

THE CARBON SEQUESTRATION NEWSLETTER

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January 2007

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HIGHLIGHTS



FutureGen Alliance, “Xstrata Coal Joins FutureGen Alliance,” and Xstrata Press Release, “Xstrata Coal Commits \$25 Million To FutureGen Clean Coal Project.”

Xstrata Coal has become a member of the FutureGen Alliance (Alliance) and will put \$25 million toward the \$1 billion FutureGen Initiative. FutureGen is a project to build a first-of-a-kind near zero emissions 275 megawatt (MW) prototype coal-fueled power plant. The Alliance is a non-profit consortium of global electric utilities and coal companies working with the US Department of Energy to design and build the FutureGen to generate electricity by hydrogen-driven turbines and capture and permanently store carbon dioxide deep underground. Xstrata is the

Artist Rendition of the FutureGen Plant (Source: US Department of Energy)

world’s largest exporter of thermal coal, and is joining the Alliance to demonstrate its commitment to work collaboratively to reduce greenhouse gas emissions resulting from the use of coal in power generation. Xstrata joins 11 other companies to become a member of the Alliance. These other companies include: American Electric Power, Anglo American, BHP Billiton, the China Huaneng Group, CONSOL Energy Inc., E.ON US, Foundation Coal, Rio Tinto Energy America, Peabody Energy, PPL Corporation, and Southern Company. Four candidate sites are in the running to host FutureGen, two in Texas and two in Illinois. The US Department of Energy is reviewing the candidate sites in accordance with the National Environmental Policy Act prior to the Alliance’s selection of a final site by late summer 2007. For more information visit <http://futuregenalliance.org/>. December 6, 2006, http://www.futuregenalliance.org/news/releases/pr_12-06-06.pdf, and December 7, 2006, <http://www.freemarketnews.com/Press-Release.asp?nid=12585>.

E&E News PM, “Supreme Court Appears Divided in Greenhouse Gas Case,” and Reuters, “Supreme Court Hears First Global Warming Case.” The Supreme Court considered the oral arguments of its first global warming case on November 29. The case, *Massachusetts v. EPA*, was brought against the US Environmental Protection Agency (EPA) by Massachusetts, 11 other US states, and 13 organizations. The plaintiff argues that greenhouse gases from vehicles and factories should be regulated by the US government. The EPA maintains that it lacks the authority to limit greenhouse gases such as carbon dioxide (CO₂), and that even if it did have this authority, the science on global warming is so uncertain no regulation should be made. The plaintiffs argue that if the greenhouse gases fit the federal Clean Air Act’s definition of a pollutant, EPA has the power to regulate the emissions. During the hour long oral arguments, the justices examined whether the plaintiffs had standing under the Constitution to challenge EPA’s decision not to regulate vehicle

HIGHLIGHTS (continued)

greenhouse gas emissions. Chief Justice John Roberts and Justice Antonin Scalia had doubts about the plaintiff's ability to show standing in the case. Legal analysts have predicted that Justice Anthony Kennedy will provide the swing vote regarding standing, and hinted during oral arguments that the plaintiffs have room to advance their case. Justice Stephen Breyer indicated that a new rule by the EPA could trigger wider action domestically, including sequestration of CO₂ emissions from power plants. The Supreme Court is expected to issue its opinion by next summer. The case is *Massachusetts v. Environmental Protection Agency*, 05-1120. To view the oral argument transcript, see: http://www.supremecourtus.gov/oral_arguments/argument_transcripts/05-1120.pdf. (Subscription may be required.) November 29, 2006, <http://www.eenews.net/eenewspm/2006/11/29/archive/1/?terms=sequestration>, and November 30, 2006, <http://www.alertnet.org/thenews/newsdesk/N29372625.htm>.

Sequestration in the News

Reuters, "Clean Coal Power Plant for Norway."

An international group of companies, including France's Eramet, US Alcan, Norway's Norsk Hydro, and Norwegian family-owned industrial company Tinfos are seeking bids from construction firms for a 400-megawatt coal-fired power plant to be built in west Norway, utilizing a carbon capture technology developed by the Norwegian clean energy group Sargas. The plant itself will cost approximately \$700 million. Ninety-five percent of the carbon dioxide, as well as nitrous oxide, will be captured. The 2.6 million tons of carbon dioxide captured would be piped or shipped to offshore oil or gas fields and sequestered deep below the sea floor. The timeline for the project is for a bid in 2007, to start the project in 2008, and production to begin in 2011. Power generation costs are estimated at \$0.047-\$0.055 per kilowatt hour, including costs of capture, equivalent to about 25 percent above power generation costs without capture. November 26, 2006, <http://www.theage.com.au/news/World/Clean-coal-power-plant-plan-for-Norway/2006/11/27/1164476105162.html>.

Agence France-Presse, "Australia Plans Massive Carbon Storage System." The Australian government has committed \$46.5 million to the Gor-

gon gas project, a large carbon capture and storage system, located off the West Australian coast. The plan is to sequester 125 million tons of carbon dioxide, two-thirds of the total emissions, which is equal to two-thirds of the total CO₂ emissions that the plant would emit, over 20 years of operations. The carbon dioxide removed while processing the natural gas will be injected 1.6 miles underground. Australian Environmental Minister Ian Campbell believes that carbon sequestration is "one of the key technologies that the world will need if we are to address climate change." The funding is dependant on environmental approval for the development of the massive natural gas field on Barrow Island by Chevron Corp and its partners Exxon Mobil and Royal Dutch Shell. November 23, 2006, <http://www.energy-daily.com/reports/Australia Plans Massive Carbon Storage System 999.html>.

DOE Techline, "DOE Advances Production of Hydrogen from Coal." The US Department of Energy (DOE) selected six research and development projects for funding, with the aim to promote large-scale production of hydrogen from coal. Production of hydrogen from coal will combat climate change by allowing for the capture

and se-



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Announcements

Sixth Annual Conference on Carbon Capture and Sequestration, May 7-10, 2007, Pittsburgh, PA. More details to follow in the upcoming newsletters.

CO₂ Capture and Sequestration Project Development: Challenges and Solutions. A joint workshop will be held on "CO₂ Capture and Sequestration Project Development: Challenges and Solutions," in Los Angeles, California by the US Department of Energy's National Energy Technology Laboratory and the United Kingdom's Department of Trade and Industry in Los Angeles, CA on March 19-21, 2007. Workshop attendees will include senior staff from the regulatory, financial, insurance, OEM and utility sectors. (See this Newsletter's Events section for more details, and this link: [http://www.netl.doe.gov/events/07conferences/ccs/.](http://www.netl.doe.gov/events/07conferences/ccs/))

Read Jeffrey Jarrett's Opinion Column on Carbon Sequestration. Jeffrey Jarrett, Assistant Secretary, Office of Fossil Energy, of the US Department of Energy has written a guest column on Carbon Sequestration which appeared in several newspapers including the *San Diego Union Tribune* on November 30, 2006. Read it at this link: http://www.signonsandiego.com/uniontrib/20061129/news_lz1e29jarrett.html.

