THE CARBON SEQUESTRATION NEWSLETTER

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October 2006

HIGHLIGHTS

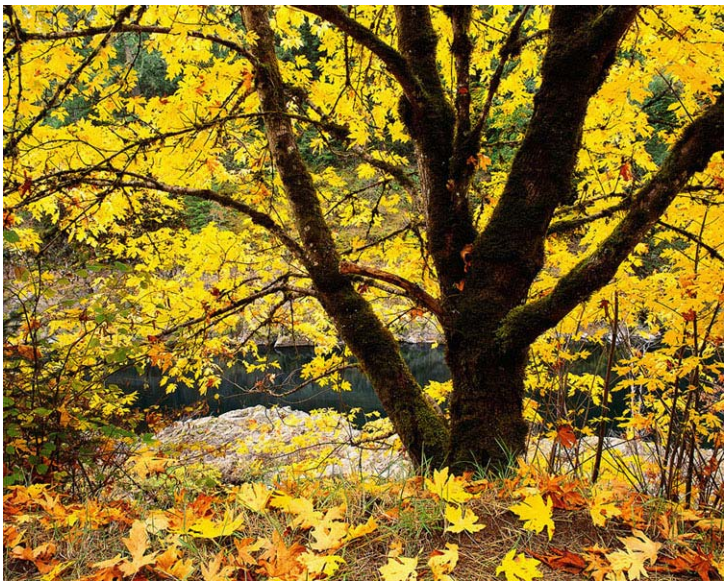
The DOE-sponsored Midwest Regional Carbon Sequestration Partnership is using so-called "Thumper Trucks" as part of a seismic survey to generate vibrations in the ground that can be used to create images of the subsurface. The goal is to locate a test site in the Appalachian Basin where carbon dioxide can be safely sequestered in a geologic formation below the ground.

***DOE Fossil Energy Techline,* "Critical Carbon Sequestration Assessment Begins: Midwest Partnership Looks at Appalachian Basin for Safe Storage Sites. Seismic Surveys to Determine Viability of Rock Formations for CO_2 Storage."** The US Department of Energy's National Energy Technology, through the work of the Midwest Regional Carbon Sequestration Partnership, is conducting seismic testing of the Appalachian Basin geology to determine whether the sites can serve as reservoirs for carbon dioxide (CO_2) storage. The testing is being conducted at FirstEnergy Corp's R.E. Burger plant in Shadyside, Ohio, and in nearby areas. The program falls under the President's Global Climate Change Initiative, which aims to reduce greenhouse gas intensity—the ratio of greenhouse gas emissions to economic output—by 18 percent by 2012. An earlier phase of the project determined that the sandstone and limestone rock formations around the plant held potential for serving as a repository for CO_2—estimated storage of at least 200 years. The current phase of the project utilizes truck-mounted seismic equipment to generate pulses in the ground around the Burger plant. The seismic signal from the vibrations is used to create images of the subsurface area and determine its suitability for injecting CO_2. The surveys focuses on the area immediately surrounding the Burger Plant but also extends 10 miles in length, and along other routes in order to provide a "quasi three-dimensional" survey, at a lower cost than a full-three dimensional survey. Wells will be drilled at depths of 4,000 to 7,000 feet, well below drinking water supplies, which are at 100 feet in that region. Eventually, CO_2 will be injected into the brine field to test the feasibility of geologic sequestration in this type of setting. Battelle of Columbus, Ohio, leads this project in cooperation with the Midwest Regional Carbon Sequestration Partnership, which includes 38 partners in seven states: Indiana, Kentucky, Maryland, Michigan, Ohio, Pennsylvania, and West Virginia. In addition to this geologic project, the Battelle-led partnership will later conduct two additional geologic and three terrestrial projects throughout its multi-state region. To see a video of NETL project manager Charlie Byrer discussing the project, go to: http://ims.netl.doe.gov/video/TL-Byrer-256k.wmv. September 12, 2006, http://www.fossil.energy.gov/news/techlines/2006/06052-Sequestration_Assessment_Begins.html.

Sequestration in the News

DOE Fossil Energy Techline, **"Two-For-One Solution....Alabama Project Plans to Store Carbon Dioxide, Boost Oil Production."** In the Department of Energy's (DOE's) efforts to pursue demonstration projects to promote the capture, transportation, and injection of produced carbon dioxide (CO_2) for sequestration into oil and gas fields while boosting oil and natural gas production (mandated in the Energy Policy Act of 2005), a funding opportunity was announced earlier in 2006 for research in enhanced oil recovery (EOR) with carbon sequestration. The project selected for funding was University of Alabama-Birmingham's (UAB) CO_2 flooding of the Citronelle oilfield in Mobile County, Alabama. Citronelle is Alabama's largest producer and a mature field that has undergone primary and secondary recovery (waterflooding) efforts, and is now a candidate for tertiary recovery, or EOR. Typically an additional 20 percent of the original-oil-in-place in a reservoir can be recovered using CO_2 EOR, with an estimated 64 million barrels of oil that could be recovered in Citronelle. Southern Company of Atlanta, Georgia, a large electrical power producer, is evaluating the capacity of reservoirs such as Citronelle for possible sequestration of any CO_2 that it might capture and separate from its emissions. Sequestration potential and estimated oil yields will be studied under this project, as will computer simulations of the oil yield and sequestration capacity of a given geologic formation and the rate at which CO_2 can be introduced into the underground formations. Partners with UAB and Southern Company in the project are Citronelle field owner and operator Denbury Resources Inc., Plano, Texas; University of Alabama, Tuscaloosa, Alabama; Alabama A&M University, Huntsville, Alabama; Geological Survey of Alabama, Tuscaloosa; and the University of North Carolina at Charlotte, North Carolina. Total project cost is about $6 million, with a little under $3 million to be cost-shared by DOE. September 6, 2006. http://www.fossil.energy.gov/news/techlines/2006/06050-DOE_Awards_EOR_Project.html.

Air Liquide Press Release, **"Air Liquide Partners in CO_2 Sequestration Project Sponsored by U.S. Department of Energy."** Air Liquide is collaborating on a project with the Midwest Geological Sequestration Consortium (MGSC) in a project sponsored by the US Department of Energy, National Energy Technology Laboratory and the Illinois Office of Coal Development. The project is being led by the Illinois State Geological Survey (ISGS). Air Liquide's R&D center in Countryside, Illinois has been involved in a carbon sequestration project since 2003.



