NETL

Carbon Sequestration Newsletter

A Call for Abstracts

see page 3

May 2010

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

***Fossil Energy Techline*, "Illinois CO_2 Injection Project Moves Another Step Forward."**

The Midwest Geological Sequestration Consortium (MGSC) recently completed a 3-D seismic survey at a large-scale carbon capture and storage (CCS) test site in Decatur, Illinois. The survey, which will determine the geometry and internal structures of the deep, underground saline formation where carbon dioxide (CO_2) will be injected, is an important step toward the project's planned early 2011 startup. The project will capture CO_2 from the Archer Daniels Midland (ADM) Ethanol Production Facility and inject it into a deep saline reservoir more than one mile underground. Beginning in early 2011, up to 1 million metric tons of the captured CO_2 will be compressed into a dense, liquid-like state and injected over a three-year period. The Mt. Simon Sandstone, which is the rock formation targeted for the injection, is the thickest and most widespread saline reservoir in the Illinois Basin, with an estimated CO_2 storage capacity as high as 110 billion metric tons. Analysis of the survey data is a key component in the comprehensive monitoring program that will be implemented to ensure the injected CO_2 is safely and permanently stored. In addition, the survey data will serve as a baseline for reservoir and fluid distribution, provide information to identify any fault networks in or above the injection zone, and be used to predict where additional geophysical surveys should be deployed as CO_2 is injected. To learn more about the U.S. Department of Energy's (DOE) Regional Carbon Sequestration Partnership (RCSP) Program, go to: http://fossil.energy.gov/programs/sequestration/partnerships/index.html. March 15, 2010, http://fossil.energy.gov/news/techlines/2010/10009-Illinois_CO2_Project_Moves_Forward.html.

***White House Press Release*, "Interagency Carbon Capture and Storage Task Force."**

Following a memorandum sent by President Barack Obama to the heads of 14 Executive Departments and Federal Agencies that established an Interagency Task Force on CCS, the White House Council on Environmental Quality, DOE, and U.S. Environmental Protection Agency (EPA) announced the launch of a website for the task force. The task force will develop a comprehensive and coordinated Federal strategy to accelerate the commercial development and deployment of CCS technologies. By August 2010, the task force will propose a plan for overcoming the barriers to the widespread and cost-effective deployment of CCS within 10 years, while bringing five to 10 commercial demonstration projects online by 2016. To view the Presidential Memorandum, titled, "A Comprehensive Federal Strategy on Carbon Capture and Storage," click: http://www.whitehouse.gov/the-press-office/presidential-memorandum-a-comprehensive-federal-strategy-carbon-capture-and-storage. April 2, 2010, http://www.whitehouse.gov/administration/eop/ceq/initiatives/ccs.

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Sequestration in the News

***University of Calgary News Release*, "Greenhouse Gas Storage Capacity Not a Problem."**

According to a new University of Calgary study, it is technologically feasible to store a large amount of CO_2 deep underground in central Alberta. Coordinated by the Institute for Sustainable Energy, Environment, and Economy (ISEEE), the Wabamun Area CO_2 Sequestration Project (WASP) is one of the most comprehensive studies of large-scale CO_2 storage to have its findings made public. The WASP study was conducted over 16 months to examine the feasibility, cost, and potential risk of permanently storing 20 million tonnes of CO_2 underground annually for 50 years in a 5,500-kilometer area. The researchers believe that further investigation is required before initiating a commercial-scale operation to store the CO_2 in rock formations deep beneath the Wabamun area of Alberta, Canada. The study also found that the costs of injecting and storing the CO_2 would be about $3 per tonne; however, that cost would multiply by 10 for a full CCS project, as the CO_2 would need to be pressurized and transported. Approximately half of the targeted storage capacity (about 500 million tonnes of CO_2) can be accomplished without managing the pressure of the geologic formation. The study used existing geological, seismic, and other data to examine the Nisku geologic formation as the primary target for CO_2 storage. (**See Recent Publications section for a portion of the Introduction and a link to University of Calgaryôs WASP Project.**) March 12, 2010, http://www.ucalgary.ca/wasp/PressRelease12-03.pdf.

***Carbon Capture Journal*, "DNV Releases CO_2 Storage Guideline."**

DNV has developed a comprehensive guideline for safe and sustainable geological CO_2 storage. With contributions from government agencies, "The CO2QUALSTORE Guideline for Selection, Characterization, and Qualification of Sites and Projects for Geological Storage of CO_2" provides a tailored regulatory framework that covers the full lifecycle of a CO_2 storage project. While taking into account the specific characteristics of each potential site, the guidelines are provided for screening and site selection to closure and transfer of responsibility from the operator back to the national state. The goal is to hasten the implementation of CCS by providing a common, predictable, and transparent basis for decision making. In addition to benefiting the project developers, operators, and regulators, compliance with this guideline is expected to assure the general public that selected storage sites will be safely and responsibly managed. DNV plans to periodically update the CO_2 storage guideline. To view the guideline, visit: http://www.dnv.com/binaries/CO2QUALSTORE_guideline_tcm4-412142.pdf. April 7, 2010, http://www.carboncapturejournal.com/displaynews.php?NewsID=553&PHPSESSID=ajnj7576q9ignclvm4q52hio51.