Register for NYSERDA's Carbon Capture and Sequestration Listserv. Join New York State Energy Research and Development Authority's email listserv to receive updates on NYSERDA's and New York State's involvement with Carbon Sequestration issues. To subscribe to the list, visit: http://www.nyserda.org/programs/Research_Development/CCSListserv.asp for instructions. Or send an email to: listserv@listserv.nyserda.org. Leave SUBJECT blank, and put in the BODY of the email message (using your name): subscribe CCS-L firstname lastname. E-mail info@nyserda.org if you have questions about registering.

questration of carbon dioxide during hydrogen production. The projects chosen support President Bush's Hydrogen Fuel Initiative, which provides research and development funding for these types of projects with the aims to minimize America's growing dependence on foreign oil and reduces greenhouse gas emissions. Several technological challenges must be overcome before the use of large-scale production of hydrogen from coal can become wide spread. The projects are focused in two areas of interest including: 1.) Ultra-Pure Hydrogen, which investigates the purity standard of hydrogen in a number of end-use applications, including hydrogen turbines, fuel cells, and modified internal combustion engines; and 2.) Process Consolidation, which considers strategies for selectively removing pure hydrogen, carbon dioxide, and synthesis gas impurities in a single-reactor configuration that can operate simultaneously at high temperature and high conversion (of synthesis gas to hydrogen). Six projects were chosen to be funded, with \$7.4 million to be provided by the DOE and \$1.8 to be contributed by industry partners. (To view a detailed list of project descriptions, see the link at the end of this news item.) December 6, 2006, http://www.fossil.energy.gov/news/techlines/2006/06070-Hydrogen_from_Coal_Projects.html.

Reuters, "Clean" Coal Seen in 5-10 Years. Harry Audus, general manager of the International Energy Agency IEA's Greenhouse Gas Research and Development Program commented that carbon capture and sequestration for "clean" coal-fired power plants would be demonstrated technically viable within 5 to 10 years, but that there are still no commercial incentives to do so. He also remarked that it is up to politicians to institute the commercial incentives. Enabling power generators to capture and sequester carbon dioxide (CO₂) would be a technological step toward "clean coal" worth tens of billions of dollars. A 2005 United Nations report stated that capture and storage of CO₂ could meet 15 to 55 percent of the world's greenhouse gas reduction needs by 2100, making storage the largest contributor to the reductions. Carbon storage, according to Mr. Aldus, is only economically feasible to power generators if carbon prices trade for \$25-\$30 per ton. They are currently traded at \$24 per ton for 2008 delivery, but after 2012 when many emissions targets expire under the Kyoto Protocol, there will be a price vacuum. Nations under the Kyoto Protocol are looking at ways to extend the agreement beyond 2012. Many companies are working to develop capture and storage technologies in-

cluding American Electric Power, BP, E.ON, Statoil and Vattenfall. "The fundamental problem is that carbon capture and storage now costs around \$100 a ton," said David Garman, US Under Secretary of Energy. "We have to cut that cost to \$10 a ton or thereabouts in order for it to be widely adopted and available." The US Department of Energy is in the process of choosing between sites in Illinois and Texas for the \$1 billion FutureGen project. The European Union (EU) is planning to build a near-zero emissions coal-fired plant in China by 2020, and hopes to commercially operate carbon capture and storage plants as early as 2010 in both the United Kingdom and Norway. Norway's planned gas-fired Mongstad plant will capture 100,000 tons of carbon a year in 2010, with full carbon capture from 2014. Carbon taxes in Norway led to CO₂ capture and storage at Statoil's Sleipner gas field in 1996, and these taxes in 2006 ranged from \$255 to \$300 per ton. In Canada, En-Cana is injecting CO₂ from a US lignite gasification plant in an enhanced oil recovery project in Weyburn, Saskatchewan. BP and Algerian company Sonatrach are injecting carbon dioxide from the In Salah natural gas field in Algeria due to a high percentage of CO₂ in the gas. December 8, 2006, http://today.reuters.co.uk/news/articlenews.aspx?type=reutersEdge&storyID=2006-12-08T122452Z_01_NOA840704_RTRUKOC_0_CLIMATE-COAL.xml&WTmodLoc=Editors+Choice-C1-Headline-9.

Illinois Government News Network, "Governor Blagojevich Takes First Step Toward Building Innovative and Environmentally Friendly Carbon Dioxide Pipeline; Major Component of His Energy Independence Plan." As part of Illinois Governor Rod R. Blagojevich's Energy Independence Plan, a Request for Information (RFI) was submitted to acquire the necessary information for the construction and operation of a carbon dioxide (CO₂) pipeline. The pipeline would become part of the \$775 million investment plan which calls for the construction of ten new coal gasification plants to be completed by 2017. The proposed pipeline would run from the coal gasification plants planned for central and southern Illinois to Illinois Basin oilfields in southeastern Illinois. The outcome of this initiative is that 50 percent of Illinois' oil would be used to meet their energy needs, thus reducing their dependence on foreign oil. The 140-mile CO₂ pipeline would transport carbon dioxide captured by the coal gasification plants and pipe it to oil fields. The pressurized CO₂ would be used to extract more oil from existing reserves through enhanced oil recovery (EOR). Illinois will also be the second state to join the Chicago Climate Exchange. To read a bullet list of the specifics on Illinois' EOR and carbon sequestration potential, see the news item link. November 6, 2006, <http://www100.state.il.us/PressReleases/ShowPressRelease.cfm?SubjectID=18&RecNum=5500>.

St. Petersburg Times, "Carbon Goes Undercover." Carbon sequestration, along with energy efficiency and clean alternative fuels, are part of the three-pronged approach that the US government is using to cut greenhouse gases. Several Florida Power companies, as part of the National Energy Technology Laboratory's Southeast Regional Carbon Sequestration Partnership, including Progress Energy Inc., TECO Energy Inc., Gulf Power Co. and Florida Power & Light Co. are working to advance carbon sequestration technology. TECO anticipates using carbon sequestration at its Polk County Power Plant. Gulf Power is currently surveying potential carbon dioxide storage sites, including oil wells located throughout northwest Florida. A Gulf Power sister company is participating in a demonstration project to pump carbon dioxide (CO₂) into a salt formations 9,000 feet underground in South Mississippi. Formations for sequestration exist along the Gulf Coast and cover all of Florida south of Citrus County. Florida power companies anticipate future regulation of CO₂. The biggest challenge has not been storage of CO₂, but how to capture, condense and transport the gas. The federal government estimates that current meth-



ods of isolating flue gas from power plants could double the price of electricity. The government's goal is for sequestration to add no more than 10 percent to the cost of power. TECO's Polk County Power Plant fits the bill since the technology used promotes cheaper CO₂ capture. Researchers estimate that half of all man-made CO₂ could be sequestered by 2050.

