

# THE CARBON SEQUESTRATION NEWSLETTER

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February 2006

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## Sequestration in the News

**CNN.com, "US to Attend Asia-Pacific Climate Talks,"** Energy Secretary Samuel Bodman, Secretary of State Condoleezza Rice (who cancelled due to the health condition of Ariel Sharon), and Presidential advisor James Connaughton are to meet in Sydney Australia on January 11-12 with representatives from five Asia and Pacific Nations: Australia, China, India, Japan and South Korea. Along with the US, these countries account for almost half of the world's population, energy use, and economic output. The White House feels that these talks serve to enhance, rather than replace the Kyoto talks. The US and Australia were the only developed countries that rejected the 1997 Kyoto Protocol treaty.

### *Asia-Pacific Partnership talks held in Australia*



Connaughton said the "Asia-Pacific partnership" would drum up more private investment for common goals, including US and Chinese plans to improve energy efficiency in coal-burning power plants

and cut acid rain-causing sulfur dioxide emissions. "This is harder than negotiating a diplomatic document, because this is creating real work plans," said Connaughton. January 5, 2006, [http://www.cnn.com/2006/TECH/science/01/05/us.asia.climate.change.ap/index.html?section=cnn\\_latest](http://www.cnn.com/2006/TECH/science/01/05/us.asia.climate.change.ap/index.html?section=cnn_latest)

**Environmental News Service, "Bush to Request \$52 Million for Asia-Pacific Energy Partnership,"** President Bush will request that Congress budget \$52 million in the upcoming FY 2007 budget to promote clean energy technologies in the Asia-Pacific region and international cooperation in other energy areas, said US Energy Secretary Samuel Bodman addressing the inaugural gathering for the Asia-Pacific Partnership for Clean Development and Climate (APP) on January 12. Secretary Bodman said that the funding request is designed to complement the \$3 billion that the US currently spends per year on clean energy projects. As head of the US delegation to the meeting, Bodman stated, "In order to achieve meaningful results, we must engage growing and emerging economies from the outset and encourage the implementation of technologies that have demonstrated success." Australian Industry Minister Ian Macfarlane stated that Australia has a responsibility to explore fully the potential of new and innovative emission reducing technology, such as geosequestration and clean coal technologies. He announced on January 9 that Australia's first CO<sub>2</sub> capture and

## HIGHLIGHTS

**US State Department Press Release, "Climate Change Partnership Looks to Private Sector for Help,"** The Asia-Pacific Partnership for Clean Development and Climate meeting was held in Sydney, Australia, January 11-12. The Asia-Pacific Partnership on Clean Development and Climate meeting concluded with the establishment of eight public-private task forces serving to accelerate clean technology deployment and share best practices in key business sectors. The task forces are described in detail in the work plan and include: (1) cleaner fossil energy; (2) renewable energy and distributed generation; (3) power generation and transmission; (4) steel; (5) aluminum; (6) cement; (7) coal mining; and (8) buildings and appliances. Partner countries have agreed to work together with private companies to expand markets for investment and trade in cleaner, more efficient energy technologies, goods, and services. On the last day of the meeting, the ministers adopted three documents: a charter that provides a framework and a structure, a communiqué that highlights key outcomes, and a work plan that maps out an intensive agenda of near-term work for the task forces. Australian Foreign Minister Alexander Downer said that over the next year "we want to find out from the working groups what specific progress they're making in those areas, not just to facilitate access to technology but to see that technology is evolving in ways that are going to contribute to alleviating the problems of climate change." Downer said that Australia will contribute \$100 million over five years to the partnership. (See: <http://www.dfat.gov.au/environment/climate/ap6/> for links to the charter, communiqué, and work plan.) January 13, 2006, <http://usinfo.state.gov/gi/Archive/2006/Jan/13-487324.html>

storage demonstration project will start this year. About half of Australia's CO<sub>2</sub> emissions could potentially be sequestered because they are derived from stationary sources, Macfarlane stated. Secretary Bodman said that the success of the APP will be measured largely by the success of the investment and collaboration of private sector partners. (Read the full text of Secretary Bodman's remarks at: <http://www.energy.gov/news/2964.htm>.) January 13, 2006, <http://www.ens-newswire.com/ens/jan2006/2006-01-13-01.asp>

**Wall Street Journal, "Coal Gasification Begins to Emerge,"** Integrated gasification combined cycle (IGCC) technology and implementation is discussed. In the US, there are two IGCC plants: one in Indiana and one in Florida, subsidized by the US Department of Energy. IGCC plants gasify coal and generate electricity with advanced turbines that use the gas and excess heat. American Electric Power's (AEP's) program manager for technology development, Mike Mudd, said that lowered capital costs and heavier penalties on emissions have brought the cost to within 20 percent of supercritical pulverized coal plants, "Primarily because IGCC is a new technology and it's got to go through a cost maturation." Since tax credits in the new energy bill bring the IGCC plant's life cycle cost of electricity within 10 percent of the next cheapest alternative, but with key environmental advantages, Mr. Mudd feels that utility commissions will accept slightly higher initial costs. The most compelling advantage of an IGCC plant is the ability to control CO<sub>2</sub> emissions. According to Ed Lowe, manager of GE's Gasification business, the additional cost of electricity for stripping CO<sub>2</sub> from a pulverized coal plant is 66 percent versus 25 percent for an IGCC plant. January 4, 2006, <http://proquest.umi.com/pqdweb?did=955609771&Fmt=3&clientId=17454&RQT=309&VName=PQD>

(To access Wall Street Journal online, a subscription may be required.)

**Bloomberg, "Australia's First Carbon Dioxide Storage Project Set to Start,"** Western Australia's Otway Basin will be the site of Australia's first carbon sequestration research project. This \$30 million (\$22.4 million USD) geosequestration project will be partly financed by companies including Chevron Corporation, Xstrata Plc and Rio Tinto. BHP Billiton, the world's biggest miner, BP Plc and Royal Dutch Shell Plc are also backing the research project. The Cooperative Research Centre for Greenhouse Gas Technologies hopes to start the operation by the end of this year. For this project, carbon dioxide will be extracted from a gas mixture, transported several kilometers by pipeline and injected about 1.2 miles underground into a depleted gas field. The project will involve the injection of about 100,000 metric tons a year of carbon dioxide, said Peter Cook, chief executive of the research project. The project announcement is timely since geosequestration is one of the technologies to be discussed January 11-12 in Sydney at the Asia-Pacific Partnership on Clean Development and Climate meeting. January 9, 2006, <http://www.bloomberg.com/apps/news?pid=10000081&sid=aRY5dPHOLyww>



