

THE NETL CARBON SEQUESTRATION NEWSLETTER: ANNUAL INDEX

AUGUST 2003 – AUGUST 2004

This is an indexed compilation of the past year's monthly National Energy Technology Laboratory Carbon Sequestration Newsletter. The newsletter is produced by the NETL to provide information on activities and publications related to carbon sequestration. It covers domestic, international, public sector, and private sector news. This compilation covers newsletters issued between September 2003 and August 2004. It highlights the primary news and events that have taken place in the carbon sequestration arena over the past year. Information that has become outdated (e.g. conference dates, paper submittals, etc.) was removed.

To subscribe to the newsletter, please send a message to majordomo@list-manager.netl.doe.gov with "subscribe sequestration" in the body (not subject) of the message.

SEQUESTRATION IN THE NEWS	1
EVENTS & ANNOUNCEMENTS	11
SCIENCE	15
GEOLOGY	20
TECHNOLOGY	23
OCEAN	27
TERRESTRIAL	31
TRADING	40
POLICY	44
PUBLICATIONS	53
LEGISLATION	63
INDEX	66
CONTACT INFORMATION	72



Sequestration in the News

September 2003

DOE names regional sequestration partners. The U.S. Department of Energy named seven regional partnerships that will make up a nationwide network to study the most suitable carbon sequestration methods for specific areas of the country. The organizations will also determine possible regulatory and permitting requirements, along with infrastructure needs that would be necessary to implement carbon sequestration. The DOE will provide approximately \$11.1 million (up to \$1.6 million per partnership) of support over the next two years, and participating organizations will contribute another \$7 million – an average of nearly 40 percent of the initial funding, NETL Techline, August 18, 2003, http://www.netl.doe.gov/publications/press/2003/tl_sequestration_partnershipselections.html.

Casper Star Tribune, Wyoming hopeful FutureGen site. Several eastern Wyoming counties say the area's productive coal mines and aging oilfields make it the best site for FutureGen, the White House's \$1 billion zero-emissions power generation and CO₂ sequestration initiative. “Counties vie for \$1 billion clean coal plant,” August 25, 2003, <http://www.casperstartribune.net/articles/2003/08/25/news/wyoming/8308c5068b298bc0fae5b6b19e2647e6.txt>.

The Independent, CO₂ not a pollutant. The Bush administration has decreed that CO₂ from industrial emissions is not a pollutant nor does the administration have the power under the Clean Air Act to declare CO₂ emissions from autos as a pollutant. “U.S. says CO₂ is not a pollutant,” August 31, 2003, <http://news.independent.co.uk/world/americas/story.jsp?story=438719>; and “EPA says won't regulate CO₂ emissions from autos,” *Reuters*, August 29, 2003, <http://www.reuters.com/>. See also: “A change of air,” *Washington Post*, August 30, 2003, <http://www.washingtonpost.com/ac2/wp-dyn?pagename=article&contentId=A5513-2003Aug30¬Found=true>.

October 2003

Philadelphia Inquirer summarizes the pros and cons of geologic CO₂ storage in general and highlights the borehole seismic study of the Mount Simon aquifer being conducted near AEP's coal-fired power plant in Mountaineer West Virginia. “Digging deep for an answer to global warming,” *Philadelphia Inquirer*, September 4, 2003, <http://www.philly.com/mld/philly/living/health/6685575.htm> (registration required).

Public Utilities Fortnightly discusses the future involvement of coal utilities in carbon capture and sequestration. IGCC is the most promising option for combining sequestration technology with power production, but there are no 500-MW models of IGCC plants, and the environmental superiority of IGCC is financially unrewarded in today's market. Technology development, incentives, and clear regulations are needed to provide inexpensive coal power while emitting fewer pollutants and sequestering CO₂, according to this article. “The carbon conundrum; Technology exists to sequester carbon – but will utilities ever buy in?” *Public Utilities Fortnightly*, August 2003, <http://www.pur.com/puftocs/aug03.cfm> (subscription required).

Cinergy to cut emissions by 5 percent. The Cincinnati-based power company with core operations that account for one percent of worldwide GHG emissions announced “a voluntary plan to reduce its greenhouse gas emissions to an average of five percent below their 2000 level during the period 2010 through 2012. Cinergy will spend \$21 million between 2004 and 2010 on projects to reduce or offset its emissions.” Cinergy's Chairman, President and Chief Executive James Rogers said in a statement, “We are also participating in new

technology development to find ways to burn coal without emissions.” Cinergy news release, September 10, 2003, http://www.cinergy.com/News/default_corporate_news.asp?news_id=385.

Marion Daily Republican, FutureGen News. The town of Marion, Illinois is vying to host the project. “Bradley wants Marion behind FutureGen,” *Marion Daily Republican*, September 24, 2003, http://www.mariondaily.com/articles/2003/09/24/local_news/news01.txt (subscription required).

Platts, Regional partnerships news. DOE’s seven regional partnerships also continued to receive press. “Carbon sequestration alliances to focus on assessing storage needs, resources,” *Platts Coal Outlook*, September 1, 2003. See also, “Energy Secretary Abraham Creates Regional Partnerships to Develop carbon sequestration options,” *US Newswire*, September 2, 2003, <http://releases.usnewswire.com/GetRelease.asp?id=121-09022003>; “Energy Dept. picks regional teams to plan carbon sequestration,” *Waste News*, September 3, 2003, <http://www.wastenews.com/headlines2.html?id=1062620887>; “New Mexico Tech named regional leader for science partnership,” *New Mexico Business Weekly*, September 10, 2003, <http://albuquerque.bizjournals.com/albuquerque/stories/2003/09/08/daily8.html>; and “Illinois geological survey to lead study of carbon sequestration,” *Chester Sun Times*, IL, August 27, 2003, <http://www.suntimesnews.com>.

The Guardian, UK Ministers consider sub-sea geologic storage. A report by UK government scientists recommends the study of capturing and storing CO₂ in the geologic strata beneath the North Sea to meet long-term GHG targets of 60 percent reduction by 2050. The Commons select committee on science and technology has endorsed the technology, saying it considers CO₂ sequestration “a necessary part of the transition to a non-carbon fuel economy”. Said UK environment minister Elliott Morley, “I certainly think it should be looked at. I don't believe it's the long-term answer but it may have some benefits at the transitional stage in terms of moving away from dirty technology to clean technology. There is a gap that renewables are not going to fill in the short term.” Enhanced oil and gas recovery in the North Sea are also mentioned as options. “Minister backs plan to dump CO₂,” *The Guardian*, September 6, 2003, <http://politics.guardian.co.uk/green/story/0,9061,1036594,00.html>. See also, “Dispute scuppers CO₂ targets,” *The Engineer*, September 12, 2003.

International Oil Daily, Netherlands look into underground CO₂ storage. Dutch Economy Minister mandated Gaz de France to undertake a feasibility study into CO₂ sequestration in depleted gas fields and aquifers in the Netherlands. The study will be called Crust (CO₂ re-use through underground storage). An earlier scoping study reported that up to 10 billion tons of carbon could be sequestered. “Dutch Order CO₂ Study,” *International Oil Daily*, September 22, 2003.

European Chemical News, CO₂ capture from wine making in Finland. A Finnish CO₂ recovery plant will expand to capture 8,000 tonnes CO₂ per year from the wine and spirit fermentation plant of Altia. Messer Suomi invested €4 million in the plant expansion. “Messer Suomi to boost CO₂ recovery: In Finland,” *European Chemical News*, September 1, 2003.

November 2003

Business Week. An article, “Putting carbon dioxide in its place,” describes a test bore hole being drilled into a saline formation in West Virginia. The formation underlies a coal-fired power plant owned and operated by American Electric Power Co. (AEP). The hole (2,800 meters deep) is finished, and researchers are analyzing the samples from each layer. Economists peg CO₂ burial cost at a relatively affordable \$1 to \$8 per ton of CO₂, but CO₂ capture costs are still high. Howard Herzog (MIT), Dale Heydlauff (AEP), and Vello Kuuskraa (ARI) are quoted in this article. *Business Week*, October 20, 2003, <http://www.businessweek.com/index.html> (subscription required). The project is also highlighted in the *Milwaukee Journal Sentinel*, “Global warming solution may be underground,” September 28, 2003.

UK vote of confidence to CO₂ capture and storage. Plans have just been approved to build a £350 million Integrated Coal Gasification Combined Cycle (IGCC) power station close to Hatfield Colliery in Yorkshire, UK.

The 430MW plant will convert coal into hydrogen to generate electricity. Pollutants such as sulfur dioxide and nitrogen oxide will be converted to useable by-products while CO₂ will be separated before combustion. *IEAGHG Newsletter*, Issue 68, September 2003, <http://www.ieagreen.org.uk/sep68.htm#ukcoal>.

Bozeman Daily Chronicle. The Department of Energy has designated Montana State University as the leader of a regional partnership aimed at reducing GHG emissions. Funded with a \$1.6-million grant from the agency - matched by \$400,000 in state and regional dollars - the partnership will identify suitable ways of sequestering GHGs in the northern Rockies, including Montana, Idaho, and South Dakota. Susan Capalbo, professor of agricultural economics at MSU, leads the partnership. "MSU to lead regional partnership on carbon sequestration," *MSU News Service*, October 2, 2003, <http://www.bozemandailychronicle.com/articles/2003/10/02/news/greenhousebzbigs.txt>.

India Times. The October 30, 2003 issue contains an overview article on CO₂ sequestration in the oceans. The article opines, "The U.S. Department of Energy also finds the technique attractive, and is funding research in the area." "Ocean storage of carbon dioxide to help contain greenhouse gases," October 30, 2003, <http://economictimes.indiatimes.com/cms.dll/html/uncomp/articleshow?msid=257769&Curpg=1>.

The Beacon Journal. Battelle Memorial Institute will lead a \$2.4 million study of the viability of pumping CO₂ gas into underground rock formations in the Midwest as a means of curtailing global warming. "It's unique to have a research team with such depth and breadth of skills paired with major industrial firms such as these," said Ron Cudnick, Battelle's program manager. "Think Tank, Utilities have plan for CO₂," *Akron Beacon Journal*, October 2, 2003, <http://www.ohio.com/mld/beaconjournal/6919514.htm>. A press release from the Ohio Department of Natural Resources quotes Thomas Berg, chief of the ODNR Division of Geological Survey, as saying, "In Ohio, coal-fired electric utility plants, steel mills, and fertilizer plants generate the largest amounts of carbon dioxide. Showing where these sources are in relation to the best geologic storage reservoirs provides decision makers the tools they need for planning sequestration options."

Star Tribune, IGCC proposed in Minnesota. Excelsior Energy Inc. wants to build a 1,000 MW "coal-gasification" plant in the Iron Range region of Minnesota. Xcel Energy Inc., which would be the plant's largest customer, is unconvinced the plant will work, and environmentalists worry pollution controls won't be sufficient. "The primary environmental claim [for coal-gasification plants] is the hope or expectation of at some point capturing 100 percent of the CO₂ emissions," said Michael Noble, director of Minnesotans for an Energy-Efficient Economy. *Star Tribune*, October 14, 2003, <http://www.startribune.com/> (registration required).

December 2003

CNN highlights Sleipner. An article posted on CNN.com highlights the Sleipner project, in which CO₂ is captured from an offshore natural gas processing platform in the North Sea and injected into a saline formation below the sea floor. Statoil, the project operator, has found a profitable business model for CO₂ emissions reduction and is exploring the possibility of receiving CO₂ from onshore sources such as steel plants or coal-fired power plants. "If that solution adds up financially, it would be a dream scenario for Statoil," said Jan Karlsen, Statoil's senior vice president for gas sales. But he said it was too early to predict the practical and financial viability. Statoil's giant Snoehvit natural liquefied gas (LNG) project in the Barents Sea is due to come on stream in 2006 with the same [CO₂ capture] technology. "Oil group buries greenhouse gas under sea," *Reuters*, November 19, 2003, <http://www.cnn.com/2003/TECH/science/11/19/greenhouse.gas.reut/>.

Presentation on FutureGen at the Lignite Energy Council's Annual Meeting. Scott Klara, the Carbon Sequestration Technology Manager at NETL, set forth the potential benefits of DOE's FutureGen project at the plenary session of the Lignite Energy Council's Annual Meeting in Bismarck, ND. Said Harvey Ness, director of research and development for the Lignite Energy Council, "North Dakota, with over 800 years of lignite

reserves, is in a perfect position for this new technology because lignite is more reactive than either bituminous or subbituminous coal during the gasification process.” “DOE official outlines plans for emissions-free, coal-based energy plant,” Partners for Affordable Energy, November 14, 2003, <http://www.affordable-energy.org/news/details.asp?ID=99>.

The New York Times provides an overview of the global climate change issue and the enormous challenge of GHG emissions reduction. Carbon sequestration is mentioned as an option, “The technology for injecting carbon dioxide is straightforward, but scientists need better knowledge on suitable locations and leak prevention.” “As Earth warms, the hottest issue is energy,” *New York Times*, November 4, 2003, <http://query.nytimes.com/gst/abstract.html?res=F00713FF35540C778CDDA80994DB404482>.

January 2004

USA Today, “Administration eyes burying carbon dioxide.” Highlights AEP’s geologic sequestration field test in West Virginia. “The project is being closely watched by the Bush administration, which is funding it, and by the power industry. Both see burying the gas, carbon dioxide, as a possible long-term solution to keeping gases from power plants out of the atmosphere.” *USA Today*, December 9, 2003, http://www.usatoday.com/news/washington/2003-12-08-carbondioxide-usat_x.htm.

PR Newswire, **Entergy First U.S. Utility to Buy Geologic Carbon Sequestration Credits.** Article on Entergy’s recent purchase of 100,000 tonnes of GHG emissions credits from Blue Source. Says Jim O’Brien of Entergy, “This is exactly the kind of project that Entergy looks to invest in with our Environmental Initiatives Fund monies. Credits from this emissions trade will be used to fulfill our voluntary CO₂ stabilization commitment made in May of 2001.” *PR Newswire*, December 18, 2003, <http://www.prnewswire.com>.

Wall Street Journal, “If an oak eats CO₂ in a forest, who gets emissions credit?” In a front page article on the AEP terrestrial sequestration project in the Mississippi River Delta, the WSJ describes some of the questions coming up in the field: How do you count the CO₂? What species are best for local ecosystems and store carbon well? What about credit for pre-existing reforestation activities? The article also describes AEP’s CCX goals (1 percent per year reduction), and the power industry consortium called PowerTree, which aims to plant six forest sinks in the area. *Wall Street Journal*, December, 10, 2003.

Science’s Editors Name Soil Carbon Research an Area to Watch. Soil scientists have started to ask, and answer, ecological questions, according to the editors of *Science*. They say to look for more studies of how microbes contribute to GHGs and more accurate knowledge of soils’ impact on climate change. “Breakthrough of the year: Areas to Watch in 2004,” *Science*, December 19, 2003.

Lawrence Journal World, “Experiment in oil recovery begins in Kansas.” A 5-year test of CO₂ enhanced oil recovery was initiated in Russell, Kansas. A nearby ethanol plant is the source of the CO₂. The experiment is the first application of CO₂ enhanced oil recovery in Kansas. *Lawrence Journal World*, December 5, 2003, <http://www.ljworld.com/section/stateregional/story/154140>. Also see, “Method may lead to revival: Field near Russell first to embark on new oil recovery system,” *Topeka Capital Journal*, December 5, 2003, http://www.cjonline.com/stories/120503/bus_petrol.shtml (registration required).

Wired Magazine, “Where CO₂ Goes to Die.” Quick rundown and commentary on four sequestration methods: saline aquifers, deep coal seams, offshore seabed aquifers, and forests. December 2003, <http://www.wired.com/wired/archive/11.12/start.html?pg=7>.

February 2004

ABC News, “U.S. Begins Work on CO₂ Storage Project.” Anadarko Petroleum Corp. began pumping CO₂ into an oil reservoir in Wyoming’s Salt Creek field on February 1, 2004. Over a 30 year project life, 25 million tons of injected CO₂ is expected to remain sequestered underground. The CO₂ is “anthropogenic,” that is it is captured from ExxonMobil’s natural gas plant at LaBarge and transported to the oil field via pipeline. “This week the Wyoming State Geological Survey released a map of about 50 oil fields in the state that would be candidates for carbon dioxide injection. The fields, which once held 8 billion barrels of oil, could yield 1.2 billion barrels with the assistance of CO₂, state officials said.” January 22, 2004, http://abcnews.go.com/wire/US/ap20040128_199.html. See also, “CO₂ to be used to flush out Wyoming oil,” *Billings Gazette*, January 22, 2004, <http://www.billingsgazette.com/index.php?display=rednews/2004/01/22/build/wyoming/30-carbondioxidemining.inc>; and “Innovative carbon dioxide storage project under way in Wyoming,” *Salt Lake Tribune*.

Oil & Gas Journal, “Geological Sequestration Opens Opportunities in the Permian Basin.” Article highlights recent CO₂ EOR activities of Occidental, Kinder Morgan, University of Texas Center for Energy and Economic Development (CEED), Society of Petroleum Engineers (SPE), and Ridgeway. “Incentives for sequestering anthropogenic CO₂ could create the necessary elements for a dramatic increase in CO₂ flooding in Permian basin reservoirs,” says L. Stephen Melzer an oil industry consultant from Midland, TX. January 5, 2004, http://ogj.pennnet.com/Search/ShowIssue.cfm?Section=Search&ISSUE_NUM=&VOLUME_NUM=&ISSUE_DATE=05-Jan-2004.

The Japan Times, “Is 'Burying' Carbon Dioxide the Cure for Global Warming?” Reports on a geologic sequestration field test at the Niigata Prefecture in Japan. The field test involves injecting 20 tons per day of liquefied carbon dioxide into saline formations over a period of 18 months. CO₂ injection began in July. “The project is designed to keep the annual rate of carbon dioxide leaking from the formations below 0.01 percent, so that the gas can be kept underground for nearly 10,000 years,” said project leader, Shigeo Murai. January 4, 2004, <http://www.japantimes.co.jp/cgi-bin/getarticle.pl5?nn20040104a5.htm>.

National Geographic, “The Case of the Missing Carbon.” Provides an overview of the carbon cycle and human impacts on it. Full article mentions carbon sequestration as a possible option for net emissions reduction. February 2004, <http://magma.nationalgeographic.com/ngm/0402/feature5/>.

The Financial Times, “The Case for Carbon Capture and Storage.” Feature article outlines the progress of CO₂ capture and sequestration from a fringe “wacky” idea to an emissions mitigation option now being given serious consideration by mainstream entities. Discusses environmental concerns and cites a UK government report released last September that concluded “large-scale deployment of carbon dioxide capture and storage may be needed by 2020,” if the UK is to meet its ambitious targets for CO₂ reductions. Science and Health section, January 23, 2004, http://search.ft.com/search/article.html?id=040123000359&query=carbon+capture&vsc_appId=totalSearch&state=Form (subscription required).

The Baltimore Sun, “Burial for carbon dioxide?” Highlights AEP’s mountaineer CO₂ injection field test and discusses the pros and cons of CO₂ capture and storage. January 6, 2004.

March 2004

Los Angeles Times, “Oil Project Goes Underground for Cleaner Air.” Reviews the Canadian oil field experiment at Weyburn. At the four year mark, oil production is up 50 percent, 5,000 tons of carbon dioxide are injected per day, and no leaks have been detected. “The carbon originated from under the ground. We're putting it back,” said Gardiner Hill, manager of BP's environmental technology group. February 15, 2004, [Los Angeles Times Archives](#) (registration required). See also, “Canada places carbon dioxide underground to clean air,” *The Seattle Times*, February 20, 2004, http://seattletimes.nwsourc.com/html/nationworld/2001861641_carbon19.html; and “Canada goes underground for the environment,” *Contra Costa Times*, February 23, 2004, <http://www.contracostatimes.com/ml/d/cctimes/news/8019022.htm> (registration required).

Agence France Presse, “Carbon storage: When a pollutant can make a profit.” Describes a recently unveiled Dutch government and Gaz de France (GDF) plan in which CO₂ will be captured from a natural gas processing facility on the shore of the North Sea, transported 60 miles offshore, and injected into an ageing methane gas field (K12 -B). Roughly ten thousand tonnes of CO₂ will be injected into the reservoir between April and September of 2004. If that goes well, storage will be scaled up in 2005, and could ultimately reach 480,000 tonnes of CO₂ a year. February 15, 2004, <http://www.afp.com/> (subscription required).

Financial Times, “Clean coal strategy is within reach.” In a letter to the editor, Professor Jeffrey Sachs, Director of the Earth Institute at Columbia University, writes, “...whether we use these fuels to produce gasoline or to produce hydrogen as the energy carrier, we will need to introduce new carbon capture and disposal technologies to limit decisively the rise of atmospheric carbon.” February 10, 2004, <http://www.ft.com> (subscription required). Mr. Sachs writes in response to James Page's dismissal of coal in place of Middle East oil (Letters, December 29, 2003).

University of Queensland Newsletter, “Smokestack emissions could go underground.” Paul Massarotto, the Principal Research Fellow at the University of Queensland's CO₂ program is studying carbon sequestration in unmineable coal beds in Australia. February 21, 2004, <http://www.uq.edu.au/news/index.phtml?article=5331>.

Waste News, “Capturing carbon contains promise.” Carbon Sequestration is compatible with the existing energy infrastructure and needed, given the magnitude of GHG emissions reduction that will be required for atmospheric stabilization. “As sequestration technologies continue to take hold and ideas come to fruition, the longer-term reductions that we look for from sequestration could be enormous,” said Scott M. Klara, technology manager for the Carbon Sequestration Program at the U.S. Department of Energy's National Energy Technology Laboratory. February 2, 2004, <http://www.wastenews.com> (subscription required).

April 2004

Paula Dobriansky speaks on U.S. Climate Change Policy. Dobriansky, Undersecretary for Global Affairs at the U.S. State Department, highlighted carbon sequestration and the Carbon Sequestration Leadership Forum in her remarks before the Federation of Austrian Industry in Vienna. “The United States remains fully committed to the United Nations Framework Convention on Climate Change and shares its ultimate objective of stabilizing greenhouse gas concentrations in the atmosphere at a level that will prevent dangerous human interference with the climate.” Ms. Dobriansky cited three “fundamental pillars,” of U.S. policy: increasing international collaboration, improving scientific understanding, and developing breakthrough technologies. Carbon sequestration was set forth as a promising breakthrough technology. U.S. Department of State, March 3, 2004, <http://usinfo.state.gov/gi/Archive/2004/Mar/08-969909.html>.

St. Louis Post-Dispatch, “Utility Tree Plantings Transition from Public Relations to Carbon Credits.” Article describes the goals and day-to-day operations of PowerTree and other terrestrial sequestration efforts

being undertaken by U.S. Utility companies. Focus is turning to finding inexpensive land and verifying carbon uptake. *St. Louis Post-Dispatch*, February 29, 2004, <http://www.stltoday.com/>.

***Energy Pulse*, “Carbon Sequestration - Bridging the Gap between Kyoto and a Viable Global Carbon Management Program?”** Essay summarizes the global climate change issue and discusses carbon sequestration as a GHG emissions mitigation option. *Energy Pulse*, March 5, 2004, http://www.energypulse.net/centers/article/article_print.cfm?a_id=633.

Making Money Off Carbon Dioxide. Article highlights enhanced gas recovery operations at the K12-B field in the North Sea and the Weyburn project in Canada. *Iafrica.com*, March 1, 2004, <http://cooltech.iafrica.com/features/303058.htm>.

***The Monroe Times*, “CO₂ Capture Welcome in Monroe, WI.”** A four hundred ton per day commercial CO₂ capture and marketing operation is being appended to an existing ethanol production facility in Monroe, Wisconsin. Local officials are pleased with the jobs it will bring. CO₂ capture also promises to lower the odors from the fermentation facility. *The Monroe Times*, March 10, 2004, <http://www.themonroetimes.com>.

May 2004

***The Virginian-Pilot*, “All Fired Up About Coal.”** Coal is seeing a resurgence in the U.S. power industry, with more than 100 new coal-fired power plants in the planning stages. Explanations offered include prolonged high prices and high futures for natural gas, a relaxation of air emissions regulations by EPA, higher prices for electricity that coal plants are able to garner in deregulated power markets, the administration’s policy regarding carbon dioxide emissions, and that advanced clean coal technologies are viewed as “nearly ripe for broad deployment.” April 2, 2004, <http://home.hamptonroads.com/stories/story.cfm?story=68365&ran=96538>.

***Reuters News Service*, “Using CO₂ to prolong UK North Sea oil too costly.”** A study conducted by the UK Department of Trade and Industry has determined that CO₂-based enhanced oil recovery is not, at present, economically feasible. The UK had hoped to use carbon dioxide to help pump oil from its North Sea reservoirs, thus sequestering carbon while offsetting the cost of doing so with revenues from easier oil recovery. But the gap between costs and revenues remains too large. April 13, 2004, <http://www.planetark.com/dailynewsstory.cfm/newsid/24659/story.htm>.

***The Washington Post*, “Algae may not be the answer.”** Findings from the South Ocean have diminished hopes that using iron to fertilize algae blooms could significantly increase “carbon sink” in the deep ocean; April 18, 2004, <http://www.washingtonpost.com>. The *Oakland Tribune* gives a more optimistic interpretation “Iron Fertilization May Help Cool Off Simmering Planet,” April 16, 2004, <http://www.oaklandtribune.com/>. Scientists dumped one metric ton of iron and observed the impact over a ten square mile section of ocean. They were surprised at the efficiency of carbon transport to the deep ocean but the carbon flux was found to be quite low compared to natural variations at those latitudes. The original research articles, found in the April 16, 2004 issue of *Science Magazine*, are discussed in more detail in the oceans section, which begins on page 27.

***BBC News*, “City trees fight global warming.”** Trees for Cities, a nonprofit dedicated to planting trees in urban areas to absorb carbon dioxide emissions, kicked off a five-year plan to “transform 20 cities around the world” on April 14, 2004 with tree plantings in London and Manchester. Also included in the first phase of the project will be the cities of Madrid, Bucharest, and Adis Ababa. Says Graham Simmonds, chief executive of Trees for Cities, “Our experience in London over the last 10 years has taught us people and companies want to do something for the environment and our aim is to harness this enthusiasm and generate a greening renaissance in cities around the world.” April 14, 2004, http://news.bbc.co.uk/2/hi/uk_news/england/london/3623961.stm.

BBC News, “Plan to build emissions scrubber.” Two Tucson, Arizona companies, Global Research Technologies and Kelly, Wright & Associates, have joined forces to produce the first-ever “wind scrubber,” a device that would capture large volumes of carbon dioxide from the atmosphere. Though the project is in its earliest stages, the developers plan to have a working, ten-square-meter unit by 2005 and claim it is the first attempt to build such a device. Other scientists tender that, barring major breakthrough gas/liquid contacting technology, an air CO₂ scrubber will require prohibitive amounts of energy per unit CO₂ captured. April 13, 2004, <http://news.bbc.co.uk/1/hi/sci/tech/3612739.stm>.

Fulton Valley News, “Ethanol plant project still brewing—Perdue Farms and BOC Gases sign on as strategic partners.” Northeast Biofuels is securing \$140 million to convert a former Miller beer facility into a 100-million-gallon-per-year ethanol production plant. BOC Gases and Northeast Biofuels have a letter of intent outlining a future contract for BOC Gases to purchase the carbon dioxide that is produced during the ethanol production. BOC plans to construct a \$15 million carbon dioxide liquefaction plant in the business park adjacent to the proposed ethanol plant. April 10, 2004, http://www.valleynewsonline.com/news/2004/0410/Front_Page/011.html.

June 2004

“U.S. Energy Secretary Abraham Signs Department's First-Ever Bilateral Agreement with Norway.” U.S. Secretary of Energy Spencer Abraham signed a non-binding Memorandum of Understanding (MOU) with Norway, a first for the two countries with respect to energy research. Under this agreement, the U.S. and Norway will conduct joint research in the areas of carbon sequestration, hydrogen, and clean fuels. “This MOU marks a significant advancement in our efforts to improve energy security in the United States and Norway, as well as the entire world,” Secretary Abraham said. *U.S. Newswire*, May 22, 2004, <http://releases.usnewswire.com/GetRelease.asp?id=101-05222004>.

The New York Times, “Climate Change Gets a Hollywood Makeover.” In what might be the first “carbon neutral” movie production, director Roland Emmerich reportedly paid \$200,000 for a reforestation project in the Himalayas and energy saving projects for poor families in the United States to offset the carbon energy used during filming of “The Day After Tomorrow.” May 12, 2004, <http://www.nytimes.com/>.

Miami Herald, “Economic and political stability depend on finding alternative fuels.” “The world's largest energy-user nations need to agree on actions to develop new technologies for carbon capture and storage, and for utilizing alternative energy supplies,” says famed Columbia University Economist Jeffery D. Sachs in this op-ed piece. Sachs cautions against making a “mad dash” for renewable energy sources that may not prove affordable or widely available, and instead encourages improvements to the use of existing non-oil fuels like coal and gas. May 4, 2004, <http://www.miami.com/mld/miamiherald/news/opinion/8583434.htm>. Sachs' opinions are also covered in “Experts urge thinking ahead on climate and not waiting for 'certainty' to act,” *Electric Utility Week*, April 26, 2004, Vol., No.; Pg. 17.

Oil and Gas Journal, “EOR and climate change.” A report from the UK Department of Trade and Industry (DTI) embraces the idea of moderating emissions of carbon dioxide with projects that raise oil production. However, producers surveyed by DTI don't think dual-purpose CO₂ injection makes economic sense in the North Sea under current conditions. They also don't think credits available at expected values under the European Union's Emission Trading Scheme would make the technique commercial. “If EOR is to be deployed broadly in the UK North Sea,” the study observes, “additional market changes will be needed.” *Oil & Gas Journal*, April 26, 2004, Pg. 17.

The Times (London), “A global threat buried.” Reports on the Frio Pilot Test CO₂ sequestration project east of Houston, Texas, in an abandoned oilfield. According to Susan Hovorka, a geologist with the Texas Bureau of Economic Geology, which is leading the Frio Pilot Test, “the Frio Formation alone can hold between 200 and 350 billion tonnes of carbon dioxide, or at least 28 years' worth.” The article also mentions the Sleipner

experiment and the CO₂ Capture Project. May 20, 2004, Features, <http://www.timesonline.co.uk/> (subscription required). Also see, "A 'Burial' for air pollutants," *Global News Wire*, Business Line, April 28, 2004.

July 2004

***The Guardian*, "Shell Boss' "confession" shocks industry."** Ron Oxburgh, chairman of Shell stated that the threat of climate change makes him "really very worried for the planet." He continued, "Sequestration is difficult, but if we don't have sequestration then I see very little hope for the world." June 17, 2004, <http://www.guardian.co.uk/oil/story/0,11319,1240565,00.html>. See also, "Shell boss 'fears for the planet'," *BBC*, June 17, 2004, http://news.bbc.co.uk/2/hi/uk_news/3814607.stm.

