



Carbon Sequestration Newsletter



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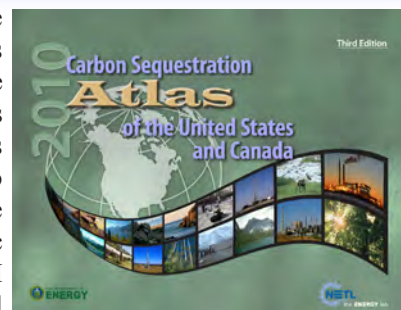
DECEMBER 2010

Carbon Sequestration

WHAT'S INSIDE?

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resource potential in saline formations, oil and gas reservoirs, and unmineable coal areas in the United States and portions of Canada. This suggests a potential 500 to 5,700 years of CO₂ storage resource in assessed geologic formations. In addition, Atlas III provides updates on Regional



Carbon Sequestration Partnerships (RCSPs) activities, DOE's Carbon Sequestration Program, international carbon capture and storage (CCS) collaborations, worldwide CCS projects, CCS regulatory issues, and CO₂ stationary source emissions. The CO₂ storage resource calculation methodology of Atlas III was refined to better reflect uncertainties in geologic formation properties. Two versions of Atlas III are available: (1) an interactive version located at the National Carbon Sequestration Database and Geographic Information System (NATCARB) website (<http://www.natcarb.org>), and (2) a print version available for download at the NETL website (http://www.netl.doe.gov/technologies/carbon_seq/refshelf/atlasIII/). (Ugg'T gegpv'Rwdlec vkgputge vkgp 'hqt 'c 't qt vkgp 'qhl' vj g'CvruKKHqt gy qt f 'epf 'c 'hpnitq'CvruKKH. December 1, 2010, http://www.netl.doe.gov/publications/press/2010/10058-Third_Edition_of_Carbon_Sequestrat.html.)

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, "Third Carbon Sequestration Atlas Estimates Up to 5,700 Years of CO₂ Storage Potential in U.S. and Portions of Canada."

On December 1, the U.S. Department of Energy (DOE) released the "Carbon Sequestration Atlas of the United States and Canada – Third Edition (Atlas III)," which documents 1,800 billion to more than 20,000 billion metric tons of carbon dioxide (CO₂) storage

Fossil Energy Techline, "DOE-Sponsored Field Test Finds Potential for Permanent Storage of CO₂ in Lignite Seams."

The Plains CO₂ Reduction (PCOR) Partnership injected approximately 90 tons of CO₂ over two weeks into a 10- to 12-foot deep coal seam at an approximate depth of 1,100 feet in Burke County, North Dakota, in a DOE-sponsored field test, demonstrating that opportunities to address climate change by permanently storing CO₂ in unmineable coal seams of lignite may be more widespread than previously documented. The field test showed that the CO₂ did not significantly move from the wellbore and was contained within the coal seam for the duration of a three-month monitoring period. In addition, the PCOR Partnership evaluated a variety of carbon storage operation conditions to determine their applicability to similar coal seams, and investigated the feasibility of combining CO₂ storage with enhanced methane production. The results indicate that suitable lignite seams are potential targets for CCS, and that the combination of CO₂ storage and enhanced methane production has the potential to offer both a near-term economic return and a long-term environmental benefit. The successful injection and storage of CO₂ in this field test provides for similar CO₂ injection tests at a larger scale and longer



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duration. To learn more about DOE's RCSP Initiative, visit: <http://www.fossil.energy.gov/programs/sequestration/partnerships/index.html>, or click: <http://www.undeerc.org/pcor/>, for more information on the PCOR Partnership. November 4, 2010, http://www.fossil.energy.gov/news/techlines/2010/10054-Field_Test_Demonstrates_CO2_Storage.html.

Fossil Energy Techline, "New DOE-Sponsored Study Helps Advance Scientific Understanding of Potential CO₂ Storage Impacts."

A Duke University study, sponsored by DOE, has confirmed earlier research showing that proper site selection and monitoring is essential for helping anticipate and mitigate possible risks. The report, titled "Potential Impacts of Leakage from Deep CO₂ Geosequestration on Overlying Freshwater Aquifers," presented the results of a year-long study in which researchers incubated core samples from a variety of freshwater formations with CO₂ for more than 300 days. The Duke research project, which also provides information that can be used for advanced detection of CO₂, is one of many DOE-sponsored projects that investigate the impact of CO₂ injection into geologic formations. To learn more about DOE's Carbon Sequestration Research Program, visit: <http://www.fossil.energy.gov/programs/sequestration/index.html>. November 30, 2010, http://www.fossil.energy.gov/news/techlines/2010/10057-Study_Helps_CCS_Understanding.html.

SEQUESTRATION IN THE NEWS

Europa Press Release, "State Aid: Commission Approves [\$200] Million Aid for Carbon Capture and Storage."

