorption, no further swelling effect occurs under any CO_2 pressure or phase condition. Moreover, the swelling process continues longer under super-critical CO_2 adsorption. It is concluded that super-critical CO_2 adsorption can induce more matrix swelling than sub-critical CO_2 adsorption under the same adsorption pressure." **M.S.A. Perera, P.G. Ranjith, S.K. Choi, D. Airey**, *Energy*, Available online October 13, 2011, doi:10.1016/j.energy.2011.09.023, http://www.sciencedirect.com/science/article/pii/S0360544211006207. (Subscription required.)

"Parameters affecting mineral trapping of CO_2 sequestration in brines."

The following is from the Abstract of this article: "Carbon dioxide [storage] using brines has emerged as a promising technology to mitigate the adverse impacts of climate change due to its large storage capacity and favorable chemistries. However, the permanent storage of CO_2 in brines takes significantly long periods of time as the formation of carbonates is slow. This review focuses on the four main parameters (brine composition, brine pH, system temperature, and pressure) that have been reported to have a major effect on mineral trapping of CO_2 [storage] in brines. These parameters are difficult to control for *in situ* underground CO_2 [storage]. However, understanding the effects of these main parameters is useful for both aboveground and underground carbonation reactions. Brine pH is the most important parameter. The precipitation of carbonate minerals is favored over a basic pH of 9.0. In order to promote the formation of carbonates, brine pH could be enhanced by using additives. System temperature has a greater effect than pressure." **Qi Liu and M. Mercedes Maroto-Valer**, *Greenhouse Gases: Science and Technology*, Available online September 2011, DOI:10.1002/ghg.29, http://onlinelibrary.wiley.com/doi/10.1002/ghg.29/abstract. (Subscription may be required.)

"Deterioration of a fractured carbonate caprock exposed to CO_2-acidified brine flow."

The following is from the Abstract of this article: "A flow-through experiment was performed to investigate evolution of a fractured carbonate caprock during flow of CO_2-acidified brine. A core was taken from the Amherstburg limestone, a caprock formation overlying the Bois Blanc and Bass Islands formations, which have been used to demonstrate CO_2 storage in the Michigan basin. The inlet brine was representative of deep saline brines saturated with CO_2, resulting in a starting pH of 4.4. Experimental conditions were 27 °C and 10 MPa. X-ray computed tomography and scanning electron microscopy were used to observe evolution of fracture geometry and to investigate mineralogical changes along the fracture surface. The initial brine flow corresponded to an average fluid velocity of 110 cm hr^{-1}. After one week, substantial mineral dissolution caused the average cross-sectional area of the fracture to increase from 0.09 cm2 to 0.24 cm^2. This demonstrates that carbonate caprocks, if fractured, can erode quickly and may jeopardize sealing integrity when hydrodynamic conditions promote flow of CO_2-acidified brine. However, changes to fracture permeability due to mineral dissolution may be offset by unaltered constrictions along the flow path and by increases in surface roughness. In this experiment, preferential dissolution of calcite over dolomite led to uneven erosion of the fracture surface and an increase in roughness. In areas with clay minerals, calcite dissolution left behind a silicate mineral-rich microporous coating along the fracture wall. Thus, the evolution of fracture permeability will depend in a complex way on the carbonate content, as well as the heterogeneity of the minerals and their spatial patterning." **Brian Ellis, Catherine Peters, Jeffrey Fitts, Grant Bromhal, Dustin McIntyre, Robert Warzinski, Eilis Rosenbaum**, *Greenhouse Gases: Science and Technology*, Available online September 2011, DOI:10.1002/ghg.25, http://onlinelibrary.wiley.com/doi/10.1002/ghg.25/abstract. (Subscription may be required.)

Technology

"Pore-scale study of capillary trapping mechanism during CO_2 injection in geological formations."