***The Charlotte Observer*, "Exxon Head: Energy Independence Is a Myth."** "We do not have the resource base to be energy independent," ExxonMobil chairman Lee R. Raymond said in a speech in which he outlined some of what he called the "hard truths" about global energy markets. As for global warming, Raymond expressed his skepticism about the science and predicted that in the decades ahead "carbon dioxide emissions from greater fossil fuel use will climb." He said, "we simply do not yet have the economic solutions or technologies that would permit us to meet future energy demands without carbon emissions growth." *Associated Press*, June 8, 2004, <http://www.charlotte.com/mld/charlotte/business/8864868.htm?1c> (registration required).

***The New Zealand Herald*, "New Zealand coalminer to bury gas."** State-owned Solid Energy New Zealand is investing NZ\$175 million to find a way to bury unwanted carbon dioxide produced by the burning of fossil fuels. With the announcement of a carbon tax expected in 2007, it is likely coal-based energy production and electricity generation will become more expensive. "Capture and storage of carbon dioxide offers the opportunity to avoid the carbon tax and directly reduce greenhouse gas emissions to the atmosphere," Solid Energy chief executive Don Elder said. In neighboring Australia, a survey has shown there are enough sites to bury its current carbon dioxide emissions, by compressing the gas to a near-liquid form and injecting it deep underground, for at least 1600 years. June 22, 2004, <http://www.nzherald.co.nz/storydisplay.cfm?storyID=3573903&thesection=news&thesubsection=general>.

"Carbon Sequestration: Can It Help Beat Back Global Climate Change?" This article by the American Public Power Association provides an overview of current carbon sequestration projects and the science behind the technology. The discussion encompasses all areas of carbon sequestration (geologic, oceanic, and terrestrial) and mentions numerous commercial projects such as Weyburn and Sleipner, as well as projects/research focused on ocean and terrestrial sequestration. The article provides estimates of the costs of the various carbon capture technologies and stresses the importance of educating the public about carbon sequestration technology to prevent a similar backlash as was experienced with nuclear power technology. American Public Power Association, May/June 2004, <http://www.appanet.org/newsletters/ppmagazinedetailarchive.cfm?ItemNumber=2104> (subscription required).

Press for Weyburn. "It's one thing to say that underground is a great place to store carbon dioxide, but it's another thing to be able to prove it as we have done," said Dr. Ben Rostron of the University of Alberta. "We have been able to show that you can safely capture carbon dioxide that would otherwise go back into the atmosphere, and put it back into the ground. It's very exciting work." *EurekaAlert*, June 25, 2004, http://www.eurekaalert.org/pub_releases/2004-06/uoa-ucd062504.php. See also, "Greenhouse gas sequestration in abandoned oil reservoirs: The International Energy Agency Weyburn pilot project." *GSA Today*, July 2004 (v. 14, no. 7, p. 4-10), <http://www.gsaonline.org/gsaonline/?request=get-current-toc&issn=1052-5173>.

"Green Coal to Take on Wind Power in UK." Mitsui Babcock, one of Britain's biggest power plant engineering companies, says that if its energy-efficient boilers and turbines were applied across all 18 large coal-fired stations in the country, it could meet half the 2010 renewables target without the risks of disruption that wind and wave power present. "It would produce power equivalent to hundreds of windmills and, of course, the plant would keep working even when the wind isn't blowing," said Les King, director of technology

and engineering at Japanese-owned Mitsui Babcock. The latest technology could make coal a viable long-term source of clean energy in the government's bid to cut damaging greenhouse gases. Scotsman.com, May 30, 2004, <http://business.scotsman.com/index.cfm?id=614102004>.

August 2004

Science, Spencer Abraham on "The Bush Administration's Approach to Climate Change." In the July 30, 2004 issue of *Science*, energy Secretary Abraham discusses the steps the Administration is taking to address climate change, which include: Near-term policies and measures, advancing climate change science, and accelerating climate change technology development. Carbon capture and sequestration is cited as a central element of the Administration's strategy. By Spencer Abraham, *Science*, July 30, 2004, Vol. 305, pp. 616-617.

The New York Times, "U.S. to Unveil Plan to Harvest Methane with 7 Countries." The Bush administration announced an agreement with seven countries to slow global warming and harvest an otherwise wasted fuel by capturing emissions of methane from landfills, coal mines, and oil and gas fields and pipelines. Michael O. Leavitt, the administrator of the Environmental Protection Agency, said the administration would propose spending \$53 million over the next five years. He said the goal of the participating countries would be to inspect sites for leaks and, by 2015, capture nine million metric tons of the gas annually, to sell or to burn directly as a source of heat. *The New York Times*, July 28, 2004, <http://www.nytimes.com/2004/07/28/politics/28methane.html>. For more information visit the EPA's methane web site at <http://www.epa.gov/methane/international.html>.

Democratic National Convention goes CO₂ neutral using credits from coal mine. The Boston Carbon Corporation (BCC) donated 27,000 Greenhouse Gas Certified Trading Credits (CTCs) to the Democratic National Convention (DNC). The credits offset the estimated 27,000 tonnes of CO₂ emissions generated by delegates, media, staff, and others as they traveled to and from Boston during the week of the convention. The credits donated by BCC to the DNC were created through the capture of fugitive methane gas from Jim Walter Resources, Inc., a coal mining company in Alabama. "Boston Carbon Corporation to Donate 27,000 Tons of Greenhouse Gas Credits to the DNC," BCC Press Release, July 26, 2004, http://biz.yahoo.com/pnews/040726/nem036_1.html.

Weyburn on the Discovery Channel. An article on the Discovery Channel web site discusses carbon sequestration and monitoring at the Weyburn oil field. Using seismic reflection technology the Canadian geologists have been able to get an "ultrasound" image of the Weyburn oil field before and after injections of carbon dioxide. Said Don White of the Geological Survey of Canada, "We can actually watch as carbon dioxide spreads." "Oil Fields: Cold Storage for Greenhouse Gases?" *Discovery News*, July 9, 2003, <http://dsc.discovery.com/news/briefs/20040705/oilfields.html>.

BBC, Sequestration key, says UK scientist. The UK could secure its energy supply for many decades if it could use its huge reserves of coal, according to several scientists speaking at the Royal Institution in London. Says professor Ian Fells, "There's 10 times as much coal as the oil and gas reserves we have. The Russians told me they're going to build more nuclear plants, because they can't rely on oil and gas - and it's their oil and gas we're planning to rely on!...If we unlocked our coal it would transform the prospects for using fossil fuel, so carbon sequestration is the key to the future." "Carbon store 'could free UK coal'," *BBC News*, July 27, 2004, <http://news.bbc.co.uk/1/hi/sci/tech/3930245.stm>.

Energy Daily, Eight States, New York City Sue Five Utilities Over CO₂. In an unprecedented global warming action, eight states and the city of New York sued five major electric utilities, asking the court to order the companies to reduce their emissions of carbon dioxide by 3 percent per year for 10 years. "There is no dispute that global warming is upon us and that these defendants' carbon dioxide pollution is a major contributor," New York Attorney General Eliot Spitzer said at a press conference. "Others are taking action to reduce emissions and these companies could also do so by building cleaner energy sources." *Energy Daily*,

July 22, 2004. Other articles on this topic are as follows: "U.S. Power Companies to be Sued Over CO₂ Emissions," Point Carbon, July 21, 2004, <http://www.pointcarbon.com/article.php?articleID=4134&categoryID=147>; "New York City and 8 States Plan to Sue Power Plants," *The New York Times*, July 21, 2004, <http://www.nytimes.com/2004/07/21/national/21pollute.html>; "AEP facing environmental lawsuits," *American Business Daily*, July 21, 2004, <http://www.bizjournals.com/columbus/stories/2004/07/19/daily19.html> [0/1090471201230650.xml](http://www.bizjournals.com/columbus/stories/2004/07/19/daily19.html); "New Lawsuits Put Top Global Warming Polluters in the Legal Crosshairs," NRDC Press Release, July 21, 2004, <http://www.nrdc.org/media/pressreleases/040721a.asp>; "Editorial: A mighty important nuisance," *The Cincinnati Post*, July 22, 2004, <http://www.cincypost.com/2004/07/22/edit07-22-2004.html>; and "Greenhouse 'polluters' taken to court," *news@nature.com*, July 22, 2004, <http://www.nature.com/news/2004/040719/full/040719-12.html>.

***The Sydney Morning Herald*, "Carbon emissions must be halved, says [Australian] science chief."** Chief Scientist, Robin Batterham, said Australia must halve its greenhouse gas emissions by 2050. Dr. Batterham said he supported the Federal Government's decision not to ratify the Kyoto protocol on climate change because the reductions it set were not high enough. "I'm talking about enormous reductions - 80 percent by the end of the century," Dr Batterham said. "Fifty percent by 2050, I think, is realistic." Batterham said consumers needed to use energy more efficiently while industry must explore technologies that would allow them to deal with their emissions, which includes geosequestration. *Sydney Morning Herald*, July 19, 2004, <http://www.smh.com.au/articles/2004/07/18/1090089038120.html?oneclick=true#> (registration required).

Events & Announcements

September 2003

NETL Fact Sheets: A fact sheet entitled, "Carbon Sequestration on Surface Mine Lands," August 18, 2003, http://www.netl.doe.gov/publications/proceedings/01/carbon_seq_terr/graves.pdf. A fact sheet entitled, "Restoring Sustainable Forests on Appalachian Mined Lands for Wood Products, Renewable Energy, Carbon Sequestration, and Other Ecosystem Services," August 11, 2003, <http://www.netl.doe.gov/whatsnew/2003/08-03.html>. An article entitled, "Degradation Pathways for Monoethanolamine in a CO₂ Capture Facility," July 29, 2003, <http://www.netl.doe.gov/products/r&d/techpapers/techpapers.htm>

Natural disasters and policy. The website for the Second International Conference on Early Warning 'Integrating early warning of natural disasters into public policy' (EWCII, Bonn, 16-18 October) is available online at: <http://www.ewc2.org/>.

December 2003

Speech by Energy Secretary Spencer Abraham Highlights Carbon Sequestration. From the Secretary's remarks at the Clean Coal and Power Conference: "Coal is an energy winner with one glaring drawback, it is among the most environmentally problematic of all energy resources. We are here this week to continue the vital work of making coal into one of the cleanest of energy resources, and a valued contributor to a transformed energy future. . . Carbon sequestration has rapidly grown in importance to become one of this Administration's highest clean coal priorities. Our activities and our plans bear out the determination with which we are pursuing the promise of carbon sequestration. Current activities include 65 carbon sequestration projects across the country, funded with \$110 million in public and private funds." For the full speech, visit the U.S. Department of Energy's Fossil Energy website, November 17, 2003, http://www.fe.doe.gov/news/speeches/2003/03_sec_cleancoal_111703.html.

January 2004

COP 9. The annual ministerial meeting of the 188 Parties to the United Nations Framework Convention on Climate Change was attended by more than 5,000 participants. An agreement on the modalities and scope for carbon-absorbing forest management projects in the Clean Development Mechanism (see below) completes the Marrakesh issues of two years ago and expands the CDM to an additional area of activity. Two funds, the Special Climate Change Fund and the Least Developed Countries Fund were further developed. "Milan conference concludes as ministers call for urgent and coordinated action on climate change," December 12 2003, http://unfccc.int/press/prel2003/pressrel121203_1.pdf.

Midland Reporter-Telegram, "Emerging focus on CO₂ sequestration could benefit Permian Basin." A carbon sequestration workshop was added to this year's CO₂ flood conference held in Midland TX. "There are concerns about CO₂ outflow," said Michael Moore, managing partner of Falcon Environmental Services, "We are one of the few, if not the only, industries that can make it a commodity." December 15, 2003, http://www.mywesttexas.com/site/news.cfm?newsid=10660653&BRD=2288&PAG=461&dept_id=474107&rfi=6.

March 2004

AAAS Meeting on Ocean and Carbon. Sessions on CO₂ fertilization, a CO₂ enriched ocean, new technologies, and methane hydrates were headed by MBARI chemist Peter Brewer and several other MBARI scientists. "Cutting- edge oceanography helps scientists understand climate," *AScribe*, February 15, 2004, <http://www.ascribe.org/cgi-bin/spew4th.pl?ascribeid=20040212.104707&time=15%2006%20PST&year=2004&public=1>.

EnergyReview.net, "Fossil Fuels are our Future: APPEA." At the International Energy Agency's Zero Emissions Technologies (ZETS) Conference, held mid February, the Australian Petroleum Production Exploration Association executive director Barry Jones said that carbon capture and sequestration, "is not just a question for the private sector, as near zero emissions technologies deliver a legacy of public benefits that will continue generations into the future." February 24, 2004, <http://www.energyreview.net>.

Data on Atmospheric Concentrations of GHGs Available. The U.S. Department of Energy's Carbon Dioxide Information Analysis Center (CDIAC) released an updated database of concentrations of methane, nitrous oxide, several halogenated hydrocarbons, carbon monoxide, and hydrogen produced from its global ALE/GAGE/AGAGE monitoring network. Updated July 2004, <http://cdiac.ornl.gov/ndps/alegag.html>.

WRI Earthtrends Database. Provides a useful search tool to access climate data. Visit <http://earthtrends.wri.org/>.

April 2004

DOE Submits FutureGen Program Plan to Congress. 275 MW power plant with hydrogen production and CO₂ capture to begin operation in 2011. Plan offers a 26 percent non-Federal cost share. Read full plan at: http://www.fossil.energy.gov/programs/powersystems/futuregen/futuregen_report_march_04.pdf.

DOE Announces Eight Awards for Breakthrough Carbon Sequestration Research. The eight awards, totaling \$4.5MM of effort over three years (no cost share), were selected from a pool of over 100 proposals. The rewards result from a successful collaboration between DOE and the National Academies of Science aimed at bolstering the DOE Program's portfolio of high-risk / high-reward projects. March 5, 2004, DOE Techline, http://www.netl.doe.gov/publications/press/2004/tl_novelapproaches_sel.html.

Australian Government Announces Research Effort into Advanced Coal Power with Sequestration. The Australian federal government has launched the COAL21 National Action Plan – a joint government/industry initiative on greenhouse gas reduction technologies. At the core of the COAL21 strategy is the aim of reducing the average emissions intensity target to 650kg of CO₂ per megawatt hour by 2030, from the present 1,017kg. Achieving this would require the equivalent of about 20 percent of coal-based generation to produce zero emissions by 2030, through CO₂ capture and storage. The proposal is contentious within Australian politics as other groups would prefer GHG emissions mitigation money be spent on efficiency, renewables, and demand management. “Canberra funds ways to cut dioxide emissions from coal,” March 24, 2004, <http://www.theaustralian.news.com.au/archives/>. National Action Plan can be downloaded at: <http://www.coal21.com.au/>.

May 2004

IPIECA Brochure on Sequestration. “Carbon Dioxide Capture and Geological Storage: Contributing to Climate Change Solutions,” summarizes the proceedings of an October, 2003 IPIECA international workshop. The brochure, presentations and transcripts of the workshop can be downloaded. International Petroleum Industry Environmental Conservation Association, April 2004, http://www.ipieca.org/working_groups/climate_change/cc_home.html.

“Climate Policy in the United States and Japan: A Workshop Summary.” Resources for the Future and the Institute for Global Environmental Strategies (Japan) convened a workshop on domestic and international climate policy on February 12– 13, 2004. The report summarizes a dialogue among representatives from the two nations. Voluntary actions and capture and sequestration of CO₂ from coal-fired power plants were emphasized for the United States. Japan’s policy is centered on CO₂ emissions taxes, which will likely be combined with targeted subsidies. William Pizer and Kentaro Tamura, April 2004, <http://www.rff.org/rff/Documents/RFF-DP-04-22.pdf>.

BP, Ford renew Support for the Carbon Mitigation Investigation (CMI) at Princeton University. British Petroleum and the Ford Motor Company have pledged \$20 million of financial aid over the next ten years to the CMI, awarding the project a second allocation of funds after internal and external reviews of CMI's progress over the past three years. The CMI is focused on finding “alternative ways to collect and store carbon dioxide gas.” *The Daily Princetonian*, April 1, 2004, <http://www.dailyprincetonian.com/archives/2004/04/01/news/10100.shtml>.

Pittsburgh Post-Gazette, “Science savvy teens test Sequestration.” At the 65th annual Pittsburgh Regional Science and Engineering Fair, a high school student neutralized bauxite residue – an alkaline by-product of aluminum production and possible cause of groundwater pollution – with carbon dioxide and water to sequester the carbon. Her project's subtitle was, “Turning lemons into lemonade.” Said she, “I see there's a future in this idea.” April 4, 2003, <http://www.post-gazette.com/pg/04095/295928.stm>.

June 2004

Third National Conference on Carbon Sequestration. In his keynote address, U.S. Energy Secretary Abraham set the tone for the conference, “Together, we can and will perfect the technology of carbon sequestration. We can and will transform our economies from carbon-based to hydrogen-based. And we can and will restrain the emission of greenhouse gases so we bestow a healthy planet on future generations.” The conference was a great success with groundbreaking technical sessions and robust dialogue among professionals working in the area. For information about the conference or for proceedings visit <http://www.carbonsq.com/>.

Presentations from Stanford Hydrogen Workshop Available Online. The Global Climate and Energy Project (GCEP) held a series of energy workshops to identify the technical barriers and research opportunities for developing technologies that may lead to reduced greenhouse gas emissions. Selected presentations from the workshop held April 26-27, 2004 are available on the internet. Topics include Carbon-Free Production of Hydrogen from Fossil Fuels and Carbon Capture and Separation. See also “GCEP: Keep up the good work,” *Stanford Daily*, http://daily.stanford.edu/tempo?page=content&id=14264&repository=0001_article.

Secretary Abraham Invites Poland to Join Carbon Sequestration Leadership Forum. “I believe the Carbon Sequestration Leadership Forum is a vital part of the world's energy security because coal will be an inescapable part of our energy mix for years to come,” said Secretary Abraham in his remarks as he invited Poland to become the 17th member of the CSLF. May 28, 2004, http://www.doe.gov/engine/content.do?PUBLIC_ID=15961&BT_CODE=PR_PRESSRELEASES&TT_CODE=PRESSRELEASE.

July 2004

U.S. Energy Secretary Speaks at Conference on U.S. Climate Policy. In his prepared remarks at the Brookings/Pew Conference – “U.S. Climate Policy: Towards a Sensible Center” – held June 24-25, 2004, in Washington D.C., Energy Secretary Spencer Abraham emphasized the Administration’s commitment to reducing greenhouse gas emissions through scientific and technological advancement. Secretary Abraham outlined DOE’s establishment of “six pillars of collaborative climate research” to meet growing future energy needs while also aggressively confronting the challenge of climate change. The pillars are: hydrogen, clean coal, safe nuclear power, fusion, energy efficiency, and renewable energy. “In the 22nd century, we will likely produce and consume energy in ways that we cannot imagine today,” said Secretary Abraham in closing. A transcript of his speech is available at http://www.doe.gov/engine/content.do?PUBLIC_ID=16063&BT_CODE=PR_SPEECHES&TT_CODE=PRESSSPEECH. For additional information about the Brookings/Pew conference, and to view archived video of conference speakers visit <http://www.brookings.edu/int/research/projects/climateconference20040624a.htm>.

Carbon Sequestration Program Adds Partners. The Department of Energy announced that seven new states and 13 organizations have joined the Carbon Sequestration Regional Partnership Program. Three of the seven partnerships added new partners. *U.S. Newswire*, June 10, 2004, <http://releases.usnewswire.com/GetRelease.asp?id=121-06102004>.

“Senator Nelson of Nebraska hosts D.C. workshop on carbon.” Giving farmers incentives to store carbon in the ground would provide both financial advantage and environmental benefits by addressing global warming and climate change concerns, said Sen. Ben Nelson (D-NE) at a June 9th workshop in Washington D.C. The workshop brought together a wide range of agricultural and environmental groups to look at the benefits of storing carbon in the ground, along with what role the federal government could play in developing carbon markets in the United States. *Grand Island Independent*, June 10, 2004, http://www.theindependent.com/stories/061004/new_carbon10.shtml.

Clean Coal Plant to Anchor West Virginia “Eco-Park.” Secretary of Energy Spencer Abraham commissioned a new \$215 million West Virginia clean coal project based on new technology that over the next 60 months will deliver environmental improvements, economic benefits, and thousands of new jobs. “The Greenbrier plant is a prime example of President Bush's commitment to coal,” Secretary Abraham said. “Greenbrier will clean an existing environmental waste site, reduce emissions, deliver needed electric power at affordable rates, and produce new economic activity. It marks another step toward achieving a zero-emissions power plant and will help us meet a primary goal of the National Energy Policy – to make maximum use of our domestic energy resources while elevating environmental and economic security.” June 7, 2004, available at http://www.netl.doe.gov/publications/press/press_toc.html.

“Australia's Howard shies from emissions trading, CO₂ tax.” As anticipated, Australia's Prime Minister John Howard unveiled an energy white paper on June 15, 2004. It rejected calls for emissions trading or a carbon tax introducing instead incentives and research money for renewable energies. Point Carbon, June 15, 2004, <http://www.pointcarbon.com/article.php?articleID=3903&categoryID=147>.

Summary available of the twentieth sessions of the Subsidiary Bodies (SB-20) to the UN Framework Convention on Climate Change (UNFCCC), which took place at the Maritim Hotel in Bonn, Germany, from June 16-25, 2004. Approximately 1,350 participants from 161 governments, one observer State, and 134 intergovernmental, non-governmental, and other observer organizations and media outlets were in attendance. See *Earth Negotiations Bulletin*, June 28, 2004 for more details. Available at: <http://www.iisd.ca/climate/sb20/>.

August 2004

U.S.– New Zealand Climate Change Partnership Update. Six new projects were announced in Washington D.C. under the New Zealand – United States bilateral climate change partnership. The new projects announced are: A study of global methane emissions, the rescue and digitization of historic climate data, work on carbon dioxide sequestration in coal seams, work to develop new materials for the hydrogen economy, work on nitrous oxide emissions from grazed pastures, and the hosting of a joint event with Australia to work with developing countries in the Pacific on climate observation. U.S. State Department Press Release, July 15, 2004, <http://www.state.gov/r/pa/prs/ps/2004/34411.htm>.

Clean Coal Initiative linked to carbon dioxide capture. The Department of Energy (DOE) announced it has received proposals for projects in a new generation of clean coal projects, valued at nearly \$6 billion. “Industry has enthusiastically responded to the Department's latest clean coal solicitation calling for technologies that would help make it possible for coal to remain a cornerstone of our domestic energy portfolio, particularly for power generation, and to continue that role into the long-term future,” Secretary of Energy Spencer Abraham said. The projects are described as “providing the technical foundation for the FutureGen Initiative” and “presenting opportunities to demonstrate potential readiness of energy technologies for carbon dioxide management.” “President's Clean Coal Initiative Attracts Second Wave of Technologies to Address Environmental, Energy Priorities,” *U.S. Newswire*, July 26, 2004, <http://releases.usnewswire.com/GetRelease.asp?id=155-07262004>.

Science

November 2003

Swapping CO₂ for methane in hydrates. A team of Canadians and Koreans, through the National Research Council Canada, has shown in laboratory experiments that CO₂ can extract gaseous methane from methane hydrates, and be stored away long-term. “Injecting carbon dioxide to extract methane from methane hydrate deposits?” *Chemie.de*, Germany, October 27, 2003, <http://www.chemie.de/news/e/30425/>.

December 2003

Carbon Sequestering Phage. Researchers from the Institute for Biological Energy Alternatives (IBEA), led by J. Craig Venter, Ph.D., have significantly advanced methods to improve the speed and accuracy of genomic synthesis. The research, accepted for publication and in press with the *Proceedings of the National Academy of Sciences*, was announced in Rockville, MD on November 13, 2003 at a press conference with Secretary of the

Department of Energy, Spencer Abraham and Dr. Venter. IBEA researchers hope that by making synthetic organisms they can rapidly and effectively harness all energy in the organism toward either energy production, likely in the form of hydrogen, or carbon sequestration. "With this advance," Abraham said, "it is easier to imagine, in the not-too-distant future, a colony of specially designed microbes living within the emission-control system of a coal-fired plant, consuming its pollution and its carbon dioxide, or employing microbes to radically reduce water pollution or to reduce the toxic effects of radioactive waste." "Advance In Developing Biological Strategies To Produce Hydrogen And Sequester Carbon Dioxide," *Science Daily*, November 17, 2003, <http://www.sciencedaily.com/releases/2003/11/031117074518.htm>.

January 2004

Soot in Snow May Contribute Significantly to Global Warming. James E. Hansen, a researcher at NASA's Goddard Space Center, has studied the climate-warming effects of soot. "A soot content of only a few parts per billion (ppb) is needed to reduce snow albedo by one percent. Climate simulations show that this modest albedo effect would cause a global warming that is more than a quarter of the warming observed in the past century." Hansen also suggests that, in addition to being a major cause of global warming, soot may be partially responsible for the accelerated melting of ice that is usually attributed solely to global warming. "For any given soot amount, its destruction of ice is greatly magnified by positive feedbacks. Increased absorption of sunlight causes snow to "age" more rapidly, thus increasing the ice crystal size and causing more absorption of sunlight." "Soot worse for global warming than thought," *New Scientist*, December 22, 2003, <http://www.newscientist.com/news/news.jsp?id=ns99994508>.

Prehistoric Farming May Have Impacted Atmospheric GHGs. Analysis of air trapped in ice cores drilled from the Antarctic ice sheet show anomalous increases in carbon dioxide levels beginning 8,000 years ago – just as crop lands began to replace previously forested regions across Asia and Europe. About 5,000 years ago, the ice cores reflect a similarly anomalous rise in methane levels, this time tied to increased emissions from flooded rice fields, as well as burgeoning numbers of livestock. These explanations, set forth by Bill Ruddiman of the University of Virginia at the fall meeting of the American Geophysical Union, could explain why the current trends of increasing CO₂ and methane concentrations in the atmosphere predate the industrial revolution. Further details appear in the December issue of the journal *Climatic Change*. "Man changed climate for 8,000 years?" *CNN*, December 11, 2003, <http://us.cnn.com/2003/TECH/science/12/10/prehistoric.climate.ap/index.html>. See also, "Climate change and civilization," *Economist*, December 10, 2003, <http://www.economist.com/science/>.

Australian Bushfires Linked to Warming. Fires are natural to Australia's dry bush, roaring through parched undergrowth and into oil-filled eucalyptus trees, sparking infernos. Dr. Kevin Tolhurst from Australia's newly-formed Bushfire Research Centre claims the trend is due to droughts and more frequent severe weather events caused by global climate change. Another factor is that increased CO₂ in the atmosphere enhances bush growth providing more fuel for the fire. Says Mr. Tolhurst, "...instead of talking about a one in a hundred year event, we'd be talking more likely one in fifty or one in thirty year events becoming much more the par for the course." "Severe bushfires linked to global warming," *ABC Online* (Australia), December 9, 2003, <http://www.abc.net.au/pm/content/2003/s1006755.htm>.

February 2004

Scientists mull out-of-the-box ideas for combating global climate change. Scientists from around the world gathered at the Isaac Newton Institute – Cambridge, England – to discuss "macro-engineering" ideas for controlling the global climate. The technologies are divided into two categories: (1) CO₂ capture and sequestration and (2) shading the earth from solar radiation. "Most of these macro-engineering options are not yet in the mainstream for climate policy, but the mere fact that they have been suggested, places an obligation on scientists from many disciplines to explore their feasibility and evaluate their consequences and wider

implications,” said Professor John Shepherd, Director of the Tyndall Centre. “In the event of an unanticipated climatic catastrophe, we may need a rapid fix,” said Ed Boyle of MIT, a co-organizer of the conference. “Scientists use creativity to fight global warming,” *The Boston Globe*, January 20, 2004. See also, “Thought experiment on macro engineering to combat climate change,” *Environmental Data Interactive*, January 9, 2004, <http://www.edie.net/news/Archive/7912.cfm>.

Better Understanding of Black Carbon Enhances Carbon Cycle Modeling. There are two types of black carbon: (1) graphitic black carbon, which was created as sedimentary rocks underwent metamorphism and (2) combustion-derived black carbon such as soot, charcoal. Both are highly persistent in the environment, unlike other types of carbon. A recently developed capability to differentiate between the two provides better insight into the kinetics of carbon cycling. “One type of carbon so resilient it skews carbon cycle calculations,” *Innovations Report*, January 23, 2004, http://www.innovations-report.com/html/reports/interdisciplinary_research/report-25061.html. Also appears in *EurekAlert*, January 22, 2004, http://www.eurekalert.org/pub_releases/2004-01/uow-oto012204.php.

March 2004

Pentagon Briefing on Sudden Climate Change. “...Recent research suggests, however, that there is a possibility that this gradual global warming could lead to a relatively abrupt slowing of the ocean’s thermohaline conveyor, which could lead to harsher winter weather conditions, sharply reduced soil moisture, and more intense winds in certain regions that currently provide a significant portion of the world’s food production.” The report considers average temperature drops in some regions of 5-10 degrees Fahrenheit in a single decade. “An Abrupt Climate Change Scenario and Its Impact on National Security”, October 2003, by Peter Schwartz and Doug Randall. Full report: http://www.ems.org/climate/pentagon_climate_change.html. Summary articles can be found in *Fortune*, “The Pentagon’s Weather Nightmare,” February 27, 2004, <http://www.fortune.com/fortune/technology/articles/0,15114,582584,00.html>; *The New York Times*, “Global Chilling,” January 28, 2004, <http://query.nytimes.com/gst/abstract.html?res=F40D14F93E5C0C7B8EDDA80894DC404482>; and the UK *Guardian*, “Now the Pentagon tells Bush: climate change will destroy us,” February 22, 2004, <http://observer.guardian.co.uk/international/story/0,6903,1153513,00.html>.

Coral Reefs Study. A report by the Pew Center on Global Climate Change, released at the American Association for the Advancement of Science meeting in Seattle, predicts that warming and acidifying ocean water will negatively affect coral reefs. “Global warming threatens coral reefs,” February 16, 2004, news@nature.com, <http://www.nature.com> (registration required).

April 2004

Atmospheric CO₂ Accelerating. Average readings at the 11,141-foot Mauna Loa Observatory, where CO₂ density peaks each northern winter, hovered around 379 parts per million on March 19, 2004, compared with about 376 a year ago. That year-to-year increase of about 3 parts per million is considerably higher than the average annual increase of 1.8 parts per million over the past decade, and markedly more accelerated than the 1-part-per-million annual increase recorded a half century ago, when observations were first made here. *Yahoo News*, March 20, 2004.

Atmospheric CO₂ Correlated to Global Temperature Changes over Past 570 Million Years. “Reviewing the geologic records of CO₂ and glaciations, we found that CO₂ was low during periods of long-lived and widespread continental glaciations and high during other, warmer periods,” says Dana L. Royer, research associate in geosciences at Penn State. “Previous suggestions that cosmic ray flux correlated better with ancient temperatures than carbon dioxide do not appear true. While cosmic ray flux may be of some climatic significance, it is likely of second-order importance on a multimillion year timescale.” Researchers adjusted

estimates for atmospheric CO₂ based on ocean water pH. "Oceans' acidity influences early carbon dioxide and temperature link estimates," *Penn State Live*, March 22, 2004, <http://live.psu.edu/story/6011>.

