

THE CARBON SEQUESTRATION NEWSLETTER

<http://www.netl.doe.gov/sequestration>

December 2005

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Special Announcement: Career Opportunity. The National Energy Technology Laboratory is seeking an accomplished senior-level scientist or engineer to lead its in-house research focus area for Geological and Environmental Sciences (GES). The research conducted by the GES includes improved exploration and production of natural gas and oil from unconventional domestic resources and geological sequestration of carbon dioxide. U.S. citizenship is required. *The U.S. Department of Energy is an equal opportunity employer.* The announcement closes on December 30, 2005. For information about qualification requirements and procedures for applying, contact Scott Sigley at (304) 285-4470, or visit the career opportunities page on the NETL website at www.netl.doe.gov

Sequestration in the News

Numerous articles about the Weyburn Project appeared in the news this month. Highlights are as follows:

Associated Press, "Carbon Dioxide Storage a Success."

According to the Department of Energy, the Weyburn EOR project in Canada has proven to be a success, removing 5 million tons of CO₂, while enhancing oil recovery. If the methodology could be applied worldwide, from one-third to one-half of the carbon dioxide emissions that go into the atmosphere could be eliminated over the next century and billions of barrels of additional oil could be recovered, the department said. "The success of the Weyburn Project could have incredible implications on reducing CO₂ emissions and increasing America's oil production," said Energy Secretary Samuel Bodman. In a statement released by his office, Bodman said that if the process were used in all the oil fields of western Canada, "we would see billions of additional barrels of oil and a reduction of CO₂ emissions equivalent to pulling more than 200 million cars off the road for a year." This AP article was picked up by news organizations throughout the world including: *Yahoo News, Washington Post, USA Today, LA Times, Seattle Post-Intelligencer, and the Peoples Daily (China).* November 15, 2005, <http://www.enn.com/today.html?id=9261>

Oil & Gas Journal, "Weyburn project demonstrates CO₂ sequestration, EOR."

Highlighting the success of the Weyburn project, this article says scientists project that knowledge gained from the project will keep the Weyburn oil field viable for an additional 20 years, produce an additional 130 million bbl of oil, and sequester as much as 30 million tons of CO₂. The project now will move into a second phase, where researchers will compile a best practices manual to serve as a reference in the design and implementation of CO₂ sequestration in conjunction with enhanced recovery projects. Researchers also will expand their efforts to the neighboring Midale Unit, develop more rigorous risk-assessment modeling techniques, improve injection efficiencies, and monitor CO₂ flooding and storage with a variety of methods, including seismic wave technologies and geochemical surveys, DOE said. November 16, 2005, http://ogj.pennnet.com/articles/article_display.cfm?Section=ONART&C=GenIn&ARTICLE_ID=241606&p=7 (subscription required)

Star Tribune, "Cleaning up coal: Promising new, cleaner technologies."

Article chronicles the development of what some environmentalist and industry folks say could be a watershed case in determining the future role of coal-fired generation in several Upper Midwest states. Lines are being drawn in response to a proposal by Great River Energy and its partners to build the Big Stone II plant in South Dakota that would bring coal-fired power to the Twin Cities. The \$1.2 billion Big Stone II plant will generate less mercury and other pollutants than the smaller Big Stone I plant in eastern South Dakota generates today, thanks to waste-heat usage, pretreatment of the coal and advance scrubbers that will be installed in both units. However, environmentalists argue that the proposed pulverized-coal plant will do little to mitigate carbon dioxide emissions. Environmental groups plan to fight the necessary construction and transmission permits before state regulators and they will insist that it's foolish to proceed with old, pulverized-coal technology and that the plant can wait until carbon-capturing technologies are in place. Great River CEO Dave Saggau has said he believes new technologies (IGCC with CCS) are too far off to be included in Big Stone II, which is scheduled to start construction in 2007. November 9, 2005, <http://www.startribune.com/stories/1069/5715770.html>

Greenwire, "In Florida, Residents Stop Proposed Power Plant."

A plan by Florida Power & Light, which sought to build two 850-megawatt coal units on a 3,000-acre tract in rural southwest St. Lucie County, was dealt a blow when the County Commission voted down the proposal with a 5-0 commission vote. The utility had tried to win public support for the plant with assurances that it would be equipped with state-of-the-art pollution controls allowing for minimal air and water emissions. It also said the plant would be an economic boon to the county by providing nearly 200 jobs and millions of dollars in tax revenue. But such arguments did not win favor with the commission, which ultimately decided that concerns about noise, light and air emissions were enough to derail the project. FPL planned to use supercritical pulverized coal combustion technology. Stephen Smith, executive director of the Southern Alliance for Clean Energy, which worked to stop the project, said that while his organization and others encouraged FPL to adopt coalbed gasification technology for the St. Lucie County plant, the company refused on grounds that IGCC was unproven and that the same environmental protections could be achieved with pulverized coal. (continued on page 2)