The following is from the Abstract of this article: "Geological [storage] of CO_2 gas has emerged as a promising solution for reducing the amount of greenhouse gases in atmosphere. A number of continuum scale models are available to describe the transport phenomena of CO_2 [storage]. These models rely heavily on a phenomenological description of subsurface transport phenomena and the predictions can be highly uncertain. 'First-principle' pore-scale models provide a better understanding of fluid displacement processes. In this work [the authors] use a Smoothed Particle Hydrodynamics (SPH) model to study pore-scale displacement and capillary trapping mechanisms of super-critical CO_2 in the subsurface. Simulations are carried out to investigate the effects of gravitational, viscous, and capillary forces on the amount of trapped CO_2 in terms of non-dimensional numbers. [The authors] found that the displacement patterns and the amount of trapped CO_2 depends mainly on Capillary and Gravity numbers. For large Gravity numbers, most of the injected CO_2 reaches the cap-rock due to gravity separation. A significant portion of CO_2 gets trapped by capillary forces when the Gravity number is small. When the Gravity number is moderately high, trapping patterns are heavily dependent on the Capillary number. If the Capillary number is very small, then capillary forces dominate the buoyancy forces and a significant fraction of injected CO_2 is trapped by the capillary forces. Conversely, if the Capillary number is high, trapping is

Technology (Continued)

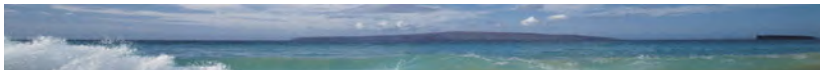
relatively small since buoyancy dominates the capillary forces." **Uditha C. Bandara, Alexandre M. Tartakovsky, Bruce J. Palmer**, *International Journal of Greenhouse Gas Control*, Available online October 7, 2011, doi:10.1016/j.ijggc.2011.08.014, http://www.sciencedirect.com/science/article/pii/S1750583611001708. (Subscription required.)

"Storage of CO_2 hydrate in shallow gas reservoirs: pre- and post-injection periods."

The following is from the Abstract of this article: "With the growing concern about climate change, interest in reducing CO_2 emissions has increased. Geological storage of CO_2 is perceived to be one of the most promising methods that could provide significant reductions in CO_2 emissions over the short and medium term. Since a major concern regarding geological storage is the possibility of leakage, trapping CO_2 in a solid form is quite attractive. Unlike mineral trapping, the kinetics of CO_2-hydrate formation is quite fast, providing the opportunity for long-term storage of CO_2. Thermodynamic calculations suggest that CO_2 hydrate is stable at temperatures that occur in a number of formations in Northern Alberta, in an area where there are significant CO_2 emissions associated with the production of oil sands and bitumen. In this paper, [the authors] study storage of CO_2 in hydrate form at conditions similar to those at depleted gas pools in Northern Alberta. Numerical simulation results show that the CO_2 storage capacity of such pools is many times greater than their original gas-in-place. This provides a local option for storage of a portion of the CO_2 emissions from the oil sands operations in northeastern Alberta. In an earlier paper, [the authors] studied hydrate formation during a period of continued CO_2 injection. In this paper, [the authors] extend the duration of the investigation to include the period after injection has stopped. In particular, [the authors] study the storage capacity of such depleted gas pools and the fate of the hydrate over long periods of time when the injection of CO_2 has slowed down or ceased. [The authors] examine the effect of properties of the reservoir and cap/base rocks, as well as operating conditions. In particular, [the authors] investigate a shut-in case as the most realistic condition in CO_2 field [storage]." **Olga Ye Zatsepina and Mehran Pooladi-Darvish**, *Greenhouse Gases: Science and Technology*, Available online September 2011, DOI:10.1002/ghg.23, http://onlinelibrary.wiley.com/doi/10.1002/ghg.23/abstract. (Subscription may be required.)

"Strong and Reversible Binding of Carbon Dioxide in a Green Metal-Organic Framework."

The following is from the Abstract of this article: "Although porous metal-organic frameworks (MOFs) have been shown to be very effective at adsorbing CO_2 selectively by dint of dipole-quadruple interactions and/or ligation to open metal sites, the gas is not usually trapped covalently. Furthermore, the vast majority of these MOFs are fabricated from nonrenewable materials, often in the presence of harmful solvents, most of which are derived from petrochemical sources. Herein [the authors] report the highly selective adsorption of CO_2 by CD-MOF-2, a recently described green MOF consisting of the renewable cyclic oligosaccharide γ-cyclodextrin and RbOH, by what is believed to be reversible carbon fixation involving carbonate formation and decomposition at room temperature. The process was monitored by solid-state ^{13}C NMR spectroscopy as well as colorimetrically after a pH indicator was incorporated into CD-MOF-2 to signal the formation of carbonic acid functions within the nanoporous extended framework." **Jeremiah J. Gassensmith, Hiroyasu Furukawa, Ronald A. Smaldone, Ross S. Forgan, Youssry Y. Botros, Omar M. Yaghi, and J. Fraser Stoddart**, *J. Am. Chem. Soc.*, Available online August 30, 2011, doi:10.1021/ja206525x, http://pubs.acs.org/doi/abs/10.1021/ja206525x. (Subscription required.)



