



Office of Fossil Energy

Carbon Sequestration Newsletter



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DECEMBER 2011

Carbon Sequestration

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Sequestration in the News

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Ethanol Production Facility in Decatur, Illinois. A processing plant built for this project removes water from the CO₂ stream and then compresses the dry CO₂ to a supercritical phase. The compressed CO₂ then travels through a 1 mile-long pipeline to the wellhead where it is injected into the Mt. Simon Sandstone at a depth of about 7,000 feet. November 21, 2011, http://www.netl.doe.gov/publications/press/2011/111121_co2_injection.html.

Kansas Geological Survey News Release, "Kansas Geological Survey Receives \$11.5 Million to Test Storage of CO₂ Underground."

DOE's National Energy Technology Laboratory (NETL) has awarded the Kansas Geological Survey (KGS) at the University of Kansas \$11.5 million to test the safety and efficacy of storing CO₂ deep underground in south-central Kansas. This four-year project is a collaborative effort between government and industry and represents the first time CO₂ emitted during industrial activities will be captured and stored long-term underground in the state. The CO₂ will be transported from a global biotech company – the Abengoa Bioenergy Corporation, located near Colwich, Kansas – to an injection well at the Wellington oil field, south of Wichita in Sumner County. A minimum of 40,000 metric tons of CO₂ emitted from the plant will be compressed and injected more than 5,000 feet underground into the lower portion of the Arbuckle formation, which is located approximately 1,350 feet beneath the Wellington field's Mississippian producing zone. Also, approximately 30,000 metric tons of CO₂ will be injected into the shallower oil-producing Mississippian formation as part of an enhanced oil recovery (EOR) pilot program. December 2, 2011, <http://www.kgs.ku.edu/General/News/2011/arbuckle.html>.

INTRODUCTION

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

HIGHLIGHTS

Fossil Energy Techline, "CO₂ Injection Begins in Illinois."

The Midwest Geological Sequestration Consortium (MGSC), one of seven of the U.S. Department of Energy's (DOE) Regional Carbon Sequestration Partnerships (RCSPs), has begun injecting carbon dioxide (CO₂) for their large-scale CO₂ injection test in Decatur, Illinois. The CO₂ is being captured from the Archer Daniels Midland (ADM)

SEQUESTRATION IN THE NEWS

Linc Energy Media Release, "Linc Energy Starts Enhanced Oil Recovery (EOR) with Injection of CO₂ in Wyoming."

Linc Energy has commenced the injection of CO₂ into its first well in its Glenrock, Wyoming, oil fields. Well preparation work has also begun, including the installation of a new liner to ensure injection integrity. By introducing EOR in the Glenrock oil fields, Linc Energy expects to recover more than 80 million barrels of oil. As part of the operation, CO₂ will be delivered, heated to approximately 16°C, and then pumped at high pressure at an approximate rate of one to three barrels per minute. Once injection is completed, the well will "soak" for 19 to 21 days and the CO₂ will



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SEQUESTRATION IN THE NEWS (CONTINUED)

disperse in the reservoir. The well will then be flowed back to tanks where the oil, water, and CO₂ are separated. An independent analysis of the South Glenrock field determined that CO₂ flooding has the potential to produce more than 10,000 barrels per day. Planning, engineering, and permitting are underway for introduction of CO₂ for EOR at the South Glenrock B Oil Field, and will begin in the Dakota formation before the end of 2011. The formation will be the first of nine potential stratigraphic zones identified for EOR using CO₂ injection. November 23, 2011, http://www.lincenergy.com/data/media_news_articles/LNC-Media_Release-711.pdf.