The article points out that IGCC technology was selected for another Florida power plant being built by Southern Co. and the Orlando Utilities Commission. That project, known as the Stanton Energy Center, is expected to come online by 2012 and has faced minimal public opposition. November 8, 2005, <http://www.nrdc.org/news/newsDetails.asp?nID=1910>

Fox News, "FOX News Poll: Global Warming." Most Americans believe global warming exists and a majority thinks it is a major problem – if not a crisis, according to a recent FOX News poll. However, less than half think they personally can do anything about the problem. The new national poll finds that 77 percent of Americans believe global warming is happening and, of those, more than twice as many think it is caused by human behavior (46 percent) than by normal climate patterns (17 percent). All in all, Americans take the issue of global warming seriously. A 60 percent majority describes the situation as either a crisis (16 percent) or a major problem (44 percent), while about one in five say it is a minor problem (22 percent) and one in ten "not a problem at all" (12 percent). "Despite the skepticism that has been expressed by some business, scientific and political leaders, the existence and importance of global warming seems to be the consensus position of Americans," comments Opinion Dynamics Chairman John Gorman. "This lopsided acceptance of the problem is something we don't see for many other issues." November 10, 2005, <http://www.foxnews.com/story/0,2933,175070,00.html>

Science Daily, "Western states to host first test of carbon sequestration in lava rock." Article highlights upcoming field tests by the Big Sky Carbon Sequestration Partnership, which the U.S. Department of Energy and private companies awarded \$17.9 million in June. Researchers are making preparations to inject carbon dioxide into subterranean volcanic basalt rock and monitor whether the rock can hold it. At first, basalt seemed an unlikely candidate for sequestration; engineers regarded it as too dense. But basalt accumulates in layers, as successive lava outpourings spread out and cool, forming a stack like pancakes, each tens to hundreds of feet thick. The fast-cooled, rubble tops are full of cracks and gas bubbles; the slow-cooled, dense interiors form impermeable barriers. Using computer models of the rocks' porosity and chemistry, the group reported in 2004 that layered basalts appeared to be well suited for secure, long-term storage. November 7, 2005, <http://www.sciencedaily.com/releases/2005/11/051107081311.htm>

Houston Chronicle, "Spinning Tar into Oil." Article focuses on Alberta oil sands and discusses how the recent run up of oil prices has made this unconventional resource profitable, adding more than 170 billion barrels of oil to Canada's reserve base. Also highlighted is the effect of these operations on Canada's commitments under the Kyoto Protocol. Carbon sequestration is mentioned as a solution that can keep the oil sands progressing while keeping Kyoto alive. The article says that Kinder Morgan is interested in carbon sequestration in Alberta. Alberta Energy Minister Greg Melchin likes the idea of sequestration but said that, as it stands, the economics are marginal at best. November 6, 2005, <http://www.chron.com/cs/CDA/ssistory.mpl/business/energy/3440367>

South China Morning Post, "Despite its problems, coal is here to stay." According to this article, which focuses mainly on coal mining in China and much needed safety and infrastructure improvements, the long run answers to China's energy and environmental problems may be found in cutting-edge technologies such as underground gasification and carbon sequestration. The article says these techniques will take decades to develop on a commercial scale, however. "Until then, China will have to continue mining and burning coal the bad old way, at a heavy cost to both the country's miners and its environment." November 7, 2005, <http://www.wbcsd.org/plugins/DocSearch/details.asp?type=DocDet&ObjectId=MTcxNjE>

RigZone, "Statoil Says IOR Challenges Offer Potential for UK-Norwegian Cooperation." Speaking at a conference in London, Statoil chief executive Helge Lund urged that the use of carbon dioxide for improved oil recovery (IOR) could address growing energy demand while simultaneously reducing greenhouse gas emissions which affect the global climate. "We've been a pioneer in carbon capture and storage," said Lund. "Since 1996, we have separated carbon from the gas stream on our Sleipner fields and injected it into a permanent sub-surface store. The next step could be to establish a carbon dioxide value chain where, in addition to storage, an improved oil recovery (IOR) effect could be included." October 26, 2005, http://www.rigzone.com/news/article.asp?a_id=26316

Announcements

Presentations from the 2005 Gasification Technologies Conference. Numerous sequestration-related presentations from the 2005 Gasification Conference are available online. The conference had a session devoted to sequestration titled, "Carbon Sequestration Ready: What Does It Mean & Who Can Do It?" This site also provides an extensive library of papers addressing gasification-related issues as well as papers and presentations from previous Gasification Technologies Conferences, <http://www.gasification.org/Presentations/2005.html>

Science

"Unabated fossil-fuel use will replace polar ice with forests, DOE lab warns." Continued burning of fossil fuels at the current pace will raise sea levels nearly 23 feet and lead to polar forests instead of ice caps in 300 years, a new Department of Energy report says. Scientists at DOE's Lawrence Livermore National Laboratory in California called the findings "stunning results of climate and carbon cycle model simulations" in a statement accompanying the report's release. Their study found that the Earth would warm by 8 degrees Celsius (14.5 degrees Fahrenheit) if humans use the entire planet's available fossil fuels by the year 2300. The scientists used models that coupled climate with the carbon cycle in the atmosphere to measure changes in both global climate and the carbon cycle. The data used included actual carbon emissions and climate change from pre-industrial levels (1870) to what is projected through 2300. *Greenwire*, November 3, 2005, <http://www.wbcsd.org/plugins/DocSearch/details.asp?type=DocDet&ObjectId=17142>. Also see, "Modeling of long-term fossil fuel consumption shows 14.5-degree hike in Earth's temperature," *LLNL Press Release*, November 1, 2005, http://www.llnl.gov/pao/news/news_releases/2005/NR-05-11-01p.html

