

THE CARBON SEQUESTRATION NEWSLETTER

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April 2007

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HIGHLIGHTS



Ken Champagne, foreground, an engineering technician, and Mac Gray, background, a scientist in NETL's Office of Research and Development, test a sorbent developed at NETL to determine how well it captures carbon dioxide. (Source: NETL)

Fossil Energy Techline, "DOE Lab Teams with Universities to Develop New Carbon Capture Technology."

Researchers at the Department of Energy's (DOE) National Energy Technology Laboratory (NETL) are collaborating with scientists from West Virginia University and the University of Pittsburgh to develop improved carbon dioxide (CO₂) sorbents, a new carbon capture technology that could help address the issue of global warming. The technology is called electrostatic layer-by-layer self-assembly, or LBL, and is currently used to prevent infection in patients with medical implants and to deliver precise doses of medicine. NETL researchers are hoping that the nanotechnology could be used to remove CO₂ from fossil fuel combustion gases. In order to do this, the researchers are searching for a way to produce a higher quality, more uniform sorbent. Typically, NETL researchers prepare amine sorbents by a process that deposits the amines (the chemical compounds that contain nitrogen as the key atom) on

the substrate (the base onto which the active material is deposited). The sorbent becomes more effective when it is distributed with greater uniformity on the substrate, thus capturing more CO₂ in the process. As much as 100 times more amine could be deposited using the new technology than is currently being used. The research is possible through a program called the University Research Initiative, a program that teams NETL researchers with university professors and students from West Virginia University, the University of Pittsburgh, and Carnegie Mellon University. The program is value-added in that it allows for technologies to be used in applications where they would otherwise not be applied. For more information on DOE's Carbon Sequestration Program, go to: <http://www.fossil.energy.gov/programs/sequestration/index.html>. March 20, 2007, http://www.fossil.energy.gov/news/techlines/2007/07013-FE_Science_Meets_Medicine.html.

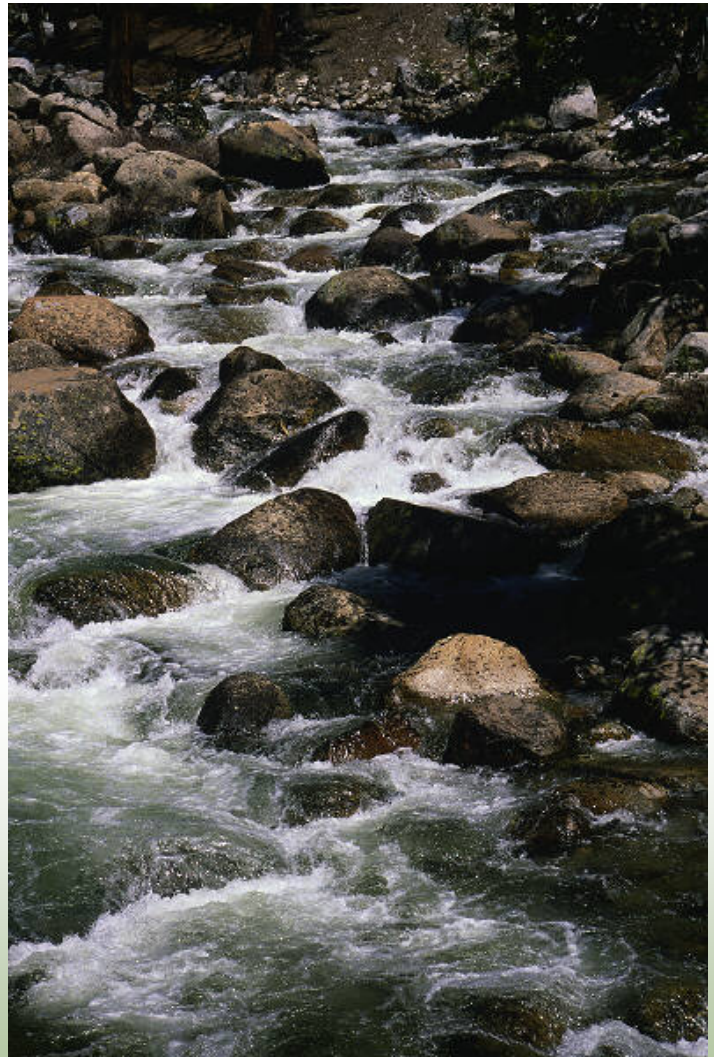
DOE Press Release, "Department of Energy Submits \$23.6 Billion Spending Plan to Congress for FY'07."

On March 16, the US Department of Energy submitted its Fiscal Year 2007 spending plan to Congress totaling \$23.598 billion. This marks a \$45 million (0.2 percent) increase over the original request, as a result of the Continuing Resolution signed by President Bush on February 15. Significant to the plan is the amount of funding allocated in order to meet the President's goal of developing technologies to substantially reduce the nation's dependency on fossil fuels, as laid out in his most recent State of the Union Address. A highlight of the spending plan is the President's \$2 billion commitment to clean coal technologies. This includes the funding for projects aimed at near-zero emissions goals, including carbon emissions. A 55 percent increase in funding for carbon sequestration will help initiate the deployment of large scale geologic carbon sequestration field projects. Funding for research and development of clean coal technologies is also allocated in the budget. Emphasis on investments in alternative fuel technologies is part of the current spending plan, and President Bush's Twenty in Ten Initiative will direct funding to areas aiming to reduce the country's dependence on foreign energy and fossil fuels. March 16, 2007, <http://energy.gov/news/4884.htm>.