Phase II of the project has begun under which 6 real-scale CO_2 injection tests will be conducted, lasting until 2009. Air Liquide's subsidiary, Air Liquide Industrial US LP serves on the project's Advisory Group. Air Liquide will provide 19,000 tons of liquid CO_2 to be injected during these tests as well as storage tanks for the CO_2. Expertise will be provided by Air Liquide regarding the design of the injection skid, and analysis of the results to ensure that the buried CO_2 will remain trapped geologically. August 28, 2006, http://home.businesswire.com/portal/site/google/index.jsp?ndmViewId=news_view&newsId=20060828005624&newsLang=en.

BBC News, **"BP Warning On 'Clean' Power Plant."** BP has warned that without more financial incentives from the UK government it may have to pull out of its Peterhead project for hydrogen power generation and carbon capture and storage. The project, which would generate 'carbon-free' electricity from hydrogen and reduce greenhouse gas emissions by capturing carbon dioxide (CO_2) and storing it, was slated to be operational by the end of 2009. Energy Minister Malcolm Wicks confirmed further CCS measures would be outlined in a pre-budget report later this year. August 25, 2006, http://news.bbc.co.uk/2/hi/uk_news/scotland/north_east/5284800.stm.

Energy Business Review Online, **"RWE CEO Calls for Cooperation for Zero-Emission Plant,"** RWE presented its plans to the general assembly of the European Commission's ZEP (European Technology Platform for Zero Emission Fossil Fuel Power Plant) in Brussels. RWE plans to build a large-scale power plant with integrated coal gasification, and carbon dioxide (CO_2) separation and storage, resulting in no emissions of CO_2. The plant would have a gross output of 450MW and could be

Announcements

DOE Releases Climate Change Technology Program Strategic Plan: Plan Outlines Strategies for Reducing Greenhouse Gas Emissions through Development and Deployment of Advanced Technologies. On September 20, the U.S. Department of Energy (DOE) released the Climate Change Technology Program (CCTP) Strategic Plan, which details measures to accelerate the development and reduce the cost of new and advanced technologies that avoid, reduce, or capture and store greenhouse gas emissions. To read the press release, see: http://www.climatetechnology.gov/library/2006/pr20sep2006.pdf. To download the report entitled **"US Climate Change Technology Program Strategic Plan September 2006,"** see: **http://www.climatetechnology.gov/stratplan/final/index.htm**. Also see this Newsletter's **Recent Publications** section for details.

"Clean Development Mechanism (CDM) and Joint Implementation (JI) in Charts" Booklet. The Institute for Global Environmental Strategies (IGES) is pleased to announce that the aforementioned booklet has now been upgraded to version 6.0. Published by IGES as part of the Integrated Capacity Strengthening (ICS) for the CDM/JI (ICS-CDM/JI) Program under the Ministry of the Environment, Japan, the booklet contains plain and easy-to-understand description of the CDM and other Kyoto mechanisms. All the changes from the previous version are listed in the book. Download at: http://www.iges.or.jp/en/cdm/report01.html.

J.D. Power and Associates Releases Alternate Powertrain Study 2006. J.D Power and Associates new Alternative Powertrain Study (APS) includes the Automotive Environmental Index (AEI), which combines US Environmental Protection Agency (EPA) publicly available information with voice-of-the-customer data related to fuel economy, air pollution and greenhouse gases for 2006 model-year vehicles. Voice-of-the-customer data is also used to help determine the relative importance of these environmental factors. The fuel economy factor represents approximately 50 percent of the index, while air pollution and greenhouse gases contribute to the remainder. The top 30 vehicle models are included in the index. To access the index and see a video explaining the ranking, see: http://www.jdpower.com/autos/green-info/green-matt.aspx.

operational by 2014. The decision to use hard coal or lignite as the plant's primary fuels will occur in 2007, and approval for the construction of the plant should be received by 2010. September 13, 2006, http://www.energy-business-review.com/article_news_print.asp?guid=D64FBDAB-45AE-4FA7-8B8B-95B33BD70A18.

***Casper Star Tribune,* "Thomas, Feinstein Talk Coal Plant."** US Senator Craig Thompson, R-Wyoming, and Dianne Feinstein, D-California, met with representatives of utilities and government agencies about planning to build a 200-megawatt integrated gasification combined cycle plant, with sequestration of its carbon dioxide, in Wyoming. The plant would cost between $500 million and $600 million, and would send its produced power to California. Congress has approved an initiative that calls for a coal gasification demonstration plant to be built at an elevation of at least 4,000 feet above sea level and to use Western coal, but Congress has yet to appropriate money for the project. The senators will look into funding a study to prove that carbon sequestration will be viable with Wyoming's geology. September 20, 2006, http://www.casperstartribune.net/articles/2006/09/20/news/wyoming/63804a435f7a11ea872571ef0004303a.txt.

Science

***BBC News,* "Ocean Plankton Absorb Less CO_2."** According to an article in the journal *Nature*, the amount of carbon dioxide absorbed by plant plankton in the Pacific Ocean is up to 4 percent less than the 50 billion tons estimated to be absorbed. Phytoplankton play a key role in the ocean's food web, and in the carbon cycle, accounting for around one half of the Earth's photosynthesis. The phytoplankton were being monitored via satellite, which could not distinguish a glowing green color, caused by lack of iron, from the color of healthy plankton. Data was examined from 12 years of data gathered from 36,000 miles of ship tracks to establish an indicator of the iron-poor and stressed plankton. The researchers identified three large areas of the Pacific

where phytoplankton appeared to be suffering from a lack of iron: 1.) the southern ocean around Antarctica, 2.) the sub-arctic north below Alaska, and 3.) a vast area in the tropical Pacific centered on the equator. September 30, 2006, http://news.bbc.co.uk/2/hi/science/nature/5298004.stm.

