

# THE CARBON SEQUESTRATION NEWSLETTER

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July 2006

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## HIGHLIGHTS

### **Department of Energy Press Release, "US and South Korea Sign Agreement on FutureGen Project."**

US Department of Energy Secretary Samuel W. Bodman and South Korean Minister of Commerce, Industry and Energy Chung Sye Kyun signed an agreement on June 26 making South Korea the second country, following India, to join the US in the FutureGen International Partnership. South Korea has pledged \$10 million to help construct and operate FutureGen, the world's first zero-emissions coal-fired power plant, and will sit on a government steering committee which will oversee the initiative. "This agreement signifies our collective commitment to global technological leadership on climate change and future energy needs," said Secretary Bodman. He added, "This bold and revolutionary initiative known as FutureGen will ensure that clean coal continues to globally supply our energy needs in ways that are environmentally sustainable and responsible." Secretary Bodman has also invited government members of the international Carbon Sequestration Leadership Forum (CSLF) to become active participants in project. The CSLF is a voluntary climate initiative that includes 20 developed and developing nations (including India and Korea) and the European Commission. The FutureGen project will be led by the FutureGen Industrial Alliance, an industrial consortium representing the coal and power industries, with the project results being shared among all participants, and industry as a whole. June 26, 2006, <http://energy.gov/news/3778.htm>.

### *US and South Korea Sign Agreement on FutureGen*



**Associated Press, "States Vie For Next-Generation Power Plant."** Seven states, with 12 candidate sites overall, are vying to host the FutureGen project. All of the states are offering some incentives to support the project. "One of these sites ultimately will become known worldwide as the place where a new generation of zero-emission energy plants made its debut," Energy Secretary Samuel Bodman said, highlighting the importance of the project when announcing the candidate sites. The FutureGen Industrial Alliance (FutureGen Alliance, or Alliance), a non-profit consortium of some of the largest coal producers and users, will partner with the US Department of Energy to site, develop and operate the coal-fueled, zero emissions FutureGen plant. The Alliance is committing \$250 million and the US government \$700 million. "It's a big deal," said John Grasser, spokesman for the US Department of Energy's Office of Fossil Energy. With two dozen states having inquired about the FutureGen Project, for the selected site "it's going to be an honor to have that science in that state," said Grasser. Illinois is offering a \$17 million grant towards project costs, an estimated \$15 million in sales tax exemptions, \$50 million for lower rate loans to the FutureGen Alliance, and other property and sales tax abatements. Kentucky is offering 215 acres of free land and \$2.5 million in incentives. North Dakota is offering a total of about \$20 million, including various tax exemptions, \$10 million in matching funds and \$1.56 million in work force training. Ohio is offering a total of up to \$164 million in grants, low-interest loans, and infrastructure support. Texas officials are offering \$20 million to the FutureGen Alliance for use on infrastructure or development, and have recently passed a law indemnifying the FutureGen Alliance of any legal issues arising from the plant's carbon dioxide. West Virginia is offering 387 acres of state land. Wyoming is offering over \$30 million in incentives including sales tax and use tax exemptions, and 640 acres of land worth \$900,000. The Alliance will deliver list of finalist sites to the Department of Energy this summer, with final site selection scheduled for fall of 2007. June 18, 2006, <http://www.cbsnews.com/stories/2006/06/18/ap/business/mainD8IASIG01.shtml>.

**Powerspan Corp. Press Release, "Powerspan CO<sub>2</sub> Pilot Combined with FirstEnergy Carbon Sequestration Project Offers Unique Testing Opportunity."** For the first time in the United States, combined carbon dioxide capture and sequestration from a conventional pulverized coal-fired power plant will be demonstrated. Powerspan and FirstEnergy previously announced their plans for a pilot test of a carbon dioxide capture technology at FirstEnergy's R.E. Burger Plant (Burger plant) in Shady-side, Ohio. The Burger Plant was selected as a carbon sequestration test site by the Midwest Regional Carbon Sequestration Partnership (MRCSP), one of seven regional partnerships set up by the US Department of Energy (DOE) National Energy Technology Laboratory. The Burger plant will be the site of the pilot scale demonstration of CO<sub>2</sub> capture with subsequent injection of the captured CO<sub>2</sub> into a test well on the property. Geological site characterization will be conducted for the project to determine suitability for geosequestration in the area. If results are favorable, permits will be pursued and test wells drilled, followed by an injection of a small amount of CO<sub>2</sub> into the well. Powerspan's CO<sub>2</sub> pilot unit will process a 1-megawatt (MW) slipstream from the company's 50-MW Electro-Catalytic Oxidation (ECO) commercial demonstration unit, where the CO<sub>2</sub> capture process will be integrated with the ECO multi-pollutant control process (which reduces sulfur dioxide, nitrogen oxides, mercury, and fine particulate matter). The CO<sub>2</sub> capture process uses an ammonia-based solution to capture the CO<sub>2</sub> in the flue gas, with regeneration of the ammonia solution for additional CO<sub>2</sub> capture. May 30, 2006, [http://www.powerspancorp.com/news/release\\_27.shtml](http://www.powerspancorp.com/news/release_27.shtml).

**NETL Press Release, "Sequestration Test to Demonstrate Carbon Dioxide Storage While Increasing Oil Production."** The US Department of Energy's Regional Carbon Sequestration Partnerships program will oversee its first geologic carbon sequestration project in Alberta, Canada. Funding for the project is provided by the National Energy Technology Laboratory. The project itself will be conducted by the Energy and Environmental Research Center at the University of North Dakota Plains CO<sub>2</sub> Reduction Partnership, in collaboration with an industry partner Apache Canada Ltd., and the Alberta Department of Energy and Natural Resources Canada. The project will evaluate the potential for geological sequestration of carbon dioxide as part of an acid gas stream that also includes high concentrations of hydrogen sulfide. Apache Canada Ltd's Zama gas-processing plant will provide the gas which will be injected into the Zama oil field at a rate of 100 tons per day over the next two years. The project has the potential to sequester 67,000 tons of carbon dioxide annually. June 26, 2006, [http://www.netl.doe.gov/publications/press/2006/06037-Carbon\\_Storage\\_Test\\_Begins.html](http://www.netl.doe.gov/publications/press/2006/06037-Carbon_Storage_Test_Begins.html).

