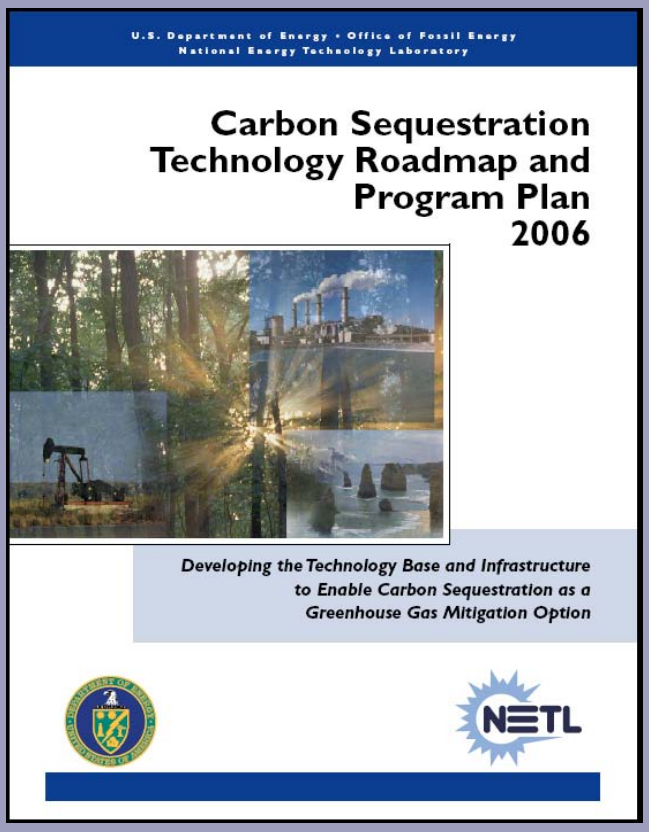
# THE CARBON SEQUESTRATION NEWSLETTER

http://www.netl.doe.gov/publications/carbon_seq/subscribe.html

September 2006


- Sequestration in the News
- Science
- Policy
- Geology
- Technology
- Terrestrial/Ocean
- Trading
- Recent Publications
- Legislative Activity
- Events & Announcements
- Contact Information


## HIGHLIGHTS




**"Carbon Sequestration Technology Roadmap and Program Plan (2006)."** The Department of Energy (DOE) National Energy Technology Laboratory (NETL) has released its annual update of the "Carbon Sequestration Technology Roadmap and Program Plan (Roadmap)." The Carbon Sequestration Program is managed within DOE's Office of Fossil Energy and implemented through the National Energy Technology Laboratory (NETL). The Roadmap (1) defines the current status of carbon dioxide ($CO_2$) capture and sequestration technology, (2) identifies research pathways that lead to achievement of the Carbon Sequestration Program goal, and (3) describes efforts that the DOE program is pursuing along priority pathways. Among the past year's Program highlights contained in the Roadmap are the following: 1. The Regional Carbon Sequestration Partnerships have progressed to a validation phase in which they will conduct 25 field tests involving the injection of $CO_2$ into underground formations where it will be stored and monitored. 2. Pilot-scale tests and modeling of amine-based $CO_2$ capture have shown that operating an amine stripper at vacuum can reduce energy use 5–10 percent per unit of $CO_2$ captured; and 3. Novel metal organic frameworks have shown significant potential as $CO_2$ sorbents. http://www.netl.doe.gov/publications/carbon_seq/2006%20Sequestration%20Roadmap%20FINAL.pdf.

**"Carbon Sequestration Project Portfolio (2006)."** The Department of Energy National Energy Technology Laboratory has released its annual update of the Carbon Sequestration Project Portfolio (Project Portfolio). The 2006 Project Portfolio is a comprehensive document, designed to serve as a key resource of the National Energy Technology Laboratory's Carbon Sequestration Program. The Project Portfolio includes maps of project distribution; a copy of the new "Carbon Sequestration Technology Roadmap and Program Plan 2006"; budget information; details about each individual research project; programmatic papers; and an index of project participants. The Project Portfolio is designed to be printed for use in a three-ring binder, or to be viewed online. Frequent updates will be posted to ensure that any new information is incorporated. To view and/or download the various sections of this document, go to the pdf table of contents: http://www.netl.doe.gov/publications/carbon_seq/project%20portfolio/project_portfolio2/1_CarbonSequestrationProjectPortfolio2005.pdf. To access each section of the document though the table of contents online, click on: http://www.netl.doe.gov/publications/carbon_seq/project%20portfolio/project_portfolio2/table_contents.pdf. http://www.fossil.energy.gov/programs/sequestration/publications/programplans/2006/project_portfolio_sequestration_06.pdf.

**The Carbon Sequestration Newsletter Annual Index.** Access the Annual Index covering September 2005-August 2006 Carbon Sequestration Newsletters at: http://www.netl.doe.gov/publications/carbon_seq/subscribe.html.