**Nickle's Daily Oil Bulletin, "Support Growing for CO<sub>2</sub> Distribution Network,"** Several pilot projects are underway in the Canadian province of Alberta using carbon dioxide for large-scale enhanced oil recovery (EOR), with a broad cross section of industries participating. In the September 2000 Journal of Canadian Petroleum Technology, Kelly Edwards (now an engineer for EnCana Corporation's Weyburn business unit) proposed a network that includes industrial CO<sub>2</sub> sources, distribution pipelines, and reservoirs for CO<sub>2</sub> injection. The Petroleum Technology Alliance Canada (PTAC) has set up a CO<sub>2</sub> enhanced hydrocarbon recovery steering committee to share research and technology options, and identify opportunities, priorities, and obstacles. The Integrated CO<sub>2</sub> Network (ICON) is a group of major emitters that has

been doing studies on the scope, cost and potential timing of a CO<sub>2</sub> network. In order to help comply with the first phase of the Kyoto Protocol starting in 2008, and with timetables of two to three years on design and construction of pipeline and capture facilities, action is needed. Enbridge, which operates the world's largest crude oil pipeline, estimates the need for a 400 kilometer pipeline capable of carrying up to 4,000 metric tons (76 million cubic feet (mmcf)) per day of CO<sub>2</sub> at a cost of \$160

million—not including the cost of compression—and another \$40 million to boost capacity to 22,000 metric tons (418 mmcf) per day with pumping stations. The most cost-effective way to move CO<sub>2</sub> over long distances is in a dense liquid-like phase, allowing for a smaller diameter pipe to be used. Though to justify costs, the pipeline would have to be sized for larger volumes that initially intended. Government support is needed for implementation due to high initial costs and extended time need for cost recovery. January 6, 2006, <http://www.dailyoilbulletin.com/> (Subscription required.)

**Nickle's Daily Oil Bulletin, "CO<sub>2</sub> Pilot Projects in Alberta, Others Planned,"** In addition to a proposed CO<sub>2</sub> pipeline network in Alberta (see this newsletter "Support Growing for CO<sub>2</sub> Distribution Network"), high oil prices and incentives from the Alberta and Canadian governments have encouraged pilot projects in CO<sub>2</sub> injection for enhanced oil recovery (EOR). Several companies have current projects in EOR which were described in detail in the article. Listed here are the companies, their current project site(s), location of the site(s), and short description of the project(s): 1. Anadarko Canada Corporation's Enchanted Arcs project in southern Alberta. A CO<sub>2</sub> injector and three CO<sub>2</sub> producers in the Enchant Arcs A&B pool. The second pilot in Enchant Arcs F&G pool is planned. In the US, Anadarko Petroleum Company has a 16-inch, 125 mile pipeline across central Wyoming delivering to its Salt Creek EOR project. 2. Apache Canada Ltd.'s Zama field in northwestern Alberta. Acid gas is injected into pinnacle reefs where one-third of the gas is

hydrogen sulfide, rather than pure CO<sub>2</sub>. 3. Apache Canada Ltd.'s Midale project in southern Saskatchewan. A pipeline was built to tap into the pipeline that delivers CO<sub>2</sub> to Weyburn from North Dakota. The current supplier is Dakota Gasification Company, which will increase CO<sub>2</sub> delivery when it installs additional compression. 4. Devon Canada Corporation's Swan Hills pilot injection, northwest of Edmonton. The existing wellbores are used, with CO<sub>2</sub> trucked from Fort Saskatchewan and Medicine Hat Air by Liquide Canada, Inc. 5. Penn West Energy Trust's Joffre Viking plant, northeast of Red Deer. This is the longest running CO<sub>2</sub> EOR in Canada. CO<sub>2</sub> from a petrochemical plant that is 96 to 98 percent pure is combined with produced CO<sub>2</sub> and hydrocarbon gases for 82 to 84 percent concentration injected, which is then cut with water. 6. Penn West Energy Trust pilot at Canada's biggest onshore oil pool Pembina Cardium. The company is currently trucking in the CO<sub>2</sub>, and is interested in a pipeline. 6. Glencoe Resources Ltd. in central Alberta. CO<sub>2</sub> is piped in from nearby petrochemical plants. 7. EnCana Corporation's Weyburn site in southeastern Saskatchewan. The company injects purchased CO<sub>2</sub> into the Weyburn oilfield and some of the recycled CO<sub>2</sub> is then reinjected. Dakota Gas is the supplier. Weyburn is to increase injection of CO<sub>2</sub> when the Beulah North Dakota plant adds a third compressor, which will result in more CO<sub>2</sub> as bi-product from the coal gasification plant. Projects are also planned for: Judy Creek by Pengrowth; Pembia/Redwater by ARC Energy Trust; and Mitsue by Canetic Energy Trust. January 6, 2006, <http://www.dailyoilbulletin.com/> (Subscription required.)

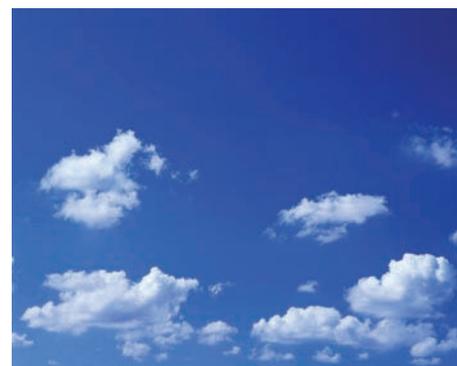
**AP, "Underground Basalt Promising As a Repository For Excess CO<sub>2</sub>,"** A Basalt formation in the Pacific Northwest that was created millions of years ago by lava flow and flooding, now covers an area of more than 60,000 square miles, thousands of feet thick. This porous rock can be used for storage of CO<sub>2</sub> emissions from power plants. Peter McGrail, a researcher at Battelle Pacific Northwest Division, a US Department of Energy-supported science laboratory and partner in the Big Sky Carbon Sequestration Partnership, is participating with other researchers in an investigation of sites for a pilot test slated to begin in 2007. The Big Sky Carbon Sequestration Partnership is a regional study into carbon capture and sequestration technologies. For the pilot test, carbon dioxide would be injected into basalt at about 3,000 feet, where the water is not suitable for drinking or irrigation. A traditional power plant can use up to one third of its power capturing CO<sub>2</sub>, which would double the costs to consumers, says Stuart Dalton director for generation for the Electric Power Research Institute. The impact is less significant for IGCC plants, which use coal or petcoke (the waste product from oil refineries), turn it into gas, and use it generate electric power. IGCC plants use about 6 percent of their power to separate the CO<sub>2</sub>, increasing the cost of power by about one third. The Big Sky project is one of seven regional partnerships backed by the US Department of Energy. January 17, 2006, [http://www.sltrib.com/utah/ci\\_3426715](http://www.sltrib.com/utah/ci_3426715)