**Times-Colonist (Canada), "Prairie Project Captures Carbon."** The Weyburn project in Saskatchewan, Canada is an enhanced oil recovery operations and globally visited carbon sequestration project. The project is financed largely by Natural Resources Canada and the US

Department of Energy's National Energy Technology Laboratory. Since 2000, more than seven million tons of carbon dioxide (CO<sub>2</sub>) have been geologically sequestered, with plans to eventually sequester 30 million tons of CO<sub>2</sub>. The CO<sub>2</sub> is transported from the Great Plains Synfuels Plant near Beulah, North Dakota via a 323-km long pipeline. The pipeline snakes through a lake and over the border into Canada, emerging from the ground onto the Weyburn site. The pipeline then leads into a large building where compressors liquefy the CO<sub>2</sub> for injection underground. From there the liquid CO<sub>2</sub> is fed

### Announcements

**"Brennan Takes Helm of US Climate Change Science Program."** The secretaries of commerce and energy have designated Dr. Bill Brennan (<http://www.noaa.gov/brennan.html>) as the acting director of the US Climate Change Science Program (CCSP) (<http://www.climatechange.gov>), the interagency program that coordinates and integrates scientific research on changes in climate and related systems. CCSP is composed of 13 federal scientific agencies and integrates the planning and budgeting of federal climate and global change activities. CCSP was launched in 2002 as a collaborative interagency program under a new cabinet-level organization designed to improve the government-wide management of climate science and climate-related technology development. The CCSP incorporates and integrates the U.S. Global Change Research Program (USGCRP) (<http://www.usgcrp.gov/>) with the Administration's U.S. Climate Change Research Initiative (CCRI) (<http://www.climatechange.gov/about/ccri.htm>). *National Oceanic and Atmospheric Administration Press Release*, June 19, 2006, <http://www.climatechange.gov/Library/pressreleases/pressrelease19jun2006.htm>.

**"Carbon Value Analysis Tool (CVAT) Released By World Resources Institute."** World Resources Institute has released their Carbon Value Analysis Tool (CVAT), a Microsoft Excel-based program that allows energy managers to compare the emissions and financial impacts for a full range of energy-efficient and renewable energy projects. The analysis helps corporate energy managers to assess the value of emissions reductions and make decisions on financing new projects. The CVAT is designed to be especially useful for multinational corporations with greenhouse gas reduction targets as well as facilities that operate under carbon-limiting government mandates, such as those throughout Europe. Several Fortune 500 companies have tested CVAT and have released case study examples. CVAT is available at: [http://pubs.wri.org/pubs\\_description.cfm?PubID=4199](http://pubs.wri.org/pubs_description.cfm?PubID=4199). The case studies are available at: <http://www.climatechange.gov/ClimateNortheastCaseStudies.php>. June 6, 2006, [http://newsroom.wri.org/newsrelease\\_text.cfm?NewsReleaseID=364](http://newsroom.wri.org/newsrelease_text.cfm?NewsReleaseID=364).

through the maze of piping buried at the 180-square-kilometre operation. Injection wells which are housed in igloo-shaped fiberglass sheds transport the CO<sub>2</sub> underground where it floods into horizontal channels bored into oil-rich rock. The CO<sub>2</sub> seeps into the rocks' pores to liberate the oil. The oil migrates to collection wells and is pulled to the surface by hundreds of pump jacks operating on the farmers' fields. About 2,500 tons of CO<sub>2</sub> per day returns with the emulsion of oil and water back up from the production wells, which is then recompressed and reinjected. This closed loop process cost about \$1.5 billion to build and generates 30,000 barrels of oil per day. May 24, 2006, <http://www.canada.com/victoriatimescolonist/news/story.html?id=04357c12-5a28-4f5b-9a3d-b45b1328101a&p=2>.

**LCG Consulting Online, "Construction Begins on Carbon-Free Coal Plant."** Groundbreaking occurred in eastern Germany for a 30-MW coal-fired power plant that will incorporate oxyfuel technology. The plant is being built by Vattenfall AB, an electric utility owned by the Swedish government. The project cost is \$64 million with operations to begin in 2008. With oxyfuel technology, the coal is combusted in pure oxygen, resulting in a lower volume of flue gas which consists of mostly carbon dioxide and water. The water can be condensed and separated, and the carbon dioxide can be liquefied and stored. The plans for storing the CO<sub>2</sub> have not been finalized but underground storage in aquifers or spent oil wells are being considered. There are also plans by Vattenfall to develop a 330 MW plant by 2015, and a 1000 MW plant by 2020. May 31, 2006, [http://www.energyonline.com/Industry/News.aspx?NewsID=7050&Construction\\_Begins\\_on\\_Carbon-Free\\_Coal\\_Plant](http://www.energyonline.com/Industry/News.aspx?NewsID=7050&Construction_Begins_on_Carbon-Free_Coal_Plant).

**The Japan Times, "Underground CO<sub>2</sub> Storage Planned."** The Ministry of Economy, Trade and Industry of Japan announced on June 12 that in an effort to cut greenhouse gas emissions, Japan plans to capture and geologically store carbon dioxide (CO<sub>2</sub>) from its factories and power plants. Using carbon dioxide capture and storage (CCS) technology, Japan's goal is to sequester one half of the 200 million tons annually of CO<sub>2</sub> in Japan, and one half of the CO<sub>2</sub> in sites overseas. The government will spearhead research, build facilities, and pursue the legislation necessary to implement CCS. An estimated 150 billion tons of CO<sub>2</sub> could potentially be stored underground nationwide. June 20, 2006, <http://search.japantimes.co.jp/cgi-bin/nb20060620a2.html>. (Subscription required.)

**The Engineer Online, "Carbon Capture Ready Clean Coal Power."** Mitsui Babcock has secured a contract with Scottish and Southern Energy (SSE) for engineering design of a carbon "capture-ready" 500 megawatt (MW) clean coal plant retrofit at SSE's Ferrybridge Power Station in Yorkshire, United Kingdom. This project would be the first application of "capture-ready" clean coal technology in the United Kingdom. The retrofit installation of the 500 MW supercritical boiler and turbine unit technology, at a cost of 250 million British pounds (\$463 million), will result a reduction of 500,000 tons of carbon dioxide (CO<sub>2</sub>) per year from the current conventional subcritical power station plant. Subsequent deployment of post-combustion carbon dioxide capture equipment at a cost of 100 million British pounds (\$185 million) would result in a saving of 1.7 million tons of carbon dioxide per year. May 31,

2006, <http://www.e4engineering.com/Articles/294699/Carbon%20capture-ready%20clean%20coal%20power.htm>. (Subscription required.)

