



Carbon Sequestration Newsletter

SEPTEMBER 2008

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Carbon Sequestration

INTRODUCTION

This Newsletter is created by the National Energy Technology Laboratory and represents a summary of carbon sequestration news covering the past month. Readers are referred to the actual article(s) for complete information. It is produced by the National Energy Technology Laboratory to provide information on recent activities and publications related to carbon sequestration. It covers domestic, international, public sector, and private sector news.

HIGHLIGHTS

Fossil Energy Techline, "DOE Project Starts CO₂ Sequestration in New Mexico Coalbed."

The US Department of Energy's (DOE) Southwest Regional Partnership (SWP) began injecting a planned 35,000 tons of carbon dioxide (CO₂) in an enhanced coalbed methane (CBM) recovery project that will develop methods to maximize permanent storage of CO₂ at the San Juan Basin near Navajo City, New Mexico. The San Juan Basin, which contains coal at approximate depths of 3,000 feet, was chosen for the six-month

demonstration project because it is regarded as one of the top basins in the world for CBM recovery due to its favorable geology, high methane content, nearby availability of CO₂ from power plants, low capital and operating costs, and well-developed natural gas and CO₂ pipelines. The basin consists of three CBM-producing wells and a centrally located injection well. The coal seams are approximately 75 feet thick and are split among three seams over a 175-foot interval. In addition, the San Juan Basin contains highly permeable coal that is required for maintaining effective CO₂ injective rates over time; DOE established the maintenance of high injection rates as a goal for large-scale CO₂ sequestration in coal. CBM production typically results in a heavy amount of produced water, which SWP plans to desalinate and use to irrigate nearby areas affected by prolonged drought. The resulting vegetation growth could induce additional CO₂ uptake. The SWP, led by the New Mexico Institute of Mining and Technology, is one of seven Regional Carbon Sequestration Partnerships (RCSPs) managed by DOE's National Energy Technology Laboratory (NETL). The partnership includes the states of Colorado, Oklahoma, New Mexico, Utah, and portions of Arizona, Kansas, Texas, and Wyoming. SWP is currently conducting three geological field tests and two terrestrial field tests, each designed to validate promising carbon sequestration technologies and infrastructure concepts. To learn more about NETL's RCSP Program, visit: <http://www.fossil.energy.gov/programs/sequestration/partnerships/index.html>. For information about SWP, go to: <http://www.southwestcarbonpartnership.org/>. August 4, 2008, http://www.fossil.energy.gov/news/techlines/2008/08031-San_Juan_Basin_CO2_Injection.html.

Fossil Energy Techline, "DOE to Provide \$36 Million to Advance Carbon Dioxide Capture."

On July 31, DOE announced that 15 projects will receive \$36 million to further develop new, cost-effective technologies that capture CO₂ from the existing fleet of coal-fired power plants. The technologies involve membranes, solvents, sorbents, oxycombustion (both flue gas purification and boiler development), and chemical looping. In particular, membrane-based projects will address technical issues like large flue gas volume, relatively low CO₂ concentration, low flue gas pressure, flue gas contaminants, and the need for high membrane surface area. Solvent-based and solid sorbent-related projects will address technical challenges such as large flue gas volume, relatively low CO₂ concentration, and flue gas contaminants, among other issues. Oxycombustion flue gas purification and boiler development will develop methods to reduce the levels of unwanted compounds (e.g., nitrogen, sulfur oxides [SO_x], nitrogen oxides [NO_x], and/or mercury [Hg]) in



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HIGHLIGHTS (CONTINUED)

flue gas and conduct laboratory- and bench-scale research into boiler characteristics and design. Chemical looping projects will research solids handling and oxygen carrier capacity, reactivity, and attrition. For more information about DOE's carbon capture projects for existing power plants, visit: <http://www.fossil.energy.gov/programs/powersystems/pollutioncontrols/index.html>. July 31, 2008, http://www.fossil.energy.gov/news/techlines/2008/08030-CO2_Capture_Projects_Selected.html.

SEQUESTRATION IN THE NEWS

EERC News Release, "EERC's Plains CO₂ Reduction Partnership and Ducks Unlimited Announce Carbon Credit Program."

A carbon offset program has been created by the Energy and Environmental Research Center's (EERC) Plains CO₂ Reduction Partnership (PCOR) and Ducks Unlimited, Inc., a leading waterfowl conservation organization. The program intends to help mitigate the effects of climate change by securing native and planted grasslands, reducing negative impacts on duck and other wildlife habitats, and ensuring that existing soil carbon will not be exposed to the atmosphere. Participating landowners who wish to ensure that existing soil carbon remains sequestered in their native prairie or expired Conservation Reserve Program land can enroll in the US Fish and Wildlife Service's Grassland Easement Program, which prohibits their grassland from being plowed. When the land is secured by the US Fish and Wildlife Service, Ducks Unlimited will purchase the carbon rights to the land, which will then be transferred to the Eco Products Fund (EPF); EPF will then sell the credits in the voluntary carbon market. Landowners who enroll and forward the carbon rights to Ducks Unlimited will be provided with a one-time payment through the carbon credit program. Ducks Unlimited is a member of PCOR, one of the seven RCSPs funded by NETL, and researches best management practices for PCOR's terrestrial field validation test. To view the PCOR website, go to: <http://www.undeerc.org/pcor/default.asp>. To visit the Ducks Unlimited website, click: <http://www.ducks.org/>. August 8, 2008, <http://www.undeerc.org/news/newsitem.aspx?id=321>.