The European Commission authorized The Netherlands to provide a [\$200] million grant for a CCS demonstration project in the Rotterdam port area. E.ON and GDF Suez will construct a 250-megawatt (MW) equivalent plant that will capture part of the CO₂ emitted by E.ON's coal-fired Maasvlakte Power Plant 3 and transport it via pipeline to a gas field in the North Sea for geologic storage. The CO₂ capture plant is expected to capture 1.1 million tons of CO₂ annually. The CCS project has also been allocated funding under the European Energy Programme for Recovery (EPR). October 27, 2010, <http://europa.eu/rapid/pressReleasesAction.do?reference=IP/10/1392&format=HTML>.

Business Standard, "Norway Offers ONGC a [Stake] of \$1-[Billion] Carbon Project."

The Oil and Natural Gas Corporation (ONGC) has been invited to participate in a \$1 billion CCS project by the Norwegian government, which holds 75 percent in the project. Located at Statoil's Mongstad oil refinery in Norway, the CO₂ Technology Centre would have access to flue gas from the gas-fired power plant. The partners have already invested approximately \$450 million in the project, which is designed to capture around 100,000 tonnes of CO₂ annually. Full commissioning is expected in 2012. October 30, 2010, <http://www.business-standard.com/india/news/norway-offers-ongc-bite-1-bn-carbon-project/413205/>.

SEQUESTRATION IN THE NEWS (CONTINUED)

Industrial Fuels and Power, “Siemens Completes First Phase of CO₂ Pilot Project, Demonstrated Capture Efficiency of 90 [Percent].”

Siemens Energy successfully completed the first test phase of its CO₂

capture facility at the E.ON-operated Staudinger power plant. Following more than 3,000 operating hours since the facility was commissioned in September 2009, a CO₂ capture efficiency of more than 90 percent was achieved. The project investigated process efficiency and long-term stability of the scrubbing agent. Sponsored by E.ON and the German Federal Ministry of Economics and Technology, the pilot project promotes research and development of low emissions power plant technologies. November 19, 2010, <http://www.ifandp.com/article/008247.html>.

ANNOUNCEMENTS

IEA Launches CCS Model Regulatory Framework.

The International Energy Agency (IEA) CCS Model Regulatory Framework provides an overview of 29 key issues associated with regulating CCS to assist both regional and national CSS regulatory framework development. For each issue, the model framework provides an explanation and examples of how each issue has been addressed in existing legislation. For more information, visit: <http://www.iea.org/ccs/legal/modelframework.asp>.

Call for Papers for 10th Annual CCS Conference.

The 10th Annual CCS Conference, scheduled to be held at the David L. Lawrence Convention Center in Pittsburgh, Pennsylvania, on May 2-5, 2011, is accepting papers and posters for peer review. Topics include: RCSP large-scale field testing, U.S.-Canadian CCS collaboration, and American Recovery and Reinvestment Act of 2009 (ARRA) investments. Abstracts are due February 18, 2011, and full papers are due April 18, 2011. For more information, including a complete list of topics, visit: <http://www.carbonsq.com/callforpapersccs2011.pdf>.

CCS Webinar.

A webinar, titled “Carbon Capture & Sequestration,” will be held on Thursday, December 16, 2010, to discuss challenges and opportunities in CCS and results from recently commissioned demonstration plants. For more information, visit the event website at: <http://www.energycentral.com/events/22607/>.

WCI Emissions Calculators Available.

The Western Climate Initiative (WCI) has posted final default emissions factor calculators for 2006, 2007, and 2008. Both “light” and full versions of the calculators are available; the light versions contain the calculator worksheet and its data table, while the full versions also include the underlying plant and unit level data. The final calculators are available for download at: <http://www.westernclimateinitiative.org/component/remository/Electricity-Team-Documents/Default-Emission-Factor-Calculators/>.

DOE’s World Gasification Database Now Available.

The 2010 Worldwide Gasification Database was made available by DOE, documenting the worldwide growth of gasification technologies. The database is a comprehensive collection of gasification plant data, describes the current world gasification industry, and identifies near-term planned capacity additions. To link to the database, click: <http://www.netl.doe.gov/technologies/coalpower/gasification/worlddatabase/index.html>.

SCIENCE

USA Today, “Global Warming May Bring Giant, Voracious Crabs to Antarctica.”

According to scientists from the National Oceanography Centre in Southampton in the United Kingdom, changing ocean temperatures may allow giant predatory crabs to enter the continental-shelf ecosystems of Antarctica. According to their research, published in the journal *Polar Biology*, a small increase in water

temperature due to potential climate change could bring king crabs into the area, where they historically have not been able to survive – the cold-blooded crabs cannot mature in water temperature less than approximately 32.9°F. Data was gathered by studying the distribution of 17 species of king crabs in the Southern Ocean; it was found that the coldest waters the crabs have been found in range from 32.72°F to 32.9°F in the Ross Sea. Scientists believe the arrival of the predatory species could cause



SCIENCE

a major shift in the current populations living in the high-Antarctic continental shelves. November 2, 2010, <http://content.usatoday.com/communities/sciencefair/post/2010/11/global-warming-may-bring-giant-voracious-crabs-to-antarctica/1?csp=34tech>.