## Science



**Reuters, "Gore To Train 1,000 to Spread Word About Climate."** Former Vice President Gore will begin a bipartisan national education campaign by the end of the summer to train 1,000 people to give a version of his slide show talk on global warming. The slide show is the basis for the book and film "An Inconvenient Truth." June 12, 2006, [http://today.reuters.com/news/newsArticle.aspx?type=topNews&storyID=2006-06-13T025339Z\\_01\\_N12361864\\_RTRUKOC\\_0\\_US-ENVIRONMENT-GORE.xml&archived=False](http://today.reuters.com/news/newsArticle.aspx?type=topNews&storyID=2006-06-13T025339Z_01_N12361864_RTRUKOC_0_US-ENVIRONMENT-GORE.xml&archived=False).

**Greenwire, "National Academy of Science Finds 'Hockey Stick' Graph's Conclusion 'Plausible' " and The National Academies Press Release, " 'High Confidence' That Planet Is Warmest in 400 Years; Less Confidence in Temperature Reconstructions Prior to 1600."** The National Academy of Science released a report on June 22 with the conclusion that the controversial "hockey stick" climate graph is plausible. The graph, published in the journal Nature in 1998, draws on "proxy evidence," which includes data on tree rings, corals, ocean and lake sediments, cave deposits, ice cores, boreholes, and glaciers, to reconstruct global temperatures over the last 1000 years. The report concludes with a high level of confidence that global mean surface temperature was higher during the last few decades of the 20th century than during any comparable period during the preceding four centuries, supporting the idea that the climate is warming due to human influence. The analysis was conducted in response to a request from Congress. (See this newsletter's **Recent Publications** section for link to the NAS report: "**Surface Temperature Reconstructions**

for the Last 2,000 Years (2006).” To view the *Nature* report and graph, refer to: “Global-scale temperature patterns and climate forcing over the past six centuries,” Michael E. Mann, Raymond S. Bradley and Malcolm K. Hughes, *Nature*, Volume 392, pages 779 – 787, April 23, 1998, doi:10.1038/33859, [http://www.nature.com/nature/journal/v392/n6678/full/392779a0\\_fs.html](http://www.nature.com/nature/journal/v392/n6678/full/392779a0_fs.html).) June 22, 2006, <http://www.eenews.net/Greenwire/2006/06/22/#11>, (Subscription may be required), and June 22, 2006, <http://www8.nationalacademies.org/onpinews/newsitem.aspx?RecordID=11676>.

## Policy

**Environmental Finance Publications Online News, “US, EU Agree to High-Level Talks on Climate Change.”** The annual EU-US Summit attended by US President George Bush and European Union (EU) President Manuel Barroso, was held on June 21 in Vienna, Austria. (For details on the summit, see the website: [http://ec.europa.eu/comm/external\\_relations/us/sum06\\_06/index.htm](http://ec.europa.eu/comm/external_relations/us/sum06_06/index.htm).) As part of the joint declaration adopted by the EU and US, the parties agreed, among four main areas, to promote strategic cooperation on energy, energy security, climate change and sustainable development. The parties also agreed to “work more closely to address the serious and long-term challenge of climate change, biodiversity loss and air pollution and will act with resolve and urgency to reduce greenhouse gas emissions.” The joint declaration also states that the EU and US will work to reinforce technological cooperation and partnerships, in areas including carbon sequestration. To read the joint declaration, see: [http://ec.europa.eu/comm/external\\_relations/us/sum06\\_06/docs/decl\\_final\\_210606.pdf](http://ec.europa.eu/comm/external_relations/us/sum06_06/docs/decl_final_210606.pdf). While dialog will continue under the UN Framework Convention on Climate Change (UNFCCC), the parties have established an “EU-US High Level Dialogue on Climate Change, Clean Energy and Sustainable Development,” which will meet in the Fall of 2006 in Helsinki, Finland. This dialogue will be guided by the ultimate objective of the UNFCCC, with discussions to include experiences with different market-based mechanisms to promote cost-effective reductions in greenhouse gas emissions, and advancing the development and deployment of existing and transformational technologies that are cleaner and more efficient. On June 20, EU environment commissioner Stavros Dimas told the European Parliament's Environment Committee that “clear market signals” are needed to promote technological solutions to climate change. “Mandatory reductions, an international price on carbon and a global cap-and-trade scheme are necessary,” he said. Dimas also said other aspects of the EU's climate policy would be strengthened with “a legislative framework for carbon capture and storage that will provide clarity for future investments.” See: <http://europa.eu/rapid/pressReleasesAction.do?reference=SPEECH/06/393&format=HTML&aged=0&language=EN&guiLanguage=en> to read the speech by Stavros Dimas as an html, pdf or doc file. June 22, 2006, <http://www.environmental-finance.com/online/22junets.htm>.

**Agence France-Presse, “EU Way Off Course For Meeting Kyoto Targets: Latest Figures.”** A report published June 22, by the European Environment Agency, showed the European Union (EU) remains off course for meeting its green-

house gas reduction pledges under the Kyoto Protocol, and that greenhouse gas emissions actually rose 0.3 percent (11.5 million tons) between 2003 and 2004, or 11.5 million tons. This marks the second annual year of increase. (To link to the report, see this newsletter's **Recent Publications** section for the report entitled: “Annual European Community Greenhouse Gas Inventory 1990-2004 and Inventory Report 2006.”) June 22, 2006, <http://www.wbcsd.org/plugins/DocSearch/details.asp?type=DocDet&ObjectId=MTk0ODM>.

## Geology

**“Mechanisms of aqueous wollastonite carbonation as a possible CO<sub>2</sub> sequestration process.”** The mechanisms of aqueous wollastonite carbonation as a possible carbon dioxide (CO<sub>2</sub>) sequestration process were investigated experimentally by systematic variation of the reaction temperature, CO<sub>2</sub> pressure, particle size, reaction time, liquid to solid ratio and agitation power. The carbonation reaction was observed to occur via the aqueous phase in two steps: (1) calcium (Ca) leaching from the wollastonite (CaSiO<sub>3</sub>) matrix and (2) calcium carbonate (CaCO<sub>3</sub>) nucleation and growth. Leaching is hindered by a Ca-depleted silicate rim resulting from incongruent Ca-dissolution. Two temperature regimes were identified in the overall carbonation process. At temperatures below an optimum reaction temperature, the overall reaction rate is probably limited by the leaching rate of Ca. At higher temperatures, nucleation and growth of calcium carbonate are probably limiting the conversion, due to a reduced (bi) carbonate activity. The mechanisms for the aqueous carbonation of wollastonite were shown to be similar to those reported previously for an industrial residue and a magnesium (Mg)-silicate. The carbonation of wollastonite proceeds rapidly relative to Mg-silicates, with a maximum conversion in 15 minutes of 70 percent at 200 degrees Celsius, 20 bar CO<sub>2</sub> partial pressure and particle size of less than 38 micrograms. The obtained insight in the reaction mechanisms enables the energetic and economic assessment of CO<sub>2</sub> sequestration by wollastonite carbonation, which forms an essential next step in its further development. **Wouter J.J. Huijgen, Geert-Jan Witkamp and Rob N.J. Comans, *Chemical Engineering Science*, Volume 61, Issue 13, The John Bridgwater Symposium: “Shaping the Future of Chemical Engineering”, July 2006, Pages 4242-4251, <http://www.sciencedirect.com/science/article/B6TFK-4JJ2BR9-2/2/147529f686327ad635e1b8df274caf79>.** (Subscription may be required.)