"Global Warming Supercharged by Water Vapor?" Water vapor, experts say, is the culprit behind Europe's rapidly rising temperatures. Evaporated H₂O is a known greenhouse gas – a gas that absorbs and re-emits infrared radiation in Earth's atmosphere, thereby increasing temperatures. But only now has a study uncovered evidence that water vapor is a major public enemy in Europe. According to a team of Swiss scientists, heat from other greenhouse gases is causing more water to evaporate, releasing the vapor into the atmosphere above Europe. That vapor in turn, adds to the greenhouse effect, further warming the region. Temperatures throughout the Northern Hemisphere have been increasing in recent years. But Europe has been heating up especially quickly, leading to studies, theories, and debate as to why. The scientists calculated that 70 percent of the recent increase in temperatures in central Europe is due to water vapor, and 30 percent is due to other greenhouse gases. *National Geographic*, November 10, 2005, http://news.nationalgeographic.com/news/2005/11/1110_051110_warming.html

“Climate Study Warns of Warming and Losses of Arctic Tundra.” If emissions of heat-trapping gases continue to accumulate in the atmosphere at the current rate, there may be many centuries of warming and a near total loss of Arctic tundra, according to a new climate study. The researchers ran a computer model that simulates the climate system and the flow of heat-trapping carbon dioxide into the air, then back into soils and the ocean. In the simulation, the atmospheric concentration of carbon dioxide rises about 0.45 percent a year through 2300. That is slightly less than the current rate, about 0.5 percent. But even at the lower rate, the concentration of carbon dioxide would double from preindustrial levels by 2070, triple by 2120 and quadruple by 2160. Consistent with many other studies, the model showed that the Arctic would see the most warming, with average annual temperatures in many parts of Arctic Russia and northern North America rising by more than 25 degrees by around 2100. In the simulation, the scrubby Arctic tundra largely vanishes as climate zones shift hundreds of miles north. Tundra would decline to 1.8 percent of the world's land area from about 8 percent. *New York Times*, November 2, 2005, <http://www.mezomorf.com/science/news-9976.html>

“Climate Shift Tied To 150,000 Fatalities: Most Victims Are Poor, Study Says.” Earth's warming climate is estimated to contribute to more than 150,000 deaths and 5 million illnesses each year, according to the World Health Organization, a toll that could double by 2030. The data, published in the journal *Nature*, indicate that climate change is driving up rates of malaria, malnutrition and diarrhea throughout the world. Health and climate scientists at the University of Wisconsin at Madison, who conducted one of the most comprehensive efforts yet to measure the impact of global warming on health, said the WHO data also show that rising temperatures disproportionately affect poor countries that have done little to create the problem. *Washington Post*, November 17, 2005, <http://www.washingtonpost.com/wp-dyn/content/article/2005/11/16/AR2005111602197.html>

Policy

“US to push at UN meeting for voluntary carbon cuts.” The Bush administration will use a United Nations climate change meeting in Canada to tout a voluntary plan to store heat-trapping gases underground, says an Energy Department official. Officials from some 150 countries will meet in Montreal on November 28 to discuss how to curb greenhouse gas emissions when the first phase of the Kyoto treaty ends. The White House prefers a voluntary, multi-national plan to sequester and store carbon dioxide. It would encourage nations to separate carbon dioxide from industrial emissions and pipe it into geologic formations or deep beneath the ocean floor for permanent storage, the Energy Department official said. The U.N. meeting is “an important moment for this technology – we are hopeful it would be endorsed in Montreal,” said Mark Maddox, the deputy assistant secretary of energy. Says John Grasser, an Energy Department spokesman, “There's got to be a better and cheaper way to do this [than mandatory cuts envisioned by Kyoto]...that's why sequestration is taking off – it might be our ace in the hole.” David Doniger, a climate change expert at the Natural Resources Defense Council, says he is “bullish” on sequestration technology, but it must be accompanied by specific carbon cuts. The federal government should give U.S. utilities incentives to capture carbon emissions from coal-fired power plants, and introduce a cap-and-trade system similar to one being used in the European Union, Doniger said. *Leading the Charge*, November 16, 2005, <http://www.leadingthecharge.com/stories/news-00100778.html>