## Sequestration in the News

***The Intelligencer*, "Experiment to Begin at Burger Plant."** The Midwest Regional Carbon Sequestration Partnership (MSRCP), under contract with the National Energy Technology Laboratory, is coordinating with First Energy at their its R.E. Burger Plant outside Shadyside, Ohio to conduct a geologic carbon sequestration pilot validation test. The pilot test is in its early stages. First Energy spokesperson Mark Durbin stated that geologists and seismologists are currently examining old mining records and maps, and are conducting tests to determine the underground geological makeup of the site. The plan is to pump pressurized carbon dioxide directly into a brine formation located between 4,000 and 7,000 feet below the surface. The MRCSP is evaluating the possibility of capturing the carbon dioxide produced at the Burger Plant for the pilot test. Initial plans call for injecting about 3,000 tons of carbon dioxide at the site over a period of several months. This is about the same amount of $CO_2$ that would be produced in two days during operations at the Plant. July 24, 2006. (Link not available.14 day online archive of news story only.)

***The Globe and Mail (Canada),* "Oil Industry to Study $CO_2$ Potential."** The Petroleum Technology Alliance Canada (PTAC), a not-for-profit association that facilitates collaborative research and technology development for the Canadian upstream conventional oil and gas industry, announced a major study in enhanced oil recovery. PTAC has issued an RFP, due August 31, 2006, for the estimation of capital and operating costs for capturing, purifying/separating, and transporting carbon dioxide ($CO_2$) that is emitted from Edmonton-area industrial operations, in particular oil refineries. (See link for RFP: http://www.ptac.org/co2/co2r0601.html.) PTAC's goal for the project is to establish a rough cost estimate to support the initiation and ongoing operation of commercial enhanced recovery of conventional oil in specific Alberta oil fields, allowing private industry to establish deals to start construction of $CO_2$ plants with the next year. The study may also make a case for the need for government assistance for these types of projects. The study is being sponsored by the $CO_2$ committee within PTAC whose members include Penn West, Enbridge Inc, Suncor Energy Inc., Husky Energy Inc., Shell Canada Ltd., EnCana Corp, and several representatives from the Alberta and Canadian governments. July 7, 2006, http://www.ptac.org/about/dl/media0601.pdf.

***Cincinnati Post,* "Project Traps Carbon Dioxide."** The Midwest Regional Carbon Sequestration Partnership is conducting a field demonstration at Duke Energy's East Bend Generating Station in Boone County, Kentucky. After seismic tests are conducted in late September or early October to gain more information regarding the geologic formations, 3,000 to 10,000 tons of carbon dioxide will be sequestered at 3,000-4,000 feet below the surface beginning within a year. The brine saturated rock of the area's Mount Simon Sandstone formation is considered to be ideal for containing the carbon dioxide. The project is testing the drilling technology, the injection process, the environmental and safety impacts, and public acceptance of the sequestration concept. Also tested will be the containment of the carbon dioxide and the movement of the carbon dioxide within the porous rock. August 9, 2006, http://news.cincypost.com/apps/pbcs.dll/article?AID=/20060809/NEWS01/608090348.

***Clean Coal Today,* "Sequestration Conference Explored Technology Progress."** Over 400 persons attended the Fifth Annual Conference on Carbon Capture and Sequestration on May 8–11, 2006, in Alexandria, Virginia, which was partly sponsored by the U.S. Department of Energy, and the National Energy Technology Laboratory. The conference focused on carbon capture, geological and terrestrial sequestration of carbon dioxide, including regulatory and economic aspects of sequestration, and international cooperation. The keynote address was given by the Department of Energy's Secretary Samuel Bodman in which he outlined the US Government's multi-faceted approach toward ensuring clean and reliable sources of energy as presented in the Advanced Energy Initiative, announced by President Bush in his January 2006 State of the Union address. The Initiative supports transformational technologies including carbon sequestration. (Highlights of many other speakers' presentations are outlined in this news article.) Spring/Summer 2006, http://www.netl.doe.gov/technologies/coalpower/cctc/newsletter/documents/cctoday_spring_summer_2006.pdf.

***USA Today,* "Burying the Evidence of Global Warming."** Carbon dioxide ($CO_2$) can be sequestered in sandstone in the Midwestern United States, where there are plenty of sandstone layers, in contrast to the Pacific Northwest and Southeast that lack sandstone formations. Environmental scientist B. Peter McGrail of the Pacific Northwest National Laboratory in Richland, WA reports that carbon dioxide can be sequestered under the hardened lava of volcanic eruptions. In a study in the *American Geophysical Union's Journal of Geophysical Research-Solid Earth*, McGrail and his team report that ancient lava flows, approximately 10 million years old and located in Washington State, form layers with deep basalt rock that could serve as potential sites for $CO_2$ sequestration. The layers are located about 3,000 feet deep and were formed as bubbles in lava flows became trapped between the cooling outer crust, making the interior of the lava layer permeable. The study reports that the lava basalt within those water-filled layers appears to mix with carbon dioxide to form limestone rock, which can serve to enhance the sequestration process. The study further states that the limestone formation process starts within one to three years of carbon dioxide injection. August 21, 2006, http://www.usatoday.com/tech/science/columnist/vergano/2006-08-20-carbon-sequestration_x.htm.

***Clean Coal Today,* "NatCarb Evaluating Carbon Sequestration Potential."** The National Carbon Sequestration Database and Geographical Information System (NatCarb) is a mapping and analysis tool funded under an agreement by the National Energy Technology Laboratory (NETL) and the University of Kansas Center for Research. Geological Survey organizations in Illinois, Indiana, Kansas, Kentucky, and Ohio,

## Announcements

**DOE Announces Meetings to Discuss Scope of FutureGen Environmental Impact Statement.** The Energy Department's National Energy Technology Laboratory is hosting public meetings near each of the four proposed FutureGen project sites to provide interested parties an opportunity to comment on the scope and content of an Environmental Impact Statement for the FutureGen power plant. Written comments are also being accepted until September 13, 2006. To read the Federal Register Notice, see: http://www.fossil.energy.gov/programs/powersystems/futuregen/pub_scoping_mtgs_futuregen.pdf.