**“In situ methane hydrate dissociation with carbon dioxide sequestration: Current knowledge and issues.”** There are large resources of methane gas as hydrates in permafrost and deep-sea sediments around the world. On the other hand, the emissions of carbon dioxide into atmosphere have gone up in the last hundred years. The emitted carbon dioxide can be sequestered as hydrate while helping dissociate the in situ methane hydrates. Such approach can improve the economics of carbon dioxide sequestration and methane hydrate dissociation, and assist in global carbon emissions manage-

ment and methane hydrate exploitation. This paper summarizes the current knowledge on producing methane gas from hydrates while simultaneously sequestering carbon dioxide gas as hydrates, and discusses the challenges and issues in its implementation. **Naval Goel**, *Journal of Petroleum Science and Engineering*, Volume 51, Issues 3-4, May 16, 2006, Pages 169-184, <http://www.sciencedirect.com/science/article/B6VDW-4JCBKXW-1/2/3a99a9da3cb51bf5f4a32cd0cd3953dc>. (Subscription may be required.)

## Technology

### “Exergy regeneration in an O<sub>2</sub>/CO<sub>2</sub> gas turbine cycle with chemical recuperation by CO<sub>2</sub> reforming of methane.”

This paper proposes a novel power cycle system composed of a chemical recuperative cycle with CO<sub>2</sub>-NG (carbon dioxide-natural gas) reforming and an ammonia absorption refrigeration cycle in which the heat is recovered from the turbine exhaust to drive the carbon dioxide-natural gas (CO<sub>2</sub>-NG)

reformer firstly, and then, lower temperature heat from the turbine exhaust is provided for the ammonia absorption refrigeration system to generate chilled media, which is used to cool the turbine inlet gas except for the exported part. Based on 1 kilograms per second (kg s<sup>-1</sup>) of methane feedstock, the turbine inlet temperature of 1573 kelvin (K) and the CO<sub>2</sub> compressor outlet pressure of 1.01 Megapascals (MPa), the simulation results show that the new cycle system reached the net electric power production of 24.444 megawatts (MW), the power generation efficiency of 48.9 percent based on the low heating value, the export chilled load of 1.070 MW and the exergy efficiency of 47.3 percent. On the other hand, 2.743 kg s<sup>-1</sup> of liquid CO<sub>2</sub> was captured, which achieved the goal of zero CO<sub>2</sub> emission. Especially, the authors investigate the exergy regeneration performances of the chemical recuperation with CO<sub>2</sub>-NG reforming, the lower temperature heat from the turbine exhaust generated chilled load and inlet cooling by the aid of the energy utilization diagram to expose the thermodynamic principle of energy integration for high efficiency power conversion in the system. **Wen Cao and Danxing Zheng**, *Energy Conversion and Management*, available online April 18, 2006, [doi:10.1016/j.enconman.2006.03.010](http://www.sciencedirect.com/science/article/B6V2P-4JRVFK8-4/2/fda16d637f6a0f410177f65e6ff14678), <http://www.sciencedirect.com/science/article/B6V2P-4JRVFK8-4/2/fda16d637f6a0f410177f65e6ff14678>. (Subscription may be required.)

“Environmental assessment and extended exergy analysis of a “zero CO<sub>2</sub> emission”, high-efficiency steam power plant.” Aim of this paper is to analyze the performance of an innovative high-efficiency steam power plant by means of two “life cycle approach” methodologies, the life cycle assessment (LCA) and the “extended exergy analysis” (EEA). The plant object of the analysis is a hydrogen-fed steam power plant in which the H<sub>2</sub> is produced by a “zero carbon dioxide (CO<sub>2</sub>) emission” coal gasification process (the ZECOTECH<sup>®</sup> cycle). The CO<sub>2</sub> capture system is a standard

humid-calcium oxide (CaO) absorbing process and produces calcium carbonate (CaCO<sub>3</sub>) as a by-product, which is then regenerated to CaO releasing the CO<sub>2</sub> for a downstream mineral sequestration process. The steam power plant is based on an innovative combined-cycle process: the hydrogen is used as a fuel to produce high-temperature, medium-pressure steam that powers the steam turbine in the topping section, whose exhaust is used in a heat recovery boiler to feed a traditional steam power plant. The environmental performance of the ZECOTECH<sup>®</sup> cycle is assessed by comparison with four different processes: power plant fed by hydrogen (H<sub>2</sub>) from natural gas steam reforming, two conventional coal- and natural gas power plants and a wind power plant. **A. Corrado, P. Fiorini and E. Sciubba**, *Energy*, available online May 19, 2006, [doi:10.1016/j.energy.2006.03.025](http://www.sciencedirect.com/science/article/B6V2S-4K0FFS5-2/2/cd480dd6670641c6afaa0ffd96c72fdc), <http://www.sciencedirect.com/science/article/B6V2S-4K0FFS5-2/2/cd480dd6670641c6afaa0ffd96c72fdc>. (Subscription may be required.)



Source: Wikipedia.com

### “Process design and energy requirements for the capture of carbon dioxide from air,”

A process to capture carbon dioxide from air to reduce its atmospheric concentration and to mitigate climate change is studied. It is based on the absorption of carbon dioxide in a sodium hydroxide solution, its precipitation as calcium carbonate, and its release as pure gas stream through oxy-fuel calcination. The process utilizes existing commercial technologies wherever possible, particularly in the case of the absorber, whose design is carried out in detail. The analysis allows deriving material and energy balances for the whole process and determining energy demands that can be used for a technical, economical, and environmental

feasibility evaluation of the technology. In particular, it indicates that the real specific energy demand is larger than the heat released to emit the same amount of CO<sub>2</sub> by the combustion of coal, and smaller than that of methane. **Renato Baciocchi, Giuseppe Storti and Marco Mazzotti**, *Chemical Engineering and Processing*, available online April 25, 2006, [doi:10.1016/j.cep.2006.03.015](http://www.sciencedirect.com/science/article/B6TFH-4JT836P-1/2/40fac7c57c5eeafc1bd68ce25fbf50cd), <http://www.sciencedirect.com/science/article/B6TFH-4JT836P-1/2/40fac7c57c5eeafc1bd68ce25fbf50cd>. (Subscription may be required.)