Daily Press, "Va. Project Aimed at Reducing Carbon Footprint," and TriCities.com, "Carbon Storage Test Called Key to Coal's Future."

A Southeast Carbon Sequestration Partnership (SECARB) project that will inject 1,000 tons of CO₂ into unmineable coal seams is underway in Russell County in southwest Virginia. The project, which is the first of its kind in the central Appalachian region, will use a pre-existing CBM well that was converted for CO₂ injection. The test is the second of three phases in a project aimed at demonstrating the commercial viability of carbon storage technology. Results are expected in January 2009. The first phase of SECARB's efforts entailed a characterization study that showed a storage capacity of up to 1.34 billion tons. The \$100 million third phase, requiring a \$60 million Federal investment co-funded by state and industry investments, is planned as a large-scale test to inject 100,000 tons of CO₂. A similar test is planned for the Black

SEQUESTRATION IN THE NEWS (CONTINUED)

Warrior Basin in Alabama. The Virginia Center for Coal and Energy Research (VCCER) at Virginia Tech will conduct the research for this project through the Southern States Energy Board, the lead entity for SECARB. For information about SECARB projects, visit: <http://www.secarbon.org/>, or click: <http://www.netl.doe.gov/publications/factsheets/project/Proj442.pdf> to view the NETL project fact sheet. August 18, 2008, <http://www.dailypress.com/news/local/virginia/dp-va--carbondioxidere0818aug18,0,4329136.story>. August 18, 2008, http://www.tricitie.com/tri/news/local/article/carbon_storage_test_called_key_to_coals_future/12834/. (Video included.)

Providence Press Release, "Providence and Star Energy Commence 'ULYSSES' Project," and The Telegraph, "Irish Energy Group in Carbon Capture Scheme."

Providence Resources, an Irish oil and gas production and development company, has teamed with Star Energy Group, a United Kingdom-based gas storage company, to study the CO₂ sequestration potential of the Kish Bank Basin located in the Irish Sea. The CO₂ sequestration assessment, called the Undersea Large-scale Saline Sequestration and Enhanced Storage (ULYSSES) Project, is part of a larger work program that will also evaluate natural gas storage. Over the next year, the ULYSSES Project will investigate the possible use of Triassic-aged saline sandstone reservoirs as CO₂ storage sites; these locales have been determined by numerous oil and gas wells drilled into the basin over the past 30 years. The saline reservoirs, located about 12.4 miles offshore of Dublin, Ireland, and approximately one mile below the seabed, are covered by an overlying layer of shale. If successful,

two Dublin-based power plants at the Ireland Electricity Supply Board-owned Poolbeg Generating Station will be targeted to capture CO₂. The project is similar to the Sleipner CO₂ sequestration project, which has successfully sequestered 10 million tonnes of CO₂ in the Norwegian North Sea since project start-up in 1996. The project recently received a three-year licensing option over several blocks in the Kish Bank Basin by the Irish government's Department of Energy, Communications and Natural Resources. August 18, 2008, <http://www.providenceresources.com/html/documents/PROVIDENCEANDSTARCOMMENCEULYSSESSTUDY-AUGUST2008.pdf>, and August 17, 2008, <http://www.telegraph.co.uk/money/main.jhtml?view=DETAILS&grid=&xm1=/money/2008/08/18/cnulys118.xml>.

Reuters, "Norway Agrees \$60 Million Carbon Capture Research," and Aker Clean Carbon Press Release, "Major Research Programme for CO₂-Capture."

A collaborate of Norwegian research groups and Aker ASA agreed to invest \$58.97 million for a research project to generate more cost effective CO₂ capture technology. The first research phase of the project will run until late 2010 and test amine-based solutions that have the ability to cleanse CO₂ emissions from coal- and gas-fired power stations. A new laboratory will house a test center for pilot projects, complete with a 98-foot tall tower and processing column that reaches 82 feet – similar to the height of full-scale industrial facilities. The eight-year science and development program, called SOLVIT, was created by the independent research organization SINTEF, the Norwegian University of Science and Technology, and Aker Clean Carbon. August 14, 2008, <http://uk.reuters.com/article/scienceNews/idUKLE13903620080814?pageNumber=1&virtualBrandChannel=10174&sp=true>, and August 14, 2008, http://www.akercleancarbon.com/publish_files/SOLVIT-endelig-eng.pdf.

ANNOUNCEMENTS

Carbon Sequestration Atlas of the United States and Canada.

NETL received an APEX Grand Award from Communications Concepts, Inc. for its Carbon Sequestration Atlas of the United States and Canada. This publication, compiled by DOE/NETL, the Regional Carbon Sequestration Partnerships, and the National Carbon Sequestration Relational Database and Geographical Information System (NATCARB), presents the first coordinated assessment of carbon capture and storage (CCS) potential across the majority of the United States and portions of Western Canada. The Atlas provides an overview of the entire CO₂ capture and sequestration process and summarizes DOE's sequestration activities. The Atlas is being updated and is expected to be re-released in November 2008. To view the Atlas, click: http://www.netl.doe.gov/technologies/carbon_seq/refshelf/atlas/ATLAS.pdf.

