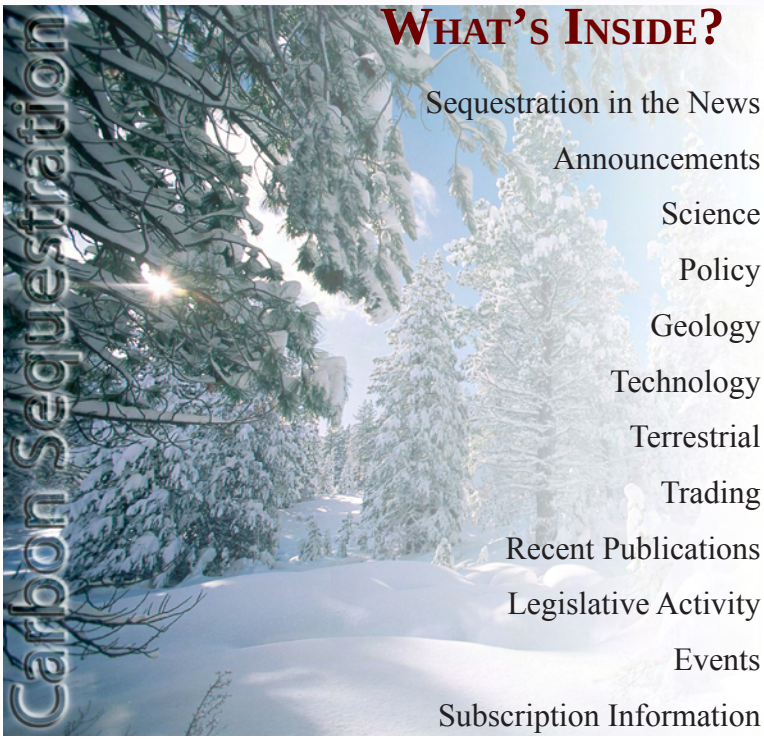
Carbon Sequestration Newsletter

February 2009



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

***U.S. Department of Agriculture News Release*, "Secretary Schafer Announces $300 Million Loan for the First Commercial Scale Carbon Sequestration Project at an Existing Coal-Fired Power Plant,"** and ***Basin Electric Power Cooperative News Release*, "USDA Approves Loan for CO_2 Capture Project."**

On January 15, 2009, the U.S. Department of Agriculture (USDA) announced the approval of a $300 million loan to finance the modification of a coal-fired power plant to capture and sequester 3,000 tons of carbon dioxide (CO_2) per day. The project, which will take place at Basin Electric Power Cooperative's Antelope Valley Station near Beulah, North Dakota, is expected to be the first of its type in the United States to operate on a commercial scale. Basin Electric will utilize a CO_2 capture technology currently being tested on a pilot-scale basis; based on the tests results, the technology would be expanded to a demonstration project at the Antelope Valley Station. Antelope Valley Station is located adjacent to the Great Plains Synfuels Plant, which already captures and ships more than 3 million tons of CO_2 per year to Canadian oilfields through a 205-mile long pipeline. The CO_2 captured from the coal-fired power plant will be cleaned, sent to the Synfuels plant, and then placed into the pipeline for use during enhanced oil recovery (EOR). Basin Electric also plans to inject a small percentage of CO_2 into a deep saline formation. The demonstration project at Antelope Valley would capture about 1 million tons of CO_2 per year. The loan was made possible through USDA's Rural Development's Rural Utilities Program. For more information about Basin Electric's Antelope Valley Station, visit: http://www.basinelectric.com/Energy_Resources/Electricity/Baseload_Power/Antelope_Valley_Station/index.html. January 15, 2009, http://www.usda.gov/wps/portal/!ut/p/_s.7_0_A/7_0_1OB?contentidonly=true&contentid=2009/01/0014.xml, and January 15, 2009, http://www.basinelectric.com/News_Center/News_Releases/USDA_approves_loan_for_CO2_cap.html.

Sequestration in the News

***Power Engineering International*, "Tenaska's Coal-Fired IGCC Plant Moves Forward."**

Tenaska's proposed Taylorville Energy Center, a coal gasification project with carbon capture and storage (CCS) technology, has obtained a final air permit from the Illinois Environmental Protection Agency (EPA) that allows it to become the "initial clean coal facility" under Illinois' Clean Coal Portfolio Standard Act (SB 1987). According to Tenaska officials, the emission levels at the Taylorville Energy Center are expected to be lower than any other type of fossil fuel plant. The plant will use Hybrid Integrated Gasification Combined-Cycle (IGCC) to generate as much as 525 megawatts of electricity. Current estimates of construction costs are approximately $2.5 billion and the project is expected to be completed by 2014. The Clean Coal Portfolio Standard Act provides a framework for the development of clean coal projects and would require project developers to capture and store more than 50 percent of CO_2 emissions. The Taylorville Energy Center project will now prepare to develop a Front-End Engineering and Design (FEED) study

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Sequestration in the News (Continued)

and facility cost report. The Clean Coal Portfolio Standard is available at: http://www.ilga.gov/legislation/95/SB/09500SB1987lv.htm. January 12, 2009, http://pepei.pennnet.com/Articles/Article_Display.cfm?Section=ARTCL&SubSection=Display&PUBLICATION_ID=6&ARTICLE_ID=350019.