### “Spectroscopic analysis of carbon dioxide and nitrogen mixed gas hydrates in silica gel for CO<sub>2</sub> separation.”

In this study solid-state nuclear magnetic resonance (NMR) spectroscopy was used to identify structure and guest distribution of the mixed nitrogen (N<sub>2</sub>) + carbon dioxide (CO<sub>2</sub>) hydrates. These results show that it is possible to recover CO<sub>2</sub> from flue gas by forming a mixed hydrate that removes CO<sub>2</sub> preferentially from CO<sub>2</sub>/N<sub>2</sub> gas mixture. Hydrate phase equilibria for the ternary CO<sub>2</sub>-N<sub>2</sub>-water system in silica gel pores were measured, which show that the three-phase hydrate (H)-water-rich liquid (L<sub>w</sub>)-vapor (V) equilibrium curves were shifted to higher pressures at

a specific temperature when the concentration of CO<sub>2</sub> in the vapor phase decreased. Carbon 13 (<sup>13</sup>C) cross-polarization (CP) NMR spectra of the mixed hydrates at gas compositions of more than 10 mol percent CO<sub>2</sub> with the balance N<sub>2</sub> identified that the crystal structure of mixed hydrates as structure I, and that the CO<sub>2</sub> molecules occupy mainly the abundant tetrakaidecahedra (5<sup>12</sup>6<sup>2</sup>) cages. This makes it possible to achieve concentrations of more than 96 mol percent CO<sub>2</sub> gas in the product after three cycles of hydrate formation and dissociation. **Jeasung Park, Yu-Taek Seo, Jong-won Lee and Huen Lee**, *Catalysis Today*, Volume 115, Issues 1-4, Proceedings of the 8th International Conference on Carbon Dioxide Utilization - Dedicated to Professor Michele Aresta, June 30, 2006, Pages 279-282, <http://www.sciencedirect.com/science/article/B6TFG-4JP9FXT-5/2/cd994f28fb43ff03e380ec054c4f3b0e>. (Subscription may be required.)

## Terrestrial/Ocean

**“Ecological restoration, carbon sequestration and biodiversity conservation: The experience of the Society for Wildlife Research and Environmental Education (SPVS) in the Atlantic Rain Forest of Southern Brazil, Journal for Nature Conservation.”** Since 1999, SPVS has been involved in three projects that combine two fundamental goals over the course of 40 years: the conservation of one of Brazil's most important remnants of Atlantic Forest and the implementation of projects for carbon sequestration. In addition, there is an interest in replicating these projects in order to restore other degraded areas, protect the Brazilian biomes, and help to diminish deforestation and forest fire, therefore reducing carbon emissions. The acquisition of 19,000 hectares of degraded areas of high biological importance in southern Brazil was the first step towards the implementation of the projects. These areas are owned by SPVS, a Brazilian non-governmental organization (NGO), and are

being restored, conserved and transformed into Private Natural Reserves, in partnership with the NGO – The Nature Conservancy, and financed by the companies – American Electric Power, General Motors and Chevron Texaco. The process of forest restoration involves several stages: soil studies, surveying the region's native plants, planning for restoration by means of a Geographical Information System, production of seedlings, application of different techniques for planting (such as manual or mechanized planting with seedlings and stakes), and biomass and biodiversity monitoring. To guarantee the survival of the seedlings on the planted areas, during the first three years, there is a continuous and systematic maintenance program including weeding of undergrowth, crowing and organic fertilization. The three projects already planted around 500,000 seedlings of native species until September 2004, and aim to plant a further 300,000 until 2008. **André Rocha Ferretti and Ricardo Miranda de Brites**, *Journal for Nature Conservation*, Available online June 5, 2006, <http://www.sciencedirect.com/science/article/B7GJ6-4K421HP-1/2/7411afcc69e72b14741bb076018ae883>. (Subscription may be required.)

**“Innovative gap-filling strategy for annual sums of CO<sub>2</sub> net ecosystem exchange.”** The determination of carbon dioxide net ecosystem exchange (NEE) using the eddy-covariance (EC) method has become a fundamental tool for the investigation of the carbon balance of terrestrial ecosystems. This study presents a strategy for the processing, subsequent quality control and gap-filling of carbon dioxide eddy-covariance flux measurements for the derivation of annual sums of NEE. A set of criteria is used for quality assessment and to identify periods with instrumental or methodological failures. The complete evaluation scheme was applied to data recorded above a spruce forest at the FLUXNET-Station Waldstein-Weidenbrunnen (DE-Wei) in 2003. Comparison of this new evaluation scheme to the use of a friction velocity ( $u^*$ ) threshold criterion of 0.3 meter per second ( $m\ s^{-1}$ ) indicates less systematic distribution of data gaps. The number of available high quality night-time measurements increased. This effect was most pronounced during summer, when data is essential for a robust parameterization of respiratory fluxes. Non-linear regression analysis showed that air temperature and global radiation explain most of the variability of NEE and further seasonal segregation of the data based on an objective method did not significantly improve predictions at this evergreen forest site. **J. Ruppert, M. Mauder, C. Thomas and J. Lüers**, *Agricultural and Forest Meteorology*, Available online May 9, 2006, [doi:10.1016/j.agrformet.2006.03.003](http://dx.doi.org/10.1016/j.agrformet.2006.03.003).



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<http://www.sciencedirect.com/science/article/B6V8W-4JX9V3Y-1/2/b3070be9ceb198a260ec46c21cf0c133>. (Subscription may be re-

| Carbon Market Update, June 14, 2006                                 |  |
|---|--|
| CCX-CFI 2006 (\$/tCO <sub>2</sub> )<br><b>\$4.10 (Vintage 2006)</b> | EU ETS-EUA DEC 2006<br>(\$/tCO <sub>2</sub> ) <b>\$ 18.61</b><br><br><b>(Converted from € to US\$)</b> |

quired.)

## Trading

**Voice of America, "Carbon Trading: How the Chicago Climate Exchange Works."** Voice of America Broadcasting service covered the basic concepts of the Chicago Climate Exchange in their Special English Agriculture Report. To read the report or download the audio files to listen to the May 30, 2006 broadcast, see: <http://www.voanews.com/specialenglish/2006-05-30-voa2.cfm>.