The Carbon Sequestration Newsletter Annual Index.

The Carbon Sequestration Newsletter Annual Index, covering the September 2007 to August 2008 issues of NETL's Carbon Sequestration Newsletter, is now available at: http://www.netl.doe.gov/technologies/carbon_seq/refshelf/subscribe.html.

Regional Carbon Sequestration Partnerships Initiative Review Meeting.

This NETL-hosted event will focus on topics such as: CO₂ sequestration in oil fields and coal seams; sequestration in saline formations; and RCSP field tests. RCSP representatives will review their activities from Phase II of the NETL-managed program and discuss the progress of their Phase III field tests. The meeting will take place on October 6-8, 2008, at the Hyatt Regency Pittsburgh International Airport Hotel in Pittsburgh, Pennsylvania. To view an online brochure, go to: <http://www.netl.doe.gov/events/08conferences/rcsp/2008CarSeqPIRMagenda.pdf>.

ANNOUNCEMENTS (CONTINUED)

Teacher Training Opportunity.

The Keystone Center for Education is holding a teacher training, titled, "CSI: Climate Status Investigations," in southeastern New Mexico on September 25-26, 2008. Hosted by SWP, the training will use hands-on, inquiry-based activities to help teachers explore global climate change with their students by examining economic, environmental, and social factors. To view the online brochure, go to: http://www.southwestcarbonpartnership.org/_Resources/PDF/NM%20Brochure.pdf.

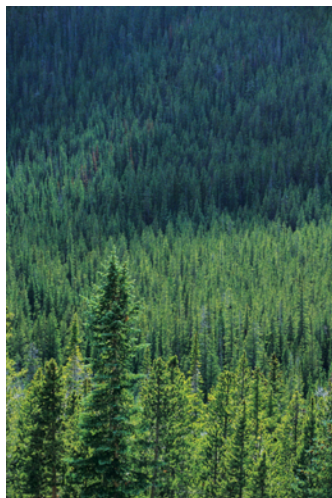
Carbon Dioxide Group Launched.

Scientists at Durham University launched the Carbon Storage Research Group to find efficient and reliable ways of gathering and storing CO₂ from fossil fuel-fired power plants. The new professorship is a three-way partnership between Durham University's Centre for Research into Earth Energy Systems (CeREES), DONG Energy, and Ikon Science. To learn more, go to: <http://www.dur.ac.uk/news/newsitem/?itemno=6776>.

SCIENCE

Reuters, "Untouched Forests Store 3 Times More Carbon: Study," and The Age, "Trees Will Fight Climate Change: Report."

According to a study conducted by scientists at the Australian National University (ANU), Australia's untouched natural forests store three times more CO₂ than originally estimated and 60 percent more than plantation forests. The report, titled, "Green carbon: the role of natural forests in carbon storage," found that the effect of retaining the current carbon stock of 25.5 billion tonnes of CO₂ in the Eucalypt forests of southeast Australia is equivalent to avoiding 460 million tonnes of CO₂ emissions over the next 100 years.



The Intergovernmental Panel on Climate Change (IPCC), which bases forest carbon storage on plantation estimates, defines a forest as trees taller than six feet and a canopy cover greater than 10 percent. However, in Australia a forest is defined as an area having trees taller than 33 feet and a canopy cover greater than 30 percent. IPCC originally estimated temperate forests held 217 tonnes of CO₂ per hectare, but the ANU report found Australia's forests stored an average of 640 tonnes per hectare, and in some areas with trees as high as 262 feet, the forests stored as much as 2,000 tonnes per hectare. Scientists believe that if the 14.5 million hectares of eucalypt forests in Australia are left undisturbed, some 9.3 billion tonnes of CO₂ could be stored; IPCC has estimated one-third of this potential capacity. Scientists believe natural forests store more carbon for a longer period of time than plantation forests because they are not cut down on a rotational basis. To read the complete ANU report, go to: http://epress.anu.edu.au/green_carbon/pdf/whole_book.pdf. August 4, 2008, <http://www.reuters.com/article/environmentNews/idUSSP25595420080804>, and August 4, 2008, <http://news.theage.com.au/national/trees-will-fight-climate-change-report-20080805-3q1n.html>.

Science Daily, "Some African Drought Linked To Warmer Indian Ocean, NASA Data Show."

A study co-funded by the National Aeronautics and Space Administration (NASA) and the United States Geological Survey (USGS) identified a connection between a warming Indian Ocean and declining rainfall in eastern and southern Africa. Since the 1980s, rainfall in eastern Africa has fallen about 15 percent during the rainy season, which runs from March through May, due to abnormalities in the transfer of moisture between the ocean and land caused by rising Indian Ocean temperatures. By analyzing seasonal rainfall data from 1950 to 2005, NASA found the declines in rainfall in Ethiopia, Kenya, Tanzania, Zambia, Malawi, and Zimbabwe were linked to rainfall increases over the Indian Ocean. The researchers simulated future rainfall changes through the use of 11 climate models that showed the increased rainfall over the Indian Ocean would continue through 2050. The research team then developed a model to determine how the future rainfall conditions could affect malnutrition in eastern Africa. The models revealed that if the current trends of declining rainfall and agricultural capacity persist through 2030, the number of malnourished individuals could increase more than 50 percent in eastern Africa; even if agricultural capacity modestly increased, the researchers believe the number of malnourished individuals would increase 40 percent. The complete study, titled, "Warming of the Indian Ocean threatens eastern and southern African food security but could be mitigated by agricultural development," is available at: <http://www.pnas.org/content/105/32/11081.abstract?sid=6c5ed07f-7b7f-4321-ac7b-2a67887cdd5e>. August 7, 2008, <http://www.sciencedaily.com/releases/2008/08/080805124005.htm>.