NASA Press Release, “NASA Study Finds Earth’s Lakes are Warming.”

In a comprehensive global survey of lake temperature trends, NASA researchers found that the Earth’s largest lakes have warmed over the last 25 years, which they believe is due to climate change. Using satellite data to measure the surface temperatures of 167 large lakes worldwide, researchers reported an average warming rate of 0.81°F per decade. The greatest increases in temperature, which in some lakes was as much as 1.8°F per decade, were found in the mid- to high-latitudes of the Northern Hemisphere. Researchers focused on summer temperatures (July to September in the Northern Hemisphere; January to March in the Southern Hemisphere) due to the difficulty in collecting data in seasons when lakes are ice-covered and/or hidden by clouds. The lakes chosen were selected from a global database of lakes and wetlands based on size (at least 193 square miles) or other unique characteristics. The selected lakes had large surface areas and were located away from shorelines, preventing land influences from interfering with the measurements; data were collected from the point farthest from any shoreline. November 23, 2010, <http://www.nasa.gov/topics/earth/features/earthb20101123.html>.

POLICY

EPA News Release, “EPA Issues Pollution Permitting Guidance for States/Focus is on Improving Energy Efficiency to Reduce GHG Pollution from the Largest Industrial Facilities,” and *The New York Times, “EPA Issues Guidelines for States’ Permitting for Greenhouse Gases.”*

The U.S. Environmental Protection Agency (EPA) released a document that provides guidance and tools to help state and local air permitting authorities identify cost-effective reduction options for greenhouse gases (GHGs) under the Clean Air Act. The guidance document, titled, “PSD and Title V Permitting Guidance For Greenhouse Gases,” is part of EPA’s approach to permitting the largest GHG emissions sources outlined in the Tailoring Rule. Large-emitting new and modified facilities, such as power plants, refineries, and cement production facilities, will be required to use the best available control technologies (BACT) for GHGs beginning January 2, 2011. (See **Recent Publications section for the Introduction and a link to the “PSD and Title V Permitting Guidance For Greenhouse Gases.”**) November 10, 2010, <http://yosemite.epa.gov/opa/admpress.nsf/d0cf6618525a9efb85257359003fb69d/d7348883f0d10676852577d700613835!OpenDocument>, and November 10, 2010, <http://www.nytimes.com/gwire/2010/11/10/10greenwire-epa-issues-guidelines-for-states-permitting-fo-82460.html>.

EPA News Release, “EPA Finalizes Rules to Foster Safe Carbon Storage Technology Actions Part of Efforts to Reduce Barriers to Widespread Deployment of Carbon Capture and Sequestration, an Important Set of Technologies to Combat Climate Change.”

Two CCS-related rules aimed to protect drinking water and to track the amount of CO₂ stored from geologic storage facilities have been finalized by EPA. The rules conform with recommendations made by the CCS Task Force and help to make a consistent national framework for ensuring the safe, effective deployment of technologies. The first rule finalized requirements for geologic CO₂ storage, including the development of a new class of injection well called Class VI, established under EPA’s Underground Injection Control (UIC) Program. EPA also finalized a rule on the GHG reporting requirements for facilities that carry out geologic storage, allowing them to track the amount of CO₂ stored by these facilities. November 22, 2010, <http://yosemite.epa.gov/opa/admpress.nsf/0/2300005fbc11568d852577e3006058bd?OpenDocument>.

“First assessment of sources and [formations] for carbon capture and geological storage in Portugal.”

The following is the Abstract of this article: “A preliminary study for a source–[formation] match for application of CCS in Portugal is presented. The location of the main CO₂ emission sources in Portugal, existing and planned, was analyzed and three main source clusters, emitting a total of 26.8 Mt/year, were defined. The three source clusters are connected by a natural gas pipeline network. [Carbon dioxide] storage reservoirs are likely to be restricted to deep saline formations. Potential storage formations are described in the Porto, Lusitanian and Algarve sedimentary basins. Due to the large continental shelf, composed mainly of sedimentary rocks, it is important to consider offshore opportunities.



A Geographical Information System (GIS), including information on the stratigraphy, seismicity, neotectonics and geothermal features, was used for prioritizing the areas where reservoir identification and characterization studies should be conducted. Despite not showing the most promising geological conditions, the area around the deepwater harbor of Sines is given the highest priority, since sources in the area account for more than 40 [percent] of point source emissions in Portugal.” **Júlio F. Carneiro, Dulce Boavida, and Ricardo Silva, *International Journal of Greenhouse Gas Control*, Available online September 15, 2010, doi:10.1016/j.ijggc.2010.08.002, <http://www.sciencedirect.com/science/article/B83WP-511BPR8-1/2/2beb01b9f72e568591659daf579b5bd5>. (Subscription may be required.)**

GEOLOGY

“Evolution of hydrogen sulfide in sour saline [formations] during carbon dioxide sequestration.”