**The Enquirer (Cincinnati), "State Stays Mum on FutureGen Site,"** At a January 26 press briefing for Ohio's efforts on the FutureGen project, state officials and consultants did not identify specific sites for the project, saying that doing so

could aid land speculators, and undermine Ohio's efforts to obtain the project. Jacqueline Bird, director of Ohio Coal Development Office, said there are 12 possible sites in 8 counties for the project. She also said that the geology of the sites, access to roads and powerlines are key. 400 to 600 acres are needed for the site, as is proximity to unmined coal seams or depleted gas wells. State representative Jimmy Stewart, R-Athens, said that siting the plant near the Ohio River where coal could be transported into Ohio would also be helpful. Larry Wickstrom, geologist/supervisor with the Ohio Department of Natural Resources said the federal government would also be looking for sites located on sandstone. Wickstrom also said that recovery of oil and gas at the site helps to recuperate costs, and that the plant needs to be sited 10 miles from the CO<sub>2</sub> storage site. January 27, 2006, <http://news.enquirer.com/apps/pbcs.dll/article?AID=/20060127/NEWS01/601270420/1077/NEWS01>

**Business Wire, "The US Department of Energy Provides \$310,000 Grant to ThermoEnergy to Begin Development of Zero-Air-Emission Industrial Power Plants,"**

ThermoEnergy Corporation announced the start of a \$310,000 federally funded project to develop compact zero air emission power plants for medium to heavy industry. Combined Heat & Power (CHP) plants allow industries to switch from natural gas to lower priced alternative fuels, resulting in cost savings. The CHP plans are based on the company's patented power plant design called ThermoEnergy Integrated Power System, or TIPS. TIPS systems eliminate emissions of NO<sub>x</sub>, SO<sub>x</sub>, mercury, and particulates, and captures and recovers CO<sub>2</sub> in pressurized liquid form



for sequestration or beneficial reuse. The Canadian energy laboratory CANMET, and Reaction Systems Engineering of Kent, UK will also participate in the project. This project is the second of three grants with a third grant, totaling \$1.5 million, to focus on the development of TIPS as a cost-effective upgrade for existing coal-fired power plants designed to convert them to zero air emission facilities. January 17, 2006, [http://home.businesswire.com/portal/site/google/index.jsp?ndmViewId=news\\_view&newsId=20060117005116&newsLang=en](http://home.businesswire.com/portal/site/google/index.jsp?ndmViewId=news_view&newsId=20060117005116&newsLang=en)

Science

**Greenwire, "Experts Urge Caution in Application of New Methane Studies,"**

An article published in the January 12 journal *Nature* by German researchers suggests that plants in open-air conditions contribute between 10 to 30 percent of the annual global flow of methane. Scientists had long believed that plants only produced methane in the absence of oxygen. Experts caution that the policy-

makers should wait until scientists know more about how plants produce methane before implementing policy shifts. Additionally in the same issue of *Nature*, an editorial was written by David Lowe of New Zealand's National Institute of Water and Atmospheric Research. Lowe stated, "We now have the specter that new forests might increase greenhouse warming through methane emissions rather than decrease it by sequestering CO<sub>2</sub>," referring to reforestation incentives agreed to by parties to the Kyoto Protocol. "This paper will undoubtedly unleash controversy, not the least of which will be political." Jay Gulledge, a senior research fellow with the Pew Center of Global Climate Change stated, "Relative to the amount of plant biomass, this is a very small amount of methane compared to the carbon dioxide plants take up to make that biomass," disagreeing with Lowe's contention that the new knowledge of plants' greenhouse gas contributions exposes a major drawback to planting trees as carbon sinks. Other research by a different group of German scientists showed high concentrations of methane over tropical rainforests. Also the USDA Forest Service found high levels of methane at upland forest sites in the Brazilian Amazon. (See Terrestrial section of this newsletter for the *Nature* paper's abstract "**Methane Emissions from Terrestrial Plants under Aerobic Conditions.**"), January 12, 2006, [http://www.eenews.net/Greenwire/searcharchive/test\\_search-display.cgi?q=methane&file=%2FGreenwire%2Fsearcharchive%2FNewline%2F2006%2FJanuary12%2F01120610.htm](http://www.eenews.net/Greenwire/searcharchive/test_search-display.cgi?q=methane&file=%2FGreenwire%2Fsearcharchive%2FNewline%2F2006%2FJanuary12%2F01120610.htm) (Subscription may be required.)

#### **SciDev.Net, "Global Warming: Plants Are Not To Blame,"**

The authors of a recent study in the journal *Nature* released a statement that plants are not to blame for climate change. The researchers from the Max Planck Institute for Nuclear Physics in Heidelberg, Germany, Utrecht University in the Netherlands, and the Department of Agriculture and Rural Development for Northern Ireland, United Kingdom, reported that plants emit up to a third of the methane (a greenhouse gas) that is in the atmosphere. (See Terrestrial section of this newsletter for the *Nature* paper's abstract "**Methane Emissions from Terrestrial Plants under Aerobic Conditions.**") A wave of media attention followed as did emails from concerned scientists and citizens regarding the role of plants and implications for global warming. Frank Keppler at the Max Planck Institute for Nuclear Physics wants to make 3 points clear to the public. First, the findings do not mean that reforestation programs should be condemned. Trees absorb carbon dioxide, so planting them is still beneficial. Second, changes in the overall amount of methane emitted by plants are likely to be caused by human activities such as deforestation. Finally, much more research is needed to discover how methane emissions from plants vary according to species, tempera-



ture, humidity, sunlight and other factors, as well as how these emissions may change as the environment changes. (See: <http://www.wbcasd.org/plugins/DocSearch/details.asp?type=DocDet&ObjectId=MTc5NDY> for the full statement released by the authors in response to the public's questions "Global Warming - The Blame Is Not With the Plants," and for an explanation of their calculations.) January 20, 2006. <http://www.wbcasd.org/plugins/DocSearch/details.asp?type=DocDet&ObjectId=MTc5NDY>

#### **BBC News website, "Experiment Probes Climate Riddle,"**

In one of the biggest climate experiments ever mounted, scientists will use radar, airplanes, weather balloons and a ship to study the life cycle of tropical clouds in order to gain a better understanding of how clouds form and carry heat high into the atmosphere. Approximately 200 scientists from 30 institutions in 10 countries will collaborate on the project over 23 days, with data analysis and modeling to extend that timeframe. Investigators and funding for the Tropical Warm Pool International Cloud Experiment (TWP-ICE) come from many countries including Australia, the US, Britain, Japan and Canada. Tropical clouds carry heat and moisture from the Earth's surface high in the atmosphere, which is a key process in moving heat around the globe. By better understanding what goes on inside clouds, how they form and how they behave, computer models can be developed to predict the extent of global climate warming more accurately. Existing computer models do not reflect the processes of convection and cloud formation accurately, said Tom Ackerman of the University of Washington in Seattle, because they typically treat them as separate processes. "But in order to do that you need to understand this total life cycle of air going into the clouds, condensation, vertical lifting and then cloud being dumped out at other levels," he stated. January 18, 2006. <http://news.bbc.co.uk/2/hi/science/nature/4624520.stm>