**Federal Loan Guarantees for Projects that Employ Innovative Technologies in Support of the Advanced Energy Initiative.** Funding Opportunity Number: DE-PS01-06LG00001. The solicitation was updated on August 10, 2006. A principal purpose of the Title XVII loan guarantee program is to encourage early commercial use in the United States of new or significantly improved technologies in energy projects. The Department of Energy's (DOE's) loan guarantee program is not intended for technologies in research and development. DOE believes that accelerated commercial use of new or improved technologies will help to sustain economic growth, yield environmental benefits, and produce a more stable and secure energy supply. In the first round, the DOE will evaluate loan guarantee pre-applications for projects that employ technologies in areas including carbon sequestration practices and technologies, pollution control equipment, and other areas. Overall, the first round of loan guarantee applications is valued at a total of $2 billion. The Pre-Application is due November 6, 2006 by 5 PM eastern time. Successful pre-applicants will be contacted with an invitation to submit a full application. The due date and time for the full application will be set at that point. For additional information on the Loan Guarantee Program, see: http://www.lgprogram.energy.gov/. To link to the full announcement, see: http://www.grants.gov/search/search.do?mode=VIEW&oppId=10547.

**Agency Information Collection Activities: Proposed Collection; Comment Request (on Form EIA-1605, "Voluntary Reporting of Greenhouse Gases").** The Energy Information Administration (EIA) is soliciting comments on a proposed three-year extension and revision to Form EIA-1605, "Voluntary Reporting of Greenhouse Gases." The EIA also proposes to discontinue the Form EIA-1605EZ (short form. Comments must be submitted by September 25, 2006. For details see: http://a257.g.akamaitech.net/7/257/2422/01jan20061800/edocket.access.gpo.gov/2006/pdf/E6-12039.pdf.

the US Geological Survey, NETL's seven Regional Partnerships, and the Massachusetts Institute of Technology are all participating in this project which provides access to natural resource data related to carbon management. NatCarb data include data collected from the characterization phase of NETL's Regional Partnerships Program, as well as several national data sources including data from the USGS Earth Resources Observation Systems (EROS) center, the Geography Network, the US Environmental Protection Agency, and the US Energy Information Administration. Access the database at: http://www.natcarb.org/. Spring/Summer 2006, http://www.netl.doe.gov/technologies/coalpower/cctc/newsletter/documents/cctoday_spring_summer_2006.pdf.

***Greenwire,* "Underground Movement Emerges for Sequestering $CO_2$."** An overview of many aspects of carbon capture and sequestration are discussed. Three major commercial projects currently underway and implementing sequestration technology include: 1. The Sleipner project which began in 1966 and injects about 1 million tons of CO2 per year into saline aquifers in the North Sea, with an estimated project capacity of 20 million tons; 2. The Great Plains Synfuels natural gas power plant in Beulah, North Dakota which has captured about 1 million tons of carbon dioxide ($CO_2$) per year since 1999, with a 200-mile pipeline to the Weyburn field in Saskatchewan, Canada, for Enhanced Oil Recovery operations; and 3. Sonatrach, the state energy company in Algeria, which partners with Statoil and BP on a project to reinject 17 million tons of $CO_2$ that is extracted from a natural gas field. The 2005 report by the Intergovernmental Panel on Climate Change (http://arch.rivm.nl/env/int/ipcc/pages_media/SRCCS-final/IPCCSpecialReportonCarbondioxideCaptureandStorage.htm) estimated that geologically there is 200 to 2,000 gigatons of $CO_2$ storage capacity worldwide that is economically available for sequestration. Also, the Battelle report from April 2006 (http://www.battelle.org/news/06/CCS_Climate_Change06.pdf#search=%22%22carbon%20dioxide%20capture%20and%20geologic%20storage%22%22) estimated 11,000 gigatons of geologic $CO_2$ storage with 3,400 gigatons of capacity in the US. Humans produce about 7 gigatons of greenhouse gas emissions per year. Ocean sequestration would provide for additional storage. August 14, 2006. http://www.eenews.net/Greenwire/2006/08/14/#1. (Subscription may be required.)

***Nature,* "Putting the Carbon Back: The Hundred Billion Tonne Challenge,"** and ***Nature,* "Putting the Carbon Back: Black is the New Green."** This two-part series of articles discusses 1. geological carbon sequestration technology, and 2. "terra preta" soils as a tool for carbon sequestration. The first article mentions the upcoming project in Ketzin, Germany that, within the next two years, will be the site of Europe's first large-scale carbon capture and storage demonstration project. About 60,000 tons of carbon dioxide will be injected into a saline forma-

tion over 2,000 feet below the surface. The capacity of the Earth for geological sequestration is discussed, as is implementing carbon capture and storage at power plants, including integrated gasification combined cycle (IGCC) plants. The article on “terra preta” discusses the origin of the scientific study of “terra preta” soils which started with Wim Sombroek. “Terra preta” is the dark and fertile soil of the Amazon that is fortified with material including char, organic matter that smolders in an oxygen-poor environment rather than burning. “Terra preta” soils can contain 250 tons of carbon, as opposed to 150 tons that is contained in unimproved soil. The production of char is discussed, including turning farm waste into biofuel while producing char. Robert Brown, an engineer from Iowa State University working on “terra preta” production technology, estimates that a 250-hectare farm which uses a char created from biowaste which is then combined with ammonium bi-carbonate, a nitrogen fertilizer, can help to sequester roughly 1,900 tons of carbon per year. August 10, 2006, http://www.nature.com/news/2006/060807/full/442624a.html, and http://www.nature.com/news/2006/060807/full/442620a.html. (Subscription required.)