“US States say Power Bills Won't Soar on CO₂ Plan.” Businesses who oppose a plan to cut greenhouse gas emissions in nine Northeastern U.S. states have overestimated how much the plan will raise electric bills, according to a study released by the states. The study sponsored by the Northeast states showed the plan by nine governors to cut greenhouse emissions would raise electricity rates only between 0.3 and 6.9 percent – not by 23 percent, as a business group had contended. By the end of the year, the states hope to pass the Regional Greenhouse Gas Initiative aimed at cutting greenhouse gas emissions 10 percent by 2010. *Reuters*, November 8, 2005, <http://www.planetark.com/dailynewsstory.cfm/newsid/33372/story.htm>

“International Climate Efforts – Beyond 2012.” The Pew Center on Global Climate Change released a new report outlining options and recommendations for advancing the international climate change effort post-2012. The report is from the Climate Dialogue at Pocantico, a group of 25 senior policymakers and stakeholders from 15 countries convened by the Pew Center. The report was formally released at an event in the hearing room of the U.S. Senate Foreign Relations Committee hosted by Senator Richard G. Lugar (R-Indiana) and Senator Joseph R. Biden Jr. (D-Delaware), the committee's Chairman and Ranking Minority Member. At the event, Senators Lugar and Biden also announced the introduction of a Sense of the Senate resolution calling for the United States to participate in negotiations under the Framework Convention on Climate Change to establish mitigation commitments by all major emitting countries (see *Legislative Activity* section of this newsletter). For information on the Pocantico dialogue and report, and on the Lugar-Biden Climate Change resolution, please visit http://www.pewclimate.org/global-warming-in-depth/international/reports/pocantico_release.cfm. Also see, “Panel Calls for Flexible Climate Treaty,” *Wall Street Journal*, November 16, 2005, http://online.wsj.com/public/article/SB113211692367798698-JV1k5nCdZw2CrRmY6BgM_Hts6Y8_20061116.html?mod=fff_main_tff_top

“New Technologies to Reduce Global Warming.” During a follow-up meeting to the climatic agreement established during the G-8 Summit in Gleneagles in July 2005, the Ministries of Energy and Environment of the G-8 member countries discussed how to reduce global warming with new technologies. Delegates from China, Brazil, Mexico and India took part in the summit, at which British PM Tony Blair said science and technology will permit the solution of climatic problems, not the agreements taken. He mentioned a technique to capture and store carbon dioxide through plants, which break it down in photosynthesis, liquefy it and store it in the subsoil. *Prensa Latina*, November 2, 2005, <http://www.plenglish.com/article.asp?ID=%7BE92F4E2B-5F6D-4551-B889-4510D4636C88%7D&language=EN>

“G20 climate summit pushes technology not targets.” The industrialized and developing nations that emit the most greenhouse gases have pledged to work together to develop and deploy “clean technologies” to tackle climate change. Meeting in London, energy and environment ministers from the G20 group of nations also agreed to work with the World Bank to create incentives for large-scale private investment in such technologies. The meeting took place in the run-up to the UN conference in Montreal that is expected to focus on how to tackle climate change once the Kyoto Protocol expires in 2012. Regarding the development of renewable energy sources and technologies to capture and store carbon emissions from coal-fired power stations, UK Prime Minister Tony Blair said, “The blunt truth about the politics of climate change is that no country will want to sacrifice its economy in order to meet this challenge. The solutions will come in the end, in part at least, through the private sector developing the technology and science.” *SciDev.net*, November 3, 2005, <http://www.wbcsd.org/plugins/DocSearch/details.asp?type=DocDet&ObjectId=17144>

"Germany to Link Up with Mexico and Brazil on CO₂."

Germany hopes to sign partnership deals for greenhouse gas emission cuts with Mexico and Brazil at the United Nations climate change conference in Montreal, a government official said. Germany is in talks with a raft of countries on memoranda of understanding (MOUs) aimed at helping German firms earn carbon dioxide reduction credits abroad, said Franzjosef Schafhausen, head of the Berlin government's climate working group. "There are about 30 MOUs under negotiation and those with Mexico and Brazil are the furthest advanced so their realization by Montreal is highly likely," Schafhausen said at an emissions trading conference in Frankfurt. The MOUs will create the legal foundation for Joint Implementation (JI) and Clean Development Mechanism (CDM) programs, two of the main emissions reduction tools promoted in the Kyoto Protocol on climate change. The other Kyoto mechanism is emissions trading. By agreeing JIs and CDMs, companies in industrialized countries can earn credits towards their mandatory greenhouse gas reduction targets by investing in green projects in poorer countries, where it can be cheaper and easier to curb pollution. *Reuters*, September 11, 2005, <http://www.planetark.com/dailynewsstory.cfm/newsid/33387/story.htm>

"China Unlikely to Sign on to Kyoto Emissions Cuts."