***Hattiesburg American*, "Mississippi Power Plans Cleaner, More Plentiful Fuel."**

Mississippi Power announced plans to build a $2 billion, lignite-fired power plant in Kemper County, located north of Meridian in eastern Mississippi, which could become the first full-scale, clean coal generating plant in the United States. The plant would employ coal gasification technology to produce electricity and capture 50 percent of CO_2 emissions. The captured CO_2 would be compressed and sold to a company that would inject it into depleted oil wells around Mississippi for EOR. The plant is anticipated to open sometime between 2013 and 2015. Mississippi Power is currently negotiating with property owners in Kemper County for the mineral rights to approximately 12,000 acres. The proposed plant would use between 100 and 150 million tons of the Mississippi's 4 billion ton supply of lignite, a low grade of coal that gives off a smaller amount of heat. December 15, 2008, http://www.hattiesburgamerican.com/article/20081218/NEWS01/812180316&referrer=FRONTPAGECAROUSEL.

***TransAlta News Release*, "TransCanada to Participate in TransAlta's Carbon Capture and Storage (CCS) Project."**

TransCanada Pipelines, Ltd. announced plans to participate with TransAlta Corporation in the development of Project Pioneer, Canada's first fully-integrated CCS plant. The project will employ Alstom Canada's chilled ammonia process and will be designed to capture one megatonne (Mt) of CO_2 emissions from an existing coal plant in the Wabamun area located in western Edmonton. The CO_2 will be used for EOR and injected into a permanent geological storage site. Preliminary FEED work has started on Project Pioneer and TransAlta hopes to receive funding commitments during 2009 that will allow for construction to begin in early 2010 and operations to commence in 2012. Project Pioneer is expected to deliver at least 20 percent of Alberta's 2015 target of five Mt in annual CO_2 reductions. December 18, 2008, http://www.transalta.com/transalta/webcms.nsf/AllDoc/1894680E80DB8BBC872575220063CC1C?OpenDocument.

Sequestration in the News (Continued)

***The Associated Press*, "Algerian Project Captures and Buries Carbon Dioxide,"** and ***International Herald Tribune*, "Algeria's Gas Fields Seek to Set Eco-Example."**

Algerian and international oil firms invested $100 million in a joint venture to capture and sequester CO_2 at In Salah, one of Algeria's largest natural gas fields. Algeria's natural gas usually holds four to six percent CO_2, but its primary customer, the European Union, only accepts two percent. According to officials, 800,000 tons of CO_2 are buried each year at In Salah. Carbon dioxide represents seven percent of the 9 billion cubic meters (318 billion cubic feet) of gas extracted at In Salah each year. Over the anticipated 30-year life of the project, about 20 million tonnes of CO_2 will be captured and sequestered. The In Salah gas project includes Sonatrach of Algeria, BP of Britain, and Statoil of Norway. Algeria hopes other foreign drilling partners will include CCS plans in their investment projects. December 15, 2008, http://www.google.com/hostednews/afp/article/ALeqM5jRoddcZUKYkN4anwfycPz1XuQ_zQ, and December 16, 2008, http://www.iht.com/articles/ap/2008/12/16/africa/AF-Algeria-Green-Gas-Field.php.

Announcements

Annual NETL CO_2 Capture Technology for Existing Plants R&D Meeting.
Scheduled for March 24-26, 2009, in Pittsburgh, Pennsylvania, the Annual National Energy Technology Laboratory (NETL) CO_2 Capture Technology for Existing Plants R&D Meeting will address the state of technologies for capturing CO_2 emissions from existing coal-fired power plants. The conference will include current progress from existing projects and project details from recent award selections from the U.S. Department of Energy's (DOE) CO_2 capture technology research conducted through NETL's Innovations for Existing Plants (IEP) Program. For more information, visit: http://www.netl.doe.gov/events/09conferences/co2capture/index.html.

PCOR Receives IOGCC Award.
The University of North Dakota's Energy & Environmental Research Center (EERC) received the prestigious Chairman's Stewardship Award from the Interstate Oil and Gas Compact Commission (IOGCC) for its work in the Plains CO_2 Reduction (PCOR) Regional Carbon Sequestration Partnership (RCSP). EERC was selected in the environmental partnership category. PCOR is composed of more than 90 members that provide data, guidance, financial resources, and practical experience with CCS and terrestrial sequestration. For more information about PCOR, visit: http://www.undeerc.org/pcor/default.asp.

List of CCS Projects Released.
On December 22, 2008, the American Coalition for Clean Coal Electricity (ACCCE) released a list of 80 projects in the United States that are related to various aspects of CCS. The majority are research and development (R&D) projects for the commercial deployment of CCS technology. To view the list, click: http://www.americaspower.org/Media/Files/List-of-80-Projects. An interactive U.S. map can be found at: http://www.americaspower.org/The-Facts/Clean-Coal-Technology%20.

Climate Policy Forum: Charting the Path Ahead.
The Climate Registry, a non-profit organization that provides information to reduce greenhouse gas (GHG) emissions, will present a climate policy forum series in three different cities. The series will start in Tampa, Florida, on February 3, travel to Denver, Colorado, on February 26, and end in Columbus, Ohio, on March 11. An agenda for the initial forum, scheduled to take place at the Hyatt Regency Tampa, can be viewed at: http://www.theclimateregistry.org/downloads/Events/2009/forums/se-info-page.pdf.