#### **Reuters, "2005 Was Australia's Hottest Yet,"**

Australia's Bureau of Meteorology said temperatures were on average 1.09 degrees Celsius (1.96 degrees Fahrenheit) higher than normal in 2005, making it the hottest year since the first records from 1910. Meteorologist Mike Coughlan said previous record hot years in 1988, 1998 and 2002 were caused by El Niño events, where warmer waters in the southwest Pacific led to lower rainfall and hotter weather in Australia. But there was no El Niño in 2005. "The strong culprit has to be global warming," Coughlan told Reuters. "The 2005 record is yet another sign that our climate is changing," he said. The Bureau of Meteorology report came ahead of the January 11-12 inaugural gathering of

the Asia-Pacific Partnership on Clean Development and Climate in Sydney. Australia's Environment Minister Ian Campbell said the latest data on Australia's weather proved countries needed to work together on cleaner technology. "It is a huge and serious challenge. These figures add to the weight of evidence that climate change is real and it's a problem that the world needs to work together to seek to solve," Campbell told Australian Broadcasting Corporation radio. January 4, 2006, <http://www.cnn.com/2006/WEATHER/01/04/waether.australia.reut/index.html>

**Reuters, "Gore to Publish Book on Global Warming,"** Former Vice President Al Gore is to release his second book in April entitled "An Inconvenient Truth" published by Rosdale Books. The book is associated with a documentary of the same name that was shown at the Sundance Film festival. According to Rosdale "In the film, Mr. Gore guides audiences through indisputable evidence of the environmental impact of global warming. In the book, the former US Vice President writes about global warming and shares his personal story about how the issue became of urgent importance to him." January 24, 2006, [http://today.reuters.com/news/NewsArticle.aspx?type=scienceNews&storyID=2006-01-24T174509Z\\_01\\_N24233070\\_RTRUKOC\\_0\\_US-ENVIRONMENT-GORE.xml](http://today.reuters.com/news/NewsArticle.aspx?type=scienceNews&storyID=2006-01-24T174509Z_01_N24233070_RTRUKOC_0_US-ENVIRONMENT-GORE.xml)

## Policy

**IPPR Press Release, "Two Thirds of European Union Countries Set to Miss Kyoto Commitments,"** Ten of 15 European Union countries that are part of the Kyoto Protocol will fall short of their targets, according to a report published December 27, 2005 by the United Kingdom's think tank Institute for Public Policy Research (IPPR). The United Kingdom and Sweden are on course to meet their targets. Three countries, France, Greece and Germany, will only meet their targets if new policies are implemented. Ten countries will fail to meet their targets even with planned additional measures, including: Finland, Austria, Belgium, Luxembourg, Netherlands, Italy, Spain, Portugal, Ireland, and Denmark. December 27, 2005, <http://www.ippr.org.uk/pressreleases/?id=1863>

**Oil & Gas Journal, "European Union, France Seek Integrated Energy Policy,"** The European Union (EU) is pursuing an integrated, efficient energy policy. At a meeting of 25 EU finance ministers in Brussels on January 24, Austrian Minister Martin Bartenstein said he would focus on energy during his country's 6-month presidency of the European Union. French Economic and Finance Minister Thierry Breton presented a memorandum which outlined many energy policy recommendations to the EU including encouraging continued development of hydrogen, fuel cell, and carbon dioxide sequestration technology. January 26, 2006, [http://ogj.pennnet.com/articles/article\\_display.cfm?Section=ONART&C=GenIn&ARTICLE\\_ID=246636&p=7](http://ogj.pennnet.com/articles/article_display.cfm?Section=ONART&C=GenIn&ARTICLE_ID=246636&p=7)

## Geology

**"Japanese potential of CO<sub>2</sub> sequestration in coal seams."** As a reduction strategy for global warming by greenhouse gases, underground storage or sequestration of CO<sub>2</sub> into coal

beds or seams has been studied by the Japanese government and some associated organizations. The principle of this study depends on the adsorption of CH<sub>4</sub> or CO<sub>2</sub> on the surface of coal molecules as well as nearly twice the amount of adsorption of CO<sub>2</sub> compared with CH<sub>4</sub>. One of the authors had experimentally clarified the adsorption abilities of the coals in each Japanese coalfield. Based on these adsorption-abilities, the amount of the coal-bed methane resources was calculated, and also the sequestration-potential of carbon dioxide was estimated for each coalfield. In this paper, the CO<sub>2</sub> sequestration-potential obtained from each coalfield is compared with the potentials from the other coalfields in Japan. Among the Japanese coalfields, the Ishikari coalfield in Hokkaido is the biggest and shows 50 percent of Japanese CO<sub>2</sub> sequestration potential. And the other big coalfields are the solitary island area in the northwestern district of Kyushu and the Miike-Ariake Sea area. Their potential percentages are 14 percent and 13 percent, respectively. *Applied Energy*, Available Online January 6, 2006, <http://www.sciencedirect.com/science/article/B6V1T-4J022X8-1/2/c0645af851cfa0ee71edbf47fbb4be> (Subscription may be required.)



## Technology

**"Pressure dependence of the contact angle in a CO<sub>2</sub>-H<sub>2</sub>O-coal system,"** Carbon dioxide injection into coal layers serves the dual purpose of enhancing coal bed methane production (ECBM) and to storing CO<sub>2</sub>. The efficiency of this process is expected to be much higher if water is the non-wetting phase in the coal-water-gas system. Therefore, contact angles in the coal-water-CO<sub>2</sub> system have been measured using the captive bubble technique in the pressure range between atmospheric pressure and 141 bar at a temperature of 45 degrees Celsius. At atmospheric pressure the contact angle of a shrinking CO<sub>2</sub> droplet increases with time, but stays below 90 degrees. At higher pressures (>2.6 bar) the contact angle increases beyond 90 degrees. The pressure dependence of the contact can be represented by the equation:  $\theta = (111 \pm 10.5) + (0.17 \pm 0.14)P$  [bar]. The exceptional behavior at atmospheric pressure is possibly related to the stability of water patches on the coal surface. It is concluded that water is

the non-wetting phase in this coal–water–CO<sub>2</sub> system. *Journal of Colloid and Interface Science*, Available online January 9, 2006, <http://www.sciencedirect.com/science/article/B6WHR-4J0PF96-9/2/5f9feeabb2e97a1b595692261e4f8463> (Subscription may be required.)