China is unlikely to commit to cutting emissions in the next phase of the Kyoto Protocol, fearing it would retard economic growth, but analysts say the government is waking up to the threat of climate change. China, now the world's second largest emitter of greenhouse gases after the United States, recently unveiled a five-year economic plan that stresses sustainable rather than breakneck growth, an acknowledgment of the environmental and social costs of its economic success. "China might be willing to commit to a cap at some time if there is a package on the table, for instance a technology transfer from the EU," says Yu Jie, a climate and energy campaigner at Greenpeace. "I think developing countries have made it pretty clear from the beginning that they weren't going to accept cuts because that would impede their capacity to grow," said Alan Oxley, an environment and trade expert and head of the Australia APEC Study Centre. "That situation hasn't changed." *Reuters*, November 14, 2005, <http://www.planetark.com/dailynewsstory.cfm/newsid/33446/story.htm>

"Energy Bill Impacts R&D, Conservation, Nuclear, Wind, Solar, Coal, Oil, Oil Shale and Ethanol Endeavors."

Senate Energy & Natural Resources Chairman Pete V. Domenici outlined some of the tangible results already seen from the enactment of the Energy Policy Act of 2005. In a statement, Chairman Domenici said "Coal companies are seeking to partner with the federal government on clean coal projects while innovative strategies are already producing more oil from our own mature oil fields and sequestering carbon at the same time...The energy bill is making a difference. It's already evident in the energy production sector. In the next year or two, I hope that difference will be evident at the gas pump and in our electric bills." *Press Release*, November 18, 2005, http://energy.senate.gov/public/index.cfm?FuseAction=PressReleases.Detail&PressRelease_id=234792&Month=11&Year=2005

"N.Y. adopts new emissions standards." New York became the second of six Northeastern states considering similar rules to adopt emissions standards like those in California – the only state with stricter guidelines than the federal government. Vermont adopted the guidelines last week. Under the new carbon dioxide emissions guidelines all 2009 and later model cars sold in New York and Vermont will have to meet higher fuel efficiency standards. *E&E Daily*, November 10, 2005, <http://www.wbcsd.org/plugins/DocSearch/details.asp?type=DocDet&ObjectId=MTcyMjg>. Also see, "Vt. adopts new rules to cut car emissions," *Associated Press*, November 3, 2005, <http://www.enn.com/today.html?id=9166>

Norway: "Efforts to realize capture, use and storage of carbon dioxide have commenced." According to a press release issued by the Norwegian Ministry of Petroleum and Energy, "the Government has ambitious goals regarding capture, use and storage of carbon dioxide and our timetable is demanding." NOK 20 million is allocated to this work, says Mr. Odd Roger Enoksen, Minister of Petroleum and Energy. The Government will also contribute substantially to the development of technology for capture of carbon dioxide through Gassnova – the Norwegian state centre for sustainable gas technologies – as well as on R&D through the Norwegian Research Council. The release also says the government will proceed with the planning of CO₂ capture at the Kårstø gas fired power plant. *Press release*, November 10, 2005, <http://www.odin.dep.no/oed/english/026001-070329/dok-bn.html>

"Greenhouse gas to rise by 52%." In a new report, the IEA warns that energy consumption must be reduced. Global greenhouse gas emissions will rise by 52% by 2030, unless the world takes action to reduce energy consumption, the study says. The prediction comes from the latest annual World Energy Outlook report from the International Energy Agency. It says that under current consumption trends, energy demand will also rise by more than 50% over the next 25 years. The IEA adds that oil prices will "substantially" rise unless there is extra investment in oil facilities. It says the world has seen "years of under-investment" in both oil production and the refinery sector. The organization estimates that the global oil industry now needs to invest \$20.3 trillion in fresh facilities by 2030, or else the wider global economy could suffer. *BBC News*, November 7, 2005, <http://news.bbc.co.uk/2/hi/business/4414000.stm>

Geology

"Field-Project Designs for Carbon Dioxide Sequestration and Enhanced Coalbed Methane Production."

In this study, reservoir-simulation computations are performed for a hypothetical pilot-scale project in coal seams. The authors vary operational parameters, such as injector length, injection well pressure, time to injection, and production well pressure, in order to evaluate different production schemes and determine an optimum for various coal types. Values of total CO₂ sequestered and methane produced are presented for multiple coal types and different operational designs. *Energy & Fuels*, Volume 19 Issue 6 (November 16, 2005), <http://pubs.acs.org/cgi-bin/abstract.cgi/enfuem/2005/19/i06/abs/ef049667n.html> (subscription required)

Technology

"DOE Advances Oxycombustion for Carbon Management."

The Department of Energy has selected two projects to demonstrate "oxycombustion" – a promising carbon capture technology – in existing coal-fired power plants. The projects, valued at nearly \$10 million, are expected to help expedite the timeline for commercialization of oxycombustion technology through slip stream or pilot plant testing. In an oxycombustion-based power plant, oxygen rather than air is used to combust a fuel resulting in a highly pure carbon dioxide exhaust that can be captured at relatively low-cost and sequestered. No commercial oxygen combustion power plants are operating today, due mainly to the high cost of producing oxygen. Significant reduction in the cost of oxygen compared to today's best cryogenic technology is a key requirement to making the oxycombustion power plant a viable future option. The two projects selected by DOE show promise for reducing those costs when compared to existing CO₂ capture systems. Babcock and Wilcox and BOC Group, Inc. will head the two projects. *DOE/FE TechLine*, November 17, 2005, http://www.fossil.energy.gov/news/techlines/2005/tl_oxycombustion_award.html