The following is the Abstract of this article: “Many deep saline [formations] suitable for CO₂ sequestration contain measurable concentrations of hydrogen sulfide (H₂S). These [formations] are described here as sour saline [formations] and the other ones as ordinary saline [formations]. Sour saline [formations] occur wherever even minor amounts of anhydrite or other sulfate sources are present in the formation. In this paper, compositional modeling of CO₂ injection into such [formations] is studied. When CO₂ is injected into a sour saline [formation], the H₂S initially dissolved in the brine will be exsolved and released into an expanding CO₂ plume. At any time after the start of CO₂ injection, the region swept by the plume consists of two sub-regions. The first of these is an inner sub-region extending from the injection well, and is characterized by the absence of H₂S in both aqueous and gaseous phases. The dissolved H₂S in this inner sub-region is nearly completely removed from the brine via an exsolution process. The second sub-region extends from the outer edge of the inner sub-region to the leading edge of the plume. In this outer sub-region, the mole fraction of H₂S in the gas plume gradually increases toward the leading edge and reaches a peak value. While the gas plume is expanding the size of the outer sub-region enlarges. Following the discussion of these phenomena, in the next part of the paper, injection of acid gases (mixtures of H₂S and CO₂) into sour saline [formations] and ordinary saline [formations] is explored. In contrast to sour [formations], unsaturated water in an ordinary [formation] will strip away H₂S from the CO₂ stream and consequently the mole fraction of H₂S toward the gas front decreases. The highly toxic nature of H₂S gas suggests the need to account for dissolved H₂S in sour saline [formations] when establishing risk assessment, monitoring, and management strategies at CO₂ storage sites.” **Seyyed M. Ghaderi, David W. Keith, Rob Lavoie, and Yuri Leonenko**, *International Journal of Greenhouse Gas Control*, Available online October 30, 2010, doi:10.1016/j.ijggc.2010.09.008, <http://www.sciencedirect.com/science/article/B83WP-51BX6S1-1/2/a41558c879de83dc094bb13bf796fb42>. (Subscription may be required.)

“Simultaneous CO₂ injection and water production to optimize [formation] storage capacity.”

The following is the Abstract of this article: “The estimates for geologic CO₂ storage capacity worldwide vary, but it is generally believed that the capacity in saline [formations] will be sufficient for the amounts of CO₂ that will need to be stored. The effort required to select and qualify a geological storage site for safe storage will, however, be significant and storage capacity may be a limited resource regionally. Both from an economic and resource management perspective it is therefore important that potential storage sites are exploited to their full potential. In static capacity estimates, where the maximum stored amount of CO₂ is given as a fraction of the formation pore volume, typically arrive at efficiency factors in the range of a few per cents. Recent work has shown that when the dynamic behavior of the injected CO₂ is taken into account, the efficiency factor will be reduced because of the increase in pore pressure in the region around the injection well(s). The increase in pore pressure will propagate much further than the CO₂. The

EU directive on geological CO₂ storage specifically addresses the restriction that will apply when different storage sites are interacting due to pressure communication. Consequently, the pore pressure increase at the boundary of the storage license area will be an important limiting factor for the amount of CO₂ that can be injected. One obvious method to control the pore pressure is to produce water from the [formation] at some distance from the CO₂ injection wells. This paper discusses results from simulations of CO₂ injection in two [formations] on the Norwegian Continental Shelf; the Johansen [formation] and the southern part of the Utsira [formation]. These [formations] are candidates for injection of CO₂ shipped out via pipeline from the Norwegian West Coast. The injected amounts of CO₂ over a period of 50 years are 0.518 Gt for the Johansen [formation] and 1.04 Gt for the Utsira [formation]. Several design options for the injection operations are investigated: Injection of CO₂ without water production; injection into several wells to distribute the injected fluids and reduce the local pressure increase around each injection well; and injection with simultaneous production of water from one or more wells. The boundaries of the formations are assumed closed in all simulations. The possible consequences of other types of boundary conditions (semi-closed or open) are briefly discussed.” **Per Eirik S. Bergmo, Alv-Arne Grimstad, and Erik Lindeberg**, *International Journal of Greenhouse Gas Control*, Available online November 3, 2010, doi:10.1016/j.ijggc.2010.09.002, <http://www.sciencedirect.com/science/article/B83WP-51CRWN0-1/2/952a2238f859ddcdacff14f242b32cd6>. (Subscription may be required.)

TECHNOLOGY

“Co-optimization of Enhanced Oil Recovery and Carbon Sequestration.”