December 11, 2006, http://www.sptimes.com/2006/12/11/Business/Carbon_goes_undercove.shtml.

Reuters, "Carbon Capture Decision to Be Made in 2007," and Reuters, "BP Seeks Clean Power Plant Talks." United Kingdom's Chancellor Gordon Brown announced in his pre-budget report that the Secretary for Industry will appoint engineers to the first carbon capture and storage (CCS) demonstration plant in the United Kingdom (UK). After this announcement, BP said that it would like to meet with UK for discussions. BP is already planning to build the world's first industrial-scale hydrogen power plant with CCS at Peterhead power station, but wants a promise of financial incentives from the UK government before proceeding. The \$985 million project could be operational by the end of 2009. December 6, 2006, http://today.reuters.co.uk/news/articlenews.aspx?type=domesticNews&storyID=2006-12-06T140237Z_01_L06832895_RTRUKOC_0_UK-BRITAIN-CARBONCAPTURE.xml&WTmodLoc=NewsLanding-C3-UK-3, and December 6, 2006, http://news.bbc.co.uk/2/hi/uk_news/scotland/north_east/6214490.stm.

Business Wire, "ADA-ES Announces Greenhouse Gas Mitigation Project." ADA-ES Inc. and RTI (Research Triangle Institute) International will collaborate on a project for the development and demonstration of a novel carbon dioxide capture process. RTI is the prime contractor to the US Department of Energy's National Energy Technology Laboratory on a \$4 million cooperative agreement. The capture technology is a sorbent injection system technology which can be applied to existing power plants. November 13, 2006, http://home.businesswire.com/portal/site/google/index.jsp?ndmViewId=news_view&newsId=20061113005746&newsLang=en.

Austin-American Statesman, "TXU Gets Resolutions on New Plant Plans." TXU Corporation is building 11 new coal-burning power generating plants in Texas, at least doubling its carbon dioxide emissions. Kimberly Morgan, a TXU spokeswoman stated that they are building their new units to be carbon-capture ready

by building in space to install the appropriate equipment when it becomes available, but that it is not economically feasible to do so yet. December 8, 2006, Link unavailable.



Science

AP, "Forest Fires May Cool Area Climate Rather Than Warm It, Researchers Say." According to a study in the journal *Science* by James T. Randerson, Associate Professor of Earth System Science at the University of California, Irvine, forest fires could have a cooling effect which cancels the impact of the greenhouse gases released from the fire. It was long thought that forest fires would worsen global warming by adding carbon dioxide to the atmosphere. Fires in northern forests release greenhouse gases, but also cause changes in the forest canopy. The result is more sunlight being reflected back into space during the spring and summer for many decades after the fire. The net cooling effect is close to neutral when averaged globally, and may lead to slightly cooler temperatures in Northern regions. November 16, 2006, http://www.iht.com/articles/ap/2006/11/16/america/NA_GEN_US_Cooling_Fires.php.

Agence France-Presse, "Climate Change Worsening Biodiversity Crisis: UN Report." According to a report by the UN Environment Programme (UNEP), climate change is impacting the survival of whales, dolphins, turtles, birds, and other rare species that migrate over long distances. Changes in the habitat, including changes in temperature and food, are affecting many species. Rising temperatures already are having an effect on the species' food, habitat, health and reproduction. The North Atlantic right

whale is at risk due to its food supply of plankton declining with a shift in ocean currents. White-beaked dolphins cannot adapt to the warmer waters now occupied by its prey. Green turtles have developed tumors due to warmer waters, allowing disease to thrive. Also, higher temperatures of nesting beaches result in a greater number of female turtles, with ratios of four females to one male soon to threaten the species. Lower water tables and more frequent droughts will reduce the habitat of the Baikal teal and aquatic warbler birds. November 16, 2006, Link unavailable.

Reuters, “Arctic May Be Ice-Free by Summer 2040 – Study.” According to the research to be published by the journal *Geophysical Research Letters* on December 12, computer modeling has shown that, due to global warming, most of the ice in the Arctic basin may retreat by September of 2040. The study was jointly conducted by the US National Center for Atmospheric Research, the University of Washington, and Montreal’s McGill University. The modeling showed that if greenhouse gases continue to increase at the current rate, the Arctic’s future ice cover will experience periods of relative stability followed by an abrupt retreat of the ice cover as the Arctic Ocean warms. In one model simulation, the September ice shrinks from 2.3 million square miles to 770,000 square miles over a 10-year period; winter ice thins from about 12 feet to less than 3 feet. December 12, 2006, <http://www.planetark.com/dailynewsstory.cfm?newsid=39423&newsdate=12-Dec-2006>.

“Possible role for dust or other northern forcing of ice-age carbon dioxide changes,” A simple impulse-decay model driven by the history of atmospheric dust loading from Greenland can match the history of glacial–interglacial changes in atmospheric carbon dioxide concentration rather accurately, if model parameters are tuned within physically possible ranges; forcing with the Greenland temperature record produces a similarly good match. Calculations using southern forcing do not match as accurately. These results leave open the possibility of northern control of glacial–interglacial carbon dioxide changes. *Quaternary Science Reviews*, T.C. Johnston and R.B. Alley, Available online November 27, 2006, <http://www.sciencedirect.com/science/article/B6VBC-4MFCW7D-2/2/4be3232f89d4a91b8ea8aab26cf9a4b4>. (Subscription may be required.)

Policy

Reuters, “U.N. Climate Talks Make Progress on Kyoto Overhaul,” and *Earth Negotiations Bulletin*, “Summary Of The Twelfth Conference Of The Par-

ties To The UN Framework Convention On Climate Change And Second Meeting Of The Parties To The Kyoto Protocol: November 6-17, 2006.”