SSE Press Release, "UK's First Carbon Capture Plant Opens at Ferrybridge Power Station," and **Reuters, "UK's Biggest Carbon Capture Pilot Project Opens."**

The largest carbon capture pilot plant in the United Kingdom (UK) has begun capturing emissions from Scottish and Southern Energy's (SSE) 490-megawatt (MW) coal-fired power station in West Yorkshire. A joint development by SSE, Doosan Power Systems, and Vattenfall, the project is the first of its size to be integrated into a live power plant in the UK. According to SSE, the plant bridges the gap between small pilot trials currently underway and \ commercial-scale demonstration projects by capturing 100 tonnes of CO₂ per day from the equivalent 5-MW coal-fired generating capacity. The project represents a learning tool for industry regulators, enabling the UK to move closer to widespread deployment of CCS. For more information on the pilot project at Ferrybridge, go to: <http://www.sse.com/ferrybridge/>. November 30, 2011, <http://www.sse.com/PressReleases2011/FerrybridgeCarbonCapturePlant/> and November 30, 2011, <http://uk.reuters.com/article/2011/11/30/uk-carbon-capture-pilot-idUKTRE7AT1CI20111130>.

BBC News, "Route of Proposed Carbon Dioxide Capture Pipe Announced."

The proposed route of a 40-mile long pipeline in the North Sea has been announced by National Grid. The underground pipeline would carry liquid CO₂ from a power station near Doncaster to formations off of the Holderness coast to be stored. If approved, construction work on the route, which was drawn up after consulting with local residents, would begin in 2014. According to National Grid, the pipe would be three feet wide and the corridor would be approximately 1 kilometer wide to allow for environmental and engineering considerations on the final route of the pipeline. Local facilities producing CO₂ emissions may also be able to connect to the pipeline in the future. November 17, 2011, <http://www.bbc.co.uk/news/uk-england-humber-15781524>.

Carbon Capture Journal, "Alstom to do Feasibility Study for CCS at Daqing Oil Fields."

China Datang Corporation and Alstom, building on a Memorandum of Understanding (MOU) signed in September 2011, have signed a feasibility study agreement for a 350-MW oxy-combustion

SEQUESTRATION IN THE NEWS (CONTINUED)

CCS demonstration project located in Daqing, Heilongjiang province. Using its oxy-firing technology, Alstom will conduct the study for the

project, which is scheduled to be in operation in 2015. The Daqing CCS demonstration project will be capable of capturing more than 1 million metric tonnes of CO₂ per year. In addition, the project will aim to establish the most cost-effective demonstration plant and set a benchmark for the CCS industry. November 15, 2011 <http://www.carboncapturejournal.com/displaynews.php?NewsID=868>.

ANNOUNCEMENTS

Carbon Capture Trial Begins in Western Australia.

The Government of Western Australia's Department of Mines and Petroleum (DMP) announced that drilling will commence in early 2012 at Harvey 1 Well in southwest Australia as part of the government's first onshore CCS trial project. The \$8.5 million research project will also investigate underground heat for geothermal energy and assess water and other resources. To learn more about the 40-day drilling program, click: http://www.dmp.wa.gov.au/7105_14234.aspx.

CCS Network Announced.

Nine environmental non-governmental organizations (NGOs) have formed the Environmental NGO Network on Carbon Capture and Sequestration (ENGO Network) with a mission of pursuing domestic and international policies, regulations, and initiatives that safely and efficiently enable CCS. For more information, visit: <http://www.engonetwork.org/>.



Call for Scientific Research Proposals.

Carbon Management Canada (CMC) is now accepting proposals for its third round of research funding, emphasizing research with impacts on greenhouse gas (GHG) emissions from the fossil fuel industry and stationary emitters. CMC expects to allocate approximately \$10 million for this call for proposals, with a deadline of February 15, 2012. For more information, go to: <http://www.cmc-nce.ca/news/2011/11/15/call-for-scientific-research-proposals/>.



Call for Papers.

Abstracts are now being accepted for the 11th International Conference on Greenhouse Gas Control Technologies (GHGT-11), to be held November 18-22, 2012, at the Kyoto International Conference Center in Kyoto, Japan. Technical themes include: CO₂ capture technology development, geologic CO₂ storage, CCS for industrial sources, CO₂ transport and infrastructure development, commercial issues, CCS system integration, public perception and acceptance of CCS, energy and climate change policies, legal and regulatory aspects of CCS, and CO₂ storage liability. Abstracts are due no later than Friday, February 20, 2012. For more information, click: http://www.ghgt.info/docs/docs/GHGT-11/GHGT_11_CFP_FINAL_web.pdf.