***The New York Times,* “Team Looks At Seafloor As Gas Trap.”** A paper was published in the August 7 edition of the weekly Proceedings of the National Academy of Sciences in which a team of researchers identified seafloor sediments that are suitable for carbon sequestration. The research, partly funded by the Department of Energy, shows that there are ideal depths of ocean water and sediment that would allow carbon dioxide to stay denser than the water above; at about 10,000 feet deep where the temperature is typically about 35 degrees and the pressure from the water above would cause liquid carbon dioxide pumped into porous sediment to stay denser than water. Experts who were not involved in the analysis say that the concept would need to be extensively tested in the field. The lead author of the study, Kurt Zenz House said that the study showed there was “an inherently stable and permanent storage option that could bite off a huge chunk of the CO2.” (For an abstract of the proceedings ***“Permanent carbon dioxide storage in deep-sea sediments”*** see this Newsletter’s **Terrestrial/Ocean** section.). August 8, 2006, http://www.nytimes.com/2006/08/07/science/07cnd-carbon.html?_r=1&ei=5094&en=d638052622c63014&hp=&ex=1155009600&adxnnl=1&partner=homepage&adxnnlx=1155128076-qXekUhbJIQKkfqjHBj1vJQ&oref=slogin. (Subscription required.)

## Science

***Washington Post,* “More Frequent Heat Waves Linked to Global Warming,”** Scientists who have studied decades of weather records and computer climate models say that recent heat waves that have hit the United States and Europe have become more frequent because of global warming. Though one single weather event cannot be attributed to climate change, recent studies have suggested that human-generated emissions are causing both overall higher temperatures and greater weather variability. Paul Della-Marta, a researcher at Switzerland's Federal Office of Meteorology and Climatology, presented findings that the duration of heat waves since 1880 in Western Europe has doubled and the number of unusually hot days in the region has nearly tripled. In 2004, researchers at Britain's Hadley Centre for Climate Prediction and Research produced computer models that showed that greenhouse gas emissions have doubled the likelihood of heat wave events like what occurred in 2003 in Europe, and that by 2040 it is likely that such heat waves will take place there every other year. The National Climatic Data Center (Data Center) in Asheville, North Carolina reported that nighttime summer temperatures across the United States have been unusually high for the past eight years, a record streak. Richard Hime of the Data Center stated that only the Dust Bowl Period of the 1930’s rivaled recent summers for sustained heat levels. Some researchers say that it is hard to correlate severe heat waves and climate change because heat waves occur less often than other weather events and arise from specific weather conditions. National Weather Service meteorologist Dennis Feltgen says that the current heat wave is caused by "a large persistent area of high pressure in the upper atmosphere" that has drifted from the West to the East Coast of the United States. August 4, 2006, http://www.washingtonpost.com/wp-dyn/content/article/2006/08/03/AR2006080301489.html.

## Policy

***E&E News PM,* “Interior Shelves Rulemaking on $CO_2$ Sequestration Incentives.”** The US Department of the Interior has decided against crafting royalty incentives to promote using carbon dioxide ($CO_2$) injection for enhanced oil recovery (EOR) and carbon sequestration. The Energy Policy Act of 2005 requested that the Department’s Bureau of Land Management and Minerals Management Service explore the use of royalty waivers for oil and gas produced via EOR for both on shore and off shore applications, provided the incentive would increase the use of the technique. Several memos outlined reasons why rulemaking will be shelved. One memo stated that current EOR production areas and new target areas are on state and private lands, not federal lands, and that a limit cited regarding the use of EOR is the availability and

cost of sufficient volumes of $CO_2$. Another point made is that $CO_2$ is not fully sequestered using most EOR technologies, though the Department of Energy is currently studying the amounts of $CO_2$ that can be sequestered using EOR. Also, the memo stated that there are already existing federal and state tax incentives in place that provide sufficient incentive for EOR projects. Another memo states that the deferred rulemaking does not prevent the Department's Bureau of Land Management from providing royalty reductions for specific EOR projects under regulations currently in place. Regarding using the technology on the outer continental shelf, a separate memo stated that more must be know about the technology and economics that apply with respect to offshore applications, therefore rulemaking would be premature. August 23, 2006, http://www.eenews.net/eenewspm/2006/08/23/archive/1/?terms=CO2.