Antarctic Glacier Melting Much Faster Than Expected. Scientist on expedition in Antarctica found that Brown Glacier is melting at a rate four times that which had been measured between 1950 and 2000. "Glacier melt indicates global warming changes," *ABC News Online* (Australia), March 6, 2004, <http://www.abc.net.au/news/newsitems/s1060459.htm>.

NASA's Improved Web-Resource on the World's Changing Climate. The website provides a wealth of information and current data related to global climate change. Site is designed to be useful to users ranging from climate scientists to elementary school teachers. NASA's Earth Observatory, March 1, 2004, <http://earthobservatory.nasa.gov/Newsroom/NasaNews/2004/2004030116590.html>.

June 2004

"Global dimming may stop the Earth overheating." Since the late 1950s, scientists have observed a 2 to 4 percent reduction in the amount of solar radiation reaching the Earth's surface, thought to be caused by particles and clouds in the atmosphere scattering the light. Some scientists see global dimming as part of a possible negative feedback loop working against global warming. According to Michael Roderick, from the Australian National University in Canberra, "burning fossil fuels not only increases carbon dioxide levels in the atmosphere; it also pumps tiny particles into the air. Meanwhile higher temperatures increase the amount of cloud cover. The clouds and particles help to block the Sun's rays, and the scattered light they allow through actually boosts plants' absorption of carbon dioxide, the principle greenhouse gas. This would help to keep carbon dioxide levels stable, protecting the planet from runaway global warming." *news@nature.com*, May 19, 2004, <http://www.nature.com/nsu/> (registration required).

Global warming pioneer says only nuclear power can now halt global warming. James Lovelock, one of the first scientists to warn of the threat from the greenhouse effect, says "global warming is now advancing so swiftly that only a massive expansion of nuclear power as the world's main energy source can prevent it overwhelming civilization." Citing melting of the Greenland ice sheet and last summer's heat wave in central Europe, Lovelock says there is not enough time for renewables to replace the use of carbon dioxide producing fossil fuels. "Only nuclear power can now halt global warming: Leading environmentalist urges radical rethink on climate change," *The Independent*, May 24, 2004, <http://news.independent.co.uk/uk/environment/story.jsp?story=524313>. Research Council report originally published in 2002 is now available for download in PDF format at: <http://www.nap.edu/catalog/10136.html>.

"Importance of ocean temperature to global biogeochemistry." Analyses conducted by researchers from the University of Chicago and the Potsdam Institute for Climate Impact Research (Germany) show that changes in the temperature of the ocean could have drastic long-term effects on atmospheric concentrations of CO₂ and O₂. *Earth and Planetary Science Letters*, Volume 222, Issue 2, May 30, 2004, <http://www.sciencedirect.com/science/article/B6V61-4C7VXHK-1/1/631db7e24ee774647ce18572fca3372f>.

July 2004

"Global change: Hydrocarbon-driven warming." This paper investigates the relationship between the release of huge amounts of hydrocarbons (1,500 to 3,000 Gigatons) during the "initial Eocene thermal maximum" (IETM), occurring about 55 million years ago, and current emissions from fossil fuels. The authors find the events at the IETM to be intriguing, but an imperfect analogue of current fossil-fuel emissions. Given the comparable estimates for carbon release at the IETM and anthropogenic release of carbon into the

atmosphere over the coming centuries (estimated at 3,000–4,000 Gt), environmental change during the IETM should become the subject of general investigation. By Gerald R. Dickens, in *Nature* 429, 513-515 (June 3, 2004).

“The world's oceans possess two CLAW cycles.” Dimethylsulfide (DMS) is a climatically-important trace gas that is produced by various types of marine phytoplankton and is believed to play a major role in maintaining earth's temperature within bounds conducive to the existence of life. This “CLAW” phenomenon, named for the four scientists who formulated it –Charlson, Lovelock, Andreae, and Warren (Charlson et al., 1987) – has now been joined by a companion phenomenon that accomplishes the same task over the world's nutrient-poor marine waters. *CO2 Science Magazine*, June 2004, <http://www.co2science.org/edit/v7/v7n24edit.htm>.

Study Supports View That Ice Age Is Still Quite a Way Off. Despite the recent trend toward global warming, scientists have long wondered whether the earth was nearing another ice age – an end to the 12,000-year temperate spell in which modern civilizations arose. Some have said such a transition is overdue, given that each of Earth's three previous temperate intervals lasted only about 10,000 years. But now, in a study in the journal *Nature*, a group of climate and ice experts says it has new evidence that Earth is not even halfway through the current warm era. The evidence comes from the oldest layers of Antarctic ice ever sampled. *The New York Times*, June 9, 2004. Original article, **Palaeoclimate: Frozen time**, by Gabrielle Walker, in *Nature*, June 10, 2004, http://www.nature.com/cgi-taf/Dynapage.taf?file=/nature/journal/v429/n6992/full/429596a_fs.html.

“Can geological carbon storage be competitive?” A new working paper from CICERO reviews the literature on the costs and benefits of geological carbon storage. In the near term, Carbon Capture and Storage (CCS) is likely only to be an economically viable option in enhanced oil recovery. In the medium and longer term, with improvements in CCS technology and the likelihood of increased greenhouse gas permit prices, CCS is likely to become an economically viable option under a wider range of circumstances. For details and download see http://www.cicero.uio.no/publications/detail.asp?publication_id=2735&lang=en.

August 2004

Amazon burning makes Brazil a leading CO₂ emitter. The Brazilian Government is expected to publish an inventory of Brazil's greenhouse gas emissions in the coming months. The inventory is anticipated to show that Brazil produces around 300 million metric tons of carbon dioxide-equivalent a year, 200 million of which comes from logging and burning of the world's largest tropical forest. This discovery challenges the view that the Amazon serves as the “lungs of the world” by converting carbon dioxide into oxygen. Instead, it will show that a large majority of Brazil's greenhouse gas emissions come from smoke linked to deforestation of the Amazon, and not fossil fuels which are the main culprit in most countries. “Amazon burning makes Brazil a leading polluter,” *Reuters*, July 19, 2004, http://www.enn.com/news/2004-07-20/s_26000.asp. Also, for information about a new study that says the Amazon is still a net producer of oxygen despite widespread burning of the jungle see, “Data Show Amazon Still 'Lungs of the World',” *Reuters*, July 30, 2004, <http://www.planetark.com/dailynewsstory.cfm/newsid/26334/story.htm>.

“Climate change affects deep sea life.” The remote and lightless deep-sea floor has long been thought to be protected from events on the surface, such as global warming. But it now seems that climate change impinges on the rhythm of life on the seabed after all. According to work done by Henry Ruhl and his colleagues at the Scripps Institution of Oceanography in La Jolla, California, “The climate may be affecting deep sea communities as rapidly as terrestrial or shallow-water systems.” In an article appearing in *Science*, researchers report that the sea cucumber, *Elpidia minutissima*, showed up in many photos taken of the ocean floor in the years before El Niño, when food was scarce. But it practically disappeared when disturbances wrought by the system apparently increased the food supply. By contrast, a white cucumber that is normally rare, *Scotoplanes globosa*, thrived in plentiful times. *news@nature.com*, July 22, 2004, <http://www.nature.com/news/2004/040719/full/040719-13.html>. For the original article see, Ruhl H. A., and Smith K. L., *Science*, 305: 513-515 (2004).

CO₂ uptake into the Oceans from the Atmosphere. Two articles in *Science Magazine* present results from analysis of data obtained through the World Ocean Circulation Experiment/Joint Global Ocean Flux Study. One study finds that increased CO₂ uptake into the ocean may have negative impacts on shell-forming species. Another study indicates that feedback loops may reduce the rate of CO₂ uptake into oceans over the next few decades, a change that could increase pressure to mitigate anthropogenic emissions. For the original articles see R.A. Feely et al., "Impact of Anthropogenic CO₂ on the CaCO₃ System in the Oceans," *Science*, July 16, 2004, Vol. 305, pp. 362-366; and C.L. Sabine et al., "The Oceanic Sink for Anthropogenic CO₂," *Science*, July 16, 2004, Vol. 305, pp. 367-371. The original articles are available by subscription only. The following are synopses from the popular press: "Carbon Dioxide Emissions May Harm Ocean Life," *Reuters*, July 15, 2004, <http://www.planetark.com/dailynewsstory.cfm/newsid/26065/newsDate/16-Jul-2004/story.htm>. "High Carbon Dioxide Levels Turning Oceans More Acidic," *ENS Newswire*, July 19, 2004, <http://www.peopleandplanet.net/doc.php?id=2291>. "Sea survey measures acid increase: Oceanic carbon sinks herald bad news for wildlife," *news@nature.com*, July 15, 2004, <http://www.nature.com/news/2004/040712/full/040712-14.html>; and "Study: Ocean absorbing excess carbon dioxide," *CNN*, July 15, 2004, http://abcnews.go.com/wire/Politics/ap20040715_1965.html.

Geology

September 2003

Asian CO₂ EOR project. A team of Asian electric power interests is considering capturing CO₂ emitted from liquefied natural gas production facilities for enhanced oil recovery in Indonesia. If implemented, the project would be the largest CO₂ enhanced oil recovery effort in the world. The study will focus on a technique called "flue gas decarbonization technology," developed by KEPCO and Mitsubishi jointly. "Asian interests look at new CO₂ storage scheme," *The Electricity Daily*, August 7, 2003.

BLM approves CO₂ pipeline. The pipeline project will move CO₂ 125 miles from southwest Wyoming to Anadarko's Salt Creek oil field north of Casper, Wyoming. The CO₂ comes from ExxonMobil's Shute Creek natural gas processing plant and Anadarko will inject about 7,200 tons of CO₂ per day. "CO₂ pipeline project approved," *The Associated Press State & Local Wire*, August 12, 2003.

R&D to turn underground CO₂ back into fuel. The DOE Office of Science has funded a project through its small business research grants to turn CO₂ in geologic storage sites back into methane. Advanced Resources International will develop a methodology to use bacteria to remediate underground CO₂, creating new methane resources in the process. "Small businesses get \$100M to develop array of innovative energy devices," *Inside Energy /with Federal Lands*, August 4, 2003.

High oil prices still don't prompt new EOR. Wellhead prices of \$25-\$30 per barrel are not prompting new EOR projects at the rate the economics would support, according to these two articles. EOR ventures are capital intensive, and producers so far have stuck to less expensive methods. The CO₂ from an ExxonMobil gas processing plant in southwestern Wyoming is available, and some of the CO₂ goes to an Exxon EOR project in Colorado, but most of it is vented into the atmosphere. "High oil prices not prompting EOR projects," *Oil Daily*, August 12, 2003. See also, "North Dakota producers still not buying CO₂ for oil recovery," *Associated Press State & Local Wire*, August 21, 2003.

CO₂ flooding and other IOR methods. An article on all aspects of improved oil recovery (IOR), a term that encompasses enhanced oil recovery techniques, refers extensively to the Advanced Resources International (ARI) work done on EOR analysis. "Progress in IOR technology, economics deemed critical to staving off world's oil production peak," *Oil & Gas Journal*, August 4, 2003, <http://www.adv-res.com/>.

Extract more oil with innovation. This article sets out a timeline and recommendations for technological improvements to avert an oil shortage crisis. Deepwater development, enhanced oil recovery using CO₂ or microbes, and self-renewing enclosed energy systems are some ideas tendered. “Oil change: In the pipeline?” *The Engineer*, August 8, 2003.

October 2003

Comprehensive database of domestic brines and brine formations available from NETL. The NETL national brine database is a compilation of data from the Texas Bureau of Economic Geology, the U.S. Geological Survey, over seven hundred well data sets provided by various State Geologic Surveys, oil and gas reports, and other published literature sources. To obtain a copy on CD-ROM, contact James.Knoer@netl.doe.gov.

Coal sequestration model available. Coal-Seq, a model developed by Advanced Resources International, screens potential ECBM and carbon sequestration projects in coal. The model consists of a database of reservoir simulator runs based on varying values for coal permeability, well spacing, coal depth, coal rank, injection rate, injection gas composition, and injection timing. Economic calculations can also be performed. For more information visit, <http://www.coal-seq.com/models.htm>.

MM&V at a commercial EOR operation. Enhanced oil recovery in depleted fields has been operational at Rangely, Colorado since 1986, with over 23 million tonnes of CO₂ injected. This paper presents data on the measurements of methane and CO₂ in soil gas and as fluxes into the atmosphere. “CO₂ Sequestration in Depleted Oil/Gas Fields: Evaluation of Gas Microseepage and CO₂ Fate at Rangely, Colorado U.S.A.,” Colorado School of Mines, http://aapg.confex.com/aapg/sl2003/techprogram/paper_78330.htm. Other AAPG 2003 Geologic Sequestration presentations available at: http://aapg.confex.com/aapg/sl2003/techprogram/session_2165.htm.

Estimating CO₂ solubility in brine. Researchers from Alberta Geological Survey, Canada developed a methodology to estimate the ultimate CO₂ sequestration capacity in solution (UCSCS) of an aquifer. They estimate that the Viking aquifer in the Alberta basin in western Canada can sequester 100 Gt CO₂ in solution in the formation water. “Sequestration of CO₂ in geological media in response to climate change: capacity of deep saline aquifers to sequester CO₂ in solution,” *Energy Conversion and Management*, Volume 44, Issue 20, December 2003, <http://www.sciencedirect.com/science/journal/01968904>.

November 2003

EOR CO₂ NM depot. BOC opened a CO₂ depot in Hobbs, New Mexico, to distribute to Enhanced Oil Recovery customers in the Permian Basin. The liquefied gas is obtained from BOC's CO₂ plant in Denver City, Texas. “BOC Opens Carbon Dioxide Depot in New Mexico,” *Business Wire*, October 23, 2003, http://www.processingmagazine.com/Web_First/PR.nsf/ArticleID/DVMN-5SXXNHE/.

Genesis Energy to enter carbon business. Houston-based Genesis Energy LP may begin a wholesale CO₂ marketing business. “Genesis Energy to buy carbon dioxide assets,” *Houston Business Journal*, http://houston.bizjournals.com/houston/stories/2003/10/13/daily42.html?jst=b_ln_hl.

Zero sum research? Australia and the U.S. share defense of coal-powered electricity through a “climate action partnership” which directs research to CO₂ capture and geologic sequestration. The Howard Government allocated \$112 million for strategic fossil fuel energy research, mainly for carbon sequestration. The article notes a correlating decrease in renewable energy R&D. “The Coalition of the global polluters,” *The Age*

(Melbourne), October 23, 2003.

January 2004

Interactive Guide on the North Sea Utsira Formation Statoil carbon sequestration project. Available at: <http://www.guardian.co.uk/flash/0,5860,1040175,00.html>.

Microseepage Measurements at the CO₂-enhanced oil recovery operation at Rangely, Colorado, USA. The methodology and results for measuring microseepage are discussed. Shallow and deep soil gas concentration and direct transport of CO₂ and CH₄ into the atmosphere were measured. *Applied Geochemistry*, Volume 18, Issue 12, December 2003, Pages 1825-1838.

Capacity Estimate for CO₂ Storage in Saline Formations. Considering only the region where the injected CO₂ would be a dense fluid, the capacity of the Viking aquifer in Alberta Canada to sequester CO₂ in solution in the formation water is calculated to be 100 Gt. *Energy Conversion and Management*, Volume 44, Issue 20, December 2003, Pages 3151-3175.

“U.S. DOE Field Efforts Sequestering CO₂ in Geologic Formations.” Describes the West Virginia, Texas, and New Mexico geologic field tests. December 12, 2003, <http://www.netl.doe.gov/coal/Carbon%20Sequestration/index.html>.

February 2004

Enhanced Oil Recovery in Alberta. Describes EOR potential and challenges in Alberta. Enbridge Pipelines Inc. calculates that \$160 million will cover initial building of a new 400- kilometer pipeline delivery grid to transport 4,000 tones of CO₂ per day. Injections of up to 11,500 tones per day of the clean gas would be needed to keep production going at three of the biggest and oldest Canadian oilfields: Swan Hills, Pembina, and Taber. “Carbon emissions may raise well yields,” *Edmonton Journal* (Alberta), January 20, 2004.

April 2004

Beta Demonstration of the NatCarb Online Database Available NATCARB portal now pulls data in real time from Kansas, Illinois, Ohio, (Indiana soon), and USGS (EROS Datacenter). Please visit the NATCARB Portal Beta Site (<http://drysdale.kgs.ku.edu/natcarb/midflash/natcarb.html>) for a demonstration. A progress report in can be found at http://www.natcarb.org/Committee/NATCARB_Progress_Report.pdf.

May 2004

CO₂ from Coal Industry for EOR. Bellona Foundation president Frederic Hauge told an industry seminar on clean coal technology in Brussels that the coal industry's best opportunity to be green was to provide CO₂ to oil companies for enhanced oil recovery (EOR). It would be worth up to \$15/tonne for CO₂ from the European coal industry to enhance their oil recovery in the North Sea, he said. “CO₂ from coal worth up to \$ 15/ tonne for oil recovery,” *Platts EU Energy*, March 26, 2004; Issue 79; Pg. 3, <http://www.platts.com>.

June 2004

Alberta producers rewarded for use of CO₂ in enhanced oil recovery. Four companies using carbon dioxide in enhanced oil recovery projects will share a C\$14 million bonus from the Alberta Government in Canada. The four companies qualify for royalty credits under the province's plan to reduce greenhouse gas emissions by encouraging the sequestration of CO₂ as part of oil and gas production. The companies plan to inject about 110 metric tons of CO₂ per day for the duration of a project in Swan Hills, central Alberta. Point Carbon, May 25, 2004, <http://www.pointcarbon.com/article.php?articleID=3774&categoryID=147>.

August 2004

Study of Coal Absorption Isotherm Measurement. Several laboratories conducted CO₂ absorption isotherm measurements on a series of coal samples to determine reproducibility of results and identify factors causing any differences. Improved isotherm measurement techniques can enable CO₂ sequestration in coal beds. “An Inter-laboratory Comparison of CO₂ Isotherms Measured on Argonne Premium Coal Samples” was posted on the NETL Office of Science, Technology and Analysis web site: <http://www.netl.doe.gov/osta/techpapers/techpapers.htm>.

Technology

October 2003

Letters to Lackner. Dan Golomb of UMass-Lowell and Meyer Steinberg of Brookhaven National Lab responded to Klaus Lackner's Perspective, “A guide to CO₂ sequestration” (*Science*, June 13, 2003). Golomb takes issue with the practicality of using chemical sorbents on windmill rotors, which, he says, would take up too much space due to the partial pressure limits on substantial mass transfer. He also questions the thermal dynamics of using waste heat to convert CaCO₃ back into CaO. Lackner responds by rephrasing the capture area as a per capita number or 0.04 m² per person and points to the use of fuel cells which operate at a high enough temperature to perform the CaCO₃ to CaO conversion. “Issues of Carbon Sequestration,” Dan Golomb, Meyer Steinberg, and Klaus Lackner, *Science*, September 5, 2003, <http://www.sciencemag.org/cgi/search?volume=&firstpage=&author1=&author2=&titleabstract=sequestration&fulltext=&month=Oct&fyear=1995&tmonth=Sep&year=2003&hits=10&sendit.x=20&sendit.y=7>.

DOE funds crosscutting energy technological R&D. Two projects funded are related to sequestration. University of California, Berkeley to design and synthesize iron catalysts with controlled and predictable activity and structural stability during Fischer-Tropsch reactions, and the University of Wisconsin's Department of Chemical Engineering seeks to predict catalyst activity and hydrocarbon selectivities over a range of temperatures, pressures, and hydrogen-to-carbon-dioxide ratios. “DOE Provides \$12.3 Million for Crosscutting Energy Projects,” September 10, 2003, http://www.energy.gov/engine/content.do?PUBLIC_ID=14125&BT_CODE=PR_PRESSRELEASES&TT_CODE=PRESS RELEASE.

November 2003

Mineral membrane moves forward. A zeolite mineral membrane, made by a team at Yamaguchi University in Japan, acts as a molecular sieve to filter CO₂ from power station flue gas. CO₂ passes through the new membrane over 100 times as fast as N₂, at temperatures of up to 200 degrees C. "Mineral sieve filters out carbon from flue gases," *New Scientist*, October 4, 2003.

Canadian engineering firm to study CO₂ capture for United Arab Emirates. Lavalin International Inc. has been awarded an engineering and design study by the Abu Dhabi National Oil Company (ADNOC) in United Arab Emirates, to determine the most suitable method of recovering CO₂ from boilers and steam reformers. The CO₂ will be used at the Bab Thamama "B" oil reservoir in an EOR process. "SNC-Lavalin Awarded Carbon Dioxide Recovery Contract in United Arab Emirates," *Canada NewsWire*, October 3, 2003, <http://www.newswire.ca/en/releases/archive/October2003/03/c7859.html>.

December 2003

Underground Gasification. Oil and Natural Gas Corporation (ONGC) intends to work with Coal India Ltd. (CIL) and Gujarat State Petroleum Corporation (GSPC) for its underground coal gasification (UCG) project, hoping to gain carbon credits. "India's ONGC to gasify coal as alternative feedstock," *Business Standard*, November 11, 2003.

January 2004

Landfill Gas Capture. Renovar Energy, a Texas-based company, plans to separate and recover methane from CO₂ and other landfill gases. "Devil's Swamp landfill gets new name, role," *Baton Rouge Advocate*, LA, <http://www.2theadvocate.com>.

Synthetic Virus May Lead to Sequestration. Dr. Craig Venter and researchers from the Institute for Biological Energy Alternatives have synthesized a virus with the potential to convert CO₂ to hydrocarbon fuels. They pieced together phi-174 from short, single strands of synthetically produced, commercially available DNA known as oligonucleotides. Enzymes were used to glue the oligonucleotides together to form and copy a 5,386-base genetic strand. "Synthetic virus 10 years away from battling pollution," *The Engineer*, December 5, 2003.

Bioengineering Insufficient? This article describes the (above) biological carbon sequestration plan to find carbon-loving microbes in the sea, find the genes responsible for their carbon-munching ways, and transfer them to other microbes that can be cultured easily in bioreactors. The article also talks about terrestrial sequestration using forests, and changing agricultural practices by reducing tillage. "Carbon-Crunching Critters: Genetic engineering won't stop global warming," *Spectrum*, December 31, 2003, <http://www.spectrum.ieee.org/WEBONLY/publicfeature/jan04/0104bio2.html>.

February 2004

Revolutionary Technology for CO₂ Conversion. Robert R. Holcomb, M.D., Ph.D., an assistant professor at Vanderbilt University School of Medicine announced a revolutionary new technology, Electron Stream Carbon Dioxide Reduction (ESCO₂ R), commonly called the Carbon Dioxide Converter. "The unique technology of the Carbon Dioxide Converter permanently splits the molecular structure of carbon dioxide into its basic elements - carbon and oxygen," said Dr. Holcomb. The technology performance has been verified by the engineering firm Black & Veatch Corporation. "Worldwide Solution to Global Warming," *Scoop.com*, January 30, 2004, <http://www.scoop.co.nz/mason/stories/SC0401/S00065.htm>.

March 2004

Breakthrough Technology Claimed for Producing Hydrogen from Ethanol. A new process, developed by Lanny Schmidt, a chemist at the University of Minnesota, uses rhodium and ceria as catalyst to convert ethanol to hydrogen. Using a simple fuel injector from an automobile engine Schmidt and his colleagues sprayed an ethanol-water mix into a warm chamber to vaporize it. When the vapor passed through a porous ceramic plug embedded with the rhodium and ceria catalysts - viola, hydrogen flowed out the other end. Schmidt's process is autothermal, meaning it supplies its own heat. Because of that, the equipment is only a hundredth the size of conventional steam reforming systems and requires far less energy. "One step closer to hydrogen economy?" *Christian Science Monitor*, February 19, 2003.

Fluor, Mitsui Babcock, Alstom Power, and Imperial College London to Work Together on Study. Fluor Corporation has been selected by the International Energy Agency Greenhouse Gas Research and Development Program to study the capture and recovery of CO₂ in natural gas combined-cycle and pulverized-coal fueled power generation plants. Fluor will be working with Mitsui Babcock, Alstom Power, and Imperial College London. The study will investigate cost options, unresolved issues, and visualize likely technology developments over the next two decades. Fluor developed proprietary ECONAMINE FG(SM) and ECONAMINE FG Plus(SM) technologies, which are used for amine scrubbing of fuel gases. "Fluor Selected for Greenhouse Gas R&D Study," *PR Newswire*, February 5, 2004, <http://www.prnewswire.com>.

Electron Stream Carbon Dioxide Reduction (ESCO2R). An article in *Business Week* sets forth the opinions of some skeptics regarding the ESCO2R process. "Trouble is, that [the ESCO2R process] would violate physical laws," argues Hans Joachim Ziock, a physicist and energy expert at Los Alamos National Laboratory. Breaking the chemical bonds that glue atoms together into molecules takes even more energy than was used to create them, he explains. Since the energy released by burning coal stems mainly from oxidizing carbon, reversing the process would require all that energy output, and then some. "I'm missing the magic here," agrees Henry J. Cialone, senior vice-president for energy services at Battelle Memorial Institute, a think tank in Columbus, Ohio. Yet Holcomb has some hopeful supporters. "I'm confident there's no hoax here," declares J. Alex Silver, head of energy consulting at Black & Veatch Corp., an Overland Park (Kansas) engineering firm. Holcomb hired Black & Veatch to test his prototype CO₂ converter in January 2004. Says Silver: "We definitely were getting dissociation of CO₂ [into carbon and oxygen], and that by itself is very neat." Still, he adds, "the big question is how much energy was going into the converter?" "All fired up over clean coal," February 16, 2004, http://www.businessweek.com/magazine/content/04_07/b3870116.htm. See also, "Breakthrough purports answer to global warming," *Solar Access*, February 2, 2004, <http://www.solaraccess.com/news/story?storyid=6001>.

April 2004

Lithium Zirconate Paper in *Science* describes how the CO₂ sorption properties lithium zirconate can be modified through doping. "The rate of the CO₂ sorption on pure lithium zirconate is controlled by the diffusion of CO₂ in the solid lithium carbonate shell. For potassium doped lithium zirconate or lithium yttrium-zirconate the rate limiting step for CO₂ sorption is shifted to diffusion of oxygen ions in the zirconia shell. *Separation and Purification Technology*, Volume 36, Issue 1, April 2004, Pages 41-51, <http://www.sciencedirect.com/science/article/B6THJ-48Y6WMR-3/1/3bc54d8dc31ed52512b97fe54e6a9329>.

EU Steelmakers Push Toward Breakthrough Technology. A consortium of European steelmakers and other organizations put forward to the European Commission a research project to develop Ultra Low CO₂ Steelmaking (ULCOS) technologies. These reportedly include the capture and sequestration of vented CO₂. "Corus Involved in Breakthrough CO₂ Reduction Technology," *PR Newswire European*, March 12, 2004.

May 2004

EPA GHG Center Verifies Technology to Reduce Natural Gas Emissions. The Greenhouse Gas Technology Center verified the performance of the Quantum Leap Natural Gas Dehydration (QLD) Technology, developed by Engineered Concepts LLC of New Mexico. Natural gas systems represent almost two percent of the total GHG emissions in the U.S. according to the EPA (20 percent of total U.S. methane emissions). The QLD process eliminates hydrocarbon emissions from the glycol still column vent stream. A synopsis and final performance evaluation report can be accessed on the U.S. EPA ETV website, <http://www.epa.gov/etv/verifications/vcenter3-4.html>. “Greenhouse Gas Technology Center Completes Verification for Engineered Concepts' Quantum Leap Natural Gas Dehydration Technology,” *PR Newswire*, March 31, 2004.

Energy, H₂, and CO₂ sequestration. Greg Rau discusses a novel means of converting waste CO₂ to a solid or dissolved carbonate at ambient temperature and pressure, with carbon-free H₂ and electricity produced as byproducts. The value of these byproducts significantly offsets the cost of CO₂ capture and sequestration or may even make it profitable. “Possible use of Fe/CO₂ fuel cells for CO₂ mitigation plus H₂ and electricity production,” *Energy Conservation and Management*, Vol 45, Iss 13- 14, August 2004. A talk on this process was also presented at the American Chemical Society meeting in Anaheim on March 31, 2004: <http://oasys2.confex.com/acs/227nm/techprogram/P732839.HTM>.

Carbon Capture from CHP/Bioenergy Systems = Negative CO₂. Researchers from International Institute for Applied Systems Analysis, Luleå University of Technology, and the Chinese Academy of Sciences combine CO₂ capture and storage with biomass-based combined heat and power production (CHP) in Kraft pulp and paper mills in this study. “Efficient energy systems with CO₂ capture and storage from renewable biomass in pulp and paper mills,” *Renewable Energy*, Volume 29, Issue 9, July 2004, <http://www.sciencedirect.com/science/journal/09601481>.

June 2004

Calixarene crystals as new absorption agents for the purification of hydrogen. A pair of scientists from Missouri and South Africa have discovered that the supposedly impregnable cavities formed by calixarene crystals actually absorb and store molecules from the air. They absorb CO₂ particularly well, but they do not absorb hydrogen at all. This could mean that calixarene crystals might be used both to capture carbon and to isolate hydrogen for fuel cells. *Chemie* (Germany), <http://www.chemie.de/news/e/37747/>.

July 2004

“Novel concepts for CO₂ capture.” This paper describes the possibilities for power generation with CO₂ capture using envisaged key technologies: gas turbines, membranes, and solid oxide fuel cells (SOFCs). The SOFC anode off-gas is a CO₂ rich stream, which can be used for sequestration without elaborate treatment. Several implementation schemes of the technique are discussed. By J. W. Dijkstra and D. Jansen, *Energy*, Volume 29, Issues 9-10, July-August 2004, Pages 1249-1257.

“Integration of H₂-separating membrane technology in gas turbine processes for CO₂ capture.” The paper describes the promising possibility to capture CO₂ in natural gas fired power cycles through the use of a high-temperature membrane reactor of the methane-steam reforming type with an integrated H₂-separating membrane. Two types of membranes are integrated: Palladium membranes, which could allow for zero-emission power cycles, and microporous membranes, the use of which in the present work means that 20 percent of the generated CO₂ is emitted to the atmosphere. By K. Jordal et al., *Energy*, Volume 29, Issues 9-10, July-August 2004, Pages 1269-1278.

“An experimental investigation into the use of molten carbonate fuel cells to capture CO₂ from gas turbine exhaust gases.” This paper describes the conceptual design of a hybrid molten carbonate fuel cell (MCFC) system to generate power and simultaneously capture CO₂ from small (<10 MW) gas turbine exhaust streams. Initial modeling studies indicated that a 1.6 MW MCFC could reduce the CO₂ emissions from a 4.6 MW gas turbine by 50 percent on a per kWh basis. Initial data from investigations confirm that the fuel cell can operate at sub-optimal CO₂ levels with limited loss in power and efficiency. By A. Amorellia et al., *Energy*, Volume 29, Issues 9-10, July-August 2004, Pages 1279-1284.