Sequestration in the News (Continued)

***News-Leader.com*, "Drilling to Start for Carbon Sequestration Project."**

City Utilities (CU) is set to initiate Phase II of a project that will drill a 2,000-foot deep well into saltwater-saturated rock to test the feasibility of injecting food-grade CO_2 for geologic storage beneath its Southwest Power Station. The project received $2.4 million in 2008 to determine the potential of the geologic formations to store CO_2. This work followed an initial assessment by the Missouri University of Science and Technology in 2006 that concluded the Lamotte Sandstone beneath CU's Southwest Power Station holds the potential for shallow CO_2 storage. CU is partnering with several utilities and Missouri State University, Missouri University of Science and Technology, and the Missouri Department of Natural Resources. For more information, go to: http://www.cityutilities.net/renewable/carbon.htm. April 7, 2010, http://www.news-leader.com/article/20100407/NEWS01/4070447/1007/NEWS01/Drilling-to-start-for-carbon-sequestration-project.

Announcements

Call for Abstracts.
The 2010 Behavior, Energy, and Climate Change (BECC) Conference, which will be held November 14-17, 2010, in Sacramento, California, is seeking abstracts for formal presentations and short talks focused on the practical applications of social and behavioral research to achieve viable solutions to energy/climate challenges. The deadline for abstracts is May 15, 2010. For more details, visit the conference website at: http://www.beccconference.org/.

Wyoming EOR Reservoir Database Updated.
The updated Wyoming Enhanced Oil Recovery (EOR) Database Version 2.1 was released on March 16, 2010. The new reservoir field database, which includes interactive mapping, can be found at: http://eori.gg.uwyo.edu/Internet%20Mapping.asp. To view the updated EOR reservoir database, visit: http://eori.gg.uwyo.edu/database.asp.

RGGI States Issue Notice for June 2010 CO_2 Allowance Auction.
The 10 Northeast and Mid-Atlantic states participating in the Regional Greenhouse Gas Initiative (RGGI) released the Auction Notice and application materials for the second quarterly CO_2 allowance auction to be held on June 9, 2010. A reserve price of $1.86 will be used for the 40,685,585 CO_2 allowances on sale for the current control period (2009-2011) and the 2,137,993 CO_2 allowances on sale for the future control period (2012-2014). To view RGGI's news release, click: http://www.rggi.org/docs/Auction_8_Notice_Release_FINAL.pdf.

ETI Launches "Next Generation" CCS Project.
The Energy Technologies Institute (ETI) launched a research project designed to accelerate the development of CCS. The updated technology is expected to be capable of capturing a higher proportion of greenhouse gas (GHG) emissions than current technologies. For more information, click: http://www.businessgreen.com/business-green/news/2259886/eti-launches-generation-ccs.

EPA Finalizes 2008 U.S. GHG Inventory.
EPA released the 15th annual "U.S. Greenhouse Gas Inventory Report," which shows a 2.9 percent decrease in overall emissions from 2007 to 2008 due to the drop in CO_2 emissions associated with fuel and electricity consumption. In 2008, total emissions of the six primary GHGs (CO_2, methane [CH_4], nitrous oxide [NO_X], hydrofluorocarbons [HFCs], perfluorocarbons [PFCs], and sulfur hexafluoride [SF_6]) were equivalent to 6,957 million metric tons of CO_2. Although overall emissions dropped in 2008, emissions remain 13.5 percent higher than the 1990 total. For more details, visit: http://yosemite.epa.gov/opa/admpress.nsf/0/B57052C72AB2DA3E852577060059E04E.

Science

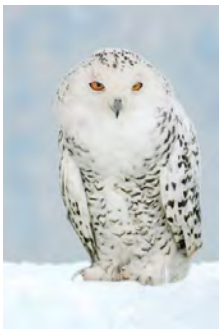
***Science Daily*, "Earlier Butterfly Emergence Linked to Climate Change."**

According to a University of Melbourne study, butterflies are emerging in spring more than 10 days earlier than they were 65 years ago, which scientists believe is the result of climate change. The study found that the mean emergence date for adults of the Common Brown butterfly has shifted approximately 1.6 days earlier per decade over the past 65 years. The results of the study are believed to be the first link between the increase of GHG emissions, warming temperatures, and the altered timing of a natural event. The early arrival coincides with an increase in air temperatures in the same area of approximately 0.14°C per decade, which, according to scientists, is shown to be human-induced. To arrive at their conclusions, scientists raised caterpillars in a laboratory to measure the physiological impact of temperature on the rate of development. The data was used to model the effect of historical climate trends in Melbourne on the speed of the butterfly's development. Then, to examine whether natural climate change variability or human influence was more likely to have caused the climate change,

Science (Continued)

the results were combined with the global climate model outputs for the same area over the same time period. The study, titled, "Early emergence in a butterfly casually linked to anthropogenic warming," can be found at: http://rsbl.royalsocietypublishing.org/content/early/2010/03/09/rsbl.2010.0053. March 19, 2010, http://www.sciencedaily.com/releases/2010/03/100318132510.htm.