Science

***MSNBC.com*, "2 Trillion Tons of Ice Gone Since '03,"** and ***CNN.com*, "Ice Melting Across Globe at Accelerating Rate, NASA Says."**

According to National Aeronautics and Space Administration (NASA) satellite data showing the latest signs of potential climate change, more than 2 trillion tons of land ice in Greenland, Antarctica, and Alaska have melted since 2003. NASA's Gravity Recovery and Climate Experiment (GRACE) showed that more than half of the loss of landlocked ice over the past five years has occurred in Greenland. Since 2003, when the NASA satellite started taking measurements, Alaska has lost 400 billion tons of land ice. However, after dropping in 2005, land ice in Alaska showed a slight increase in 2008 due to large winter snow falls. According to NASA scientists, the melting of land ice slightly increases sea levels, which has led to Greenland adding approximately half a millimeter to the world's sea level each year. Over the past five years, melting land ice in Greenland, Antarctica, and Alaska has raised global sea levels approximately one-fifth of an inch. Sea levels can also rise from water expanding as it warms; according to scientists, parts of the Arctic north of Alaska were nine to 10 degrees warmer this past fall. The Arctic waters absorb more heat in the summer as sea ice melts due to the loss of reflective powers. The absorbed heat is then released into the air in the fall, which according to researchers, has led to autumn temperatures being six to 10 degrees warmer than in the 1980s. December 16, 2008, http://www.msnbc.msn.com/id/28249708/, and December 17, 2008, http://www.cnn.com/2008/TECH/science/12/16/melting.ice/index.html.

***Los Angeles Times*, "Moose are Roaming Right out of Existence."**

A recent study shows that climate change has caused the number of moose in northwest Minnesota to decrease from 4,000 to less than 100 in two decades. There are approximately 7,700 moose in all of Minnesota – a 50 percent decrease from 20 years ago. Over the past 40 years in northwestern Minnesota, the average winter temperature has risen 12 degrees and the average summer temperature has risen four degrees. The moose is not endangered in the United States, but it is in danger of disappearing from the Midwest, the far southern fringe of its range. Minnesota and Michigan wildlife biologists say that heat, water, and parasites play important roles in the diminishing of the species, but they believe that warmer temperatures are the main source. Unlike other local animals who have adapted to warmer temperatures, such as deer, wolves, and bears, moose have suffered because they require shade, water, and cool weather to survive – all of which are dwindling in northwestern Minnesota. When temperatures rise, the moose work harder to find places to stay cool, which affects their immune system and prevents them from gaining enough fat for the winter, leaving them vulnerable to parasites. In northeastern Minnesota, which offers more shade and, thus, more opportunities to cool off, the moose population is declining approximately 10 percent a year. December 29, 2008, http://www.latimes.com/news/science/environment/la-na-minnesota-moose29-2008dec29,0,3445902.story.

Policy

***Energy Business Review*, "CCS: Technology's Prospects Boosted by Dutch Government."**

The Dutch Government granted Shell and a consortium led by GDF-Suez approximately $39.5 million for the development of CCS schemes that are expected to capture a combined 2 million tonnes of CO_2 over the next 10 years at two new sites in Holland. Shell will capture CO_2 from its Pernis oil refinery in Rotterdam and sequester it in depleted gas fields. The consortium headed by GDF-Suez will capture CO_2 from DSM Agro's ammonia plant and store it in a depleted coal mine in the southeastern Limburg region. In addition, the GDF-Suez led consortium has already identified other sites that may be suitable for the geological CO_2 storage, because the conversion of the coal mine to a CCS capable facility may be contingent upon the local geography. January 9, 2009, http://www.energy-business-review.com/article_feature.asp?guid=D8543B83-3E75. (Subscription required.)

"A Multi-Level Approach to Outreach for Geologic Sequestration Projects."

The following is the abstract of this article: "Public perception of CCS projects represents a potential barrier to commercialization. Outreach to stakeholders at the local, regional, and national level is needed to create familiarity with and potential acceptance of CCS projects. This paper highlights the Midwest Geological Sequestration Consortium (MGSC) multi-level outreach approach which interacts with multiple stakeholders. The MGSC approach focuses on external and internal communication. External communication has resulted in building regional public understanding of CCS. Internal communication, through a project Risk Assessment process, has resulted in enhanced team communication and preparation of team members for outreach roles." **Sallie E. Greenberg, Hannes E. Leetaru, Ivan G. Krapac, Ken Hnottavange-Telleen, and Robert J. Finley**, Presented at the 9th International Conference on Greenhouse Gas Control Technologies (GHGT-9), held November 16-20, 2008, at the Omni Shoreham Hotel in Washington, DC, United States, https://www4.eventsinteractive.com/iea/viewpdf.esp?id=270005&file=%5C%5Cserenity%5CEP11%24%5CEventwin%5CPool%5Coffice27%5Cdocs%5Cpdf%5Cghgt%5F9Final00647%2Epdf.

"Case studies of the application of the Certification Framework to two geologic carbon sequestration sites."

The following is the abstract of this article: "[The authors] have developed a certification framework (CF) for certifying that the risks of geologic carbon sequestration (GCS) sites are below agreed-upon thresholds. The CF is based on effective trapping of CO_2, the proposed concept that takes into account both the probability and impact of CO_2 leakage. The CF uses probability estimates of the intersection of conductive faults and wells with the CO_2 plume along with modeled fluxes or concentrations of CO_2 as proxies for impacts to compartments (such as potable groundwater) to calculate CO_2 leakage risk. In order to test and refine the approach, [the authors] applied the CF to (1) a hypothetical large-scale GCS project in the Texas Gulf Coast, and (2) [West Coast Carbon Sequestration Partnership's (WESTCARB)] Phase III GCS pilot in the southern San Joaquin Valley, California." **Curtis**

Policy (Continued)

M. Oldenburg, Jean-Philippe Nicot, and Steven L. Bryant, Presented at GHGT-9, held November 16-20, 2008, at the Omni Shoreham Hotel in Washington, DC, United States, https://www4.eventsinteractive.com/iea/viewpdf.esp?id=270005&file=%5C%5Cserenity%5CEP11%24%5CEventwin%5CPool%5Coffice27%5Cdocs%5Cpdf%5Cghgt%5F9Final00687%2Epdf.

