



Carbon Sequestration Newsletter

OCTOBER 2010

Carbon Sequestration

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The field test was conducted in the Prairie Pothole Region – an area that stretches from central Iowa into Northern Alberta, Canada, and contains thousands of shallow wetlands formed by retreating glaciers approximately 10,000 years ago. Terrestrial carbon capture and storage (CCS) involves plant removal of CO₂ from the atmosphere using photosynthesis and storing the greenhouse gas (GHG) in biomass and soils. Soil and gas samples from restored grasslands, native prairie, croplands, and wetlands throughout Montana, North and South Dakota, Minnesota, and Iowa were collected by participating organizations; carbon uptake and storage measurements were also measured to estimate the net change in GHG levels. The results will help to develop protocols for terrestrial carbon credit development and trading, as well as serve as a model for promoting and implementing terrestrial sequestration across the Prairie Pothole Region and other areas of North America. The Prairie Pothole Region project is one of four small-scale validation tests (one terrestrial and three geologic) completed by the PCOR Partnership, which is currently conducting two large-scale geologic storage development tests. To learn more about the PCOR Partnership, click: <http://www.undeerc.org/pcor/>. August 19, 2010, http://www.netl.doe.gov/publications/press/2010/10037-DOE_Partner_Successfully_Demonstra.html.

Fossil Energy Techline, “Secretary Chu Announces Carbon Capture Storage Simulation Initiative,” and *Fossil Energy Techline*, “Secretary Chu Announces Simulation-Based Engineering User Center.”

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, “DOE Regional Partnership Successfully Demonstrates Terrestrial CO₂ Storage Practices in Great Plains Region of U.S. and Canada.”

The Plains CO₂ Reduction (PCOR) Partnership, one of seven U.S. Department of Energy (DOE) Regional Carbon Sequestration Partnerships (RCSPs), successfully completed a field test demonstrating approaches for terrestrial carbon dioxide (CO₂) storage in North America.

On September 8, 2010, U.S. Secretary of Energy Steven Chu announced the creation of the Carbon Capture and Storage Simulation Initiative with an investment of up to \$40 million from the American Recovery and Reinvestment Act of 2009 (Recovery Act) to fund simulation and modeling activities at national laboratories and universities across the United States. The initiative will examine the following areas: (1) the development of validation data for simulations that predict processes and components associated with CO₂ capture at industrial facilities and long-term CO₂ storage in geologic reservoirs; (2) development of advanced simulation tools to speed the path from concept to deployment of new methods for capturing CO₂ at a variety of industrial facilities; and (3) development of simulation tools for quantitative assessment of potential risks associated with long-term storage. These efforts will build upon the efforts of DOE’s National Risk Assessment Partnership (NRAP) and the Administration’s goal to overcome the barriers to widespread, cost-effective deployment of CCS within 10 years. In addition, on September 16, 2010, Energy Secretary Chu announced the creation of the Simulation-Based Engineering User Center (SBEUC) to facilitate



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computational research for energy applications with \$20 million in Recovery Act funding. The SBEUC will (1) develop a high performance computing user center as a platform for utilization of the advanced simulation tools, and (2) accelerate the deployment of industrial carbon capture technology through enhanced ability to predict industrial-scale performance. For more information on DOE's Carbon Sequestration Research Program, click: <http://www.fossil.energy.gov/programs/sequestration/index.html>. September 8, 2010, http://www.fossil.energy.gov/news/techlines/2010/10043-DOE_Announces_CCS_Simulation_Initi.html, and September 16, 2010, http://www.fossil.energy.gov/news/techlines/2010/10045-DOE_Creates_SBEUC.html.

Fossil Energy Techline, "New Recovery Act Funding Boosts Industrial Carbon Capture and Storage Research and Development."

Twenty-two projects have been selected to receive funding from the Recovery Act to accelerate CCS research and development (R&D) for industrial sources. The 22 projects, located in 15 states, will receive more than \$575 million in Recovery Act funds to support President Barack Obama's goal of cost-effective CCS deployment within 10 years. The funding for the selected projects covers four areas of CCS R&D: (1) large-scale testing of advanced gasification technologies (\$312 million); (2) advanced turbo-machinery to lower emissions from industrial sources (\$123 million); (3) post-combustion CO₂ capture with increased efficiencies and decreased costs (\$90 million); and (4) geologic storage site characterization (\$50 million). To view the full list of selected projects, click: http://www.fossil.energy.gov/recovery/projects/ices_projects_0907101.pdf. September 7, 2010, http://www.fossil.energy.gov/news/techlines/2010/10042-DOE_Announces_Industrial_CCS_Proje.html.

SEQUESTRATION IN THE NEWS

DOE Press Release, "Secretary Chu Announces U.S. Centers for U.S.-China Clean Energy Research," and The Charleston Gazette, "WVU to Lead New Carbon Capture Project."