The following is from the Abstract of this article: “In this paper, [the authors] present an economic analysis of CO₂-enhanced oil recovery (EOR). This technique entails injection of CO₂ into mature oil fields in a manner that reduces the oil’s viscosity, thereby enhancing the rate of extraction. As part of this process, significant quantities of CO₂ remain sequestered in the reservoir. If CO₂ emissions are regulated, oil producers using EOR should therefore be able to earn revenues from sequestration as well as from oil production. [The authors] develop a theoretical framework that analyzes the dynamic co-optimization of oil extraction and CO₂ sequestration, through the producer’s choice of the fraction of CO₂ in the injection stream at each moment. [The authors] find that the optimal fraction of CO₂ is likely to decline monotonically over time, and reach zero before the optimal termination time. Numerical simulations, based on an ongoing EOR project in Wyoming, confirm this result. [The authors] also find that cumulative sequestration is less responsive to the carbon tax than to the oil price. Only at high taxes does a tradeoff between revenues from oil output and sequestration arise.” **Andrew Leach, Charles F. Mason, and Klaas van’t Veld**, *Resource and Energy Economics*, Available online November 26, 2010, doi:10.1016/j.reseneeco.2010.11.002, <http://www.sciencedirect.com/science/article/B6VFJ-51JPWPY-1/2/9986a08fe2875a499d02f2833121cbcc>. (Subscription may be required.)

TECHNOLOGY (CONTINUED)

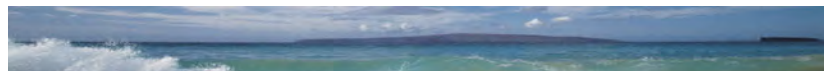
“Post-combustion CO₂ Capture with Chemical Absorption: A State-of-the-art Review.”

The following is the Abstract of this article: “Global concentration of CO₂ in the atmosphere is increasing rapidly. [Carbon dioxide] emissions have an impact on global climate change. Effective CO₂ emission abatement strategies such as CCS are required to combat this trend. There are three major approaches for CCS: Post-combustion capture, Pre-combustion capture and Oxyfuel process. Post-combustion capture offers some advantages as existing combustion technologies can still be used without radical changes on them. This makes post-combustion capture easier to implement as a retrofit option (to existing power plants) compared to the other two approaches. Therefore, post-combustion capture is probably the first technology that will be deployed. This paper aims to provide a state-of-the-art assessment of the research work carried out so far in post-combustion capture with chemical absorption. The technology will be introduced first, followed by required preparation of flue gas from power plants to use this technology. The important research programs worldwide and the experimental studies based on pilot plants will be reviewed. This is followed by an overview of various studies based on modeling and simulation. Then the focus is turned to review development of different solvents and process intensification. Based on these, [the authors] try to predict challenges and potential new developments from different aspects such as new solvents, pilot plants, process heat integration (to improve efficiency), modeling and simulation, process intensification and government policy impact.” **M. Wang, A. Lawal, P. Stephenson, J. Sidders, and C. Ramshaw**, *Chemical Engineering Research and Design*, Available online November 13, 2010, doi:10.1016/j.cherd.2010.11.005, <http://www.sciencedirect.com/science/article/B8JGF-51FXRGB-1/2/3fc82f9cb694031b0198884ad1dcf33e>. (Subscription may be required.)

“Effective retrofitting of post-combustion CO₂ capture to coal-fired power plants and insensitivity of CO₂ abatement costs to base plant efficiency.”

The following is the Abstract of this article: “Existing coal-fired power plants were not designed to be retrofitted with [CO₂] post-combustion capture (PCC) and have tended to be disregarded as suitable candidates for [CCS] on the grounds that such a retrofit would be uneconomical. Low plant efficiency and poor performance with capture compared to new-build projects are often cited as critical barriers to capture retrofit. Steam turbine retrofit solutions are presented that can achieve effective thermodynamic integration between a post-combustion CO₂ capture plant and associated CO₂ compressors and the steam cycle of an existing retrofitted unit for a wide range of initial steam turbine designs. The relative merits of these capture retrofit integration options with respect to flexibility of the capture system and solvent upgradability will be discussed. Provided that effective capture system integration can be achieved, it can be shown that the abatement costs (or cost per tonne of CO₂ to justify capture) for retrofitting existing units is independent of the initial plant efficiency. This then means that a greater number of existing power plants are potentially suitable for successful retrofits of post-combustion capture to reduce power sector emissions. Such a wider

choice of retrofit sites would also give greater scope to exploit favorable site-specific conditions for CCS, such as ready access to geological storage.” **Mathieu Lucquiaud and Jon Gibbins**, *International Journal of Greenhouse Gas Control*, doi:10.1016/j.ijggc.2010.09.003, <http://www.sciencedirect.com/science/article/B83WP-51FX0CW-1/2/d52a7934a24eea381f745dc993e0ef5c>. (Subscription may be required.)



TERRESTRIAL

“Can no-tillage stimulate carbon sequestration in agricultural soils? A meta-analysis of paired experiments.”