Geology

"Impact of Injected CO_2 on Reservoir Mineralogy During CO_2-EOR."

The following is the abstract of this article: "An investigation of the impact of injected CO_2 on reservoir mineralogy was completed as part of the geochemical monitoring and modeling of the Pembina Cardium CO_2 Monitoring Project southwest of Drayton Valley, Alberta, Canada. Oil production at the pilot is primarily from the upper two of three stacked sandstone units of the Cardium Formation in the Pembina field. Core analyzed included samples from each of the three sandstone units, and encompassed three distinct time periods: pre-water flood (1955), pre-CO_2 flood (2005), and post-CO_2 flood (2007). The results of whole rock analysis (XRF, ICP, and XRD), and microscopy (polarizing and electron microprobe) suggest the three separate sandstone units are both texturally and compositionally similar regardless of when the core was recovered. Framework grains are predominately sub-angular to sub-rounded quartz/chert (up to 90.0 wt%), and include smaller amounts of lithic fragments (shale), feldspar (k-feldspar, and albite), mica (muscovite and chlorite), and fluor-apatite. Authigenic pyrite is found as finely disseminated rhombs throughout the formation. Clay minerals present are predominantly kaolinite and illite. Kaolinite appears as fine discrete pore filling books, and is considered to be authigenic. Illite occurs as a major constituent of shale fragments, as well as fine pore bridging strands. The sandstone's irregular pores are cemented to varying degrees by silica and/or carbonate minerals (calcite and siderite). Dissolution features associated with formation diagenesis, including the degradation of detrital grains (quartz and feldspar), the partial and/or complete removal of carbonate cements, and the presence of residual clays, are found in core from each of the three time periods. Attributing dissolution features in post-CO_2 flood core to the interaction of minerals and carbonic acid is difficult due to the geologic history of the formation." **M. Nightingale, G. Johnson, M. Shevalier, I. Hutcheon, E. Perkins, and B. Mayer**, Presented at GHGT-9, held November 16-20, 2008, at the Omni Shoreham Hotel in Washington, DC, United States, https://www4.eventsinteractive.com/iea/viewpdf.esp?id=270005&file=%5C%5Cserenity%5CEP11%24%5CEventwin%5CPool%5Coffice27%5Cdocs%5Cpdf%5Cghgt%5F9Final00696%2Epdf.

"Geological Factors Affecting CO_2 Plume Distribution."

The following is the abstract of this article: "Understanding the lateral extent of a CO_2 plume has important implications with regards to buying/leasing pore volume rights, defining the area of review for an injection permit, determining the extent of an [monitoring, verification, and accounting (MVA)] plan, and managing basin-scale sequestration from multiple injection sites. The vertical and lateral distribution of CO_2 has implications with regards to estimating CO_2 storage volume at a specific site and the pore pressure below the caprock. Geologic and flow characteristics such as effective permeability and porosity, capillary pressure, lateral and vertical permeability anisotropy, geologic structure, and thickness all influence and affect the plume distribution to varying degrees. Depending on the variations in these parameters one may dominate the shape and size of the plume. Additionally, these parameters do not necessarily act independently. A comparison of viscous and gravity forces will determine the degree of vertical and lateral flow. However, this is dependent on formation thickness. For example in a thick zone with injection near the base, the CO_2 moves radially from the well but will slow at greater radii and vertical movement will dominate. Generally the CO_2 plume will not appreciably move laterally until the caprock or a relatively low permeability interval is contacted by the CO_2. Conversely, in a relatively thin zone with the injection interval over nearly the entire zone, near the wellbore the CO_2 will be distributed over the entire vertical component and will move laterally much further with minimal vertical movement. Assuming no geologic structure, injecting into a thin zone or into a thick zone immediately under a caprock will result in a larger plume size. With a geologic structure such as an anticline, CO_2 plume size may be restricted and injection immediately below the caprock may have less lateral plume growth because the structure will induce downward vertical movement of the CO_2 until the outer edge of the plume reaches a spill point within the structure." **Scott M. Frailey and Hannes Leetaru**, Presented at GHGT-9, held November 16-20, 2008, at the Omni Shoreham Hotel in Washington, DC, United States, https://www4.eventsinteractive.com/iea/viewpdf.esp?id=270005&file=%5C%5Cserenity%5CEP11%24%5CEventwin%5CPool%5Coffice27%5Cdocs%5Cpdf%5Cghgt%5F9Final00673%2Epdf.

Technology

"Mitigation planning for large-scale storage projects: multiple injection zones and reservoir pressure reduction engineering design."