**Greenwire, "Farmers Find New Cash Crop in Emissions Trading."** Some US farmers engaged in no-till farming practices have signed up with Chicago Climate Exchange (CCX) to receive compensation for the carbon sequestration value of their soils. CCX allows no-till farming to be listed among the available credits for members that cannot meet their emission targets. According to a 1997 inventory by United States Department of Agriculture's Natural Resource and Conservation Service (NRCS), sixteen percent of 382 million total US farmland acres were in continuous no-till operations. Rataan Lal, a soil scientist at The Ohio State University, said the number of no-till farms has not risen much since that study. He said that the conversion of all US farmland to continuous and permanent no-till, along with other improved farming practices, would offset about 300 million metric tons of carbon per year, or more than 4 percent of the nation's annual emissions. Lal said global carbon storage potential for all soils through no-till and other land practices is between 600 million and 1.2 billion tons of carbon per year would be enough to offset between 5 and 15 percent, respectively, of global greenhouse emissions. No till will not work in every type of soil or with any crop. Keith Paustian, a professor at Colorado State University, said soils with the highest potential for carbon sequestration stretch from southern Minnesota across the Midwestern Corn Belt -- Iowa, Illinois, Indiana, southern Michigan and western Ohio. June 22, 2006, <http://www.eenews.net/Greenwire/2006/06/22/#1>. (Subscription may be required.)

**International Herald Tribune (from The New York Times), " 'Carbon Leaders' and 'Carbon Dogs' Join Gauges for Climate Investment."** Investment research firms such as Sanford C. Bernstein and Innovest Strategic Value Advisers are setting up carbon-tilted rating scales for companies on that are traded on the stock exchange. Innovest, in partnership with UBS, has created a "carbon beta" basket—a fund that will consist of 50 stocks in five industries. The fund managers will monitor global warming regulations, and buy and sell stocks based on how the companies would be affected by the regulations. Each grouping of industry stocks would include an equal number of 'carbon leaders' and 'carbon

dogs,' " as an Innovest analyst Doug Morrow calls the ratings. Innovest and Sanford Bernstein are anticipating that the US Government will eventually set up a system for trading carbon credits. Once companies under the carbon credit system would start buying and selling carbon credits, the buyers would be "carbon dogs" and the sellers "carbon leaders." May 24, 2006, <http://www.iht.com/articles/2006/05/24/business/green.php>.

## Recent Publications

**"Annual European Community Greenhouse Gas Inventory 1990-2004 and Inventory Report 2006."** This report is the annual submission of the greenhouse gas inventory of the European Community to the United Nations Framework Convention on Climate Change. It presents greenhouse gas emissions between 1990 and 2004 by individual Member State and by economic sector. The report shows that, between 2003 and 2004, emissions in the 15 pre-2004 Member States increased by 11.5 million tons, or 0.3% and total EU emissions increased by 0.4%. (Technical Report number 6/2006.) To view the abstract, or link to the tab with the content of the report and all annexes, see: [http://reports.eea.europa.eu/technical\\_report\\_2006\\_6/en](http://reports.eea.europa.eu/technical_report_2006_6/en).

**"International Energy Outlook 2006."** The International Energy Outlook 2006 (IEO2006) presents an assessment by the US's Energy Information Administration (EIA) of the outlook for international energy markets through 2030. US projections appearing in IEO2006 are consistent with those published in EIA's Annual Energy Outlook 2006 (AEO2006), which was prepared using the National Energy Modeling System (NEMS). The report also provides projections of energy-related carbon dioxide emissions by country, region, and fuel type. World carbon dioxide emissions continue to increase steadily in the IEO2006 reference case, from 25.0 billion metric tons in 2003 to 33.7 billion metric tons in 2015, and 43.7 billion metric tons in 2030. June 20, 2006. To view the webpage where the report or chapters of the report, including chapter 7: "Energy-Related Carbon Dioxide Emissions," can be downloaded, see: <http://www.eia.doe.gov/oiaf/ieo/index.html>.

**"Advice on a Long-term Strategy on Energy and Climate Change."** Canada's National Round Table on the Environment and the Economy has released a report of key findings derived from an examination of a 2050 scenario developed by energy consultants ICF International. The June 2006 document addresses opportunities and challenges facing Canada in relation to its long-term energy and climate change future. Specifically, it deals with how to, by 2050: 1.) meet the energy needs of a growing economy, 2.) achieve substantial reductions in carbon emissions, and 3.) improve the quality of Canada's air. Carbon capture and sequestration in the oil and gas sector is one of the strategic priorities named in the report. To read the report in html format, see: [http://www.nrtee-trnee.ca/eng/programs/Current\\_Programs/Energy-Climate-Change/EEC-Wedge-Advisory-Note/ECC-Wedge-advisory-note\\_Section-1\\_e.htm](http://www.nrtee-trnee.ca/eng/programs/Current_Programs/Energy-Climate-Change/EEC-Wedge-Advisory-Note/ECC-Wedge-advisory-note_Section-1_e.htm). To download the pdf format of the report, click: [http://www.nrtee-trnee.ca/eng/programs/Current\\_Programs/Energy-Climate-Change/EEC-Wedge-Advisory-Note/final\\_advisory%20note%20energy%20and%20climate%20change%20strategy-15-June-2006\\_e.pdf](http://www.nrtee-trnee.ca/eng/programs/Current_Programs/Energy-Climate-Change/EEC-Wedge-Advisory-Note/final_advisory%20note%20energy%20and%20climate%20change%20strategy-15-June-2006_e.pdf).

**“The Carbon Boom: National and State Trends in Carbon Dioxide Emissions Since 1960.”** Twenty-eight states more than doubled their carbon dioxide (CO<sub>2</sub>) emissions between 1960 and 2001, according to a new analysis of government data released by the watchdog group US Public Interest Research Group (US PIRG). They state that increased combustion of oil to fuel cars and light trucks, and coal for electricity drove the steep rise in emissions. Using data compiled by the US Department of Energy’s Oak Ridge National Laboratory, their report examines trends in carbon dioxide emissions and fossil fuel combustion nationally, regionally, and by state between 1960 and 2001, the most recent year for which state-by-state data are available. To download the pdf file of the June 2006 report, or view the news release or report summary, see: <http://uspirg.org/uspirgnewsroom.asp?id2=24976>.



**“Clean Energy, a Strong Economy and a Healthy Environment.”** In this report, the Western Governors’ Association’s Clean and Diversified Energy Advisory Committee reported its recommendations to the Governors (June 21, 2006). The Governors adopted a policy resolution that incorporated many of the recommendations aimed at bringing on-line 30,000 Megawatts of clean energy by 2015, increasing energy efficiency 20 percent by 2020 and providing adequate transmission for the region. (See this newsletter’s Legislative Activity section for the related article: **Western Governor’s Association Press Release, “Western Governors Adopt Policies on Clean, Diversified Energy, Global Climate Change and Transportation Fuels.”**) To download the report, go to: <http://www.westgov.org/wga/initiatives/cdeac/CDEAC06.pdf>.