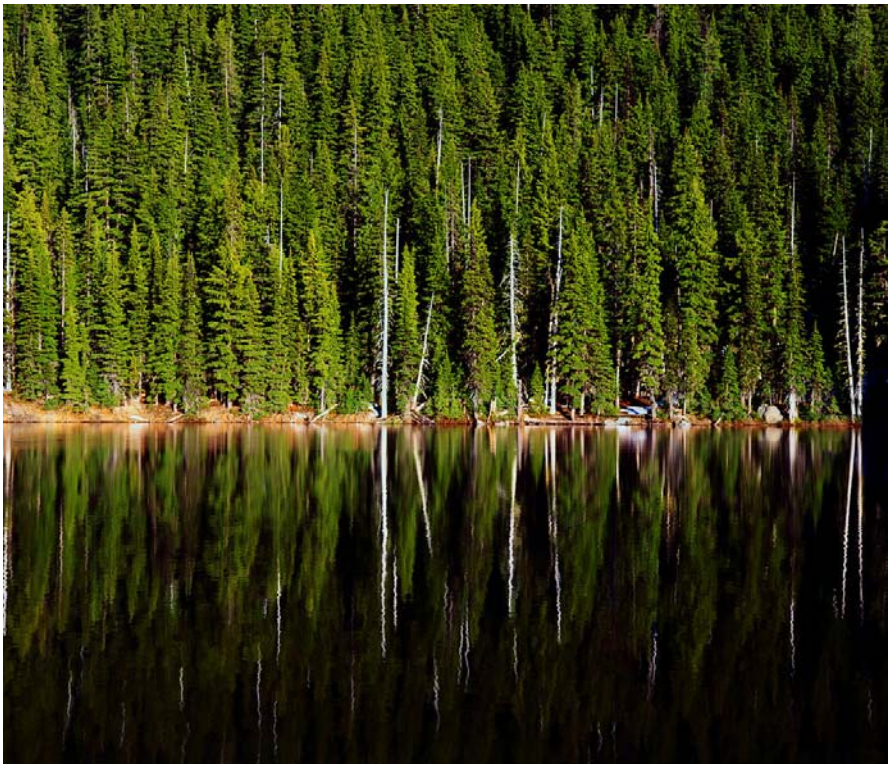
Policy

***AP,* "Emission Targets Set at Helsinki Summit."** At ASEM 6, a forum that promotes various levels of cooperation among Asian and European countries that was held September 10-11 in Helsinki, Finland, European and Asian leader pledged to set new carbon dioxide emissions target that go beyond those set under the Kyoto Protocol for 2012. In a joint declaration, the 25 EU and 13 Asian leaders said they were determined to cooperate on an international level in response to climate change. No targets were set, but each side pledged to do its best, which was considered a setback for the Europeans who had hoped for tougher action by their Asian counterparts, notably China. Europe and Asia promised to share low carbon "cleaner and climate-friendly" technologies, both existing and new technologies. Both agreed that long term answers will be through technological breakthroughs. For more information, visit the ASEM website at: http://www.asem6.fi/. September 11, 2006, http://abcnews.go.com/International/wireStory?id=2419679&CMP=OTC-RSSFeeds0312.

***EurActiv.com,* "EU in Attempt to Link Car Taxes to CO_2 Pollution."** On September 5, the European Parliament backed a proposal to introduce a European Union (EU) wide car tax based on CO_2 emissions, that that would subsequently abolish the car registration tax. Any approval on car taxation at the EU level would require unanimity backing from all the 25 Member States. Unanimity voting in Council means the proposal is likely to be vetoed. The European Parliament is consulted on an advisory basis. Proposed in July of last year by the European Commission, the carbon dioxide (CO_2) based tax is meant to allow citizens to avoid being doubly taxed when moving around Europe and create level tax conditions for automakers on the European car market. September 5, 2006, http://www.wbcsd.org/plugins/DocSearch/details.asp?type=DocDet&ObjectId=MjAzMTQ.

Geology

"Detailed compositional analysis of gas seepage at the National Carbon Storage Test Site, Teapot Dome, Wyoming, USA." A baseline determination of carbon dioxide (CO_2) and methane (CH_4) fluxes and soil gas concentrations of CO_2 and CH_4 was made over the Teapot Dome oil field in the Naval Petroleum Reserve No. 3 (NPR-3) in Wyoming, USA. This was done in anticipation of experimentation with CO_2 sequestration in the Pennsylvanian Tensleep Sandstone underlying the field at a depth of 1680 meters. The baseline data were collected during the winter 2004 in order to minimize near-surface biological activity in the soil profile. The baseline data were used to select anomalous locations that may be the result of seeping thermogenic gas, along with background locations. Five 10-meter holes were drilled, 3 of which had anomalous gas microseepage, and 2 were characterized as "background." These were equipped for nested gas sampling at depths of 10-, 5-, 3-, 2-, and 1-meter depths. Methane concentrations as high as 170,000 parts per million by volume (ppmv) (17 percent) were found, along with high concentrations of ethane (C_2H_6), propane (C_3H_8), n-butane (n-C_4H_{10}), and isobutene (i-C_4H_{10}). Much smaller concentrations of ethylene (C_2H_4) and propene (C_3H_6) were observed indicating the beginning of hydrocarbon oxidation in the anomalous holes.



The anomalous 10-meter holes also had high concentrations of isotopically enriched CO_2, indicating the oxidation of hydrocarbons. Concentrations of the gases decreased upward, as expected, indicating oxidation and transport into the atmosphere. The ancient source of the gases was confirmed by carbon 14 (^{14}C) determinations on CO_2, with radiocarbon ages approaching 38 radio carbon years (ka) within 5 meters of the surface. Modeling was used to analyze the distribution of hydrocarbons in the anomalous and background 10-meter holes. Diffusion alone was not sufficient to account for the hydrocarbon concentration distributions, however the data could be fit with the addition of a consumptive reaction. First-order rate constants for methanotrophic oxidation were obtained by inverse modeling. High rates of oxidation were found, particularly near the surface in the anomalous 10-meter holes, demonstrating the effectiveness of the process in the attenuation of CH_4 microseepage. The results also demonstrate the importance of CH_4 measurements in the planning of a monitoring and verification program for geological CO_2 sequestration in sites with significant remaining hydrocarbons (i.e. spent oil reservoirs). **Ronald W. Klusman,** *Applied Geochemistry,* Volume 21, Issue 9, September 2006, Pages 1498-1521. Available online September 26, 2006, http://www.sciencedirect.com/science/article/B6VDG-4KPX8T1-3/2/686b4a45f405af8ecf48bbd58ed1838c. (Subscription may be required.)

Technology

"Can Advances in Science and Technology Prevent Global Warming?: A Critical Review of Limitations and Challenges." The most stringent emission scenarios published by the Intergovernmental Panel on Climate Change (IPCC) would result in the stabilization of atmospheric carbon dioxide (CO_2) at concentrations of approximately 550 parts per million (ppm) which would produce a global temperature increase of at least 2 degrees Celsius by 2100. Given the large uncertainties regarding the potential risks associated with this degree of global warming, it would be more prudent to stabilize atmospheric CO_2 concentrations at or below current levels which, in turn, would require more than 20-fold reduction (i.e., greater than or equal to 95 percent) in per capita carbon emissions in industrialized nations within the next 50–100 years. Using the Kaya equation as a conceptual framework, this paper examines whether CO_2 mitigation approaches such as energy efficiency improvements, carbon sequestration, and the development of carbon-free energy sources would be sufficient to bring about the required reduction in per capita carbon emissions without creating unforeseen negative impacts elsewhere. In terms of energy efficiency, large improvements (greater than or equal to 5-fold) are in principle possible through aggressive investments in research and development and the removal of market imperfections such as corporate subsidies. However, energy efficiency improvements per se will not result in a reduction in carbon emissions if, as predicted by the IPCC, the size of the global economy expands 12–26-fold by 2100. Terrestrial carbon sequestration via reforestation and improved agricultural soil management has many environmental advantages, but has only limited CO_2 mitigation potential because the global terrestrial carbon sink (ca. 200 gigatons of carbon) is small relative to the size of fossil fuel deposits (greater than or equal to 4000 gigatons of carbon). By contrast, very large amounts of CO_2 can potentially be removed from the atmosphere via sequestration in geologic formations and oceans, but carbon storage is not permanent and is likely to create many unpredictable environmental consequences. Renewable energy can in theory provide large amounts of carbon-free power. However, biomass and hydroelectric energy can only be marginally expanded, and large-scale solar energy installations (i.e., wind, photovoltaics, and direct thermal) are likely to have significant negative environmental impacts. Expansion of nu-