The following is the abstract of this article: "Effective mitigation plans are an absolutely critical component of mitigation plans for commercial-scale geologic carbon sequestration. One fundamental component of mitigation engineering design is immediate reduction of reservoir pressure. The Southwest Regional Partnership on Carbon Sequestration (SWP) is employing immediate reservoir pressure reduction as a primary mitigation tool in our geologic sequestration field projects. [The authors] are also employing multiple injection zones at the SWP deep saline injection site, both to maximize capacity and optimize mitigation plans. [The authors] developed models for each of our test sites to forecast optimum density and placement of injection and observation wells. Likewise, [the authors] designate certain observation wells as 'observation-pressure reduction,' or 'OPR' wells. These are wells that serve as observation wells, but are engineered for quick conversion to production (pumping) wells to facilitate immediate pressure reduction, if needed. Results of our reservoir models suggest that immediate pressure reduction may stem geomechanical deformation, stem and/or close crack/fracture growths, shut down 'piston-flow' displacement of brines into unintended

Technology Cont'd

reservoirs, slow leakage through wellbores, slow leakage of CO_2 through faults, and even induce closure of faults. Much like the injection wells, the distribution of such OPR wells is critical. For example, in ongoing Partnership field-testing, observation wells are being drilled that will serve as OPR wells, and [the authors] are using reservoir models to identify well locations that optimize both monitoring and mitigation potential. Reservoir model results also suggest that OPR wells can be converted to injection wells to maximize capacity and control reservoir pressure. For example, as one portion of the reservoir 'fills' or if pressure control becomes problematic, the injection well can be converted to OPR mode, and the next well in the series (whether linear or in a grid design) can become an injection well. Simulation results suggest that if pressure reduction wells are used to 'make space' for CO_2 by removing brine ahead of the CO_2 front, this pumping will also increase residual gas trapping by promoting horizontal migration. Additional results of our reservoir models suggest several caveats and potential problematic processes: (1) rapid reduction of reservoir pressure decreases CO_2 density, potentially leading to accelerated buoyancy effects, (2) premature CO_2 breakthrough may occur in pressure reduction wells, (3) pressure reduction decreases solubility of CO_2 in the formation water, potentially leading to exsolution and undesired phase changes, and (4) finally, a detailed cost analysis must accompany such an engineering approach, because reservoir pressures directly affect compression and injection costs, e.g., it is possible that pressure reduction wells may reduce or increase net costs of injection, depending on costs associated with water production and handling at the pressure reduction wells. [The authors] will show results of this sequestration field engineering approach for specific field tests, including ongoing geologic sequestration field-testing in several U.S. sites, including projects in Utah, New Mexico, and Texas." **Brian J. McPherson, Weon Shik Han, Si-Yong Lee, Chuan Lu, and Richard P. Esser**, Presented at GHGT-9, held November 16-20, 2008, at the Omni Shoreham Hotel in Washington, DC, United States, https://www4.eventsinteractive.com/iea/viewpdf.esp?id=270005&file=%5C%5Cserenity%5CEP11%24%5CEventwin%5CPool%5Coffice27%5Cdocs%5Cpdf%5Cghgt%5F9Final00905%2Epdf.

"A coupled reservoir-geomechanical simulation study of CO_2 storage in a nearly depleted natural gas reservoir."

The following is the abstract of this article: "Atzbach-Schwanenstadt natural gas field located in Upper Austria Molasse Foreland basin was one of the four European sites selected for subsurface CO_2 storage feasibility/performance evaluation in the recently completed EU-funded research project CASTOR. The objectives of the coupled reservoir-geomechanical modeling effort at Atzbach-Schwanenstadt gas field were: 1) evaluation of the hydro-mechanical response of the reservoir rock and overburden formations to historical and current gas production rates, different CO_2 injection scenarios and its long-term storage; and 2) assessment of the potential for shear failure and/or re-activation of pre-existing faults as a result of changes in the reservoir pressure due to natural gas production and CO_2 injection. The simulation results in terms of changes in the reservoir stresses and associated reservoir compaction/uplifting are presented and their likely impact on reservoir integrity discussed. The widely used Mohr-Coulomb shear failure analysis was carried out for the gas reservoir undergoing reservoir pressure depletion and then re-pressurization due to CO_2 injection, in particular under the regional strike-slip fault stress regime relevant to the gas field. An equation was derived to estimate the maximum sustainable pore pressure under different horizontal/vertical stress ratios and rock strength properties, with reference to the stress path hysteresis during reservoir re-pressurization." **Ji-Quan Shi and Sevket Durucan**, Presented at GHGT-9, held November 16-20, 2008, at the Omni Shoreham Hotel in Washington, DC, United States, https://www4.eventsinteractive.com/iea/viewpdf.esp?id=270005&file=%5C%5Cserenity%5CEP11%24%5CEventwin%5CPool%5Coffice27%5Cdocs%5Cpdf%5Cghgt%5F9Final00100%2Epdf.

Terrestrial

"The effect of reduced tillage agriculture on carbon dynamics in silt loam soils."

The following is the abstract of this article: "Reduced tillage (RT) agriculture is an effective measure to reduce soil loss from soils susceptible to erosion in the short-term and is claimed to increase the soil organic carbon (SOC) stock. The change in distribution and total SOC stock in the 0-60 cm layer, the stratification of microbial biomass carbon (MB-C) content in the 0-40 cm layer and the carbon mineralization in the upper 0-5 cm layer in silt loam soils in Western Europe with different periods of RT agriculture were evaluated. Ten fields at seven locations, representing the important RT types and maintained for a different number of years, and eight fields under conventional tillage (CT) agriculture with similar soil type and crop rotation were selected. RT agriculture resulted in a higher stratification of SOC in the soil profile than CT agriculture. However, the total SOC stock in the 0-60 cm layer was not changed, even after 20 years [of] RT agriculture. The MB-C was significantly higher in the 0-10 cm layer under RT agriculture, even after only [five] years, compared to CT agriculture. The higher SOC and MB-C content in the upper 0-5 cm layer of RT fields resulted in a higher carbon mineralization rate in undisturbed soil in the laboratory. Simulating ploughing by disturbing the soil resulted in inconsistent changes (both lower and higher) of carbon mineralization rates. A crop rotation with root crops, with heavy soil disturbance every two or three years at harvest, possibly limited the anticipated positive effect of RT agriculture in our research." **Karoline D'Haene, Steven Sleutel, Stefaan De Neve, Donald Gabriels, and Georges Hofman**, *Earth and Environmental Science*, Available online December 30, 2008, doi:10.1007/s10705-008-9240-9, http://www.springerlink.com/content/qjl77371v5868313/?p=7f041d14542a4b9eab90a3c2739555e9&pi=2. (Subscription required.)