**“Surface Temperature Reconstructions for the Last 2,000 Years (2006).”** In response to a request from Congress, this National Academy of Science (NAS) report assesses the state of scientific efforts to reconstruct surface temperature records for the Earth over approximately the last 2,000 years and the implications of these efforts for our understanding of global climate change. Because widespread, reliable temperature records are only available for the last 150 years or so, scientists estimate temperatures in the more distant past by analyzing “proxy evidence,” which includes tree rings, corals, ocean and lake sediments, cave deposits, ice cores, boreholes, and glaciers. Starting in the late 1990s, scientists began using sophisticated methods to combine proxy evidence from many different locations in an effort to estimate surface temperature changes during the last few hundred to few thousand years. This report concludes that large-scale surface temperature reconstructions are important tools in our understanding of global climate change that allows the NAS to state, with a high level of confidence, that global mean surface temperature was higher during the last few decades of the 20th century than during any comparable period during the preceding four centuries. The report says less confidence can be placed in large-scale surface temperature reconstructions for the period from A.D. 900 to 1600, although available proxy evidence indicates that temperatures at many, but not all, individual locations were higher during the past 25 years than during any period of

comparable length since A.D. 900. It also concludes that very little confidence can be assigned to statements concerning the hemispheric mean or global mean surface temperature prior to about A.D. 900, primarily because of the scarcity of precisely dated proxy evidence. To view this report or sections of it online, go to: <http://www.nap.edu/catalog/11676.html>. To download a shorter briefing, go to: [http://dels.nas.edu/dels/rpt\\_briefs/Surface\\_Temps\\_final.pdf](http://dels.nas.edu/dels/rpt_briefs/Surface_Temps_final.pdf). (Also see this newsletter’s **Science** section for a related item: **Greenwire, “National Academy of Science Finds ‘Hockey Stick’ Graph’s Conclusion ‘Plausible’**” and **The National Academies Press Release, “‘High Confidence’ That Planet Is Warmest in 400 Years; Less Confidence in Temperature Reconstructions Prior to 1600.”**)

## Legislative Activity

**Greenwire, “Representative Waxman Unveils Emission-Reduction Bill.”** On June 20, Representative Henry Waxman (Democrat-CA), and other house members introduced the “Safe Climate Act,” a bill aimed to reduce emissions of greenhouse gases at more stringent levels than any previous Capitol Hill proposal. The bill would require the US Environmental Protection Agency (EPA) in 2010 to freeze total US greenhouse gas emissions at the 2009 level. In 2011, emissions would be cut by approximately 2 percent per year (to reflect 1990 emissions levels by 2020). Then in 2021, emissions levels would be cut by 5 percent per year, to a level reflecting 1990 emissions levels by 2050. The EPA would also be tasked to set up a cap and trade system with allowances auctioned/allocated by the President of the US. The EPA would also set motor vehicle emissions standards as least as stringent as California’s standards and tighten the standards in 2014. The National Academy of Sciences and the National Research Council would review the process every five years and recommend adjustments needed nationally and internationally. To view an overall and section by section summary of the bill, and/or download a pdf of the bill, see: <http://www.waxman.house.gov/waxman/safeclimate/index.htm>. June 20, 2006, <http://www.eenews.net/Greenwire/2006/06/20/#11>. (Subscription may be required.)

**Western Governor’s Association Press Release, “Western Governors Adopt Policies on Clean, Diversified Energy, Global Climate Change and Transportation Fuels.”** On June 11, the first day of the Western Governors’ Association (WGA) Annual Meeting, the governors (representing 19 states and 3 US Flag Pacific Islands) backed a broad set of proposals for meeting future electricity needs. The policy resolution they adopted was based on the recommendations developed over the past 18 months by more than 250 stakeholders, outlined in the WGA report entitled, “Clean Energy, a Strong Economy and a Healthy Environment.” (See **Recent Publications** section of this Newsletter for the link to the report: **“Clean Energy, a Strong Economy and a Healthy Environment.”** To read the policy resolution see: <http://>



[www.westgov.org/wga/policy/06/clean-energy.pdf](http://www.westgov.org/wga/policy/06/clean-energy.pdf).) The goals outlined in the report are to develop an additional 30,000 megawatts of clean energy by 2015; increase energy efficiency 20 percent by 2020; and ensure secure, reliable transmission for the next 25 years. Governor Mike Rounds of South Dakota said that the governors will consider measures most appropriate for their states by encouraging regulators, policymakers, utilities, transmission operators and other stakeholders to eliminate barriers to greater utilization of clean energy resources. Several federal level policies and legislation were identified by the governors as being needed to work toward their efforts including extending the federal tax credit for Integrated Gas Combined Cycle facilities for five years and providing a tax credit program for carbon capture and sequestration for at least five years. June 11, 2006, <http://www.westgov.org/wga/press/plenary1-pr.htm>.

## Events

July 10-11, 2006, **EU Emissions Trading 2006**, *Sheraton Brussels Hotel & Towers, Brussels, Belgium*. The conference will provide an in-depth review of the EU Emissions Trading Scheme since its launch in 2005. The event was timed to coincide with the submissions of Phase II national allocation plans. Leading specialists from industry and government will assess the impact of the Phase I emission limits and present their ideas about Phase II. Those who are encouraged to attend the conference include: energy providers, financial institutions, government and regulatory bodies, environmental consultants, utilities, major emitters, and law firms. To download a brochure on the event, see: <http://www.environmental-finance.com/conferences/2006/EUETS06/EUETweb13.06.06.pdf>. For online information, see: <http://www.environmental-finance.com/conferences/2006/EUETS06/intro.htm>.

July 20, 2006, **Workshop to Support the Regional Greenhouse Gas Initiative on the Topic: Implementing the Minimum 25 Percent Public Benefit Allocation**, *Offices of the Public Service Commission, New York, NY*. Resources for the Future will host a one-day workshop exploring the use of auctions in the implementation of the Regional Greenhouse Gas Initiative (RGGI) consumer benefit and strategic energy purpose set-aside. This workshop is likely to be of great interest to RGGI state officials, staff and stakeholders. For more information and to register before the deadline of July 12, contact Laura Rogers via e-mail or call her at (202) 328-5177.

July 24-25, 2006. **Environmental Trading Congress: Strategies for Succeeding in the Environmental Financial Markets**, *The New York Hemlsey, New York, NY*. This conference will examine key issues impacting environmental trading, including carbon trading; case studies; trading models; global environmental finance models; state and federal policy updates; and pending legislation. For more information, contact Sarah Dunham at 704-889-1325 or [sdunnam@frallc.com](mailto:sdunnam@frallc.com), or download the conference brochure at <http://www.frallc.com/conference.aspx?ccode=b371>.