***Science Daily*, "Warmer Summers Could Create Challenges for Nesting Arctic Seabirds."**



A warmer, wetter climate in the Canadian Arctic could create problems for nesting seabirds, according to a team of Canadian scientists. The study, which was published in *Arctic*, the journal of the Arctic Institute of North America, is based on observations of six species of birds on 11 different seabird colonies in the eastern Arctic. The group of Canadian scientists spent more than 7,000 days observing the birds, combining 33 years of observations. They found that Arctic birds, which have adapted to survive in the cold, dry high Arctic summers, typically spend the winter floating in the North Atlantic Ocean, returning to the Arctic in the spring to nest. However, temperatures in the Arctic have been rising, creating stronger storm fronts, heavy fog and winds, rain, freezing rain, and wet snow. Scientists tracked the mortality rates of the Arctic seabirds and predicted that a warming climate could have serious consequences to the species' survival. March 24, 2010, http://www.sciencedaily.com/releases/2010/03/100324113538.htm.

Policy

***U.S. Environmental Protection Agency News Release*, "EPA Proposes to Add Sources to Greenhouse Gas Reporting System/ Requirements Target Potent and Persistent Greenhouse Gases."**

EPA is proposing to include emissions data from the oil and natural gas sector and from facilities that inject and store CO_2 underground for the purposes of geologic storage or enhanced oil and gas recovery (EOR/EGR) in its first-ever national mandatory GHG reporting system. The rule currently requires 31 industry sectors, covering 85 percent of total GHG emissions in the United States, to track and report their emissions. The data collected from facilities that inject CO_2 underground would enable EPA to track the amount of CO_2 that is injected and allow businesses to track their own emissions, compare them to similar facilities, and identify cost-effective methods to reduce future emissions. Under these proposals, newly covered sources would begin collecting emissions data on January 1, 2011, with the first annual reports submitted to EPA on March 31, 2012. EPA finalized the first-ever mandatory GHG reporting requirement in October 2009. March 23, 2010, http://yosemite.epa.gov/opa/admpress.nsf/e77fdd4f5afd88a3852576b3005a604f/8d717a8525394687852576ef00595ffc!OpenDocument.

***Carbon Capture Journal*, "UK Launches CCS Industrial Strategy."**

The United Kingdom (UK) Government recently published their CCS Industrial Strategy, which outlines plans to set up a CCS industry worth up to $8.8 billion by 2030. An Office of Carbon Capture and Storage (OCCS) within the Department of Energy and Climate Change (DECC) has also been set up for the facilitation of CCS activities in the UK. One of the first activities of OCCS will be the development of a CCS Roadmap. In addition, the report addresses how to provide an opportunity for project developers to propose co-located capture projects and develop experience with CO_2 pipelines and CO_2 storage practices. (**See Recent Publications section for portion of the Executive Summary and a link to the CCS Industrial Strategy.**) March 17, 2010, http://www.carboncapturejournal.com/displaynews.php?NewsID=543&PHPSESSID=63e82fcv36ldqinmrm7jua0kn4.

"Lay perceptions of carbon capture and storage technology."

The following is the Abstract of this article: "The extent of social acceptance of CCS is likely to significantly influence the sustainable development of CO_2 storage projects. Acceptance of CCS by the key stakeholders (policymakers, the general public, the media and the local community), linked to specific projects, as well as how the technology is communicated about and perceived by the public, have become matters of interest for the social sciences. This article reports on an investigation of the public perception of CCS technology in Spain. Individuals' views on CCS are analyzed through focus groups with lay citizens using 'stimulus materials.' As the analysis shows, lay views of CCS differ significantly from the views of decision makers and experts. Public concerns and reactions to CCS technology and potential projects, as well as the degree of consensus on its acceptance or rejection are detailed. Implications for the future use of CCS are discussed." **C. Oltra, R. Sala, R. Solà, M. Di Masso, and G. Rowe**, *International Journal of Greenhouse Gas Control*, Available online March 11, 2010, doi:10.1016/j.ijggc.2010.02.001, http://www.sciencedirect.com/science/article/B83WP-4YK8MMV-1/2/c57bdeeb60b5edeb8f62f807f79f743c. (Subscription may be required.)

Geology

"Swelling of Coals by Supercritical Gases and Its Relationship to Sorption."