TRADING

Carbon Market Update, January 12, 2009	
CCX-CFI 2008 ($/tCO$_2$) $1.80 (Vintage 2009)	EU ETS-EUA DEC 2008 ($/tCO$_2$) $18.30 (Converted from € to US$)

***RGGI News Release*, "RGGI States' CO_2 Auction Continues Strong Performance."**

On December 17, 2008, the 10 northeastern and mid-Atlantic states participating in the Regional Greenhouse Gas Initiative (RGGI) held their second auction of CO_2 emissions allowances in the United States. All of the 31,505,898 allowances offered for sale were sold at $3.38 per allowance for a total of $106.5 million. The funds will be distributed to the 10 RGGI states and invested in energy efficiency and clean energy technologies. According to RGGI, 69 participants form the energy, financial, and environmental sectors took part in the bidding, which had a demand for the allowances at 3.5 times the available supply. Following the auction, RGGI released the "Post-Settlement Auction Report," which states that the auction was administered in a fair and transparent manner and in accordance with the noticed auction procedures. According to the report, compliance entities and their affiliates accounted for more than 80 percent of the quantity of bids submitted; a total of 46 entities won allowances and bid prices ranged from $1.86 (the minimum bid allowed) to $7.20. RGGI also issued a notice for Auction 3, which will be held on March 18, 2009. The notice can be found at: http://www.rggi.org/docs/Auction_Notice_Jan_12_2009.pdf. The complete Post-Settlement Auction Report for the RGGI CO_2 Allowance Auction 2 is available at: http://www.rggi.org/news/releases. December 19, 2008, http://www.rggi.org/docs/Auction_2_Release_Final_08_12_19b.pdf.

RECENT PUBLICATIONS

"Greenhouse Gas Offsets in a Domestic Cap-and-Trade Program."

The following is a summary of this document: "This brief presents the key issues and identifies options for the incorporation of GHG offsets into emerging U.S. climate change policy. A GHG offset represents a reduction, avoidance, destruction, or sequestration of GHG emissions from a source not covered by an emission reduction requirement. The elimination of GHG emissions can be converted into tradable offset credits, and cap-and-trade programs can be designed to permit firms to use these credits to meet their compliance obligations. A carefully crafted and implemented offset program can significantly reduce cap-and-trade compliance costs by providing lower cost emission reduction options. Yet, while economic modeling has shown that incorporation of offsets into a cap-and-trade program can significantly reduce costs and allowance prices, their inclusion is not without controversy or complication. Some are concerned that offset inclusion will reduce the price signal to the point that the innovation and technological change needed to address the climate problem will be diminished. Others focus on the difficulty associated with substantiating offsets as real emission reductions. Important considerations in designing offset programs include the way in which offsets are defined; the types, location and quantity of offsets allowed; and the methods for assessing and crediting projects. Generally speaking, offset projects come in three distinct types: (1) direct emission reductions, (2) indirect emission reductions, and (3) sequestration. Before a project can create an offset credit, the emission reductions should meet all of the following criteria: they must be real, measurable, additional, permanent, monitored, independently verified, measured from a credible baseline, not represent leakage, and be able to convey as a clear property right. Additionality is perhaps the most important yet complicated issue, as it requires an assessment of what would have happened in the absence of the project. Offset project assessments can be either project specific or standardized. A hybrid assessment approach, which uses some standardization methodologies but allows for a degree of flexibility in assessing projects, may be the most effective. Each of these important factors for creating high quality offsets are discussed in this brief." To read the entire policy brief, click: http://www.pewclimate.org/docUploads/DDCF-Offsets.pdf.

"From EOR to CCS: The Evolving Legal and Regulatory Framework for Carbon Capture and Storage."

The following is the Synopsis of this document: "Carbon capture and storage has been proposed around the world as a potentially key technology for reducing CO_2 emissions. The United States oil and gas industry has a long experience in transporting, injecting, and effectively storing CO_2 in tertiary oil recovery operations usually known as [EOR]. As a result, there already exists a legal and regulatory framework that addresses many – but not all – of the issues that will need to be addressed if [CCS] is to be adopted by policymakers as part of a carbon regulation regime. A review of that existing framework allows identification of those aspects that appear adequate to govern the sale, transport, and injection of CO_2 for [CCS] purposes as well as those that do not. Building on this analysis, the authors conclude that the current legal framework will be largely adequate from a transactional and interim standpoint to allow parties to structure a relatively seamless transition from CO_2 storage that is an incidental result of oil production operations to those incremental injections of CO_2 intended solely for permanent underground storage. The authors also suggest some possible approaches for crafting new rules to fill potentially remaining legal or regulatory gaps." To view the entire document, click: http://www.marstonlaw.com/index_files/From%20EOR%20to%20CCS.pdf.