***Reuters*, "EU CO2 Plans For 2008-12 "Ambitious Enough" – Piebalgs."** European Union Energy Commissioner Andris Piebalgs responded to a question regarding the possibility of the carbon price collapsing in the EU carbon trading scheme, given a market concern that the Phase II National Allocation Plans to be submitted to the European Commission would be too lenient. Piebalgs feels that the plans that have been submitted thus far have proposed ambitious emission cuts. Estonia, Poland, Latvia and Luxembourg have all proposed large increases in carbon credit quotas reflecting their desire to cut greenhouse gases. Germany, Ireland, Latvia, Lithuania and Britain have also submitted their plans thus far. August 24, 2006, http://www.planetark.com/dailynewsstory.cfm?newsid=37819&newsdate=24-Aug-2006.

## Geology

**"$CO_2$ storage and gas diffusivity properties of coals from Sydney Basin, Australia."** Measurements of carbon dioxide ($CO_2$) adsorption and diffusion properties of coals are reported for various coalfields within Sydney Basin, New South Wales (NSW), Australia. Adsorption measurements were undertaken using a gravimetric method. Measurements carried out on 27 coals show that Sydney Basin coals at $CO_2$ sub-critical conditions, namely gas pressures below 6 mega pascals (MPa) and temperatures below 39 degrees Celsius (C), can adsorb a maximum volume (Langmuir volume) of 40 to 80 cubic meters ($m^3$) of $CO_2$ per ton of coal on a dry ash free (daf) basis. The coals used in this study are of sub-bituminous to bituminous rank, ranging from 0.66 to 1.45 percent mean maximum vitrinite reflectance, and are from depths ranging from about 27 meters to 723 meters. The highest adsorption capacity applies to the highest rank coal, which is also the deepest coal. The standard deviation between Langmuir modeled and measured values is less than 1.5 cubic meters per ton ($m^3$/t), corresponding to a relative error of less than 2.7 percent for all except one coal. Based on adsorption isotherms, the $CO_2$ storage capacity for in-situ seam pressure conditions range from about 6 to 51 $m^3$/t. $CO_2$ diffusion properties of 15 of these coals, determined using a newly developed system capable of accurately measuring diffusivity of gases in solid coal indicate that $CO_2$ diffusivity (diffusion coefficient) in the Sydney Basin coals varies from $1.2 \times 10^{-6}$ to $10.2 \times 10^{-6}$ centimeters squared per second ($cm^2$/s). The diffusivity does not show any discernable trend with the variation in depth and rank. Porosity measured by a mercury injection method varies from 4 to 10 percent and decreases with increase in coal depth and rank. For some of the coal samples adsorption measurements for pure methane ($CH_4$), $CO_2$ and nitrogen ($N_2$) indicate that the Sydney Basin coals can store twice as much $CO_2$ as $CH_4$ and six times more $CO_2$ than $N_2$ (volume basis). Also, measurement of diffusivity in solid coal samples shows that $CO_2$ diffuses twice as quickly as $CH_4$. The data obtained from this study and the estimated coal resources in the state of New South Wales, allow $CO_2$ sequestration potentials to be calculated. **A. Saghafi, M. Faiz and D. Roberts,** *International Journal of Coal Geology*, Available online July 7, 2006, http://www.sciencedirect.com/science/article/B6V8C-4KBVV1S-4/2/f5ff10ec703fe2e2c400eb9ad292f9b6. (Subscription may be required.)

## Technology

**"Process evaluation of an 865 $MW_e$ lignite fired $O_2/CO_2$ power plant"** In order to reduce emissions of carbon dioxide from large point sources, new technologies can be used in capture plants for combustion of fossil fuel for subsequent capture and storage of carbon dioxide ($CO_2$). One such technology is the $O_2/CO_2$ combustion process (also termed oxy-fuel combustion) that combines a conventional combustion process with a cryogenic air separation process so that the fuel is burned in oxygen and recycled flue gas, yielding a high concentration of $CO_2$ in the flue gas, which reduces the cost for its capture. In this work, the $O_2/CO_2$ process is applied using commercial data from an 865 $MW_e$ (mega watt net electricity output) lignite fired reference power plant and large air separation units (ASU). A detailed design of the flue gas treatment pass, integrated in the overall process layout, is proposed. The

essential components and energy streams of the two processes have been investigated in order to evaluate the possibilities for process integration and to determine the net efficiency of the capture plant. The electricity generation cost and the associated avoidance cost for the capture plant have been determined and compared to the reference plant with investment costs obtained directly from industry. Although an existing reference power plant forms the basis of the work, the study is directed towards a new state of the art lignite fired $O_2/CO_2$ power plant. The boiler power of the $O_2/CO_2$ plant has been increased to keep the net output of the capture and the reference plant similar. With the integration possibilities identified, the net efficiency becomes 33.5 percent, which should be compared to 42.6 percent in the reference plant. With a lignite price of 5.2 dollars per megawatt hours ($/MW h) and an interest rate of 10 percent, the electricity generation cost increases from 42.1 to 64.3 $/MW h, which corresponds to a $CO_2$ avoidance cost of 26 dollars per ton ($/ton) $CO_2$. **Klas Andersson and Filip Johnsson,** *Energy Conversion and Management,* Volume 47, Issues 18-19 , November 2006, Pages 3487-3498, http://www.sciencedirect.com/science/article/B6V2P-4KD5BK1-1/2/2fe89144fb001cbcde411a6a87791801. (Subscription may be required.)