The following is from the Abstract of this article: “Adopting no-tillage in agro-ecosystems has been widely recommended as a means of enhancing carbon sequestration in soils. However, study results are inconsistent and varying from significant increase to significant decrease. It is unclear whether this variability is caused by environmental, or management factors or by sampling errors and analysis methodology. Using meta-analysis, [the authors] assessed the response of soil organic carbon (SOC) to conversion of management practice from conventional tillage (CT) to no-tillage (NT) based on global data from 69 paired-experiments, where soil sampling extended deeper than 40 cm. [The authors] found that cultivation of natural soils for more than [five] years, on average, resulted in soil carbon loss of more than 20 t ha⁻¹, with no significant difference between CT and NT. Conversion from CT to NT changed distribution of carbon in the soil profile significantly, but did not increase the total SOC except in double cropping systems. After adopting NT, soil carbon increased by 3.15 ± 2.42 t ha⁻¹ (mean ± 95 [percent] confidence interval) in the surface 10 cm of soil, but declined by 3.30 ± 1.61 t ha⁻¹ in the 20–40 cm soil layer. Overall, adopting NT did not enhance soil total carbon stock down to 40 cm. Increased number of crop species in rotation resulted in less carbon accumulation in the surface soil and greater carbon loss in deeper layer. Increased crop frequency seemed to have the opposite effect and significantly increased soil carbon by 11 [percent] in the 0–60 cm soil. Neither mean annual temperature and mean annual rainfall nor nitrogen fertilization and duration of adopting NT affected the response of soil carbon stock to the adoption of NT. [The authors’] results highlight that the role of adopting NT in sequestering carbon is greatly regulated by cropping systems. Increasing cropping frequency might be a more efficient strategy to sequester carbon in agro-ecosystems. More information on the effects of increasing crop species and frequency on soil carbon input and decomposition processes is needed to further [the authors’] understanding on the potential ability of carbon sequestration in agricultural soils.” **Zhongkui Luo, Enli Wang, and Osbert J. Sun**, *Agriculture, Ecosystems & Environment*, Available online September 9, 2010, doi:10.1016/j.agee.2010.08.006, <http://www.sciencedirect.com/science/article/B6T3Y-510244F-1/2/affdf8a7e6edd8d7f14e53d12403d762>. (Subscription may be required.)

TRADING

Carbon Market Update, December 1, 2010

CCX-CFI 2010 (\$/tCO ₂)	EU ETS-EUA DEC 2010
\$0.05 (Vintage 2009)	(\$/tCO ₂) \$19.57

(Converted from € to US\$)

Yahoo! News, “California Unveils Greenhouse Gas Trading Plan.”

On October 29, Californian officials announced the intention to give away permits (rather than sell the majority of the necessary permits) to factories and power plants when the state’s GHG trading program starts in 2012. On average, emitters will be given approximately 97 to 98 percent of the permits they will require in the first year. In addition, up to eight percent of permit needs could be met with offset credits that avoid emissions for storing GHGs. California will create as many permits as expected emissions in the first year of the plan, and will set aside an

average of four percent of permits from 2012 to 2020 to be sold if trading prices increase higher than expected; the reserve will be approximately one percent in 2012. Permits auctioned by the state will cost at least \$10 per tonne in the first year and \$15 per tonne in 2020. California is part of WCI, a consortium of seven western states and four Canadian provinces aiming to start a joint trading scheme in 2012. October 29, 2010, http://news.yahoo.com/s/nm/20101029/us_nm/us_carbon_california.

BBC News, “Kenya to Launch Africa’s First Carbon Exchange.”

Kenyan officials announced plans to launch a climate exchange platform to facilitate the trading of carbon credits. The first of its kind in Africa, the market will enable all African countries to sell their carbon credits to help prevent potential climate change. According to Kenyan officials, the trade in carbon credits has the potential to spur investment in the generation of renewable energy and forestry projects. Kenya’s government estimates that the Mau, the country’s largest forest, has the potential to earn the country nearly \$2 billion a year over the next 15 years – a value that would have to be certified by the United Nations Framework Convention on Climate Change (UNFCCC). November 11, 2010, <http://www.bbc.co.uk/news/science-environment-11733765>.

RECENT PUBLICATIONS

“Carbon Sequestration Atlas of the United States and Canada – Third Edition (Atlas III)”

The following is from the Foreword of the document: “The U.S. Department of Energy’s (DOE) National Energy Technology Laboratory (NETL) is proud to release the third edition of the Carbon Sequestration Atlas of the United States and Canada (Atlas III). Production of Atlas III is the result of collaboration among carbon storage experts from local, State, and Federal agencies, as well as industry and academia. Atlas III provides a coordinated update of CCS potential across most of the United States and portions of Canada. The primary purpose of Atlas III is to update the CO₂ storage potential for the United States and Canada, and to provide updated information on the Regional Carbon Sequestration Partnerships’ (RCSPs) field activities. In addition, Atlas III outlines DOE’s Carbon Sequestration Program, DOE’s international CCS collaborations, worldwide CCS projects, and CCS regulatory issues; presents updated information on the location of CO₂ stationary source emissions and the locations and storage potential of various geologic storage sites; and further provides information about the commercialization opportunities for CCS technologies from each RCSP.” The complete Atlas III is available for download at: http://www.netl.doe.gov/technologies/carbon_seq/refshelf/atlasIII/.