clear energy is highly unlikely due to concerns over reactor safety, radioactive waste management, weapons proliferation, and cost. In view of the serious limitations and liabilities of many proposed CO_{-2} mitigation approaches, it appears that there remain only few no-regrets options such as drastic energy efficiency improvements, extensive terrestrial carbon sequestration, and cautious expansion of renewable energy generation. These promising CO_2 mitigation technologies have the potential to bring about the required 20-fold reduction in per capita carbon emission only if population and economic growth are halted without delay. Therefore, addressing the problem of global warming requires not only technological research and development but also a reexamination of core values that equate material consumption and economic growth with happiness and wellbeing. **Michael H. Husemann,** *Mitigation and Adaptation Strategies for Global Change,* 2006, Volume 11, Pages 539–577, DOI: 10.1007/s11027-006-2166-0. http://www.springerlink.com/content/9024t888tr0m778r/. (Fee or subscription may be required.)

"CCS: A future CO2 mitigation option for Germany?--A bottom-up approach." The role that carbon capture and storage (CCS) technologies could play within the framework of an overall CO_2 mitigation strategy is examined in the form of scenarios up to 2030 with the example of Germany. As the calculations show, the use of CCS can represent an interesting mitigation option in view of stringent CO_2 reduction goals. The scenarios, performed with the aid of the IKARUS optimization model, however, also show that according to cost-efficiency criteria a large number of measures would have to be taken covering all energy sectors. CCS can at best represent one element in an overall strategy. The model results show that a mitigation goal for 2030 corresponding to a 35 percent reduction of CO_2 as compared to 1990 is necessary to trigger a significant contribution of CCS. As an alternative to a CO_2 restriction, we also calculated reduction scenarios based on CO_2 penalties. These scenarios showed that a penalty price of approximately $38/$tCO_2$ dollars per ton of CO_2 is necessary before CCS can be included in the model. **Dag Martinsen, Jochen Linssen, Peter Markewitz and Stefan Vögele, *Energy Policy,* Available online September 1, 2006.** http://www.sciencedirect.com/science/article/B6V2W-4KSSWHP-1/2/57a869c18475437bb0bb0cffa5dc4708. (Subscription may be required.)

Terrestrial/Ocean

"Soil Properties and Carbon Sequestration of Afforested Pastures in Reclaimed Minesoils of Ohio." Land-use change affects many soil properties, including soil organic carbon (SOC) pool, and the transfer of atmospheric carbon dioxide (CO_2) to terrestrial landscapes. The objective of this study was to evaluate the effects of converting pastureland to Australian pine (*Casuarina spp*) and black locust (*Robinia pseudoacacia* L) forest on selected soil physical and chemical properties and SOC sequestration in reclaimed minesoils (RMS) of southeastern Ohio. The study sites were surface mined for coal, reclaimed and managed as pasture, and then converted into woodland 10 years before the present study. Soil pH and electrical conductivity (EC) were higher in the RMS than in a nearby undisturbed hardwood forest. Conversion to Australian pine decreased soil pH and EC in the top 20 centimeters (cm). Bulk densities of the RMS ranged from 1.24 to 1.82

megagrams per cubic meter (Mg m^{-3}), and only minor changes were observed in soil bulk density after land-use conversion. Mean weight diameter (MWD) and root biomass increased significantly ($P < 0.05$) with conversion of pasture to Australian pine or black locust. In addition, aggregate stability was greater in RMS under hardwood forest than under pasture. Conversion to the Australian pine forest increased the SOC pool in the top 50 cm by 6 megagrams per hectare (Mg ha^{-1}) (11 percent) in 10 yr. However, the nitrogen pool in the top 50 cm was not affected by the land-use conversion from pasture to Australian pine. Conversion to black locust increased the SOC pool in the top 50 cm by 24 Mg ha^{-1} (42 percent), while the nitrogen pool increased by 10 percent under black locust in year 10. The increase in the SOC pool was accompanied by an increase in the carbon/nitrogen (C/N) ratios and root biomass in both Australian pine and Black locust sites in the 20- to 50-cm depth. Establishment of tree plantation has a greater potential for SOC sequestration than pastures in the RMS. **D. A. N. Ussiri, R. Lal and P. A. Jacinthe,** *Soil Science Society of America Journal,* 70:1797-1806 (2006), Published online August 22, 2006. DOI: 10.2136/sssaj2005.0352. http://soil.scijournals.org/cgi/content/abstract/70/5/1797. (Subscription may be required.)

"Methodological issues in developing a community forestry greenhouse gas emissions mitigation project in Mancherial forest division of Andhra Pradesh, India." There are several contentious issues related to forestry mitigation projects. The special report of the IPCC and literature published so far have shown that permanence, leakage, baseline establishment, measurement, monitoring, etc., could be addressed satisfactorily using existing scientific methods and accounting rules. To understand the methodological issues of developing community forestry projects, a case study was conducted in Mancherial forest division of Adilabad district in Andhra Pradesh, India. This paper addresses: the setting of project boundaries, baseline selection, establishment of additionality and the calculation of carbon sequestration as a result of the project, prior to project implementation. The steps involved in development of the project and the different methods used for establishing baseline, estimating leakage and transaction cost of developing a community forestry project are presented. The stock is projected to increase by 1480×10^3 tons of Carbon (t C) during 2000–2012 over the baseline scenario under the modeling approach and the cost of establishing a baseline and project formulation for a project extending over 32,956 hectare (ha) is estimated to be US $1.25 per hectare ($ha^{-1}$) and $4 per ton of carbon ($t\ C^{-1}$). I.K. Murthy, G.T. Hegde, P. Sudha and N.H. Ravindranath**,** *Environmental Science & Policy*, Volume 9, Issue 6, , October 2006, Pages 525-537, http://www.sciencedirect.com/science/article/B6VP6-4KKNNJ9-1/2/efa0201faa473eefe72d4f0c330bbcbd. (Subscription may be required.)