“Oxy-fuel combustion technology for coal-fired power generation.” This paper provides a comprehensive review of research on oxy-fuel combustion, gives the status of the technology development and assessments providing comparisons with other power generation options, and suggests research needs. *Progress in Energy and Combustion Science*, Volume 31, Issue 4, Pages 283-370 (2005), <http://www.sciencedirect.com/science/journal/03601285> (subscription required)

“CO₂ capture using some fly ash-derived carbon materials.” In this work, low cost carbon materials derived from fly ash are presented as effective CO₂ sorbents. The results show that for samples derived from a fly ash carbon concentrate, the CO₂ adsorption capacities were relatively high, especially at high temperatures where commercial active carbons relying on physisorption have low capacities. *Fuel*, Volume 84, Issue 17 (December 2005), <http://www.sciencedirect.com/science/journal/00162361> (subscription required)

“Economical CO₂, SO_x, and NO_x capture from fossil-fuel utilization with combined renewable hydrogen production and large-scale carbon sequestration.” The objective of this project was to investigate and demonstrate production methods at a continuous, bench-scale level and generate sufficient material for an initial evaluation of a potentially profitable method of producing bioenergy and sequestering carbon. The novel process uses agricultural, forestry, and waste biomass to produce hydrogen using pyrolysis and reforming technologies conducted in a 50 kg/h pilot demonstration. A pyrolysis temperature profile was discovered that results in a carbon char with an affinity for capturing CO₂ through gas phase reaction with mixed nitrogen-carrying nutrient compounds within the pore structures of the carbon char. The total amount of CO₂ sequestration was managed by controlling particle discharge rates based on density. The patent-pending process is particularly applicable to fossil-fuel power plants as it also removes SO_x and NO_x, does not require energy-intensive carbon dioxide separation and operates at ambient temperature and pressure. The complete process produces three times as much hydrogen as it consumes, making it a net energy producer for the affiliated power plant. *Energy*, Volume 30, Issue 14, (November 2005), <http://www.sciencedirect.com/science/journal/03605442> (subscription required)

“Engineering economic analysis of biomass IGCC with carbon capture and storage.” This study surveys the methods of integrating biomass technologies with carbon dioxide capture, and models an IGCC electric power system in detail. *Biomass and Bioenergy*, Volume 29, Issue 6, Pages 399-466 (December 2005), <http://www.sciencedirect.com/science/journal/09619534> (subscription required)

Terrestrial

“Carbon Sequestration in Arable Soils is Likely to Increase Nitrous Oxide Emissions, Offsetting Reductions in Climate Radiative Forcing.” The authors conducted simulations with a biogeochemical model to evaluate the impact of different cropland management strategies on the coupled cycles of C and N, with special emphasis on C-sequestration and emission of the greenhouse gases methane (CH₄) and nitrous oxide (N₂O). Reduced tillage, enhanced crop residue incorporation, and farmyard manure application each increased soil C-sequestration, increased N₂O emissions, and had little effect on CH₄ uptake. Over 20 years, increases in N₂O emissions, which were converted into CO₂-equivalent emissions with 100-year global warming potential multipliers, offset 75–310% of the carbon sequestered, depending on the scenario. *Climatic Change* (October 2005) 72, Number 3, <http://www.springerlink.com/openurl.asp?genre=article&id=doi:10.1007/s10584-005-6791-5> (subscription required)

“Carbon sequestration potential estimates with changes in land use and tillage practice in Ohio, USA.” This study estimates the carbon sequestration potential of soil in Ohio for two scenarios: (1) with reforestation of both current cropland and grassland where soil organic carbon (SOC) pools are less than the baseline SOC pool under current forest; and (2) with the adoption of no-till (NT) on all current cropland. *Agriculture, Ecosystems & Environment*, Volume 111, Issues 1-4 (December 1, 2005), <http://www.sciencedirect.com/science/journal/01678809> (subscription required)

“Forest soils and carbon sequestration.” This study investigates soil carbon sequestration in boreal and temperate forests and the potential to ameliorate changes in atmospheric chemistry. *Forest Ecology and Management*, Volume 220, Issues 1-3 (December 10, 2005), <http://www.sciencedirect.com/science/journal/03781127> (subscription required)

Ocean

“Asleep in the deep: Model helps assess ocean-injection strategy for combating greenhouse effect.” Highlights a theoretical model developed by University of Michigan researcher Youxue Zhang that can be used to explore the fate of CO₂ injected into oceans under various temperature and pressure conditions. Zhang's model shows that liquid CO₂ would have to be injected to a depth of at least 800 meters (about a half mile) and possibly as much as 3,000 meters (nearly two miles) to keep it from escaping. “Droplets injected to a depth of 800 meters will rise, but if they are small enough they should dissolve completely before reaching the liquid-gas transition depth – assuming everything works perfectly,” said Zhang, a professor of geological sciences. However, at a high injection rate, seawater full of CO₂ droplets would have an average density smaller than that of surrounding seawater, creating conditions that could lead to a rapidly-rising plume. *University of Michigan News Service*, November 3, 2005, <http://www.umich.edu/news/index.html?Releases/2005/Nov05/r110305>