The following is the Abstract of this article: "If CO_2 can be sequestered in coal seams while simultaneously displacing coalbed methane (enhanced coalbed methane [ECBM]), some of the sequestration costs can be recovered through the production of CH_4. One potential difficulty with ECBM is that CO_2 is known to swell coal, which may reduce its permeability. Coals also swell in other gases, although not to the same extent. Here, [the authors] report on the swelling of subbituminous and bituminous coals in CO_2, CH_4, nitrogen (N_2), tetrafluoromethane (CF_4), ethane, and various noble gases. Helium and neon (Ne) induced negligible swelling; all other gases swelled the coals to varying degrees. The maximum swelling was proportional to the critical temperature of the gas, except for CF_4, which is attributed to its greater size, preventing it from penetrating the coal

Geology (Continued)

as completely as the other gases. This indicates that swelling of these coals by all of these gases has a similar basic mechanism; CO_2 is only different in the extent to which it swells coal. All coals swelled more in the direction perpendicular to the bedding plane than parallel to it, with the ratio of the swelling in each direction independent of pressure or gas type. Gas sorption and swelling in coal were found to be related according to a simple quadratic polynomial expression. The same relationship held for all of the coals and all gases investigated here. This means that swelling can be accurately predicted from the condensed volume of the gas adsorbed, regardless of the type of coal or gas." **Stuart Day, Robyn Fry, Richard Sakurovs, and Steve Weir**, *Energy & Fuels*, Available online March 16, 2010, doi:10.1021/ef901588h, http://pubs.acs.org/doi/abs/10.1021/ef901588h. (Subscription may be required.)

"Geologic assessment and injection design for a pilot CO_2-enhanced oil recovery and sequestration demonstration in a heterogeneous oil reservoir: Citronelle Field, Alabama, USA."

The following is the Abstract of this article: "CO_2 pilot injection studies, with site-specific geologic assessment and engineering reservoir design, can be instrumental for demonstrating both incremental [EOR] and permanent geologic storage of GHGs. The purpose of this paper is to present the geologic and reservoir analyses in support of a field pilot test that will evaluate the technical and economic feasibility of commercial-scale CO_2-[EOR] to increase oil recovery and extend the productive life of the Citronelle Oil Field, the largest conventional oil field in Alabama (SE USA). Screening of reservoir depth, oil gravity, reservoir pressure, reservoir temperature, and oil composition indicates that the Cretaceous-age Donovan sand, which has produced more than 169×106 bbl in Citronelle Oil Field, is amenable to miscible CO_2 flooding. The project team has selected an 81 ha (200 ac) [five]-spot test site with one central gas injector, two producers, and two initially temporarily abandoned production wells that are now in production. Injection is planned in two separate phases, each consisting of 6,804 t (7,500 short tons) of food-grade CO_2. The Citronelle Unit B-19-10 #2 well (Permit No. 3232) is the CO_2 injector for the first injection test. The 14-1 and 16-2 sands of the upper Donovan are the target zones. These sandstone units consist of fine to medium-grained sandstone that is enveloped by variegated mudstone. Both of these sandstone units were selected based on the distribution of perforated zones in the test pattern, production history, and the ability to correlate individual sandstone units in geophysical well logs. The pilot injections will evaluate the applicability of tertiary oil recovery to Citronelle Field and will provide a large volume of information on the pressure response of the reservoirs, the mobility of fluids, time to breakthrough, and CO_2 sweep efficiency. The results of the pilot injections will aid in the formulation of commercial-scale reservoir management strategies that can be applied to Citronelle Field and other geologically heterogeneous oil fields and the design of similar pilot injection projects." **Richard A. Esposito, Jack C. Pashin, Denise J. Hills, and Peter M. Walsh**, *Environmental Earth Sciences*, Available online March 10, 2010, doi:10.1007/s12665-010-0495-5, http://www.springerlink.com/content/726183q6h7341351/?p=893829d7de6548a2a7848d48fe10121b&pi=5. (Subscription may be required.)

"Navajo Sandstone-brine-CO_2 interaction: implications for geological carbon sequestration."

The following is the Abstract of this article: "The injection of CO_2 into deep saline [formations] is being considered as an option for GHG mitigation. However, the response of [a formation] to the injected CO_2 is largely unknown. Experiments involving the reaction of Navajo Sandstone with acidic brine were conducted at 200°C and 25 or 30 MPa to evaluate the extent of fluid-rock interactions. The first experiment examined sandstone interaction with CO_2-impregnated brine; the second experiment examined sandstone dissolution in CO_2-free acidic brine; the third one is carried out in a mixed-flow reactor and designed to measure sandstone dissolution rates based on time-series [silicon (Si)] concentrations. The solution chemistry data indicate that the [silicon dioxide (SiO_2)(aq)] increases gradually and pH increases slowly with reaction progress. Silicate minerals in the sandstone display textures (dissolution features, secondary mineralization), indicating that these phases are reacting strongly with the fluid. Dissolution of feldspars and conversion of smectite to illite are likely to be the two reactions that contribute to the release of SiO_2(aq). The product minerals present at the end of the experiments are illite, illite/smectite, allophane, and carbonate minerals (for the CO_2-charged system). Dissolved CO_2 is likely to acidify the brine and to provide a source of carbon for the precipitation of carbonate minerals. Mineral trapping through the precipitation of carbonate minerals is favored thermodynamically and was observed in the experiments. The chemical reactions likely increase the bulk porosity of the sandstone due to dissolution of silicate minerals. However, allophane and illite/smectite fill voids in sandstone grains. There is no evidence for the removal of clay coatings due to chemical reactions. It is uncertain whether the mechanical forces near an injection well would mobilize the smectite and allophane and clog pore throats. Trace amounts of metals, including [copper (Cu), zinc (Zn), and barium (Ba)], were mobilized." **Peng Lu, Qi Fu, William E. Seyfried Jr, Anne Hereford, and Chen Zhu**, *Environmental Earth Sciences*, Available online March 2, 2010, doi:10.1007/s12665-010-0501-y, http://www.springerlink.com/content/4716615w9361k231/?p=893829d7de6548a2a7848d48fe10121b&pi=9. (Subscription may be required.)