**"Incorporating carbon capture and storage technologies in integrated assessment models."** Low-carbon emitting technologies are a key component of technical change in integrated assessment models. The authors develop a methodology for incorporating technologies into computable general equilibrium economic models and demonstrate this methodology by implementing carbon capture and storage technologies in the MIT Emissions Prediction and Policy Analysis (EPPA) model. Three primary implementation issues are discussed: characterization of the technical system, translation of bottom-up engineering information into an economic model, and the depiction of realistic technology adoption rates. The specification of input substitution, relative costs, and plant dispatch are the most critical factors in technology representation. Technology adoption rates in economic models are governed by exogenous and endogenous constraints. A comparison of the current approaches used in economic models with the theoretical and empirical factors affecting adoption rates highlights opportunities for refining the current methods. **James R. McFarland and Howard J. Herzog,** *Energy Economics,* Available online July 7, 2006, http://www.sciencedirect.com/science/article/B6V7G-4KBVVDM-2/2/14ae1e8dbe56dba7b6457d36a69dd7f3. (Subscription may be required.)

**"Techno-economic modeling and cost functions of $CO_2$ capture processes."** The paper presents the techno-economic modeling of $CO_2$ capture process in coal-fired power plants. An overall model is being developed to compare carbon capture and sequestration options at locations within the United Kingdom, and for studies of the sensitivity of the cost of disposal to changes in the major parameters of the most promising solutions identified. Technological options of $CO_2$ capture have been studied and cost estimation relationships (CERs) for the chosen options calculated. Created models are related to the capital, operation and maintenance cost. A total annualized cost of plant electricity output and amount of $CO_2$ avoided have been developed. The influence of interest rates and plant life has been analyzed as well. The CERs are included as an integral part of the overall model. **Jirí Klemes, Igor Bulatov and Tim Cockerill,** *Computers & Chemical Engineering,* Available online July 20 ,2006, http://www.sciencedirect.com/science/article/B6TFT-4KFMMC2-1/2/5911705c2cc0f639878e9881b0b59b1b. (Subscription may be required.)

## Terrestrial/Ocean

**"Policy and technological constraints to implementation of greenhouse gas mitigation options in agriculture."** A recent assessment of agricultural greenhouse gas (GHG) emissions has demonstrated significant potential for mitigation, but suggests that the full mitigation will not be realized due to significant barriers to implementation. In this paper, the authors explore the constraints and barriers to implementation important for GHG mitigation in agriculture. The authors also examine how climate and non-climate policy in different regions of the world has affected agricultural GHG emissions in the recent past, and how it may affect emissions and mitigation implementation in the future. The authors examine the links between mitigation and adaptation and drives for sustainable development and the potential for agricultural GHG mitigation in the future. The authors describe how some countries have initiated climate and non-climate policies believed to have direct effects or synergistic effects on mitigating GHG emissions from agriculture. Global sharing of innovative technologies for efficient use of land resources and agricultural chemicals, to eliminate poverty and malnutrition, will significantly mitigate GHG emissions from agriculture. Previous studies have shown that as less than 30 percent of the total biophysical potential for agricultural GHG mitigation might be achieved by 2030, due to price- and non-price-related barriers to implementation. The challenge for

successful agricultural GHG mitigation will be to remove these barriers by implementing creative policies. Identifying policies that provide benefits for climate, as well as for aspects of economic, social and environmental sustainability, will be critical for ensuring that effective GHG mitigation options are widely implemented in the future. **Pete Smith, Daniel Martino, Zucong Cai, Daniel Gwary, Henry Janzen, Pushpam Kumar, Bruce McCarl, Stephen Ogle, Frank O'Mara, Charles Rice et al,** *Agriculture, Ecosystems & Environment*, Available online July 18, 2006, http://www.sciencedirect.com/science/article/B6T3Y-4KF6BK4-1/2/91b9e64a0c7ec66d438899c86dc09c3d. (Subscription may be required.)

## Trading

| Carbon Market Update, August 15, 2006 | |
|---|---|
| CCX-CFI 2006 ($/tCO$_2$) **$4.20 (Vintage 2006)** | EU ETS-EUA DEC 2006 ($/tCO$_2$) **$ 19.96** **(Converted from € to US$)** |

***RGGI Press Release,* "States Reach Agreement on Proposed Rules for the Nation's First Cap-and-Trade Program to Address Climate Change."** On August 15, 2006 the seven Northeast states under the Regional Greenhouse Gas Initiative (RGGI) release a model set of regulations to be proposed in each state to implement the program. Also released was an amendment to the December 2005 Memorandum of Understanding, serving to simplify the way "offset credits" will be implemented. The states participating in RGGI include Connecticut, Delaware, Maine, New Hampshire, New Jersey, New York, and Vermont, with Maryland to join by 2007. Under RGGI, the states will launch a regional cap and trade system in which emissions credits will be issued to limit the total amount of carbon dioxide ($CO_2$) emissions. The State will issue one credit or allowance to permit one ton of $CO_2$ emissions. Coal, gas and oil-fired electric generating units with a capacity of 25 megawatts or more will be able to buy and sell allowances and will be required to have enough allowance to cover its reported emissions of $CO_2$. Starting in 2009, the emissions of $CO_2$ from power plants in the region would be capped at 121 mission tons annually until 2015. The states would then be required to reduce emissions in increments over a four year span to achieve a 10 percent reduction by 2019. Twenty-five percent of a states allowance will be allocated to strategic energy or consumer benefit purposes such as energy efficiency, new clean energy technologies and ratepayer rebates, with funds generated from the sale of these to be used for beneficial energy programs. Offset projects, which serve to "offset" $CO_2$ emissions from outside the electricity sector, will be allowed for up to 3.3 percent of the plant's overall emissions. Off-set projects such as natural gas end-use efficiency, landfill gas recovery, reforestation, and methane capture from farms will allow the power plant owner/operator to select the lowest cost emissions reductions and apply them to a portion of the plants' emissions requirements. Offset projects can be conducted in other states, as long as that state agrees to certain administrative requirements. After the states adopt the program, the RGGI program will begin on January 1, 2009. To read the RGGI model rule, and post-model rule action plan, see: http://www.rggi.org/modelrule.htm. For more information, see http://www.rggi.org/. August 15, 2006, http://www.rggi.org/docs/model_rule_release_8_15_06.pdf.