“CO₂ capture and storage – the essential bridge to the hydrogen economy.” This paper explains the key issues that may favor the hydrogen economy in the long-term, and addresses CO₂ capture options that are essential to help develop the required hydrogen infrastructure in the short-term. By D.R. Simbeck, *Energy*, Volume 29 (2004) 1633-1641.

“Prospects for carbon capture and sequestration technologies assuming their technological learning.” This paper analyzes the potentials of carbon capture and sequestration technologies (CCS) in a set of long-term energy-economic-environmental scenarios based on alternative assumptions for technological progress of CCS. Past experience in controlling sulfur dioxide emissions (SO₂) from power plants is used as a guide for estimating technical progress. A “learning curve” for CCS, which describes the relationship between the improvement of costs due to accumulation of experience in CCS construction, is quantified. Due to the assumed technological learning, the costs of emissions reductions for CCS drop rapidly and in parallel with the massive introduction of CCS on the global scale. By Keywan Riahi et al., *Energy*, Volume 29, Issues 9-10, July-August 2004, Pages 1309-1318.

“Geological storage of CO₂: What do we know, where are the gaps and what more needs to be done?” The aim of this paper is to present an overview of the research work that is currently underway, and to provide an analysis of the current state of knowledge on geological storage of CO₂. The analysis is broken down to address the key geological storage options: deep coal seams, depleted hydrocarbon reservoirs, and deep saline aquifers. In each case, areas of uncertainty are highlighted, as well as areas where it is considered that further work will be needed so that the technology can be accepted by Governments and the general public as a mitigation option suitable for wide-scale application throughout the world. By John Gale, *Energy*, Volume 29, Issues 9-10, July-August 2004, Pages 1329-1338.

August 2004

How to Estimate Forest Carbon for Large Areas from Inventory Data. Determining the level of carbon stocks in forest ecosystems has become a concern of governments, businesses, and many organizations. This article provides examples of inventory-based calculations and identifies resources that are available for analysts and planners to develop large-scale carbon estimates consistent with totals for U.S. forests. James E. Smith et al., *Journal of Forestry*, Jul/Aug 2004, Vol.102, Iss. 5; pg. 25-31.

Ocean

September 2003

Ocean algae genes decoded. With DOE and National Science Foundation funding, three international teams of scientists traced the genetic blueprints for four forms of photosynthetic organisms that can turn sunlight and CO₂ into biomass with very few (2000) genes. “Microbe project may aid CO₂ capture,” *Inside Energy /with Federal Lands*, August 18, 2003, <http://www.platts.com>. See also, “NSF Microbes' genomes promise insight into oceans,” *M2 Presswire*, August 14, 2003; and “Genome sequence of the cyanobacterium *Prochlorococcus marinus*

SS120, a nearly minimal oxyphototrophic genome,” *Proceedings of the National Academy of Sciences*, August 19, 2003, vol. 100, no. 17, <http://www.pnas.org/cgi/content/abstract/100/17/10020>.

Salinity decreases CO₂ absorption. Recent drought conditions in the North Pacific Ocean near Hawaii have decreased the strength of the CO₂ sink, according to a study published in the journal *Nature*. A team funded by the National Science Foundation (NSF) and led the University of Hawaii used 15 years of time-series measurements to compare the precipitation, salinity, and CO₂ concentrations at Station ALOHA. “Ocean carbon cycle affected by drought,” *M2 Presswire*, August 14, 2003. See also, “Decrease in salt in ocean decreases amount of carbon dioxide,” *The Associated Press State & Local Wire*, August 13, 2003, <http://www.soest.hawaii.edu/>.

October 2003

Ocean acidification. The coming centuries may see more ocean acidification than the past 300 million years as a result of increased levels of CO₂ in the atmosphere. “Oceanography: Anthropogenic carbon and ocean pH,” *Nature*, September 2003, Ken Caldeira and Michael Wickett, <http://www.nature.com>. See also, “GHGs linked to acidic oceans” *Ananova*, September 24, 2004, http://www.ananova.com/news/story/sm_822606.html.

November 2003

Phytoplankton in rapid decline. Plant life covering the surface of the world's oceans is disappearing at a dangerous rate, scientists have discovered. According to Watson Gregg, a NASA biologist at the Goddard Space Flight Center, the greatest loss of phytoplankton has occurred where ocean temperatures have risen most significantly between the early 1980s and the late 1990s. “Decline in oceans' phytoplankton alarms scientists, Experts pondering whether reduction of marine plant life is linked to warming of the seas,” *San Francisco Chronicle*, October 6, 2003, <http://sfgate.com/cgi-bin/article.cgi?f=/c/a/2003/10/06/MN31432.DTL&type=science>.

Ocean health. According to this article, oceans have begun to undergo accelerated transformations: Rising temperatures and water levels, damage to coral reefs, disappearing saltmarsh and mangrove swamps, declining fish stocks, and rising levels of pollution. A central concern is the rapid accumulation of carbon in the atmosphere, and its effect on oceans. The article considers the question of speeding up oceans' natural biological pump to move carbon from the surface to the bottom of the oceans. “What future for the oceans,” *Foreign Affairs*, October 2003.

December 2003

Effects of CO₂ in Ocean Water Described. Increased CO₂ in the oceans would result in decreased pH levels of seawater, resulting in dramatic physiological effects on many species, says Brad Seibel, assistant professor of marine biology at the University of Rhode Island. “Shallow-living organisms like shelled mollusks and corals are already being affected by the growing levels of CO₂ in the atmosphere. As atmospheric CO₂ diffuses into the upper layers of the water, it inhibits the ability of shellfish to form shells and causes coral reefs to dissolve. “Marine biologist says carbon dioxide injection in deep sea would alter ocean chemistry...” *Science Daily*, November 17, 2003, <http://www.sciencedaily.com/releases/2003/11/031118072844.htm>.

January 2004

Raman Spectrometer on the Ocean Floor. Article summarizes the studies and experiments being performed by MBARI in the Monterey Bay. “The emergence of Global Positioning Systems and remotely operated vehicles such as MBARI make the use of our instrumentation in extreme environments more and more feasible,” says Jill Pasteris of MBARI. “Trapping Carbon Dioxide In An Icy Cage: Researchers explore the ocean floor with rare instrument,” *Science Daily*, December 31, 2003, <http://www.sciencedaily.com/releases/2003/12/031231082637.htm>.

Climate Influence of Ocean Salt Cycling. A comparison of salinities on a long transect through the western basins of the Atlantic Ocean between the 1950s and the 1990s finds systematic freshening at both poleward ends contrasted with large increases of salinity pervading the upper water column at low latitudes. Results extend a growing body of evidence indicating that shifts in the oceanic distribution of fresh and saline waters are occurring worldwide in ways that suggest links to global warming and possible changes in the hydrologic cycle of the Earth. “A change in the freshwater balance of the Atlantic Ocean over the past four decades,” *Nature*, December 18, 2003.

Ocean Upwelling Affected by Climate Change. Noah Diffenbaugh and others at the University of Santa Cruz predict through computer simulations that global warming-induced wind will change the intensity and the seasonal timing of coastal ocean upwelling along the California coast. *UCSC Press Release*, December 17, 2003, http://www.ucsc.edu/news_events/press_releases/text.asp?pid=433.

February 2004

Ocean Fertilization Field Test Embarks. Researchers from the Alfred Wegener Institute for Polar and Marine Research in Germany set sail to dissolve an iron sulphate solution in a 150-200 square-kilometer patch of the Southern Ocean, near Antarctica, where currents may keep the iron within a limited area. The team will monitor phytoplankton growth from a helicopter for a period of eight to ten weeks. “Climate test sets sail,” *Nature*, January 26, 2004. See also, “Life: Dispatch: News from Nature, the international journal of science: Can dumping iron halt global warming.” *The Guardian* (London), January 29, 2004.

Diatoms are a Significant CO₂ Sink. Recent satellite measurements suggest that phytoplankton process nearly half of all the CO₂ removed from the atmosphere by photosynthesis. Of the many types of phytoplankton, diatoms are the most efficient CO₂ processors and the most prolific. A diatom doubles about once a day. François Morel, a Princeton University oceanographer and Allen Milligan, an oceanographer at Rutgers' Institute of Marine and Coastal Sciences have found that the silica in the diatom's shell chemically speeds the conversion of bicarbonate back into usable CO₂, and its complex shell maximizes surface area photosynthesis. “Gas Guzzlers,” *Smithsonian Magazine*, February 2004, <http://www.smithsonianmag.si.edu/smithsonian/issues04/feb04/phenomena.html>.

March 2004

“Geological Carbon Sequestration: Critical Legal Issues.” Reviews the legal issues concerning geological carbon sequestration in the offshore waters surrounding the United Kingdom. Different locations of the sea are subject to different prescriptions under international law. A key legal question is whether CO₂ is considered to be a “waste,” and whether storing it is considered “dumping.” It is likely that CO₂ sequestration will be defined as both, according to this paper. Tyndall Centre Working Paper 45, Ray Purdy and Richard Macrory, January 2004, http://www.tyndall.ac.uk/publications/working_papers/wp45.pdf.

Ice Sequestration. Preliminary research by University of Manitoba researcher Tim Papakyriakou suggests that the icebound Arctic Ocean absorbs CO₂ faster than the North Atlantic Ocean. His results show the ice drawing down carbon at “roughly 50 to 60 percent of what you'd expect over a temperate wetland or marsh during its growing season.” Bacteria and phytoplankton living inside the ice layer may be capturing the CO₂. “Arctic research makes greenhouse gas find,” *Edmonton Journal* (Alberta, Canada), February 17, 2004.

Ocean Carbon Distribution. Highlights the VERTIGO study project by Woods Hole Oceanographic Institution engineer Brian Guest. “Voyage to ocean's 'Twilight Zone,’” *Christian Science Monitor*, <http://www.csmonitor.com/2004/0212/p14s01-sten.html>.

April 2004

Ocean Experiments Sought. Scientist Peter Brewer seeks to conduct large-scale tests to determine the environmental impacts of elevated atmospheric CO₂ on the oceans. “The problem,” Brewer says, “is that about 50 percent of the 400 billion tons of CO₂ we have put in the ocean is in the upper 200 meters. Since the average depth of the ocean is 4,000 meters, we are having a large impact on the shallow surface layers where most marine life is.” *MSNBC*, March 18, 2004, <http://www.msnbc.msn.com/id/4286438/>.

May 2004

The Ocean Floor's own CO₂ Emissions. For information on CO₂ coming from the sea floor, including videos of the liquid CO₂ bubbling up from the Eifuku vent along the Mariana Arc in the western Pacific, visit <http://oceanexplorer.noaa.gov/explorations/04fire/logs/april10/april10.html>.

Southern Ocean Fertilization Study. Several new articles in the April 16, 2004 issue of *Science* cover the investigative efforts of over 40 researchers from 16 institutions (Moss Landing Marine Laboratories, MBARI, Woods Hole Oceanographic Institution, NOAA, Scripps, LBL, and ten universities). The first, “Southern Ocean Iron Enrichment Experiment: Carbon Cycling in High and Low Si Waters,” by Kenneth H. Coale et al., investigates the response of algae and diatoms to iron added to sea water with varying amounts of natural silica. The second, “The Effects of Iron Fertilization on Carbon Sequestration in the Southern Ocean” measured the flux of carbon to the deep ocean, and found that it was similar in magnitude to that of natural blooms in the Southern Ocean and thus small relative to global carbon budgets and proposed geoengineering plans to sequester atmospheric carbon dioxide in the deep sea. The third, “Robotic Observations of Enhanced Carbon Biomass and Export at 55°S During SOFeX,” suggests that each atom of iron added to the sea could pull between 10,000 and 100,000 atoms of carbon out of the atmosphere by encouraging plankton growth. The biomass buildup and export were much higher than expected for iron-amended low-silicate waters. The fourth, “Ocean Science: Ironing Out Algal Issues in the Southern Ocean,” reviews the three others. *Science*, Vol 304, Issue 5669. A number of publications discussed the findings, links below: “Effects of Ocean Fertilization with Iron to Remove Carbon Dioxide from the Atmosphere Reported,” *Innovations Report*, April 19, 2004, http://www.innovations-report.com/html/reports/earth_sciences/report-28146.html; “Fertilization Of Phytoplankton Not A Solution For CO₂ Removal,” *Science a Go Go*, April 19, 2004, http://www.scienceagogo.com/news/20040318210325data_trunc_sys.shtml; “Research tackles key factors in climate change,” San Francisco State University, April 16, 2004, <http://www.sfsu.edu/~news/2004/spring/55.htm>; and “Phytoplankton may stimulate uptake of CO₂,” *EurekaAlert*, April 15, 2004, http://www.eurekaalert.org/pub_releases/2004-04/osu-pms041304.php.

June 2004

The Role of Coastal Seas in the Ocean Carbon Cycle. Researchers evaluated the contribution of coastal and marginal seas to global ocean carbon uptake, especially the North Sea. High biological activity acts to pump carbon into the subsurface seas. Once CO₂ uptake has occurred it is transported to the deep ocean via currents. Although coastal and marginal seas represent only 7 percent of the total ocean surface, they account for about 20 percent of the carbon inputs, according to the extrapolated calculations in this paper. “Enhanced Open Ocean Storage of CO₂ from Shelf Sea Pumping,” *Science*, Helmuth Thomas, et al, p. 1005, May 14, 2004, <http://www.sciencemag.org/cgi/content/abstract/304/5673/1005?etoc> (registration required).

July 2004

“Can Iron-Enriched Oceans Thwart Global Warming?” After adding iron to the waters around Antarctica to encourage phytoplankton blooms, Ken Buesseler, a marine chemist at the Woods Hole Oceanographic Institution in Massachusetts, summarized the results by saying, “we measured an increase in carbon flux in the iron-fertilized patch and did not see an equivalent increase in flux outside in the control stations. However, this increase was not particularly large.” Despite these results Buesseler has not given up on the idea of using carbon sinks to combat climate change. “We need to explore ways to decrease inputs of carbon dioxide to the atmosphere and enhance carbon sinks,” Buesseler said. “The ocean is one of the sinks and the link between the surface ocean and deep ocean with respect to these sinking particles is one of the most poorly understood areas of ocean science.” *National Geographic News*, June 9, 2004, http://news.nationalgeographic.com/news/2004/06/0609_040609_carbonsink.html.

August 2004

“Iron Seeding Just Doesn't Pay.” Another article summarizing the results of the many DOE-sponsored iron seeding experiments says the hypothesis that iron seeding would create a photosynthetic bloom is correct, but it is far less economical than expected. The breakeven point for sequestration programs is \$10 per ton of carbon dioxide; according to this article, the models based on the iron-seeding experiments still put the cost at \$100 or more. *The Scientist*, July 5, 2004, http://www.the-scientist.com/yr2004/jul/research1_040705.html.

Terrestrial

September 2003

Soil carbon MM&V. Researchers at the South Dakota School of Mines and Technology have earned a patent pending on a technique called C-Lock that could help farmers measure, certify and market the carbon stored in their soil. The Tech scientists also received a \$250,000 DOE grant to test the technique in the field. “Tech scientists doing carbon sequestration work,” *The Associated Press State & Local Wire*, September 1, 2003. Also see, “Benefit to farmers from 'carbon trapping' up in the air,” *Omaha World Herald*, August 23, 2003.

Soil and vegetative carbon capacity. New research by the UK Met Office's Hadley Centre for Climate Research found that the capacity of soil and vegetation to absorb CO₂ could become saturated over the next few decades, according to a paper published by the Institute for Public Policy Research. The Hadley Centre

examined the complex interaction of CO₂ emissions and rising temperatures on vegetation and soils. “Scientists issue new warning on gas emissions,” *Financial Times* (London), August 7, 2003.

Climate warming effect on vegetation may increase soil moisture. Convention predicts that global warming may increase aridity in water-limited ecosystems by accelerating evapotranspiration, but this study by six researchers at Stanford University and the Carnegie Institution of Washington shows the reverse effect. In a 2-year grassland field experiment, simulated warming increased spring soil moisture by 5 to 10 percent under both ambient and elevated CO₂. Warming also made trees leaf out earlier, which decreased transpirational water losses. “Plants reverse warming effect on ecosystem water balance,” *Proceedings of the National Academy of Sciences*, August 19, 2003, vol. 100, no. 17, <http://www.pnas.org/cgi/content/abstract/100/17/9892>.

Bogs sink carbon. Britain's attempts to reduce GHGs could get a helping hand from the country's ancient bogs. Researchers at Leeds and Durham universities have found that the bogs offer a carbon reservoir almost as effective as tropical rainforests and that blocking modern drainage ditches would top up the existing bogland. “Bogs could deflate gas emissions,” *The Guardian*, August 25, 2003, http://www.guardian.co.uk/uk_news/story/0,3604,1028763,00.html.

Insured expiring credits for terrestrial sequestration. This overview of different strategies addressing non-permanence or reversibility of terrestrial carbon sequestration projects evaluates potential costs compared with uninsured and permanent credits. Approaches include forest carbon insurance, land reserves, and issuance of expiring credits. “Replacing carbon lost from forests: an assessment of insurance, reserves, and expiring credits,” *Climate Policy*, 3 (2, 2003), 107-122.

Identifying terrestrial carbon leaks. This analysis divides sources of leakage into primary and secondary types. The actors or agents responsible for baseline activities cause primary leakage, and secondary leakage occurs when the project's outputs create incentives for third parties to increase emissions elsewhere. The paper demonstrates leak identification for the case study of avoided deforestation projects. “A conceptual framework and its application for addressing leakage: the case of avoided deforestation,” *Climate Policy*, 3 (2, 2003), 123-136.

Land use mitigation and the surface energy budget. Climate mitigation policies affect the surface albedo, the fluxes of sensible and latent heat to the atmosphere, and the distribution of energy within the climate system. Changes in these components can affect the local, regional, and global climate, but recognition of these effects challenges a system of credits and debits where sequestration of carbon in the biosphere is equated with emission of carbon from fossil fuels. “The climate impacts of land surface change and carbon management, the implications for climate-change mitigation policy,” *Climate Policy*, 3 (2, 2003), 149-157.

The Noel Kempff Mercado Climate Action Project (NKMCA) local community benefit? The long-term impact of the Bolivian carbon sequestration project on the local communities may be positive, however, in the short run, certain sections of the local communities are financially poorer, according to this study. “Can forest-protection carbon projects improve rural livelihoods? Analysis of the Noel Kempff Mercado Climate Action Project, Bolivia,” *Mitigation and Adaptation Strategies for Global Change*, 7 (4, 2002), 323-337.

Super-trees. The Japanese Ministry of Education, Culture, Sports, Science, and Technology has started a project to develop genetically modified trees to absorb more CO₂. “JP: Gov't eyes genetically modified trees to fight greenhouse gases,” *Kyodo News*, August 27, 2003, <http://www.co2e.com/News/story.asp?StoryID=1247>. Also, scientists are planting genetically engineered trees in areas around this country that may help deforestation and supply growing paper demands. “Genetically engineered trees sprout,” *MSNBC*, August 1, 2003, <http://www.webprowire.com/summaries/552633.html>.

Leasing reduction certificates in CDM forestry. As vegetation is an unstable dynamic system, emission credits generated by carbon sink projects under the Clean Development Mechanism (CDM) of the UN Framework Convention on Climate Change (FCCC) Kyoto Protocol suffer from an inherent permanence risk.

This article discusses the pros and cons of two approaches to balance GHG emissions and carbon uptake in vegetation: the ton-year approach and temporary credits. "Fractions of permanence: squaring the cycle of sink carbon accounting," *Mitigation and Adaptation Strategies for Global Change*, 7 (4, 2002): 381-402.

Forest clean-up to fuel biopower. Trees cleared from Arizona's forests will provide fuel for an Arizona Public Service Co. (APS) power plant instead of being burned in the forest. Annual GHG emissions are expected to be reduced by up to 15,000 tons per year by burning the woodchips under controlled conditions. "Arizona biomass plant offers many benefits," *Business Wire*, August 27, 2003, <http://www.solaraccess.com/news/story?storyid=4977>.

World water and climate change. This paper assesses the terrestrial water cycle and the impact of climate change by running a macro-scale water balance model and two General Circulation Model (GCM)-based climate change scenarios. The results show that in 2021-2030, water demand will increase worldwide due to climate change. Water shortage is expected to worsen in western Asia, the Arabian Peninsula, northern and southern Africa, northeastern Australia, southwestern North America, and central South America. A significant increase in surface runoff is expected in southern Asia and a significant decrease is expected in northern South America. "Terrestrial water cycle and the impact of climate change," *Ambio*, 32 (4, 2003), 295-301.

October 2003

Measuring tree root biomass with radar. USDA Forest Service researchers are using ground-penetrating radar (GPR) to study tree roots nondestructively. Results are published in the September 2003 issue of the *Soil Science Society of America Journal*. "Using ground-penetrating radar to estimate tree root biomass," *Science Daily*, September 25, 2003, <http://www.sciencedaily.com/releases/2003/09/030925065001.htm>.

Forested financial investments. Nissho Iwai Corp. will introduce an investment fund that supports its afforestation projects in Vietnam and offers CO₂ emission rights to investors as dividends. "Japan's Nissho Iwai to launch afforestation fund," *Asia Pulse*, September 18, 2003, <http://www.co2e.com/News/story.asp?StoryID=1283>.

Reducing methane emissions from India rice fields. A paper from the National Botanical Research Institute of Lucknow proposes strategies to contain methane emissions from tropical Asian paddy fields. Strategies include: water management, use of fermented manures with low carbon to nitrogen ratio, application of sulfate-containing chemical fertilizers, selection of low methane emitting rice cultivars, and implementation of one or two short aeration periods before the heading stage. "Investigating options for attenuating methane emission from Indian rice fields," *Environment International*, Volume 29, Issue 5, August 2003, <http://www.sciencedirect.com/science/journal/01604120>.

Biodiversity and economic incentives for carbon sequestration. The economic, ecological, and legal implications of the interrelationship between carbon sequestration programs and biodiversity are sometimes negative, according to this paper. The relationship between the Kyoto process and the Convention on Biological Diversity is also studied. "Conflicts between biodiversity and carbon sequestration programs: economic and legal implications," *Ecological economics*, 46 (1, 2003).

International abatement risks. The risks associated with investing in GHG abatement projects in developing countries depend on the volatility of the growth rate of regional CO₂ emissions, and well-diversified portfolios significantly reduce investment risks, according to this paper. Existing models generally neglect investment risks and therefore overestimate the cost savings due to international emissions trading. "International diversification of investments in climate change mitigation," *Ecological economics*, 46 (1, 2003).

Global estimation of crop productivity. This study integrates the Erosion Productivity Impact Calculator (EPIC) model with Geographic Information System (GIS) to simulate crop productivity at the global level. Using IPCC's future climate scenarios, GIS-based EPIC shows that global warming will be harmful for most countries. "Global estimation of crop productivity and the impacts of global warming by GIS and EPIC

integration,” *Ecological Modelling*, Volume 168, Issue 3, October 15, 2003, <http://www.sciencedirect.com/science/journal/03043800>.

European forests’ role. Britain's forests contain roughly enough carbon to offset one year's CO₂ emissions from fossil fuels and certain industrial processes. Measures taken to protect and expand forest areas can increase the biomass resource potentially available to future generations, the report, “Forests, carbon and climate change: the UK contribution,” states. “The carbon case for wood fuel,” *Forestry & British Timber*, September 9, 2003, [http://www.forestry.gov.uk/website/PDF.nsf/pdf/fcin048.pdf/\\$FILE/fcin048.pdf](http://www.forestry.gov.uk/website/PDF.nsf/pdf/fcin048.pdf/$FILE/fcin048.pdf). See also, “Use forestry waste, cut emissions,” *Wired News*, September 21, 2003, from the World Forestry Congress meeting in Quebec City, <http://www.wired.com/news/technology/0,1282,60531,00.html>.

November 2003

Organic farming and soil carbon storage. Researchers at the Rodale Institute say a long-term study shows organic farming practices retain 15 to 28 percent more soil carbon than conventionally farmed soil - roughly 1,000 pounds of carbon per acre foot of soil. Using data on corn and soybeans gathered since 1981 in east-central Pennsylvania, the system keeps crops in the field longer, grows legume cover crops and uses manure fertilizer. “Organic-farming benefit shown,” *Philadelphia Inquirer*, October 12, 2003, <http://www.philly.com/mld/inquirer/news/local/6995051.htm> (registration required). See also, “Farming systems trial,” The Rodale Institute, http://www.rodaleinstitute.org/bookstore/products/farm_books/main.shtml.

Ozone interference with carbon uptake. Field tests performed by researchers at Michigan Technological University and the Forest Service's North Central Research Station indicate that plants and soils might be less able to clean the air of excess CO₂ when ozone levels are high. With ambient concentrations of ozone and CO₂ both increased by 50 percent, the formation rates of soil carbon are reduced by 50 percent relative to the amounts entering the soil when the forests were exposed to increased CO₂ alone. “Reduction of soil carbon formation by tropospheric ozone under increased CO₂ levels,” *Nature*, 425, October 16, 2003. See also, “Ground-level ozone degrades soil, study says,” *Atlanta Journal Constitution*, October 16, 2003, <http://www.ajc.com/news/content/news/1003/16ozone.html> (registration required).

December 2003

Homegrown Carbon Farming. In Kansas, farmers, Republicans, and an environmental advocacy group are supporting the chance to gain carbon credits through agricultural carbon sequestration projects and land management techniques. “Plan gives U.S. farmers a role in fighting global warming,” *New York Times*, November 25, 2003.

Study finds that Certain Types of Trees are more Effective at Transferring Carbon to Soil. Root replacement rate, not faster growth, is most effective at transferring carbon to soil. Trees with durable roots transfer less carbon to the soil, according to research funded primarily by DOE. As reported in *Science* magazine (November 21, 2003), scientists from DOE's Argonne National Laboratory, Oak Ridge National Laboratory, and two universities measured the longevity of roots – the source of some of the carbon that would be transferred by decay into the soil – in forest plots infused with computer-controlled CO₂ simulating mid-century air. “Pine forests have slow root replacement which decreases the potential to accumulate carbon in the soil in the short-term,” said lead author Argonne Roser Matamala. “Tree root life controls CO₂ absorption,” *EurekAlert*, November 20, 2003, http://www.eurekalert.org/pub_releases/2003-11/dnl-tr112003.php.

Canadian Government plans to Encourage Private Sustainable forests. The Canadian government announced an investment of \$20 million in the Forest 2020 Plantation Demonstration and Assessment initiative to encourage the planting of fast-growing hardwood trees on non-forested rural private lands. The Government

of Canada has committed more than \$3.7 billion to climate change programs and to the development of leading-edge technologies. "Canada to invest \$20 million in trees," *Canada NewsWire*, November 27, 2003, <http://www.newswire.ca/en/releases/archive/November2003/27/c7271.html>.

Tropical Rainforests: Disturbance in dry Seasons Leads to Carbon loss in wet Seasons. Researchers based in Brazil and the U.S. found that older Amazon rainforests experiencing drought or other natural disturbances may release more carbon than they take up. Disturbances that kill trees can lead to higher levels of CO₂ released when the dead wood breaks down in wet seasons. This contrasts with studies finding that carbon loss generally increases in dry seasons. See, "Disrupted forests 'release more carbon,'" *SciDev.net*, November 28, 2003, <http://www.scidev.net/news/index.cfm?fuseaction=readnews&itemid=1126&language=1>; or the original publication, *Science* 302, 1554 (2003), <http://www.sciencemag.org/cgi/content/full/302/5650/1554?ijkey=dew6hPmY3O6P6&keytype=ref&siteid=sci> (registration required).

January 2004

Soil Carbon Modeling Web Site. Scientists at Purdue and Colorado State Universities developed prototype web-based tools to simulate how much carbon is stored in soil under different management regimes. The C-STORE model, a simplified version of the Century model accounts for different cropping, tillage, hydric conditions, and soil texture. A Web interface for the Indiana COMET database is available at <http://pasture.ecn.purdue.edu/~cstore/COMET>. The prototype version of the Web GIS based CSTORE is available at <http://danpatch.ecn.purdue.edu/~cstore/C-STORE/>.

Forestation Incentives from USDA. A part of the Conservation Reserve Program authorized by the 2002 Farm Bill provides eligible farmers \$50 a year or more per acre for as long as 15 years as incentive to reforest farmland. Nut and seed producing species, such as oaks, maple, ash and tupelo will be preferred to promote wildlife. Farmers may also eventually trade the value of their timber to industries for carbon credits. The initiative is targeted toward land within a 100-year flood plain adjacent to a permanent stream that has been farmed for four years of a six-year span ending in 2002. The land also must contain at least 51 percent hydric soils, which are representative of wetland areas. Farmers interested can contact the state Farm Service Agency office, (318) 473-7721. "Farmers urged to create forests; Program pays them to plant hardwoods," *The Times-Picayune* (New Orleans, LA), December 13, 2003.

Climate Change Feedbacks in Northern High Latitudes. Scientists at NASA's Jet Propulsion Laboratory predict that increased carbon uptake from a longer growing season in Alaska and other northern regions may be overwhelmed by CO₂ released from thawing permafrost. "Frozen soil can store carbon for hundreds to thousands of years," said lead author Dr. Kyle McDonald of JPL, "but when the permafrost thaws and begins to dry out, it releases the carbon back into the atmosphere." "NASA scientists discover spring thaw makes a difference," *Innovations Report*, http://www.innovations-report.com/html/reports/earth_sciences/report-24217.html.

Urban Trees Reduce Energy Costs. Results from an hourly building energy simulation model show that ratepayers in the greater Toronto Area could realize annual energy savings of over \$11M from cool roofs, shade trees, wind shielding of trees, and ambient cooling by trees and reflective surfaces. Potential annual electricity savings are estimated at about 150 GWh and potential peak power avoidance at 250 MW. "Energy effects of heat-island reduction strategies in Toronto, Canada," *Energy*, Volume 29, Issue 2, February 2004, <http://www.sciencedirect.com/science/journal/03605442>.

February 2004

Entergy's Terrestrial Sequestration Activities. Entergy's Grand Gulf Nuclear Station in Mississippi is Entergy's first site location to use intensive forest management to support carbon sequestration. The process began recently when Box Elder, Sweetgum, Dogwood and Elm trees were cut down in a field located at the north end of Grand Gulf's property, and 9,400 Cypress, Ash, and Oak trees were planted in their place. In a few years, the 65-acre field will be home to thousands of carbon sequestering trees, which will be monitored in five years and then every 10 years thereafter by a carbon monitoring program that will measure how much carbon the forest is trapping. "Entergy's Grand Gulf Nuclear Station Supports Carbon Sequestration," *PR Newswire*, January 16, 2004, <http://www.prnewswire.com>.

Deforestation Emits More CO₂ than New Plantations Can Soak Up, in Some Areas. This model estimates changes in land-use and subsequent emissions over the next twenty years. The model shows that the greatest carbon emissions, using part of Panama as a case study, is from deforestation. Reducing deforestation would therefore be the most effective way to reduce carbon emissions, according to the authors. Under the current CDM framework, only credits arising from reforestation are allowed. Virginia H. Dale, et al., "Estimating baseline carbon emissions for the eastern Panama Canal watershed," *Mitigation and Adaptation Strategies for Global Change*, 8 (4, 2003), <http://ipsapp008.kluweronline.com/content/getfile/5012/27/5/abstract.htm>.