POLICY

Bloomberg, "Japan Power Exchange to Start Carbon-Credit Trading in October."

Following Japanese Prime Minister Yasuo Fukuda's announcement before a Group of Eight (G-8) meeting in early July to reduce Japan's greenhouse gases (GHGs) by more than half and the subsequent endorsement by the Prime Minister's cabinet, the Japan Electric

POLICY (CONTINUED)

Power Exchange will begin trading carbon credits on a trial basis in October 2008 and increase research on carbon capture technology. The trade ministry has directed the 39-member stock exchange in Tokyo to design an experimental, web-based trading platform with the credits being traded in yen per metric ton. Under this plan, the stock exchange will match the bids and offers placed on the trading platform. Tokyo Electric Power Co., Merrill Lynch & Co., and Mitsubishi Corp. are among those who are expected to use the trading platform. The United Nations' (UN) Clean Development Mechanism (CDM) allows rich, polluting countries to buy credits from projects that cut emissions in the poorer nations; the credits are tradable on the European Climate Exchange (ECX). The Japanese government will monitor the trial trading process to determine if any adjustments are needed before full-fledged trading can proceed. August 11, 2008, <http://www.bloomberg.com/apps/news?pid=20601101&sid=aTfts8D4pzN0&refer=japan>.

“Modeling the Price Dynamics of CO₂ Emission Allowances.”

In this paper [the authors] analyze the short-term spot price behavior of carbon dioxide (CO₂) emission allowances of the new EU-wide CO₂ emissions trading system (EU ETS). After reviewing the stylized facts of this new class of assets [the authors] investigate several approaches for modeling the returns of emission allowances. Due to different phases of price and volatility behavior in the returns, [the authors] suggest the use of Markov switching and AR-GARCH models for stochastic modeling. [The authors] examine the approaches by conducting an in-sample and out-of-sample forecasting analysis and by comparing the results to alternative approaches. [The authors'] findings strongly support the adequacy of the models capturing characteristics like skewness, excess kurtosis and in particular different phases of volatility behavior in the returns. **Eva Benz and Stefan Trück**, *Energy Economics*, Available online July 16, 2008, doi:10.1016/j.eneco.2008.07.003, <http://www.sciencedirect.com/science/article/B6V7G-4T0MMJH-1/2/991161593335051c51f268dd12ee5024>. (Subscription may be required.)

GEOLOGY

“Comparison of adsorption models in reservoir simulation of enhanced coalbed methane recovery and CO₂ sequestration in coal.”

The following is the abstract of this article: “Coalbed methane is an important resource of energy. Meanwhile CO₂ sequestration in coal is a potential management option for greenhouse gas emissions. An attractive aspect to this process is that CO₂ is adsorbed to the coal, reducing the risk of CO₂ migration to the surface. Another aspect to this is that the injected CO₂ could displace adsorbed methane leading to enhanced coalbed methane recovery. Therefore, in order to understand gas migration within the reservoir, mixed-gas adsorption models are required. Moreover, coal reservoir permeability will be significantly affected by adsorption-induced coal swelling during CO₂ injection. Coal swelling is directly related to reservoir pressure and gas content which is calculated by adsorption models in reservoir simulation. Various models have been studied to describe the pure- and mixed-gas adsorption on

coal. Nevertheless, only the Langmuir and Extended Langmuir models are usually applied in coal reservoir simulations. This paper presents simulation work using several approaches to representing gas adsorption, implemented into the coal seam gas reservoir simulator SIMED



II. The adsorption models are the Extended Langmuir model (ELM), the Ideal Adsorbed Solution (IAS) model and the Two-Dimensional Equation of State (2-D EOS). The simulations based on one Australian and one American coal sample demonstrated that (1) the Ideal Adsorbed Solution model, in conjunction with Langmuir model as single-component isotherm, shows similar simulation results as the ELM for both coals, with the IAS model representing the experimental adsorption data more accurately than the ELM for one coal and identically with the ELM for the other coal; (2) simulation results using the 2-D EOS, however, are significantly different to the ELM or IAS model for both coal samples. The magnitude of the difference is also dependent on coal swelling and the well operating conditions, such as injection pressure.” **Zhejun Pan and Luke D. Connella**, *International Journal of Greenhouse Gas Control*, Available online July 11, 2008, doi:10.1016/j.ijggc.2008.05.004, <http://www.sciencedirect.com/science/article/B83WP-4SYKM4C-1/1/78c694dce5925cb10b8b8afede7ab848>. (Subscription may be required.)