Recent Publications - Continued

"Carbon Capture and Sequestration: Framing the Issues for Regulation."
The following is from the Executive Summary of this document: "When fossil fuel (coal, oil and gas) is burned, much of the CO_2 that is produced stays in the atmosphere for over 100 years. In order to stabilize the atmospheric concentration of CO_2, [humans] must reduce emissions approximately 80 [percent] from current levels, otherwise the atmospheric concentration of CO_2 will continue to grow. While renewable and other low-carbon energy technology will help, for at least the next half century [humans] will also have to continue to use fossil fuel. Fortunately, there is technology that will allow [humans] to capture the CO_2 before it is released, and 'sequester' it permanently several thousand feet or more underground in appropriate geological formations. This process is called [carbon capture and sequestration]. CCSReg is an interdisciplinary project to develop recommendations for how best to regulate the process of capturing CO_2, transport it in pipelines, and sequester it safely and securely in appropriate deep geological formations. The project is anchored in the Department of Engineering and Public Policy at Carnegie Mellon, and involves co-investigators at the Institute for Energy and the Environment at the Vermont Law School, the Hubert H. Humphrey Institute of Public Affairs at the University of Minnesota, and the Washington, DC law firm of Van Ness Feldman. A list of project investigators is provided on page ii of the report. This interim report is not designed to provide answers. Rather it frames the issues that the CCSReg project team believes must be considered if CCS is to be safely and effectively developed." The complete CCSReg report is available at: http://www.ccsreg.org/pdf/CCSReg_12_28.pdf.

Legislative Activity

***Yahoo*, "Wyoming to Continue Work on Carbon Storage Bills,"** and ***Casper Star-Tribune*, "Carbon Storage Bills Could Protect Wyo Coal."**

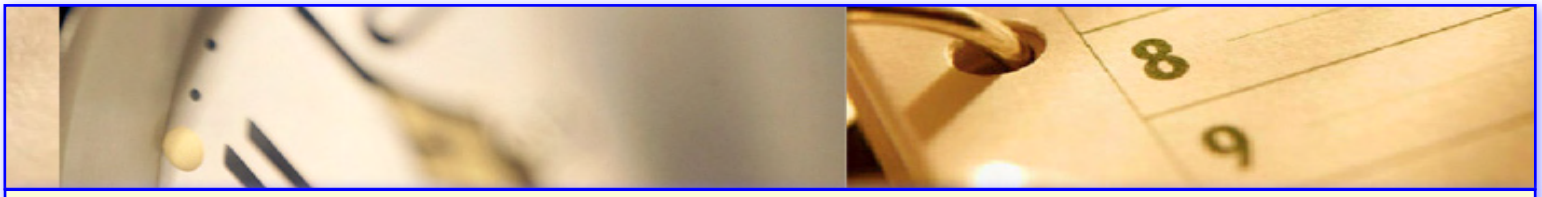
The Joint Judiciary Interim Committee of the Wyoming Legislature sponsored three new carbon storage-related bills that gained approval on January 15, 2009. They build upon legislation passed in 2008 for regulating the underground storage of CO_2 emissions from coal plants and other sources. One bill ensures responsibility remains with those who inject CO_2 emissions. The second bill will prohibit the injecting of CO_2 in areas with recoverable hydrocarbon deposits without permission of the owner of the deposits. The third bill will specify the mineral portion of the real estate takes legal precedence over the carbon storage portion. The previous bills passed by Wyoming's Legislature, which were some of the Nation's first bills to regulate various aspects of CCS, established that Wyoming's Department of Environmental Quality will oversee carbon storage projects and that the owners of the surface property also own the underground storage rights. December 30, 2008, http://finance.yahoo.com/news/Wyoming-to-continue-wo.html, and January 15, 2009, http://www.trib.com/articles/2009/01/15/news/wyoming/433026826eec35ad872575400006c627.txt.

***Chicago Tribune*, "Iowa Council Releases Plan to Cut Greenhouse Gases,"** and ***Des Moines Register*, "Climate Change Report Proposes $4.8 Billion in Programs."**

The 23-member Iowa Climate Change Advisory Council (ICCAC) presented a report on January 2, 2009, that suggests methods for reducing GHG emissions by as much as 90 percent by 2050. In the first of two scenarios the report proposes, the state would plan a 50 percent reduction of emissions by 2050, with interim goals of one percent by 2012 and 11 percent by 2020. In the second scenario, the state would plan a 90 percent reduction of emissions by 2050, with interim goals of three percent by 2012 and 22 percent by 2020. The report also includes 56 policy options that would help meet the second scenario goals. Both scenarios are based on 2005 numbers and projections supplied by the non-profit Center for Climate Strategies. The proposals would require the energy industry, which accounts for 31 percent of the state's GHG emissions, to reduce CO_2 emissions and increase renewable energy sources. To view the ICCAC report, click: http://www.iaclimatechange.us/capag.cfm. January 2, 2009, http://www.chicagotribune.com/news/chi-ap-ia-stateclimaterepor,0,1689286.story, and January 2, 2009, http://www.desmoinesregister.com/article/20090102/NEWS/90102013/1001.

Events

February, 1-4, 2009, **EUEC 2009 – 12th Annual Energy & Environment Conference & Expo**, *Phoenix Convention Center, Phoenix, Arizona, USA*. This event offers attendees more than 400 technical presentations by leading experts in concurrent sessions on clean air, mercury, global warming, the environment, and renewable energy. Among the topics to be addressed: risks and opportunities in emerging climate change law and policy; global climate change; and global carbon markets. To view the extensive conference agenda, visit: http://www.euec.com/downloads/DraftProgram2009.pdf.