Siberian Peatlands Older Than thought, Bigger Carbon Stores. UCLA researchers led a 22-member international team to the West Siberian Lowland to radiocarbon date the bogs (2,000 to 3,000 years older than previously thought). They may be partly attributable to the rise in atmospheric methane levels 9,000 to 11,500 years ago. "Study: Siberian Bogs Big Player in Greenhouse Gas," *Science*. See also, "Study pinpointing origins of Siberian peat bogs raises concerns," *EurekAlert*, January 15, 2004.

March 2004

Terrestrial Uptake. The Free Air CO₂ Enrichment (FACE) experiment is designed to simulate the response of trees to elevated amounts of CO₂ in the atmosphere. Early results indicate a sustained 24 percent increase in plant and fine root production but no sustained growth in wood production. Also, argue scientists, the magnitude of the increased uptake is not enough to counterbalance anthropogenic GHG emissions." "Carbon dioxide fertilization is neither boon nor bust," *Newswise*, February 16, 2004, <http://www.newswise.com/articles/view/503175/>; and "Duke open-air experiment results could deflate hopes that forests can alleviate global warming," *EurekAlert*, February 15, 2004, http://www.eurekalert.org/pub_releases/2004-02/du-doe020904.php.

Soy Yields May Increase Under CO₂ Fertilization, Warming. Scientists at the University of Illinois at Urbana-Champaign have tended experimental soybean plots near the university since 2001, exposing the plants to increased levels of ozone and CO₂. Despite the negative effects of ozone, soy yields could increase 13 percent by 2050, all else remaining equal. "Climate change could boost cash crops," *Nature*, February 17, 2004, <http://www.nature.com/nsu/040216/040216-8.html>.

Self-insurance for Terrestrial Carbon Sequestration Credits. The one-to-one conversion of long-term or temporary Carbon Emission Rights (CERs) into allowances could be accomplished either through drawing on only some of the credits of a project (and the remainder as a self-insurance); or insuring the credit by other means. The inclusion of sinks is an impending issue within the EU linking Directive. Guest commentary by Bernhard Schlamadinger, *Carbon Market Europe*, February 27, 2004, http://www.pointcarbon.com/wimages/CME_27_February_2004.pdf.

April 2004

Exotic Trees Shown to Grow on Coal Mine Spoil Land. On the basis of biomass and primary productivity, Eucalyptus hybrid and Acacia auriculiformis were found suitable for plantation on coal mine spoil land.

Ecological Engineering, Volume 21, Issues 2-3, December 2003, Pages 143-151,

<http://www.sciencedirect.com/science/article/B6VFB-4BRP6N7-2/1/edd39eed2eecb363afa466ee0a1c0c99>.

Urban Terrestrial Carbon. According to American Forests, the nation's urban areas as defined by the Census Bureau have lost 21 percent of their tree cover in the last decade. Stephen Bratkovich, a forester with the U.S. Forest Service in St. Paul, Minnesota, has drawn from published studies to calculate that cities produce about 3.8 billion board feet of usable logs each year due to natural mortality, disease, storm blow-downs, and development

- more wood than harvested from all of the country's 147 million acres of national forestlands. Private citizens shoulder much of the burden as urban foresters. In Los Angeles, the city government owns 1.5 million to 2 million trees, while businesses and homeowners are responsible for perhaps 10 million. "The Nation; No Safe Arbor in the City; Trees are disappearing from urban areas," *Los Angeles Times*, March 8, 2004.

Evidence that Atmospheric CO₂ is Affecting Rainforests. William Laurance of the Smithsonian Tropical Research Institute in Panama and his team, whose research was published in the journal *Nature*, noticed that the growth of large trees in the Amazonian rainforests have accelerated over the past two decades while the growth of smaller ones has slowed. The fast-growing large trees are less dense than slow growing ones and they therefore hold less carbon overall. Scientists fear this is reducing the rate of forests' carbon absorption per acre.

"Rainforests absorbing less carbon dioxide: study," *ABC News Online* (Australia), March 11, 2004,

http://abc.net.au/science/news/scitech/SciTechRepublish_1063540.htm. Full article: Laurance, W.F. et al., *Nature*, 428, 171-175, (2004).

Design Incorporating Ecological Services. Architect William McDonough says he aims to design a building that "makes oxygen, fixes nitrogen, sequesters carbon, distills water, builds soil, accrues solar energy as fuel, makes complex sugars and food, creates microclimates, changes colors with the seasons and self-replicates." He has designed buildings for Nike, Gap, IBM, Ford, the Smithsonian Institution and the U.S. Environmental Defense Fund. "Natural designs," *New Scientist*, March 20, 2004.

May 2004

"Coaxing Soil to Soak Up Carbon." Experiments at the DOE's Pacific Northwest National Laboratory show that soil's carbon-sequestering capacity can be boosted by maintaining proper alkalinity and frequent wetting and drying cycles – plus, the same treatment reinvigorates nutrient-depleted cropland. Alkaline soil additives like "fly ash," a coal waste product, along with plenty of wetting and drying, can speed up soil's "humification" process, which fixes carbon into stable soil structures. "For The Sake Of Land And Climate, Coaxing Soil To Soak Up Carbon," *Science Daily*, April 2, 2004, <http://www.sciencedaily.com/releases/2004/04/040402073631.htm>.

See also, "Digging Up a Global Warming Cure," April 21, 2004,

<http://www.solaraccess.com/news/story?storyid=6563>.

Shell Canada received the first ever Tree Canada Afforestation Leadership Award. The award recognizes achievements of the voluntary challenge and registry members. Shell planted 85,000 trees across Alberta in 2003, with the help of Tree Canada. Trees were planted to help offset some of the CO₂ emitted by the Athabasca Oil Sands Project. "Shell lauded for tree-planting efforts," *Fort McMurray Today* (Alberta, Canada), April 2, 2004.

Soil Carbon's Integrative Role. Researchers Rattan Lal, Michael Griffin, Jay Apt, Lester Lave, and M. Granger Morgan, wrote in *Science* that no-till agriculture, in combination with mulching and crop rotation to

enhance the soil organic carbon pool, is a viable strategy for carbon sequestration and sustainable management of soils of the tropics and sub-Saharan Africa. They recommend that governments implement programs to increase soil organic content or provide financial incentives to farmers. Aid programs should place greater emphasis on providing technical and other assistance for soil restoration. "Ecology: Managing Soil Carbon," *Science*, Vol 304, Issue 5669, April 16, 2004.

Utility Sector Launches Sequestration Fund. A coalition of 25 power companies has established a multi-million dollar fund to undertake six hardwood reforestation projects in Louisiana, Mississippi, and Arkansas. The projects are expected to capture more than 1.6 million tons of carbon dioxide over the century and restore about 3,600 acres of wildlife habitat. Joined by the Conservation Fund, The Nature Conservancy, Ducks Unlimited, Old South Woodlands LLC, Central Arkansas Resources Conservation and Development Council, and The Carbon Fund, PowerTree Carbon Co. will help return these marginal agricultural lands to thriving ecosystems. The Conservation Fund News Release, "The Conservation Fund Teams Up with Public, Private Partners to Address Climate Change, Restore Critical Habitat," April 19, 2004, <http://www.conservationfund.org/?article=2873&back=true>.

"Brazilian sugar bagasse wins 'best CDM project'." The Brazilian sugarcane bagasse project Vale de Rosario was awarded Best CDM Project by a panel of experts at the Carbon Market Insights conference. Point Carbon, April 22, 2004, <http://www.pointcarbon.com/article.php?articleID=3549&categoryID=147>.

June 2004

Study Measures Mountain Trees' Carbon Uptake. Scientists seek to find the rate at which forests in the mountains pull carbon from the atmosphere through the Airborne Carbon in the Mountains Experiment (ACME) project. They will measure changes in carbon dioxide concentration as small as five to 20 parts per million. "Study to eye trees at altitude," *The Denver Post*, May 13, 2004; Pg. B-03.

Climate Change Policy Rewards Permanent Reforestation. The owners of permanent forests in New Zealand will be able to get Kyoto Protocol carbon credits under a new Government climate change policy. Point Carbon, May 19, 2004, <http://www.pointcarbon.com/article.php?articleID=3743&categoryID=147>.

July 2004

Soil Carbon Sequestration Impacts on Global Climate Change and Food Security. The amount of carbon that can be restored in the world's degraded agricultural soils will directly influence global food security and climate change within our lifetime, said Rattan Lal, director of the carbon management and sequestration center at Ohio State University. The carbon sink capacity of the world's agricultural and degraded soils is 50 to 66 percent of the historic carbon loss of 42 to 78 gigatons of carbon. An increase of carbon (1 ton C per ha) in degraded cropland soils may increase crop yield by 20 to 40 kilograms per hectare (kg/ha) for wheat, 10 to 20 kg/ha for maize, and 0.5 to 1 kg/ha for cowpeas. As well as enhancing food security, carbon sequestration has the potential to offset fossil fuel emissions by 0.4 to 1.2 gigatons of carbon per year, or 5 to 15 percent of the global fossil-fuel emissions. By R. Lal, available in *Science*, Vol 304, Issue 5677, 1623-1627, 11 June 2004.

"U.S. paved surfaces would cover Ohio." If all the paved surfaces in the 48 contiguous United States were pieced together, they would almost cover the state of Ohio. That is the result of a study by the National Oceanic and Atmospheric Administration's National Geophysical Data Center of the highways, streets, buildings, parking lots and other solid structures in the country. The replacement of heavily vegetated areas by impervious surface areas reduces sequestration of carbon, which plants absorb from the atmosphere, the researchers said. *Washington Times*, June 14, 2004, <http://washingtontimes.com/upi-breaking/20040614-102351-1406r.htm>.

Public-Private Partnership Addresses Climate Change and Restores Critical Habitat. Cinergy Corp., the Kentucky Department of Fish and Wildlife Resources, Environmental Synergy Inc., and The Conservation Fund are joining forces to create a market-based conservation solution that will offset the environmental impacts of greenhouse gasses, provide new fish and wildlife habitat, and bring recreation-driven economic benefits to Kentucky. “Carbon sequestration may well become one of the most important tools that we have for the recovery and management of imperiled species. It’s a win-win situation for wildlife and people when land is restored and reforested. The added benefit of public access to these lands is remarkable,” said Commissioner Tom Bennett of the Kentucky Department of Fish and Wildlife Resources. *Business Wire*, May 28, 2004, <http://www.conservationfund.org/?article=2887&back=true>.

August 2004

“How costly are carbon offsets? A meta-analysis of carbon forest sinks.” In this study, meta-regression analysis is used to examine 981 estimates from 55 studies of the costs of creating carbon offsets using forestry. Baseline estimates of costs of sequestering carbon through forest conservation are US\$47–\$260/t C (\$13–\$71/t CO₂). Tree planting and agroforestry activities increase costs by more than 200 percent. When post-harvest storage of carbon in wood products, or substitution of biomass for fossil fuels in energy production, are taken into account, costs are lowest. Average costs are greater when appropriate account is taken of the opportunity costs of land. *Environmental Science & Policy*, Volume 7, Issue 4, August 2004, Pages 239-251, <http://www.sciencedirect.com/science/article/B6VP6-4CNJDX-3/1/de60547fa8ae035ebe7d525c8126a28c>.

Tillage-induced carbon dioxide loss. In the 1990s, Don Reicosky happened onto a concept – tillage-induced carbon dioxide loss – that has gained him a global audience in the past few years. While working on a project to use CO₂ emissions to determine how fast corn plants died after a killing frost, Reicosky observed an elevated CO₂ concentration on a bare field that was downwind of a field being plowed. When he measured the CO₂ on the freshly plowed area, the infrared gas analyzer maxed out in 15 seconds. According to Reicosky, “One of the bottom line, main points is that the amount of CO₂ released is directly proportional to the volume of soil disturbed in a tillage operation.” For more details see “Minnesota scientist travels world discussing carbon loss in farmland,” in *Agweek*, July 20, 2004, <http://www.aglink.com>.

Carbon Farming Potential in Western Australia. This paper describes opportunities for the land management sector in Western Australia arising from greenhouse gas abatement and in particular the development of carbon sinks as a result of land-use change. There is a large potential carbon sink in Western Australia through both the reforestation of farmland (maximum potential sink estimated to be 2,091 Mt CO₂-e, across 16.7 Mha of cleared farmland) and the destocking of pastoral lands (an estimated 3,072 Mt CO₂-e in biomass and soils for a 20-year period following 100 percent destocking). Analysis was based on carbon prices between \$5-15/t CO₂e. *AETF Review*, June/July 2004, <http://www.aetf.net.au/ContentStore/pdf/ReviewJunJul2004.pdf>.

Carbon Sequestration and Pigs? A graduate student study at the University of Saskatchewan shows the addition of swine manure to soil has a variable, but usually beneficial, effect on soil organic matter content. Adding organic matter to the soil improves the soil's structure or tilth and increases its nutrient storage capacity while, at the same time, increasing carbon sequestration. “U of S Examines Impact of Swine Manure Application on Soil Organic Matter,” July 15, 2004, <http://www.thepigsite.com/LatestNews/Default.asp?AREA=LatestNews&Display=7872>.

Trading

September 2003

On CO₂ emissions trading in the US. Washington State and Northeastern U.S. governors consider proposals to reduce CO₂ emissions from power plants. “The States step up,” *Tide Pool*, August 29, 2003, http://www.tidepool.org/original_content.cfm?articleid=85776.

EPA’s Climate and Waste program seeks input on GHG tool. The Manufacturing and Purchasing Greenhouse Gas (MAP-GHG) tool allows users to calculate the GHG benefits of using recycled inputs in the materials they manufacture and/or purchase. For more background on EPA’s analysis of climate change and waste management, check out the report entitled: “Solid Waste Management and Greenhouse Gases: A Life-Cycle Assessment of Greenhouse Gas Emissions and Sinks,” available at, <http://yosemite.epa.gov/oar/globalwarming.nsf/content/ActionsWasteToolsReports.html>.

World Bank and Czech Republic trade CO₂. The Czech Environment Minister signed an agreement with the World Bank in which the bank will pay the Czech Republic between US\$4 and \$7 million for more than one million tons of emissions that the country saves by the year 2012. “Ambrozeb signs deal with world bank regarding emissions,” *Prague Business Journal*, August 1, 2003.

October 2003

Dutch to invest in Vietnam CDM. The Dutch Government will provide Vietnam with non-refundable aid via the United Nations Environment Programme. This aid will go towards a Clean Development Mechanism project in Vietnam. “Netherlands to help implement CDM in Vietnam,” *Vietnam News Agency*, September 11, 2003, <http://www.vnagency.com.vn>.

Indonesian CDM interests potential buyers. Thirteen carbon emission reduction projects are available under the Clean Development Mechanism, according to the Indonesian delegation at the environmental forum in the Philippines. “Indonesia carbon projects attract foreign buyers,” *The Jakarta Post*, September 16, 2003, <http://www.thejakartapost.com>. See also, “Indonesia to 'sell' carbon emissions,” *The Jakarta Post*, September 8, 2003, <http://www.thejakartapost.com>.

Japan’s planned trading system grows. More than 100 companies and organizations will join the Japanese Ministry of Economy, Trade and Industry (METI) in creating a system for trading CO₂. “Japan firms to join METI plan to create CO₂ rights trading system,” *AFX News*, September 2, 2003, <http://www.co2e.com/News/story.asp?StoryID=1261>.

NZ carbon credit subsidy. New Zealand's government is offering 4 million carbon credits as a subsidy for projects that reduce GHGs. Projects must show additionality and deliver verifiable savings of at least 10,000 tonnes of carbon dioxide or its equivalent in other greenhouse gases during the first commitment period of the Kyoto Protocol, 2008 to 2012 to qualify. “Many a hoop to snaffle carbon credits,” *The New Zealand Herald*, September 13, 2003, <http://www.nzherald.co.nz/business/businessstorydisplay.cfm?storyID=3523295&thesection=business&thesubsection=general&thesecondsubsection=&thetickercode=>.

CCX raises \$24.5 million. The Chicago Climate Exchange raised roughly \$24.5 million via a London-listed investment company, according to this article. “Chicago climate exchange raises £15 million,” *Environmental Finance*, September 19, 2003, <http://www.environmental-finance.com>.

World Resources Institute joins CCX. “We are joining the Chicago Climate Exchange for two reasons. We want to strengthen a pioneering effort to create market-based solutions to the problem of climate change, and CCX helps us maintain our own organizational commitment to keep our net carbon dioxide emissions at zero,” said Jonathan Lash, president of WRI. “WRI Joins Chicago Climate Exchange,” WRI, September 25, 2003, <http://www.chicagoclimateexchange.com/news/pdf/CCXPressRelease092503.pdf>.

First brokered transaction in EU Emission Allowances in Nordic countries completed. The power companies ENERGIE2 A/S from Denmark and Joensuu Energia Oy from Finland did not disclose any information on the trade. “Denmark has a very challenging target for the Kyoto period 2008-2012. We believe that the best way to prepare oneself and to learn about emissions trading is to carry out concrete deals,” says Peter Hjorth Andersen, portfolio manager with ENERGI E2 A/S. “The first Nordic deal in EU emission allowances has been closed,” Point Carbon, September 10, 2003, <http://www.pointcarbon.com/article.php?articleID=2412>.

Russia taking steps to form a domestic market for CO₂. Companies like Gazprom, Rusal, and Yukos may form an independent business council to help work out the rules for the market and future legislation concerning GHGs. “Russia to create domestic emissions trading market,” Russian Information Agency, Novosti, September 26, 2003, http://en.rian.ru/rian/index.cfm?prd_id=160&msg_id=3479718&startrow=1&date=2003-09-26&do_alert=0 (subscription required).

November 2003

CCX News: New members. Premium Standard Farms, a livestock/agriculture company, joined CCX as a charter member. Natsource, an energy and environmental brokerage firm, REFCO, a diversified financial services firm, and Evolution Markets LLC, an emissions and OTC brokerage firm, all joined the CCX as liquidity providers. October 23, 2003, http://www.chicagoclimatex.com/news/pdf/Refco_Joins_CCX_10_23_03.pdf.

Market values. The Chicago Climate Exchange has announced the results of its first auction of CO₂ emission allowances. A total of 125,000 tonnes of CO₂ was sold at a price average less than \$1/tonne. “Chicago climate exchange announces result of first auction,” *Business Wire*, September 30, 2003, http://quickstart.clari.net/qs_se/webnews/wed/co/Bil-ccx.RU63_DSU.html.

Iowa farms to experiment in carbon trades. The Iowa Farm Bureau Federation will begin a four-year pilot program to aggregate and trade carbon credits from Iowa fields. Credits from carbon sequestered in no-tilled and minimum-tilled cropland and permanent pasture will be aggregated by Farm Bureau for trading on the newly formed Chicago Climate Exchange. “Our hope is to enroll at least 100,000 acres in Iowa in this program,” says David Miller, director of commodity services for the Iowa Farm Bureau. “FB launching pilot carbon credit trading,” Iowa Farm Bureau, October 21, 2003, <http://www.casmsg.colostate.edu/insider/vigview.asp?action=2&titleid=363>.

January 2004

AETF Review December/January issue (Australasian Emissions Trading Forum). The December/January 2003 issue reviews the UK emissions trading scheme (ETS) upon completion of its first year of operation. Available at: <http://www.aetf.net.au/ContentStore/pdf/ReviewDecJan2003.pdf>.

Chicago Climate Exchange New Members. London-based brokerage Traditional Financial Services (TFS) and IBM are the latest to join the CCX. IBM committed to reduce its GHG emissions by 4 percent below the

average of its 1998-2001 baseline by 2006. “TFS joins the Chicago Climate Exchange,” Point Carbon, December 9, 2003, <http://www.pointcarbon.com/article.php?articleID=2931&categoryID=147>; and “IBM joins Chicago Climate Exchange,” Point Carbon, December 11, 2003, <http://www.pointcarbon.com/article.php?articleID=2945&categoryID=147>.

February 2004

The University of Oklahoma and Rolls-Royce North America joined the Chicago Climate Exchange. The Chicago Climate Exchange saw over 31,000 tonnes of CO₂ traded in December, 2003. On January 13, 2004, 21,000 tonnes of emissions credits were traded at \$0.95/t in a record trading day, CCX News, http://www.chicagoclimatex.com/news/pdf/CCXAnnouncement-1_13_04.pdf.

A Global Greenhouse Gas Register was launched by the World Economic Forum to stimulate the disclosure and management by companies of their GHG emissions. Ten companies have joined. “Global greenhouse gas register launched,” Point Carbon, January 23, 2004, <http://www.pointcarbon.com/article.php?articleID=3125&categoryID=147>.

Australia halts emissions trading research. The Australian Greenhouse Office halted work on emissions trading, according to *The Age*. “Key Kyoto emissions plan cast off,” January 12, 2004, <http://www.theage.com.au/articles/2004/01/11/1073769452480.html> (registration required). See also, “Govt scraps greenhouse gas trading scheme,” *ABC News Online* (Australia), January 12, 2004, <http://www.abc.net.au/news/newsitems/s1023960.htm>.

March 2004

Outlook on 2004 CO₂ Trades. Point Carbon estimates that the global transactions volume in the carbon market will be around 100 million tonnes CO₂-equivalents in 2004, and sets the value of the carbon market to almost 400 million euros this year. “Carbon market worth €400 million in 2004,” January 2004 issue of Carbon Market Analyst, February 9, 2004, <http://www.pointcarbon.com/article.php?articleID=3194&categoryID=147>.

CCX News: Big Trades in January, Dow New Member, Trust Negotiated. The Chicago Climate Exchange saw 82,200 tonnes of CO₂ traded in its first full month. The price stayed just below one U.S. dollar per tonne. More participants traded, and they exchanged larger lots. Dow Corning is a new member. CCX News, “Chicago Climate Exchange Announces January 2004 Trading Results,” February 2, 2004, <http://www.chicagoclimatex.com/news/pdf/CCXPressRelease020204-Jan04TradingResults.pdf>. Premier Minister of Manitoba, Canada signed an agreement with CCX to develop a climate trust to work with groups to develop GHG emission reduction projects. “Manitoba and CCX to develop climate trust,” *Winnipeg Sun*, Point Carbon, February 4, 2004, <http://www.pointcarbon.com/article.php?articleID=3185&categoryID=147>.

Alaska’s Terrestrial Sequestration Potential. Restoration of forests, wetlands, and other habitat that offset CO₂ emissions by cars and factories could raise up to \$450 million of dollars for Alaska, according to Rep. Ethan Berkowitz, an Anchorage Democrat. “Could Alaska trade forest restoration for money?,” *Juneau Empire*, http://www.juneauempire.com/stories/020304/sta_forests.shtml.

April 2004

The Australian Sustainable Investments Fund (ASIF) Acquires Terrestrial Carbon Rights. ASIF recently agreed to buy 20,500 hectares of mainly freehold land in Victoria, South Australia and Western Australia from Timbercorp for \$46.6 million. Timbercorp will lease the land back but carbon rights vested in 15,800 hectares of standing timber will be transferred to the fund. There is still no legal framework for carbon trading in Australia. "Investors twig to carbon credits," *Australian Financial Review*, March 8, 2004.

Environmental Fund Plans to Buy up Carbon Credits. The U.S. based Carbonfund.org aims to purchase 50,000 tonnes of CO₂ emissions credits this year - and retire them. It aims to double the volume of credits purchases within a year or two. Credits will be purchased from a variety of markets across the world. The current price asked by the fund for a tonne of CO₂ is \$5.50. Point Carbon, March 10, 2004, <http://www.pointcarbon.com/article.php?articleID=3361&categoryID=147>.

May 2004

Statoil's In-house Unit to Trade CO₂. The European Union plans to have its system for trading in CO₂ operational by January 1, 2005. Several leading European oil and power groups, including Statoil, are starting in-house emissions trading units to prepare for it. "Statoil Sets Up CO₂ Unit," *International Oil Daily*, April 2, 2004.

June 2004

"As Emissions Trading Moves Closer to Reality, Firms Brace for Change." As European countries prepare to move forward in 2005 with the Emissions Trading Scheme – a cap and trade system E.U. nations will use to meet greenhouse gas (GHG) reduction targets under the Kyoto Protocol – hundreds of major corporations are beginning to factor climate change issues into their business decisions, according to a major industry survey released by an investors' group last week. *Greenwire*, May 26, 2004, <http://www.greenwire.com/> [subscription required].

Australian Emissions Trading Scheme Expensive. A report by Allen Consulting concluded that an Australian emissions trading system equivalent to a tax of \$5 per ton of CO₂ emitted would cut 15,000 jobs, severely affect the national economy until 2050 and increase power prices by 5.5 percent. Point Carbon, May 19, 2004, <http://www.pointcarbon.com/article.php?articleID=3742&categoryID=147>.

First Carbon Sequestration Trade by U.S. Utility. Entergy conducted the first geologic carbon sequestration trade, by a utility in the U.S., through the newly formed trade registry of the Emissions Marketing Association (EMA). Entergy purchased geologic carbon sequestration credits to meet a voluntary CO₂ stabilization commitment. The project captures CO₂ vent gases for use in enhanced oil recovery. The total amount of carbon credits will equal 100,000 metric tons. "Entergy's Carbon Sequestration Trade First Transaction Through EMA's Registry," *PR Newswire*, May 26, 2004, <http://www.caprep.com/b0504040.htm>.

July 2004

Japanese utility to purchase GHG emissions credits. Natsource announced that Chugoku Electric Power Co., Inc, a Japanese electric utility, has agreed to purchase 3.6 million tonnes of greenhouse gas emission reductions through Natsource's greenhouse gas credit aggregation pool (GGCAP). The GG-CAP will contract for and manage delivery of low cost, high quality greenhouse gas emission reductions usable for compliance against

emissions limitations in the 2005-2012 period. In a statement released in Japan, Chugoku said it plans to pay US\$17 million for the emissions credits, implying a price of US\$4.72 per tonne. “Chugoku to purchase 3.6 MtCO₂e,” Point Carbon, June 1, 2004, <http://www.pointcarbon.com/article.php?articleID=3813&categoryID=147>.

“Greenhouse gas trade heats up.” The prospect that Russia may ratify the Kyoto Protocol is triggering some large-scale trading in emission credits by companies and countries seeking to limit the financial impact of future government restrictions on industrial emissions of carbon dioxide and other greenhouse gases. “People are beginning to assess that they may have some risks,” said Ken Newcombe, who manages six funds for the World Bank that are involved in emissions trading. *Wall Street Journal*, June 2, 2004, <http://afr.com/articles/2004/06/01/1086058850473.html>.

Most UK companies will fail to meet CO₂ emissions regulation deadline. Fifty-four percent of UK companies could face penalties running into millions of euros because they will not be ready in time to comply with new EU regulations on CO₂ reduction. According to a European study by LogicaCMG, one in five UK companies have yet to start the process of moving towards compliance with the EU Emissions Trading Scheme (ETS) which has a deadline of January 1, 2005. “European companies not ready for greenhouse gas monitoring,” Point Carbon, June 2, 2004, <http://www.pointcarbon.com/article.php?articleID=3817&categoryID=147>.

August 2004

CCX Reached 1 Million Tons of Carbon Dioxide Traded. 130,000 metric tons of CO₂ was traded on the Chicago Climate Exchange (CCX) during the month of June, taking the total volume traded since the December launch past one million tonnes. The majority of trades in June were for 2006 allowances, which traded between \$0.88 and \$0.99 per tonne. CCX News, July 1, 2004, http://www.chicagoclimatex.com/news/CCXPressRelease_040701.html.

Strong Upward Trend in EU Emissions Trading Scheme. Having dropped more than a euro following the European Commission’s approval of eight allocation plans, the price for CO₂ allowances has now climbed up past the pre-approval level nearing €9.00/tonne (US\$10.85). Point Carbon, July 19, 2004, <http://www.pointcarbon.com/article.php?articleID=4126&categoryID=279> (subscription required).

“Rocky Mountain Institute Joins Chicago Climate Exchange.” Rocky Mountain Institute (RMI) has joined the Chicago Climate Exchange, Inc. (CCX). As an Associate Member, RMI will quantify its greenhouse gas emissions each year, then purchase through the CCX market an equivalent amount of carbon dioxide credits to offset its emissions. RMI will then permanently retire the purchased credits from the CCX market, effectively mitigating the Institute's impact on global climate change. “RMI is excited to work toward climate neutrality with its carbon emissions, both for the environmental benefits and the business case it will help us promote,” said RMI CEO Amory Lovins. Greenbiz.com, July 28, 2004, http://www.greenbiz.com/news/news_third.cfm?NewsID=26994.

Policy

September 2003

States urged to act. At the National Association of Regulatory Utility Commissioners meeting, government officials encouraged state regulators to pressure utilities to improve emissions associated with coal-fired generation. “States urged to move on emissions, but some regulators question urgency,” *Electric Utility Week*, August 4, 2003, <http://www.platts.com>.

Massachusetts and New York Governors to hash out CO₂ plan. Massachusetts Governor Romney accepted New York Governor Pataki's invitation to design a regional CO₂ emissions cap for power plants. “Romney accepts request to develop regional carbon emissions cap,” *Lincoln Journal*, July 30, 2003, http://www.townonline.com/lincoln/news/local_regional/lin_newljstatecarbon07302003.htm.

Commentary on U.S. climate policy in the Bush era. “EPA tilt on global warming,” *Washington Times*, August 8, 2003, <http://www.washtimes.com/commentary/20030809-110407-6331r.htm>.

Japan and U.S. plan to capture and store CO₂. Japan and the United States signed a deal to cooperate on 11 projects to collect CO₂ from emitting facilities like thermal power plants and dissolve it into water deep in the sea. “Japan, U.S. sign global warming prevention deal,” *Kyodo News*, August 8, 2003.

Air travel tax. A report to be issued by the Commission for Integrated Transport calls for a European Union-wide CO₂ emission charge to be set at \$70 per tonne of carbon. “Plea on airline pollution taxes,” *Financial Times*, September 1, 2003, <http://news.ft.com/home/us> (subscription required). See also, “Radical aviation tax plans proposed,” *The Irish Examiner*, September 1, 2003, <http://www.examiner.ie/breaking/2003/09/01/story111734.html>.

State and local greenhouse gas reduction programs. The Pew database currently contains 44 case studies of programs from 27 states. Three new case studies have been added from California's Greenhouse Gas Standards for Vehicles program, Maryland's Smart Growth program, and Pennsylvania's Green Pricing: Electric Consumer Choice program. Pew Center on Global Climate Change, August, 2003, <http://ealert.pewclimate.org/ctt.asp?u=438171&l=3894>.

October 2003

Breakthrough technologies needed for large CO₂ reductions. At a speech in Berlin, U.S. Energy Secretary Abraham described U.S. carbon sequestration research and clean coal technology programs. “U.S. energy secretary says new technologies needed to achieve global climate goals,” *U.S. Newswire*, September 17, 2003.