“Dissolution mechanisms of CO₂ hydrate droplets in deep seawaters.” Carbon dioxide dissolution at intermediate ocean depths was studied using physical and mass transfer models. *Energy Conversion and Management*, Volume 47, Issue 5 (March 2006), <http://www.sciencedirect.com/science/journal/01968904> (subscription required)

“Effects of Mixing Functions of Static Mixers on the Formation of CO₂ Hydrate from the Two-Phase Flow of Liquid CO₂ and Water.” Formation experiments of CO₂ hydrate from the two-phase flow of liquid CO₂ and water were carried out using static mixers with different types of mixing elements to elucidate the effects of mixing functions of the static mixer on CO₂ hydrate formation. The observed behaviors of CO₂ hydrate formation were classified into six patterns and the formation mechanisms are discussed. *Energy Fuels*, 19 (6), 2364 -2370 (November 16, 2005), <http://pubs.acs.org/cgi-bin/abstract.cgi/enfuem/2005/19/i06/abs/ef0500843.html> (subscription required)

Trading

Carbon Market Update, November 22, 2005

CCX-CFI 2005 (\$/tCO ₂)	\$2.00
EU ETS-EUA 2005 (\$/tCO ₂)	\$25.76

“European firms trade emission credits.” Volumes in the European Union's carbon dioxide emission trading scheme have soared with over 200 million tonnes of credits expected to change hands this year, says a report from consultants Prospex. Trade is expected to increase further next year as more companies, especially in southern and eastern Europe, enter the market. “The pioneering days are over. In the first three quarters of 2005 alone, we estimate trading volumes reached 177 million tonnes, or eleven times global volumes in all of 2004,” said Amsterdam-based Prospex. September was the busiest month so far with trade reaching 43 million tonnes. The EU launched the emissions trading scheme in January as part of its drive to curb heat-trapping greenhouse gas pollution which is blamed for causing climate change. *Reuters*, October 28, 2005, <http://www.climateark.org/articles/reader.asp?linkid=47737>

“Red tape slows Kyoto pollution credit scheme.” According to this article, the Clean Development Mechanism (CDM) – potentially a big source of cheap carbon dioxide reduction credits – is struggling to deliver as hundreds of climate-friendly projects in India, China and other developing countries wait in a queue for official approval to go ahead. Market sources say that calls to streamline the CDM, which allows rich nations to claim credits from projects in poor countries, will reach a crescendo at the United Nations climate change conference in Montreal later this month. “There will be major pressure in Montreal to increase funding for the CDM's executive board, and to strengthen the procedures, to speed up the process,” said Pedro Moura Costa, managing director of UK-based carbon trader EcoSecurities. “CDM will be a major issue because now the private sector has real (climate change) liabilities, it's not a joke anymore, it's a reality,” he said. *Reuters*, November 15, 2005, http://news.yahoo.com/s/nm/20051115/sc_nm/energy_kyoto_pollution_dc_1;_ylt=AkcWQwOQfKqxybnOjS4QBd5rAlMA;_ylu=X3oDMTbiMW04NW9mBHNIYwMIJVRPUCU

Events

November 28 - December 9, 2005, **United Nations Climate Change Conference (COP 11 and COP/MOP 1)**, Montreal, Canada. Canada will host the first meeting of the Parties to the Kyoto Protocol in Montréal in conjunction with the eleventh session of the Conference of the Parties to the Climate Change Convention. For more details, please see http://unfccc.int/meetings/cop_11/items/3394.php

November 30, 2005, **European and American Business Perspectives on Emissions Trading and Climate Policy**, The Roosevelt Hotel, New York, NY. The event will inform EU and U.S. companies, financial firms, and climate negotiators on recent developments in emissions trading and climate policy on both sides of the Atlantic. For more information, please see <http://lists.iisd.ca:81/read/attachment/26909/1/MistralInvite.pdf>

December 5-9, 2005, **American Geophysical Union's (AGU) 2005 Fall Meeting**, San Francisco, CA. Session B07: Approaches to Stabilizing Atmospheric CO₂ and Climate, will provide a forum for discussion of promising CO₂ and climate change mitigation strategies. For meeting details see <http://www.agu.org/meetings/fm05>

December 6-7, 2005, **Corporate Strategies for Reducing Utility Emissions**, Miami, FL. Topics include developing mobile reduction projects, an EPA perspective on Cap & Trade, GHG offset partnership program, CO₂ litigation update, the science behind climate change and fitting GHG into the emissions trading portfolio. Experts will also be examining what considerations are necessary in managing risk in regards to carbon costs. For additional information visit https://www.euci.com/conferences/december_05/1205_reducing_emissions.php?q=hguthr@netl.doe.gov&c=C33.1051602.130.4.0104