Sequestration in the News

The New York Times, “In a Test of Capturing Carbon Dioxide, Perhaps a Way to Temper Global Warming,” and ***Alstom Press Release***, “Alstom and American Electric Power Sign Agreement to Bring Carbon Dioxide Capture Technology to Commercial Scale by 2011.” On March 14, an announcement was made to conduct a large-scale, post-combustion carbon capture project between American Electric Power (AEP) and Alstom, a large manufacturer of generating equipment. The project will utilize chilled ammonia to capture the carbon dioxide (CO₂) that is emitted from coal-fired power plants and will isolate it into a highly concentrated, high-pressure form. The new process, developed by Alstom, dramatically reduces the energy required to capture the CO₂, which can amount to as much as a third of a power plant’s energy output. Results of testing the technology have shown capture rates exceeding 90 percent of CO₂ and at a cost significantly lower than other capture methods. The technology is also significant in that it can be retrofitted for application in existing coal-fired power plants. The project will be implemented in two phases. The initial pilot test will take place in late 2008 at the company’s Mountaineer plant in New Haven, West Virginia and will capture 100,000 tons of CO₂ per year and then sequester it 9,000 feet underground in a saline formation at the site. The demonstration is expected to cost \$800 million, and the company is expected to request federal money to fund the project, as well as passing the cost to customers if state regulators permit it. A much larger commercial demonstration, scheduled to begin in late 2011, will follow at AEP’s 450 megawatt plant at the Northeastern Station location in Oklahoma. As much as 1.5 million tons of CO₂ will be captured for this test and subsequently sold for enhanced oil recovery operations. The project is expected to last for twelve to eighteen months. This initiative signifies that AEP may be expecting government regulations in the form of carbon emission limits, according to some climate policy specialists. March 15, 2007, <http://www.nytimes.com/2007/03/15/business/15carbon.html?pagewanted=print>, (Subscription required.) and March 15, 2007, http://home.businesswire.com/portal/site/google/index.jsp?ndmViewId=news_view&newsId=20070315005762&newsLang=en.

Geo-Processors USA, Inc. Press Release, “Geo-Processors Breakthrough in Carbon Capture and Storage Technology.” Geo-Processors USA recently announced the development of a unique carbon capture and storage (CCS) technology called Carbon Capture and Products Recovery (CCPR). The CCPR system differs from traditional capture methods in that it converts the carbon dioxide from ambient air or point-sources into mineral products that can be utilized in other industrial applications, recycled, or sequestered. Geo-Processors USA, which focuses on the development and commercialization of cost-effective sustainable energy technologies, successfully conducted testing of the process in Australia. Significant to the development of this technology is that the alkaline-produced water from oil and gas industries, coal mining, and coal power stations will now be able to be used as a resource rather than a waste stream, and will eliminate the cost associated with the use of synthetic caustic sorbents in other CCS processes. February 26, 2007, <http://www.geo-processors.com/files/GeoProc-PressRelease-26Feb07.pdf>.



Announcements

“Two Senior Energy Department Officials to Depart.” On March 5, Assistant Secretary for Fossil Energy Jeffrey Jarrett, announced his resignation from the Department of Energy (DOE). Jeffrey Jarrett joined DOE in January 2006 as chief advisor to Secretary of Energy Samuel Bodman on fossil fuel policies and programs, which includes carbon sequestration research and development, as well as oversight of the FutureGen project. Mr. Jarrett has accepted the position of executive director of Coal-Based Generation Stakeholders. Assistant Secretary for Congressional and Intergovernmental Affairs Jill Sigal will be leaving the Department of Energy to join EnergySolutions as Senior Vice President for Government Relations. To read Secretary Bodman’s remarks concerning the announcement and to view the full DOE press release, go to: <http://energy.gov/news/4832.htm>.

Secretary of Energy Participates in Online Forum, “Ask the White House.” The online interactive forum allows the public to participate in online discussions with Cabinet Secretaries, senior White House officials, behind-the-scenes professionals at the White House, and others. On February 23, Secretary Bodman responded to an inquiry on advances being made with clean coal technology, saying that carbon sequestration and the FutureGen initiative are two examples of progress being made. A question inquiring about Department of Energy (DOE) advances in life sciences sparked the Secretary to comment on DOE-sponsored research into microbes to aid in carbon sequestration. To read the Q&A session in its entirety, go to: <http://www.whitehouse.gov/ask/20070223.html>.

Sean Plasynski on National Public Radio’s *Morning Edition*. To listen to a radio story “Scientists Hunt for Solution to Carbon Dioxide Problem,” with comments by Sean Plasynski, Sequestration Technology Manager at the Department of Energy’s National Energy Technology Laboratory go to: <http://www.npr.org/templates/story/story.php?storyId=7874053>.

Read “Farming the Climate,” an Article about Plantstone Carbon Research. Plantstone Carbon, or phytolith occluded carbon, is a process which occurs naturally in plants and could play an important role in countering carbon dioxide emissions and global warming. The authors discuss the technology and the financial and environmental benefits it could bring to the agricultural sector in Australia. The article was first published in *Australian R&D Review* on February 7, 2007 – “Linking Australian Science, Technology and Business.” Read it at this link: <http://www.sciencealert.com.au/farming-the-climate.html>.

View a Presentation by the Electrical Power Resource Institute (EPRI) on “Electricity Technology in a Carbon-Constrained Future.” EPRI has presented a technical analysis of the potential for significant carbon dioxide reductions from the US electric power sector within the next 25 years. To view the executive summary and PowerPoint presentation, see: http://my.epri.com/portal/server.pt?space=CommunityPage&cached=true&parentname>Login&parentid=1&in_hi_userid=2&control=SetCommunity&CommunityID=205&PageID=410.



Reuters, "Norway Says to Form State Carbon Dioxide Storage Company." In efforts to contribute to technological development and broad use of carbon capture and storage (CCS) technology, the government of Norway announced that it will form a state-owned company to manage such projects. The new company will be responsible for the government's CCS projects, including plans to construct two of the country's first gas-fired power plants. The first project, which would be the world's largest full-scale carbon dioxide (CO₂) capture and storage project, is a combined heat and power plant at the state-controlled oil and gas company Statoil's Mongstad refinery on the west coast. The facility will capture partial CO₂ emissions from the power plant beginning in 2010, with plans for full-scale capture in operation by the end of 2014. Initially, the government will own 80 percent of the project, but hopes to bring in more industrial partners in order to eventually decrease the government's interest in it. Statoil has been involved in an offshore carbon sequestration project at the Sleipner gas field since 1996. In a second project, the government will be involved in building another gas-fired power plant at the Kaarstoe gas-processing plant north of Stavanger. Currently, Norway relies almost exclusively on hydro-powered plants for electricity, even though the country is one of the world's largest exporter of crude oil and Western Europe's biggest natural gas producer. The government is planning for the new plants to integrate CCS into their operations. March 6, 2007, <http://www.planetark.org/avantgo/dailynewsstory.cfm?newsid=40664>.