"Storage and forms of organic carbon in a no-tillage under cover crops system on clayey Oxisol in dryland rice production (Cerrados, Brazil)." The management and enhancement of soil organic carbon (SOC) is very important for agriculture (fertility) as well as for the environment (carbon sequestration). Consequently, changes in soil management may alter SOC content. No-tillage (NT) practices are potential ways to increase SOC. We studied the SOC from agricultural soils in the Cerrados in Central Brazil. We compared two different tillage systems: conservation agriculture with no-tillage under cover crops (NT) and disc tillage (DT) for 5 years in a context of rainfed rice production. The soil is a dark red Oxisol with high clay content (about 40 percent). The objectives of the study were: (i) to evaluate the short-term (5 years) impact of tillage systems on SOC stocks in an Oxisol and (ii) to better understand the dynamics of SOC in different fractions of this soil. The authors first studied the initial situation in 1998, and compared it to the 2003 situation. NT with cover crop (*Crotalaria*) was found to increase the storage of carbon in the topsoil layer (0–10 centimeters (cm)) compared to DT. The difference observed for the 0–10 cm layer under NT in comparison with DT represented carbon enrichment under no-tillage amounting to 0.35 megagrams of carbon per hectare per year (Mg C ha^{-1} $year^{-1}$) and corresponding to less than 10 percent of cover crops residues returned to the soil. A particle-size fractionation of soil organic matter (SOM) showed that differences in total SOC between NT and DT mainly affected the 0–2 microgram (µm) fraction and, to a smaller extent the 2–20 µm fraction. This specific enrichment of SOC in the silt and clay fraction was attributed to (i) the storage of a water soluble carbon in the field and (ii) the effect of soil biota and especially fauna activity. The mean residence time of carbon associated with the fine fractions being rather long, it might be assumed that the preferential storage in fine fractions resulted in a long-term carbon storage. This study suggests a positive short-term effect of a no-tillage system on carbon sequestration in an Oxisol. Aurélie Metay, José Aloisio Alves Moreira, Martial Bernoux, Thomas Boyer, Jean-Marie Douzet, Brigitte Feigl, Christian Feller, Florent Maraux, Robert Oliver and Eric Scopel, *Soil and Tillage Research,* Available online September 7, 2006. http://www.sciencedirect.com/science/article/B6TC6-4KV2R9B-1/2/54bc59a525bac6678ef0afc1bc9c4d63. (Subscription may be required.)

Trading

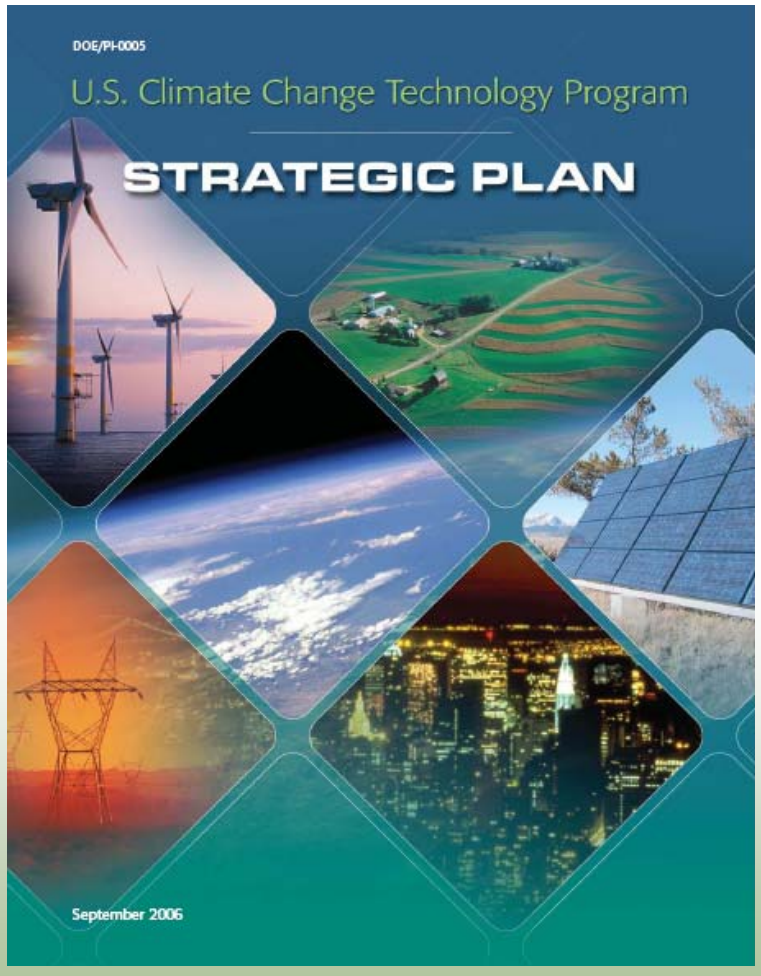
Carbon Market Update, September 20, 2006	
CCX-CFI 2006 ($/tCO$_2$) **$4.15 (Vintage 2006)**	EU ETS-EUA DEC 2006 ($/tCO$_2$) **$ 18.05** **(Converted from € to US$)**

***Greenwire,* "Massachusetts Delegation Urges Governor Romney to Rejoin RGGI."** Two senators and several members of congress, all Democrats, sent a letter to Massachusetts Governor Mitt Romney questioning Romney's decision to withdrawal from the Regional Greenhouse Gas Initiative (RGGI). Both Massachusetts and Rhode Island have pulled out of RGGI after initial discussions. RGGI is a cap-and-trade program with a goal to cap carbon dioxide emissions from power plants at the current level of 121 million tons per year, to year 2015. Also by 2020 the member states must cut CO_2 emissions by 10 percent. Member states currently include: Connecticut, Delaware, Maine, New Hampshire, New Jersey, New York and Vermont. Maryland will join RGGI in June 2007, and Pennsylvania is an observer of the program. The final model rule was released last month and will take effect January 1, 2009. Each state is now tasked with developing regulations to implement the plan. To view the letter to Governor Romney, see: http://www.eenews.net/features/documents/2006/09/12/document_gw_01.pdf. September 12, 2006, http://www.eenews.net/Greenwire/print/2006/09/12/9.