Technology

"High-resolution simulation and characterization of density-driven flow in CO_2 storage in saline aquifers."

The following is the Abstract of this article: "Simulations are routinely used to study the process of CO_2 sequestration in saline [formations]. In this paper, [the authors] describe the modeling and simulation of the dissolution-diffusion-convection process based on a total velocity splitting formulation for a variable-density incompressible single-phase model. A second-order accurate sequential algorithm, implemented within a block-structured adaptive mesh refinement (AMR) framework, is used to perform high-resolution studies of the process. [The authors] study both the short-term and long-term behaviors of the process. It is found that the onset time of convection follows closely the prediction of linear stability analysis. In addition, the CO_2 flux at the top boundary, which gives the rate at

Technology (Continued)

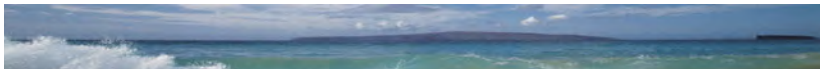
which CO_2 gas dissolves into a negatively buoyant aqueous phase, will reach a stabilized state at the space and time scales [the authors] are interested in. This flux is found to be proportional to permeability, and independent of porosity and effective diffusivity, indicative of a convection-dominated flow. A 3D simulation further shows that the added degrees of freedom shorten the onset time and increase the magnitude of the stabilized CO_2 flux by about 25 [percent]. Finally, [the authors'] results are found to be comparable to results obtained from TOUGH2-MP." **George S.H. Pau, John B. Bell, Karsten Pruess, Ann S. Almgren, Michael J. Lijewski, and Keni Zhang**, *Advances in Water Resources*, Available online February 4, 2010, doi:10.1016/j.advwatres.2010.01.009, http://www.sciencedirect.com/science/article/B6VCF-4Y9XM19-1/2/7a4fb2b870dd37307414661adc778083. (Subscription may be required.)

"CO_2 sequestration in coals and enhanced coalbed methane recovery: New numerical approach."

The following is the Abstract of this article: "Mixed gases injection into a large coal sample for CO_2 sequestration in coals and ECBM recovery was investigated using a new numerical approach. A dynamic multi-component transport (DMCT) model was applied to simulate ternary gas (CH_4-CO_2-N_2) diffusion and flow behaviors for better understanding and prediction of gas injection ECBM recovery processes. Several cases were designed to analyze the effects of injection gas composition and pressure on gas displacement dynamics in a large coal sample. The calculated results suggest that mixed gas injections have similar profiles of methane recovery as pure N_2 injection, and mixtures of N_2 and CO_2 reduce the ultimate methane recovery compared to pure CO_2. The breakthrough time of pure CO_2 injection is longer than mixed gas injections. Injection gas composition has significant effect on produced gas composition." **Xiaorong Wei, Paul Massarotto, Geoff Wang, Victor Rudolph, and Sue D. Golding**, *Fuel*, Available online February 4, 2010, doi:10.1016/j.fuel.2010.01.024, http://www.sciencedirect.com/science/article/B6V3B-4Y9TYBK-2/2/74555145111256c7ba2e93d67b6a89a1. (Subscription may be required.)

"Time-window-based filtering method for near-surface detection of leakage from carbon sequestration sites."

The following is the Abstract of this article: "[The authors] use process-based modeling techniques to characterize the temporal features of natural biologically controlled surface CO_2 fluxes and the relationships between the assimilation and respiration fluxes. Based on these analyses, [the authors] develop a signal-enhancing technique that combines a novel time-window splitting scheme, a simple median filtering, and an appropriate scaling method to detect potential signals of leakage of CO_2 from geologic carbon sequestration sites from within datasets of net near-surface CO_2 flux measurements. The technique can be directly applied to measured data and does not require subjective gap filling or data-smoothing preprocessing. Preliminary application of the new method to flux measurements from a CO_2 shallow-release experiment appears promising for detecting a leakage signa relative to background variability. The leakage index of ±2 was found to span the range of biological variability for various ecosystems as determined by observing CO_2 flux data at various control sites for a number of years." **Lehua Pan, Jennifer L. Lewicki, Curtis M. Oldenburg, and Marc L. Fischer**, *Environmental Earth Sciences*, Available online February 9, 2010, doi:10.1007/s12665-009-0436-3, http://www.springerlink.com/content/b55v485161121410/?p=3c5c743728ef4e6399e57e439e1e7d78&pi=20. (Subscription may be required.)



Terrestrial

"Tillage effects on soil organic carbon storage and dynamics Corn Belt of Ohio USA."