West coast states team up to address CO₂. The Democratic governors of California, Oregon, and Washington announced a partnership to reduce GHGs. The partnership will work together to obtain better fuel-efficiency, remove barriers to the development of renewable electricity generation, develop coordinated GHG emission inventories and protocols, and collaborate on improved scientific tools to more precisely measure the impact of climate change. “West Coast States Unveil Climate Change Strategy,” *The Energy Daily*, September 23, 2003. See also, “The State; Governors Target Global Warming,” *Los Angeles Times*, September 23, 2003; and “West coast states team up against greenhouse emissions,” *Knight Ridder Newspapers*, September 22, 2003, http://www.kentucky.com/mld/kentucky/news/breaking_news/6836249.htm.

Tighter target set for Japanese company. The Japanese Kao Corp. has set a goal of reducing its emissions of CO₂ by 13 percent from the fiscal 1990 level by 2005, after clearing an earlier target eight years ahead of schedule. "Japan's Kao sets new, stricter CO₂ emissions goal," *Asia Pulse* (Tokyo), September 4, 2003, <http://www.co2e.com/News/story.asp?StoryID=1263>.

U.S., Southeast Asia may cooperate on climate. A delegation of senior U.S. climate change policy experts visited Vietnam, Thailand, and Malaysia. "Vietnam, U.S. to discuss climate change initiatives," *Vietnam News Agency*, September 10, 2003. See also, "U.S. climate change team visiting," *Bangkok Post*, September 9, 2003.

Asian energy efficiency pact. A mutual understanding between China and four countries from East Asia and the Asia-Pacific region in three areas calls for accelerating renewable energy use and energy efficiency co-operation. "Asian countries achieve energy understanding," *China Daily*, September 3, 2003, http://www.chinadaily.com.cn/en/doc/2003-09/03/content_260644.htm.

November 2003

States attempt to force EPA to regulate GHG emissions. Law enforcement officials from eleven states, the District of Columbia and American Samoa petitioned a federal appeals court on October 23, 2003, to force the EPA to regulate emissions of CO₂ under the Clean Air Act. "The warming is global but the legislating, in the US, is all local," *New York Times*, October 29, 2003, <http://www.nytimes.com/2003/10/29/national/29CLIM.html?ex=1068008400&en=bf070bbd07a049dc&ei=5062&partner=GOOGLE>.

Washington State proposes electricity CO₂ constraints. A Washington state proposal would require new fossil-fueled plants of 350 MW or larger to offset 20 percent of their CO₂ emitted during its 30 years of operation. The regulations set a mitigation cost of 87 cents per ton of CO₂. "Washington proposes CO₂-mitigation rules," *Seattle Press*, October 7, 2003, <http://www.seattlepress.com/article-10314.html>.

Florida Power & Light to join EPA's Climate Leaders Program. FPL, the first electric utility to join the CLP, announced that by 2008 it will reduce the average carbon intensity of its power generation by 18 percent below the 2001 level of 1.05 lb CO₂/ kWh. This will be achieved through efficiency improvements, natural gas use, increased nuclear production, expanded use of wind-driven turbines, and energy conservation programs. "FPL vows to cut rate of greenhouse gas emissions by 18% at power plants," *Fort Lauderdale Sun Sentinel*, FL, October 29, 2003.

Deciding when to act. A working paper from CICERO reconsiders the importance of irreversibility in climate change and abatement technology investments, both of which are subject to uncertainty that will change gradually over time as a result of learning. "Option values and the timing of climate policy," CICERO Working Paper 2003:04, <http://www.cicero.uio.no/publications/detail.asp?2388>.

Climate policy instruments and economics. Several articles from the journal, *Environmental modeling and assessment*, address the issues of limiting impacts on domestic energy intensive industries; global welfare cost; marginal abatement cost and its relation to the carbon price; possible competition between Russia and China; and control of non-CO₂ GHGs. "Assessing the impact of carbon tax differentiation in the European Union," "A stochastic dynamic game of carbon emissions trading," "Coupling climate damages and GHG abatement costs in a linear programming framework," "Modeling non-CO₂ greenhouse gas abatement," and others. *Environmental modeling and assessment*, 8 (3, 2003).

December 2003

Rate of Fossil Fuel use Many Times Higher than Rate of Replacement. According to calculations by ecologist Jeff Dukes of Carnegie Institution of Washington (Stanford), less than one part in 10,000 of decomposing organic matter becomes oil. By applying that ratio he estimates that in 1997 we burned fossil fuels equivalent to more than 400 times the amount of plant matter produced on Earth in the same year. Modern ways to convert biomass into fuels such as ethanol are relatively efficient, but it would still take nearly a quarter of all the plants on Earth to replace the fuel used in 1997. Dukes, J. S. "Burning buried sunshine: Human consumption of ancient solar energy," *Climatic Change*. A summary of the full article is contained in *news@nature.com*, October 29, 2003, "Calculations illustrate fossil-fuel crisis," <http://www.nature.com/nsu/031027/031027-3.html>.

Canadian Government, DuPont Canada Inc. agree on GHG emissions reduction plan. DuPont Canada has signed a Memorandum of Understanding with the Canadian government committing to reduce the GHG emissions intensity of nylon intermediates production by 15 percent by 2012. This target reflects recognition for early action taken by DuPont since 1997 and is consistent with government commitments to not disadvantage firms who have taken steps to reduce greenhouse gas emissions. "Canada and Dupont sign climate change agreement," Point Carbon, November 20, 2003, <http://www.pointcarbon.com/article.php?articleID=2794&categoryID=147>.

World Bank Advised to not Finance new Coal and Oil Projects. An independent review commissioned by the World Bank recommends that the bank consider pulling out of financing all coal and oil projects in developing countries based on greenhouse gas emissions and other environmental impacts. One bank official said the report's recommendations were unlikely to gain support within the bank's governing board, which will make the final decision on what proposals to adopt after receiving advice from management. "It doesn't seem to make much sense to me to concentrate on limiting small developing countries' oil production in order to try to achieve goals on climate change," the bank official said. "World Bank advised to pull out of oil and coal financing," *Financial Times* November 20, 2003, <http://news.ft.com/servlet/ContentServer?pagename=FT.com/StoryFT/FullStory&c=StoryFT&cid=1069132010677> (subscription required).

"U.S. Investors Seek Disclosure of Risks from Climate Change." Eight U.S. state and city treasurers, comptrollers, and two major labor pension fund leaders called on the U.S. Securities and Exchange Commission (SEC) to increase corporate disclosure of the risks posed by climate change to investors. Point Carbon, November 27, 2003, <http://www.pointcarbon.com/article.php?articleID=2839&categoryID=147>.

Atmospheric Methane Stabilizing. The U.S. and Dutch researchers who measured the change in methane levels said they found evidence that human actions appeared to be the cause, specifically the near shutdown of oil and gas extraction after the disintegration of the Soviet Union. Old production methods released vast streams of the gas from leaking pipelines, uncapped wells and the like. Newer, less leaky methods are slowly being adopted. "Methane in atmosphere stabilizing," *Seattle Times*, November 23, 2003, http://seattletimes.nwsourc.com/html/nationworld/2001798935_methane23.html.

Netherlands and the EU Carbon Market Interactions. The Energy research Centre of the Netherlands (ECN) released a new report entitled, "The Interaction between the EU Emissions Trading Scheme and Energy Policy Instruments in the Netherlands - Implications of the EU Directive for Dutch Climate Policies." The report finds that once the EU ETS becomes operational, all other policies to reduce CO₂ emissions of the participating sectors will be rendered ineffective and actually increase the overall costs of meeting the cap. The full report, November 2003: <http://www.ecn.nl/library/reports/2003/c03060.html>.

January 2004

Annex I Countries Allowed to Store One Percent of Annual GHG Emissions in CDM Forestry Projects.

The rules agreed on at COP 9 stipulate that trees must be at least two meters tall, with canopies covering at least 10 percent of an area, and that cultural and religious sites are taken into account when deciding where to plant. The agreement does not rule out genetically modified plants or single species plantations. "Agreement on use of carbon sinks in CDM finalized," *Edie weekly summaries*, December 12, 2003, <http://www.edie.net/news/Archive/7859.cfm>.

Deep Emissions Reductions Called for by German Advisory Council. In a report published November 25, 2003, the German Advisory Council on Global Change contends that the world can tolerate a rise of up to 2 degrees Celsius over pre-industrial levels. Beyond this, sudden phenomena such as abrupt disturbances to the North Atlantic Ocean's currents would negatively affect society. Global mean temperatures have increased by 0.6 degrees Celsius since 1900, and may increase by a further 1.4 to 5.8 degrees Celsius by 2100, according to the Intergovernmental Panel on Climate Change. The report concludes that global CO₂ emissions would need to be curbed by 45 to 60 percent by 2050 compared with 1990 levels to avoid severe societal impact. "Climate Protection Strategies for the 21st Century: Kyoto and Beyond," November 25, 2003. For the report, visit http://www.wbgu.de/wbgu_sn2003_presse_engl.html.

Uncertainty and the Power Industry. This article discusses uncertainty and planning in the power industry, including the effects of potential legislation for mercury and carbon control. Bill Hall, executive vice president of Duke Power said, "The only viable technology seems to be carbon sequestration." According to the article, state policy-makers trying to address climate change concerns on a state level make planning and resource acquisition more uncertain, without a national level playing field. "Power Flux; Generators struggle to plan for the future as they cope with an unstable present," *Public Utilities Fortnightly*, December, 2003.

Letter to the Editor from Dr. John Marburger. The Director of the Office on Science and Technology Policy wrote to the editor of *The New York Times* in response to an article on the Kyoto Protocol, offering evidence of U.S. leadership on climate issues. Investing billions of dollars in collaboration with developed and developing countries, mobilizing tens of billions of private-sector dollars, and investment in carbon sequestration, hydrogen fuel cycle technology, and energy-related biotechnology are some examples. "Policy on Climate Change, Re 'Kyoto Protocol in Peril,'" *The New York Times*, December 11, 2003.

Editorial in the *Financial Times* by Paula Dobriansky. The U.S. undersecretary of state for global affairs wrote that the open-ended path toward breakthrough, transformative technologies is favored by U.S. policy, while sharing the goals of the UNFCCC. Stabilization of GHG concentrations at a level that will prevent dangerous human interference with the climate through collaborative R&D on carbon sinks, the FutureGen project, and the Carbon Sequestration Leadership Forum are preferable to targets-based policy, according to the article. "Only new technology can halt climate change," *Financial Times* (England), December 1, 2003.

February 2004

Public Service Enterprise Group Inc. (PSEG) joins EPA's Climate Leaders. Company plans to cut its CO₂ emissions rate by 18 percent per kWh from 2000 levels by 2009. EPA Climate Leaders web site, <http://www.epa.gov/climateleaders/partners/pseg.html>.

U.S. Industry Sees Tougher CO₂ Controls Coming. Article assesses the likelihood of government action and technological evolution related to the future of obligatory CO₂ reductions. "There is growing evidence that we should be concerned about global warming," says Ron Drewnowski, director of environmental strategy for PSEG. "We are a company that says the time to act is sooner rather than later." "Tougher CO₂ Controls are Coming," *UtiliPoint*, January 15, 2004, <http://www.utilipoint.com/issuealert/article.asp?id=1976>.

Lobbying for America's Policy on Climate Change: Energy Companies and Environmentalists. The program takes viewers to the UN conference in Milan for a behind-the-scenes look at forces at work shaping US policy on climate change. "NOW with Bill Moyers," PBS, January 23, 2004, transcript available at http://www.pbs.org/now/transcript/transcript304_full.html.

Permitting Carbon Sequestration Projects: California Test Case. Carbon sequestration projects in California may have to obtain a total of 15 permits (3 federal, 6 state, 6 local). Ed Vine of the California Institute for Energy Efficiency writes that the permitting process may impede sequestration technologies. "Regulatory Constraints to Carbon Sequestration in Terrestrial Ecosystems and Geologic Formations: A California Perspective," *Mitigation and Adaptation Strategies for Global Change*, 2004, Volume 9, Issue 1, August 5, 2003.

A New Criterion of Corporate Social Responsibility for Utilities? Assesses the recent development of shareholder movements aimed at forcing a more progressive utility corporate response to climate change, and what some companies are doing about it. The article covers the relevant activities of Entergy, Environmental Defense's Partnership for Climate Action, the World Wildlife Fund-U.S.'s PowerSwitch! group, DTE, American Electric Power, Cinergy, the FPL Group, PowerTree, and the Chicago Climate Exchange (CCX). "Climate Change: The Heat is On; From reporting to trading, utilities try to meet new expectations," *Public Utilities Fortnightly*, January 2004, <http://www.pur.com/puf.cfm>.

Designing Energy Policy(s) to Address Energy Utilities' CO₂ Emissions. The Polluter Pays Principles deals with externalities of electricity generation. Under it, companies can pass compliance costs onto end-users. This paper describes some of the economic efficiency, equity, and ethics issues, and creates supply-demand models with implicit weighting of welfare gains. "Economics of Polluter Pays Principles for Mitigating Social Costs of Electricity: A Search for an Optimal Liability Share," *European Journal of Law and Economics*, vol. 17(1), January 2004, <http://ipsapp007.kluweronline.com/IPS/frames/toc.aspx?J=4668&I=40>.

Kyoto Forest Owners Association (KFOA) in New Zealand claims that the NZ Government's decision to trade carbon credits from their forests is theft. "New Zealand Kyoto credit conflict," *National Business Review*, December 30, 2003, <http://www.pointcarbon.com/article.php?articleID=3032&categoryID=147>.

March 2004

EIA Voluntary U.S. Greenhouse Gas Reductions in 2002. More than 228 U.S. companies and other entities voluntarily cut the equivalent of 265 million metric tons of CO₂ emissions in 2002, according to the DOE's Energy Information Administration (EIA). "Voluntary Reporting of Greenhouse Gases 2002," EIA press release, January 30, 2004, <http://www.eia.doe.gov/neic/press/press228.html>. For the summary report visit, <http://www.eia.doe.gov/oiaf/1605/vrrpt/pdf/summary.pdf>. For the full report visit, [http://www.eia.doe.gov/oiaf/1605/vrrpt/pdf/0608\(02\).pdf](http://www.eia.doe.gov/oiaf/1605/vrrpt/pdf/0608(02).pdf).

Silicon Valley Carbon Reduction Plans. As many as 20 large Silicon Valley companies are in line to kick off a corporate carbon dioxide reduction campaign. "Companies joining forces to curb carbon dioxide," *San Jose Business Journal*, January 23, 2004, <http://sanjose.bizjournals.com/sanjose/stories/2004/01/26/story5.html>.

Industry Support for Mandatory CO₂ Caps. Five electric utility companies (Austin Energy, Burlington Electric, Sacramento Municipal Power District (SMUD), Waverly Light and Power, and FPL Group, which owns Florida Power & Light and FPL Energy) pledged to support a mandatory cap on CO₂ and make other efficiency and renewable energy commitments. No companies use sequestration, although several view it as a potentially viable option in the future. "Five Utilities Call For CO₂ Emissions Cap," *The Energy Daily*,

February 12, 2004. See also, "First U.S. power companies pledge a power switch," *Edie weekly summaries*, February 13, 2004, http://www.edie.net/gf.cfm?L=left_frame.html&R=http://www.edie.net/news/Archive/8067.cfm.

AEP Anticipates Change in U.S. Policy on CO₂. "We don't expect Kyoto timeframes to be enforced in the United States but we do expect international consensus on this issue (CO₂ emissions) will prevail in the United States," Susan Tomasky, chief financial officer at American Electric Power (AEP) told a conference. AEP is the largest burner of coal in the western hemisphere. "U.S. likely to limit carbon emissions – AEP," *Reuters*, February 16, 2004, http://www.forbes.com/home_europe/newswire/2004/02/16/rtr1262425.html.

Revised Bush Administration CCSP Improved. According to a National Academies panel, the revised strategic plan for climate change research has been improved and should be implemented as soon as possible. Commitments to fund many of the newly proposed activities are still lacking, and research should be shielded from political pressures. "Implementing Climate and Global Change Research: A Review of the Final U.S. Climate Change Science Program Strategic Plan," *National Academies Press*, <http://www.nap.edu/catalog/10635.html>. See also, "Bush climate plan somewhat improved," *New York Times*, February 19, 2004, <http://query.nytimes.com/gst/abstract.html?res=FB0710FC38590C7A8DDDAB0894DC404482>.

Japan Reevaluating Reliance on Coal. "Owing mostly to its low and stable prices, coal is ranked as the second essential energy after oil, accounting for roughly 20 percent of Japan's total primary energy source. Coal's preeminent position resulting from its reliability as well as efficiency is, however, becoming increasingly precarious because of concerns over a rapid increase in China's coal demand and an ever-rising need to reduce greenhouse gas emissions," said the Ministry of Energy, Trade and Industry (METI). "Japan to reposition on coal," *Point Carbon*, February 9, 2004, <http://www.pointcarbon.com/article.php?articleID=3210&categoryID=147>.

A European Commission report shows EU CO₂ transportation emissions have decreased 11 percent between 1995 and 2002. The EU is aiming for a 35 percent drop by 2010. Road transport generates more than a fifth of all CO₂ emissions in the EU. "EU cars spew out less carbon dioxide-report," *Reuters*, February 12, 2004, <http://www.reuters.co.uk/>.

Australia Supports Coal and Sequestration. Australian Federal Government-backed plans sequester carbon emissions underground to make brown coal power generation in the Latrobe Valley more viable in the future. "Canberra backs plan to lock power for future," *The Age*, Feb. 9, 2004, <http://www.theage.com.au/articles/2004/02/08/1076175032044.html> (registration required).

April 2004

Natural Resources Canada Announces Incentive for Industry to Capture and Store CO₂. The \$15 million program can cover up to 50 percent of capital investment. The federal money will be coupled with \$15 million in royalty incentives announced last year by the Alberta government. The joint-effort is "a signal of cooperation" between the federal and provincial governments. "Carbon dioxide could help pump oil: \$30M to market technology," *Calgary Herald* (Alberta, Canada), March 2, 2004. Incentive program description is found at: http://www.nrcan-rncan.gc.ca/media/newsreleases/2004/2004-X2a_e.htm.

EPA Welcomes New SmartWay Partners. Thirty-seven new freight industry partners joined EPA's SmartWay Transport Partnership, bringing the total number of partners in the program to 52. SmartWay Transport is a voluntary partnership between freight industry sectors and EPA that establishes incentives for fuel efficiency improvements and greenhouse gas emissions reductions. A complete list of partners is available at: <http://www.epa.gov/smartway/partners.htm>.

Northeast United States is Struggling to Make Progress Towards its GHG Emissions Reduction Goals. Article says regional governments are doing what they can to reduce GHG emissions, but growth in emissions

from automobiles, which are under the purview of the federal government, are overwhelming gains. *Boston Globe*, March 15, 2004,

http://www.boston.com/news/local/articles/2004/03/15/region_struggles_on_greenhouse_emissions_goals.

Geography and GHG Emissions Per Capita. Study correlates population density and coldness of climate with GHG emissions per capita. The author, Eric Neumayer, says, “It is often argued that high emitters should face more stringent emission reductions than low emitters. One needs to ask, however, why emissions are higher in one country than in another. High emissions can be partly the result of geographical disadvantage. In future negotiations, geographical differences across countries should be taken more into account.”

“Geographical Factors Impact On Carbon Dioxide Emissions,” March 2, 2004, *Science Daily*,

<http://www.sciencedaily.com/releases/2004/03/040302082113.htm>.

May 2004

“Let the market fight emissions.” This op-ed from a major Canadian paper argues that price signals are indispensable in Canada’s effort to reduce GHG emissions toward meeting her Kyoto obligations. “Cool your jets: Let the market fight emissions,” *The Globe and Mail*, March 31, 2004,

<http://www.theglobeandmail.com/servlet/ArticleNews/TPStory/LAC/20040331/COJACCARD31/TPComment/TopStories>.

June 2004

“Australia Still Won't Ratify Kyoto.” Australian Prime Minister John Howard repeated his decision to not ratify the Kyoto Protocol. A potential Russian ratification, which would see the Protocol enter into force, would not change his mind. Point Carbon, May 26, 2004,

<http://www.pointcarbon.com/article.php?articleID=3785&categoryID=147>.

“Japan is Struggling to Meet Kyoto Target.” Japan's emissions are rising, according to reports from the Ministry of Environment of Japan. A progress report showing emissions of greenhouse gases up 8.2 percent in 2001 from 1990 levels. Emissions from mobile sources and coal-fired power plants are Japan's largest source of greenhouse gas emissions. Japan plans to use credits from forest management activities to meet the Kyoto targets. Point Carbon, May 17, 2004, <http://www.pointcarbon.com/article.php?articleID=3731&categoryID=147>.

“Russia Backs Kyoto to get on path to join WTO.” Russia signaled that it would ratify the Kyoto climate change treaty in exchange for European support for its bid to join the World Trade Organization, a breakthrough that could revive the long stalled pact designed to curb global warming. “We are for the Kyoto process,” Putin said during a news conference after a summit with European leaders. “We support it, although we do have some concerns over the obligations that we will have to assume. The European Union has met us halfway in negotiations on the WTO, and it could not help but have a positive effect on our attitude toward ratification of the Kyoto protocol.” Upon Russia's formal ratification, their 17 percent share of the world's greenhouse gas emissions would bring the total endorsement by developed nations to 55 percent, which is the threshold level for the Kyoto Protocol to officially enter into force. *The Washington Post*, May 22, 2004,

<http://www.washingtonpost.com/wp-dyn/articles/A46416-2004May21.html>. See also, “A change in the climate: will Russia help the Kyoto Protocol come into force?” *Financial Times* (London), May 20, 2004, Features; Pg. 17.

“How Can the Transatlantic Partners Help in Addressing Developing Country Emissions?” This note briefly describes the current situation with respect to greenhouse gas emissions in developing countries, summarizes the current political context for future actions, and describes specific actions that Europe and the US, despite their differences of views, can take to help address developing country emissions. Benito Müller, October 2003, Report available at: <http://www.wolfson.ox.ac.uk/~mueller/>.

G8 to collaborate on clean energy R&D. A strategy drafted by the White House aims to coordinate G8 development of an international Earth Observation System and clean energy technologies. The agreement will apply to hydrogen fuel cells, carbon sequestration and renewable R&D, as well as energy efficiency and clean fossil energy technologies. *Inside Energy /with Federal Lands*, April 26, 2004; Vol., No.; Pg. 16, <http://www.platts.com>.

Massachusetts to consider the GHG impact when state regulators evaluate public construction plans. Governor Mitt Romney unveiled a comprehensive agenda on climate change, which makes Massachusetts the first state to consider the impact of greenhouse gases when state regulators evaluate highway projects and other public construction plans. "Massachusetts launches climate change strategy," May 6, 2004, Point Carbon, <http://www.pointcarbon.com/article.php?articleID=3654&categoryID=147>.

Securing Our Future: The Economics and Ecology of Coal. "Regulatory uncertainty puts a premium on flexibility when electric utilities make decisions on fuels and technologies," said James Rogers, Chairman and CEO of Cinergy, at the RFF Policy Leadership Forum on May 18, 2004. A Video of the presentation is available online at: <http://www.rff.org/Events/Securing-Our-Future-The-Economics-and-Ecology-of-Coal.cfm>.

July 2004

Action on Kyoto: Indonesia ratifies Kyoto Protocol. The Indonesian Parliament has approved a bill ratifying the Kyoto Protocol. June 24, 2004, Point Carbon, <http://www.pointcarbon.com/article.php?articleID=3964&categoryID=279> (subscription required). **Algeria stops short of ratifying.** Algeria will not formally ratify the Protocol unless it enters into force. This is potentially a very significant event, as it would make Algeria the first OPEC country to ratify the protocol. Point Carbon, June 28, 2004, <http://www.pointcarbon.com/article.php?articleID=3991&categoryID=279> (subscription required).

"Indiana Business and Farm Lobbyists Oppose GHG Bill." Indiana business and farm lobbyists joined forces to oppose the federal McCain-Lieberman bill designed to curb global warming by capping greenhouse gas emissions at 2000 levels. The Indiana Chamber of Commerce and Indiana Farm Bureau argue the bill could cost Indiana families as much as \$1,500 and cause as many as 9,000 lost jobs in 2010, according to a recent economic study. Environmentalists disagreed with the study as an example of one-dimensional thinking that ignores the economic benefits of alternative energy sources and investments in energy efficiency. Point Carbon, June 16, 2004, <http://www.pointcarbon.com/article.php?articleID=3911&categoryID=147>.

"EPA Says Millions Are Inhaling Too-Sooty Air." Ninety-nine million Americans are breathing unhealthy air that can cause respiratory problems and even premature death, according to assessments released by the Environmental Protection Agency. The agency identified 243 counties throughout the country that fail to meet national air standards for fine-particle pollution – mainly soot. Once the rulemaking process is complete, state and local officials will have to devise plans to reduce the pollution. States now have three months to respond before the agency issues a final rule in November. EPA Administrator Mike Leavitt said the announcement was "about getting our air cleaner and our standards getting tougher." *Washington Post*, June 29, 2004, <http://www.washingtonpost.com/wp-dyn/articles/A15929-2004Jun29.html>.

"Japanese Firms Must Report CO₂ Emissions." The Japanese Environment Ministry made it compulsory for commercial premises over a certain size to submit reports on how much carbon dioxide they produce. Proprietors of offices and shops will have to calculate how much carbon dioxide their businesses have produced on the basis of how much electricity and fuel they have consumed, and report the total to the central and local governments. The central government will add up the carbon dioxide emission totals and publish a national tally. The aim of the measure is to pressure major producers of CO₂ to reduce their emissions of the gas. Point Carbon, June 7, 2004, <http://www.pointcarbon.com/article.php?articleID=3845&categoryID=147>.

August 2004

Russian Economic Advisor Intensifies Anti-Kyoto Campaign. Russian presidential economic advisor Andrei Illarionov called the Kyoto Protocol an “undeclared war against Russia” at a Moscow press conference, but he did not rule out the possibility that Russia will ratify. “Illarionov intensifies anti-Kyoto campaign,” Point Carbon, July 9, 2004, <http://www.pointcarbon.com/article.php?articleID=4075&categoryID=147>.

UK Adds Transport to GHG Target. The UK Government decided to include transport in its self-imposed target of reducing greenhouse gas emissions by 20 percent by 2020, drawing aviation into the emissions trading arena. “Climate change curbs Darling's plans,” *The Guardian*, July 13, 2004, <http://politics.guardian.co.uk/green/story/0,9061,1259883,00.html>. See also “British Airlines to spend millions on emissions allowances,” Point Carbon, July 15, 2004, <http://www.pointcarbon.com/article.php?articleID=4104&categoryID=147>.

FAIR 2.0 Now Available. FAIR 2.0 supports policy makers in assessing the environmental and cost implications of various international climate regimes for differentiation of future mitigation commitments. The new version now includes: an extension of the total regions, all greenhouse gases, the IPCC SRES emission scenarios, new climate regimes, and a new abatement costs model (multi-gas). A special demo version can be downloaded free of charge from the FAIR website at <http://www.rivm.nl/fair/>.

“2 Million Euro Fine or Complete Shutdown for Non-Compliance with Kyoto.” The Spanish Government is making it clear that though it has negotiated and tried to please everybody in the National Allocation Plan (NAP), it intends to force compliance. Companies who do not comply with the required obligations face severe sanctions: fines from 50,000 to two million euros, a complete or partial closedown of the installation, or two year suspension of the permits given to the infringing company. Point Carbon, July, 14, 2004, <http://www.pointcarbon.com/article.php?articleID=4098&categoryID=279> (subscription required).

Publications

September 2003

“The Carbon Dioxide Dilemma: Promising Technologies and Policies,” *National Academies Press*, August 2003, http://www.nap.edu/catalog/10798.html?onpi_listserv082203.

“Estimating Climate Sensitivity: Report of a Workshop,” *National Academies Press*, August 2003, http://www.nap.edu/catalog/10787.html?onpi_listserv082203.

Power sector adaptations to carbon constraints. A study of the European power generation sector under a mandatory emissions reduction program found that in the medium term many European generators are likely to convert existing coal-fired capacity to burn gas, extend the lives of nuclear capacity and replace old inefficient coal-fired plants with more efficient plants. In the long-term the economic potential of carbon sequestration could allow coal to be considered a sustainable energy source. “Options, costs and strategies for CO₂ reductions in the European power sector,” *Energy Studies Review* 11 (2, 2003): 171-204.

Economic effects of northern European carbon reductions. This paper provides a survey of top-down modeling analyses of carbon abatement mitigation costs, distributional effects and ancillary benefits in the Nordic countries, the U.K., and Ireland. According to the analyses, modest emissions reductions can be met without substantial costs for the countries studied. The gross domestic product or welfare effects are mostly in the range of -0.4 and 1.2 percent when carbon emissions are reduced by 20-30 percent. “Mitigation costs,

distributional effects, and ancillary benefits of carbon policies in the Nordic countries, the U.K., and Ireland,” *Mitigation and Adaptation Strategies for Global Change*, 7 (4, 2002), 339-366.

October 2003

EIA analysis of McCain Climate Stewardship Act of 2003. S.139, the Climate Stewardship Act of 2003, would limit total (covered and non-covered) GHG emissions to 2000 levels by 2025. Under a reference case scenario EIA estimates the price of carbon emissions allowances under S.139 would be \$79 per ton of carbon in 2010 increasing to \$221 per ton of carbon in 2025. The EIA analysis (S.139 case) expects geological sequestration to become economical, resulting in 140 gigawatts of capacity equipped with this technology (38 GW using coal) by 2025. EIA assesses the electricity supply situation under S.139 as follows, “It is impossible to say which of the relatively low carbon technologies discussed – new nuclear, biomass, geothermal, wind, gas with sequestration, or coal with sequestration – might prove the most attractive over the next 20 years or so.” *Analysis of S.139, the Climate Stewardship Act of 2003*, EIA, July 3, 2003, [http://tonto.eia.doe.gov/FTPROOT/service/sroiaf\(2003\)02.pdf](http://tonto.eia.doe.gov/FTPROOT/service/sroiaf(2003)02.pdf). For the text of the Bill, <http://thomas.loc.gov/cgi-bin/bdquery/z?d108:s.00139>:

RFF analysis of McCain Climate Stewardship Act of 2003 (S.139). Resources for the Future fellows analyzed S.139 and praise its flexible trading structure and economy-wide approach calling it, “one of the most cost-effective proposals to date.” “Summary and Analysis of McCain-Lieberman – ‘Climate Stewardship Act of 2003’ S.139, introduced 01/09/03,” RFF, January 28, 2003, <http://www.rff.org/rff/News/Features/Understanding-the-McCain-Lieberman-Stewardship-Act.cfm>.

The Pew Center has conducted an assessment of the EIA assessment of S.139. They claim that “the model’s structure (that is, NEMS), combined with unrealistic input assumptions, results in unrealistically high cost projections.” “Pew Center Assessment of New EIA Analysis of the Climate Stewardship Act,” June 2004, http://www.pewclimate.org/policy_center/analyses/.