From November 6-17, 2006, climate change meetings were held in Nairobi, Kenya. The “UN Climate Change Conference – Nairobi 2006” included the twelfth Conference of the Parties (COP12) to the UN Framework Convention on Climate Change (UNFCCC) and the second Conference of the Parties serving as the Meeting of the Parties to the Kyoto Protocol (COP/MOP 2). Over 5,900 people attended. At COP/MOP2, the Clean Development Mechanism and Joint Implementation were discussed, as were parties’ compliance with the Protocol and a proposed amendment to the Protocol. At COP12, the adverse effect of climate change on developing and least developed countries was discussed, as was the response measures and needs of the least developed countries. Both COP/MOP 2 and COP 12 focused on long-term action regarding climate change, and for developing a framework for action once the Kyoto Protocol’s “first commitment period” ends in 2012. A review of the Protocol will be completed by 2008. For a detailed reporting on the meetings, see: <http://www.iisd.ca/vol12/enb12318e.html>. November 17, 2006, http://today.reuters.com/news/articlenews.aspx?type=worldNews&storyID=2006-11-17T162443Z_01_L1343825_RTRUKOC_0_US-ENVIRONMENT-CLI-MATE.xml&pageNumber=1&imageid=&cap=&sz=13&WTModLoc=NewsArt-C1-ArticlePage1, and November 20, 2006, <http://www.iisd.ca/vol12/enb12318e.html>.

Reuters, “Calls for Climate Change Action at Asia-Pacific Summit.” Plans to examine the issue of global warming were in the forefront at the Asia Pacific Economic Cooperation (APEC) Summit, held on November 16-19, 2006 in Hanoi, Vietnam. APEC is comprised of 21 nations, including the US and China, and accounts for half of the world’s global trade market. Member countries were encouraged to pledge their efforts in transitioning to low-carbon energy systems and promote the transfer of similar technologies to less developed countries. Commitments to address clean energy initiatives and climate change were also discussed. During his attendance at the summit, President Bush voiced his support to Australia’s Prime Minister John Howard, who is taking proactive steps to address climate change issues, despite his country’s refusal to sign the Kyoto Protocol. Howard is pushing for Asia-wide emissions trading and has set up a task force to examine a pos-

sible role for Australia to address global warming issues. He has also proposed a joint alliance with the US, China, India, South Korea, and Japan to address the same issues. Australia, the world's biggest exporter of coal, will also establish a joint working group on clean coal technology with China. November 18, 2006,

http://today.reuters.co.uk/news/articlenews.aspx?type=scienceNews&storyID=2006-11-18T225544Z_01_BKK212827_RTRIDST_0_SCIENCE-APEC-ENVIRONMENT-DC.XML&WTmodLoc=NewsArt-C2-NextArticle-1.

Reuters, “Four States Set to Join EU Carbon Market – UK.” and Reuters, “Norway To Join EU CO₂ Scheme In 2008 – EU Source.”

On December 6, Britain's Finance Minister Gordon Brown announced that Iceland, Liechtenstein, Norway and Switzerland have agreed in principle to join the European Union's emissions trading scheme. Norway will submit their plan to the executive European Commission, which will outline the limits that Norwegian industries will have regarding carbon dioxide emissions. Norway would become the twenty-eighth country to join the EU's carbon market. In November, Australia and Canada were investigating their own domestic carbon markets, which could join the European scheme. The various independent carbon markets could make way for competitive pricing of emissions permits.

December 7, 2006, <http://www.planetark.com/dailynewsstory.cfm/newsid/39366/story.htm>, and November 28, 2006, <http://www.planetark.com/dailynewsstory.cfm/newsid/39176/story.htm>

Reuters, “London Targets Gas-Guzzlers with Congestion Charge.” London's mayor, Ken Livingstone, has proposed to charge the more polluting cars, which emit more than 225 grams of CO₂ per kilometer 25 pounds (about \$47) per day to enter the central London traffic congestion zone. Eco-friendly cars would travel free. Other vehicles would continue to pay the current rate of 8 pounds, about \$16, when entering the congestion zone between 6:30 a.m. and 7:00 p.m. Only one in 20 Londoners overall drives the more polluting cars, but the rate increases to 1 in 5 for cars in the congestion zone. A poll in August found that over two-thirds of Londoners backed the mayor's plan to discourage the use of 4x4 vehicles. November 15, 2006, <http://www.planetark.com/avantgo/dailynewsstory.cfm?newsid=38981>.

Geology

“Opportunities for low-cost CO₂ storage demonstration projects in China,” Several carbon dioxide (CO₂) storage demonstration projects are needed in a variety

of geological formations worldwide to prove the viability of CO₂ capture and storage as a major option for climate change mitigation. China has several low-cost CO₂ sources at sites that produce NH₃ from coal via gasification. At these plants, CO₂ generated in excess of the amount needed for other purposes (e.g., urea synthesis) is vented as a relatively pure stream. These CO₂ sources would potentially be economically interesting candidates for storage demonstration projects if there are suitable storage sites nearby. In this study a survey was conducted to estimate CO₂ availability at modern Chinese coal-fed ammonia plants. Results indicate that annual quantities of available, relatively pure CO₂ per site range from 0.6 to 1.1 million tons. The CO₂ source assessment was complemented by analysis of possible nearby opportunities for CO₂ storage. CO₂ sources were mapped in relation to China's petroliferous sedimentary basins where prospective CO₂ storage reservoirs possibly exist. Four promising pairs of sources and sinks were identified. Project costs for storage in deep saline aquifers were estimated for each pairing ranging from \$15–21 per ton of CO₂. Potential enhanced oil recovery and enhanced coal bed methane recovery opportunities near each prospective source were also considered.

Kyle C. Meng, Robert H. Williams and Michael A. Celia, *Energy Policy*, Available online October 27, 2006, <http://www.sciencedirect.com/science/article/B6V2W-4M6SG95-1/2/99822ea843b49648303a7cdfdcd64102>. (Subscription may be required.)