December 6-9, 2005, **Carbon Management Workshop and 11th Annual CO₂ Flooding Conference**, Midland, Texas. Planned for December 6 and 7, the EOR Carbon Management Workshop will offer an in-depth look at CO₂ geologic storage, its trends, developments and opportunities. Also featured is a field tour on December 7 of Kinder Morgan Production Company's Yates Field where the company conducts a gravity-dominated CO₂ flood. The CO₂ flooding conference, set for December 8 and 9, will focus on the use of carbon dioxide for enhanced oil recovery. The conference features theme sessions that examine current industry best practices in operations and reservoir management. For additional information visit http://www.spe-pb.org/co2_conference/index.asp

January 22-25, 2006, **9th Annual EUEC 2006 Conference on Air Quality, Climate Change & Renewable Energy**, Westin La Paloma Resort, Tucson, Arizona. This event organized by EPA, DOE, EPRI and EEI has a track devoted to global warming, which includes sessions on GHG mitigation, corporate strategies, carbon sequestration, and carbon trading. For more information, please visit <http://www.euec.com> or contact EUEC at 520- 615-3535 or info@euec.com

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

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

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

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

June 19-22, 2006, **GHGT-8**, Trondheim, Norway. The aim of this conference is to provide a forum for the discussion of the latest advances in the field of greenhouse gas control technologies. Details at <http://www.ghgt-8.no>

Special Edition of *Environmental Science & Policy*. The December 2005 issue of the journal *Environmental Science & Policy* focuses on Mitigation and Adaptation Strategies for Climate Change. Articles of interest include: Misdefining “climate change”: consequences for science and action, Defining response capacity to enhance climate change policy, Integrating mitigation and adaptation into climate and development policy, and others. Volume 8, Issue 6, Pages 537-654 (December 2005), <http://www.sciencedirect.com/science/journal/14629011> (subscription required)

“Target 2020: Policies and measures to reduce greenhouse gas emissions in the EU.” According to a new report by the Wuppertal Institute in Germany, the European Union can cut a third of its greenhouse gas emissions by 2020 through energy efficiency and renewable energies, as well as through a strong emissions trading system. The report highlights the concrete steps that the EU should take to cut CO₂ emissions by 33 percent by 2020, even with a moratorium on nuclear energy. The full report and the summary can be downloaded from http://www.panda.org/news_facts/publications/index.cfm?uNewsID=24155

“Key GHG Data.” In this publication the United Nations Climate Change secretariat confirms that developed countries, taken as a group, have achieved sizable emission reductions. Compared to the 1990 levels, overall greenhouse gas emissions of these countries were down 5.9% in 2003. But the secretariat warns that further efforts are required to sustain these reductions and to cut the emissions further. However, Richard Kinley, acting head of the secretariat of the UNFCCC, emphasizes that a large part of these reductions was achieved in the early 1990s in countries of Eastern and Central Europe undergoing transition to a market economy. The report is the first UNFCCC publication covering all GHG data officially submitted by developed and developing countries under the Climate Change Convention. The publication includes data on greenhouse gas emissions from 40 developed and 121 developing countries. For additional information and a link to the full report visit http://unfccc.int/essential_background/background_publications_htmlpdf/items/3604.php

“Evidence and Implications of Recent Climate Change in Northern Alaska and Other Arctic Regions.” This study reviews a broad array of evidence that illustrates the Arctic is undergoing a system-wide response to an altered climatic state. According to the study, new extreme and seasonal surface climatic conditions are being experienced, a range of biophysical states and processes influenced by the threshold and phase change of freezing point are being altered, hydrological and biogeochemical cycles are shifting, and more regularly human sub-systems are being affected. *Climatic Change* (October 2005) Volume 72, Number 3, <http://www.springerlink.com/openurl.asp?genre=article&id=doi:10.1007/s10584-005-5352-2> (subscription required)

“Lugar-Biden Initiative Calls For American Leadership on Climate Change.” On November 11th U.S. Senator Joe Biden (D-DE) joined with Dick Lugar (R-IN) to introduce a Senate Resolution calling for the United States to return to international negotiations on climate change. The Lugar-Biden Climate Change Resolution also proposes an official Senate Observer Group to ensure bipartisan Senate support for any new agreements. If adopted, this resolution will replace the last major statement of the Senate’s position on international climate change which was made back in 1997, prior to the Kyoto Protocol. *Press Release*, November 15, 2005, <http://biden.senate.gov/newsroom/details.cfm?id=248835&&>

“Committee Defeats Resolution of Inquiry.” On November 9, the House Science Committee defeated a resolution of inquiry that would have required the Administration to provide to Congress, within 14 day of enactment, all documents related to “the effects of climate change on the coastal regions of the United States” produced by the National Aeronautics and Space Administration, National Weather Service, National Science Foundation, National Oceanic and Atmospheric Administration, National Assessment Synthesis Team, and the U.S. Geological Survey. The resolution, which was introduced by Representative Dennis Kucinich (D-OH), was defeated 11 to 16 and, by voice vote, was reported from Committee adversely. It will not be brought before the full House. *House Committee on Science*, November 9, 2005, <http://www.house.gov/science/press/109/109-159.htm>