Events (Continued)

February 3-4, 2009, **Carbon & Climate Change Conference,** *AT&T Conference Center, Austin, Texas, USA*. This program covers carbon markets, the emerging technologies and economics of CO_2 capture, regulation of emissions, and storage and transport. There will also be a special project development panel addressing the financial and legal issues in combined EOR/sequestration projects. Impacts on the power sector, smart grids, and the measurement and benchmarking of carbon footprints will also be covered. To view the event program, go to: http://www.utcle.org/conferences/CH09.

February 10-12, 2009, **CO_2 Geological Storage Modeling Workshop**, *BRGM, Orleans, France*. This workshop will unite specialist modeling practitioners from industrial and research organizations across the world to address current approaches to modeling, available software tools for modeling, whether current models provide the necessary results to inform risk assessments, whether modeling technologies can fulfill likely regulatory requirements, current knowledge gaps, and future research. The scale effects of various processes, parameterization, and the incorporation of leakage pathways to overburden into reservoir models will also be discussed. Further details and a workshop agenda are available at: http://www.co2captureandstorage.info/networks/1stmodelling.htm.

February 18-19, 2009, **International Conference on CCS Regulation for the EU and China**, *Centre Albert Borschette, Brussels, Belgium*. This conference will examine the opportunities and challenges to CCS regulation in the EU and the possibilities of future cooperation between the EU and China on this issue. The primary agenda discussions will include: safety and liability, site qualification, incentivization, and EU-China Cooperation. For more information, go to: http://www.euchina-ccs.org/events.php.

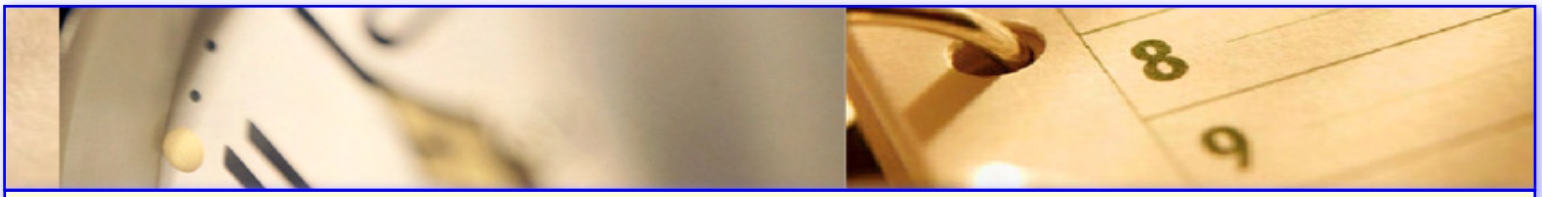
February 26-27, 2009, **3rd Annual Carbon Capture and Storage**, *Hilton Brussels, Brussels, Belgium*. Platts' 3rd Annual European Capture and Storage conference will bring together members of the CCS community to debate and discuss topics to secure the future of CCS. Some of the issues to be discussed: international CCS case studies; creating value in CCS through finance and investment; the importance of mobilizing the supply chain to the successful deployment of CCS; and storage selection and liability. For more information, go to: http://www.platts.com/Events/2009/pc965/index.xml.

February 26-27, 2009, **3rd Annual Global CO_2 Cap and Trade Forum**, *The Fairmont San Jose, San Jose, California, USA*. The 3rd Annual Global CO_2 Cap and Trade Forum will cover CO_2 mitigation through CO_2 emission markets, policy, regulatory issues, and practical solutions. Attendees will be able to network with strategists, policymakers, and government and non-governmental organizations. To learn more, click: http://www.insightinfo.com/index.cfm?ci_id=25778&la_id=1.

March 6-7, 2009, **MIT Energy Conference**, *Marriott Hotel in Kendall Square, Cambridge, Massachusetts, USA*. The goal of this Massachusetts Institute of Technology (MIT) conference is to develop solutions for the challenges facing today's energy markets. To learn more about the conference, visit: http://www.mitenergyconference.com/friday.htm.

March 16-17, 2009, **International Standards to Promote Energy Efficiency and Reduce Carbon Emissions**, *OECD Conference Centre, Paris, France*. This workshop brings together leading policymakers, standardization professionals, and the private sector to discuss the areas of standardization that will be required to support energy efficiency and carbon reduction objectives. This event hopes to strengthen standardization efforts and the potential of energy efficiency gains. To learn more, click: http://www.iea.org/Textbase/work/workshopdetail.asp?WS_ID=400.

March 17-19, 2009, **Carbon Market Insights 2009**, *Bella Center in Copenhagen, Denmark*. This event will examine the impact(s) that the global economy is having on carbon markets and the effect(s) international policy will have on reaching a new climate agreement. All market aspects – from carbon trading to the voluntary carbon trading market – will be covered. For more information, go to: http://www.pointcarbon.com/events/conferences/cmi09/1.986082/.



EVENTS (CONTINUED)

March 19-21, 2009, **ENVIROENERGY 2009: International Conference on Energy and Environment**, *Taj Chandigarh, Chandigarh, India*. This international conference aims at addressing the challenges related to energy and environment. The conference agenda will focus on environmental policies, identification of green technologies, and their subsequent implementation for sustainable development. To learn more about ENVIROENERGY 2009, click: http://www.enviroenergy2009.org/.

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