## Terrestrial

**“Methane emissions from terrestrial plants under aerobic conditions.”** This paper demonstrates by using stable carbon isotopes that methane is readily formed *in situ* in terrestrial plants under oxic (meaning, in the presence of oxygen) conditions by a process that was previously unrecognized. Significant methane emissions from both intact plants and detached leaves were observed during incubation experiments in the laboratory and in the field. If our measurements are typical for short-lived biomass and scaled on a global basis, we estimate a methane source strength of 62–236 teragrams (Tg) per year for living plants and 1–7 Tg per year for plant litter (1 Tg = 10<sup>12</sup> g). The authors suggest that this newly identified source may have important implications for the global methane budget and may call for a reconsideration of the role of natural methane sources in past climate change. (See Science section of this newsletter for related news articles “**Experts Urge Caution in Application of New Methane Studies**” and “**Global Warming: Plants Are Not To Blame,**”), *Nature* 439, Pages 187-191, January 12, 2006, doi:10.1038/nature04420. <http://www.nature.com/nature/journal/v439/n7073/abs/nature04420.html> (Subscription may be required.)

**“Biomass equations and carbon content of aboveground leafless biomass of hybrid poplar in Coastal British Columbia,”** Hybrid poplar plantations offer opportunities for enhancing carbon sinks, but accurate assignment of carbon credits requires accurate estimation of the amount of carbon stored in poplar biomass. The authors present individual-tree bole and branch biomass equations derived for *Populus trichocarpa* Torr. and Gray × *P. deltoides* Marsh. hybrids from plantations in coastal British Columbia, Canada. Trees ranged in age from 4 to 13 years and were planted at a density of 1111 stems per hectare (ha<sup>-1</sup>). Equations were applied to similar short-rotation intensive-culture plantations near or at rotation age to derive estimates of aboveground leafless biomass production and amount of carbon sequestered. After 12 years, predicted aboveground leafless biomass accumulation ranged from 9.2 to 13.6 megagrams per hectare per year (Mg ha<sup>-1</sup> year<sup>-1</sup>); predicted bole biomass accumulation ranged from 7.5 to 11.3 Mg ha<sup>-1</sup> year<sup>-1</sup>. Total carbon in aboveground leafless biomass at age 12 ranged from 51.2 to 75.7 Mg ha<sup>-1</sup>. Three of the stands reached 14 years of age prior to harvest. Predicted carbon content of aboveground leafless biomass at 14 years of age ranged from 73.7 to 88.7 Mg ha<sup>-1</sup>. *Forest Ecology and Management*, Available online January 4, 2006, doi:10.1016/j.foreco.2005.11.009, <http://www.sciencedirect.com/science/article/B6T6X-4HYMW3C-2/2/d6d9adb89f29e38474675a41a31c51a6> (Subscription may be required.)

## Ocean

**“Determination of gas bubble fractionation rates in the deep ocean by laser Raman spectroscopy,”** A new deep-sea laser Raman spectrometer (DORISS—Deep Ocean Ra-

man In Situ Spectrometer) is used to observe the preferential dissolution of CO<sub>2</sub> into seawater from a 50:50 CO<sub>2</sub>–N<sub>2</sub> gas mixture in a set of experiments that test a proposed method of CO<sub>2</sub> sequestration in the deep ocean. In



a first set of experiments performed at 300 meters (m) depth, an open-bottomed 1000 cubic centimeters (cm<sup>3</sup>) cube was used to contain the gas mixture; and in a second set of experiments a 2.5 cm<sup>3</sup> funnel was used to hold a bubble of the gas mixture in front of the sampling optic. By observing the changing ratios of the CO<sub>2</sub> and N<sub>2</sub> Raman bands we were able to determine the gas flux and the mass transfer coefficient at 300 meters

depth and compare them to theoretical calculations for air–sea gas exchange. Although each experiment had a different configuration, comparable results were obtained. As expected, the ratio of CO<sub>2</sub> to N<sub>2</sub> drops off at an exponential rate as CO<sub>2</sub> is preferentially dissolved in seawater. In fitting the data with theoretical gas flux calculations, the boundary layer thickness was determined to be ~ 42 micrometers (μm) for the gas cube, and ~165 μm for the gas funnel reflecting different boundary layer turbulence. The mass transfer coefficients for CO<sub>2</sub> are  $k_L = 2.82 \times 10^{-5}$  m/s for the gas cube experiment, and  $k_L = 7.98 \times 10^{-6}$  m/s for the gas funnel experiment. *Marine Chemistry*, Available online January 18, 2006, doi:10.1016/j.marchem.2004.10.006. <http://www.sciencedirect.com/science/article/B6VC2-4J2M0N6-3/2/e74e856a11f958bb87cf9a0081543084> (Subscription may be required.)

**“An improved model for the calculation of CO<sub>2</sub> solubility in aqueous solutions containing Na<sup>+</sup>, K<sup>+</sup>, Ca<sup>2+</sup>, Mg<sup>2+</sup>, Cl<sup>-</sup>, and SO<sub>4</sub><sup>2-</sup>.”** An improved model is presented for the calculation of the solubility of carbon dioxide (CO<sub>2</sub>) in aqueous solutions containing Na<sup>+</sup>, K<sup>+</sup>, Ca<sup>2+</sup>, Mg<sup>2+</sup>, Cl<sup>-</sup>, and SO<sub>4</sub><sup>2-</sup> in a wide temperature–pressure–ionic strength range (from 273 to 533 K, from 0 to 2000 bar, and from 0 to 4.5 molality of salts) with experimental accuracy. The improvements over the previously published model include: (1) By developing a non-iterative equation to replace the original equation of state in the calculation of CO<sub>2</sub> fugacity coefficients, the new model is at least twenty times computationally faster and can be easily adapted to numerical reaction-flow simulator for such applications as CO<sub>2</sub> sequestration and (2) By fitting to the new solubility data, the new model improved the accuracy below 288 K from 6 percent to about 3 percent of uncertainty but still retains the high accuracy of the original model above 288

K. The authors comprehensively evaluate all experimental CO<sub>2</sub> solubility data. Compared with these data, this model not only reproduces all the reliable data used for the parameterization but also predicts the data that were not used in the parameterization. In order to facilitate the application to CO<sub>2</sub> sequestration, we also predicted CO<sub>2</sub> solubility in seawater at two-phase coexistence (vapor–liquid or liquid–liquid) and at three-phase coexistence (CO<sub>2</sub> hydrate–liquid water–vapor CO<sub>2</sub> [or liquid CO<sub>2</sub>]). The improved model is programmed and can be downloaded from the website <http://www.geochem-model.org/programs.htm>. *Marine Chemistry*, Volume 98, Issues 2-4, February 1, 2006, Pages 131-139. <http://www.sciencedirect.com/science/article/B6VC2-4H8MP5G-1/2/4fadd1f41afa32ef980e0b2192ea406> (Subscription may be required.)