Terrestrial

"Carbon Sequestration, Optimum Forest Rotation and Their Environmental Impact."

The following is the Abstract of this article: "Due to their large biomass forests assume an important role in the global carbon cycle by moderating the greenhouse effect of atmospheric pollution. The Kyoto Protocol recognizes this contribution by allocating carbon credits to countries which are able to create new forest areas. Sequestrated carbon provides an environmental benefit thus must be taken into account in cost–benefit analysis of afforestation projects. Furthermore, like timber output carbon credits are now tradable assets in the carbon exchange. By using British data, this paper looks at the issue of identifying optimum felling age by considering carbon [storage] benefits simultaneously with timber yields. The results of this analysis show that the inclusion of carbon benefits prolongs the optimum cutting age by requiring trees to stand longer in order to soak up more CO_2. Consequently this finding must be considered in any carbon accounting calculations." **Erhun Kula and Yavuz Gunalay**, *Environmental Impact Assessment Review*, Available online October 2, 2011, doi:10.1016/j.eiar.2011.08.007, http://www.sciencedirect.com/science/article/pii/S0195925511001004. (Subscription may be required.)

Trading

***RGGI News Release*, "RGGI States Initiate Bidding Process for December 2011 CO_2 Allowance Auction."**

The Regional Greenhouse Gas Initiative (RGGI) released the Auction Notice and application materials for CO_2 Allowance Auction 14, providing potential auction participants with the information required to submit a Qualification Application and indicate their intent to bid in the auction scheduled for December 7, 2011. The Northeast and Mid-Atlantic states participating in RGGI, the Nation's first market-based, mandatory cap-and-trade program to reduce GHG emissions, will auction 42,983,482 CO_2 allowances for the current control period (2009 to 2011) and 1,864,951 CO_2 allowances for the future control period (2012 to 2014); a reserve price of $1.89 will be used for all allowances. Since its inception in September 2008, RGGI has auctioned more than 380 million CO_2 allowances. For more information about previous auction results, including prices, bids, and participation, visit: http://www.rggi.org/market/co2_auctions/results. October 7, 2011, http://www.rggi.org/docs/PR-20111007_Auction14BidderInitiation.pdf.

Trading (Continued)

"Carbon sequestration and permit trading on the competitive fringe."

The following is from the Abstract of this article: "This paper makes two contributions to the carbon-[storage] policy literature. First and foremost, [the authors] develop a theoretical framework in which [storage] and permit-trading markets are analyzed jointly in the context of a competitive fringe model. [The authors'] framework formalizes the linkage between regulatory policy changes (as they manifest themselves in the permit market) and subsequent equilibrium allocations in the [storage] market. Second, [the authors] perform a numerical analysis demonstrating the role market structure, or market power, might play in the determination of the equilibrium [storage] allocation and carbon price. Both [the authors'] analytical and numerical results demonstrate the importance of incorporating into empirical supply-side models demand-side information that is reflective of an underlying market structure." **Arthur J. Caplan**, *Economic Modeling*, Available online September 28, 2011, doi:10.1016/j.econmod.2011.08.018, http://www.sciencedirect.com/science/article/pii/S0264999311002100. (Subscription may be required.)

Recent Publications

"The Global Status of CCS: 2011."

The following is from the Executive Summary of this document: "In 2011 the CCS industry exhibited measured progress, with an increase in the number of large-scale integrated projects (LSIPs) in operation or under construction and a clustering of projects around the advanced stages of development planning. There are eight large-scale projects in operation around the world and a further six under construction. Three of these projects have recently commenced construction. Importantly, these include a second power project, Boundary Dam in Canada, and the first project in the United States that will store CO_2 in a deep saline formation, the Illinois Industrial Carbon Capture and Sequestration (ICCS) project. The total CO_2 storage capacity of all 14 projects in operation or under construction is over 33 million tonnes a year. This is broadly equivalent to preventing the emissions from more than six million cars from entering the atmosphere each year. In the Institute's annual project survey for 2010, ten projects reported that they could be in a position in the next 12 months to decide on whether to take a final investment decision (FID) and move into construction. Power generation projects are prominent in this group and include Project Pioneer in Canada, the Texas Clean Energy project in the United States and the ROAD project in Europe. While the prospect of a number of power projects moving to [an] FID in the next year is a positive development, this is contrasted with other high-emitting industries such as iron and steel and cement, where there is a paucity of projects being planned at large-scale. In total there are 74 LSIPs recorded in this report, compared with 77 reported in the *Global Status of CCS: 2010* report. These CCS projects continue to be concentrated in North America, Europe, Australia and China with few large-scale projects planned in developing countries. It is vital that the lessons learned from demonstration projects in developed countries are conveyed to developing countries, and that capacity development activities and customized project support are undertaken so that these countries can eventually deploy CCS." To download the entire Global CCS Institute publication, go to: http://www.globalccsinstitute.com/publications/global-status-ccs-2011.