***AP,* "Blair, Schwarzenegger Unite Against Global Warming."** British Prime Minister Tony Blair and California Governor Arnold Schwarzenegger announced an agreement on July 31 to share information and ideas regarding ways to fight global warming. Specifically the two agreed to collaborate on research into cleaner-burning fuels and technologies and the possibility of setting up a carbon dioxide emissions trading system. A main target of the agreement is carbon dioxide from cars, trucks and other modes of transportation, since 41 percent of California's and 28 percent of Britain's greenhouse gas emissions are from transportation. California is looking to cut greenhouse gas emissions to 2000 levels by 2010, and Britain to reduce carbon dioxide emissions to 60 percent of its 2000 level by 2050. California was the 12th largest source of greenhouse gas emissions in 2005, greater than most countries. August 1, 2006, http://www.ctv.ca/servlet/ArticleNews/story/CTVNews/20060801/blair_schwarzenegger_global_warming_060801/20060801?hub=SciTech.

***The Australian,* "States Go Cool on Carbon Trading."** The Australian states have withdrawn their plan for a carbon trading system, due to government concerns that the scheme would affect low income households. The extent of the exemptions contained in the program also makes the scheme more complex than the European Union's carbon trading system. "The states' scheme has exclusions, generous permit allocations, offset credits, gateways, soft starts and compensation for loss of profits and no effective global greenhouse response," said John Howard, the Prime Minister of Australia. A green paper that was to outline the proposed system released the week of August 28 will be downgraded to a "discussion paper" and the 2010 deadline for carbon trading will not be met. August 4, 2006, http://www.theaustralian.news.com.au/story/0,20867,20013169-2702,00.html.

## Recent Publications

**"International Energy Annual (IEA) 2004."** The International Energy Annual (IEA) is the Energy Information Administration's primary report of international energy statistics. For many series, data begin with the year 1980. Included are data on energy consumption and production; overviews of petroleum, natural gas, coal, and electricity, as well as carbon dioxide emissions from the use of fossil fuels, petroleum prices, energy reserves, and population; and data unit conversion tables. To view data tables of "World Carbon Dioxide Emissions from the Use of Fossil Fuels," go to: http://www.eia.doe.gov/iea/carbon.html. For the overall report, see: http://www.eia.doe.gov/iea/.

**"Annual Energy Outlook Evaluation, 2005."** Each year since 1996, EIA's Office of Integrated Analysis and Fore-

casting has produced a comparison between realized energy outcomes and the projections included in previous editions of the AEO. Each year, the comparison adds the projections from the most recent AEO and updates the historical data to the most recently available. The comparison summarizes the relationship of the AEO reference case projections since 1982 to realized outcomes by calculating the average absolute percent differences for several of the major variables for AEO82 through AEO2005. The average absolute percent difference is the simple mean of the absolute values of the percentage difference between the Reference Case projection and the actual value. The historical data are typically taken from the *Annual Energy Review (AER).* As indicated in Table 1 of the report, the reference case projections of energy consumption, energy production, and carbon dioxide emissions have been relatively close to realized outcomes. Table 7 presents detailed data of the Total Carbon Dioxide Emissions, Actual vs. Reference Case. To view the report and supporting tables, go to: http://www.eia.doe.gov/oiaf/analysispaper/forecasteval/index.html. Document number DOE/EIA-0640(2005), July 2006.

**"Following The Paper Trail: The Impact of Magazine And Dimensional Lumber Production On Greenhouse Gas Emissions: A Case Study. 2006."** Canfor, The Home Depot, Stora Enso in North America (SENA) and Time Inc. (listed in alphabetical order) commissioned the greenhouse gas (GHG) life-cycle analysis (LCA) of two magazine chains and a dimensional lumber chain. The collaboration of the four companies in this project reflects the flows of (i) Canfor wood fiber to The Home Depot, a large do-it-yourself remodeling and construction retailer, and (ii) flows of Canfor kraft pulp, SENA wood fiber and SENA kraft pulp used to produce magazine paper for *Time* and *InStyle* magazines. The Heinz Center for Science, Economics and the Environment, an environmental non-governmental organization (NGO), helped the participants identify and address relevant environmental issues. The participants undertook the self-initiated study to quantify sources of GHG emissions for each major step in the magazine and dimensional lumber product chains. This life-cycle analysis provides valuable information that company managers can use to increase efficiency in the production of paper and wood products by decreasing the demand for energy resources and reducing GHG emissions. [The authors] only examined the major components of GHG budgets in this study. This study is unlike other forest product LCA studies in that the participants in this study provided their product-specific data. **Dr. Stith T. Gower, Ann McKeon-Ruediger, Annabeth Reitter, Michael Bradley, David J. Reflcin, Timothy Tollefson, Fred J. Souba Jr., Amy Taup, Lynn Embury-Williams, Steven Schiavone, James Weinbauer, Anthony C. Janetos, and Ron Jarvis,** The H. John Heinz III Center for Science, Economics and the Environment, Washington, DC, 2006, http://www.heinzctr.org/publications.shtml.