The following is the Abstract of this article: "No-till (NT) agriculture reduces soil disturbance, conserves soil and water, and lowers the cost of agricultural production. However, its role in soil organic carbon (SOC) sequestration can be soil and site specific. The applicability of the results from long-term tillage experiments (LTTEs) showing positive rate of carbon (C) sequestration is being questioned under large scale farmers' field conditions. Therefore, this study assessed the soil C dynamics under conventional till (CT) and NT practices using three LTTEs and three farmer's field sites in Ohio, USA with diverse soil types, and environmental and management conditions. The hypothesis tested was that reduced soil disturbance in NT management system enhances soil C sequestration in comparison to CT management. Soils were sampled (0-40 cm) from adjacent CT, NT and woodlot (WL) plots at each site. Total C and nitrogen (N) pools were calculated based on equivalent soil mass basis. The SOC was fractioned into old C and new (corn C) using $\delta^{13}C$ natural abundance. The CT soils had 26-55 [percent] lower SOC and [seven to] 34 [percent] lower N pool compared to forest soils. Most of the historic SOC and N losses in cultivated soils occurred within the plow (0-25 cm) layer. The SOC pool in the top 40 cm was significantly greater under NT than CT at LTTEs and Coshocton farm. There were no significant differences in SOC pool of the top 40 cm among CT and NT at Delaware and Hoytville farms. Old C accounted for 69 [percent] and 66 [percent] of SOC under CT and NT, respectively at Northwestern Agricultural Research Station. However, at Western Agricultural Research Station, corn-derived C dominated CT and NT soils, accounting for 55 [percent] and 66 [percent] of SOC in the top 40 cm, respectively. At North Appalachian Experimental watersheds, corn-derived C dominated NT soils (64 [percent]), while old C dominated CT soils (64 [percent]). Result of this study indicated that a decrease in SOC and N pools occurs when forest soil is cultivated. Conversion of CT to NT restores some of the depleted SOC and N pools. This supports [the authors'] hypothesis that the reduced soil disturbance in NT system slows the decomposition of SOC which increases soil C sequestration. The quantity and rate of loss or

Terrestrial (Continued)

sequestration depends on several factors including soil type, texture and drainage, tillage intensity, and duration of NT practice." **Umakant Mishra, David A.N. Ussiri, and Rattan Lal**, *Soil and Tillage Research*, Available online March 17, 2010, doi:10.1016/j.still.2010.02.005, http://www.sciencedirect.com/science/article/B6TC6-4YMHFJT-1/2/9d3531c0d4aeb37611729f2c41d4d192. (Subscription may be required.)

Trading

Carbon Market Update, April 9, 2010	
CCX-CFI 2010 ($/tCO$_2$)	EU ETS-EUA DEC 2010
$0.10 (Vintage 2010)	($/tCO$_2$) $13.68
	(Converted from € to US$)

***The Independent*, "Tokyo Launches Asia's First Carbon Emissions Trade Scheme,"** and ***United Press International*, "Tokyo Adopts Carbon-Trading Scheme."**

Tokyo launched Asia's first mandatory cap-and-trade scheme on April 1, 2010, in an effort to reduce the city's CO_2 emissions by 25 percent from 2000 levels by 2020. Businesses in Tokyo will have to cut CO_2 emissions by six to eight percent from 2010 to 2014, compared with their highest three-year average from 2002 to 2007. In Phase II of the plan (FY 2015 to 2019), commercial buildings and factories would be required to cut emissions by 17 percent from base-year levels. Businesses in Tokyo can comply with the emissions targets by implementing their own energy-saving measures; purchasing emissions credits from other entities that have reduced their emissions beyond obligatory levels; purchasing credits earned through reduction efforts by small- and medium-sized Tokyo companies; or purchasing renewable energy certificates issued by power generators. Trading under the mandatory cap-and-trade system will begin in FY 2011. April 4, 2010, http://www.independent.co.uk/environment/tokyo-launches-asias-first-carbon-emissions-trade-scheme-1935627.html, and April 8, 2010, http://www.upi.com/Science_News/Resource-Wars/2010/04/08/Tokyo-adopts-carbon-trading-scheme/UPI-39261270751006/.

"Estimates of GHG emission reduction potential by country, sector, and cost."

The following is the Abstract of this article: "In this study, emission reduction potentials in GHG are assessed by country, sector, and cost using a GHG emission reduction assessment model with high resolutions with respect to region and technology and high consistency in terms of assumptions, interrelationships, and solution principles. Model analyses show that large potential reductions can be achieved at low cost in developing countries and power sectors. In addition, cost-efficient emission reductions were evaluated for some international emission reduction targets that have been derived on the basis of the principle of common but differentiated responsibilities among developed and developing countries. If (1) emission reduction measures at negative costs and below 50 $/tCO$_2$ for developed countries, (2) intensity improvement measures for selected sectors at negative costs and below 20 $/tCO$_2$ for major developing countries, and (3) all emission reduction measures with negative costs for other developing countries in 2020 are adopted, then emission reductions of 8.9, 14.8, and 27.7 GtCO$_2$ eq./yr compared to the technology-frozen case can be expected in developed countries, major developing countries, and globally, corresponding to a 11 [percent] decrease, 40 [percent] increase, and 17 [percent] increase from 2005 levels, respectively. Large-scale emission reductions can be achieved even if CO_2-intensity targets for major sectors are assumed for major developing countries." **Keigo Akimoto, Fuminori Sano, Takashi Homma, Junichiro Oda, Miyuki Nagashima, and Masanobu Kii**, *Energy Policy*, Available online March 2, 2010, doi:10.1016/j.enpol.2010.02.012, http://www.sciencedirect.com/science/article/B6V2W-4YH9YSC-1/2/4f71ecec7b325c56e3a1993128f3f4e5. (Subscription may be required.)