EIA report on Clear Skies 3P and Carper 4P bills. This report analyzes the impacts of S. 843, the Clean Air Planning Act of 2003 and S. 485, the Clear Skies Act of 2003. The economic impact of limits on NO_x, SO_x, Hg, and CO₂ (for S. 843) emissions from electricity generators are compared. CO₂ allowance prices are also projected to vary significantly across the Carper 4P cases. In 2010, CO₂ allowance prices are projected to range from \$4 to \$66 per metric ton carbon equivalent, while in 2025 the range widens to between \$26 and \$135 per metric ton carbon equivalent. “Analysis of S. 485, the Clear Skies Act of 2003, and S. 843, the Clean Air Planning Act of 2003,” EIA, September 23, 2003, [http://www.eia.doe.gov/oiaf/servicerpt/ccs/pdf/sroiaf\(2003\)03.pdf](http://www.eia.doe.gov/oiaf/servicerpt/ccs/pdf/sroiaf(2003)03.pdf).

Carbon capture and sequestration techno-economics. Researchers from Carnegie Mellon University examine the extent to which carbon capture and sequestration technologies might lower the cost of CO₂ control in competitive electric markets. This paper employs an electric system dispatch model to examine how natural gas prices, sunken capital, and the availability of coal plant retrofits affect CCS economics. Despite conservative assumptions about cost, CCS units are seen to provide significant reductions in baseload CO₂ emissions at a carbon price below \$100/tC. “Fossil electricity and CO₂ sequestration: How natural gas prices, initial conditions and retrofits determine the cost of controlling CO₂ emissions,” *Energy Policy*, Volume 32, Issue 3, February 2004, <http://www.sciencedirect.com/science/journal/03014215>.

Treaties to address the threat of global climate change: Critical review. Resources for the Future authors use six criteria to evaluate the Kyoto Protocol and thirteen alternative policy proposals: environmental outcome, dynamic efficiency, cost effectiveness, equity, flexibility in the presence of new information, and incentives for participation and compliance. The Kyoto Protocol does not fare well on a number of criteria, but none of the alternative proposals fare well along all six dimensions. Kyoto is “too little, too fast”; developing countries should play a more substantial role and receive incentives to participate; implementation should focus on market-based approaches, especially those with price mechanisms; and participation and compliance incentives

are inadequately addressed by most proposals. “13 + 1: A Comparison of Global Climate Change Policy Architectures,” RFF, August 2003, <http://www.rff.org/rff/Documents/RFF-DP-03-26.pdf>.

Responsibility for GHG over-emissions. This paper proposes a new way to assign responsibility for CO₂ emissions instead of territorial responsibility. It suggests that responsibility lies with the driving forces behind the activities that emit pollutants rather than direct emitters. “Allocating the responsibility of CO₂ over-emissions from the perspectives of benefit principle and ecological deficit,” *Ecological economics*, 46 (1, 2003).

November 2003

Issues with GHG intensity as a metric. GHG intensities are an appealing tool to foster abatement without imposing constraints on economic growth. This paper shows, however, that the computation of intensities is subject to some significant statistical and conceptual problems which relate to the inflation proofing of GDP growth. The choice of price index, the updating of quantity weights and the choice of base year prices can have a significant impact upon the commitment of intensity targets. “Price-related Sensitivities of GHG Intensity Targets,” Benito Müller and Georg Müller-Fürstenberger, *Climate Policy*, September 2003, <http://www.wolfson.ox.ac.uk/~mueller/>.

Full issue of *Energy Policy* magazine devoted to Climate Policy. Articles include: “The challenging economic and social issues of climate change,” “Climate coalitions and international trade: assessment of cooperation incentives by issue linkage,” “The safety valve and climate policy,” and “On the quality of compliance mechanisms in the Kyoto Protocol,” Volume 32, Issue 4, (March 2004) <http://www.sciencedirect.com/science/journal/03014215>.

The October/November issue of the AETF Review. Articles included are: “Kyoto - Threat or opportunity?” “The need for a carbon signal,” and “Canada's domestic trading program.” Australian Trading Emissions Forum Review, October 2003, <http://www.aetf.net.au>.

Market prices and activity in 2002. A report on North American carbon offset market activity, pricing, and price forecasts. The results show a significant divergence between the European and North American markets, and between those in Canada and the US. “2003 Canada-U.S. GHG Offset price survey,” International Offsets Unlimited, Inc., October 2003, <http://www.carboncorp.ca/projects.htm>.

NREL transport report. The National Renewable Energy Laboratory published “Consumer Views on Transportation and Energy,” a report on how the American public views various transportation, energy, and environmental issues. Topics covered by the surveys include energy policy; global warming; alternative fuels, and vehicles. NREL, August 2003, <http://www.nrel.gov/docs/fy03osti/34468.pdf>.

A methane/CO₂ economy. Vision Instruments and the University of Michigan's Department of Mechanical Engineering propose to use methane and CO₂ to support an energy economy, instead of hydrogen. Instead of a single pipeline or tank of hydrogen, there are two pipelines or tanks, forming a circuit. CO₂ is sent back to the energy source to react with hydrogen (produced from electrolysis), producing methane. Fuel cells are not required, and there are no huge infrastructure changeovers. The researchers determined that it will be more efficient and less expensive than a pure hydrogen economy. “VISION Instruments and University of Michigan propose innovative approach to hydrogen economy,” *Emediawire*, October 17, 2003, <http://www.emediawire.com/releases/2003/10/prweb84970.htm>.

Rapidly changing tone. If CO₂ generated by making hydrogen from fossil fuels were sequestered underground, cars and power plants of the future would not release GHGs. *The Economist* recommends a gradually rising gasoline tax, along with increased investment in alternative energy R&D. “The end of the Oil Age,” *The Economist*, October 25, 2003.

Climate Policy Journal. Issue 3(3) papers include: “Climate Negotiations Beyond Kyoto: Developing Countries Concerns and Interests,” and “The Impact of Private Investor's Transaction Costs on the Cost Effectiveness of Project-Based Kyoto Mechanisms.” September 2003, <http://www.sciencedirect.com/science/journal/14693062>.

Emissions trading in Western Europe. Datamonitor's report, “Emissions Trading in Western Europe,” examines the implications to Europe's utilities of EU policy on emissions reductions, and the future of emissions trading in key European markets. August 16, 2002, <http://click.cminteractive.com/?LZRXd=1096640>.

Energy and Transportation: Challenges for the Chemical Sciences in the 21st Century. Book contains a 4-page chapter, “Could Carbon Sequestration Solve the Problem of Global Warming?” Offers pros and cons of various sequestration approaches. *National Academies Press*, http://www.nap.edu/catalog/10814.html?onpi_listserv100303.

Forestry and CDM. “The role of forestry sinks in the CDM: Analyzing the effects of policy decisions on the carbon market,” Hamburg Institute of International Economics: Discussion Paper 241, August, 2003, http://www.hwwa.de/Publikationen/Discussion_Paper/2003/241.pdf.

December 2003

EIA: U.S. GHGs emissions grew 0.5 Percent in 2002. DOE's Energy Information Administration (EIA) announced that U.S. GHG emissions increased 0.5 percent in 2002. Carbon dioxide emissions, which increased by 0.8 percent, were offset by decreases in methane, mostly from captured landfill gas, and nitrous oxide emissions, due to reduced emissions from agriculture. The U.S. economy grew by 2.4 percent in 2002, which means that the greenhouse gas intensity decreased by 2.1 percent. “Emissions of Greenhouse Gases in the United States 2002,” EIA, October 2003, <ftp://ftp.eia.doe.gov/pub/oiaf/1605/cdrom/pdf/ggrpt/057302.pdf>.

“Understanding Climate Change Feedbacks.” “According to estimates generated by current climate models, more than half of the warming expected in response to human activities will arise from feedback mechanisms internal to the climate system.” This paper develops a strategy to understand, model, and monitor feedback processes. *National Academies Press*, <http://www.nap.edu/catalog/10850.html>.

Environmental Science & Policy Journal. The December 2003 issue contains the article, “The role of scientific uncertainty in compliance with the Kyoto Protocol to the Climate Change Convention.” Volume 6, Issue 6, Pages 475-486 (December 2003), <http://www.sciencedirect.com/science/journal/14629011>.

Next Steps for the Global Climate Regime - Deeper Inclusion of Developing Countries' Interests. This paper argues that we need to return to the basic principles outlined in the Framework Convention on Climate Change in searching for a north-south bargain on climate change, and its original stated goals of sustainable development. “Climate negotiations beyond Kyoto: developing countries concerns and interests,” *Climate Policy* 3 (3, 2003).

Comparative State-level Policy on Forestry Sequestration. This report compares the approaches of the governments of Japan, Canada, and the European Union member countries toward using terrestrial carbon sinks to meet their respective Kyoto Protocol carbon reduction targets under Articles 3.3 and 3.4. Japan appears likely to rely most heavily on forest and biological sinks to meet its Kyoto targets, while Canada will not. For the EU, the role of sinks is likely to be even smaller, with sinks playing no role for some EU countries. The final decisions have not yet been made for any of these countries. “Forest Carbon Sinks: European Union, Japanese, and Canadian Approaches,” *Resources for the Future*, October 2003, <http://www.rff.org/Documents/RFF-DP-03-41.pdf>.

Oxford Review of Economic Policy. The current issue focuses on climate change. Articles included are: “The Assessment: Climate-Change Policy;” “The Social Cost of Carbon and its Policy Implications;” “Fiscal Interactions and the Case for Carbon Taxes Over Grandfathered Carbon Permits;” “The Tradable-Permits Approach to Protecting the Commons: Lessons for Climate Change;” “Carbon Trading in the Policy Mix;” “Credible Carbon Policy;” and “The Kyoto Protocol: A Review and Perspectives.” *Oxford Review of Economic Policy*, Oxford University Press, Volume 19, Issue 3, Autumn 2003, <http://www.oxrep.oupjournals.org/current.shtml>.

The Potential Role of Transportation in GHG Reductions. The Transportation Research Board of the U.S. National Research Council released, “Travel Matters: Mitigating Climate Change with Sustainable Surface Transportation,” a report that examines potential GHG emissions reductions from transportation. The report’s companion website allows individuals to calculate transportation-related emissions. November 7, 2003, http://gulliver.trb.org/news/blurb_detail.asp?id=2071.

January 2004

Overview of the Carbon Market 2003. The World Bank PCF*plus* Research Program released its 2003 “State and Trends of the Carbon Market.” Key findings include: Volume exchanged on the carbon market has doubled in 2003 compared with 2002, up to more than 70 million tonnes of CO₂e. The bulk of the volume is exchanged mostly for the purpose of compliance with the Kyoto Protocol. Most emission reduction projects are located in transition economies and developing countries, and the private sector represents more than 40 percent of the volume purchased. The report is based on material provided by Evolution Markets LLC, Natsource LLC, Point Carbon, and from direct interviews with market participants. Report available at: <http://prototypcarbonfund.org/router.cfm?Page=Research>.

Trading analysis of 2003. The International Emissions Trading Association (IETA) has published “Greenhouse gas Market 2003: Emerging but fragmented,” with contributions from Point Carbon, Natsource, BP, PWC, CO₂e and many others. Report available at: <http://66.175.17.98/ieta/www/pages/download.php?docID=169>.

“U.S. Technology and Innovation Policies: Lessons for Climate Change.” This Pew Center Report examines U.S. experience with technology and innovation policies and draws lessons for addressing the climate change issue. November 2003, <http://ealert.pewclimate.org/ctt.asp?u=438171&l=12457>.

“Global Warning.” The lead article in the December 2003 issue of *Audubon* Magazine addresses climate change. “...across the political spectrum, Republicans, Democrats, governors, senators, and industry leaders agree that climate change is for real and must be dealt with—*now*.” Visit <http://magazine.audubon.org/>.

New Analytical Tool and Interactive Database. The World Resources Institute launched the Climate Analysis Indicators Tool (CAIT) at COP-9. CAIT provides a comparable database of GHG emissions data (including all major sources and sinks). Available at: <http://cait.wri.org>. For more information, contact Kevin Baumert, World Resources Institute, kbaumert@wri.org, <http://www.wri.org>.

February 2004

Canadian Clean Coal Timing Challenges. A University of Alberta Centre for Applied Business Research in Energy and the Environment report reviews different types of clean coal technologies and their deployment potential. Cost and technology concerns may not be overcome within 15 years, according to the report. The Canadian federal government's promise to cap credits at \$15 per tonne of CO₂ may be cheaper than investing in

clean coal technology, the report says. "Clean Coal Technologies: Can They Help Meet Alberta's Climate Change Commitments?" CABREE, January 12, 2004, http://www.bus.ualberta.ca/cabree/pr_Carlson.htm.

"Capturing Carbon and Conserving Biodiversity: The Market Approach." A set of essays edited by Ian Swingland of Kent University advocates commercial terrestrial sequestration with an appraisal of the potential problems. Several authors point out that, because tropical countries can secure the highest rates of biomass growth, they can secure the highest rates of carbon sequestration. Therefore, sequestration becomes an economic good. Other chapters deal with measuring biomass assets in the developing world, the legal aspects of the Kyoto flexibility mechanisms, and various scientific aspects of forest and soil dynamics. ISBN 1 85383 950 7 and 9515.

Carbon Sequestration, Timber, and Wildlife Objectives Model. Presents a new approach to assessing carbon sequestration in commercial forests at spatial scales relevant to forest managers. The approach combines carbon sequestration objectives with timber and non-timber management objectives. "Combining carbon sequestration objectives with timber management planning," *Mitigation and Adaptation Strategies for Global Change*, 8 (4, 2003), <http://ipsapp008.kluweronline.com/IPS/content/ext/x/J/5012/I/27/A/7/abstract.htm>.

Energy Policy Journal. In this issue, 23 analysts from Asia and the Pacific, Europe and the U.S. tackle the economic and social aspects of climate change and offer their views on economic and environmental implications of the U.S. withdrawal from the Kyoto Protocol. *Energy Policy*, 32 (4, 2004).

March 2004

A supplement to the Climate Policy Journal. Contains articles on absolute versus intensity-based emission caps, carbon trading systems, and others. *Climate Policy* 3 (Sup. 2, 2003), <http://www.sciencedirect.com/science/journal/14693062>.

UK Report Forecasts Energy Demand, CO₂ and SO₂ Emissions to 2015. Cambridge Econometrics, the economic and industrial forecasting group, published its latest edition of UK Energy and the Environment which says the UK is set to make good progress towards a low carbon future, but the achievement of the 20 percent cut in carbon emissions by 2010 hinges crucially on the impact of the EU Emissions Trading Scheme (ETS) in reducing coal burnt in electricity generation. UK Energy and the Environment is published twice a year, in January and July. The report is available by subscription at: <http://www.camecon.co.uk/>.

UK Parliamentary Briefings on Climate Change and Environmental Policy. The UK Parliamentary Office of Science and Technology (POST) published two briefings on the environment, one entitled "Climate Change and Business" and another, "Environmental Policy and Innovation." The publication on climate change points out that the Government's Climate Change Programme (CCP) is aimed at reducing UK emissions of carbon dioxide by a fifth, against 1990 levels, by 2010. UK policy depends on international developments, most directly the EU Emissions Trading Scheme. Long-term success depends on convincing businesses, their financial stakeholders, and their customers, that there are gains to be made by moving towards low carbon options. Environment-Centre, February 13, 2004, <http://www.environment-centre.net>.

The Public Perceptions of Carbon Capture and Storage. Based on responses from two citizen panels held in late 2002 /early 2003 in the UK, the paper describes the changes in the perceptions of the risks associated with CCS when first presented with the idea and when more background information is given. Tyndall Centre Working Paper 44, Simon Shackley, Carly McLachlan and Clair Gough, January 2004, http://www.tyndall.ac.uk/publications/working_papers/wp44.pdf.

“Geologic Sequestration of Carbon Dioxide: Sequestration of Emissions From Fossil-Fired Power Plants.” Coauthored with Melissa Chan, Scott M. Smouse, and Scott Klara, this article was published in the November-December 2003 special issue of the journal *Asia Pacific Tech Monitor*, http://www.techmonitor.net/techmon/03nov_dec/tm/pdf/03nov_dec_geologic.pdf.

April 2004

“Statehouse and Greenhouse,” a book by University of Michigan professor Barry Rabe examines the growing role played by state governments in reducing greenhouse gas emissions. *Brookings Institution Press* (2004), <https://www.brookings.edu/press/books/statehouseandgreenhouse.htm>.

“Tools of the Trade: A Guide to Designing and Operating a Cap and Trade Program for Pollution Control.” A guide available from EPA draws upon the experience of the highly successful sulfur dioxide trading program used to address acid rain. It includes appendices on the economics of emissions trading and an example assessment of the potential for cap and trade. “Tools of the Trade” may be downloaded at: <http://www.epa.gov/airmarkets/international/tools.pdf>.

“Effects of CO₂ Emission Reduction Strategies on Air Pollution.” Taking into account the relevant energy, environmental, and political framework, the study assesses the influence of CO₂ emission reduction strategies for the German state of Baden-Wurttemberg on emissions of SO₂ and NO_x. *International Journal of Global Environmental Issues* 3 (3, 2003): 245-265.

“Appropriate measures for Conservation of Terrestrial Carbon Stocks - Analysis of trends of forest management in Southeast Asia,” Dr. N. Kim Phat, *Journal of Forest Ecology and Management*, April 5, 2004, <http://authors.elsevier.com/sd/article/S0378112704000428>.

“Oil Crises & Climate Challenges - 30 Years of Energy Use In IEA Countries.” This publication examines how energy efficiency and other factors such as economic structure, income, lifestyle, prices, and fuel mix have shaped developments of energy use and CO₂ emissions in IEA countries over 30 years. IEA Publications (2004), <http://www.iea.org/dbtw-wpd/bookshop/add.aspx?id=174>.

May 2004

“Benchmarking Air Emissions.” A study of data collected by the federal government from the utility industry from 1991 to 2002 finds that utilities generate roughly the same amount of carbon dioxide for each kilowatt of power produced that they did in 1991, while emissions of SO_x and NO_x, which are subject to mandatory regulations, have decreased significantly. Summary article, *The New York Times*, April 14, 2004, <http://www.nytimes.com/2004/04/14/business/14smog.html?ex=1082520000&en=be42980d29708740&ei=5062>. Full report can be downloaded at: <http://www.nrdc.org/air/pollution/benchmarking/default.asp>.

RFF Assesses the European Union Emissions Trading Program. Ten times the size of the Acid Rain trading program in the United States, the design of the EU program takes advantage of past lessons, but lack of data and weaker institutions in some EU Member States could make allowance allocations, compliance, and enforcement tricky. “The EU Emissions Trading Directive: Opportunities and Potential Pitfalls,” Joseph Kruger and William A. Pizer, April 2004, <http://www.rff.org/Documents/RFF-DP-04-24.pdf>.

Agricultural and Forest Meteorology. “Seasonal variation in carbon dioxide exchange over a Mediterranean annual grassland in California,” by Liukang Xu and Dennis Baldocchi, Volume 123, Issues 1-2, May 20, 2004, <http://www.sciencedirect.com/science/article/B6V8W-4B6CPJ3-6/1/f8878c5caae25dbdd780ac2ea0a0fb73>.

Soil and Tillage Research. Two articles of interest: “Transport of labile carbon in runoff as affected by land use and rainfall characteristics,” P.A. Jacinthe, R. Lal, L.B. Owens, and D.L. Hothem; and “Long-term tillage and crop rotation effects on microbial biomass and C and N mineralization in a Brazilian Oxisol,” Elcio Balota, Arnaldo Filho, Diva Andrade, and Richard Dick. Volume 77, Issue 2, June 2004, <http://www.sciencedirect.com/science/journal/01671987>.

June 2004

“Economics of Sequestering Carbon in the U.S. Agricultural Sector.” The Economic Research Service (ERS) of the U.S. Department of Agriculture published a report that analyzed the performance of alternative incentive designs and payment levels if farmers were paid to adopt land uses and management practices that raise soil carbon levels. At payment levels below \$10 per metric ton for permanently sequestered carbon, the model predicts landowners would find it cost-effective to adopt changes in rotations and tillage practices. At higher payment levels, afforestation dominates sequestration activities, mostly through conversion of pastureland. A 50-percent cost-share for cropland conversion to forestry or grasslands would increase sequestration at low carbon payment levels. Technical Bulletin 1909 (TB1909), 68 pp, March 2004, by Jan Lewandrowski, Mark Peters, Carol Jones, Robert House, Mark Sperow, Marlen Eve, and Keith Paustian. The full report can be downloaded from the ERS website at <http://www.ers.usda.gov/publications/tb1909/>.

“Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2002” was submitted to the United Nations Framework Convention on Climate Change (UNFCCC) by the U.S. Department of State. The full Inventory document can be downloaded, as well as individual chapters and annexes, from EPA's web site at <http://www.epa.gov/globalwarming/publications/emissions>.

“Transportation systems for CO₂ – application to carbon capture and storage.” Commercialization of carbon capture and storage from fossil fueled power plants requires an infrastructure for transportation of the captured CO₂ from the sources of emission to the storage sites. This paper identifies and analyses different transportation scenarios with respect to costs, capacity, distance, means of transportation, and type of storage. The scenario analysis shows that feasible transportation alternatives are pipelines (on and off shore), water carriers (offshore), and combinations of these. *Energy Policy*, Volume 32 Issue 17, September 2004, <http://www.sciencedirect.com/science/article/B6V2P-4BJ1XCD-2/1/ead6509577cca1df8732fec59030dbbc>.

California, Permitting and Terrestrial Sequestration. This paper advocates carbon sequestration programs in California and addresses their possible regulatory and economic dimensions. It makes the case that California provides a rich landscape for terrestrial and geologic sequestration activities, and promises that the state would garner substantial co-benefits from these programs. “Regulatory constraints to carbon sequestration in terrestrial ecosystems and geologic formations: a California perspective,” *Mitigation and Adaptation Strategies for Global Change*, Edward Vine, 9 (1, 2004): 77-95.

Greenhouse Gas Calculator. The Global Environment and Technology Foundation (GETF) added a new greenhouse gas equivalencies calculator to the U.S. Climate Technology Cooperation Gateway Web site. The calculator enables organizations and individuals to quickly translate greenhouse gas reductions into terms that are easier to conceptualize, such as gallons of gasoline, barrels of oil, the number of cars not driven for one year, or the number of acres of forest preserved from deforestation. The online tool also allows users to calculate greenhouse gas emissions from a known quantity of kilowatt-hours or gallons of gasoline, or a given number of cars and trucks not driven for one year. The U.S. Climate Technology Cooperation Gateway was developed by GETF in partnership with the U.S. Agency for International Development and EPA. Available at: <http://www.usctgateway.net/tool/>.

“Step changes for decarbonising the energy system: research needs for renewables, energy efficiency and nuclear power.” Research is needed in a number of areas if large, long-term reductions in carbon emissions from energy use are to be achieved. Decomposition analysis is used to illustrate the various parts of the energy

system, the differential carbon emissions associated with each part, and the different kinds of policy measures which will be required to reduce them. Common themes where research is needed include: human behavior, social acceptability, economic costs, network and infrastructure issues, how to stimulate innovation, security and reliability, and markets and governance. Progress will need to be made in developing a better understanding of most if not all of these issues if radical reductions of carbon emissions are to be achieved. *Energy Policy*, Volume 32, Issue 17, November 2004, Pages 1891-1904, <http://www.sciencedirect.com/science/article/B6V2W-4CBVSHB-1/1/f10a526a46986bae397d0d1b288d5784>.

July 2004

Energy, Special Issue. A special issue of *Energy* dedicated to the 6th International Conference on Greenhouse Gas Control Technologies (GHGT-6), held in Kyoto, Japan in October 2002, is available (Volume 29, Issues 9-10, July-August 2004). Over 300 papers were submitted to the conference and more than 500 delegates attended.

Scaled-Down Climate Change Bill Has Lower Costs, Smaller Emissions Cuts. Changes made by Senators John McCain (R-AZ) and Joseph Lieberman (D-CT) to scale down their climate change legislation have reduced the costs of the measure, but have also reduced its impact on U.S. greenhouse gas emissions, the Energy Information Administration said in a report released June 8, 2004, entitled, "Analysis of Senate Amendment 2028, the Climate Stewardship Act of 2003." The report is available on the EIA website at: http://www.eia.doe.gov/oiaf/analysispaper/sacsa/pdf/s139amend_analysis.pdf.

Pew Center reports available for download. "Unfortunately, we're already past the point where climate change can be prevented entirely," said Eileen Claussen, President of the Pew Center on Global Climate Change. "Now we need a two pronged approach that combines reductions in greenhouse gas emissions with policies that will help us adapt to the climate change that is going to occur." "Coping with Global Climate Change: The Role of Adaptation in the United States," discusses the importance of adapting to climate change, the options available for adaptation, and the challenges of implementing them in the United States. June 15, 2004, http://www.pewclimate.org/press_room/sub_press_room/adaptation.cfm. Other Pew Center reports that address market and non-market impacts from climate change are: "A Synthesis of Potential Climate Change Impacts on the United States" and "U.S. Market Consequences of Global Climate Change," http://www.pewclimate.org/press_room/sub_press_room/28apr04.cfm.

"CO₂ sequestration in Ontario, Canada." This paper evaluates the potential for reservoirs in Canada to store CO₂. Two different major reservoirs with approximate storage capacities of 289 million and 442 million tonnes are identified in southwestern Ontario for CO₂ sequestration, one located in the southern part of Lake Huron and the other located inside Lake Erie. These reservoirs could contain approximately 14–21 years of CO₂ emissions from a nearby coal-fired power generation unit having a total generation capacity of about 4000 MW. By A. Shafeen et al., in *Energy Conversion and Management*, Volume 45, Issue 17, October 2004, Pages 2645-2659. <http://www.sciencedirect.com/science/article/B6V2P-4C4BH5J-1/1/97a1b3101906f775f047261c8564e03e>.

"Beyond Kyoto." "Business, in particular, is accustomed to making decisions in conditions of considerable uncertainty, applying its experience and skills to areas of activity where much is unknown. That is why it will have a vital role in meeting the challenge of climate change – and why the contribution it is already making is so encouraging," said Lord John Browne, CEO of BP, in an article in *Foreign Affairs* (July/August 2004, Volume 83, No. 4, pgs. 20-32). In this article Browne offers his business perspective on the question of CO₂ emissions.

August 2004

U.S. Greenhouse Emissions Increased Moderately in 2003. U.S. carbon dioxide emissions from burning fossil fuels increased by 0.9 percent in 2003, according to preliminary estimates released by DOE's Energy Information Administration (EIA). Since emissions actually declined in 2001 and grew at moderate rates in both 2002 and 2003, the emissions still remain below 2000 levels. EIA attributes the growth in 2003 to a number of factors, including increased heating demand during a cold winter, an increase in the number of U.S. homes, increased energy use in the commercial sector, and a shift in electric generation from natural gas to coal and oil, which emit more carbon. The preliminary estimates are on EIA's web site at: <http://www.eia.doe.gov/oiaf/1605/flash/flash.html>. EIA press release: <http://www.eia.doe.gov/neic/press/press238.html>.

CICERO report. The report is based on a comprehensive and structured literature review of key issues associated with long-term goals for climate policy, and to the framework for implementing climate policy. The study provides a basis for working with global climate policy after 2012, whether the Kyoto Protocol enters into force or not. "Climate policy beyond 2012: A survey of long-term targets and future frameworks." Report 2004:02; CICERO, Oslo; 51pp. For details and download visit http://www.cicero.uio.no/publications/detail.asp?publication_id=2776.

Harvested Wood Products. A paper entitled, "Approaches for inclusion of harvested wood products in future GHG inventories under the UNFCCC, and their consistency with the overall UNFCCC inventory reporting framework," (July 13, 2004) is available at <http://www.joanneum.atf>.

Online Book. "Lessons Learned from Workshop on Novel Approaches to Carbon Management: Letter Report" is available for viewing at <http://www.nap.edu/catalog/11047.html>. The report presents an assessment of the workshop, the solicitation process, and the NRC role. In addition, recommendations are provided for improving the process for subsequent DOE carbon management initiatives. *National Academies Press*.

Western Europe cuts greenhouse gases. Emissions of greenhouse gases have fallen in Europe's most industrialized countries, according to new figures. A report by the European Environment Agency (EEA) shows that production of six key climate-warming gases dipped in 2002 after two dispiriting years of increase. The release of the gases, which include carbon dioxide, methane, and nitrogen dioxide, fell by 0.5 percent in the European Union (EU) from 2001 to 2002, the report says. *news@nature.com*, July 16, 2004, <http://www.nature.com/news/2004/040712/full/040712-19.html>. To download the report, "Annual European Community greenhouse gas inventory 1990-2002 and inventory report 2004 Technical report No 2/2004," visit http://reports.eea.eu.int/technical_report_2004_2/en.

New Guide on Addressing Financial Risks and Opportunities from Global Warming. According to the Guide, emerging limits on global warming pollutants, both in U.S. states and worldwide, are creating new pressures to reduce emissions and are opening new markets for cleaner technologies – creating both risks and opportunities for companies and their investors. "Analyzing climate risk is a new and important challenge for investors, fund managers and corporations. This guide is intended to show how they can coordinate their efforts to achieve better disclosure, better outcomes and more certainty in addressing what until recently was considered an 'off-balance sheet' risk," said Doug Cogan, author of the guide. "The Investor Guide to Climate Risk" is available at www.ceres.org and on the INCR web site at www.incr.com.

Legislation

September 2003

The Energy Plan. A deadlock in the U.S. Senate over energy legislation ended, when Republican leaders abruptly agreed to shelve their proposal in favor of a measure passed last year under Democratic leadership. “Senate breaks deadlock, passes 2002 Energy Bill,” *Washington Post*, August 1, 2003, <http://www.washingtonpost.com>. See also, “Energy Bill Gives Way To Old One In the Senate,” August 1, 2003, *The New York Times*, <http://query.nytimes.com/gst/abstract.html?res=F40617F73E5A0C728CDDA10894DB404482>; and “U.S. energy policy,” *Financial Times*, August 5, 2003, <http://www.ft.com> (subscription required). For a copy of the Bill, see H.R.6, Energy Policy Act of 2003, July 31, 2003, <http://thomas.loc.gov/cgi-bin/bdquery/z?d108:h.r.00006>.

October 2003

Barebones overview of key content in the U.S. energy bill. “Key provisions in the energy bill,” *Scripps Howard News Service*, September 17, 2003, <http://www.knoxstudio.com/shns/story.cfm?pk=ENERGYSIDE-09-17-03&cat=WW>.

November 2003

Cap and trade proposal for GHG emissions defeated. On October 30, 2003, the U.S. Senate rejected a proposal for mandatory caps on “greenhouse gas” emissions from utilities and other industries. The vote on the Climate Stewardship Act of 2003, which was co-sponsored by Sen. John McCain (R-AZ) and Sen. Joseph I. Lieberman (D-CT), was 55-43. *Washington Post*, October 30, 2003, <http://www.washingtonpost.com>.

December 2003

“Senate Energy Bill Dead for This Year.” After much effort and negotiation, consideration of the energy bill by the U.S. Senate has been postponed to 2004. *Washington Post*, November 25, 2003, <http://www.washingtonpost.com>.

House Hearing on GHG control technologies. David Conover, director of the Climate Change Technology Program (CCTP), and DOE Deputy Assistant Secretary George Rudins testified at a November 6, 2003 House Science Subcommittee hearing. They brought the committee up to date on carbon sequestration and FutureGen. “Lawmakers question Bush climate change policies, priorities,” *Platts Coal Outlook*, November 10, 2003, Vol. 27, No. 45.