SCIENCE

***ScienceDaily*, “Walnut Trees May Not Be Able to Withstand Climate Change.”**

Research conducted at Purdue University has found that warmer, drier summers, coupled with weather events brought on by potential climate change, could be fatal for walnut trees. Researchers studied the physiology of walnut trees, which are economically significant for their lumber, veneer, and nuts, for five years and discovered that the tree is sensitive to particular climates and would have difficulty tolerating droughts that could potentially be brought on by climate change. In addition, the study found that walnut trees are also sensitive to cold weather and do not begin sprouting leaves until nearly a month after other trees in the spring. This “defense mechanism” could be compromised by weather events associated

with potential climate change; specifically, late spring frosts could kill the trees after walnuts have developed leaves. Purdue's Hardwood Tree Improvement and Regeneration Center has a walnut breeding program that is currently attempting to identify trees that can be used in different climates, with a goal of finding walnuts that can survive in heat or cold stresses. November 29, 2011, <http://www.sciencedaily.com/releases/2011/11/111129103312.htm>.

***The Vancouver Sun*, “Thawing Permafrost Could Speed Global Warming, Researchers Warn,” and *Bloomberg*, “Permafrost Thaw May Emit More than Deforestation, Study Says.”**

According to an international team of scientists, thawing permafrost may contribute more to climate change than originally expected. Research conducted by biologists from the University of Florida and the University of Alaska estimated that Arctic warming of 7.5°C this century may thaw soils and release the equivalent of 380 billion tons

SCIENCE (CONTINUED)

of CO₂. The study was based on a survey of 41 international permafrost scientists who performed calculations such as the percentage of surface permafrost likely to thaw and how much CO₂ would be released as a result. The United Nations calculated that Arctic warming is nearly twice the average rate for the rest of the planet. According to the International Energy Agency (IEA), the global average temperature may rise by more than 3.5°C, implying a potential 7°C rise in the Arctic region. The report, which was published in the journal *Nature*, also concludes that this effect on the climate could be 2.5 times worse than deforestation, and under a “high warming scenario,” up to 15 percent of the top three meters of permafrost could degrade by 2040, jumping to 61 percent by 2100. November 30, 2011, <http://www.vancouversun.com/technology/Thawing+permafrost+could+speed+global+warming+researchers+warn/5791260/story.html> and December 1, 2011, <http://www.businessweek.com/news/2011-12-01/permafrost-thaw-may-emit-more-than-deforestation-study-says.html>.

POLICY

Western Climate Initiative, “Quebec Adopts Cap-and-Trade Regulation.”

Quebec has adopted a regulation for a cap-and-trade system for GHG emission allowances, according to the Minister of Sustainable Development, Environment, and Parks. Industries that emit 25,000 tonnes or more of CO₂ equivalent per year will be subject to the system, which will begin a transition year on January 1, 2012, allowing emitters to familiarize themselves with how the system works and make the necessary adjustments. The system will be officially enforced on January 1, 2013, at which point all emitters will be required to meet their new obligations for capping and reducing GHG emissions. Beginning in 2015, companies that import or distribute fuels in Quebec that are used in the transportation and building sectors, and whose emissions exceed the 25,000-tonne threshold, will also be subject to capping and reducing emissions. For more information, visit: <http://www.mddep.gouv.qc.ca/changements/carbone/Systeme-plafonnement-droits-GES-en.htm>. December 15, 2011, <http://www.westernclimateinitiative.org/news-and-updates/139-quebec-adopts-cap-and-trade-regulation>.

“Development of a CO₂ network for industrial emissions.”

The following is the Abstract of this article: “The application of Carbon Capture and Storage (CCS) technology to energy-intensive processes is starting to attract attention, presenting an opportunity for developing multi-user CO₂ transportation networks. Recognizing that most industrial facilities have not been designed with CCS in mind, this paper begins by looking at the practical issues associated with retrofitting CCS to industrial facilities. It then explores the technical and legal issues associated with building a CO₂ network. This is followed by an analysis of the costs involved. Having identified the key issues, a case study from North East England is presented as an example of what is possible in an area of high CO₂ emissions.