"World Energy Outlook 2011."

The following is a summary of this document: "World Energy Outlook 2011 brings together the latest data, policy developments, and the experience of another year to provide robust analysis and insight into global energy markets, today and for the next 25 years. This edition of the IEA's flagship WEO publication gives the latest energy demand and supply projection for different future scenarios, broken down by country, fuel and sector. It also gives special focus to such topical energy sector issues as: Russia's energy prospects and their implications for global markets; The role of coal in driving economic growth in an emissions-constrained world; The implications of a possible delay in oil and gas sector investment in the Middle East and North Africa; How high-carbon infrastructure 'lock-in' is making the 2°C climate change goal more challenging and expensive to meet; The scale of fossil fuel subsidies and support for renewable energy and their impact on energy, economic and environmental trends; A 'Low Nuclear Case' to investigate what a rapid slowdown in the use of nuclear power would mean for the global energy landscape; [and] The scale and type of investment needed to provide modern energy to the billions of the world's poor that do not have it." For more information on the IEA document, scheduled for release on November 9, 2011, visit the World Energy Outlook 2011 website at: http://www.worldenergyoutlook.org/.

"Technology Roadmap: Carbon Capture and Storage in Industrial Applications."

The following is from the Introduction of this document: "The IEA projects that cutting CO_2 emissions to 50 [percent] of their 2005 levels – the target necessary to limit the global warming between 2°C and 3°C – would require a reduction of 43 Gigatonnes of CO_2 ($GtCO_2$). Total CCS in power generation and industrial applications is expected to contribute 19 [percent] to this reduction target in 2050. Much of the most promising short-term potential for CCS – and half of the global economic potential by 2050 – lie in industrial applications, particularly in the developing world. In many industry sectors CCS is often the only technology, with the exception of energy-efficiency measures, that allows for deep reductions in CO_2 emissions. CCS in industrial applications has so far received little attention. Most studies on the potential application of CCS have focused on the power sector, even though all existing operational large-scale demonstrations of

Recent Publications (Continued)

CCS are in industrial applications. If CCS is to achieve its full potential to reduce overall emissions, this imbalance needs to be corrected. The need to recognize the potential of CCS for industrial emission sources and to review demonstration opportunities was one of the conclusions of the April 2011 Clean Energy Ministerial meeting held in Abu Dhabi. In their report to the 2010 Muskoka G8 Summit, the IEA and the CSLF, in partnership with the Global CCS Institute, called for the identification of a larger number of CCS projects in industrial sectors globally, as well as support for CCS in developing countries. If developing countries are to implement CCS in the short- to medium-term, each country needs to address its own specific requirements and take steps to increase awareness of the possibilities for CCS in industrial applications." To read the entire Technology Roadmap, go to: http://cdn.globalccsinstitute.com/sites/default/files/ccs_industry_roadmap_web_2.pdf.

Legislative Activity

***MarketWatch*, "Australia's Carbon Tax Gets Green Light,"** and ***Nasdaq*, "Australia's Lower House Passes Carbon Pricing Bill."**

A plan to price carbon emissions passed through the lower house of the Australian parliament on Wednesday, October 12. The plan would allow the government to price CO_2 emissions by Australia's largest carbon emitters in an attempt to limit emissions. According to officials, the legislation is expected to encourage investment, estimated at $101.7 billion, in clean and renewable energy; provide assistance to several affected industries; and other areas. Under the legislation, the nation's 500 biggest carbon emitters will be subject to an initial fixed carbon price of $23.4 per tonne tax beginning in July 2012. The package will eventually transition to an emissions-trading scheme with a floating price in 2015. The package will now be debated in the upper house Senate. October 11, 2011, http://www.marketwatch.com/story/australias-carbon-tax-gets-green-light-2011-10-11, and October 12, 2011, http://www.nasdaq.com/aspx/stock-market-news-story.aspx?storyid=201110112209dowjonesdjonline000472&title=update-australias-lower-house-passes-carbon-pricing-bill.