“Carbon Capture and Storage Model Regulatory Framework.”

The following is from the Executive Summary of this document: “According to the IEA publication *Energy Technology Perspectives 2010 (ETP 2010)*, in the absence of new energy policies or supply constraints, energy-related CO₂ emissions in 2050 will be twice 2007 levels... This publication, the IEA *Carbon Capture and Storage Model Regulatory Framework (Model Framework)*, seeks to deal with the reality that such rapid expansion and scale-up of CCS technology raises a number of regulatory issues that need to be addressed in parallel with ongoing efforts to demonstrate the technical, safety and environmental viability of industrial scale CCS projects. Regulatory frameworks are required to ensure the effective stewardship of CO₂ storage sites over the long term, the protection of public health and the environment, and the security of CCS activities. Appropriate regulatory frameworks are also required to clarify the rights and responsibilities of CCS stakeholders, including relevant authorities, operators and the public. Additionally, regulations are needed to underpin performance and associated incentive schemes, commercial transactions relating to CCS operations, and also to build public confidence in, and acceptance of, the technology.” To view the entire document, visit: http://www.iea.org/ccs/legal/model_framework.pdf.

“CCS Ready.”

The following is from the Summary of this document: “Recent efforts by the Global CCS Institute, in collaboration with the IEA, and Carbon Sequestration Leadership Forum (CSLF) to establish a definition for Carbon Capture and Storage Ready (CCSR), highlights increasing recognition of its potential to facilitate CO₂ mitigation in the future. In addition, many governments around the world are now considering how CCSR can play a role in broader climate change policies. The introduction of CCSR policy anticipates a future transition

RECENT PUBLICATIONS (CONTINUED)

to broader CCS deployment. It acts as a signaling mechanism by indicating that governments are willing to mandate a technology still in development if there is perceived to be an environmental benefit. CCSR is an option for governments seeking to facilitate any future transition to CCS deployment.” To view the complete Issues Brief, visit: http://new.globalccsinstitute.com/sites/default/files/GCCSI%20Issues%20Paper%2010.01%20-%20CCS%20Ready_1.pdf.

“CCS and Community Engagement: Guidelines for Community Engagement in Carbon Dioxide Capture, Transport, and Storage Projects.”

The following is from the Introduction of this document: “Globally, nearly 70 percent of anthropogenic (human-caused) CO₂ emissions are related to energy consumption. The IEA projects these energy-related CO₂ emissions will nearly double between 2007 and 2050 if the world follows a business-as-usual path. Therefore, achieving significant cuts in these energy-related emissions is critical to avoiding more than a 2.7°F rise in global temperatures by 2050 and the irreversible and damaging impacts such a temperature rise would have on people and ecosystems... In July 2008, the [Group of Eight (G8)] set a goal of launching 20 CCS demonstration projects globally by 2010, with wide-scale deployment beginning in 2020. However, this goal is far from being met, and local opposition is often cited as one of the reasons for CCS project delays and cancellations. Past experience suggests that CCS will not be widely deployed at the pace needed without local community support. Such support can evolve from active participation in an engagement process by regulatory policy designers and regulatory authorities, project developers, local opinion leaders, national and local policy-makers, and community members.” The complete World Resources Institute (WRI) report is available at: http://pdf.wri.org/ccs_and_community_engagement.pdf.

“PSD and Title V Permitting Guidance For Greenhouse Gases.”

The following is the Introduction of this document: “EPA is issuing this guidance document to assist permit writers and permit applicants in addressing the prevention of significant deterioration (PSD) and title V permitting requirements for GHGs that begin to apply on January 2, 2011. This document: (1) describes, in general terms and through examples, the requirements of the PSD and title V permit regulations; (2) reiterates and emphasizes relevant past EPA guidance on the PSD and title V review processes for other regulated air pollutants; and (3) provides additional recommendations and suggested methods for meeting the permitting requirements for GHGs, which are illustrated in many cases by examples. [The authors] believe this guidance is necessary to respond to inquiries from permitting authorities and other stakeholders regarding how these permitting programs will apply to GHG emissions.” The complete permitting guidance document is available at: http://www.eenews.net/assets/2010/11/10/document_gw_04.pdf.

LEGISLATIVE ACTIVITY

New Mexico Environment Department Press Release, “Environmental Improvement Board Approves First-in-the-Nation Rules to Reduce Global Warming Pollutants from Multiple Sectors,” and Reuters, “New Mexico Quietly Adopts Country’s Most Comprehensive Greenhouse Gas Rules.”