“Heterogeneous saline formations for carbon dioxide disposal: Impact of varying heterogeneity on containment and trapping,” Natural gas fields often contain carbon dioxide in their reservoir fluids. Exploitation of these resources requires the



removal of carbon dioxide (CO₂) from produced fluids to meet quality standards for sale into a domestic market or for the processing of the gas into liquefied natural gas (LNG). To limit the atmospheric emissions of carbon dioxide, a major greenhouse gas, it has been proposed that one method of abatement could be to inject the CO₂ into deep saline formations. This study shows that the selection process for identifying appropriate saline formations should not only consider their size and permeability but should also consider their degree of heterogeneity. To this end, notional yet realistic geological marine sand models were constructed, on an areal scale of 50 square kilometers (km²), to examine the effects of reservoir heterogeneity on the migration and storage of a 50 million tonne plume over a time scale of 1000 years. The models were identical in geometry and in their distribution of porosity and permeability but were individually populated with facies realizations for different net-to-gross ratios. Standard geostatistical techniques were used to generate the various distributions. With regard to the shale content, the ratio of sand to shale was varied from 100:0 (i.e. homogeneous) to 40:60. A radial shale variogram, with a length of 300 meters was used. The models were up-scaled, using flow-based methods, to make the computation feasible. A set of metrics were developed and used to compare plume migration (both vertically and laterally) and containment (through dissolution and residual phase trapping) between the various scenarios. The study showed that heterogeneity had a significant impact on the subsurface behavior of the carbon dioxide. Increasing the shale content, corresponding to a gradual decrease in reservoir quality, progressively inhibited vertical flow of the plume whilst promoting its lateral flow. This increase in the tortuosity of the carbon dioxide migration pathways resulted in a reduction in the rate of residual gas trapping through hysteresis effects. Ultimately, however, less carbon dioxide is likely to collect under the seal, thereby reducing the risk of seepage to overlying formations. It is evident that for the time scales of containment being considered here simulation periods of the order of tens of thousands of years, or even longer, will be required to demonstrate the onset of an equilibrium state. **Matthew Flett, Randal Gurton and Geoff Weir**, *Journal of Petroleum Science and Engineering*, Available online November 30, 2006. <http://www.sciencedirect.com/science/article/B6VDW-4MG1P1G-2/2/68b42f95e1b0ee6b2891f76a44049a1b>. (Subscription may be required.)

“Reducing energy-related CO₂ emissions using accelerated weathering of limestone.” The use and impacts of accelerated weathering of limestone (AWL; reaction: $\text{CO}_2 + \text{H}_2\text{O} + \text{CaCO}_3 \rightarrow \text{Ca}^{2+} + 2(\text{HCO}_3^-)$) is explored as a carbon dioxide (CO₂) capture and sequestration method. It is shown that significant limestone resources are relatively close to a majority of CO₂-emitting power plants along the coastal US, a favored siting location for AWL. Waste fines, representing more than 20 percent of current US crushed limestone production (>10⁹ tons per yr), could provide an inexpensive or free source of AWL carbonate. With limestone transportation then as the dominant cost variable, CO₂ mitigation costs of \$3-\$4/ton appear to be possible in certain locations. Perhaps 10–20 percent of US point-source CO₂ emissions could be mitigated in this fashion. It is experimentally shown that CO₂ sequestration rates of 10⁻⁶ to 10⁻⁵ moles per second per square meter (moles/sec per m²) of limestone surface area are achievable, with reaction densities on the order of 10⁻² tons CO₂ cubic meters per day (m⁻³day⁻¹), highly dependent on limestone particle size, solution turbulence and flow, and CO₂ concentration. Modeling shows that AWL would allow carbon storage in the ocean with significantly reduced impacts to seawater pH relative to direct CO₂ disposal into the atmosphere or sea. The addition of AWL-derived alkalinity to the ocean may itself be beneficial for marine biota. **Greg H. Rau, Kevin G. Knauss, William H. Langer and Ken Caldeira**, *Energy*, Available online November 29, 2006, <http://www.sciencedirect.com/science/article/B6V2S-4MFTVGD-1/2/f4b9dd99d12f90f6b4814a789ab1fcde>. (Subscription may be required.)

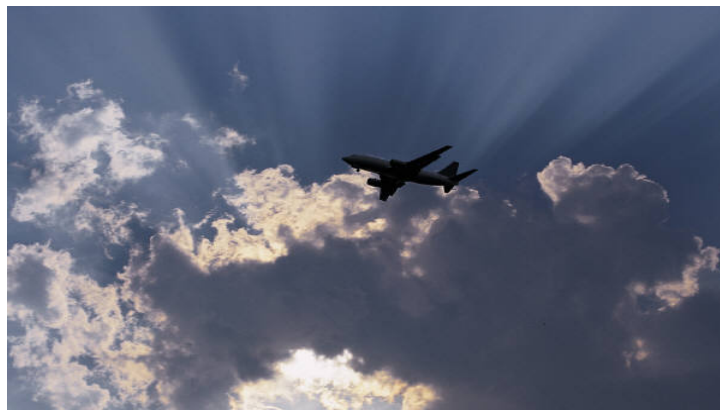
Technology

“Adoption of carbon dioxide efficient technologies and practices: An analysis of sector-specific convergence trends among 12 nations,” Carbon dioxide intensities in economic terms (gross domestic product in Purchasing Power Parity (PPP) terms) in industrialized and developing countries have been shown to converge, and it has been argued that technology diffusion, leading to the use of similar technologies in all countries, is an important reason for this convergence. Indicators based on carbon dioxide (CO₂) per output in PPP terms, however, give in

comparison to physical indicators limited understanding of the process of technology diffusion. In order to analyze the technology diffusion hypothesis in more detail, the authors therefore study the trend in carbon dioxide emissions in relation to the production output in four separate sectors: iron and steel; paper, board and pulp; coal fueled power plants; and natural gas fueled power plants, in each of 12 countries, between 1980 and 1998. The indicators converge in each sector, indicating that across countries, technologies with more similar carbon dioxide efficiencies are used today than 25 years ago. The authors also find that at least some developing countries with high energy prices use more efficient technologies than industrialized countries with low energy prices. **Tobias A. Persson, Ulrika Claesson Colpier and Christian Azar**, *Energy Policy*, Available online November 28, 2006, <http://www.sciencedirect.com/science/article/B6V2W-4MFJTKJ-1/2/e3e88b9d6c9d3ff7fb52a3aff970e3df>. (Subscription may be required.)

“Modeling and simulation of fixed bed adsorbers (FBAs) for multi-component gaseous separations.” A rigorous model for multi-component adsorbers is developed. This considers non-isothermal effects, pressure variations, axial dispersion of components inside the gas (macro-void) phase as well as the diffusion of components inside the particles (micro-void). The partial differential equations (PDEs) for the gas phase are converted into ordinary differential equations (ODEs) or algebraic equations, using the finite difference technique in the axial direction. The method of orthogonal collocation (OC) is used to convert the PDEs for the diffusion inside the particles into ODEs. The complete set of differential-algebraic equations (DAEs) is solved using the Petzold-Gear technique. Data on two systems [O_2-N_2 on Zeolite 5A (Jee et al., 2002 [Jee, J. G., Park, M. K., Yoo, H. K., Lee, K., & Lee, C. H. (2002). Adsorption and desorption characteristics of air on zeolite 5A, 10X, and 13X fixed beds, *Separation Science and Technology*, 37, 3465–3490]), and $CO_2-C_2H_6-N_2$ on Linde 5A molecular sieves (Basmadjian and Wright, 1981 [Basmadjian, D., & Wright, D.W. (1981). Non-isothermal sorption of ethane-carbon dioxide mixtures in beds of 5A molecular sieves. *Chemical Engineering Science*, 36, 937–940])] are taken from the literature for validation of this model. The optimal values of the model parameters are obtained using one set of experimental data for each of these systems. Genetic algorithm is used for this purpose. Excellent agreement is observed between the predictions of the tuned model and the experimental data used. In addition, it was observed that the predictions of the tuned model agree quite well with several other sets of experimental data (under different operating conditions). The more