West Virginia University (WVU) will lead a new effort to aid in the development of technology to capture GHG emissions from coal-fired power plants as part of U.S.-China Clean Energy Research Center (CERC) funding announced by U.S. Energy Secretary Steven Chu. DOE is providing a total of \$25 million in funding, with \$12.5 million going toward the WVU-led consortium (the remaining \$12.5 million will fund a separate project). Partners in WVU's consortium will contribute funds, bringing their consortium's funding total to \$50 million. September 2, 2010, <http://www.energy.gov/news/9443.htm>, and September 2, 2010, <http://sundaygazetteemail.com/News/201009021095>.

ScottishPower Press Release, "ScottishPower Sponsors UK's First Academic Alliance to Focus on Carbon Capture and Storage."

ScottishPower announced it will invest \$7.9 million over the next five years to fund the ScottishPower Academic Alliance (SPAA), the first alliance between industry and academia in the United Kingdom (UK) that specifically focuses on CCS. ScottishPower's investment will fund up to 12 full-time researchers from the Imperial College London and the

SEQUESTRATION IN THE NEWS (CONTINUED)

University of Edinburgh to help develop the UK's CCS industry. SPAA will focus on technical innovation with regards to the capture and offshore storage of CO₂; the policy and regulatory aspects of CCS; and determining commercial opportunities. ScottishPower will seek additional contributions from government and international sponsors. September 9, 2010, http://www.scottishpower.com/PressReleases_2073.htm.

EUROPA Press Release, "Commission Sets up World's First Project Network for CO₂ Capture and Storage."

On September 17, 2010, the European Commission launched the "CCS Project Network" to foster knowledge sharing and raise public

awareness in the role of CCS in reducing emissions. Officials hope the network will accelerate learning and ensure that CCS safely fulfills its potential as a commercial-scale viable technology. To date, a number of members already conducting CCS projects have signed a joint agreement to share CCS knowledge. These projects are supported by the European Commission's European Energy Programme for Recovery (EEPR); as a condition for receiving European Union (EU) funding, each beneficiary is required to distribute a project's results, thus enhancing the network. The European Commission's goal is to create a community of projects united in their goal of achieving commercially viable CCS by 2020. In addition, an annual Advisory Forum was established to review progress and specify the network's current and future activities. In 2008, the EU committed to reducing CO₂ emissions by 50 percent by 2050. To learn more about the CCS Project Network, visit: <http://www.ccsnetwork.eu/>. September 17, 2010, <http://europa.eu/rapid/pressReleasesAction.do?reference=IP/10/1140&format=HTML&aged=0&language=EN&guiLanguage=en>.

ANNOUNCEMENTS

The Carbon Sequestration Newsletter Annual Index Available Online.

The Carbon Sequestration Newsletter Annual Index, covering the September 2009 to August 2010 issues of NETL's Carbon Sequestration Newsletter, is now available at: http://www.netl.doe.gov/technologies/carbon_seq/refshelf/subscribe.html.

NETL Releases Annual Accomplishments Report.

DOE's NETL released its 2009 Accomplishments Report, highlighting energy research and technology development achievements, including advances in clean, fossil-based systems with CCS. The report details NETL R&D projects and activities, as well describes the laboratory's research over the past century. To read the report, visit: http://www.netl.doe.gov/publications/others/accomp_rpt/accomp09.pdf.

NETL Carbon Sequestration Project Portfolio Available Online.

DOE/NETL's 2010 Carbon Sequestration Project Portfolio contains selected carbon sequestration program papers and publications; NETL's Best Practices Manuals (BPMs); DOE's RCSP fact sheets (Validation and Development Phases); Carbon Sequestration Focus Area fact sheets (pre-combustion capture; geologic carbon storage; monitoring, verification, and accounting [MVA]; simulation and risk assessment; and CO₂ utilization); and Recovery Act fact sheets. The portfolio is available at: http://www.netl.doe.gov/technologies/carbon_seq/refshelf/project%20portfolio/2010/index.html.

Call for Research Proposals.

Carbon Management Canada (CMC), a non-profit corporation mandated to promote and support research into carbon management in the extraction and use of fossil fuels, is accepting research proposals for innovative research on GHG emissions in fossil fuel recovery and use. The submission deadline is October 22, 2010. To learn more about the call for proposals, visit: <http://www.carbonmanagement.ca/assets/files/CMC%20Call%20for%20Proposals%202010-08-06.pdf>.

Website Launched to Track Climate Change Financing.

The United Nations (UN) launched a website that tracks how countries provide aid to help fight potential climate change. According to the website, five countries have contributed financing to help implement new technologies that could reduce carbon emissions. To visit the website, which is titled, "Fast Start Finance," click: <http://www.faststartfinance.org/home>.