The New Mexico Environmental Improvement Board (EIB) has approved two sets of proposed GHG emission reduction regulations. The first set of potential climate change regulations establishes rules for GHG reporting and verification; the second set deals with more specific GHG cap-and-trade regulations. The rules, proposed by the New Mexico Environment Department, will enable the state to participate in WCI, a consortium of seven western states and four Canadian provinces focused on developing strategies to address potential climate change. The cap-and-trade program will affect approximately 63 facilities, primarily fossil fuel-fired power plants and oil and gas operations, which emit more than 25,000 metric tons of GHGs annually. Beginning in 2012, each facility will be required to begin reducing emissions by two percent per year below 2010 levels. November 2, 2010, http://www.nmenv.state.nm.us/OOTS/documents/PR-EIBDecision-11-2-10_3_.pdf, and November 3, 2010, <http://www.reuters.com/article/idUS323795324720101103>.

The Vancouver Sun, “Alberta Gov’t Moves to Assume Carbon-Capture Liability.”

The Alberta Government introduced legislation that would have the province assume long-term liability for CO₂ injected underground. A fund would be created that is financed by CCS operators for monitoring costs and any required remediation. The Alberta Government has promised \$2 billion for CCS projects, the focus of their 2008 Climate Change Strategy, which commits to reducing projected emissions by 200 megatonnes by 2050. The projects are still in early stages and CO₂ will not be injected until 2015 at the earliest. November 2, 2010, <http://www.vancouversun.com/business/Alberta+moves+assume+carbon+capture+liability/3761219/story.html>.





EVENTS (CONTINUED)

December 8-10, 2010, **The 16th Annual CO₂ Flooding Conference**, *Midland, Texas, USA*. This event includes trips to Hess' Seminole field and CO₂ facilities in Gaines County, and to Legado's Goldsmith-Landreth Field and facilities in Ector County. In addition, field cases will be presented and operation and reservoir topics will be discussed. For more information on the field trips and field cases, click: http://co2conference.net/agenda_midland.html.

December 16-18, 2010, **Climate Change: Spatial Concerns and Mitigation Strategies**, *ISPER Headquarters, Chandigarh, Haryana, India*. Organized by the Institute for Spatial Planning and Environment Research (ISPER), this seminar will provide a platform to discuss opportunities to maintain climatic equilibrium and develop mechanisms to control potential climate change. Among the topics to be covered are climate change monitoring, methodologies, and techniques. For more information, visit: http://www.isperonline.com/show_events.php?id=18.

January 24-25, 2011, **Coal Markets: The Outlook for Coal and Coal-Fired Power**, *Hyatt Regency, Miami, Florida, USA*. This event will look at the current state of the coal industry, focusing on topics such as the regulatory landscape and new clean coal technologies. Included are sessions on carbon legislation, CCS, and CO₂ cap-and-trade schemes. To download a brochure, visit the conference website at: <http://www.euci.com/conferences/0111-coal-markets/>.

January 25-26, 2011, **Carbon Markets and Climate Finance Africa**, *Hilton Sandton, Johannesburg, South Africa*. This conference provides attendees with a forum to develop and discuss carbon market institutional capacity and increase the pace of project investment and development. Included is a session on the Clean Development Mechanism (CDM). To download the full agenda, visit the conference website at: <http://www2.greenpowerconferences.co.uk/EF/?sSubSystem=Prospectus&sEventCode=CM1101ZA&sSessionID=4ac1fcafd0aca881be3564fe03b6479-1692677>.

February 21-24, 2011, **Coal Power Generation 2011**, *Mandarin Orchard, Singapore*. This two-day event focuses on the building of coal-fired power plants in Asia. Among the topics to be discussed are the commercial competitiveness of CCS, costs and risks of CCS, and how CCS can make coal power generation more socially acceptable. For more information, visit the conference website at: <http://www.coalpowergeneration.com/>.

March 1-3, 2011, **Carbon Market Insights 2011**, *Amsterdam RAI, Amsterdam, The Netherlands*. This conference will focus on international negotiations and domestic legislation in the carbon market. The program will also focus on the trading and market dynamics of carbon as an emerging commodity. To view the conference website, which includes a downloadable program, click: <http://www.pointcarbon.com/events/conferences/cmi2011/>.

April 13-15, 2011, **3rd Annual China Clean Coal Summit 2011**, *Qingdao, Shandong, China*. In addition to providing updates in China's clean coal technology, coal-to-liquids (CTLs), CCS, and future integrated gasification combined cycle (IGCC) technology, this summit will offer case studies, future project information, site tours, and an international forum. For more information, click: <http://chinacleancoalsummit.com/index.asp>.

FOR SUBSCRIPTION DETAILS...

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

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

To learn more about DOE's Carbon Sequestration Program, please contact John T. Litynski at john.litynski@netl.doe.gov, or Dawn Deel at dawn.deel@netl.doe.gov.