Events

November 15-16, 2011, **Low-Carbon Energy Technologies: Innovations in Efficiency and Greenhouse Gas Reduction Science and Technology Seminar**, *Southwest Research Institute, San Antonio, Texas, USA*. This seminar will focus on alternative energy technologies, carbon reduction through improvements in efficiency, and carbon conversion and storage. Topics include: efficiency improvements to reduce carbon footprint, alternative power (wind, solar, and energy storage), low-carbon emission power plant cycles, CO_2 compression and storage, and CO_2 conversion and utilization. For more information, go to: http://www.swri.org/mailer/Div18/2011/IndLectureFlyr-4.pdf.

November 15-17, 2011, **DOE's Carbon Storage Program Infrastructure Annual Review Meeting**, *Sheraton Station Square, Pittsburgh, Pennsylvania, USA*. This meeting highlights DOE's carbon storage infrastructure projects, which include the efforts of DOE's RCSPs; however, it is now expanding to include other U.S. and international projects that are working to characterize storage capacity through exploration and injection operations. For more information, go to: http://www.netl.doe.gov/events/11conferences/Carbon%20storage%20program/index.html.

December 5-6, 2011, **The Future of Fossil-Fired Plants: Risks and Opportunities in Light of Regulatory and Economic Uncertainty**, *Hyatt Regency Crystal City, Arlington, Virginia, USA*. This conference will provide a forum for discussions with leading industry participants and analysts who are facing challenges ranging from impending EPA regulations, low gas prices, and uncertain prospects for CO_2 regulation. For more information, visit: https://www.euci.com/events/?ci=1470&t=O.

December 13-15, 2011, **POWER-GEN International 2011**, *Las Vegas Convention Center, Las Vegas, Nevada, USA*. POWER-GEN International is the industry leader in providing comprehensive coverage of trends, technologies, and issues facing the generation sector. This year's program consists of a variety of tracks, including: industry trends, power generation, environmental issues, fossil technologies, gas turbine technologies, renewable energy, onsite power, and plant performance. Conference details are available at: http://www.power-gen.com.

Events (Continued)

December 14-15, 2011, **International Conference on Climate Change & Social Issues**, *Colombo, Sri Lanka*. This conference offers a forum that stimulates discussions from multi-sectoral stakeholder groups to share practical knowledge/experience, exchange ideas, develop collaborations, and set up working groups in order to take actions for climate change mitigation and adaptation. This conference will bring together interdisciplinary researchers and practitioners to meet, discuss, and debate the global impacts of climate change. Detailed information can be found at: http://www.ihdt.org/Intro.html.

January 25-26, 2012, **Coal Symposium: Responding to Regulations, Enhancing Operational Efficiency & the Latest Word on Clean Coal Technology**, *Calgary TELUS Convention Center, Calgary, Alberta, Canada*. This symposium offers strategies for responding to provincial and Federal emissions regulations, information for building new and retrofitting old coal power plants, proactive public engagement tactics for the long-term viability of coal power generation in Canada, and insight on groundbreaking economical and technological advancements for clean energy in Canada and around the world. More details are available at: http://www.canadianinstitute.com/2012/324/coal-symposium.

February 7-9, 2012, **Carbon Management Technology Conference**, *Caribe Royale Hotel & Convention Center, Orlando, Florida, USA*. This inaugural conference draws professionals from all engineering disciplines to share their expertise on the reduction of GHG emissions and adaptation to changing climate. The conference will focus on engineering perspectives regarding key issues, including technologies, strategies, policies, and management systems. More information is located at: http://www.spe.org/events/cmtc/2012/index.php.

April 24-25, 2012, **Carbon Capture and Storage Conference**, *Venue to be Determined, Calgary, Alberta, Canada*. This event provides an opportunity for attendees to hear from regulators, scientists, and industry players on the latest in CCS-related legislation, overcoming geologic challenges, devising business models for commercialization, gaining public acceptance, and other topics. Visit: http://www.canadianinstitute.com/2012/338/carbon-capture-and-storage-conference/ for more details.

November 18-22, 2012, **11th International Conference on Greenhouse Gas Technologies (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. A formal agenda has not yet been developed; however, planning for GHGT-11 is underway, with a call for papers open through February, 20, 2012. Visit: http://www.ghgt.info/index.php/Content-GHGT11/ghgt-11-overview.html for more details.

For subscription details...

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.