The Age, "Carbon Storage Plan Gains Momentum." Australia's Otway Basin is home to the country's first carbon dioxide (CO₂) geosequestration project, which has received international attention. The \$23.6 million (\$30 million Australian) endeavor has received \$3.1 million (\$4 million Australian) in funding from the Australian government. Plans to sequester the CO₂ may begin as

early as July 2007. Researchers from the Research Centre for Greenhouse Gas Technologies (CO₂CRC) will conduct the tests. The local government is currently filing a permit to rezone the site so that non-agricultural development can take place on the farmland. According to CO₂CRC chief executive Peter Cook, the rezoning application should not cause delays in launching the project. CO₂CRC will carry out a sophisticated monitoring program that aims to demonstrate to the community, government regulators and industry that the technology is a safe, viable greenhouse gas mitigation option. February 19, 2007, <http://www.theage.com.au/news/business/carbon-storage-plan-gains-momentum/2007/02/18/1171733612638.html#>.

Australian Broadcasting Corporation, "New South Wales Government Launches Carbon Capture Project." On March 2, the New South Wales government launched a \$17 million (\$22 million Australian) carbon capture and storage project. The announcement was made by the government's Mineral Resources Minister Ian Macdonald, who also commented on other carbon sequestration projects taking place overseas where carbon dioxide (CO₂) is safely transported via pipelines. The project will take place on the central coast of the country and involves capturing CO₂ from regional power plants and subsequently storing it underground. Additionally, the government of New South Wales is also considering ultra clean coal technology to minimize greenhouse gas emissions. March 2, 2007, <http://www.abc.net.au/news/items/200703/1861927.htm?midnorthcoast>.

C News (Canada), "Alberta Plans \$1.5 Billion Carbon Dioxide Pipeline." The Canadian province of Alberta plans to construct a \$1.3 billion (\$1.5 billion Canadian) carbon dioxide (CO₂) pipeline. Alberta Premier Ed Stelmach said that the monies would come from Prime Minister Stephen Harper's Eco-Fund. Alberta plans to capture CO₂ emissions from heavy emitters and pump them into mature oil fields in the Alberta oil patch for enhanced oil recovery. Additional funds for construction of the pipeline will be generated through a provincial technology fund. Emitters will pay into the fund according to how many metric tons of emissions they produce over the target level, which will be set by the government in the spring. The Alberta government is aiming to reduce emissions by 12 percent, and plans to set the targets by July 1, 2007. March 5, 2007, <http://www.freedominion.ca/phpBB2/viewtopic.php?t=76911&sid=9ce5d490888b51a6f354fae28b51755f>.

Science

Greenwire, “Asian Smog Disrupting Northwestern US Weather, Study Shows.” In a study published in the Proceedings of the National Academy of Sciences, air pollution from Asia is worsening the severity of storms in the northwestern United States. Texas A&M University scientist and lead author of the report, Renyi Zhang, studied the Pacific United States storms from 1994 to 2005 and concluded that air pollution from Asia is increasing the severity of storms by as much as 20 to 50 percent. The reasoning behind the data shows that emissions of dust, sulfur, carbon grit, and trace metals from the Asian industrial sources are interfering with rain drop formation, causing the creation of deep convective clouds. This type of cloud creates more intensive updrafts that result in more severe and more intense thunderstorms. March 6, 2007, <http://www.eenews.net/Greenwire/print/2007/03/06/15>.

The Australian, “Heating Planet ‘Makes Children Sick’.” Findings from a two-year study completed at the University of Sydney have found a link between rise in temperature and childhood illness. Increased instances of fever and gastroenteritis in children under six years of age were sited, and more specifically the study showed that for every five-degree rise in temperature, two more children in that age group were admitted with fever to the hospital. The study’s lead researcher and pediatric specialist, Dr. Lawrence Lam, collected data from the Bureau of Meteorology in 2001 and 2002 and analyzed several different climate factors for his study. They included UV index, rainfall and humidity. Dr. Lam admits that further studies may be needed to ascertain whether illnesses were triggered as a direct result of the increased temperatures or whether problems stemming from the heat, like pollution, were the cause. Dr. Lam does contend, however, it is clear that children are not able to regulate their bodies to overheating as well as adults, since their brains’ thermal regulation mecha-

nisms are not as well developed. Furthermore, they are particularly at risk of extreme changes, more so than adults. (See Publications section of this newsletter, “The association between climatic factors and childhood illnesses presented to hospital emergency among young children,” for an abstract and link to the full study.) February 22, 2007, <http://www.theaustralian.news.com.au/story/0,20867,21268910-1702,00.html>.

“Regional patterns of radiocarbon and fossil fuel-derived CO₂ in surface air across North America.” Radiocarbon levels in annual plants provide a means to map out regional and continental-scale fossil fuel plumes in surface air. The authors collected corn (*Zea mays*) across North America during the summer of 2004. Plants from mountain regions of western North America showed the smallest influence of fossil fuel-derived carbon dioxide (CO₂) with a mean delta carbon 14 ($\Delta^{14}\text{C}$) of 66.3 parts per thousand ± 1.7 parts per thousand. Plants from eastern North America and from the Ohio-Maryland region showed a larger fossil fuel influence with a mean $\Delta^{14}\text{C}$ of 58.8 parts per thousand. ± 3.9 parts per thousand and 55.2 parts per thousand ± 2.3 parts per thousand respectively, corresponding to 2.7 parts per million (ppm) ± 1.5 ppm and 4.3 ppm ± 1.0 ppm of added fossil fuel CO₂ relative to the mountain west. A model–data comparison suggests that surveys of annual plant $\Delta^{14}\text{C}$ can provide a useful test of atmospheric mixing in transport models that are used to estimate the spatial distribution of carbon sources and sinks. **Diana Y. Hsueh, Nir Y. Krakauer, James T. Randerson, Xiaomei Xu, Susan E. Trumbore, and John R. Southon.** *Geophysical Research Letters*, Volume 34, L02816, doi: 10.1029/2006GL027032, January 23, 2007, <http://www.agu.org/pubs/crossref/2007/2006GL027032.shtml>. (Subscription required.) See the related University of California, Irvine press release, “**Scientists Map Air Pollution Using Corn Grown in US Fields**” at: http://today.uci.edu/news/release_detail.asp?key=1564. Also, view a color-coded US Fossil Fuel Carbon Dioxide map (Note the key: red equals most polluted, blue equals least polluted) at this link: http://today.uci.edu/news/images/carbon_display_head.jpg.