popular multi-component LDF model is also tuned on the same data, but the model predictions do not match experimental data as well. Since the computational time is almost the same for the two models, the rigorous model is recommended for use. **B. Sankararao and Santosh K. Gupta**, *Computers & Chemical Engineering*, Available online November 28, 2006, <http://www.sciencedirect.com/science/article/B6TFT-4MFKD7V-1/2/8a964bb6c149573351d407500b6f58e4>. (Subscription may be required.)



Terrestrial/Ocean

“Carbon and nitrogen in a temperate agroforestry system: Using stable isotopes as a tool to understand soil dynamics,” Natural exchanges of carbon (C) between the atmosphere, the oceans, and terrestrial ecosystems are currently being modified through human activities as a result of fossil fuel burning and the conversion of tropical forests to agricultural land. These activities have led to a steady increase of atmospheric carbon dioxide (CO_2) over the last two Centuries. The goal of this study was to determine the potential of temperate agroforestry systems to sequester C in soil. Therefore, changes in the soil organic C (SOC) and nitrogen (N) pools were quantified and the $\delta^{13}C$ and $\delta^{15}N$ stable isotope technique was applied to assess soil C and N dynamics in a 13-year old hybrid poplar alley cropping system in Southern Canada. Results from this study showed that after 13 years of alley cropping the SOC and N pools did not differ significantly ($p = 0.01$) with distance from the tree row, although a trend of a larger SOC and N pool near the tree row could be observed. Soil organic C after 13 years of alley cropping, was 19 milligrams of carbon per gram ($mg\ C\ g^{-1}$) compared to 11 $mg\ C\ g^{-1}$ upon initiation of agroforestry. Soil organic C and N were not evenly distributed throughout the plow layer.

The largest C and N pool occurred in the top 20 centimeters (cm), which is due to the accumulation of organic material in the upper horizons as a result of no-till cultivation. The entire soil, to a 40 cm depth, showed a $\delta^{13}\text{C}$ shift to that of C_3 residue. This shift reflects the greater input of residues from C_3 plants such as that derived from beans, wheat, and hybrid poplar leaf litterfall. The proportion of C derived from a C_3 source ranged from 64 to 69 percent to a 40 cm depth. The soil $\delta^{15}\text{N}$ signature of this study is similar to that of mineral soil, and reflect values characteristic of N mineralization processes. However, the entire soil shows a positive shift in $\delta^{15}\text{N}$ as a result of historical additions of manure and current use of mineral fertilizers, and ongoing processes of denitrification and nitrate leaching, which leads to an enrichment of the soil. **Maren Oelbermann and R. Paul Voroney**, *Ecological Engineering*, Available online November 16, 2006, <http://www.sciencedirect.com/science/article/B6VFB-4MC0TCD-1/2/d1fca1c73964fc964af77c14f2d79ca6>. (Subscription may be required.)

“Carbon sequestration in wood products: a method for attribution to multiple parties,” When forest is harvested some of the forest carbon ends up in wood products. If the forest is managed so that the standing stock of the forest remains constant over time, and the stock of wood products is increasing, then carbon dioxide is being removed from the atmosphere in net and this should be reflected in accounting for greenhouse gas emissions. The authors suggest that carbon sequestration in wood products requires cooperation of multiple parties; from the forest owner to the product manufacturer to the product user, and perhaps others. Credit for sequestering carbon away from the atmosphere could acknowledge the contributions of these multiple parties. Accounting under a cap-and-trade or tax system is not necessarily an inventory system, it is a system designed to motivate and/or reward an environmental objective. The authors describe a system of attribution whereby credits for carbon sequestration would be shared among multiple, contributing parties. It is hoped that the methodology outlined herein proves attractive enough to parties concerned to spur them to address the details of such a system. The system of incentives one would choose for limiting or controlling greenhouse gas emissions could be quite different, depending on how the attribution for emissions and sequestration is chosen. **Bruce Tonn and Gregg Marland**, *Environmental Science & Policy*, November 22, 2006, <http://www.sciencedirect.com/science/article/B6VP6-4MD95F2-1/2/5075797d87a730d253657a051877a7b3>. (Subscription may be required.)

“Some perspectives on carbon sequestration in agriculture,” One of the main options for greenhouse gas (GHG) mitigation identified by the Intergovernmental Panel on Climate Change (IPCC) is the sequestration of carbon in soils. Since the breaking of agricultural land in most regions, the carbon stocks have been depleted to such an extent, that they now represent a potential sink for carbon dioxide (CO_2) removal from the atmosphere. Improved management will however, be required to increase the inputs of organic matter in the top soil and/or decrease decomposition rates. In this paper the authors use data from selected regions to explore the global potential for carbon sequestration in arable soils. While realizing that carbon sequestration is not limited to the selected regions, the authors have, however, focused their review on two regions: (i) Canadian Prairies and (ii) The Tropics. In temperate regions, management changes for an increase in carbon involve increase in cropping frequency (reducing bare fallow), increasing use of forages in crop rotations, reducing tillage intensity and frequency, better crop residue management, and adopting agroforestry. In the tropics, agroforestry remains the primary method by which sequestration rates may be significantly increased. Increases in soil carbon may be achieved through improved fertility of cropland/pasture; on extensive systems with shifting cultivation cropped fallows and cover crops may be beneficial, and adopting agro forestry or foresting marginal cropland is also an alternative. In addition, in the tropics it is imperative to reduce the clearing of forests for conversion to cropland. Some regional analyses of soil carbon sequestration and sequestration potential have been performed, mainly for temperate industrialized North America where the majority of research pertaining to carbon sequestration has been carried out. More research is needed, especially for the Tropics, to more accurately capture the impact of region-specific interactions between climate, soil, and management of resources on carbon sequestration, which are lost in global level assessments. By itself, carbon sequestration in agricultural soils can make only modest contributions (3–6 percent of fossil fuel contributions) to mitigation of overall greenhouse gas emissions. However, effective mitigation policies will not be based on any single ‘magic bullet’ solutions, but rather on many modest reductions which are economically efficient and which confer additional benefits to society. In this context, soil carbon sequestration is a significant mitigation option. **J.J. Hutchinson, C.A. Campbell and R.L. Desjardins.**

Agricultural and Forest Meteorology, Available online November 28, 2006, <http://www.sciencedirect.com/science/article/B6V8W-4MFJJOK-3/2/620a0b36c4b24faace27735d1c691238>. (Subscription may be required.)