January 2004

Ocean and Coastal Observation Systems Act. S.1400 is a bill to develop a system that provides for ocean and coastal observations, data and information required by all components of an integrated ocean observing system and related research. Sponsored by Senator Snowe, Olympia J. [ME], with 8 cosponsors. Referred to House

Committee after being received from Senate, November 13, 2003, <http://thomas.loc.gov/cgi-bin/bdquery/z?d108:s.01400:>.

March 2004

Summary Impacts of Modeled Provisions of the 2003 Conference Energy Bill, Energy Information Administration, February 2004, [http://www.eia.doe.gov/oiaf/servicerpt/pceb/pdf/sroiaf\(2004\)02.pdf](http://www.eia.doe.gov/oiaf/servicerpt/pceb/pdf/sroiaf(2004)02.pdf).

Analysis of Five Selected Tax Provisions of the Conference Energy Bill of 2003, Energy Information Administration, February 2004, [http://www.eia.doe.gov/oiaf/servicerpt/ceb/pdf/sroiaf\(2004\)01.pdf](http://www.eia.doe.gov/oiaf/servicerpt/ceb/pdf/sroiaf(2004)01.pdf).

April 2004

Washington State Legislature Passes Bill to Limit GHG Emissions. With bipartisan support, the 2004 state Legislature passed a bill requiring new power plants to offset 20 percent of the CO₂ they send into the air through mitigation projects. Eligible projects include energy conservation projects, forestland preservation or converting diesel-powered buses to natural gas. Power producers can either finance the projects on their own or pay an independent third party approved by state authorities to do it for them at the rate of \$1.60 per ton of CO₂ produced. “Bill fights global warming,” *The Olympian*, March 16, 2004, http://www.theolympian.com/home/news/20040316/_environment/4976.shtml.

House Bill to Cap and Trade CO₂ from electricity generation, transportation, industrial, and commercial economic sectors. Representative Gilchrest (R-MD) and John Olver (DMA) introduced The Climate Stewardship Act on March 30, 2004, a House companion bill to McCain and Lieberman's Climate Stewardship Act. “Bipartisan House Bill Takes Aim at Global Warming,” *Environment News Service*, March 31, 2004, <http://www.climateark.org/articles/reader.asp?linkid=30615>.

June 2004

Congressional Hearing: Impacts of Climate Change and States' Actions. “Climate change is real and presents a clear danger on public health,” said Senator John McCain (R-AZ) in the opening Remarks to a May 6, 2004, hearing before the Senate Committee on Commerce, Science and Transportation. Witnesses included Dr. William Curry, Department of Geology and Geophysics, Woods Hole Oceanographic Institution, Dr. Paul Epstein, Harvard Medical School, Dr. William Fraser, President, Polar Oceans Research Group, Dr. Philip Mote, Research Scientist, University of Washington and Mr. Ken Colburn, Executive Director, Northeast States for Coordinated Air Use Management. “Impacts of Climate Change and States' Actions,” <http://commerce.senate.gov/hearings/witnesslist.cfm?id=1176>.

July 2004

Connecticut Climate Change Act Enters into Force. Connecticut's anti-global warming act came into effect on June 16, 2004. The Act calls for lowering greenhouse gases to 1990 levels by 2010 and to reduce emissions 85 percent by 2050. “Greenhouse gas bill goes into effect today,” *New Britain Herald*, June 14, 2004, http://www.newbritainherald.com/site/news.cfm?newsid=11943811&brd=1641&pAG=461&dept_id=10110&rft=6&nr=1&nostat=1.

“Main ushers in climate emissions reporting.” On June 17, 2004, the Board of Environmental Protection in Maine approved the first of many rules expected in an ongoing effort to reduce greenhouse gas emissions across

the state. The new rule requires paper mills, power plants, and factories to report their greenhouse gas emissions to the state Department of Environmental Protection beginning on July 1, 2005. The information could be used to implement measures to curb emissions, such as an emissions trading scheme. Though the federal government does require reporting of air pollutants, only a handful of states require that businesses track greenhouse gases. Point Carbon, June 21, 2004, <http://www.pointcarbon.com/article.php?articleID=3940&categoryID=147>.

August 2004

“The 'Target List'.” In this op-ed piece, columnist Anne Applebaum writes about The Climate Stewardship Act and lobbying in Washington. *The Washington Post*; July 14, 2004; Page A19; <http://www.washingtonpost.com/wp-dyn/articles/A48220-2004Jul13.html>.

House panel reviews energy, mining advances. The House Subcommittee on Energy and Mineral Resources held an oversight hearing June 15, 2004 on “Advances in Technology: Innovations in the Domestic Energy and Mineral Sector.” “We can produce energy and protect the environment at the same time,” Subcommittee Chairman Barbara Cubin (R-WY) said. “We don't have to choose between one or the other. New technologies allow us to place unprecedented emphasis on things like clean coal and renewable fuels and make energy security and protection of the environment no longer mutually exclusive.” Witnesses testified about the potential for enhanced oil and natural gas production from sequestration of carbon dioxide in hydrocarbon reservoirs. *Bend.com*, July 15, 2004, http://www.bend.com/news/ar_view%5E3Far_id%5E3D16772.htm#no-hash.

Index

A

ABC News, 5
ABC News Online (Australia), 16, 18, 37, 42
Abraham, Spencer, 2, 8, 10, 11, 13, 14, 15, 16, 45
Abrupt Climate Change, 17, 48
Abu Dhabi National Oil Company (ADNOC), 24
Advanced Resources International (ARI), 2, 20, 21
AETF Review, 39, 41, 55
Africa, 33, 38
AFX News, 40
Age, 21, 42, 50
Agence France Presse, 6
Agricultural and Forest Meteorology, 59
Agweek, 39
Airborne Carbon in the Mountains Experiment (ACME), 38
Akron Beacon Journal, 3
Alabama, 10
Alaska, 35, 42
Alberta Geological Survey, 21
Algae, 7, 27, 30
Algeria, 52
Allen Consulting, 43
Alstom Power, 25
Altia, 2
Amazon, 19, 35, 37
Ambio, 33
American Association for the Advancement of Science, 17
American Business Daily, 11
American Chemical Society, 26
American Electric Power (AEP), 1, 2, 4, 5, 11, 49, 50
American Forests, 37
American Geophysical Union, 16
American Public Power Association, 9
Amines, 25
Anadarko Petroleum Corp., 5, 20
Ananova, 28
Antarctica, 16, 18, 19, 31
Applied Geochemistry, 22
Arabian Peninsula, 33
Argonne National Laboratory, 34
Arizona, 33
Arizona Public Service Co. (APS), 33
Arkansas, 38
AScribe, 12
Asia, 16, 20, 33, 46, 58, 59
Asia Pacific Tech Monitor, 59
Asia Pulse, 33, 46
Associated Press, 9, 20, 28, 31
Athabasca Oil Sands Project, 37
Atlanta Journal Constitution, 34
Audubon, 57
Austin Energy, 49
Australia, 9, 11, 13, 15, 16, 21, 33, 39, 42, 43, 50, 51
Australian Financial Review, 43
Australian National University, 18
Australian Petroleum Production Exploration Association, 12
Australian Sustainable Investments Fund (ASIF), 43
Awards, 12, 24, 37, 38

B

Bacteria, 20, 30
Baltimore Sun, 5
Bangkok Post, 46
Baton Rouge Advocate, 24
Battelle, 3, 25
BBC, 7, 8, 9, 10
Bellona Foundation, 22
Bend.com, 65
Bilateral Agreements, 8, 15
Billings Gazette, 5
Bioengineering, 24
Biomass, 26, 27, 30, 33, 34, 37, 39, 47, 54, 58, 60
Black & Veatch Corp., 24, 25
Black carbon (soot), 17
Blue Source, 4
BOC Gases, 8, 21
Bolivia, 32
Boston Carbon Corporation (BCC), 10
Boston Globe, 17, 51
Bozeman Daily Chronicle, 3
BP, 6, 13, 57, 61
Brazil, 19, 35, 38, 60
British Airlines, 53
Brookhaven National Laboratory, 23
Brookings Institution, 14, 59
Brussels, 22
Burlington Electric, 49
Bush Administration, 1, 4, 7, 10, 11, 14, 15, 17, 45, 50, 52, 63
Bushfire Research Centre, 16
Business Standard, 24
Business Week, 2, 25
Business Wire, 21, 33, 39, 41

C

CABREE, 58
Calgary Herald, 50
California, 26, 37, 45, 49, 59, 60
California Institute for Energy Efficiency, 49
Calixarene crystals, 26
Cambridge Econometrics, 58
Canada, 6, 7, 10, 15, 21, 22, 23, 30, 35, 37, 42, 47, 50, 51, 55, 56, 61
Canada NewsWire, 24, 35
Carbon Credits, 4, 6, 10, 24, 32, 34, 35, 36, 38, 40, 41, 43, 49
Carbon cycle, 5, 17, 31
Carbon Dioxide
 Atmospheric concentration, 12, 17, 18, 38
 Burial cost, 2, 39
 Capture cost, 2, 31
 Storage estimates, 5, 8, 9, 21, 22, 39, 61
Carbon Fund, 38
Carbon intensity, 46, 55, 56
Carbon Market Europe, 36
Carbon Sequestration Leadership Forum (CSLF), 6, 14, 48
Carbonfund.org, 43
Carnegie Mellon University, 54
Carper Bill, 54

Casper Star Tribune, 1
 Central Arkansas Resources Conservation and Development Council, 38
 CERES, 62
Charlotte Observer, 9
Chemie.de, 15, 26
Chester Sun Times, 2
 Chicago Climate Exchange (CCX), 4, 40, 41, 42, 44, 49
 China, 46, 50
China Daily, 46
 Chinese Academy of Sciences, 26
Christian Science Monitor, 25, 30
 Chugoku Electric Power Co., 43
 CICERO, 19, 46, 62
Cincinnati Post, 11
 Cinergy Corp., 1, 39, 49, 52
 Clean Air Act, 1, 46
 Clean Air Planning Act of 2003, 54
 Clean Coal Power Initiative, 15
 Clean Development Mechanism (CDM), 12, 32, 36, 38, 40, 48, 56
 Clear Skies Initiative, 54
 Climate Change Technology Program (CCTP), 63
 Climate Leaders, 46, 48
Climate Policy, 32, 55, 56, 58
 Climate Stewardship Act of 2003, 52, 54, 61, 63, 64, 65
Climatic Change, 16, 47
CNN, 3, 16, 20
 CO₂ Capture Project (CCP), 9
CO₂ Science Magazine, 19
 CO₂E, 57
 Coal India Ltd. (CIL), 24
 COAL21, 13
 Colorado, 20, 21, 22
 Colorado School of Mines, 21
 Colorado State University, 35
 Columbia University, 6, 8
 Combined heat and power (CHP), 26
 Conference Energy Bill of 2003, 64
 Conferences, 11, 12, 13, 14, 15, 17, 38, 49, 61
 Connecticut, 64
 Connecticut Climate Change Act, 64
 Conservation Fund, 38, 39
Contra Costa Times, 6
 Convention on Biological Diversity, 33
 Coral reefs, 17
 Crust Study, 2
 Czech Republic, 40

D

Daily Princetonian, 13
 Datamonitor, 56
 Deep Coal Seams, 4
 Democratic National Convention (DNC), 10
 Denmark, 41
Denver Post, 38
 Depleted oil and gas fields, 2, 21, 27
 Discovery Channel, 10
 Dow Corning, 42
 DTE Energy, 49
 Ducks Unlimited, 38
 Duke Power, 48
 Duke University, 36
 DuPont, 47

Durham University, 32

E

Earth and Planetary Science Letters, 18
Earth Negotiations Bulletin, 15
Ecological economics, 33, 55
Ecological Engineering, 37
Ecological Modelling, 34
 Economics, 7, 8, 19, 20, 26, 33, 46, 49, 52, 53, 54, 55, 59, 60
Economist, 8, 16, 55
Edie weekly summaries, 48, 50
Edmonton Journal, 22, 30
Electric Utility Week, 8, 45
Electricity Daily, 20
 Electron Stream Carbon Dioxide Reduction (ESCO₂ R), 24, 25
Emediawire, 55
 Emissions Marketing Association (EMA), 43
 Emissions Trading Scheme (ETS), 43, 44
 Enbridge Pipelines Inc., 22
 ENERGIE2 A/S, 41
Energy, 26, 27, 35, 61
Energy Conservation and Management, 26
Energy Conversion and Management, 21, 22, 61
Energy Daily, 10, 45, 49
 Energy Information Administration (EIA), 49, 54, 56, 61, 62, 64
Energy Policy, 54, 55, 58, 60, 61
 Energy Policy Act of 2003, 14, 63
Energy Pulse, 7
Energy Studies Review, 53
EnergyReview.net, 12
Engineer, 2, 21, 24
 Engineered Concepts LLC, 26
 England, 7, 16, 40
 Enhanced Coalbed Methane (ECBM), 21
 Enhanced Gas Recovery, 7
 Enhanced Oil Recovery (EOR), 2, 4, 5, 7, 8, 19, 20, 21, 22, 23, 24, 43
ENS Newswire, 20
 Entergy, 4, 36, 43, 49
Environment International, 33
Environment News Service, 64
Environmental Data Interactive, 17
 Environmental Defense, 37, 49
Environmental Finance, 40
Environmental modeling and assessment, 46
Environmental Science & Policy, 39, 56
 Environmental Synergy Inc., 39
 Environment-Centre, 58
 Ethanol, 4, 7, 8, 25, 47
 Ethiopia, 7
EurekaAlert, 9, 17, 30, 34, 36
 Europe, 18, 62
European Chemical News, 2
 European Commission, 25, 44, 50
 European Environment Agency (EEA), 62
European Journal of Law and Economics, 49
 European Union (EU), 8, 22, 25, 36, 41, 43, 44, 45, 46, 47, 50, 51, 56, 59, 62
 Evolution Markets LLC, 41, 57
 Excelsior Energy Inc., 3
 ExxonMobil, 5, 9, 20

F

FACE, 36
FAIR, 53
Falcon Environmental Services, 12
Farm Bill, 35
Federation of Austrian Industry, 6
Feedback mechanisms, 16, 18, 35, 56
Financial Times, 5, 6, 32, 45, 47, 48, 51, 63
Finland, 2, 41
Fires, 16, 19
Florida Power & Light, 46
Flue gas decarbonization, 20
Fluor Corporation, 25
Food security, 38
Ford Motor Company, 13, 37
Foreign Affairs, 28, 61
Forest 2020, 34
Forestry & British Timber, 34
Fort Lauderdale Sun Sentinel, 46
Fort McMurray Today, 37
Fortune, 17
FPL Group, 49
Frio Pilot Test, 8
Fuel Cells, 23, 26, 27, 52
Fulton Valley News, 8
FutureGen, 1, 2, 3, 12, 15, 48, 63

G

G8, 52
Gap, 37
Gasification, 1, 2, 3, 4, 24
Gaz de France, 6
Gazprom, 41
Genesis Energy, 21
Geologic field tests, 5, 22
Geological Survey of Canada, 10
Germany, 11, 15, 18, 26, 29, 45, 48, 59
GG-CAP, 43
GHG Inventories, 19, 45, 60, 62
GHGT-6, 61
Global Climate and Energy Project (GCEP), 14
Global Environment and Technology Foundation (GETF), 60
Global News Wire, 9
Global Warming, 16, 18, 57
Globe and Mail, 51
Grand Island Independent, 14
Grasslands, 32
Great Britain, 32, 34
Green Building, 37
Greenbiz.com, 44
Greenbrier Plant, 14
Greenhouse Gas R&D Programme, 25
Greenland, 18
Greenwire, 43
GSA Today, 9
Guardian, 2, 9, 17, 29, 32, 53
Gujarat State Petroleum Corporation (GSPC), 24

H

Hamburg Institute of International Economics, 56
Harvard University, 64
Hawaii, 28

Himalayas, 8
Hollywood, 8
Houston Business Journal, 21
Hydrogen, 3, 6, 8, 12, 13, 14, 16, 25, 26, 48, 52, 55
Hydrogen Economy, 15, 25, 27, 55

I

Iafrica.com, 7
IBM, 37, 41
Ice Age, 19
Idaho, 3
IEAGHG Newsletter, 3
Illinois, 2, 22
Imperial College London, 25
Improved Oil Recovery (IOR), 20
Independent, 1, 18
India, 24, 33
India Times, 3
Indiana, 22, 35, 52
Indiana Farm Bureau, 52
Indonesia, 20, 40, 52
Innovations Report, 17, 30, 35
Inside Energy /with Federal Lands, 20, 27, 52
Institute for Biological Energy Alternatives (IBEA), 15, 24
Institute for Global Environmental Strategies, 13
Institute for Public Policy Research, 31
Insurance, 32, 36
International Emissions Trading Association (IETA), 57
International Energy Agency (IEA), 9, 12, 25, 59
International Journal of Global Environmental Issues, 59
International Offsets Unlimited, Inc., 55
International Oil Daily, 2, 43
International Petroleum Industry Environmental Conservation Association (IPIECA), 13
Investor Network on Climate Risk (INCR), 62
Iowa Farm Bureau, 41
IPCC, 33, 48, 53
Ireland, 53
Irish Examiner, 45
Iron fertilization, 7, 12, 29, 30, 31

J

Jakarta Post, 40
Japan, 5, 13, 24, 32, 33, 40, 43, 45, 46, 50, 51, 52, 56, 61
Japan Times, 5
Jim Walter Resources, Inc., 10
Joensuu Energia Oy, 41
Journal of Forest Ecology and Management, 59
Journal of Forestry, 27
Juneau Empire, 42

K

Kansas, 4, 22, 25, 34
Kao Corp., 46
Kelly, Wright & Associates, 8
Kent University, 58
Kentucky Department of Fish and Wildlife Resources, 39
KEPCO, 20
Kinder Morgan, 5
Klara, Scott, 3, 6, 59
Knight Ridder Newspapers, 45

Korea, 15
Kyodo News, 32, 45
Kyoto Forest Owners Association (KFOA), 49
Kyoto Protocol, 7, 11, 32, 33, 38, 40, 41, 43, 44, 48, 50, 51, 52,
53, 54, 55, 56, 57, 58, 61, 62

L

Lake Erie, 61
Lake Huron, 61
Land use, 32, 36, 39
Lavalin International Inc., 24
Lawrence Journal World, 4
Least Developed Countries Fund, 12
Legal issues, 10, 29, 33, 58
Life cycle assessment, 40
Lignite Energy Council, 3
Lincoln Journal, 45
Lithium Zirconate, 25
LogicaCMG, 44
Los Alamos National Laboratory (LANL), 25
Los Angeles Times, 6, 37, 45
Louisiana, 38
Lulea University of Technology, 26

M

M2 Presswire, 27, 28
Macro-engineering, 16
Maine, 64
Malaysia, 46
Marion Daily Republican, 2
Marrakesh, 12
Maryland, 15, 45
Massachusetts, 10, 31, 45, 52
Massachusetts Institute of Technology (MIT), 2, 17
Membranes, 8, 24, 26
Messer Suomi, 2
Methane, 10, 15, 16, 26, 33, 36, 47, 55, 56, 62
Methane Hydrates, 12, 15
Miami Herald, 8
Michigan Technological University, 34
Midland Reporter-Telegram, 12
Miller Brewing Company, 8
Milwaukee Journal Sentinel, 2
Minnesota, 3, 37, 39
Minnesotans for an Energy Efficient Economy, 3
Mississippi, 36, 38
Mississippi River, 4
Missouri, 26
Mitigation and Adaptation Strategies for Global Change, 32,
33, 36, 49, 54, 58, 60
Mitsubishi, 20
Mitsui Babcock, 9, 25
Models and Modeling, 21, 27, 33, 35, 36, 46, 53, 54, 56, 58, 60
Monitoring, Mitigation, and Verification (MM&V), 4, 5, 21,
22, 31, 32, 36
Monroe Times, 7
Montana State University, 3
Monterey Bay Aquarium Research Institute (MBARI), 12, 29,
30
Mount Simon, 1
Mountaineer Plant, 5
MSNBC, 30, 32
MSU News Service, 3

N

NASA, 16, 18, 28, 35
NATCARB, 22
National Academies of Science, 12, 50
National Academies Press, 50, 53, 56, 62
National Allocation Plan (NAP), 44, 53
National Association of Regulatory Utility Commissioners, 45
National Botanical Research Institute, 33
National Business Review, 49
National Energy Technology Laboratory (NETL), 1, 3, 6, 11,
14, 21, 23
National Geographic, 5, 31
National Oceanic and Atmospheric Administration (NOAA),
30, 38
National Renewable Energy Laboratory (NREL), 55
National Research Council (NRC), 15, 57, 62
National Resources Defense Council (NRDC), 11
National Science Foundation (NSF), 27, 28
Natsource, 41, 43, 57
Natural Resources Canada, 50
Nature, 19, 28, 29, 34, 36, 37
Nature Conservancy, 38
Netherlands, 2, 6, 40, 47
New Britain Herald, 64
New Mexico, 2, 21, 22, 26
New Mexico Business Weekly, 2
New Mexico Tech, 2
New Scientist, 16, 24, 37
New York, 10, 45
New York Times, 4, 8, 10, 11, 17, 19, 34, 46, 48, 50, 59, 63
New Zealand, 9, 15, 38, 40, 49
New Zealand Herald, 9, 40
news@nature.com, 11, 17, 18, 19, 20, 47, 62
Newswise, 36
Niigata Prefecture, 5
Nike, 37
Nissho Iwai Corp., 33
Noel Kempff Mercado Climate Action Project (NKMCAAP), 32
North Dakota, 3, 20
North Sea, 2, 3, 6, 7, 8, 22, 31
Northeast Biofuels, 8
Northeast States for Coordinated Air Use Management
(NESCAUM), 64
Norway, 8

O

Oak Ridge National Laboratory (ORNL), 34
Oakland Tribune, 7
Occidental Chemical Corporation, 5
Ocean
Arctic, 30
Atlantic, 29
North Atlantic, 30, 48
North Pacific, 28
Western Pacific, 30
Ocean acidification, 28
Ocean and Coastal Observation Systems Act, 63
Ocean cycling, 29, 31
Office on Science and Technology Policy, 48
Ohio, 1, 3, 22, 25, 38
Ohio Department of Natural Resources (ODNR), 3
Ohio State University, 38
Oil & Gas Journal, 5, 8, 20

Oil and Natural Gas Corporation (ONGC), 24
Oil Daily, 2, 20
Old South Woodlands LLC, 38
Olympian, 64
Omaha World Herald, 31
OPEC, 52
Oregon, 45
Organic farming, 34
Oxford Review of Economic Policy, 57
Ozone, 34, 36

P

Pacific Northwest National Laboratory (PNNL), 37
Panama, 36, 37
Partners for Affordable Energy, 4
Peatlands, 32, 36
Penn State Live, 18
Pennsylvania, 34, 45
Pennsylvania State University, 17
Pentagon, 17
Perdue Farms, 8
Permian Basin, 5, 12, 21
Pew Center on Global Climate Change, 14, 17, 45, 54, 57, 61
Philadelphia Inquirer, 1, 34
Philippines, 40
Phytoplankton, 19, 28, 29, 30, 31
Pittsburgh Post-Gazette, 13
Platts, 2, 22
Platts Coal Outlook, 63
Point Carbon, 11, 15, 23, 38, 41, 42, 43, 44, 47, 50, 51, 52, 53, 57, 65
Poland, 14
Polar Oceans Research Group, 64
Potsdam Institute for Climate Impact Research, 18
PowerSwitch!, 49
PowerTree Carbon Co., 4, 6, 38, 49
PR Newswire, 4, 25, 26, 36, 43
Prague Business Journal, 40
Premium Standard Farms, 41
Price of carbon, 39, 44, 54, 55, 57, 60
PricewaterhouseCoopers, 57
Princeton University, 13, 29
Proceedings of the National Academy of Sciences, 15, 28, 32
PSEG, 48
Public Broadcasting Service (PBS), 49
Public Utilities Fortnightly, 1, 48, 49
Purdue University, 35

R

REFCO, 41
Regional Carbon Sequestration Partnerships, 1, 2, 3, 14
Regulatory issues, 1, 49, 52, 60
Renewable Energy, 11, 26
Renovar Energy, 24
Resources for the Future (RFF), 13, 52, 54, 56, 59
Reuters, 1, 3, 7, 19, 20, 50
Ridgeway, 5
Risk, 33, 44, 47, 58, 62
Rocky Mountain Institute (RMI), 44
Rodale Institute, 34
Rolls-Royce North America, 42
Romania, 7
Rural areas, 32, 34

RUSAL, 41
Russia, 10, 41, 44, 46, 47, 51, 53
Russian Information Agency, 41
Rutgers University, 29

S

Sacramento Municipal Power District (SMUD), 49
Saline aquifers, 2, 3, 4, 5, 21, 22, 27
Salt Creek field, 5, 20
Salt Lake Tribune, 5
San Francisco Chronicle, 28
San Francisco State University, 30
San Jose Business Journal, 49
SciDev.net, 35
Science, 4, 7, 10, 19, 20, 23, 25, 30, 31, 34, 35, 36, 37, 38
Science a Go Go, 30
Science Daily, 16, 28, 29, 33, 37, 51
Scientist, 31
Scoop.com, 24
Scotsman.com, 10
Scripps Howard News Service, 63
Scripps Institution of Oceanography, 19, 30
Seabed injection, 4, 6
Seattle Press, 46
Seattle Times, 6, 47
Separation and Purification Technology, 25
Shell, 9, 37
Shellfish, 20, 25, 28, 29
Shute Creek processing plant, 20
Siberia, 36
Silicon Valley, 49
Sleipner, 3, 8, 9
SmartWay, 50
Smithsonian Institution, 37
Smithsonian Magazine, 29
Smithsonian Tropical Research Institute, 37
Society of Petroleum Engineers (SPE), 5
Soil and Tillage Research, 60
Soil Science Society of America Journal, 33
Solar Access, 25
Solid Energy, 9
South Africa, 26
South America, 33
South Dakota, 3
South Dakota School of Mines and Technology, 31
Spain, 7, 53
Special Climate Change Fund, 12
Spectrum, 24
St. Louis Post-Dispatch, 6
Stanford Daily, 14
Stanford University, 14, 32, 47
Star Tribune, 3
Statoil, 3, 22, 43
Sydney Morning Herald, 11

T

Taxes, 9, 13, 15, 43, 45, 46, 55, 57, 64
Technological learning, 27, 46
Texas, 5, 8, 12, 21, 22, 24
Texas Bureau of Economic Geology, 8, 21
Thailand, 46
The Day After Tomorrow, 8
Tide Pool, 40

Tillage-induced carbon dioxide loss, 39
Timbercorp, 43
Times (London), 8
Times-Picayune, 35
Tools and online calculators, 12, 35, 40, 57, 60
Topeka Capital Journal, 4
Traditional Financial Services (TFS), 41
Transportation, 1, 45, 50, 51, 53, 55, 56, 57, 60
Tree Canada, 37
Trees for Cities, 7
Tyndall Centre, 17, 29, 58

U

U.S. Environmental Protection Agency (EPA), 1
UCSC Press Release, 29
UNEP, 40
UNFCCC, 6, 12, 15, 32, 48, 56, 60, 62
United Arab Emirates, 24
United Kingdom, 2, 5, 7, 8, 9, 10, 29, 31, 34, 41, 44, 53, 58
United Nations (UN), 49
University of Alberta, 9, 57
University of California Berkeley, 23
University of California Los Angeles (UCLA), 36
University of Chicago, 18
University of Hawaii, 28
University of Illinois, 36
University of Leeds, 32
University of Manitoba, 30
University of Massachusetts, 23
University of Michigan, 55, 59
University of Minnesota, 25
University of Oklahoma, 42
University of Queensland, 6
University of Queensland Newsletter, 6
University of Rhode Island, 28
University of Santa Cruz, 29
University of Saskatchewan, 39
University of Texas, 5
University of Virginia, 16
University of Washington, 64
University of Wisconsin, 23
Unmineable coal seams, 6, 27
Urban areas, 35, 37
US Agency for International Development (USAID), 60
US Department of Agriculture (USDA), 33, 35, 60
US Department of Energy (DOE), 1, 2, 3, 4, 6, 11, 12, 14, 15, 16, 20, 22, 23, 27, 31, 34, 37, 49, 56, 62, 63
US Department of State, 6, 15, 48, 60
US Environmental Protection Agency (EPA), 7, 10, 26, 40, 45, 46, 48, 50, 52, 59, 60
US Forest Service, 33, 34, 37
US Geological Survey (USGS), 21, 22
US House of Representatives, 63, 64, 65
 Representative Gilchrest, 64
 Representative Olver, 64
US Newswire, 2, 8, 14, 15, 45

US Securities and Exchange Commission (SEC), 47
US Senate, 63
 Senator Lieberman, 52, 54, 61, 63, 64
 Senator McCain, 52, 54, 61, 63, 64
 Senator Nelson, 14
 Senator Snowe, 63
USA Today, 4
UtiliPoint, 48

V

Vanderbilt University, 24
Vienna, 6
Vietnam, 33, 40, 46
Vietnam News Agency, 40, 46
Virginian-Pilot, 7
Vision Instruments, 55
Voluntary Programs, 1, 4, 13, 43, 49, 50

W

Wall Street Journal, 4, 44
Washington DC, 14, 15, 46
Washington Post, 1, 7, 51, 52, 63, 65
Washington State, 40, 45, 46, 64
Washington Times, 38, 45
Waste News, 2, 6
Waverly Light and Power, 49
West Virginia, 1, 2, 4, 14, 22
Weyburn, 6, 7, 9, 10
Wind Scrubber, 8
Winnipeg Sun, 42
Wired Magazine, 4
Wired News, 34
Wisconsin, 7
Woods Hole Oceanographic Institution, 30, 31, 64
Workshops, 12, 13, 14, 53, 62
World Bank, 40, 44, 47, 57
World Economic Forum, 42
World Forestry Congress, 34
World Resources Institute (WRI), 12, 41, 57
World Trade Organization (WTO), 51
World Wildlife Fund (WWF), 49
Wyoming, 1, 5, 20
Wyoming State Geological Survey, 5

X

Xcel Energy Inc., 3

Y

Yahoo News, 17
Yamaguchi University, 24
Yukos, 41

CONTACT INFORMATION



National Energy Technology Laboratory

626 Cochrans Mill Road
P.O. Box 10940
Pittsburgh, PA 15236-0940

3610 Collins Ferry Road
P.O. Box 880
Morgantown, WV 26507-0880

Contacts:

Scott Klara
National Energy Technology Laboratory
Office of Fossil Energy
412/386-4864 or
scott.klara@netl.doe.gov

Sarah Forbes
National Energy Technology Laboratory
Office of Fossil Energy
304/285-4670 or
sarah.forbes@netl.doe.gov

***For more information on the Carbon Sequestration Program
please visit our web site:***
NETL Carbon Sequestration Page @
<http://www.netl.doe.gov/coal/Carbon%20Sequestration/index.html>

September 2004