tively low level of \$14 Australian dollars (\$10.4) per metric ton of carbon emissions, adding 6 percent to electricity prices. Comparatively the European emissions market trades at \$34 Australian dollars (\$25) per metric ton. A carbon tax is more punitive than credits since it is paid by all emitters and cannot be traded. New Zealand must hold its emissions at their 1990 levels, but it is currently running 37 percent above. Also despite the country's extensive use of hydropower and geothermal power, it will be 30 percent above targets for 2012. December 30, 2005, <http://www.theage.com.au/news/business/carbon-tax-too-costly-says-nz/2005/12/29/1135732693442.html>

**USA Today, “Drivers Atone for Exhaust with Carbon Offsets,”** DriveNeutral, a non-profit launched in October by students at the Presidio School of Management in San Francisco sells “carbon offsets” to drivers to offset their vehicle emissions. DriveNeutral compensates for vehicle emissions by participating in the voluntary emissions market Chicago Climate Exchange (CCX) as an associate member, where it can buy blocks of emissions credits and divide them into increments tailored to fit the ecological footprint of an individual automobile. Though individual buyers cannot participate in CCX, there are 130 corporations, non-profits, and governments on the exchange that are legally bound to achieve annual reductions in carbon dioxide emissions, either by reducing them internally or by buying “emissions credits” from companies that have exceeded reductions targets. After purchasing the credits, DriveNeutral takes them off the market, thereby reducing the overall pool of allowable credits. As a result CO<sub>2</sub> emissions go down and market demand for credits increases. A California resident who drives 1,000 miles per month in the Bay Area of California spent \$25 to offset her Infiniti sedan, earning a DriveNeutral decal to display on her car, and compensating for about 5 tons of carbon emissions for the year. Over the past two months, DriveNeutral has sold 125 car certifications, compensating for 600 metric tons of CO<sub>2</sub>. A for-profit competitor of DriveNeutral, called TerraPass and launched by Wharton School of Business students last year, has sold 2,500 certifications, or the equivalent of 19,000 tons in CO<sub>2</sub> reductions. CarbonFund, a non-profit that offsets home, office, and transportation emissions, has sold the equivalents of 37,000 tons in reductions. Since its launch in 2003, CCX has traded 4 million tons of CO<sub>2</sub> with a value of \$8 million. January 4, 2006, [http://www.usatoday.com/tech/news/techinnovations/2006-01-04-carbon-offsets\\_x.htm](http://www.usatoday.com/tech/news/techinnovations/2006-01-04-carbon-offsets_x.htm)

**Silicon Valley/San Jose Business Journal, “PG&E Proposes Program to Make Customers ‘Climate Neutral,’”** Pacific Gas and Electric Co. wants to offer “offsets” to its customers and has asked for approval of the program from the California Public Utilities Commission. Through the Climate Protection Program, customers could opt to pay a premium on their monthly bills, based on their energy usage, to help offset their environmental impact associated with their energy consumption, making the net impact of their consumption “climate neutral.” A fund will be set up and projects will be funded in forest restoration and other conservation aimed at removing CO<sub>2</sub> from the atmosphere. The projects will all be based in California, and

## Trading

Carbon Market Update, January 19, 2006	
CCX-CFI 2005 (\$/tCO <sub>2</sub> ) <b>\$1.65</b>	EU ETS-EUA 2005 (\$/tCO <sub>2</sub> ) <b>\$ 32.76</b>
<b>(Converted from € to US\$)</b>	

**Bloomberg, “EU Carbon-Emission Trading on ECX Surges to Record,”** On January 19, the European Climate Exchange (Exchange) surged to a record high and more than doubled the previous daily all-time high. A total of 5.2 million metric tons of CO<sub>2</sub> allowances were traded on the Exchange on January 19. The figure also included a 3.3 million-ton trade, where ABN Amro Futures Ltd. was one of the two parties involved in the trade. (ABN Amro Holding NV is the largest Dutch bank.) Taking into account the most recent price of 25.85 euros per ton (\$31.47 per ton), the trading value for January 19 was valued at 134 million euros (\$162 million). January 19, 2006, <http://www.europeanclimateexchange.com/pages/page344.php>

**Reuters, “European Union Urges States to Simplify Emissions Trading Plans,”** The European Commission (Commission) told European Union (EU) member states on January 9 to keep it simple when they formulate their emissions trading plans for 2008-2012 for environmental commitments under the Kyoto Protocol. The twenty-five EU states must submit National Allocation Plans (NAPs) to the EU executive by June 30 stating how much CO<sub>2</sub> their industrial factories will emit. The NAPs are part of the EU emissions trading scheme, which began last year. Drawing from experience with the first trading period from 2005-2007, the Commission feels that these plans need to be “more transparent and easier to implement.” The Commission said it will “look very closely at the overall policy mix” that member states will use to implement their pollution reduction goals, including their planned use of the emissions trading system. January 10, 2006, <http://www.planetark.com/dailynewsstory.cfm/newsid/34402/story.htm>

**The Age (Australia), “Carbon Tax Too Costly, Says New Zealand,”** New Zealand will not introduce a carbon tax since it would not cut emissions enough to justify the cost of its introduction. New Zealand's carbon tax was to be set at a rela-

selected through competitive bids with stringent criteria under protocols developed by the California Climate Action Registry, an independent non-profit. The projects will be overseen by an external advisory group comprised of community groups, businesses, and nonprofit conservation agencies. An estimated \$20 million may be received by the end of the three year demonstration, with a goal of removing at least two million tons of carbon dioxide from the air. January 26, 2006, <http://sanjose.bizjournals.com/sanjose/stories/2006/01/23/daily45.html>

## Recent Publications

**“Technological Development and Economic Growth,”** In conjunction with the Inaugural Ministerial Meeting of the Asia Pacific Partnership on Clean Development and Climate between Australia, China, India, Japan, the Republic of Korea and the United States held January 11-12, the independent government economic research agency the Australian Bureau of Agricultural and Resource Economics (ABARE), published the above-named report. The purpose of the report is to assess the potential economic, environmental and energy consumption effects of possible action on the development and deployment of clean technologies under the Asia Pacific Partnership on Clean Development and Climate. In this report, medium and long-term drivers and projections of energy demand and emissions in the six partnership economies are discussed. The environmental and economic impacts of three alternative scenarios, reflecting enhanced technological development and transfer under the partnership agreement, are considered using ABARE’s global trade and environment model (GTEM). The results of the study indicate that potential use of such technologies in the electricity, transport and industry sectors could provide substantial opportunities to curb greenhouse gas emissions in the medium to long term, without hindering the development aspirations of developing countries. *ABARE research report (06.1)*, January 2006, [http://www.abare.gov.au/publications/2006/RR06\\_1\\_ClimateAsiaPacific.pdf](http://www.abare.gov.au/publications/2006/RR06_1_ClimateAsiaPacific.pdf).