Atlas on Geological Storage of Carbon Dioxide Launched in Africa.

On September 9, 2010, South Africa officially initiated efforts to develop Africa's first atlas to identify geologic CO₂ storage opportunities in the region with the help of government entities and the private industry. The atlas will be incorporated into the work program of the South African Centre for Carbon Capture and Storage, and will provide an overview of the country's energy economy, a roadmap on CCS, and progress made to date. To learn more, click: http://www.ccf.org.za/index.php?option=com_content&view=article&id=138:atlas-on-geological-storage-of-carbon-dioxide-&catid=4:press-releases&Itemid=25.

SCIENCE

University of Florida News Release, “UF Study Shows Carnivore Species Shrank During Global Warming Event.”

Extinct carnivorous mammals shrank in size during a climate change event that occurred 55 million years ago, according a recent University of Florida study. Scheduled to appear in the *Journal of Mammalian Evolution*, the study describes a new species, referred to as a “hyena-like animal,” that began the size of a bear, but during a 200,000-year period in which the average temperature of the Earth saw an approximate 15 degree Fahrenheit increase, evolved to the size of a coyote. As the Earth’s temperature cooled following this warming period, the animal, *Palaeonictis wingi*, began evolving back to a larger size. Researchers discovered a nearly complete jaw from the animal in Wyoming’s Big Horn Basin during a fossil collecting expedition in 2006. Recent findings are expected to help scientists better understand the impact of potential climate change. August 24, 2010, <http://news.ufl.edu/2010/08/24/global-warming-3/>.

Science Daily, “Most Penguin Populations Continue to Decline, Biologists Warn.”

According to penguin biologists, 10 of 18 penguin species have experienced population declines due to the effects of potential climate change. Many penguin species are dependent on small schooling fish for food, such as sardines and anchovies, which are seasonally brought to penguin habitats by cold water currents. The warming of sea surface temperatures prevents cold water currents along the western coast of South America. Galapagos penguins and Humboldt penguins, found on the coasts of Peru and Chile, have already been affected by reduced food availability as cold water currents have shifted and are now found further offshore. Research shows that, at the current rate, Galapagos penguins have a 30 percent probability of extinction this century; in addition, Humboldt penguins have been classified as endangered by the Peruvian government. September 9, 2010, <http://www.sciencedaily.com/releases/2010/09/100906145115.htm>.



POLICY

Global CCS Institute Press Release, “China Joins Global CCS Institute as Legal Member.”

China’s lead governmental body responsible for industrial sector policy development and management has become a legal member of the Global CCS Institute. Members of the Institute can help shape the organization’s strategic direction through participation in meetings and working groups and by sharing knowledge, information, and expertise that can facilitate the commercial deployment of CCS. Funded by the Australian government, the Global

CCS Institute works to accelerate the commercial deployment of CCS and ensure that the technology plays a role in responding to the need for a low-carbon energy future. The Global CCS Institute’s interim goal is to accelerate the development of 20 commercial-scale integrated demonstration projects prior to 2020. August 14, 2010, <http://www.globalccsinstitute.com/downloads/news/2010/PressRelease-China-Joins-Global-CCS-Institute-as-Legal-Member.pdf>.

“Deployment Models for Commercialized Carbon Capture and Storage.”

The following is the Abstract of this article: “Even before technology matures and the regulatory framework for CCS has been developed, electrical utilities will need to consider the logistics of how widespread commercial-scale operations will be deployed. The framework of CCS will require utilities to adopt business models that ensure both safe and affordable CCS operations while maintaining reliable power generation. Physical models include an infrastructure with centralized CO₂ pipelines that focus geologic sequestration in pooled regional storage sites or supply CO₂ for beneficial use in enhanced oil recovery (EOR) and a dispersed plant model with sequestration operations which take place in close proximity to CO₂ capture. Several prototypical business models, including hybrids of these two poles, will be in play including a self-build option, a joint venture, and a pay at the gate model. In the self-build model operations are vertically integrated and utility owned and operated by an internal staff of engineers and geologists. A joint venture model stresses a partnership between the host site utility/owner’s engineer and external operators and consultants. The pay to take model is turn-key external contracting to a third party owner/operator with cash positive fees paid out for sequestration and cash positive income for CO₂-EOR. The selection of a business model for CCS will be based in part on the desire of utilities to be vertically integrated, source-sink economics, and demand for CO₂-EOR. Another element in this decision will be how engaged a utility decides to be and the experience the utility has had with pre-commercial R&D activities. Through R&D, utilities would likely have already addressed or at least been exposed to the many technical, regulatory, and risk management issues related to successful CCS. This paper provides the framework for identifying the different physical and related prototypical business models that may play a role for electric utilities in commercial-scale CCS.” **Richard A. Esposito, Larry S. Monroe, and Julio S. Friedman**, *Environ. Sci. Technol.*, Available online August 19, 2010, doi:10.1021/es101441a, <http://pubs.acs.org/doi/abs/10.1021/es101441a>. (Subscription required.)