Trading

Carbon Market Update, December 11, 2006	
CCX-CFI 2006 (\$/tCO ₂) \$4.15 (Vintage 2007)	EU ETS-EUA DEC 2007 (\$/tCO ₂) \$ 9.40
(Converted from € to US\$)	

Reuters, “EU’s Dimas Says CO₂ Emission Decisions Due November 29.” Stavros Dimas, Environment Commissioner to the European Union (EU), announced that initial decisions concerning member states’ carbon dioxide (CO₂) emissions allocations plans would be issued on November 29. Current efforts will focus on reducing emissions levels in the 2008-2012 plans, since poor efforts in 2005 by some governments to control the number of pollution permits to industries resulted in a crash in carbon prices. EU countries who fail to provide the necessary emissions reductions and Kyoto Protocol targets will be sent back for revisions. The EU trading scheme sets limits on the amount of CO₂ that factories can release, otherwise requiring those companies to purchase carbon credits when caps are exceeded. October 11, 2006, <http://www.planetark.com/dailynewsstory.cfm?newsid=38916&newsdate=10-Nov-2006>.

Reuters, “Banks Buy Over 200 Million Euro Chinese Carbon Credits.” On November 30, over \$263 million worth of carbon credits were bought from a Chinese mining company by banks including Lehman, Fortis and BNP Paribas. The investors will fund two projects to destroy the greenhouse gas methane in the coal mines at Yangquan Coal Industry Company, using the gas to generate power. Investors have been buying carbon credits inexpensively from countries like China and are selling them to European countries which face emissions targets enforced by the European Union. According to the World Bank, global carbon trade was worth \$21.5 billion in the first nine months of 2006 versus \$11.1 billion for the whole of last year. December 1, 2006, <http://www.planetark.com/avantgo/dailynewsstory.cfm?newsid=39268>.

Reuters, “NY Plans To Auction 100 Percent of CO₂ Permits – Source.” As part of the Regional Greenhouse Gas Initiative (RGGI), New York State plans to distribute

its carbon emissions permits via auction. This method was chosen in order to avoid the European Union’s mistake of giving away carbon permits which caused a drop in the carbon trading prices last year. The carbon permits will function to set emissions limits for businesses, and allow businesses to buy carbon credits in order to emit over that limit. It is thought that the power plants which have more carbon dioxide emissions will be shorter on emissions credits, and would have the strongest money in the market. This would prevent the lesser emitting plants from hoarding credits. Vermont will also auction permits but has limited power generation in the state. The other RGGI states, including Maine, New Hampshire, Connecticut, New Jersey and Delaware, have not determined how they will distribute credits. A lawyer from the National Resources Defense Council advising RGGI feels that New York’s decision on how to distribute permits will influence decisions in other states regarding distribution of their allowances. December 6, 2006, [http://www.planetark.com/dailynewsstory.cfm/newsid/39347/story.htm](http://www.planetark.com/dailynewsstory.cfm?newsid/39347/story.htm).

Greenwire, “Nonprofit Floats Emissions Certification Tool For Consumers.” The San Francisco-based non-profit Center for Resource Solutions (CRS) is developing a retail greenhouse gas reduction product standard, its “Green-e” emissions product certification standard. CRS will open its proposed standard for public comment in December and will promulgate it early next year. CRS is aiming to provide consumers third-party verification of greenhouse gas offsets in order to ensure that a vendor is supplying equal sales and retired offsets as advertised. The proposed standard was developed with input from the US government, World Resources Institute, National Resources Defense Council, Interface Inc., and others. The Green-e logo is currently used to certify renewable energy products, and would expand to include offsets. For more information, see: <http://www.resourcesolutions.org/where/pressreleases/2006/Upcoming-Comment-Period-for-Retail-GHG-Reduction-Certification-Program-Announced.11.20.06.htm>. November 21, 2006, <http://www.eenews.net/Greenwire/print/2006/11/21/7>.

Recent Publications

“Emissions of Greenhouse Gases in the United States 2005.” This report, in accordance with Section 1605(a) of the Energy Policy Act of 1992, provides estimates of US emissions of green-

house gases. US emissions of greenhouse gases in 2005 totaled 7,147.2 million metric tons carbon dioxide equivalent (MMT CO_2e), 0.6 percent more than in 2004 (7,104.6MMT CO_2e). The modest increase in total greenhouse gas emissions in 2005 is attributable mainly to below-average growth in emissions of carbon dioxide (0.3 percent). There were larger increases in emissions of nitrous oxide (1.9 percent) and methane (0.9 percent), but collectively these two gases make up only about 14 percent of total US greenhouse gas emissions. Emissions of high-GWP gases—hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF₆)—increased by 7.2 percent, but their share of the total is only 2.2 percent. The US economy grew by 3.2 percent in 2005. Consequently, US greenhouse gas intensity (greenhouse gas emissions per unit of real economic output) was 2.5 percent lower in 2005 than in 2004. From 1990 to 2005, US greenhouse gas intensity declined by 25 percent, or by an average of 1.9 percent per year. US greenhouse gas emissions in 2005 were 17 percent higher than the 1990 emissions level of 6,112.8 MMT CO_2e —an average annual increase of 1.0 percent over the period. Since 1990, US emissions have increased more slowly than the average annual growth in population (1.2 percent), primary energy consumption (1.1 percent), electric power generation (1.9 percent), or gross domestic product (3.0 percent). While the annual growth rate in carbon dioxide emissions since 1990 (1.2 percent) has closely tracked annual growth in population and energy consumption, the average annual rate of growth in total greenhouse gas emissions has been lower (1.0 percent) because of reductions in methane emissions and relatively slow annual growth in nitrous oxide emissions (0.6 percent) since 1990. The pdf of the full report and the most recent full documentation for the data and methods used to calculate the emissions estimates are available at: <http://www.eia.doe.gov/oiaf/1605/ggrpt/index.html>.