## Legislative Activity

**Washington Post, “States Adopt California’s Greenhouse Gas Limits,”** On December 30<sup>th</sup>, Massachusetts joined Oregon, Connecticut and five other states that adopted California’s tough greenhouse gas rules, limiting the amount of carbon dioxide and other gases that can be emitted from vehicle tailpipes. The new rules supplement federal exhaust standards already in place. States which have adopted the rules are: Vermont (Nov. 7), Maine (Dec. 1), Connecticut (Dec. 20), New Jersey (Dec. 20), Rhode Island (Dec. 22), New York (Dec. 22), Oregon (Dec. 22, temporarily adopted with 180 days for Oregon Environmental Quality Commission to approve permanently), and Massachusetts (Dec. 30). Every major automaker is suing to have the rules overturned. Automakers feel that the carbon dioxide regulations are so strict that they would cause extensive design changes in new vehicles that will increase prices, affecting new car sales. The California rule, which was approved by a state environmental board in 2004, and with approval by the federal government, would take affect for model year 2009. It requires a 30 percent reduction in greenhouse gases by 2016. Automakers are countering with a pro-

posed 10 percent reduction in carbon dioxide emitted in vehicle production by 2012, and are not supporting restrictions on emissions from vehicle tailpipes. Some state regulators also fear that the forthcoming study by the National Resource Council, due out this month, may be used by Congress to limit states’ ability to join the California program. In a statement the EPA said it favors other methods of lower carbon dioxide besides regulating tailpipe emissions. It stated, “The only way to cut [carbon dioxide] emissions is through drastic increase in fuel economy—which in the past has led to smaller, lighter, and less-safe vehicles.” EPA must issue a waiver before any of California’s greenhouse gas regulations can go into effect. If California is permitted to impose new regulations, the Clean Air Act allows other states with poor air quality to adopt California’s rules after Agency approval. January 3, 2006, <http://www.washingtonpost.com/wp-dyn/content/article/2006/01/02/AR2006010201467.html>

**Boston Globe, “Big Gaps in State’s Plans for Emissions,”** Governor Mitt Romney is advocating for changes to Massachusetts’ plan to limit greenhouse gas emissions from power plants in the state, which went into effect January 1, 2006. The governor’s proposed changes would allow for offsets to be purchased by power plants from anywhere worldwide, compensating for excess emissions from their facilities. State officials do not have a blueprint for administration of the complex program, including penalties. Environmental critics say that language Romney is advocating for creates a loophole. Instead of requiring projects to be “enforceable” and “permanent”, Romney wants them to be “enforceable as a practical matter,” and “permanent to the maximum extent enforceable.” The governor announced his proposed changes in December 2005, just days before the state pulled out of the Regional Greenhouse Gas Initiative (RGGI). State officials will accept public comments until early March 2006. The state’s plan applies to the state’s six oldest power plants, which account for 70 percent of the greenhouse gases emitted by all 32 plants in the state. According to the plan, limits are being phased in, with the caps that began in January 2006. Tighter restrictions begin in 2008, though plants could exceed limits if they purchase offsets. Robert W. Golledge Jr., the state Department of Environmental Protection commissioner said that the plan will cost over \$750,000 each year to run, and require two full time employees, with verifying and monitoring off-sets to be contracted out to private companies. Under Romney’s proposal, plants would have to keep offset projects in the northeastern United States until the price to offset a ton of carbon dioxide emissions reached \$6.50 for more than 12 months. If the price of offsets continued to rise to \$10 a ton for 12 months, companies could opt out of buying offsets and instead pay the amount into a fund that would also go toward efforts to reduce CO<sub>2</sub>. Romney said this “safety valve” is needed to keep energy costs from rising too high. January 17, 2006, [http://www.boston.com/news/local/massachusetts/articles/2006/01/17/big\\_gaps\\_in\\_states\\_plans\\_for\\_emissions/](http://www.boston.com/news/local/massachusetts/articles/2006/01/17/big_gaps_in_states_plans_for_emissions/)

## **Greenwire, State-led Coalition Urges Appellate Court to Overturn GHG 'Nuisance' Opinion,**

A coalition of eight states, New York City and environmental groups are in the process of reviving litigation aimed at forcing five of the largest electric power companies to adopt greenhouse gas limits. The group, consisting of California, Connecticut, Iowa, New Jersey, New York, Rhode Island, Vermont, Wisconsin, New York City and the Open Spaces Coalition, lost a lawsuit this past summer in federal district court. The group argues that CO<sub>2</sub> emissions create a public nuisance covered under common law, and are bringing a case against power plants owned and operated by American Electric Power Co., Southern Co., Tennessee Valley Authority, Xcel Energy Inc. and Cinergy Corp. US District Court Judge Loretta Preska dismissed the case in August of 2005, on the grounds that the claims raised broad "political questions" that can only be addressed by Congress or the executive branch. The group filed a brief on December 15, 2005 with the 2<sup>nd</sup> US Circuit Court of Appeals (2<sup>nd</sup> Circuit) in New York City, citing precedents set by both the Supreme Court and 2nd Circuit that do not set such restrictive limits on a lawsuit when politics also surround an issue. Environmentalists, led by the Natural Resources Defense Council, also filed a separate eighty-page petition. In both briefs, the coalition maintains that they have standing to bring the case, and that the court can order the utilities to lower their emissions of greenhouse gases. Lawyers for the electric utility have until January 30, 2006 to respond to the group's arguments, and a panel of three judges will be named to hear the case. (To see the states' brief go to: <http://www.eenews.net/Greenwire/Backissues/images/010406gwr1.pdf> For US District Court Judge Loretta Preska's opinion go to: <http://www.eenews.net/Greenwire/Backissues/images/091505gwr2.pdf> For the environmentalist's brief go to: <http://www.eenews.net/Greenwire/Backissues/images/010406gwr5.pdf>.) January 4, 2006, [http://www.eenews.net/Greenwire/searcharchive/test\\_search-display.cgi?q=carbon&file=%2FGreenwire%2Fsearcharchive%2FNewsline%2F2006%2FJanuary4%2F01040606.htm](http://www.eenews.net/Greenwire/searcharchive/test_search-display.cgi?q=carbon&file=%2FGreenwire%2Fsearcharchive%2FNewsline%2F2006%2FJanuary4%2F01040606.htm) (subscription may be required)