***Reuters,* "Californian Climate Registry Seeks National Expansion."** The California Climate Action Registry is in discussions with 30 states regarding creating a multi-state greenhouse gas registry. Companies document their greenhouse gas reductions with the registry which then verifies them though a third party. By logging their emissions reductions, companies hope to avoid the penalties such as those that early actors received in the first cap-and-trade pollution market for sulfur dioxide (SO_2) emissions. More than half of the emissions logged have been from outside the state. "Our standards are so broadly respected, that people feel it's the best place to log their reductions even they are outside the state," a source from the California Registry said. In the absence of federal laws, regulations are slowly taking shape in the States. September 19, 2006, http://www.planetark.com/dailynewsstory.cfm/newsid/38152/story.htm.

Recent Publications

"US Climate Change Technology Program Strategic Plan September 2006." The US Department of Energy (DOE) released the Climate Change Technology Program (CCTP) Strategic Plan on September 20, which details measures to accelerate the development and reduce the cost of new and advanced technologies that avoid, reduce, or capture and store greenhouse gas emissions. CCTP is the technology component of a comprehensive US strategy introduced by President Bush in 2002, to combat climate change that include measures to slow the growth of greenhouse gas emissions through voluntary, incentive-based, and mandatory partnerships, advance climate change science, spur clean energy technology development and deployment, and promote international collaboration. The CCTP Strategic Plan organizes roughly $3 billion in federal spending for climate technology research, development, demonstration, and deployment to reduce greenhouse gas emissions and increase economic growth. It provides a long-term planning context, taking into account many uncertainties, and establishes principles for formulating



research and development portfolios to identify areas for reductions in greenhouse gas emissions and highlights an array of technology strategies and investment criteria. This Plan complements other Administration efforts including short-term measures to reduce greenhouse gas emissions intensity, advance climate change science, and promote international cooperation through partnership including the Asia Pacific Partnership on Clean Development and Climate, Methane to Markets Partnership, and the International Partnership for a Hydrogen Economy. The Plan sets six complementary goals: (1) reducing emissions from energy use and infrastructure; (2) reducing emissions from energy supply; (3) capturing and sequestering carbon dioxide; (4) reducing emissions of other greenhouse gases; (5) measuring and monitoring emissions; and (6) bolstering the contributions of basic science to climate change. The Plan outlines approaches toward attaining these goals, articulates underlying technology development strategies, and identifies a series of next steps toward implementation. To read press release, see: http://www.climatetechnology.gov/library/2006/pr20sep2006.pdf. To download the report, see: http://www.climatetechnology.gov/stratplan/final/index.htm.

"Energy and Economic Impacts of H.R.5049, the Keep America Competitive Global Warming Policy Act." The Energy Information Administration (EIA), an independent statistical and analytical agency in the US Department of Energy, released this study on September 5, 2006. This report responds to a May 2, 2006 request from Congressmen Tom Udall and Tom Petri asking EIA to analyze the impacts of their legislation implementing a market-based allowance program to cap greenhouse gas emissions at 2009 levels. The legislation, introduced March 29, 2006, limits the potential economic impact through the sale of additional allowances at a safety-valve price, an allowance allocation program, and allowance credits for carbon sequestration projects. The HTML/PDF formats of this report can be viewed at: http://www.eia.doe.gov/oiaf/servicerpt/economicimpacts/index.html, and http://www.eia.doe.gov/oiaf/servicerpt/economicimpacts/pdf/sroiaf2006(03).pdf.

"Carbon Disclosure Project Report 2006 Global FT500." The Carbon Disclosure Project (CDP) has released its CDP4 report. On behalf of its 225 signatory investors, CDP requested information on corporate risks and opportunities associated with climate change from more than 2,000 companies globally, including the world's 500 largest publicly-owned companies (FT500). The institutional investors represented by CDP will receive the companies' answers and CDP's fourth annual report (CDP4) on the FT500 companies' responses written by consultancy Innovest. The $31.5 trillion in assets behind CDP4 represents an increase of over $10 trillion (50 percent) from the $21 trillion behind CDP3 in 2005. The Carbon Disclosure Project (CDP) provides a secretariat for the world's largest institutional investor collaboration on the business implications of climate change. CDP represents an efficient process whereby many institutional investors collectively sign a single global request for disclosure of information on Greenhouse Gas Emissions. CDP has historically sent this request to the FT500 largest companies in the world however, in 2006, they have expanded their reach to 2180 companies, with over 950 responding with an answered questionnaire. To view a press release regarding the report, see: http://www.cdproject.net/viewrelease.asp?id=8. To download the full CDP4 report as a pdf, go to: http://www.cdproject.net/download.asp?file=cdp4_report.pdf, or http://www.cdproject.net/download.asp?file=CDP4_FT500_Summary_Report.pdf for a summary of the report.

"Climate Change Action Plan, August 2006." The Action Plan is the product of more than a year's effort by the 35-member Climate Change Advisory Group (CCAG) and its five Technical Working Groups (TWGs). The full CCAG met six times between July 2005 and June 2006, and the TWGs met a total of 40 times via teleconference during this time. The Action Plan contains a comprehensive set of 49 recommendations for addressing and reducing greenhouse gas (GHG) emissions in Arizona. Of the 49 policy recommendations adopted by the CCAG, 45 received unanimous consent, two received a supermajority of support and two received a majority of support. Pursuant to Executive Order 2005-02, the CCAG prepared an inventory and forecast of GHG emissions in Arizona, which found that between 1990 and 2005, Arizona's net GHG emissions increased by nearly 56 percent. Arizona's GHG emissions are projected to increase by 148 percent from 1990 to 2020. As the Action Plan states, "While Arizona's high emissions growth rate presents challenges, it also provides major opportunities. Because more than three-fourths of Arizona's GHG emissions are directly related to energy and transportation, the opportunity exists for Arizona to reduce its GHG emissions while continuing its strong economic growth by being more energy efficient, using more renewable energy sources, building new infrastructure "right" in the first place to produce lower emissions and increasing the use of cleaner transportation modes, technologies and fuels."

http://www.azgovernor.gov/dms/upload/Climate_Change_Action_Plan_final-web.pdf.

"Evaluating the Role of Prices and R&D in Reducing Carbon Dioxide Emissions, September 2006." This report released by the Congressional Budget Office outlines concepts to address climate change through a combination of regulation and a long-term scientific investment plan. The report discusses policies for reducing carbon dioxide emissions including emissions taxes and cap and trade policies, and whether emission taxes would spur research and development of new technologies. Costs and benefits of research and development (R&D) are covered, as are current policies that support R&D. The effectiveness of policy approaches is also reviewed. http://www.cbo.gov/ftpdocs/75xx/doc7567/09-18-CarbonEmissions.pdf.