TECHNOLOGY

“Biofilm enhanced geologic sequestration of supercritical CO₂.”

In order to develop subsurface CO₂ storage as a viable engineered mechanism to reduce the emission of CO₂ into the atmosphere, any potential leakage of injected supercritical CO₂ (SC-CO₂) from the deep subsurface to the atmosphere must be reduced. Here, [the authors] investigate the utility of biofilms, which are microorganism assemblages firmly attached to a surface, as a means of reducing the permeability of deep subsurface porous geological matrices under high pressure and in the presence of SC-CO₂, using a unique high pressure (8.9 [millipascals]), moderate temperature (32 [degrees Celsius]) flow reactor containing 40 millidarcy Berea sandstone cores. The flow reactor containing the sandstone core was inoculated with the biofilm forming organism *Shewanella fridgidimarina*. Electron microscopy of the rock core revealed substantial biofilm growth and accumulation under high-pressure conditions in the rock pore space which caused >95 [percent] reduction in core permeability. Permeability increased only slightly in response to SC-CO₂ challenges of up to 71 [hours (h)] and starvation for up to 363 h in length. Viable population assays of microorganisms in the effluent indicated survival of the cells following SC-CO₂ challenges and starvation, although *S. fridgidimarina* was succeeded by *Bacillus mojavensis* and *Citrobacter* sp. which were native in the core. These observations suggest that engineered biofilm barriers may be used to enhance the geologic

TECHNOLOGY (CONTINUED)

sequestration of atmospheric CO₂. **Andrew C. Mitchell, Adrienne J. Phillips, Randy Hiebert, Robin Gerlach, Lee H. Spangler and Alfred B. Cunningham**, *International Journal of Greenhouse Gas Control*, Available online July 18, 2008, doi:10.1016/j.ijggc.2008.05.002, <http://www.sciencedirect.com/science/article/B83WP-4T13JHJ-1/1/ad165c642805a7faf9bb7ce1c95f4c44>. (Subscription may be required.)

“Life cycle assessment of a pulverized coal power plant with post-combustion capture, transport and storage of CO₂.”

In this study the methodology of life cycle assessment has been used to assess the environmental impacts of three pulverized coal-fired electricity supply chains with and without carbon capture and storage (CCS) on a cradle to grave basis. The chain with CCS comprises post-combustion CO₂ capture with monoethanolamine, compression, and transport by pipeline and storage in a geological reservoir. The two reference chains represent sub-critical and state-of-the-art ultra supercritical pulverized coal fired electricity generation. For the three chains [the authors] have constructed a detailed greenhouse gas (GHG) balance, and disclosed environmental trade-offs and co-benefits due to CO₂ capture, transport, and storage. Results show that, due to CCS, the GHG emissions per kilowatt (kWh) are reduced substantially to 243 [gram (g)]/kWh. This is a reduction of 78 and 71 [percent] compared to the sub-critical and state-of-the-art power plant, respectively. The removal of CO₂ is partially offset by increased GHG emissions in up- and downstream processes, to a small extent (0.7 g/kWh) caused by the CCS infrastructure. An environmental co-benefit is expected following from the deeper reduction of hydrogen fluoride and hydrogen chloride emissions. Most notable environmental trade-offs are the increase in human toxicity, ozone layer depletion and fresh water ecotoxicity potential for which the CCS chain is outperformed by both other chains. The state-of-the-art power plant without CCS also shows a better score for the eutrophication, acidification, and photochemical oxidation potential despite the deeper reduction of SO_x and NO_x in the CCS power plant. These reductions are offset by increased emissions in the life cycle due to the energy penalty and a factor five increase in [ammonia (NH₃)] emissions. **Joris Koornneef, Tim van Keulen, André Faaij and Wim Turkenburg**, *International Journal of Greenhouse Gas Control*, Available online July 23, 2008, doi:10.1016/j.ijggc.2008.06.008, <http://www.sciencedirect.com/science/article/B83WP-4T24FXP-2/1/366b12c51cc4b5824ab80be4e7e141c2>. (Subscription may be required.)

“Evaluating cubic equations of state for calculation of vapor-liquid equilibrium of CO₂ and CO₂-mixtures for CO₂ capture and storage processes.”

Proper solution of vapor liquid equilibrium (VLE) is essential to the design and operation of CO₂ capture and storage system (CCS). According to the requirements of engineering applications, cubic equations of state (EOS) are preferable to predict VLE properties. This paper evaluates the reliabilities of five cubic EOSs, including [Peng-Robinson (PR), Patel-Teja (PT), Redlich-Kwong (RK), Soave-Redlich-Kwong (SRK) and 3P1T] for predicting VLE of CO₂ and

binary CO₂-mixtures containing [methane (CH₄), hydrogen sulfide (H₂S), sulfur dioxide (SO₂), argon (Ar), nitrogen (N₂) or oxygen (O₂)], based on the comparisons with the collected experimental data. Results show that SRK is superior in the calculations about the saturated pressure of pure CO₂; while for the VLE properties of binary CO₂-mixtures, PR, PT and SRK are generally superior to RK and 3P1T. The impacts of binary interaction parameter *k_{ij}* were also analyzed. *k_{ij}* has clear effects on the calculating accuracy of an EOS in the property calculations of CO₂-mixtures. In order to improve the calculation accuracy, the binary interaction parameter was calibrated for all of the studied EOSs regarding every binary CO₂-mixture. **H. Li and J. Yan**, *Applied Energy*, Available online July 24, 2008, doi:10.1016/j.apenergy.2008.05.018, <http://www.sciencedirect.com/science/article/B6V1T-4T29WNV-1/1/192bceb4888df25879f5cf767418b3a0>. (Subscription may be required.)