Recent Publications

Wabamun Area CO_2 Sequestration Project (WASP).

The following is from the Introduction of this document: "In order to properly assess the storage capacity, injectivity, and confinement of potential deep saline [formations] in the Wabamun region it is critical to construct a static geological model that characterizes the Nisku [formation] with sufficient accuracy. The model, presented in this section of the report, provides a working understanding of potential repositories, traps, and sealing mechanisms that will be needed to design and implement a CO_2 injection project in the area of interest. As with most geocellular models, it incorporates geological information (stratigraphy, facies mapping, and structure) with estimates of critical flow parameters (e.g., porosity and permeability) at all locations. This model serves as the basis for the fluid flow simulations – a key exercise in predicting the potential for CO_2 injection and storage in the targeted [formations]." More information on the WASP Project is available at: http://www.ucalgary.ca/wasp/. The complete document is available at: http://www.ucalgary.ca/wasp/WASP-FinalReport_(Full).pdf.

Clean Coal: An Industrial Strategy for the Development of Carbon Capture and Storage across the UK.

The following is from the Executive Summary of this document: "The development of CCS in the UK, starting with coal-fired power stations, presents a major opportunity for UK businesses to capitalize on an expanding global industry. The International Energy Agency's (IEA)

Recent Publications (Continued)

CCS roadmap foresees a massive requirement for capital investment in CO_2 capture, transport, and storage equipment, estimated at almost $100 billion from 2010 to 2020, increasing to over $5,000 billion from 2010 to 2050. The European Union has already recognized the importance of CCS through its aim of having up to 12 CCS demonstration projects operational by 2015 and has put in place two funding packages designed to part-fund CCS projects: the New Entrant Reserve (NER) mechanism and the Economic Recovery Package. The UK is uniquely placed to take advantage of this new market. The geology means [the UK is] well served with offshore storage sites, sufficient to take CO_2 from [domestic] projects and potentially also to handle storage from other countries. [The UK] already [has] long experience in many of the areas that are relevant to implementing CCS, including power and offshore engineering and the high value added project management, legal and financial services needed to deliver CCS projects." The document is available for download at: http://www.decc.gov.uk/Media/viewfile.ashx?FilePath=What we do\UK energy supply\Energy mix\Carbon capture and storage\1_20100317090007_e_@@_CleanCoalIndustrialStrategy.pdf&filetype=4.

Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2008.

The following is from the Executive Summary of this document: "An emissions inventory that identifies and quantifies a country's primary anthropogenic sources and sinks of [GHGs] is essential for addressing climate change. This inventory adheres to both (1) a comprehensive and detailed set of methodologies for estimating sources and sinks of anthropogenic [GHGs], and (2) a common and consistent mechanism that enables Parties to the United Nations Framework Convention on Climate Change (UNFCCC) to compare the relative contribution of different emission sources and greenhouse gases to climate change…In 2008, total U.S. [GHG] emissions were 6,956.8 Tg CO_2 Eq. Overall, total U.S. emissions have risen by approximately 14 percent from 1990 to 2008. Emissions declined from 2007 to 2008, decreasing by 2.9 percent (211.3 Tg CO_2 Eq.). This decrease is primarily a result of a decrease in demand for transportation fuels associated with the record high costs of these fuels that occurred in 2008. Additionally, electricity demand declined in 2008 in part due to a significant increase in the cost of fuels used to generate electricity. In 2008, temperatures were cooler in the United States than in 2007, both in the summer and the winter. This lead to an increase in heating related energy demand in the winter, however, much of this increase was offset by a decrease in cooling related electricity demand in the summer." To view the complete report, go to: http://www.epa.gov/climatechange/emissions/downloads10/US-GHG-Inventory-2010_Report.pdf.

Legislative Activity

***E&E News PM*, "Study Finds Economic Opportunities in Cantwell-Collins Bill."**

A study written by the Institute for Policy Integrity at New York University School of Law states that "The Carbon Limits and Energy for America's Renewal (CLEAR) Act" introduced by Senators Maria Cantwell (Washington) and Susan Collins (Maine) in December 2009 would provide a price on carbon that could drive investments in a range of emission reduction strategies. The report also states that the bill would generate enough benefits to offset the legislation's costs to business. The CLEAR Act (S. 2877) would require energy producers to bid in monthly auctions for carbon shares and direct 75 percent of the auction revenue as a refund to compensate the public for increased energy costs, with the remaining 25 percent going toward clean energy technology research and development (R&D). More details about the CLEAR Act can be found at: http://cantwell.senate.gov/issues/CLEARAct.cfm, and the legislation can be viewed at: http://cantwell.senate.gov/issues/CLEAR%20Act%20-%20Leg%20Text.pdf. The study by the Institute for Policy Integrity, titled, "CLEAR & The Economy," is available at: http://policyintegrity.org/documents/ClearandTheEconomy.pdf. April 12, 2010, http://www.eenews.net/eenewspm/2010/04/12/1/. (Subscription may be required.)