Policy

E&E News PM, “Global Lawmakers Urge G8 to Set Emissions Goal.” A group of international legislators, including members of the US Congress and



parliamentary representatives of 20 industrialized countries, urged their countries' leaders to set a long-term goal for stabilizing greenhouse gas emissions. The formal, although nonbinding statement, is being released in advance of the upcoming G8 summit scheduled for June 2007 in Heiligendamm, Germany, a seaside resort on the Baltic Sea. Lawmakers noted that in order to meet the aggressive goals being proposed to stabilize greenhouse gases, the world's largest economies need to combine a binding United Nations framework signed by all major nations, along with bilateral and multilateral partnerships. One of the initiatives set forth by German Chancellor Angela Merkel in anticipation of the G8 summit is to add post-Kyoto talks to the agenda. The lawmakers also highlighted the necessity to establish a global carbon market as an incentive to pursue technologies aimed at energy efficiency. Although each country faces varying degrees of economic development, the statement underscores the importance of each country to take action in line with their capabilities and "historic responsibilities." February 15, 2007, <http://www.eenews.net/eenewspm/print/2007/02/15/2>. (Subscription may be required.)

Greenwire, "Small Cost Would Bring Canada into Kyoto Compliance, Study Says." A recent study conducted in Canada indicates that adding a tax of \$1 Canadian to the current cost of producing a barrel of oil would be sufficient for Canadian compliance with the Kyoto Protocol. Research pointing in this direction provides one option available for the country to meet the target of a six percent reduction in emissions below 1990 levels by 2012. Oil industry leaders feel the necessity to combine that approach with intensity-based

targets, which calculate reductions as a percentage of production, coupled with a cap-and-trade system. They also advocate government funding of carbon capture and storage technologies, which could be funded by the tax. The current cost to produce a barrel of oil from oil sands is about \$21 (\$25 Canadian). Raising the price by \$1 would raise \$640 million (\$750 Canadian) per year. February 22, 2007, <http://www.eenews.net/Greenwire/print/2007/02/22/13>. (Subscription may be required.)

Geology

"Joule-Thomson cooling due to carbon dioxide injection into natural gas reservoirs." Depleted natural gas reservoirs are a promising target for Carbon Sequestration with Enhanced Gas Recovery (CSEGR). The focus of this study is on evaluating the importance of Joule-Thomson cooling during carbon dioxide (CO₂) injection into depleted natural gas reservoirs. Joule-Thomson cooling is the adiabatic cooling or heating that accompanies the expansion of a real gas. During CO₂ injection into a natural gas reservoir, the pressure near the injection well declines rapidly as gas expands into the reservoir. If Joule-Thomson cooling during this expansion were large, injectivity and formation permeability could be altered by formation of hydrates, freezing of residual water, and fracturing due to thermal stresses. The TOUGH2/EOS7C module for carbon dioxide-methane-water (CO₂-CH₄-H₂O) mixtures is used as the simulation analysis tool. For verification of EOS7C, the classic Joule-Thomson expansion experiment is modeled for pure CO₂ resulting in Joule-Thomson coefficients in agreement with standard references to within five to seven percent. For demonstration purposes, a case with a large pressure drop (\approx 50 bars) is presented in order to show that temperature can drop by more than 20 degrees Celsius by this effect. Lower permeability increases Joule-Thomson cooling while lower porosity decreases it for a system with constant-rate injection. Two additional constant-rate injection cases show that for typical systems in the Sacramento Valley, California, with much smaller pressure drops (<10 bars), the Joule-Thomson cooling effect is minimal. This simulation study shows that for constant-rate injections into high-permeability reservoirs, the Joule-Thomson cooling effect is not expected to create significant problems for CSEGR. **Curtis M. Oldenburg**, *Energy Conversion and Management*, Published online February 27, 2007, <http://www.sciencedirect.com/science/article/B6V2P-4N4S61G-5/2/82f0fa35656cfbb4de31141b098d5370>. (Subscription may be required.)

“Black carbon sequestration as an alternative to bio-energy.” Most policy and much research concerning the application of biomass to reduce global warming gas emissions has concentrated either on increasing the Earth's reservoir of biomass or on substituting biomass for fossil fuels, with or without carbon dioxide (CO₂) sequestration. Suggested approaches entail varied risks of impermanence, delay, high costs, and unknowable side-effects. An under-researched alternative approach is to extract from biomass black (elemental) carbon, which can be permanently sequestered as mineral geomass and may be relatively advantageous in terms of those risks. This paper reviews salient features of black carbon sequestration and uses a high-level quantitative model to compare the approach with the alternative use of biomass to displace fossil fuels. Black carbon has been demonstrated to produce significant benefits when sequestered in agricultural soil, apparently without bad side-effects. Black carbon sequestration appears to be more efficient in general than energy generation, in terms of atmospheric carbon saved per unit of biomass; an exception is where biomass can efficiently displace coal-fired generation. Black carbon sequestration can reasonably be expected to be relatively quick and cheap to apply due to its short value chain and known technology. However, the model is sensitive to several input variables, whose values depend heavily on local conditions. Because characteristics of black carbon sequestration are only known from limited geographical contexts, its worldwide potential will not be known without multiple streams of research, replicated in other contexts. **Malcolm Fowles**, *Biomass and Bioenergy*, Published online March 6, 2007, <http://www.sciencedirect.com/science/article/B6V22-4N6FNT8-3/2/fa54c2bc1f5892234cd290d0b1877f70>. (Subscription may be required.)

Technology

“Sustainable clean coal power generation within a European context – The view in 2006.” The future use of coal will require strict environmental compliance with an increasing need to minimize emissions of carbon dioxide (CO₂), particularly from power plants. A pan-European approach is being established to ensure that European Union industry can have available, by 2020, fossil fuel power plants that are either capable of capturing almost all their CO₂ emissions in an economically viable manner, or are designed to include CO₂ capture systems (“capture-ready”). The overall aim is to provide a significant impetus to research, development, demonstration and deployment activities such that coal and other fossil fuels can be used in a sustainable manner. **A.J. Minchener and J.T. McMullan**, *Fuel*, Published online February 21, 2007, <http://www.sciencedirect.com>

[science/article/B6V3B-4N3PY24-1/2/422d8192cdba1092d30a7dd2a5680ca9](http://www.sciencedirect.com/science/article/B6V3B-4N3PY24-1/2/422d8192cdba1092d30a7dd2a5680ca9). (Subscription may be required.)