“Mesoscale Carbon Sequestration Site Screening and CCS Infrastructure Analysis.”

The following is the Abstract of this article: “[The authors] explore CCS at the meso-scale, a level of study between regional carbon accounting and highly detailed reservoir models for individual sites. [The authors] develop an approach to CO₂ sequestration site screening for industries or energy development policies that involves identification of appropriate sequestration basin, analysis of geologic formations, definition of surface sites, design of infrastructure, and analysis of CO₂ transport and storage costs. [The authors’] case study involves carbon management for potential oil shale development in the Piceance-Uinta Basin, CO and UT. This study uses new capabilities of the CO₂-PENS model for site screening, including

POLICY (CONTINUED)

reservoir capacity, injectivity, and cost calculations for simple reservoirs at multiple sites. [The authors] couple this with a model of optimized source-sink-network infrastructure (*SimCCS*) to design pipeline networks and minimize CCS cost for a given industry or region. The *CLEAR_{uff}* dynamical assessment model calculates the CO₂ source term for various oil production levels. Nine sites in a 13,300 km² area have the capacity to store 6.5 GtCO₂, corresponding to shale-oil production of 1.3 Mbbbl/day for 50 years (about 1/4 of U.S. crude oil production). [The authors'] results highlight the complex, nonlinear relationship between the spatial deployment of CCS infrastructure and the oil-shale production rate." **Gordon N. Keating, Richard S. Middleton, Philip H. Stauffer, Hari S. Viswanathan, Bruce C. Letellier, Donatella Pasqualini, Rajesh J. Pawar, and Andrew V. Wolfsberg**, *Environ. Sci. Technol.*, Available online August 10, 2010, doi:10.1021/es101470m, <http://pubs.acs.org/doi/abs/10.1021/es101470m>. (Subscription required.)

GEOLOGY

"Study of Caprock Integrity in Geosequestration of Carbon Dioxide."

The following is the Abstract of this article: "The Industrial Revolution has led to a substantial increase in the emission of [GHGs] like CO₂ into the atmosphere, exacerbating the global warming phenomenon. One option to mitigate GHG emission is by capturing and safely storing the CO₂ in suitable deep underground geological formations. This paper provides a literature review on the potential changes in the fluid flow and strength behavior of the sedimentary reservoir and caprock rock caused by the injected CO₂ under in-situ conditions, highlighting the factors that can potentially hamper the caprock's integrity. A 2D axisymmetric numerical model of an ideal CO₂ reservoir with 30 years of injection and 70 years of monitoring phase is also presented. The model results suggest that, for the parametric values and reservoir conditions used in the model, the injection pressure leads to an increase in pore-pressure, hence reducing the effective stress in the formation. An induced vertical displacement of less than 3 mm is observed at the caprock-reservoir interface at the end of the 100 years period. The observed relationships between injection pressure, effective stress and total displacement are also discussed." **R. Shukla, P. G. Ranjith, S. K. Choi, and A. Haque**, *International Journal of Geomechanics*, Available online July 31, 2010, doi: 10.1061/(ASCE)GM.1943-5622.0000015, <http://scitation.aip.org/getabs/servlet/GetabsServlet?prog=normal&id=IJGNXX000001000001000041000001&idtype=cvips&gifs=yes&ref=no>. (Subscription may be required.)

"Assessing drilling mud and technical fluid contamination in rock core and brine samples intended for microbiological monitoring at the CO₂ storage site in Ketzin using fluorescent dye tracers."

The following is the Abstract of this article: "The CO₂SINK project in Ketzin represents a field laboratory for the storage of CO₂ in a 650-m deep saline aquifer. The project is accompanied by a microbiological monitoring program to characterize the composition and activity of the autochthonous microbial community in rock

and brine samples and their changes in response to CO₂ storage. A prerequisite of these studies is the acquisition of samples free of contamination from microorganisms and organic and inorganic components. Drilling mud and technical fluids are the main sources of contamination. This study describes the application of the fluorescent dye tracers fluorescein and rhodamine B as contamination controls for rock core and brine samples. Fluorescein was added to drilling mud that was used during the coring phase of the Ketzin wells Ktzi 200, 201 and 202. In addition, total organic carbon (TOC) concentrations, reflecting the carboxymethyl cellulose (CMC) component of the drilling mud, were determined to verify the tracer results. The fluorescence and TOC analyses revealed that drilling mud filtrate penetrated the outer 20 mm of mildly permeable sandstone cores. Rhodamine B was added to brines that were used to displace the drilling mud and to flush the wells after completion. The tracer monitoring during the discharge of drilling mud and displacement brines from the wells during hydraulic tests and nitrogen lifts enabled the quantification of reservoir fluid quality. After the production of 140–190 m³ (16–21 borehole volumes) of fluid, the drilling mud concentration was reduced to about 0.05 [percent]. The use of fluorescein emerged as a field-capable, sensitive and reliable method during the sampling of rock core and formation brine samples." **Maren Wandrey, Daria Morozova, Michael Zettlitzer, Hilke Würdemann, and the CO₂SINK Group**, *International Journal of Greenhouse Gas Control*, Available online August 21, 2010, doi:10.1016/j.ijggc.2010.05.012, <http://www.sciencedirect.com/science/article/B83WP-50V4VW9-1/2/9cf9b4464b637edc916b295e6a2d9f70>. (Subscription may be required.)

"Swelling and sorption experiments on methane, nitrogen and carbon dioxide on dry Selar Cornish coal."

The following is the Abstract of this article: "Sorption isotherms of CO₂, [methane (CH₄)] and [nitrogen (N₂)] are determined at 318 K and 338 K for pressures up to 16 MPa in dry Selar Cornish coal using the manometric method. Both equilibrium sorption and desorption were measured. The desorption isotherms show that there is no hysteresis in N₂, CH₄ sorption/desorption on coal. The time to achieve equilibrium depends on the gases and is increasing in the following order: [helium (He)], N₂, CH₄, CO₂. The results show that the sorption ratio between the maximum in the excess sorption N₂:CH₄:CO₂ = 1:1.5:2.6 at 318 K and 1:1.5:2.0 at 338 K. Obtained ratios are within the range quoted in the literature. Swelling and shrinkage induced by CO₂ injection and extraction from Selar Cornish coal have been measured. The experiments have been conducted on unconfined cubic samples using strain gauges measurements at 321 K for pressures up to 4.1 MPa. It has been found that the mechanical deformation is fully reversible. The density of CO₂ in its sorbed phase, has been extrapolated from the excess sorption isotherm calculated including the swelling. The resulting value is unrealistically high. Possible reasons for this behavior are discussed in the text. Absolute sorption for CO₂ has been estimated considering also the change in the coal volume due to swelling. The resulting isotherm calculated with or without the swelling are almost the same." **Elisa Battistutta, Patrick van Hemert, Marcin Lutynski, Hans Bruining, and Karl-Heinz Wolf**, *International Journal of Coal Geology*, Available online August 19, 2010, doi:10.1016/j.coal.2010.08.002, <http://www.sciencedirect.com/science/article/B6V8C-50THX53-1/2/820923373114c329b534c8ca8729bd9c>. (Subscription may be required.)

TECHNOLOGY

“Designing a cost-effective CO₂ storage infrastructure using a GIS based linear optimization energy model.”

The following is the Abstract of this article: “Large-scale deployment of [CCS] needs a dedicated infrastructure. Planning and designing of this infrastructure require incorporation of both temporal and spatial aspects. In this study, a toolbox has been developed that integrates ArcGIS, a geographical information system [GIS] with spatial and routing functions, and MARKAL, an energy bottom-up model based on linear optimization. Application of this toolbox led to blueprints of a CO₂ infrastructure in the Netherlands. The results show that in a scenario with 20 [percent] and 50 [percent] CO₂ emissions reduction targets compared to their 1990 level in respectively 2020 and 2050, an infrastructure of around 600 km of CO₂ trunklines may need to be built before 2020. Investment costs for the pipeline construction and the storage site development amount to around 720 m€ and 340 m€, respectively. The results also show the implication of policy choices such as allowing or prohibiting CO₂ storage onshore on CO₂ CCS and infrastructure development. This paper illustrates how the ArcGIS/MARKAL-based toolbox can provide insights into a CCS infrastructure development, and support policy makers by giving concrete blueprints over time with respect to scale, pipeline trajectories, and deployment of individual storage sites.” **Machteld van den Broek, Evelien Brederode, Andrea Ramirez, Leslie Kramers, Muriel van der Kuip, Ton Wildenborg, Wim Turkenburg, and André Faaij**, *Environmental Modelling & Software*, Available online August 7, 2010, doi:10.1016/j.envsoft.2010.06.015, <http://www.sciencedirect.com/science/article/B6VHC-50R0F29-1/2/81f41a3e334d7126ae72687e51f2a6e2>. (Subscription may be required.)

“Lessons learned from natural and industrial analogues for storage of carbon dioxide.”

The following is the Abstract of this article: “The deployment of CCS at industrial scale implies the development of effective monitoring tools. Noble gases are tracers usually proposed to track CO₂. This methodology, combined with the geochemistry of carbon isotopes, has been tested on available analogues. At first, gases from natural analogues were sampled in the Colorado Plateau and in the French carbogaseous provinces, in both well-confined and leaking-sites. Second, [the authors] performed a [two]-years tracing experience on an underground natural gas storage, sampling gas each month during injection and withdrawal periods. In natural analogues, the geochemical fingerprints are dependent on the containment criterion and on the geological context, giving tools to detect a leakage of deep-CO₂ toward surface. This study also provides information on the origin of CO₂, as well as residence time of fluids within the crust and clues on the physico-chemical processes occurring during the geological story. The study on the industrial analogue demonstrates the feasibility of using noble gases as tracers of CO₂. Withdrawn gases follow geochemical trends coherent with mixing processes between injected gas end-members. Physico-chemical processes revealed by the tracing occur at transient state. These two complementary studies proved the interest of geochemical monitoring to survey the CO₂ behavior, and gave information on its use.” **Elodie Jeandel, Anne Battani, and Philippe Sarda**,

International Journal of Greenhouse Gas Control, Available online August 5, 2010, doi:10.1016/j.ijggc.2010.06.005, <http://www.sciencedirect.com/science/article/B83WP-50PJFX-1/2/f55bb2fb835a6de037e5ab4d692f881d>. (Subscription may be required.)



TERRESTRIAL

“Designing policies to mitigate the agricultural contribution to climate change: an assessment of soil based carbon sequestration its ancillary effects.”

The following is the Abstract of this article: “Soil carbon sequestration has been regarded as a cheap and cost-effective way to sequester carbon until other technologies to tackle climate change become available or more cost-effective. An assessment of the social desirability of a soil carbon sequestration policy requires the consideration of all associated social costs and benefits. Measures to re-accumulate carbon in soils have ancillary or co-effects on the environment that can be beneficial or detrimental to social welfare and few of which are traded in markets. This paper discusses issues related to the development of soil carbon sequestration policies into agri-environmental schemes and reports findings from an application of a choice experiment to elicit preferences and estimate benefits of a soil carbon program in Scotland under consideration of co-effects on biodiversity and rural viability. Preferences for soil carbon based mitigation are found to be heterogeneous and related to beliefs about climate change and attitudes towards its mitigation. Benefit estimates suggest that including co-effects can significantly change the outcome of cost-benefit tests. Implications for the development of climate change policies are discussed.” **Klaus Glenk and Sergio Colombo**, *Climatic Change*, Available online August 20, 2010, doi:10.1007/s10584-010-9885-7, <http://www.springerlink.com/content/7h0k45m445061643/>. (Subscription required.)

TRADING

Carbon Market Update, September 24, 2010

CCX-CFI 2010 (\$/tCO ₂)	EU ETS-EUA DEC 2010
\$0.10 (Vintage 2009)	(\$/tCO ₂) \$20.63

(Converted from € to US\$)

“RGGI News Release, “Ten States Mark Second Anniversary of Regional Program to Reduce Greenhouse Gas Emissions.”

The 10 Northeast and Mid-Atlantic states participating in the Regional Greenhouse Gas Initiative (RGGI) conducted their 9th regional CO₂ allowance auction on September 8, 2010, marking the auction’s two-year anniversary. The current control period CO₂ allowances (2009-2011) offered in the auction yielded a

TRADING (CONTINUED)

total of \$63,997,020 from the sale of 34,407,000 allowances; the auction clearing price was \$1.86 per allowance. A small amount of CO₂ allowances for a future control period (2012-2014) were also offered, yielding a total of \$2,440,320 from the sale of 1,312,000 allowances; the auction clearing price was \$1.86 per allowance. In all, more than 75 percent of the current control period CO₂ allowances offered were sold, and more than 61 percent of future control period allowances offered were sold. Since September 2008, RGGI auctions have generated \$729,281,959 in proceeds; more than 80 percent of the proceeds are being invested in strategic energy programs to benefit consumers and build a clean energy economy. September 10, 2010, http://www.rggi.org/docs/Auction_9_News_Release_MM_Report.pdf.

Reuters, “First Tokyo Carbon Credits Trade for \$142/Tonne.”

According to Point Carbon News, the first carbon credits traded in Tokyo’s new cap-and-trade scheme traded for \$142.20 per tonne; UN-backed carbon offset credits currently trade in the Japanese market at a rate of \$17.78 per tonne. Tokyo’s first mandatory cap-and-trade program launched in April 2010. Under the new plan, large-scale businesses must cut their emissions by an average of seven percent from 2010 to 2014. Tokyo is responsible for approximately five percent of Japan’s total carbon emissions; Japan has pledged to cut its national emissions by 25 percent below 1990 levels by 2020. The online marketplace is expected to handle approximately 800,000 tonnes of CO₂ in 2015, rising to 1.3 million tonnes by 2020. August 24, 2010, <http://www.reuters.com/article/idUSTRE67N3M520100824>.

RECENT PUBLICATIONS

“Government Response to the Consultation on the Proposed Offshore Carbon Dioxide Storage Licensing Regime.”

The following is from the Executive Summary of this document: “The Energy Act 2008 established a legislative basis in the UK for permitting the offshore storage of [CO₂]. A consultation document published on September 25, 2009 set out proposals for an appropriate licensing system, together with draft licensing regulations, which will also implement much of the EU Directive on geological storage of [CO₂]. This document sets out the Government’s response to the comments received. In general, respondents were supportive of the broad structure of the proposed licensing system, including the proposal for a license which would cover all phases of such developments (exploration/appraisal, operation, post-closure) and would convey an exclusive but time-limited right to apply for the storage permit required by the Directive. A number of issues prompted particular interest or comment. These included the scope of the license and its relationship to the lease. Broadly speaking, [the Department of Energy and Climate Change (DECC)] envisages that the license will refer to an essentially two dimensional plan, authorizing the relevant activities within that area and its downward projection, in the same way as the established petroleum licenses. But the storage permit when issued will contain three-dimensional definitions of the storage site and the storage complex, and the authorization conveyed will relate to these areas. The initial agreement for lease issued by The Crown Estate will relate to the same area as the license, and the subsequent lease will incorporate the same definition of the site as that in the permit... There was also particular interest in the relationship between carbon storage projects and existing petroleum developments. The Government is not persuaded by a number of proposals made for new powers to regulate such situations, but is giving further consideration to the possibility of giving priority, in certain limited circumstances, to operators of producing hydrocarbon fields for redeveloping these fields for carbon storage.” To view the DECC document, click: <http://www.decc.gov.uk/assets/decc/Consultations/carbondioxidestorage%20licensing/422-govt-response-offshore-co2-storage.pdf>.

“Oil & gas reservoirs in U.S. like the producing formation.”

The following is from the Introduction of this document: “[The Rocky Mountain Oilfield Testing Center’s (RMOTC)] operations at the Teapot Dome Oil Field (NPR-3) in Wyoming provide an excellent natural laboratory in which to conduct research in EOR and carbon sequestration in geologic reservoirs. In addition, RMOTC provides a testing center environment ideal for testing and/or demonstrating new technologies for EOR and sequestration. Several oil-producing formations at NPR-3 have characteristics similar and analogous to nationwide CO₂-EOR and sequestration target reservoirs, including: Tensleep Sandstone, Second Wall Creek Sandstone, Muddy Sandstone, [and] Dakota Sandstone. The Shannon Sandstone is also productive at NPR-3, but it is too shallow and has too low a reservoir pressure to be a candidate for CO₂-EOR, so it isn’t included in this review. However, it may still be useful for sequestration research for evaluation of leakage, containment, and monitoring technologies. NETL categorizes geologic sequestration into these classes: (1) oil and gas reservoirs; (2) unmineable coal seams; (3) deep saline formations; (4) basalt formations; [and] (5) organic-rich shales. This summary will only address #1 and #3 for the NPR-3 site. Two other identified geologic sequestration targets, #2 coals and #4 basalts, are out of scope for this summary, as those are not present at Teapot Dome. Fractured organic-rich shales (#5), including the Niobrara Formation, are productive at NPR-3, and although these are seen as future potential sequestration targets, the sequestration science for these targets is immature and they exhibit very low permeabilities, so they are also not included. NPR-3 does have two key deep saline formations (#3 in above list), conducive to research as sequestration targets, which are also analogous to similar saline reservoirs nationwide: Crow Mountain Sandstone [and] Madison Limestone. These are not EOR targets at NPR-3, but they do relate to nationwide sequestration capacity numbers discussed in a later section.” To view DOE’s RMOTC white paper, click: http://www.rmotc.doe.gov/PDFs/CO2_white_paper.pdf.

LEGISLATIVE ACTIVITY

Reuters, "Australia's Capital Sets 40 Percent Carbon Cut Law."

The government of the Australian Capital Territory (ACT) will enact carbon cutting laws that would set a target of cutting CO₂ emissions by 40 percent by 2010 from 1990 levels. The cut would rise to 80 percent

by 2050, with an aim of the territory to become carbon neutral by 2060. The ACT's Climate Change and Greenhouse Gas Reduction Bill 2010's goal is to cut carbon emissions by boosting renewable energy and increasing energy efficiency in homes and businesses. In addition, the bill would establish an independent climate change council and encourage the private sector to undertake voluntary agreements with the government. August 26, 2010, <http://www.reuters.com/article/idUSTRE67P0TQ20100826>.



EVENTS

October 7-9, 2010, **3rd Annual International Conference on Energy, Logistics and the Environment**, *Grand Hyatt Hotel, Denver, Colorado, USA*. This conference provides discussions focusing on finding solutions on how to successfully commercialize new technology, run low-carbon and efficient operations, and access funding. In addition, the agenda includes topics such as: market trends in the fossil/renewable energy and logistics industries; regulatory issues; and carbon emissions tracking. To view the course catalog, visit the conference website at: <http://www.globalcommerceforum.org/>.

October 12-14, 2010, **2010 SPE Eastern Regional Meeting**, *Morgantown, West Virginia, USA*. The technical sessions at this meeting will cover topics such as CCS and gas storage; production operations, optimization, monitoring, and control; formation evaluation; and the drilling of wells. More information can be found by visiting the conference website at: <http://www.spe.org/events/erm/2010/>.

October 19-20, 2010, **Carbon Capture and Storage Symposium 2010**, *Chifley at Lennons, Brisbane, Queensland, Australia*. The Carbon Capture and Storage Symposium 2010 features cases studies of local and global initiatives and projects related to CCS, including policy and regulatory frameworks, business models and strategies in a low carbon economy, technical presentations on low emissions technologies, site selection, and expert-led panel discussions. Detailed information can be obtained at: <http://www.carbon-capture.com.au/Event.aspx?id=329858>.

October 25-26, 2010, **Coal Power Plant Fundamentals**, *The Adolphus Hotel, Dallas, Texas, USA*. This Electric Utility Consultants, Inc. (EUCI) introductory course details the basic workings of a coal-fired power plant, covering all major systems from coal handling to the switchyard. For more information, including a detailed program agenda, view the course brochure at: <http://www.euci.com/pdf/1010-coal-power.pdf>.

October 27-28, 2010, **Emissions Regulations and Control Technologies for Fossil-Fuel Power Plants**, *The Adolphus Hotel, Dallas, Texas, USA*. This EUCI course will provide a basic understanding of how emission control technologies reduce emissions. In addition, the CAA will be discussed and CO₂ emissions standards will be reviewed. For more information, including a detailed program agenda, view the course brochure at: <http://www.euci.com/pdf/1010-emissions.pdf>.

October 31-November 3, 2010, **2010 Gasification Technologies Conference**, *Wardman Park Marriott, Washington DC, USA*. This Gasification Technologies Council (GTC) event provides the latest updates on gasification technology and developments. Attendees will be offered the opportunity to network with leaders in the field and hear technical presentation on the status of projects around the world. Included in the program is a section focused on carbon management, featuring an overview of DOE's Industrial CCS Program. To view a downloadable program, click: <http://www.gasification.org/eventDetail.asp?a=4&eventID=2>.

November 14-17, 2010, **2010 Behavior, Energy & Climate Change Conference**, *Hyatt Regency, Sacramento, California, USA*. The fourth annual Behavior, Energy & Climate Change (BECC) Conference focuses on the practical applications of social and behavioral research to achieve viable solutions for meeting long-term energy and GHG emissions reduction targets. Topics to be discussed include current policy issues; program/communication strategies; and collaboration across government, utility, business, and research sectors in order to accelerate the transition to an energy efficient, low-carbon economy. For more information, visit the conference website at: <http://www.beccconference.org/>.



EVENTS (CONTINUED)

November 23-24, 2010, **CO₂ Transportation Summit**, *The Manhattan Hotel, Rotterdam, Netherlands*. In its first year, this summit will bring together industry stakeholders to identify the safest and most cost-effective methods for transporting CO₂. The program will provide an overview of CO₂ transportation, combining topics such as regulations, policy, safety, and technology. Other topics to be covered include implementing CO₂-EOR in offshore fields and an Emission Trading Scheme (ETS). For more information, click: <http://www.c5-online.com/Carbontransport.htm>.

November 28-30, 2010, **National CCS Conference**, *Park Hyatt Melbourne Victoria, Australia*. The inaugural National CCS Conference will bring together stakeholders from all areas of CCS development to discuss the barriers to deployment of CCS technology. The conference aims to facilitate knowledge sharing and networking opportunities between CCS stakeholders – including technical, economic, social, and policy issues – and raise awareness of CCS among the community. Other topics to be discussed include: international collaboration and knowledge sharing; global deployment of CCS; and networking opportunities. For more information, go to: <http://www.nationalccs.com.au/conference.html>.

November 29-December 1, 2010, **CCS World MENA 2010**, *Mövenpick Hotel, Jumeirah Beach, Dubai*. In its first year, this conference will provide a forum to create new value chains to commercially develop CCS projects in the MENA region. Topics to be addressed include: global case studies demonstrating CCS pilot and commercial projects, partnership models to advance CCS innovation and deployment, and site exploration and management. For more information, visit the conference website at: <http://www.terrapinn.com/2010/ccsmena/>.

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

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

To learn more about DOE's Carbon Sequestration Program, please contact Sean Plasynski at sean.plasynski@netl.doe.gov, or Dawn Deel at dawn.deel@netl.doe.gov.