Legislative Activity

***Reuters,* "California Strikes Accord on Global Warming Bill" and Pew Climate Center Website, "California Global Warming Act"** On August 30, 2006, Governor Schwarzenegger and the California Legislature passed AB32, the Global Warming Solutions Act (The Act). The Act caps California's greenhouse gas emissions at 1990 levels by 2020, with mandatory reporting for top emitters such as energy companies. The Act is the first enforceable state-wide program in the US to cap all GHG emissions from major industries that includes penalties for non-compliance. The State Air Resources Board (Board) is required to establish a program for statewide greenhouse gas emissions reporting, monitoring and enforcement. The Board will adopt market-based compliance mechanisms including cap-and-trade, and allow a one-year extension of the emissions targets under extraordinary circumstances. California is the world's eighth-biggest economy and the 12th largest producer of greenhouse gas emissions. To read the legislation on AB 32, see: http://www.leginfo.ca.gov/cgi-bin/postquery?bill_number=ab_32&sess=CUR&house=B&author=nunez. To see a table of emissions targets worldwide, see: http://www.pewclimate.org/what_s_being_done/targets/index.cfm. To see a map of states with emissions targets, see: http://www.pewclimate.org/what_s_being_done/in_the_states/emissionstargets_map.cfm.
August 31, 2006, http://www.planetark.com/dailynewsstory.cfm/newsid/37896/story.htm, and http://www.pewclimate.org/what_s_being_done/in_the_states/ab32/index.cfm.

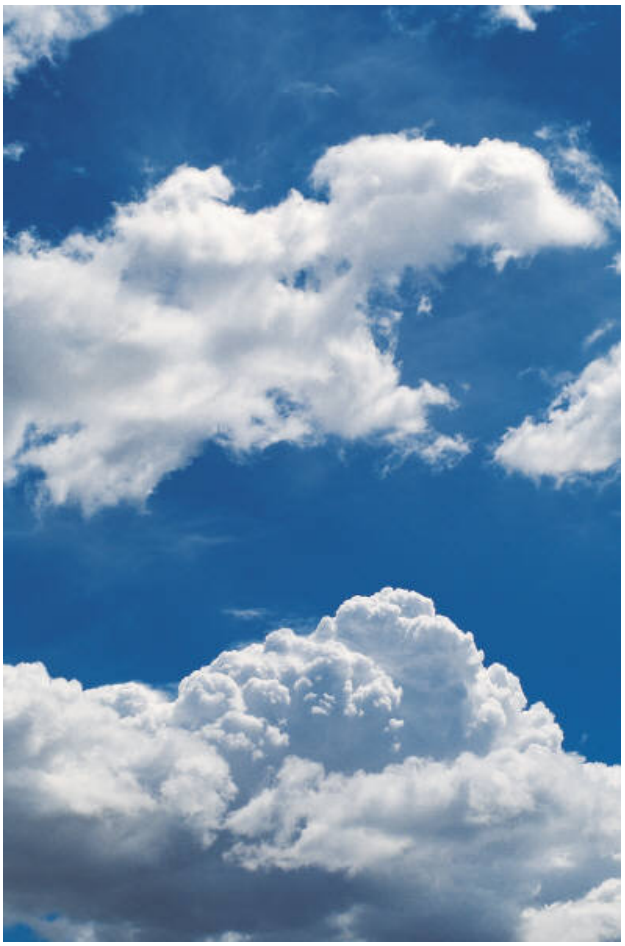
***State of Arizona Press Release,* "Governor Napolitano Issues Executive Order to Promote Energy Efficiency: Order Steps Up Efforts to Reduce "Greenhouse Gas" Emissions,"** On September 8, 2006, Arizona Governor Janet Napolitano signed Executive Order 2006–13, which establishes a statewide goal to reduce Arizona's future greenhouse gas emissions (GHG) to the 2000 emissions level by the year 2020, and to 50 percent below the 2000 level by 2040. The Governor's decision was made after receiving a report from the Governor's Climate Change Advisory Group (CCAG) on cleaner air. The Action Plan, a product of more than a year's work by the group, contains a report on the effects of climate changes and offers a list of recommendations to decrease GHG emissions. The Executive Order also creates a Climate Change Executive Committee which will develop a strategy to implement the plan, and explore ways to meet the targets sooner, by 2012 if possible, to coincide with Arizona's Centennial. Recommendations made by the Advisory Group include using better land and forest management practices to increase efforts to remove carbon from the atmosphere (known as "carbon sequestration"). View the August 2006 Climate Change Action Plan at: http://www.azgovernor.gov/dms/upload/Climate_Change_Action_Plan_final-web.pdf. September 08, 2006, http://azgovernor.gov/dms/upload/NR_090806_CCAG.pdf.

***Boston Channel.com,* "Massachusetts Sets Rules for CO_2 Trading on Power Plants," and *MassDep News Release,* "Romney Administration Promulgates Rules To Implement First-In-The-Nation Regulation To Limit Carbon Dioxide Emissions From Power Plants."** Massachusetts has filed regulations on September 14 that will be promulgated on October 6, which allow the state's six largest power plants to regulate carbon dioxide (CO_2) emissions while allowing for environmental projects to be funded by those plants. Regulations were established in 2001 for the CO_2 emissions to be met in 2 phases beginning in 2006. The new rule establishes the criteria by which the plants can meet those emissions limits. The rule specifies several different types of projects which fulfill the requirement of those reductions, including the capture of landfill gases, greenhouse gas sequestration, renewable energy generation and tree planting. The projects can be conducted on or off the plant sites, by the companies or by third parties whose emission reductions have been certified by Massachusetts' Department of Environmental Protection (MassDEP). Plants will be required to pay for projects in the Northeast US unless the price of those programs costs more than $6.50 per ton of CO_2, in which case they can pay for programs anywhere in

the world. If the price for the programs is over $10 per ton of CO_2, then the companies are to pay into a state trust fund. To view the rule, see: http://www.mass.gov/dep/air/laws/ghgappb.pdf. September 14, 2006, http://www.mass.gov/dep/public/press/0906ghg.htm.

***Greenwire,* "'Strange Bedfellows' File Briefs in Supreme Court Emissions Case."** A wide array of parties has filed their opening briefs for *Massachusetts v. EPA,* the lawsuit aimed at forcing the US EPA to regulate carbon dioxide from motor vehicles. The parties filing briefs include the states of California, Connecticut, Illinois, Maine, Massachusetts, New Jersey, New Mexico, New York, Oregon, Rhode Island, Vermont and the District of Columbia, environmental groups, scientists and energy companies. Other parties filing "friend of the court" briefs were energy companies Entergy and Calpine, former Secretary of State Madeleine Albright, Alaska native groups, the National Wildlife Federation, hunting and fishing groups, four former EPA administrators, the National Council of Churches, and the US Conference of Mayors. Oral arguments are expected in December after the US Circuit Court of Appeals for the District of Columbia denied the state's motion to reverse an earlier ruling. The case centers around the appeals court's decision upholding the Bush administration's refusal to regulate carbon dioxide as a pollutant under the Clean Air Act. To read the opening brief filed by Massachusetts and other plaintiffs in the case, see: http://www.eenews.net/features/documents/2006/09/05/document_gw_14.pdf. To read other briefs files by petitioners, go to the following news story weblink to view a chart of filers, and links to pdfs of the brief. September 5, 2006, http://www.eenews.net/Greenwire/print/2006/09/05/1. (Subscription may be required.)