“Initial evaluation of the impact of post-combustion capture of carbon dioxide on super-critical pulverized coal power plant part load performance.” Pulverized coal-fired plants often play an important role in electricity grids as mid-merit plants that can operate flexibly in response to changes in supply and demand. As a consequence, these plants are required to operate over a wide output range. This paper presents an initial evaluation of some potential impacts of adding post-combustion carbon dioxide (CO₂) capture on the part load performance of pulverized coal-fired plants. Preliminary results for ideal cases analyzed using a simple high-level model indicate that post-combustion CO₂ capture could increase the options available to power plant operators. In particular, solvent storage could allow higher effective plant load factors to be achieved to assist with capital recovery while still permitting flexible operation for grid support. A number of areas for more detailed analysis are identified. **Hannah Chalmers and Jon Gibbins**, *Fuel*, Published online February 27, 2007. <http://www.sciencedirect.com/science/article/B6V3B-4N4YTKP-3/2/19c2ddb9877481d5ae36679ac9831b2d>. (Subscription may be required.)



Terrestrial/Ocean

“Small Phytoplankton and Carbon Export from the Surface Ocean.” Autotrophic picoplankton dominate primary production over large oceanic regions but are believed to contribute relatively little to carbon export from surface layers. Using analyses of data from the equatorial Pacific Ocean and Ara-

bian Sea, the authors show that the relative direct and indirect contribution of picoplankton to export is proportional to their total net primary production, despite their small size. The authors suggest that all primary producers, not just the large cells, can contribute to export from the surface layer of the ocean at rates proportional to their production rates. **Tammi L. Richardson and George A. Jackson**, *Science*, February 9, 2007, Volume 315, Issue 5813, pages 838-840, DOI: 10.1126/science.1133471, <http://www.sciencemag.org/cgi/content/abstract/315/5813/838>. (Subscription required.)

“Plant crown traits and carbon sequestration capability by *Platanus hybrida* Brot. in Rome.” Measurements of carbon dioxide (CO₂) concentration carried out in the city of Rome in the period January–December 2005 showed a mean yearly CO₂ concentration of 414 ± 45 parts per million; polluted sites (P sites) had 21 percent higher CO₂ concentration than control sites (C sites). The significant ($p < 0.01$) correlation analysis between CO₂ concentration and traffic density measured during the study period at P sites showed that traffic density explained 51 percent of the CO₂ variation. The CO₂ trend during the traffic limitation days (provision imposed by ordinance of the City Council) did not show significant differences as regards regular traffic days, suggesting the ineffectiveness of this provision. Leaf area index (LAI) of *Platanus hybrida* Brot. was on an average 11 percent lower at P sites than at C ones associated with a lower total photosynthetic leaf surface area (SPT, 34 percent lower at P sites than at C ones). *P. hybrida* had a total carbon sequestration of 117 ± 13 kg year⁻¹ (mean value of P and C sites) playing an important role in sequestering CO₂. Thus, the choice of plant species for urban areas may be set out taking into account their own air amelioration capability. Plant traits of each species may be used for urban tree planting programs to ameliorate urban air pollution. **Loretta Gratani and Laura Varone**, *Landscape and Urban Planning*, Published online February 16, 2007, <http://www.sciencedirect.com/science/article/B6V91-4N2M685-1/2/ff70e17f2d6ffa926d90e689ebeb3ac>. (Subscription may be required.)

Trading

Carbon Market Update, March 12, 2007	
CCX-CFI 2007 (\$/tCO ₂) \$4.00 (Vintage 2007)	EU ETS-EUA DEC 2007 (\$/tCO ₂) \$ 1.75
(Converted from € to US\$)	

Greenwire, “Five Western States to Launch Greenhouse Gas Trading Program,” and **The Associated Press**, “Governors Team to Reduce Gas Emissions.” On February 26, five governors from the states of Arizona, California, New Mexico, Oregon and Washington signed a global warming agreement, pledging their commitment to cut greenhouse gas emissions. This latest agreement, signed during the annual winter meeting of the National Governors Association, is called the Western Regional Climate Action Initiative and will add to each of the states’ existing plans to reduce pollution levels and implement regulations. A coalition of ten Northeast and Mid-Atlantic States has already established their own program through the Regional Greenhouse Gas Initiative or RGGI. Other topics of discussion at the meeting included a plan by Western states to launch a regional cap-and-trade program, legislation to encourage clean-coal technology, alternative energy sources, and tax incentives to encourage the use of renewable energy. The five Western states have also agreed to start a registry to track and manage their emissions. In 2006, California Governor Arnold Schwarzenegger became the first governor to impose state legislation for emissions caps on utilities, refineries and manufacturing plants, with a goal to cut greenhouse gas emissions to 1990 levels by 2020. The Western states’ press release to launch their greenhouse gas trading program says that officials will develop specific regional emissions targets within six months and will set up a market-based system “such as a load-based cap-and-trade program” by August 2008. It may be possible for this program to merge with the Northeastern trading system, as well as with similar efforts from both Canadian provinces and Mexican states. More information about the National Governors Association can be found by clicking: <http://www.nga.org>. February 26, 2007, <http://www.eenews.net/Greenwire/print/2007/02/26/1>, (Subscription may be required), and February 26, 2007, <http://www.cbsnews.com/stories/2007/02/26/politics/ap/main2519109.shtml>. To read the keynote remarks delivered by Secretary of Energy Samuel Bodman at the National Governors Association Winter Meeting, go to: <http://www.energy.gov/news/4822.htm>.

Business Wire, “Record TXU Buyout Includes Unprecedented Global Warming, Emissions Plan,” and **Greenwire**, “TXU Agrees to \$45 Billion Takeover, Limits on New Coal Plants.”

TXU Corporation, the largest utility company in Texas, is being sold to a group of private equity investors for a reported \$32 billion plus \$13 billion in debt. The purchase would mark the largest private equity deal on record. Led by Kohlberg Kravis Roberts & Company and Texas Pacific Group, the buyout deal contains several environmental provisions which include reversing TXU's plans to build 11 new coal-fired power plants in Texas, as well as proposed plants in Pennsylvania and Virginia. Conditions of the sale include investment in a number of energy efficiency strategies, commitments to tackle global warming, and support for federal legislation to establish a cap-and-trade system for greenhouse gas emissions. The buyers worked with the Natural Resources Defense Council (NRDC), a national, nonprofit organization of scientists, lawyers and environmental specialists, in order to gain their endorsements. According to the NRDC and other environmental experts, the new company will also aim to limit total carbon dioxide (CO₂) emissions from existing plants in an effort to reduce its emissions to 1990 levels by 2020. Investments in renewable energy sources and initiatives to help customers reduce their energy needs are planned, and research on alternative technologies will be explored. Residential customers will benefit from a planned 10 percent decrease in electricity prices until 2008, which could amount to more than \$300 million per year in total savings. Salaries for top executives and performance measurement at the new company would be tied directly to the climate protection goals. Former EPA Administrator William Reilly and former Commerce Secretary Donald L. Evans will join TXU's board, and former Secretary of State James Baker will serve as advisory chairman. February 24, 2007, http://www.energycentral.com/centers/news/daily/printer_friendly.cfm?aid=7889031, (Subscription required), and February 26, 2007, <http://www.eenews.net/Greenwire/print/2007/02/26/2>. (Subscription may be required.) To listen to a story about the buyout from NPR's *Morning Edition* and to read related NPR stories on this piece, go to: <http://www.npr.org/templates/story/story.php?storyId=7615613>.

Terrapass Press Release, "Greenlighting at the Oscars." The Academy Awards made their own contribution to global climate change this year. Instead of acknowledging the presenters and performers with the usual gift bag full of lavish and expensive gifts, the Academy opted for a more meaningful and less exotic approach by presenting the recipients with a more unique token of appreciation created in collaboration between TerraPass, the leading retailer of carbon offsets, and Simon Pearce, a distinguished designer and manufacturer of hand blown glass objects. The result was a gift that consisted of a "Year of Carbon Balanced Living," an

original Simon Pearce glass sculpture and 100,000 pounds of carbon dioxide reductions from TerraPass' suite of verified clean energy projects. Also included as part of the gift was a handbook for climate-conscious living, which describes several simple suggestions for increasing energy efficiency and decreasing the amount of greenhouse gases each person produces, a term that TerraPass describes as reducing your "carbon footprint." For \$2,100 the same sculpture given to presenters and performers at the 79th Annual Academy Awards can be purchased online at: <http://www.lohacharasculpture.com/products-5yr.html>. The price includes a tour of the Simon Pearce glass workshop in Queechee, Vermont, lunch or dinner for two at a Simon Pearce restaurant, and five years of carbon balanced living (equal to 150 metric tons of greenhouse gas reductions). To read the TerraPass handbook for climate conscious living given to the Academy Award presenters, go to: <http://www.terrapass.com/handbook/>. February 26, 2006, <http://www.terrapass.com/lp/index.oscars.html>.

Chicago Climate Exchange Press Release, "Chicago Climate Exchange Sets New Record Trading Month." On March 1, Chicago Climate Exchange (CCX) announced a new record for carbon dioxide (CO₂) trading volumes in February 2007. Trading numbers reached 3,712,100 metric tons of CO₂, which is the highest trading month in the history of the CCX. The cap-and-trade program is the world's first and North America's only legally binding greenhouse gas reduction and trading system for emissions sources and offset projects. March 1, 2007, http://www.chicagoclimatex.com/news/press/release_20070301_CCX.pdf.

Recent Publications

"The Future of Coal – Living in a Carbon Constrained World." An interdisciplinary Massachusetts Institute of Technology (MIT) faculty group examined the role of coal in a world where constraints on carbon dioxide emissions are adopted to mitigate global climate change. This follows "The Future of Nuclear Power" which focused on carbon dioxide emissions-free electricity generation from nuclear energy and was published in 2003. This report, the future of coal in a carbon-constrained world, evaluates the technologies and costs associated with the generation of electricity from coal along with those associated with the capture and sequestration of the

carbon dioxide produced coal-based power generation. Growing electricity demand in the US and in the world will require increases in all generation options (renewables, coal, and nuclear) in addition to increased efficiency and conservation in its use. Coal will continue to play a significant role in power generation and as such carbon dioxide management will become increasingly important. This study, addressed to government, industry and academic leaders, discusses the interrelated technical, economic, environmental and political challenges facing increased coal-based power generation while managing carbon dioxide emissions from this sector. The full report, which was released on March 14, 2007, can be accessed by going to: <http://web.mit.edu/coal/>. To listen to a related story on National Public Radio's *Morning Edition*, "Scientists Hunt for Solution to Carbon Dioxide Problem," go to: <http://www.npr.org/templates/story/story.php?storyId=7874053>. This feature includes comments by Sean Plasynski, Sequestration Technology Manager at the Department of Energy's National Energy Technology Laboratory.

"Confronting Climate Change: Avoiding the Unmanageable and Managing the Unavoidable." For this report, the Scientific Expert Group on Climate Change and Sustainable Development (SEG) was asked to consider innovative approaches for mitigating and/or adapting to projected climate changes and to anticipate the effectiveness, cost, and implementation of possible response measures. After addressing the comments made during a wide-reaching review process and carefully considering the actions that are needed to stem the tide of climate change, the SEG prepared this final report conveying its findings and recommendations. The authors believe that these recommendations are consistent with the findings of the Intergovernmental Panel on Climate Change and will be broadly endorsed by the expert community, which agrees that both near- and long-term efforts to mitigate and adapt to climate change need to be intensified, while at the same time strengthening efforts to promote equitable and sustainable economic development. In this report, Chapter 1 summarizes the key aspects of the science of climate change and associated environmental and societal impacts. Chapter 2 provides a review of the technological options for slowing climate change by limiting emissions of greenhouse gases. In this light, several recommendations are made to fulfill the objective set forth in the 1992 United Nations Framework Convention on Climate Change. Chapter 3 offers guidance on making society less vulnerable and even more resilient to the changing climate. These chapters make clear that it is critical to begin both mitigation and adaptation, focusing in early efforts on steps that offer cost-effective

opportunities and ways to reduce pollution and other maladaptations to the current climate, while establishing the rules and incentives to spur long-term investment and change through a portfolio of approaches. The pdf of the full report, which was published in February 2007, can be accessed at: http://www.unfoundation.org/files/pdf/2007/SEG_Report.pdf.

"The association between climatic factors and childhood illnesses presented to hospital emergency among young children." This study has examined the relationship between climatic factors and common childhood illnesses among young children presented to an emergency department. To the knowledge of the author, this is one of very few studies that have investigated this specific topic of environmental child health. The results suggest that climatic factors are influential to the physical health of young children. The maximum daily temperature has been shown to be a significant risk factor for common childhood illnesses. It is positively and significantly associated with emergency presentations of fever and gastroenteritis among children younger than 6 years old. On the other hand, the UV index is negatively related to gastroenteritis only. None of the climatic variables are found to be associated with emergency presentations due to respiratory problems. These results on childhood morbidity, on the whole, are consistent with that obtained from previous studies on adults' mortality and all-ages morbidity and mortality studies by Semenza et al (1996, 1999). A detrimental effect of climatic variation, particularly temperature changes, on physical health among children has been suggested from these results. **(See Science section of this newsletter, "Heating Planet 'Makes Children Sick'," for an article pertaining to the study.)** Lawrence T. Lam, *International Journal of Environmental Health Research*, Volume 17, Issue 1, February 2007, Pages 1-8. <http://www.informaworld.com/smpp/content?content=10.1080/09603120601124264>. (Subscription required.)

Legislative Activity

E&E Daily, "Congress to Evaluate Carbon Taxes as Part of Warming Solution." Two separate hearings that may address the possibility of imposing a carbon tax to reduce greenhouse gas emissions are scheduled to take place on Capitol Hill. The proposals under consideration would create new taxes on fossil fuels and carbon dioxide (CO₂) emissions. A difference of opinion exists with

lawmakers, however, as many believe that a cap-and-trade system would be a better approach to resolve the problem. Advocates of a carbon tax defend their approach due to its simplicity of applying a fixed cost on coal, oil and other sources of greenhouse gas emissions. They claim that cap-and-trade programs are more difficult to administer and more susceptible to corruption. Proponents of a carbon tax also site the increased revenue that the tax could bring to the government. An estimate released by the Congressional Budget Office stated that an additional \$11.8 billion in revenue could result in 2008 alone with approval of a tax of \$4 per ton of CO₂ released into the atmosphere. An additional \$95.4 billion in revenue could be seen by 2012. Observers of the global warming policy debate explain that a cap-and-trade system is, in effect, a carbon tax, because whether a company is paying a straight out tax or whether they are investing money from emissions into trading markets, they are still required to pay for emissions. The Senate Finance Committee will hold the first of the proposed hearings on February 27 and is likely to explore carbon taxes and other energy incentives. Similarly, Representative Charles Rangel (D-NY), the chairman of the House Ways and Means Committee, will hold the first in a series of hearings on energy and climate change issues on February 28. Proponents of a carbon tax are keeping a watchful eye on Representative Fortney "Pete" Stark (D-CA), who is also a member of the Ways and Means Committee. He has expressed his own ideas about plans to introduce legislation that would put a tax on coal, petroleum and natural gas based on their carbon content. It may be difficult for legislation of this type to pass into law, as was the case with former President Clinton's appeal to Congress in 1993 to pass legislation taxing energy based on its British thermal unit output, otherwise known as the Btu tax. The consensus on Capitol Hill is that lawmakers are much more likely to pass cap-and-trade legislation over the imposition of a carbon tax. For one, the Bush administration has signaled no interest in carbon taxes and, if passed, a carbon tax would undercut US farmers who would earn as much as \$8 billion a year in payments through the cap-and-trade plan described in a bill by Senator Joe Lieberman (I-CT), and whereby any revenue raised by the program would be put into a "trust fund" that would be used for energy technologies, for example. Finally, opponents also state that imposing a carbon tax would not guarantee any specific reductions in emissions. February 26, 2007, <http://www.eenews.net/EEDaily/print/2007/02/26/1>. (Subscription may be required.)

U.S. House of Representatives, Committee on Science and Technology, Legislative Highlights, "National Carbon Dioxide Storage Capacity Assess-

ment Act of 2007," and "Congress Pushes to Catalog Nation's Capacity to 'Bottle' Carbon Emissions from Coal and Other Energy Plants."

US Senators Ken Salazar and Jim Webb have introduced a bill which authorizes the US Geological Service (USGS), in cooperation with the Department of Energy and the Environmental Protection Agency to conduct a comprehensive inventory of carbon dioxide storage capacity in geologic features and other natural basins. The bill was co-sponsored by Senator Jeff Bingaman (D-NM). Also introduced was the House companion bill by Representative Bart Gordon (D-TN), Chairman of the Committee on Science and Technology. The National Carbon Dioxide Storage Capacity Assessment Act of 2007 would authorize the federal government to spend \$20 million on the inventory process. Congress would need to appropriate the funds. This bill would also require the USGS to develop an official methodology of the assessment that will then be reviewed by a panel of experts and the public for accuracy. To read the text of the house version as a pdf file, click on: http://democrats.science.house.gov/Media/File/Commdocs/carbondioxide_act.pdf. To read the Senate version of the bill, click on: <http://salazar.senate.gov/images/pdf/070301env.pdf>. March 1, 2007, http://science.house.gov/legislation/leg_highlights_detail.aspx?NewsID=1587, and <http://science.house.gov/press/PRArticle.aspx?NewsID=1590>.



Events

May 7-10, 2007, **Sixth Annual Conference on Carbon Capture and Sequestration**, *Sheraton at Station Square, Pittsburgh, PA*. This conference will bring together the experts directly involved in developing, demonstrating and deploying carbon capture, separation and sequestration technologies as part of the Administration's Climate Change Technology Program. In addition, this year the Carbon Sequestration Leadership Forum Task Force on Capacity Building in Emerging Economies will sponsor a Workshop in conjunction with the conference devoted to possible approaches that can be undertaken to build capacity in the governmental and industrial sector to facilitate the development, deployment and public acceptance of carbon capture and sequestration. For conference and registration information, see: <http://www.carbonsq.com/>.

April 3-4, 2007, **Carbon Markets Americas**, *Hotel Sofitel, Rio de Janeiro, Brazil*. International Carbon Markets experts will meet in Rio de Janeiro to address the challenges and opportunities of launching new carbon mitigation projects across the region. Additionally, an intensive one-day seminar will be held that will provide project developers with the expertise and knowledge to successfully enter the carbon market. Combining expert presentations with practical case study analysis, the seminar will serve as an introduction to anyone wanting to further their knowledge or embark on a Clean Development Mechanism project. To download a conference brochure, go to: http://www.greenpowerconferences.com/carbonmarkets/documents/CarbonMarketsAmericasBrochure_001.pdf.

April 15-20, 2007, **European Geosciences Union General Assembly 2007**, *Austria Centre Vienna, Vienna, Austria*. The Assembly is open to scientists from around the world. Presentations will include results from national and international R&D projects, fundamental and concept studies, and pilot and large-scale projects. Sessions specific to carbon sequestration include CO₂ storage in unminable coal seams and advances in CO₂ storage in geological systems, which includes a forum to discuss developments in the field of anthropogenic storage of CO₂. See the following website for more information: <http://meetings.copernicus.org/egu2007/>.

April 16-17, 2007, **The Wall Street Green Trading Summit VI**, *Reuters Building, New York City*. This year promises to be one of accelerated market development for both emissions and renewable energy trading building on the success of the EU ETS and other trading initiatives. Speakers from investment banking, hedge funds, venture capital, insurance, and the brokerage community will present on the trading opportunities in alternative energy, project finance, carbon market developments, REC trading and demand response programs. For registration information and a link to download the event brochure, go to: https://www.hedgeconnection.com/atlas/event_viewer.php?eid=2.

April 19-20, 2007, **The 18th Global Warming and International Conference and Expo (GW18)**, *Sheraton Miami Mart Hotel and Convention Center, Miami Florida*. Historically, GW represents the oldest and most consistently sustained conference dedicated to the exchange of scientific data, governmental assessments, and public policies concerning global climate change, including global warming and extreme climatic events. More detailed information can be found at: <http://www.gw18.globalwarming.net/index.php>.

Events (continued)

April 22-26, 2007, **AICHE 2007 Spring National Meeting**, *Hilton Americas Houston, Houston, Texas*. A session on carbon dioxide (CO₂) capture and storage will concentrate on new or improved methods of CO₂ capture from advanced power systems and large industrial plants that can significantly reduce CO₂ capture costs and associated energy requirements. Separations involving both gas phase and liquid phase operations, as well as hybrid processes such as adsorption/membrane systems, will be included. This session will deal not only with the capture of CO₂ from flue gas and other streams, but also with the behavior and interactions of CO₂ after it has been injected into a geologic formation. For conference and registration information, go to: <http://www.iche.org/Conferences/SpringMeeting/index.aspx>.

May 1, 2007, **Emissions Trading and the Road Transport Sector**, *Energy Institute, London, England*. This one-day event will present and discuss the latest thinking on the potential for introducing a carbon emissions trading system for the road transport sector. This event is a collaboration between the Low Carbon Vehicle Partnership and the Energy Institute. To visit the conference website and download a registration form, click on: <http://www.energyinst.org.uk/index.cfm?PageID=57>.

May 1-3, 2007, **Electric Power 2007**, *Donald E. Stephens Convention Center, Chicago, Illinois*. The Electric Power Conference is programmed by the power industry--for the power industry. Electric Power brings the industry a conference program that meets the needs of the power plant owner/operator companies and project developers. Sessions include "Coal Power Plants – Upgrades and New Capacity," "Integrated Gasification Combined Cycle (IGCC), Advanced Combustion and CO₂ Capture Technologies," and "Environmental Regulatory Issues, Strategies and Technologies." For complete conference and registration information, see: <http://www.electricpowerexpo.com/index.asp>.

May 2-4, 2007, **Carbon Expo**, *Koelnmesse, 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. Participants will be able to interact with real market players representing supply and demand in the carbon market. For conference details, see: <http://www.carbonexpo.com/wEnglisch/carbonexpo2/index.htm>.

May 15-17, 2007, **Third International Conference on Clean Coal Technologies for our Future**, *T Hotel and Conference Centre, Cagliari and Sotacarbo Coal Research Centre, Carbonia, Sardinia, Italy*. The ability to use coal in an environmentally acceptable and sustainable manner is an important issue to consider. This conference will allow participants to share in the debate and formulate the important decisions that the individuals involved in the coal industry must make for the future. For further information and to visit the conference website, see: <http://www.cct2007.it/>.

May 23-24, 2007, **All-Energy '07 Exhibition and Conference**, *Aberdeen Exhibition and Conference Centre (AECC), Aberdeen, Scotland*. The All-Energy Exhibition and Conference is the United Kingdom's largest event devoted to renewable energy and is the seventh in the annual series. Admission to the exhibition and conference is free of charge to all with a professional interest in renewable/sustainable energy. A session devoted to carbon capture and storage is part of the conference agenda. Attendees can participate in a "cutting your organization's carbon footprint" clinic, and the conference website details how participants can use carbon offsetting for their air travel to the conference. For complete event information, go to: <http://www.all-energy.co.uk/Home.html>.

Events (continued)

May 24-25, 2007, **Russia and the Kyoto Protocol**, *St. Petersburg National Mining Institute, St. Petersburg, Russia*. Designated as the largest carbon market conference in Russia, this event will bring together Russian authorities, project owners and developers, emission reduction buyers, potential project hosts, technology providers, carbon investors, and analysts. The conference will include presentations and discussions on Russia's share of the global carbon market, with specific focus on Assigned Amount Units (AAU) trading and investing in Joint Investment projects in Russia. For online registration and to view the conference program, go to: <http://www.pointcarbon.com/Events/Other%20Point%20Carbon%20events/article20697-406.html>.

May 29-31, 2007, **Corporate Climate Response**, *CBI Conference Centre, London, England*. Through a series of corporate case studies and expert panels this conference will highlight and benchmark how leading companies are responding to the challenges and opportunities of climate change. Issues to be covered include: Implications of the Energy Performance Commitment, offsetting, renewables, benchmarking, strategy and senior management. For event details, go to: http://www.greenpowerconferences.com/corporateclimateresponse/ccr_london07.html.

June 4-5, 2007, **European Carbon Capture and Storage Conference**, *Amsterdam, Netherlands*. Carbon capture and storage appears as a highly attractive idea. It offers to resolve the contradiction between limiting carbon dioxide emissions and meeting growing energy demand. Moreover, it promises to do so without a radical change in energy sources, thereby avoiding the tremendous challenges posed by transitioning to a nonhydrocarbon based energy economy. Even on a small scale, it would provide a valuable wedge in the gradual transition to more sustainable energy systems. This conference will bring together key leaders from across Europe to share the challenges of development, manage the risks and ensure viability. For details about the event or to request a brochure, see: <http://www.platts.com/Events/pc773/>.

June 14-15, 2007, **Carbon Markets Asia**, *Orchard Hotel Singapore, Singapore*. Asia is fast becoming one of the world's most exciting carbon markets. In the seven months since last year's Carbon Markets Asia 2006 event over 140 new Clean Development Mechanism (CDM) projects have been listed across the region, and the pace does not appear to be slowing down. This event will bring together the

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