The paper concludes by considering the issues involved in sizing a CO₂ network which can evolve to meet future needs and linking that to the development of policy.” **Dermot J. Roddy**, *Applied Energy*, Available online November 9, 2011, doi:10.1016/j.apenergy.2011.10.016, <http://www.sciencedirect.com/science/article/pii/S0306261911006672>. (Subscription may be required.)

GEOLOGY

“Contribution of iron to the energetic of CO₂ sequestration in Mg-silicates-based rock.”

The following is the Abstract of this article: “The main purpose of this paper is to investigate the contribution of iron to the energy requirements of a process for producing magnesium hydroxide (Mg[OH]₂) from alkaline-earth Mg-silicate rock that contains iron, such as serpentinite. Once produced Mg(OH)₂ could be used to [store] carbon either by direct mineralization at a power plant or from the air, or as a means to deliver alkalinity to the ocean thus tending to restore oceanic pH and [store] atmospheric carbon. [Iron (Fe)]-containing by-products obtained from producing Mg(OH)₂ are considered to be beneficial as secondary raw materials for iron-and steel-making industries. It has been proposed that this could further reduce CO₂ emissions as well as raw material costs. However, this study hypothesized that the extent of this benefit, if any, would depend on energy intensity of reactions involving iron compounds. Using Aspen Plus® software, the contribution of iron to the energy input requirement of CO₂ [storage] was modeled. Results obtained showed that the extraction of iron from Mg-silicate minerals could present a significant energy penalty to the mineralization process. Exergy analysis shows that at the experimental optimal temperature of 400°C, the energy penalties of having iron oxide (FeO), hematite (Fe₂O₃) and magnetite (Fe₃O₄) as dominant iron compounds results are (for 10 wt.% Fe in the rock) an increase of 0.3 GJ/t CO₂ ([seven percent]), 0.7 GJ/t CO₂ (20 [percent]) and 2.2 GJ/t CO₂ (60 [percent]) respectively when compared to an iron-free base case. Recovery of input raw material, ammonium sulfate (AS) by evaporative crystallization is a major energy intensive step in this process. However, [the authors’] model applied mechanical vapor recompression (MVR), which resulted in a significant reduction in energy demand. It can be concluded that the benefit of producing useful Fe by-products comes with an energy penalty, the extent of which varies with the form of Fe compound in the mineral. The findings in this paper are useful in determining which Mg-silicate-based rocks would be energy efficient for use.” Experience **Nduagu, Johan Fagerlund, and Ron Zevenhoven**, *Energy Conversion and Management*, Available online December 2, 2011, doi:10.1016/j.enconman.2011.10.023, <http://www.sciencedirect.com/science/article/pii/S0196890411003049>. (Subscription may be required.)

“Carbon capture and storage using alkaline industrial wastes.”

The following is the Abstract of this article: “CCS is gaining momentum as a means for combating climate change. It is viewed as an important bridging technology, allowing emission targets to be met during fossil fuel dependence while sufficient renewable energy generation is installed. Mineral carbon [storage] is the only known form of permanent carbon storage and has the potential to capture and store CO₂ in a single step. It is based on

GEOLOGY (CONTINUED)

the geologic process of natural rock weathering where CO₂ dissolved in rain water reacts with alkaline rocks to form carbonate minerals. While the reactions are thermodynamically [favorable], in nature the process occurs over thousands of years. The challenge of mineral carbon [storage] is to accelerate carbonation and exploit the heat of reaction with minimal energy and material losses. Minerals commonly selected for carbonation include calcium and magnesium silicates. These minerals require energy-intensive pre-treatments, such as fine grinding, heat treatment, and chemical activation with strong acids, to provide adequate conversions and reaction kinetics. Industrial waste residues present alternative sources of mineral alkalinity that are more reactive than primary minerals and are readily and cheaply available close to CO₂ sources. In addition, the carbonation of waste residues often improves their environmental stability. This paper provides an overview of the types of industrial wastes that can be used for mineral carbon [storage] and the process routes available.” **Erin R. Bobicki, Qingxia Liu, Zhenghe Xu, and Hongbo Zeng**, *Progress in Energy and Combustion Science*, