



# Carbon Sequestration Newsletter

APRIL 2008

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## HIGHLIGHTS

### NETL News Release, "Carbon Sequestration Partner Initiates CO<sub>2</sub> Injection into Michigan Basin."

The Midwest Regional Carbon Sequestration Partnership (MRCSP), one of the US Department of Energy's (DOE) Regional Carbon Sequestration Partnerships (RCSP), has commenced a two-month field test that will inject up to 10,000 metric tons of carbon dioxide (CO<sub>2</sub>) into a saline formation some 3,200 to 3,500 feet below the Earth's surface. The Core Energy-owned, Antrim gas field location advantageously provides the project with a DTE Energy-owned gas processing plant that supplies the CO<sub>2</sub>; an eight-mile CO<sub>2</sub> pipeline previously used for enhanced oil recovery; and perhaps most importantly, the field test location at the Michigan Basin's northern rim offers a number of well documented, suitable formations ideal for the geological storage of CO<sub>2</sub>. The 3,500-foot deep injection well is located thousands of feet below drinking water levels, which are typically no deeper than 1,000 feet in the Michigan region, moreover, the Amherstburg and Lucas formations provide 900 feet of containment above the injection zone. Led by Battelle, MRCSP received an Underground Injection Control (UIC) permit from the US Environmental Protection Agency (EPA) through Core Energy LLC in

December 2007, the first such permit in the region for CO<sub>2</sub> sequestration; while the Michigan Department of Environmental Quality, Office of Geological Survey issued the permit to drill the test well. This Michigan Basin field test is one of three MRCSP-managed geologic tests and one of 20 or so similar projects currently underway throughout the United States. For more information about the MRCSP's activities, go to: <http://www.mrcsp.org/> or for more information about DOE's RCSPs, browse: [http://www.netl.doe.gov/technologies/carbon\\_seq/partnerships/partnerships.html](http://www.netl.doe.gov/technologies/carbon_seq/partnerships/partnerships.html). February 18, 2008, [http://www.netl.doe.gov/publications/press/2008/08005-CO2\\_Injection\\_Begins\\_in\\_Michigan.html](http://www.netl.doe.gov/publications/press/2008/08005-CO2_Injection_Begins_in_Michigan.html).

## SEQUESTRATION IN THE NEWS

*Urbana/Champaign News-Gazette*, "States Join Illinois' Call for Original FutureGen Plan," and *LiveMint.com*, "India May Pull Out of FutureGen as US Mulls Project Scaleback."

On March 5, representatives from Illinois, Indiana, Ohio, Kentucky, Wisconsin, and West Virginia sent a letter to President George W. Bush emphasizing the need to keep the FutureGen project in Mattoon, Illinois and the importance of developing clean coal technology and maintaining commitments to foreign countries financially contributing to the project. Although the restructured approach allows DOE to partially fund multiple projects, the letter presented concerns about the project failing to sequester as much CO<sub>2</sub> as the original FutureGen plan and questioned the expenses of those who originally applied. Dozens of proposals were received by DOE regarding the restructured approach, which will help shape bids for the project and approximate cost and project feasibility. DOE expects to begin taking industry bids sometime this spring. Meanwhile, India is considering withdrawing from the FutureGen initiative despite having already invested \$10 million, but Indian officials have maintained open lines of communication with US officials about the project. As India generates a significant portion of its electricity from coal, the FutureGen project's advanced technologies interested the Indian government, but now Indian officials describe their interest for the project as "extremely low." The restructured FutureGen approach would invest in only the carbon capture and storage (CCS) portion of the project and not an entire plant's construction, which would allow for multiple plants to be commercially working by 2015 with viable CCS technologies. For further information about FutureGen, visit: <http://www.fossil.energy.gov/programs/powersystems/futuregen/>. March 6, 2008, [http://www.news-gazette.com/news/local/2008/03/06/states\\_join\\_illinois\\_call\\_for\\_original](http://www.news-gazette.com/news/local/2008/03/06/states_join_illinois_call_for_original), and March 7, 2008,



## National Energy Technology Laboratory

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

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

One West Third Street, Suite 1400  
Tulsa, OK 74103-3519

1450 Queen Avenue SW  
Albany, OR 97321-2198

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

**Sean I. Plasynski**  
412-386-4867  
sean.plasynski@netl.doe.gov

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

Visit the NETL website at:  
[www.netl.doe.gov](http://www.netl.doe.gov)

Customer Service:  
**1-800-553-7681**

This newsletter 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.

## SEQUESTRATION IN THE NEWS (CONTINUED)

<http://www.livemint.com/2008/03/06231204/India-may-pull-out-of-FutureGe.html>. (Subscription required.)

**Bloomberg.com**, “Canada Requires New Oil-Sands Projects to Capture, Store Carbon,” and **Google News**, “Canada Unveils Carbon Capture Plan, Ban on Dirty Coal.”

New environmental regulations announced by the Canadian government state that oil sands projects beginning operation in 2012 or later will be required to capture and store their CO<sub>2</sub> emissions and the construction of new coal-fired power plants will be restricted, aiding Canada in its goal to reduce greenhouse gas (GHG) levels by 20 percent by 2020. Alberta’s oil sands are the second largest oil reserve in the world, but the estimated 173 billion barrels had gone largely untouched until 2000 due to high extraction costs (oil sands must be mined and bitumen separated from the sand and water, then upgraded and refined). However, Canadian officials believe the GHG emissions of oil sands projects, which extract oil from tar deposits, may double by 2015 if oil sand output triples over the next decade as projected. Some officials believe the new carbon regulations will deter future investment in such projects, although Enbridge Inc. announced in February that it will head a group of 19 energy firms studying the feasibility of injecting and storing CO<sub>2</sub> in saline formations 8,000 feet deep. March 10, 2008, <http://www.bloomberg.com/apps/news?pid=20601082&sid=aQ3QdGGEE8H4&refer=canada>, and March 10, 2008, [http://afp.google.com/article/ALeqM5i2qa6dmy7kOB4\\_yvmPNZRUsxCxaw](http://afp.google.com/article/ALeqM5i2qa6dmy7kOB4_yvmPNZRUsxCxaw).

**Oil Voice**, “State and RWE Dea Launch CO<sub>2</sub> Storage Project to Aid Climate Protection.”

Following \$39 million (25 million euros) in research grants to the University of Kiel and Leibniz Institute of Marine Sciences IFM-GEOMAR last year, the German Federal state of Schleswig-Holstein and RWE Dea AG are initiating a CO<sub>2</sub> storage project that will explore three regions in Germany’s northern, lowland plains – North Frisia, East Holstein, and the North Sea. RWE Dea has already applied for permission from the German State Department for



Mining, Energy and Geology to examine the CO<sub>2</sub> storage potential in these regions and hopes that once approval is received, seismic survey results could be available by the end of 2009. Should these seismic results align with projections, an exploratory well could be drilled early in the summer of 2010, which could lead to the construction of a CO<sub>2</sub> storage facility in Schleswig-Holstein. Current RWE Dea projections estimate that a \$93.2 million (60 million euros) investment would be necessary for the construction of a plant that would have an annual \$6.2 million (4 million euros) operating cost. March 12, 2008, [http://www.oilvoice.com/n/State\\_and\\_RWE\\_Dea\\_Launch\\_CO2\\_Storage\\_Project\\_to\\_Aid\\_Climate\\_Protection/aa2df854.aspx](http://www.oilvoice.com/n/State_and_RWE_Dea_Launch_CO2_Storage_Project_to_Aid_Climate_Protection/aa2df854.aspx).

# SEQUESTRATION IN THE NEWS (CONTINUED)

*Saskatoon Star Phoenix*, “Gov’t Proceeding with \$1.4B Clean Coal-Carbon Capture Project,” and *SaskPower News Release*, “New Federal Funding Opens Door to Major Carbon Capture Demonstration Project in Saskatchewan.”

Saskatchewan’s provincial government announced plans to commence a seven-year project that will reconstruct and repower SaskPower’s coal-fired power generation unit at the Boundary Dam Power Station. The announcement came one day after the Canadian Federal budget allotted \$240 million to Saskatchewan to demonstrate a clean-coal project; SaskPower’s share of the total \$1.4 billion cost will be approximately \$758 million. The proposed project would produce 100 megawatts of baseload power, reduce SaskPower’s GHG emissions by about one million tonnes per year, and use the captured CO<sub>2</sub> for enhanced oil recovery. SaskPower’s announcement follows their cancelled initiative to construct a 300-megawatt, near-zero emission, pulverized coal plant, which failed to progress because SaskPower needed the Federal government to up their financial support for an initial \$3.8 billion plant near Estevan. The project will contribute to the Saskatchewan Party government’s goal to cut GHG emissions by 32 percent by 2020. February 27, 2008,

<http://www.canada.com/saskatoonstarphoenix/news/story.html?id=98b0cc5b-943b-48ef-89bd-99eddfb95925&k=88812>, and February 27, 2008, <http://www.saskpower.com/aboutus/news/?p=368#more-368>.

*Google News*, “Utility Proposes First US Coal-Fired Plant to Capture CO<sub>2</sub>,” and *Tenaska News Release*, “Tenaska Proposes Nation’s First New Conventional Coal-Fueled Power Plant to Capture Carbon Dioxide.”

US energy company Tenaska announced a proposal for a new 600-megawatt, coal-fired power plant in Texas that would capture 90 percent of its CO<sub>2</sub> emissions to sell for enhanced oil recovery in the Permian Basin. If the plant is built it will be located near Sweetwater, Texas and operate as the first commercial-scale coal-fired plant to capture and provide storage for CO<sub>2</sub>. Tenaska has already requested a state air permit through the Texas Commission on Environmental Quality for the three billion dollar plant, but withheld any future plans, saying the final decision will come in 2009 based on government incentives, construction costs, and the price of electricity and CO<sub>2</sub>. In addition to transporting the CO<sub>2</sub> via pipeline for geological storage, the plant, which could be operational in 2014 if construction begins in late 2009, will power some 600,000 homes and contribute more than one billion dollars in oil production to Texas’ economy. February 19, 2008, [http://afp.google.com/article/ALeqM5hpAuRg-wbtc5esL6s6\\_sm6ML7K9w](http://afp.google.com/article/ALeqM5hpAuRg-wbtc5esL6s6_sm6ML7K9w), and February 19, 2008,

<http://www.tenaska.com/newsItem.aspx?id=30>.

## ANNOUNCEMENTS

### **Chinese Begin Accounting for CO<sub>2</sub> Emissions.**

Chinese cement producers have taken the first steps toward measuring and managing CO<sub>2</sub> emissions across the country’s cement sector. This represents a significant step forward by the Chinese government in its clean development and climate change strategies, because cement production accounts for five percent of global CO<sub>2</sub> emissions, of which China contributes some 45 percent. The Chinese government plans to institute a three-phase strategy to collect data, beginning with multinational companies and followed by medium and small companies. For details, click: <http://www.wri.org/stories/2008/02/chinese-cement-companies-account-co2-emissions>.

### **CCX Sets Trading Volume Record.**

On March 4, the Chicago Climate Exchange, Inc. (CCX) announced it had achieved a new monthly record in trading volume during February 2008, when 100,496 Carbon Financial Instrument (CFI) contracts were traded. This volume nearly trumps the 102,724 contracts sold in all of 2006 and brings the year-to-date volume to more than half of 2007’s volume of 229,375 contracts. For more information about CCX prices and volume information, go to: <http://www.theccx.com/market/data/summary.jsf>.

### **World Environment Day 2008.**

The United Nations Environment Programme’s (UNEP) World Environment Day scheduled for June 5, 2008 is calling for countries, companies, and individuals to educate themselves about GHG emissions and the methods available to reduce them. The event, titled, “CO<sub>2</sub> Kick the Habit! Towards a Low Carbon Economy,” will promote low carbon lifestyles, including energy efficiency initiatives, alternative energy sources and forest conservation efforts. To learn about the event or register an activity, visit: <http://www.unep.org/wed/2008/english/>.

### **Climate Change and the Western United States’ Power Sector.**

A study conducted by DOE’s Argonne National Laboratory (ANL) used results from regional climate models to study the impacts of projected changes in temperature and precipitation on the development and operations of the Western United States’ power system. The study will be presented at the IAEE Conference in Ankara, Turkey in June 2008. To read the study, go to: [http://www.dis.anl.gov/news/WECC\\_ClimateChange.html](http://www.dis.anl.gov/news/WECC_ClimateChange.html).

## ANNOUNCEMENTS - CONTINUED

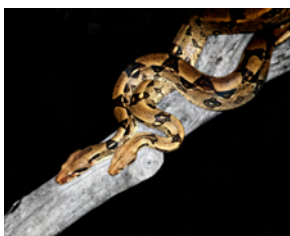
### **International Greenhouse Gas Registry Launched.**

The Gold Standard Foundation and APX, Inc. announced the creation of the Gold Standard Voluntary Emissions Reductions (VER) Registry on March 11, providing individuals with the opportunity to use APX's Environmental Market Depository technology to track and trade Gold Standard VERs throughout the world. Also, the registry tracks the certification of Certified Emission Reductions (CERs) and Emission Reduction Units (ERUs) that are part of Gold Standard's Clean Development Mechanism (CDM) and Joint Implementation (JI) project database. Go to <http://goldstandard.apx.com/> to browse the Gold Standard VER Registry website.

## SCIENCE

### **Discovery News, "Pythons Could Slither North as Climate Warms."**

A US Geological Survey (USGS) climate model for the year 2100 shows that 20-foot pythons could move into a number of US states due to global warming replicating their native Pakistani and Indonesian climates in North America. Regions where the pythons could appear include the northernmost parts of Texas and Arkansas, the southeast half of Kansas, the southern half of Missouri, and parts of southern Illinois and Indiana; while states like Tennessee, Kentucky, Maryland, Delaware, New Jersey, California, Arizona, Nevada, New Mexico, Washington, and Oregon may prove climatically hospitable to python populations in the future. Gordon Rodda, the USGS' invasive snake expert, conducted the model and admitted that factors like food and habitat were not taken into account, but he still expects the pythons could spread north wherever and whenever possible. The pythons, which can weigh over 250 pounds in some cases, are thought to be the offspring of a released pet and were first found in 2003 in the Florida Everglades. The largest snake in North America is either the bull snake or indigo snake, which are both shorter than nine feet long – a stark contrast to a python capable of killing deer, alligators, and even adult humans. USGS researchers are currently investigating the possibility of nine similar snakes, including the boa constrictor and yellow anacondas, invading North America. February 22, 2008, <http://dsc.discovery.com/news/2008/02/22/python-climate-change.html>.



### **Washington Post, "Carbon Output Must Near Zero to Avert Danger, New Studies Say."**

Two recent, separately conducted studies claim that both developing and industrial nations must reduce their GHG emissions as soon as 2050 to prevent global warming scenarios that could result in changing precipitation patterns and water sources drying up across the globe. Through the utilization of advanced computer models, the studies conclude CO<sub>2</sub> emissions must be reduced to near zero levels as soon as possible, although worldwide CO<sub>2</sub> output totals some 10 billion tons per year and continues to steadily rise. In fact, the scientists believe the situation has worsened to the point where it is no longer logical to set a GHG emissions threshold and instead, they favor setting a temperature threshold, because the Earth has already warmed by 1.4 degrees

Fahrenheit above pre-industrial levels. The consensus among scientists is that an increase of 3.6 degrees Fahrenheit could have disastrous consequences; one of the studies suggests if the status quo holds the Earth will warm by 7.2 degrees Fahrenheit by 2100 and more than 15 degrees Fahrenheit by 2300. Moreover, the scientists cautioned that even after the world's emissions reach zero, warming will still take place, as CO<sub>2</sub> can trigger deep sea warming despite natural cycles removing roughly half of anthropogenic CO<sub>2</sub> emissions from the atmosphere over the next 100 years. A report published by the United Nations Intergovernmental Panel on Climate Change (IPCC) said that industrialized nations would have to cut emissions 80 to 95 percent by 2050 to reduce GHG emissions to the 450 parts per million (ppm) goal. The global warming studies are available at <http://www.agu.org/pubs/crossref/2008/2007GB002953.shtml> and <http://www.agu.org/pubs/crossref/2008/2007GL032388.shtml>. March 10, 2008, <http://www.washingtonpost.com/wp-dyn/content/article/2008/03/09/AR2008030901867.html>.

## POLICY

### **Reuters, "EU Wants Developing Nations to do More on Climate."**

Despite being the leading purchaser of carbon offsets from developing nations, the European Union (EU) wants developing nations to stop relying on carbon offset schemes and instead begin taking a proactive role in cutting their GHG emissions. European Commission officials believe that the current process, which allows rich countries to meet binding targets on GHG emissions by funding cuts in developing nations, will not lead to targeted emissions levels. United Nations officials do not support the EU's stance, as they conversely desire to expand the carbon offset process under the Kyoto Protocol's Clean Development Mechanism (CDM). In addition, this stance poses a significant threat to the multibillion dollar carbon market. Ideally, the EU would prefer a cap-and-trade scheme to set a limit on GHG emissions and allow countries to trade carbon credits below the cap; however, developing nations refuse to be restricted by such limits, saying their primary focus is ending poverty and rich nations should resolve climate issues. The EU statement comes on the heels of their January proposal to freeze the use of carbon offsets by the energy-intensive industry from 2013 to 2020 – a move currently worrying carbon market investors. The CDM market tripled to a value of \$18.57 billion (12 billion euros) in 2007 and may find new life if developing nations agreed to sell offsets for clean energy technologies. March 11, 2008, <http://www.reuters.com/article/environmentNews/idUSL1119071820080311?sp=true>.

## POLICY (CONTINUED)

### “CO<sub>2</sub> Embodied in International Trade with Implications for Global Climate Policy.”

The flow of pollution through international trade flows has the ability to undermine environmental policies, particularly for global pollutants. In this article [the authors] determine the CO<sub>2</sub> emissions embodied in international trade among 87 countries for the year 2001. [The authors] find that globally there are over 5.3 [gigatons] of CO<sub>2</sub> embodied in trade and that Annex B countries are net importers of CO<sub>2</sub> emissions. Depending on country characteristics—such as size variables and geographic location—there are considerable variations in the embodied emissions. [The authors] argue that emissions embodied in trade may have a significant impact on participation in and effectiveness of global climate policies such as the Kyoto Protocol. [The authors] discuss several policy options to reduce the impact of trade in global climate policy. If countries take binding commitments as a part of a coalition, instead of as individual countries, then the impacts of trade can be substantially reduced. Adjusting emission inventories for trade gives a more consistent description of a country's environmental pressures and circumvents many trade related issues. It also gives opportunities to exploit trade as a means of mitigating emissions. Not least, a better understanding of the role that trade plays in a country's economic and environmental development will help design more effective and participatory climate policy post-Kyoto. **Glen P. Peters and Edgar G. Hertwich**, *Environmental Science & Technology*, Available online January 30, 2008, doi: 10.1021/es072023k, <http://pubs.acs.org/cgi-bin/abstract.cgi/esthag/2008/42/i05/abs/es072023k.html>. (Subscription required.)

## GEOLOGY



### “Competitive adsorption equilibria of CO<sub>2</sub> and CH<sub>4</sub> on a dry coal.”

Gases like CO<sub>2</sub> and [methane (CH<sub>4</sub>)] are able to adsorb on the coal surface, but also to dissolve into its structure causing the coal to swell. In this work, the binary adsorption of CO<sub>2</sub> and CH<sub>4</sub> on a dry coal (Sulcis Coal Province, Italy) and its swelling behavior are investigated. The competitive adsorption measurements are performed at 45 Å [degrees Celsius] and up to 190 bar for pure CO<sub>2</sub>, CH<sub>4</sub> and four mixtures of molar feed compositions of 20.0, 40.0, 60.0 and 80.0 [percent] CO<sub>2</sub> using a gravimetric-chromatographic technique. The results show that [CO<sub>2</sub>] adsorbs more favorably than methane leading to an enrichment of the fluid phase in CH<sub>4</sub>. Coal swelling is determined using a high-pressure view cell, by exposing a coal disc to CO<sub>2</sub>, CH<sub>4</sub> and He at 45 and 60 Å [degrees Celsius] and up to 140 bar. For CO<sub>2</sub> and CH<sub>4</sub> a maximum swelling of about 4 and 2 [percent] is found, whereas He shows negligible swelling. The presented adsorption and swelling data are then discussed in terms of fundamental, thermodynamic aspects of adsorption and properties which are crucial for an ECBM operation, i.e. the CO<sub>2</sub> storage capacity and the dynamics of the replacement of CH<sub>4</sub> by CO<sub>2</sub>. **Stefan Ottiger, Ronny Pini, Giuseppe Storti, and Marco Mazzotti**, *Adsorption*, Available online March 5, 2008, DOI: 10.1007/s10450-008-9114-0, <http://www.springerlink.com/content/1676n04035452u21/?p=0a38ca0344ec4e27bccf38189bd5f7c1&pi>.

## TECHNOLOGY

### “Atmospheric monitoring and verification technologies for CO<sub>2</sub> geosequestration.”

The paper describes various techniques for measuring emissions to the atmosphere from geologically stored carbon dioxide, from point, line and area sources at scales of meters to several kilometers. Flux chambers are suitable for measuring small leakage rates from sources at known locations but many samples are required because of large spatial heterogeneity in the fluxes. Micrometeorological eddy covariance, relaxed eddy accumulation and flux-gradient techniques are suitable for measuring leakage from large area sources, while integrated horizontal mass balance, tracer methods and plume dispersion approaches are applicable for line and point sources. Distinguishing between leakage signals and natural fluctuations in CO<sub>2</sub> concentrations due to biogenic sources pose significant challenges and the use of naturally occurring tracers such as CO<sub>2</sub> isotopologues or introduced tracers such as SF<sub>6</sub> added to the sequestered CO<sub>2</sub> will assist with this problem. Forward Lagrangian dispersion calculations showed that CO<sub>2</sub> concentrations 0–80 m downwind of a point source would be readily detectable above all natural variations for point sources >0.3 g CO<sub>2</sub> s<sup>-1</sup> (about 10 tonnes of CO<sub>2</sub> per year). The inverse problem involves solving for the unknown emission rate from measured wind fields and down wind concentration perturbations. An optimum monitoring strategy for inverse analysis will require continuous measurements of CO<sub>2</sub> and tracer compounds upwind and downwind of the possible leak location, coupled with transport modeling to determine leakage fluxes, and to differentiate them from other sources. Computations using The air pollution model (TAPM) showed that expected perturbations in CO<sub>2</sub> concentrations at distances of several hundred meters from a leak of 32 g CO<sub>2</sub> s<sup>-1</sup> (about 1000 tonnes CO<sub>2</sub> per year, or about 0.01 [percent] per year of a typical amount to be stored) will be detectable, but this anomaly will be very small compared to natural variations, thereby complicating the inverse analysis. While the techniques canvassed here have proven successful for measuring fluxes in other applications, none has yet been demonstrated for geosequestration. The next step is to test [these techniques] in the field. **Ray Leuning, David Etheridge, Ashok Luhar and Bronwyn Dunse**, *International Journal of Greenhouse Gas Control*, Available online March 6, 2008, doi:10.1016/j.ijggc.2008.01.002, <http://www.sciencedirect.com/science/article/B83WP-4S0HC8N-1/2/8df18b802f791960685c42a32311f29b>. (Subscription may be required.)

### “Sorbents for CO<sub>2</sub> capture from high carbon fly ashes.”

Fly ashes with high-unburned-carbon content, referred to as fly ash carbons, are an increasing problem for the utility industry, since they cannot be marketed as a cement extender and, therefore, have to be disposed. Previous work has explored the potential development of amine-enriched fly ash carbons for CO<sub>2</sub> capture. However, their performance was lower than that of commercially available sorbents, probably because the samples investigated were not activated prior to impregnation and,



## TECHNOLOGY (CONTINUED)

therefore, had a very low surface area. Accordingly, the work described here focuses on the development of activated fly ash derived sorbents for CO<sub>2</sub> capture. The samples were steam activated at 850 [degrees Celsius], resulting in a significant increase of the surface area (1075 m<sup>2</sup>/g). The activated samples were impregnated with different amine compounds, and the resultant samples were tested for CO<sub>2</sub> capture at different temperatures. The CO<sub>2</sub> adsorption of the parent and activated samples is typical of a physical adsorption process. The impregnation process results in a decrease of the surface areas, indicating a blocking of the porosity. The highest adsorption capacity at 30 and 70 [degrees Celsius] for the amine impregnated activated carbons was probably due to a combination of physical adsorption inherent from the parent sample and chemical adsorption of the loaded amine groups. The CO<sub>2</sub> adsorption capacities for the activated amine impregnated samples are higher than those previously published for fly ash carbons without activation (68.6 vs. 45 mg CO<sub>2</sub>/g sorbent). **M. Mercedes Maroto-Valer, Zhe Lu, Yinzhi Zhang, and Zhong Tang**, *Waste Management*, Available online February 21, 2008, doi:10.1016/j.wasman.2007.10.012, <http://www.sciencedirect.com/science/article/B6VFR-4RWHX8W-2/2/8f4752c4d3950d952e354f7afc31ff00>. (Subscription may be required.)



## TERRESTRIAL/OCEAN

### “Carbon Sequestration in Native Prairie, Perennial Grass, No-Till, and Cultivated Palouse Silt Loam.”

Comparative assessments for evaluating soil organic C (SOC) and its characteristics were made at different soil (Palouse silt loam) depths (0–5, 5–10, 10–20, and 0–20 cm) among sites with seven contrasting management histories: conventional inversion tillage (CT) followed by no-till (NT) for 4 (NT4) and 28 (NT28) yr; bluegrass (*Poa pratensis* L.) seed production for 9 yr followed by NT for 4 yr (BGNT4); a sequence of 10 yr NT, 3 yr CT, and 1 yr NT (NTR); CT followed by 11 yr perennial grass under the Conservation Reserve Program (CRP); long-term >100 yr CT; and native prairie (NP). Overall ranking of SOC, particulate organic C (POC), and microbial biomass C (MBC) at 0 to 20 cm was NP > NTR > NT4 = NT28 > CRP > BGNT4 = CT. Greater SOC, POC, and MBC in NTR than NT28 indicated that tillage rotation could result in more soil C sequestration, primarily by increasing C stocks in 5- to 20-cm depths. The POC was labile in nature as it highly correlated with C<sub>min</sub> ( $r = 0.69$ ,  $P < 0.01$ ) and MBC ( $r = 0.86$ ,  $P < 0.01$ ) as well as SOC ( $r = 0.89$ ,  $P < 0.01$ ). [The authors] concluded that: (i) neither NT nor conversion to perennial vegetation would attain the SOC found in NP over 10 to 30 yr; and (ii) medium duration of NT (10 yr) combined with short intervals of CT (3 yr) followed by NT might increase SOC compared with continuous long-term NT under annual cropping. **T. J. Purakayastha, D. R. Huggins and J. L. Smith**, *Soil Science Society of America Journal*, Available online February 28, 2008, DOI: 10.2136/sssaj2005.0369, <http://soil.scijournals.org/cgi/content/abstract/soilsci;72/2/534>. (Subscription required.)

## TRADING

### Carbon Market Update, March 17, 2008

CCX-CFI 2008 (\$/tCO <sub>2</sub> ) \$5.20 (Vintage 2008)	EU ETS-EUA DEC 2008 (\$/tCO <sub>2</sub> ) \$33.62
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(Converted from € to US\$)

**Reuters UK**, “Japan Considers Emissions Cap-and-Trade System,” and **Reuters India**, “Japan Wants Cap-and-Trade Plan Soon.”

As the world’s fifth largest emitter of GHG, Japan is considering mandating a cap on GHG emissions and implementing a domestic trading scheme in order to meet its post-Kyoto Protocol commitments. Currently, Japanese companies are free to set their own emissions targets and individually monitor their compliance practices, although this policy may change in light of an informal study requested by the Ministry of Economy, Trade and Industry (METI) that will investigate initiatives that would further cut emissions. Following the study’s expected completion in June, METI officials will meet with industry officials to lay the groundwork for a climate action plan that would take effect in 2013; in addition, Japan will host a Group of Eight (G-8) meeting in July, where 2020 emission targets will be discussed. Japanese industry officials believe voluntary emission cuts and household energy conservation initiatives would satisfy Japan’s Kyoto obligations. The METI actions arise from Japan falling behind on its Kyoto commitment to cut GHG emissions by six percent a year on average from 1990 levels over the 2008 to 2012 timeframe and the tougher emissions cuts expected to follow Kyoto’s expiration in 2013, fueled by the EU’s plan to cut emissions by 20 percent in 2020 from 1990 levels. February 20, 2008, <http://uk.reuters.com/article/oilRpt/idUKT36546720080220>, and March 11, 2008, <http://in.reuters.com/article/worldNews/idINIndia-32416820080311>.



## RECENT PUBLICATIONS

### **“Policy Options for Reducing CO<sub>2</sub> Emissions.”**

There is a growing scientific consensus that rising concentrations of carbon dioxide (CO<sub>2</sub>) and other [GHGs], which result from the burning of fossil fuels, are gradually warming the Earth’s climate. The amount of damage associated with that warming remains uncertain, but there is some risk that it could be large and perhaps even catastrophic. Reducing that risk would require restraining the growth of CO<sub>2</sub> emissions—and ultimately limiting those emissions to a level that would stabilize atmospheric concentrations—which would involve costs that are also uncertain but could be substantial. The most efficient approaches to reducing emissions of CO<sub>2</sub> involve giving businesses and households an economic incentive for such reductions. Such an incentive could be provided in various ways, including a tax on emissions, a cap on the total annual level of emissions combined with a system of tradable emission allowances, or a modified cap-and-trade program that includes features to constrain the cost of emission reductions that would be undertaken in an effort to meet the cap. This Congressional Budget Office (CBO) study—prepared at the request of the Chairman of the Senate Committee on Energy and Natural Resources—compares those policy options on the basis of three key criteria: their potential to reduce emissions efficiently, to be implemented with relatively low administrative costs, and to create incentives for emission reductions that are consistent with incentives in other countries. In keeping with CBO’s mandate to provide objective, impartial analysis, the report contains no recommendations. To read the complete Congressional Budget Office study, click: <http://www.cbo.gov/ftpdocs/89xx/doc8934/02-12-Carbon.pdf>.

### **“Climate Change Legislation Design: Appropriate Roles for Different Levels of Government.”**

Sorting out the appropriate roles of each level of government in addressing climate change is far more complicated than the specific question of whether State climate change programs should be preempted. This Paper raises more comprehensive and complex questions that the Committee must consider: what roles are best played by each level of government as we marshal our country’s resources to address climate change and how should these roles be reflected in Federal legislation. Many State and local governments have begun to address climate change, as the Subcommittee heard last year in testimony from State and local witnesses. Activity by State and local governments has helped reduce [GHG] emissions, has helped build a consensus that we need to address climate change nationally, and is helping to develop and test different policies. To read the first in a series of white papers from the House Committee on Energy and Commerce and its Subcommittee on Energy and Air Quality, go to: [http://energycommerce.house.gov/Climate\\_Change/white%20paper%20st-1cl%20roles%20final%202-22.pdf](http://energycommerce.house.gov/Climate_Change/white%20paper%20st-1cl%20roles%20final%202-22.pdf).

### **“Managing the Transition to a Secure, Low-Carbon Energy Future.”**

Over the coming decades, the world faces a daunting challenge in meeting the energy needs of a growing and developing world population while mitigating the impacts of global climate change. There is now broad-based scientific and political agreement that climate change is occurring and that the increase in atmospheric [GHG] concentrations is the single biggest factor in global temperature rise. Stabilizing GHG concentrations at levels that will not dangerously interfere with the climate system requires an urgent and fundamental change in the way we produce and use energy. At the same time, concern over energy security grows deeper as global energy demand increases, prices continue to rise, and the ability to bring new supplies to market is called into question. Although the world is not running out of energy resources overall, significant geopolitical, economic, environmental, and technical challenges lie in accessing, producing, converting, and delivering those resources to the people who need them. The entire World Resources Institute Issue Brief is available at: [http://pdf.wri.org/managing\\_transition\\_to\\_low-carbon\\_energy\\_future.pdf](http://pdf.wri.org/managing_transition_to_low-carbon_energy_future.pdf).

### **“Designing a Greenhouse Gas Emissions Registry.”**

With the federal government now debating the best way to reduce [GHG] emissions on a national scale, policymakers must also address the need to collect the emissions data necessary to ensure the success of U.S. climate change policies. The first step in reducing emissions is to measure them. Without accurate and complete data on the sources of emissions and the amount they emit, the success of U.S. climate policies may be compromised. In December 2007, Congress passed and President Bush signed into law the Consolidated Appropriations Act, 2008. The law includes a provision directing the U.S. Environmental Protection Agency to require mandatory reporting of [GHG] emissions from appropriate sources in all sectors of the U.S. economy. This policy brief explains the critical need for such a mandatory [GHG] emissions registry and reporting program and outlines key design elements to include in such a registry. To view the World Resources Institute policy brief, click: [http://pdf.wri.org/designing\\_a\\_us\\_ghg\\_emissions\\_registry.pdf](http://pdf.wri.org/designing_a_us_ghg_emissions_registry.pdf).

## LEGISLATIVE ACTIVITY

### *Casper Star Tribune, “Gov Signs Carbon Bills.”*

On March 4, Wyoming Governor Dave Freudenthal signed two bills that establish ownership and regulation principles for the state’s effort to develop CCS technologies for coal-fired power plants. The laws, which go into effect July 1, 2008, state the following: Wyoming Bill 89 designates that owners of the land surface retain underground

storage rights, while Wyoming Bill 90 creates a state regulatory framework for carbon sequestration projects. However, several legal questions still remain unresolved, such as what happens when the right to develop minerals on a piece of land interferes with the landowner’s right to store carbon underneath and what happens if stored carbon migrates under neighboring land parcels. The storage ownership bill was written by Representative Tom Lubnau, who specified Wyoming does not plan to force power plants to institute CCS technologies. As the nation’s largest coal-producing state, Wyoming hopes to market their electrical power as a “value-added” product to states like

# LEGISLATIVE ACTIVITY (CONTINUED)

California. Lubnau said the legislature will continue their work to resolve unsettled issues. To read Wyoming Bill 89, click: <http://legisweb.state.wy.us/2008/Enroll/HB0089.pdf> or for Wyoming Bill 90, click: <http://legisweb.state.wy.us/2008/Enroll/HB0090.pdf>. March 5, 2008, <http://www.casperstartribune.net/articles/2008/03/05/news/wyoming/41d80ae8b86188e48725740300021c5f.txt>.

## **Carbon Control News, “Washington State CO<sub>2</sub> Storage Rules May Set Baseline Ahead of EPA.”**

The state of Washington is working to become the first state to establish regulations for CO<sub>2</sub> injection and sequestration projects, which officials plan to have completed by the end of June. The state rules fall under

the EPA’s UIC Permitting Program of the Safe Drinking Water Act (SDWA) and may offer EPA officials a roadmap for creating nationwide rules for CCS. The proposed regulations would require CO<sub>2</sub> injection projects to acquire a UIC Class 5 permit for experimental wells, although the permit requirements nearly replicate the prerequisites necessary to obtain a UIC Class 1 permit. The intent of the regulations is to protect underground sources of drinking water (USDWs) and public health and safety; but most importantly, the legislation places full liability on project developers to ensure the safe, long-term geological storage of CO<sub>2</sub>. EPA is due to release its own draft proposal regarding CO<sub>2</sub> injection projects in July and it remains to be seen if such projects will be permitted as Class 1 wells – or possibly under a new Class 6 well designation specifically for sequestration – which may dictate amending of Washington’s regulations. To view Washington’s CO<sub>2</sub> injection and sequestration proposal, click: [http://carboncontrolnews.com/ccndocs/mar08/ccn03102008\\_washington.pdf](http://carboncontrolnews.com/ccndocs/mar08/ccn03102008_washington.pdf). March 10, 2008, [http://carboncontrolnews.com/index.php/ccn/show/washington\\_state\\_co2\\_storage\\_rules\\_may\\_set\\_baseline\\_ahead\\_of\\_epa/](http://carboncontrolnews.com/index.php/ccn/show/washington_state_co2_storage_rules_may_set_baseline_ahead_of_epa/). (Subscription required.)



## EVENTS

April 5-11, 2008, **8<sup>th</sup> International Conference on Environmental Compliance and Enforcement**, *Cape Town, South Africa*. With participants from more than 80 countries and organizations across the globe, this conference brings together environmental enforcement practitioners to discuss compliance with international and domestic environmental laws. The agenda includes a segment about climate change and compliance composed of discussions about integrity in emissions trading, energy efficiency, the Clean Development Mechanism, and Post-2012 compliance mechanisms. For more information, visit: <http://www.inece.org/conference/8/>.

April 10-11, 2008, **Sixth International Forum on Geologic Sequestration of CO<sub>2</sub> in Deep, Unmineable Coalseams “Coal-Seq VI,”** *Marriott Westchase, Houston, Texas*. This year’s forum objectives address topics such as technical and non-technical CO<sub>2</sub> sequestration issues, worldwide sequestration projects, understanding state-of-the-art in various technical areas, and an update of activities presented at “Coal-Seq V.” For further information contact Susan Pershall, Advanced Resources International at 1-281-558-9200 or by email ([spershall@adv-res-hou.com](mailto:spershall@adv-res-hou.com)). For event updates and registration information, click: <http://www.coal-seq.com/upcomingevents.htm>.

April 11-12, 2008, **2008 MIT Energy Conference**, *Marriott Hotel in Kendall Square, Cambridge, Massachusetts, USA*. The 2008 MIT Energy Conference is the ideal forum for assembling technology, policy, and industry leaders to develop solutions for capitalizing on the opportunities present in modern energy markets. The two-day event opens with a showcase for energy research and inventive businesses to the community, followed by a one-day conference that opens with a panel discussion about carbon capture and sequestration. For general conference details, go to: <http://www.mitenergyconference.com/>.

April 15-16, 2008, **Carbon Markets Americas**, *Blue Tree Hotel & Convention Centre, Sao Paulo, Brazil*. As Latin America’s leading exhibition for stakeholders in the region’s carbon markets, Carbon Market Americas offers attendees sessions about new market developments, carbon trading, industry projects, finance and investment opportunities, voluntary carbon markets, renewable energy projects, verification and monitoring, and future directions. For more information, go to: [http://www.greenpowerconferences.com/carbonmarkets/carbonmarkets\\_americas\\_2008.html](http://www.greenpowerconferences.com/carbonmarkets/carbonmarkets_americas_2008.html).

April 17, 2008, **Living in a Low Carbon World**, *Geographical Society, London, England*. The participants in Living in a Low Carbon World 2008 will examine how the development, property, finance, transport, energy and retail sectors can collaborate to communicate more effectively with the public about climate change. Through panel discussions, interactive voting, case studies, and keynote speeches, several United Kingdom-based strategic developments to combat climate change will be discussed. To browse the conference website, click: <http://conference.lowcarbonworld.net/main.php?pid=80>.





## EVENTS (CONTINUED)

April 24-25, 2008, **Carbon & Climate Change Conference**, *Austin Convention Center, Austin, Texas, USA*. This program covers carbon and climate change issues, with a special focus on the geology, science, economics, and law applicable to carbon capture, transport, and storage, including EOR applications. The program also includes special sessions on carbon markets, pending laws, incentives, and regulation (both Federal and Texas), and the latest EPA, DOE and Federal Trade Commission (FTC) initiatives dealing with carbon regulation and “green” marketing. To view the event program, go to: [http://www.utcle.org/conference\\_overview.php?conferenceid=807](http://www.utcle.org/conference_overview.php?conferenceid=807).

May 5-8, 2008, **7<sup>th</sup> Annual Carbon Capture and Sequestration Conference**, *Sheraton at Station Square, Pittsburgh, PA, USA*. This conference brings together experts directly involved in developing, demonstrating and deploying CO<sub>2</sub> capture, separation, and sequestration technologies. The 7th annual conference will address the knowledge, policy, regulatory, and technology gaps hindering expedited CCS deployment. Attendees will have the opportunities to discuss carbon capture, separation, and sequestration technologies and share experiences on developing the necessary capacity within the public and private sector to move the technology base forward. To browse the conference website, click: <http://www.carbonsq.com/>.

May 7-9, 2008, **Carbon Expo 2008**, *Exhibition Center, Cologne, Germany*. Carbon Expo 2008 offers attendees a total of eight plenary sessions and 22 workshops divided into three parallel “streams” – Project, Traders, or Global – about the state of the global carbon market, Joint Implementation (JI), Clean Development Mechanism (CDM), European Union Emissions Trading Scheme (EU ETS), carbon markets, non-Kyoto markets, and market outlook. For a conference brochure, visit: [http://www.carbonexpo.com/wEnglisch/carbonexpo2/img/dokumente/Conferenz\\_Programm.pdf](http://www.carbonexpo.com/wEnglisch/carbonexpo2/img/dokumente/Conferenz_Programm.pdf) or <http://www.carbonexpo.com/> for general conference information.

May 15-16, 2008, **Navigating the New Carbon World**, *San Diego Marriott Hall & Marina, San Diego, California, USA*. This annual conference allows over 1,000 climate change leaders to discuss evolving climate policies, standards, and trends. Topics include: National Climate Registry developments, carbon Markets, plans to curb emissions, international standards and reduction projects, carbon capture and sequestration technologies, and new and emerging climate change issues. To register for Navigating the Carbon World, click: <http://www.pointcarbon.com/Events/Navigating%20the%20Carbon%20World/category1538.html>.

June 1-5, 2008, **The Clearwater Coal Conference**, *Sheraton Sand Key, Clearwater, Florida, USA*. This five day conference, coined as the most comprehensive program on coal technologies, will highlight the issues currently impacting the electric utility industry, such as: coal and CO<sub>2</sub> for the future; coal quality issues; coal-related opportunities in developing countries; advanced energy conversion systems; and pre-combustion, post-combustion, and Oxyfuel CO<sub>2</sub> solutions. To view the conference program, click: <http://www.coaltechnologies.com/2008%20Program%20Announcement.pdf>.

June 12-13, 2008, **Global CO<sub>2</sub> Summit**, *Millennium Gloucester Hotel, London, England*. In order to help the energy sector respond to an ever-changing environment, the Global CO<sub>2</sub> Summit will enhance engagement and collaboration amongst policymakers, raise awareness concerning GHG reduction, leverage the business opportunities arising from global actions to reduce CO<sub>2</sub>, reduce exposure to future portfolio and regulatory risk, and teach how to transform CO<sub>2</sub> emissions liabilities into financial assets. For detailed information and a conference brochure, visit: [http://www.thecwcgroup.com/conf\\_detail\\_home.asp?FP=1&CID=186](http://www.thecwcgroup.com/conf_detail_home.asp?FP=1&CID=186).

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To learn more about DOE’s Carbon Sequestration Program, please contact Sean Plasynski at [sean.plasynski@netl.doe.gov](mailto:sean.plasynski@netl.doe.gov), or Dawn Deel at [dawn.deel@netl.doe.gov](mailto:dawn.deel@netl.doe.gov).