## Legislative Activity

***Reuters,* "Norway Demands $CO_2$ Capture at Gas Plant."** A decision by the Norwegian Pollution Control Authority (SFT) reversed an earlier recommendation by the Norwegian Water Resources and Energy Administration (NVE) that Statoil's planned Mongstad refinery should be allowed only if it is equipped with carbon dioxide capture technology. The Norwegian government will make the final decision regarding what type of permit will be granted to the $635 million 280 megawatt (MW) power / 350 MW heat plant, slated for a 2008-2009 start-up. Statoil's position is that a requirement for carbon capture from the start of the project would make the project impossible to implement. The SFT said that without carbon capture, the plant would emit 1.3 million tons of $CO_2$ annually. August 21, 2006, http://www.planetark.org/dailynewsstory.cfm?newsid=37742&newsdate=21-Aug-2006.

# Events

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

September 18-19, 2006, **2006 Global $CO_2$ Cap-and-Trade Forum,** *Westin Embassy Row, Washington, DC.* The Forum will include keynotes, case studies, panels, and presentations by experts from the public and private sector who will discuss: the global carbon trading commodities market overview; carbon reduction mandates; voluntary carbon reduction initiatives; carbon offsets; financing carbon reducing projects; and more. For further information about participating in or attending the event, please contact Jim Turner at 646-546-5230 or jturner@srinstitute.com. Also see: http://www.srinstitute.com/conf_page.cfm?instance_id=25&web_id=863&pid=470.

September 24-27, 2006, **Society of Professional Engineers Annual Technical Conference and Exhibition (ATCE 2006),** *Henry B. Gonzalez Convention Center, San Antonio, TX.* SPE's Annual Technical Conference and Exhibition (ATCE) is perhaps the most significant annual gathering of petroleum professionals anywhere in the world. Among the presentations scheduled, there will be 2 presentation sessions on the topic of $CO_2$ sequestration, and short courses on Enhanced Oil Recovery and Carbon Dioxide Flooding & Sequestration. See: http://www.spe.org/atce/2006/technical/tuesday_am.html and http://www.spe.org/atce/2006/technical/wednesday_am.html for the listing of the topics. Register through August 25 to receive a discounted rate. For complete information, visit the 2006 ATCE website at http://www.spe.org/atce/2006/index.html.

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

September 25-27, 2006, **The 4th NCUT/WRI Conference on the Upgrading and Refining of Heavy Oil, Bitumen and Synthetic Crude Oil,** *Westin Hotel, Edmonton, Alberta, Canada.* This triennial meeting is co-sponsored with Canada's National Centre for Upgrading Technology (Western Research Institute) through a Base Research Program with NETL. It brings together experts from the public and private sectors to discuss new developments and challenges in improving the economics and environmental performance of the heavy oil and bitumen industry. A few talks will include issues of Carbon Capture & Sequestration and Enhanced Oil Recovery. For details, see: http://www.ncut.com/acrobats/2006%20Conference.pdf.

September 25-28, 2006, **The 23rd International Pittsburgh Coal Conference,** *David L. Lawrence Convention Center, Pittsburgh, PA.* The Twenty-Third Annual International Pittsburgh Coal Conference will focus on environmental emissions issues and technologies surrounding the continued use of coal and the development of future coal-based energy plants to achieve near-zero emissions of pollutants, reduced costs, and high thermal efficiency while producing a suite of products to meet future energy market requirements. A proposed topic area of "Global Climate Change: Science, Sequestration, and Utilization" includes possible subtopics of: Kyoto protocol and policy issues; carbon dioxide capture technologies; sequestration in geological sinks; enhancing natural sinks; modeling and assessments; non-carbon dioxide greenhouse gas capture and storage; multi-pollutant capture and storage; and $CO_2$ utilization. For more information, see: http://www.engr.pitt.edu/pcc/2006%20Conference.htm.

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

## Events cont...

September 28-30, 2006, **$CO_2$ EXPO 2006 - 2nd International Exhibition on the Carbon Market,** *New Fair of Rome, Rome, Italy*. This conference and exhibition will focus on carbon markets and trading as they relate to the Emissions Trading Scheme, with a focus on Italian interests. Artenergy, publisher of the Italian climate change magazine *Clima,* is promoting the event. For more information and email updates on the event see: http://www.co2expo.com/en/.

October 1-4, 2006, **Gasification Technologies Conference,** *JW Marriot Hotel, Washington, DC*. This leading-edge conference on gasification technologies has posted a preliminary agenda which includes a session on Carbon Management with Gasification Technologies. Registration and payment must be received before September 23, 2006. You can register online at: http://www.gasification.org/Orders/register.aspx, or see the following website for more information. http://www.gasification.org/Conference/annual.htm.

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

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

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

## For Subscription Details....

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

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