## Events

February 6-8, 2006, **Clean Coal Opportunities In Electric Power Generation Conference**, *Brown Palace, Denver, CO*. The conference will focus on environmental, economic, and political issues associated with satisfying the rising demand for energy. Industry experts will examine various topics including various clean coal technologies, and the future of clean coal. A pre-conference workshop will be held February 6<sup>th</sup> with the topic "Analyzing Clean Coal Opportunities in the Marketplace," Sponsored by Electric Utility Consultants Inc., with more information at: [https://www.euci.com/conferences/february\\_06/0206\\_clean\\_coal.php#overview](https://www.euci.com/conferences/february_06/0206_clean_coal.php#overview)

February 8-9, 2006, **Emissions Trading**, *Hatton Conference Center, London, GB*. This event will provide an update on the progress of the EU Emissions Trading Scheme (EU ETS) since its launch in January. It will look at policy and legislation in the UK, the EU and internationally, and will assess the effectiveness and progress of this scheme to date. Sponsored by McGrigors legal firm and coordinated by SMi Group, Ltd. For more information see: <http://www.smi-online.co.uk/events/overview.aspx?is=5&ref=2292>

February 20-21, 2006, **2nd Australia - New Zealand Climate Change and Business Conference**, *Hilton Adelaide, Adelaide, Australia*. This conference will explore business opportunities and risks associated with climate change, especially in the Asia Pacific Region. For more information, see: <http://www.climateandbusiness.com/welcome.html>.

February 28-March 2, 2006, **Point Carbon's Carbon Market Insights 2006**, *Bella Center, Copenhagen, Denmark*. Point Carbon's annual gathering for players in the global carbon markets takes place February 28 to March 2 at the Bella Centre in Copenhagen, Denmark. More than 750 participants and 40 exhibitors are already confirmed. The first two days contain parallel conference streams on the European Union (EU) Emissions Trading System, Clean Development Mechanism and Joint Implementation (CDM&JI) and Global Market issues, respectively, with more than 120 presenters and panelists confirmed. On the third day numerous optional workshops are held, both on an introductory and advanced level, on EU, Kyoto, CDM & JI issues. Just before the conference starts, February 27 in the evening, a free introduction to the carbon market is offered to those participants who wish to take part. For more information, see: <http://www.pointcarbon.com/category.php?categoryID=940> or contact Point Carbon's conference department at [conference@pointcarbon.com](mailto:conference@pointcarbon.com).

## Events (Continued)

March 7-9, 2006, **Planning for the Future: Climate Change, Greenhouse Gas Inventories & Clean Energy Linkages**, *Sheraton Fisherman's Wharf hotel, San Francisco, CA*. This International Specialty Conference sponsored by the Air & Waste Management Association and will examine the convergence of policies and technical issues that are central to understanding and mitigating GHG emissions and Climate Change impacts. For information regarding relevant topics for paper submissions, visit AWMA's website. For further information on the conference see: <http://www.awma.org/events/confs/GLOBAL/default.asp> or contact Amy Klaus at (412) 232-3444, ext. 3119, or: [aklaus@awma.org](mailto:aklaus@awma.org)

March 8-9, 2006, **Environmental Credits Generated through Land-Use Changes: Challenges and Approaches**, *Hyatt Regency Hotel, Baltimore, MD*. The workshop will be used to study and discuss the challenges that arise when market-based mechanisms are used to encourage changes in practices on the land in order to achieve environmental goals. The primary focus will be on carbon sequestration and nutrient run-off reductions, though lessons will be applicable to a wide range of environmental issues. Space is limited. For more information, to reserve a spot, or to ensure that you receive updates on the program, contact Richard Woodward at: [r-woodward@tamu.edu](mailto:r-woodward@tamu.edu), 979-845-5864. Additional information is available at: <http://www.envtn.org/LBcreditsworkshop/>

April 19-21, 2006, **California Climate Action Registry Annual Conference**, *Laguna Cliffs Marriott Resort, Dana Point, CA*. The Registry's annual conference brings together thought leaders on climate change to take a hard look at developing climate policies, standards and trends. Full details to be announced next month. Visit: <http://www.climateregistry.org/EVENTS/Conference> or contact Rachel Tornek with any questions at [rachel@climateregistry.org](mailto:rachel@climateregistry.org)

May 8-11, 2006, **The Fifth Annual Conference on Carbon Capture & Sequestration "Taking Steps Toward Deployment,"** *Hilton Alexandria Mark Center, Alexandria, VA*. The conference will bring together experts directly involved in developing, demonstrating and deploying carbon capture, separation and sequestration technologies as part of the Administration's Climate Change Technology Program. The Conference is sponsored by EM Publications & Forums, in partnership with the US Department of Energy, the National Energy Technology Laboratory and other federal agencies. Full details are available at: <http://www.carbonsq.com/>

May 10-12, 2006, **Third Annual CARBON EXPO**, *Congress Centre East, Cologne, Germany*. CARBON EXPO is the global carbon market event that combines the up-to-date content of a high-level conference with the advantages of a trade fair. For additional information visit: <http://www.carbonexpo.com/>

May 21-26, 2006, **The Clearwater Coal Conference, 31st International Technical Conference on Coal Utilization & Fuel Systems**, *Sheraton Sand Key Hotel, Clearwater, FL*. Sponsored by: US Department of Energy, Coal Technology Association & American Society of Mechanical Engineers - Power Division, in cooperation with National Energy Technology Laboratory, US Dept. of Energy, The program presents an extensive overview of emerging, evolving, and innovative technologies, fuels and/or equipment in the power generation industry. The presentations will deal with technical solutions to problems; specific strategies; projects; innovations; industry trends; and or/ regulatory compliance. Contact Barbara Sakkestad, Coal Technology Association, Phone: 301/294-6080. E-mail: [Barbarasak@aol.com](mailto:Barbarasak@aol.com); or the website: [www.coaltechnologies.com](http://www.coaltechnologies.com).

June 19-22, 2006, **GHGT-8**, *Norwegian University of Science and Technology (NTNU), Trondheim, Norway*. The aim of this conference is to provide a forum for the discussion of the latest advances in the field of greenhouse gas control technologies. Details at: <http://www.ghgt-8.no> take part. For more information, see: <http://www.pointcarbon.com/category.php?categoryID=940> or contact Point Carbon's conference department at [conference@pointcarbon.com](mailto:conference@pointcarbon.com).

For subscription details, please visit: [http://www.netl.doe.gov/publications/carbon\\_seq/subscribe.html](http://www.netl.doe.gov/publications/carbon_seq/subscribe.html). To learn more about DOE's Carbon Sequestration Program, please contact Sean Plasynski at: [sean.plasynski@netl.doe.gov](mailto:sean.plasynski@netl.doe.gov) or Dawn Deel at: [dawn.deel@netl.doe.gov](mailto:dawn.deel@netl.doe.gov).