TERRESTRIAL/OCEAN

“Cover crops enhance soil organic matter, carbon dynamics and microbiological function in a vineyard agroecosystem.”



Impacts of soil tillage and cover crops on soil carbon dynamics and microbiological function were investigated in a vineyard grown in California's mediterranean climate. [The authors] (1) compared soil organic matter (SOM), carbon dynamics and microbiological activity of two cover crops [Trios 102 (Triticale × Trioiscale) ('Trios'), Merced Rye (Secale cereale) ('Rye')] with cultivation ('Cultivation') and (2) evaluated seasonal effects of soil temperature, water content, and precipitation on soil carbon dynamics (0 to 15 cm depth). From treatments established in November 2001, soils were sampled every 2 to 3 weeks from November 2005 to November 2006. Gravimetric water content (GWC) reflected winter and spring rainfall. Soil temperature did not differ among treatments, reflecting typical seasonal patterns. Few differences in carbon dynamics between cover crops existed, but microbial biomass carbon (MBC), dissolved organic carbon (DOC), and carbon dioxide (CO₂) efflux in 'Trios' and 'Rye' were consistently 1.5 to 4-fold greater than 'Cultivation'. Cover crops were more effective at adding soil carbon than 'Cultivation'. Seasonal patterns in DOC, and CO₂ efflux reflected changes in soil water content, but MBC displayed no temporal response. Decreases in DOC and potential microbial respiration (RESP_{mic}) (i.e., microbially available carbon) also corresponded to or were preceded by increases in CO₂ efflux, suggesting that DOC provided carbon for microbial respiration. Despite similar MBC, DOC, RESP_{mic}, annual CO₂ efflux and aboveground carbon content between the two cover crops, greater aboveground net primary productivity and SOM in 'Trios' indicated that 'Trios' provided more soil carbon than 'Rye.' **Kerri Steenwerth and K.M. Belina**, *Applied Soil Ecology*, Available online July 26, 2008, doi:10.1016/j.apsoil.2008.06.006, <http://www.sciencedirect.com/science/article/B6T4B-4T2RYSF-1/2/086cf7562cb2b80d9729555e13773daf>. (Subscription may be required.)

TRADING

Carbon Market Update, August 18, 2008

CCX-CFI 2008 (\$/tCO₂)
\$34.86 (Vintage 2008)

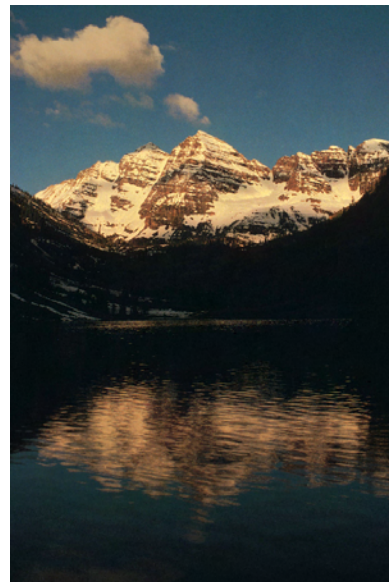
EU ETS-EUA DEC 2008
(\$/tCO₂) \$3.80

(Converted from € to US\$)

ClimateWire, “WCI Releases Design Proposal; No Auction Percentage Specified,” and *Business Green*, “Western States Plan Cap-and-Trade By 2012.”

The Western Climate Initiative (WCI) released a draft design for a carbon cap-and-trade scheme that outlines plans to cut regional emissions 15 percent below 2005 levels by 2020. The cap, which will go into effect in 2012, does not specify an emissions target; instead, the cap will start with the best estimate of actual emissions for the first the program and steadily decline through 2020. The estimate will be determined by WCI using reported data from emitters, while factoring in population and economic growth, as well as emission reductions that have occurred to date. Under the proposal, energy producers and

industrial firms emitting more than 25,000 tonnes of CO₂ equivalent a year will be required to report their emissions from 2011 ahead of the 2012 starting date. WCI is made up of seven states and four provinces and is open to accepting new members, which will be considered prior to the start of each three-year compliance period. WCI includes roughly 20 percent of the United States’ and 73 percent of Canada’s economy, respectively. To view the WCI website, visit: <http://www.westernclimateinitiative.org/index.cfm>. July 24, 2008, <http://www.eenews.net/climatewire/print/2008/07/24/3>, and July 28, 2008, <http://www.businessgreen.com/business-green/news/2222614/western-states-plan-cap-trade>.



RECENT PUBLICATIONS

“Community Acceptance of Carbon Capture and Sequestration Infrastructure: Siting Challenges.”