***Bloomberg*, "California Sues GM, Ford, Toyota Over Global Warming."** California is suing the six largest automakers in the US, including General Motors, Ford, Toyota Motor Corp., DaimlerChrysler AG, Honda Motor Co. and Nissan Motor Co. arguing that the vehicles add to global warming and cost the state billions of dollars to fight pollution and erosion. The state filed a complaint in US District Court in Oakland that the companies are creating a public nuisance, with is defined as "anything which is injurious to health," obstructs free use of property or interferes with the comfortable enjoyment of life or property. The lawsuit is California v. General Motors, 06-05755, US District Court, Northern District of California. September 20, 2006, http://www.bloomberg.com/apps/news?pid=20601103&sid=aSthCirr_IoI&refer=us.



Events

October 1-4, 2006, **Gasification Technologies Conference,** *JW Marriot Hotel, Washington, DC*. This leading-edge conference on gasification technologies has posted the final program which includes a session on Carbon Management with Gasification Technologies. You can register online at: http://www.gasification.org/Orders/register.aspx, or see the following website for more information. http://www.gasification.org/Conference/annual.htm.

October 5-6, 2006, **IEA Risk Assessment Network: Second Meeting,** *Lawrence Berkeley National Laboratory, Berkeley, CA.* IEA's Greenhouse Gas Programme is holding its second meeting of the Risk Assessment Network. If you are interested in becoming involved in the Risk Assessment Network please contact Angela Manancourt at: angela@ieaghg.org. http://co2captureandstorage.info/networks/riskassess.htm.

October 9-10, 2006, **Carbon Finance 2006: Risks and Opportunities in Emissions Markets,** *The Millennium Gloucester Hotel, London England.* The main focus of the conference will be on recent progress in the Clean Development Mechanism (CDM), global developments in emissions trading schemes, and a preview of the hot topics at the UN's forthcoming 12th Conference of the Parties and 2nd Meeting of the Parties (COP12/MOP2) meeting. The conference will be followed by an optional one-day CDM Workshop. To register online and for more information, see: http://www.environmental-finance.com/conferences/2006/CF06/intro.htm.

October 10-11, 2006**, Coal21 Conference 2006,** *Surfers Paradise Marriott Resort, Gold Coast, Australia.* Initiated by the Australian Coal Industry, COAL21 (http://www.coal21.com.au/) is a program aimed at fully realizing the potential of advanced technologies to reduce or eliminate greenhouse gas emissions associated with the use of coal. This conference is for Coal 21 participants only. To download a registration form see: http://www.tmm.com.au/Documents/COAL21_Workshop_06(reg).pdf, or register online at: https://www.amlink.com.au/secure/eilite/COAL2106.htm. Email: meetings@tmm.com.au for more information.

November 8-9, 2006, **Coal-Seq V Forum,** *Hilton Houston NASA Clear Lake, Houston, TX.* Experts from around the world will present the latest results from field projects and other technology development efforts, and discuss the unique technical and non-technical issues associated with carbon dioxide, Enhanced Coalbed Methane (CO_2 ECBM)/sequestration in coal seams. Go to www.coal-seq.com under "Upcoming Events" for a Registration Form. For further information about participating in or attending this event, please contact Susan Pershall at (713) 780-0815 or spershall@adv-res-hou.com.

November 13-15, 2006, **Coal Gasification: The Path Forward,** Sheraton Denver West, Denver, CO. Get the comprehensive update not only on the state of coal gasification technologies and the status of current gasification project developments, but also on the latest information regarding the technologies for and economics of carbon sequestration. For more information, call (818) 888-4444 or see the website: http://www.infocastinc.com/advcoal.html**.**

Events (continued)

November 15-16, 2006, **International Power Generation '06 Conference: Implementing the European Commission (EC) Directives,** Renaissance Leipzig Hotel, Leipzig, Germany. Following on from the success of last year's conference, IPG'06 will dissect the terms and conditions of the EC Directives, (Large Combustion Plant Directive (LCPD) and Integrated Pollution Prevention and Control (IPPC)) including case study examples of a compliant plant. Best available technology to bring plants in line with the regulations will also be discussed, as will carbon capture and storage. For registration and program information, see: http://www.ipg.antfx.com/index.php?option=com_content&task=view&id=65&Itemid=91.

November 20-21, 2006, **6th Emissions Trading & the Carbon Markets Conference,** *The Jumeirah Carlton Tower, London, England.* This conference will provide an analysis of the most critical developments in European and International carbon regulation, and address the strategic business implications for carbon market players. Taking place right after the close of UN's 12th Conference of the Parties and 2nd Meeting of the Parties (coP/MOP) in Nairobi this conference will be a good platform to analyze and debate issues raised and conclusions achieved at the meeting. Register before October 6 for a discounted rate. For details, see: http://www.pointcarbon.com/Events/Upcoming%20conferences/article17372-141.html.

November 27-29, 2006, **Australian Institute of Energy National Conference 2006: Energy at the Crossroads,** *University of Melbourne, Melbourne, Australia.* Discussion at the conference will focus on Australia and include climate change, renewable energy, sequestration technologies, and nuclear energy. Register before October 2 for a discounted rate. A preliminary program has also been posted. http://www.conferences.unimelb.edu.au/aie2006/home.htm.

December 11-15, 2006, **2006 American Geophysical Union (AGU) Fall Meeting,** *Moscone Center West, San Francisco, CA.* The Fall meeting of the American Geophysical Union will include several presentations regarding carbon geosequestration. Registration deadline is December 6, 2006. See: http://www.agu.org/meetings/fm06/.

Please visit http://listserv.netl.doe.gov/mailman/listinfo/sequestration, enter your email address, and create a password to receive the Newsletter at no cost, both as text and in pdf format. (If you prefer not to receive the pdf file in your email, choose "yes" for the daily digest option. Otherwise leave the default value at "no.") To view the archive of newsletters, see: http://www.netl.doe.gov/publications/carbon_seq/subscribe.html.

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