Events

May 10-13, 2010, **9th Annual Conference on Carbon Capture & Sequestration**, *Hilton Pittsburgh, Pittsburgh, Pennsylvania, USA*. Following in the footsteps of the previous eight events, this conference will focus on the potential of present and future CCS technologies deployed in the United States and North America. Members from the U.S. and international scientific and engineering communities will be present to share experiences on such technologies and systems. For more information, visit the conference website at: http://www.carbonsq.com/.

EVENTS

May 13-14, 2010, **CO_2 Shipping Conference 2010**, *Millennium Gloucester Hotel and Conference Centre London, London, England*. This conference was developed as a forum to discuss the future potential of CO_2 transportation and its significance as a new market opportunity for gas carrier operators. Attendees will discuss the challenges that face CO_2 transport and the progress that has been made to date. To learn more, visit the conference website at: http://www.rivieramm.com/events/CO2-Shipping-Conference-24/Event-Home-257.

May 19-20, 2010, **ACI's 2nd Annual Carbon Capture & Storage Summit**, *Berlin, Germany*. This two-day summit will cover current CCS projects and key challenges and opportunities for commercialization. Some of the topics to be discussed include policy options to accelerate the deployment of CCS, lessons to be learned from existing CCS sites, and CO_2 transportation in tradition pipelines. Included in the summit is a site visit and tour (May 18) of the Ketzin pilot site. For more information, click: http://www.acius.net/wiki.aspx/Conferences/Upcoming?view=overview&id=153.

May 23-28, 2010, **Energy, Water, and Global Climate Change as a Regional Agenda of the Americas**, *San Diego, California, USA*. The focus of this Pan-American Advanced Studies Institute (PASI) conference is to discuss the current state of research linking energy, water, and global climate change in the Americas. Topics to be covered during this conference include: climate and energy; climate and water; and climate and sustainability. For more information, visit the conference website at: http://www-rohan.sdsu.edu/~energy/pasi/index.htm.

June 8-9, 2010, **4th Annual Climate Change Summit**, *Regent's Park Marriott Hotel, London, United Kingdom*. This summit focuses on post-Copenhagen topics, such as: forthcoming carbon legislation; key steps to improving energy efficiency; life cycle analysis; and achieving a balance between adaption and mitigation. To download the event brochure, click: http://www.ethicalcorp.com/climate/index.asp.

June 22-23, 2010, **Carbon Capture and Storage World Australia 2010**, *Crown Conference Center, Melbourne, Australia*. Australia's only CCS-dedicated event, this two-day conference will focus on CCS commercialization and its application to primary industries. In addition, the event will cover other topics such as storage site exploration and management, government funding, and carbon pricing mechanisms. Visit the conference website, which includes a downloadable brochure, at: http://www.terrapinn.com/2010/ccs/index.stm.

June 24, 2010, **The UK Energy Summit**, *The Dorchester, London, United Kingdom*. This summit will provide strategic opportunities to discuss energy challenges facing the UK. Topics to be covered include energy security, investing in renewable energy, and energy-related technologies. For more information, including a detailed program, visit the conference website at: http://www.economistconferences.co.uk/event/uk-energy-summit/1366.

July 8-10, 2010, **Second International Conference on Climate Change: Impacts and Responses**, *University of Queensland, Brisbane, Australia*. This conference will address technological, social, ethical, and political responses to climate change. It will examine the natural and human causes of climate change, as well as its impact on ecosystems and human life. For more information, including details of four different "streams" conference attendees can follow, go to: http://on-climate.com/conference-2010/.

July 26-28, 2010, **Carbon Capture and Storage: Science, Technology, and Policy**, *MIT, Cambridge, Massachusetts, USA*. This energy short course covers the science, technology, and policy aspects of CCS, focusing on the role of CCS in the climate change mitigation portfolio; the technical approaches to CO_2 capture; the science behind geological storage, site selection, and risk evaluation; and the role of policy in establishing a market and business opportunities for CCS. For more information, visit the course website at: http://web.mit.edu/professional/short-programs/courses/carbon_capture_storage.html.

EVENTS (CONTINUED)

August 10-12, 2010, **Coal Gen 2010**, *David L. Lawrence Convention Center, Pittsburgh, Pennsylvania, USA*. This three-day event covers the latest topics affecting the design, development, upgrading, operation, and maintenance of coal-fired power plants, as well as how to address challenges associated with them. For more information, visit this conference website at: http://www.coal-gen.com/index.html.

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