Congress is considering policies to reduce U.S. emissions of carbon dioxide, a major contributor to global warming. These policies include promoting the capture and sequestration of carbon dioxide (CO₂) from manmade sources such as electric power plants and manufacturing facilities. Carbon capture and sequestration (CCS) is a three-part process involving a CO₂ source facility, an intermediate mode of CO₂ transportation (pipelines), and a permanent CO₂ sequestration site. CCS is of great interest because emerging technologies may be able to remove up to 95 [percent] of CO₂ emitted from an electric power plant or other industrial source. Power plants are the most likely initial candidates for CCS because they are predominantly large, single-point sources, and they contribute approximately one-third of U.S. CO₂ emissions from fossil fuels. As U.S. carbon policies evolve, congressional policy makers are becoming aware that a national CCS program could require an extensive new network of CO₂ related infrastructure. In the 110th Congress, there has been considerable debate and legislative activity related to the technical, economic, and regulatory aspects of such infrastructure. Another key consideration, however, is public acceptance, which may ultimately determine whether, where, and how anticipated CCS projects may be constructed. Although the general public is still largely unfamiliar with CCS, there are early indications that — similar to the siting of other kinds of energy and industrial infrastructure — community acceptance may prove a significant challenge to the siting of CCS infrastructure in the United States. This Congressional Research Service (CRS) report, prepared for Congressional members and subcommittees, can be found at: http://assets.opencrs.com/rpts/RL34601_20080729.pdf.

“Ensuring Offset Quality: Integrating High Quality Greenhouse Gas Offsets Into Cap-and-Trade Policy.”

As the United States embarks on the path toward addressing climate change, multiple strategies will be needed to achieve the significant cuts in GHG emissions (“emissions”) necessary to stabilize the climate. Among the most important, complex and controversial of these strategies is the use of GHG offsets (“offsets”). An offset represents the reduction, removal or avoidance of GHG emissions from a specific project that is used to compensate for GHG emissions occurring elsewhere. While there is currently a growing voluntary market for offsets in the United States, offsets can also be effectively incorporated into mandatory policies such as cap-and-trade systems, which can be designed to allow firms to buy and trade credits generated by qualifying emission reduction projects (“projects”) outside the boundaries of the emissions cap. These are referred to as offset credits (“offsets”), and each typically represents one metric ton of carbon dioxide equivalent. Offsets are used in lieu of an emissions reduction, removal or avoidance (“reduction”) that would have otherwise been required to occur within the boundaries of the emissions cap. In other words, provided that the project meets the established eligibility criteria, the purchasing firm is allowed to use offset credits to meet its compliance obligation as though the firm had made the reduction itself. The essential promise of an offset is the achievement of a real and verifiable reduction in global GHG emission levels beyond what would have otherwise occurred that is equally effective as on-site emission reductions by regulated entities. This document, intended to provide policymakers with recommendations regarding the integration of GHG offsets into emerging regulatory systems, is available at: <http://www.offsetqualityinitiative.org/documents/WhitePaper.pdf>.

RECENT PUBLICATIONS (CONTINUED)

“Carbon Pollution Reduction Scheme Green Paper.”

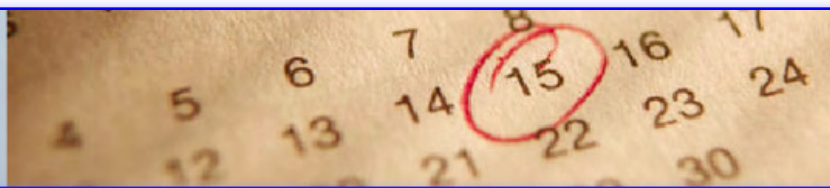
Addressing climate change is one of the key economic and environmental challenges facing Australia and the rest of the world. An effective global and domestic response to climate change is one of the highest priorities of the Australian Government. Indeed, the Government’s first official act was to ratify the Kyoto Protocol, committing Australia to play its part in addressing climate change. Climate change involves profound challenges. It has the potential to fundamentally re-shape [Australia’s] social, environmental and economic landscapes — particularly affecting water supply, agricultural industries, coastal zones and [Australia’s] natural heritage. Climate change is a by-product of industrialization. Environmental damage is caused by greenhouse gas emissions which are predominantly carbon-based. The emissions constitute carbon pollution yet those who generate the pollution are not held accountable for the costs they impose. The resulting environmental degradation is not currently reflected in the costs of business or the price of goods and services. Because firms face no cost from increasing emissions, the level of emissions is too high. Unless businesses and individuals over time bear the responsibility for their consumption and production decisions, the level of carbon pollution will remain at unsustainable levels. Emissions trading schemes are designed to redress this market failure. Emissions trading schemes are simply a mechanism to achieve an objective. That objective is to reduce carbon pollution, and to do so efficiently, by putting a cap on emissions. The Government is therefore referring to the measure as the Carbon Pollution Reduction Scheme. To read the complete green paper, which outlines the Australian Government’s approach to the design of a national emissions trading scheme, click: <http://www.climatechange.gov.au/greenpaper/report/pubs/greenpaper.pdf>.

LEGISLATIVE ACTIVITY

US Senator Jay Rockefeller Press Release, “Rockefeller Authors Bill to Promote West Virginia Coal as Solution to Energy Crisis.”