## Events cont...

July 27, 2006, **Converting Carbon Dioxide Into Chemicals, Royal Society of Chemistry—Environment, Sustainability and Energy Forum**, *Royal Society of London, London, UK*. This interactive workshop will look at conversion of carbon dioxide captured from power plants as feedstock for chemicals. It will explore where the United Kingdom is in terms of academic expertise in this field and finally, to indicate research priorities for the UK. One should attend this workshop if actively engaged in academic or industrial research directly or closely related to this area. Limited spaces are available. Email Jeff Hardy at: [hardyj@rsc.org](mailto:hardyj@rsc.org) or see: <http://www.rsc.org/ConferencesAndEvents/cfconf/alldetails.cfm?ID=17574>.

August 22- 23, 2006, **G8 Workshop: Short Term Opportunities for CO<sub>2</sub> Capture and Storage in the Fossil Fuel Sector**, *San Francisco, CA*. The workshop's goal is to foster introduction of carbon dioxide (CO<sub>2</sub>) capture and storage (CCS) technologies to the market. Its objectives include investigations and promotion of early opportunities for CCS, such as separation of CO<sub>2</sub> from natural gas and CO<sub>2</sub> enhanced oil recovery. The workshop will gather professionals working in these areas and serve as a platform for information exchange and as a preparatory event for a bigger dissemination and popularization workshop to be organized in 2007. Organizers of the conference are IEA, Chevron, USEA, IEA Greenhouse Gas R&D Programme, IEA EOR IA. Contact Jacek Podkanski, [jacek.podkanski@iea.org](mailto:jacek.podkanski@iea.org), for more information.

August 16-18, 2006, **CoalGen 2006**, *Duke Energy Center, Cincinnati, OH*. In their sixth year, the COAL-GEN 2006 conference will cover the latest topics affecting the design, development, upgrading, operation and maintenance of coal-fueled power plants. Included in the event is a session on polygeneration & carbon dioxide capture with presentations on polygeneration from IGCC facilities and CO<sub>2</sub> capture from gasified coal plants. <http://cq06.events.pennnet.com/fl/content.cfm?NavId=3535&Language=Engl>.

September 5-7, 2006, **Sixth European Conference on Coal Research and its Applications**, *University of Kent, Kent, UK*. The purpose of this conference is to bring together researchers at universities with participants from industry who also conduct research or who are interested in the application of this research in industry. Papers are invited on many topics that describe applications in coal technology, including carbon dioxide removal and storage technology. Email Dr. A. W. Thompson for information: [alan.thompson@nottingham.ac.uk](mailto:alan.thompson@nottingham.ac.uk) or see: <http://www.coalresearchforum.org/>.

September 18-19, 2006, **2006 Global CO<sub>2</sub> Cap-and-Trade Forum**, *Westin Embassy Row, Washington, DC*. The Forum will include keynotes, case studies, panels, and presentations by experts from the public and private sector who will discuss: the global carbon trading commodities market overview; carbon reduction mandates; voluntary carbon reduction initiatives; carbon offsets; financing carbon reducing projects; and more. For further information about participating in or attending the event, please contact Jim Turner at 646-546-5230 or [jturner@srinstitute.com](mailto:jturner@srinstitute.com). Also see: [http://www.srinstitute.com/conf\\_page.cfm?instance\\_id=25&web\\_id=863&pid=470](http://www.srinstitute.com/conf_page.cfm?instance_id=25&web_id=863&pid=470).

September 24-27, 2006, **Energy in a World of Changing Costs and Technologies**, *Ypsilanti Marriott at Eagle Crest, Ann Arbor, MI*. The conference will take science and technology policies as a point of departure for an in depth look at energy challenges in a world of changing costs and technologies. Among the many topics to be covered are: science & technology policy, basic research and commercialization strategies for vehicle technologies, electricity generation, and carbon sequestration. For information see: <http://www.usaee.org/usaee2006/>. Download the conference brochure at: [http://www.usaee.org/usaee2006/documents/USAEE\\_2006\\_PrintProg1\\_WEB.pdf](http://www.usaee.org/usaee2006/documents/USAEE_2006_PrintProg1_WEB.pdf).

September 25-28, 2006, **The 23rd International Pittsburgh Coal Conference**, *David L. Lawrence Convention Center, Pittsburgh, PA*. The Twenty-Third Annual International Pittsburgh Coal Conference will focus on environmental emissions issues and technologies surrounding the continued use of coal and the development of future coal-based energy plants to achieve near-zero emissions of pollutants, reduced costs, and high thermal efficiency while producing a suite of products to meet future energy market requirements. A proposed topic area of "Global Climate Change: Science, Sequestration, and Utilization" includes possible subtopics of: Kyoto protocol and policy issues; carbon dioxide capture technologies; sequestration in geological sinks; enhancing natural sinks; modeling and assessments; non-carbon dioxide greenhouse gas capture and storage; multi-pollutant capture and storage; and CO<sub>2</sub> utilization. Pay before July 16, 2006 for a discount. For more information, see: <http://www.engr.pitt.edu/pcc/2006%20Conference.htm>.

## Events cont...

September 26-27, 2006, **Sixth Annual Workshop of Greenhouse Gas Emission Trading**, *IEA Headquarters, Paris, France*. This workshop, organized jointly between the IEA, IETA, and EPRI, will provide an opportunity for government, industry, brokers, finance, and non-governmental organization delegates to discuss some of the key issues relating to emissions trading for climate policy. The workshop will combine presentations of recent research with discussion sessions on the following topics: 1. country roundtable: highlights of regulatory developments; 2. market news; 3. exploring the implications of design options (price caps, intensity targets, etc.) on the carbon dioxide market; 4. linking: technical issues; and 5. green investment schemes and Joint Implementation. *Please note: participation is by invitation only.* Email [etworkshop@iea.org](mailto:etworkshop@iea.org) for more information. [http://www.iea.org/Textbase/work/workshopdetail.asp?WS\\_ID=231](http://www.iea.org/Textbase/work/workshopdetail.asp?WS_ID=231).

September 28-30, 2006, **CO<sub>2</sub> EXPO 2006 - 2nd International Exhibition on the Carbon Market**, *New Fair of Rome, Rome, Italy*. This conference and exhibition will focus on carbon markets and trading as they relate to the Emissions Trading Scheme, with a focus on Italian interests. Artenergy, publisher of the Italian climate change magazine *Clima*, is promoting the event. For more information and email updates on the event see: <http://www.co2expo.com/en/>.

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