Global Warming in the Courts: An Overview of Current Litigation and Common Legal Issues. This report, presented by Georgetown Environmental Law and Policy Institute, Georgetown University Law Center, provides an overview of global warming litigation, discussing the question of the judiciary's proper role in addressing this issue, identifying the cross-cutting legal topics raised by the pending litigation, and describing the specific cases before the Supreme Court and lower courts across the country. On November 29, 2006, the US Supreme Court will hear oral argument in *Massachusetts v. EPA*, addressing, for the first time, one of the most pressing and controversial environmental issues of our time — global warming. While undoubtedly important, the Massachusetts case

is only the most visible in a large and growing group of lawsuits in the state and federal courts dealing with global warming. http://www.law.georgetown.edu/gelpi/current_research/documents/GlobalWarmingLit_CourtsReport.pdf.



Legislative Activity

E&E News PM, “Supreme Court Appears Divided in Greenhouse Gas Case,” and Reuters, “Supreme Court Hear First Global Warming Case.” (See Highlights section of this newsletter for the news item summary.)

Greenwire, “Boxer To Use California Model For Federal Warming Initiative.” Senator Barbara Boxer (D-CA) is taking over the US Senate Committee on Environment and Public Works in January. She plans to use California's Global Warming Solutions Act (AB32) as a model in drafting the federal climate legislation for the 110th US Congress. AB32 is requiring a 25 percent cut in greenhouse gas emissions by 2020. Though there is no timetable for the legislation, a Boxer aide stated that the senator will be engaged in the issue of global warming at the start of next Congress. November 11, 2006, <http://www.eenews.net/Greenwire/print/2006/11/10/1>.

Reuters, “Colorado Town Passes First US Carbon Tax.” Boulder, Colorado has passed the first municipal carbon tax in the US. Residents and businesses will have to pay the carbon tax according to how much electricity they use. The tax will raise the average home bill by \$1.33 per month, and the business' bill by \$3.80 per month. Annually, the carbon tax will generate \$1 million for the

city annually, and will be used to fund energy audits for homes and businesses, and energy advisors for homeowners. Residents who choose to purchase wind power will not have to pay the tax. November 13, 2006, <http://www.planetark.com/avantgo/dailynewsstory.cfm?newsid=38939>.



Events

January 17-18, 2007, **North America and the Carbon Markets**, *Ronald Regan Building and International Trade Center, Washington, DC*. This event is designed to introduce North American stakeholders to lessons and opportunities in the global carbon markets and will include public and private sector delegates from across the United States and Canada for an innovative forum of speakers, panel discussions and workshops. Register online at: <http://www.pointcarbon.com/Events/Workshops%20%20Seminars/North%20America%20and%20the%20carbon%20markets/category1307.html>.

January 18-19, 2007, **Managing your Energy Portfolio in a Greener World**, *Don DeSar Beach Resort, St. Petersburg Beach, FL*. This seminar will provide a basic overview of how to manage your energy portfolio in a green world including the following topics: gasified coal, pulverized coal and renewable energy in today's market. This seminar will equip participants with concrete information, a technical overview and insider perspectives that can make the critical difference in achieving a balanced energy portfolio. Understanding the carbon constrained world we are headed toward is a principal theme of this conference. For conference and registration information, see: http://www.ipedinc.net/conferences/Managing_Your_Energy_Portfolio_In_A_Greener_World.asp#Why

January 18-19, 2007, **Pan-European Clean Coal Forum**, *venue to be announced, London, United Kingdom*. This conference will discuss advances in clean coal technologies including integrated gasification combined cycle (IGCC), supercritical IGCC and ultrasupercritical boilers, pulverized coal combustion and fluidized bed combustion. Ongoing research efforts into improving the efficiency of coal-fired electricity generation and technologies for carbon capture and storage will also be discussed. For more information see: <http://www.marcusevans.com/events/CFEventinfo.asp?EventID=11579>.

January 21-24, 2007, **Electric Utilities Environmental Conference (EUEC), 10th Annual EPA, DOE, EPRI, EEI Conference on Clean Air, Mercury, Global Warming & Renewable Energy**, *Westin La Paloma Resort, Tucson, AZ*. EUEC is one of the best recognized annual technical meetings in the US where over 1000 professionals network in a 150+ exhibit area with 250 presentations in 5 tracks, including a Climate Policy Track. The Climate Policy Track includes topics of Carbon Capture and Storage, and Carbon Markets and Trading. For information, see: <http://www.euec.com/default.html>.

February 5-8, 2007, **Fourth USDA Greenhouse Gas Conference**, *Baltimore Marriott Camden Yards, Baltimore, MD*. The purpose of this conference is to provide a forum for presentation of scientific, technical, and policy information related to the impacts of climate change on agriculture and forestry, and the potential role of management practices in related ecosystems and product use in mitigating climate change. The conference will feature a combination of plenary sessions, technical breakout sessions, and poster sessions organized to maximize interactions, discussion, and dialogue. For information, see: <http://www.acsmeetings.org/carbon/index.php?Token=&check=1&page=>

February 7, 2007, **Environmental Trading 101**, *Chicago, IL*. This seminar will cover five primary trading instruments, including water quality trading; Emissions trading including carbon, sulfur dioxide (SO₂), nitrogen oxide (NO_x), and greenhouse gases (GHG); renewable energy credit (REC) trading; Demand response trading / or energy efficiency trading; and weather derivatives trading. Please see the link to register, or for more information: <http://www.frallc.com/conference.aspx?ccode=sh139>.

Events

February 12-14, 2007, **Time to Adapt-Climate Change and the European Water Dimension**, *BMW* (Federal Ministry of Economics and Technology), venue to be announced, Berlin, Germany. This symposium aims to provide a platform for representatives from governments, science and research, stakeholder groups and non-governmental organizations to discuss the likely impacts of climate change on water management and water dependent sectors such as agriculture, energy, inland navigation and tourism, as well as options for adaptation, and to strengthen the political profile of these issues. For further information, see: <http://www.climate-water-adaptation-berlin2007.org/contact.htm>

March 13-15, 2007, **Carbon Markets Insights 2007**, *Copenhagen, Denmark*. This event will reflect on, amongst other major issues, the opening up of the EU emissions trading scheme to the global carbon markets. Carbon Market Insights is set to be the largest carbon market conference to date. For information, see: <http://www.pointcarbon.com/Events/Carbon%20Market%20Insights/category401.html>.

March 22-23, 2007, **Optimising the Back Office in the Energy Trading Market**, *Central London, England*. This conference will examine the issues affecting the back office and provide strategies from energy firms and financial institutions. Looking across power, gas, oil and CO₂ asset classes, the event will provide solutions in order to get closer to the standardization required to significantly automate back office processes. For further information or to receive a brochure, see: <http://www.marcusevans.com/events/CFEventinfo.asp?EventID=11740>.

May 7-10, 2007, **Sixth Annual Conference on Carbon Capture and Sequestration**, *Pittsburgh, PA*. More details to follow in the upcoming newsletters.

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