US Senator Jay Rockefeller introduced a bill that would fund CCS research, expand incentives for the development of clean coal technologies, and create a coal-to-liquid program. The bill, called the “Future Fuels Act of 2008,” would provide the following incentives: Federal loan options for coal-to-liquid projects; tax credits for pipelines to transport coal-derived fuels; CBM capture; Integrated Gasification Combined Cycle (IGCC) projects capturing and storing 65 percent of CO₂ emissions; and CCS projects annually capturing a minimum of 500,000 metric tons of CO₂. The Future Fuels Act would also create the Future Fuel Corporation (FFC), a new research facility that brings together scientific experts with the focus of accelerating the production and deployment of CCS. The privately-run, government-funded FFC would be authorized to spend up to \$520 billion on CCS demonstration projects from 2010 to 2014. To view the entire bill, go to:

http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=110_cong_bills&docid=f:s3345is.txt.pdf. To read Senator Rockefeller’s official press release, visit: <http://rockefeller.senate.gov/press/record.cfm?id=301368>.



EVENTS

September 16-17, 2008, **Carbon Markets USA**, *Kellogg Conference Hotel, Washington DC, USA*. The second edition of Carbon Markets USA brings together key players in the US carbon industry to examine and explore the latest market developments and methods to accelerate market growth. Attendees have the opportunity to question experts on carbon trading, carbon offsetting, CCS, and voluntary carbon markets. To view the conference website, go to: http://greenpowerconferences.com/carbonmarkets/carbonmarkets_USA_2008.html.

September 22-24, 2008, **2008 Asia Pacific Coalbed Methane Symposium**, *Royal on the Park Hotel, Brisbane, Australia*. This conference will feature discussions, posters, and papers from the international community focusing on the exploration, field projects, geosequestration science and modeling, and commercial issues related to CBM. To learn more about the symposium, as well as view an online brochure, visit: <http://www.uq.edu.au/apcbm2008/>.



EVENTS (CONTINUED)

September 22-24, 2008, **Carbon Capture and Storage Opportunities**, *Café Royal, London, UK*. This event will focus on the current economic, technical, legislative, and scientific developments of CCS. Attendees will have the opportunity to debate and discuss topics such as: the status and development potential for CCS and transport technologies; details on the short- and long-term liabilities associated with CCS; and the current case examples for improving the commercial and economic viability of CCS. To learn more, click: <http://www.iqpc.com/ShowEvent.aspx?id=109202>.

September 24-25, 2008, **US Carbon Finance Forum**, *The Metropolitan Club, New York City, New York, USA*. This forum unites investors with representatives from finance, industry, government bodies, and international organizations to examine how carbon legislation will affect stakeholders in the United States. More than 40 high-level speakers will lead the discussion about existing opportunities in carbon markets worldwide. To learn more, visit the conference website: <http://www.uscarbonfinance.com/index.htm>.

September 29-October 2, 2008, **The 25th Annual International Pittsburgh Coal Conference**, *The Westin Convention Center, Pittsburgh, Pennsylvania, USA*. This conference focuses on the development of future coal-based energy plants as they strive to achieve near-zero emissions of pollutants while reducing costs. Some of the topics to be discussed: combustion, gasification, and environmental control technologies; synthesis of liquid fuels; and coal chemistry. A complete program outline is available at: <http://www.engr.pitt.edu/pcc/2008%20Conference.htm#SESSIONS%20and%20TOPICS>.

October 5-8, 2008, **Gasification Technologies Conference 2008**, *Wardman Park Marriott, Washington DC, USA*. This three-day event will feature presentations on the latest information and analysis of developments and trends driving the gasification industry. Some topics to be covered include: technical solutions in carbon management; research, development, and demonstration of new and emerging technologies; and industrial gasification. To learn more about the conference, go to: <http://www.gasification.org/conferences/overview.aspx>.

October 6-17, 2008, **Carbon Trading**, *The Hospital de los Venerables, Seville, Spain*. This event will help train attendees interested in participating in the carbon market. Some of the topics to be discussed include: understanding the principles of cap-and-trade programs; assessing the legal and political implications of the carbon markets; and understanding carbon in the supply chain. To learn more about this training event, click: <http://www.carbon-training.com/>.

October 7-10, 2008, **Carbon Finance Asia 2008**, *Grand Hyatt Singapore, Singapore*. The second edition of this event aims to facilitate the meeting of buyers and sellers of certified emissions reductions (CER) across Asia. Some of the key topics to be covered include: clean energy development: challenges and prospects; clean energy development through regulatory support; and pricing, trading, and exchange of carbon credits. To view a detailed schedule of the event, visit: <http://www.terrapinn.com/2008/carbon/index.stm>.

November 16-20, 2008, **9th International Conference on Greenhouse Gas Technologies**, *The Omni Shoreham Hotel, Washington DC, USA*. The Massachusetts Institute of Technology (MIT) and IEA Greenhouse Gas R&D Programme (IEA GHG) have teamed with DOE to present this conference series on GHG mitigation technologies. Attendees will be presented with 50 technical sessions that examine issues like CO₂ transport infrastructure, CBM storage, CCS policy, CO₂ storage capacity, long-term liability, and risk assessment. To learn more, click: <http://mit.edu/ghgt9/index.html>.

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To view an archive with past issues of the newsletter, see: http://www.netl.doe.gov/technologies/carbon_seq/refshelf/subscribe.html.

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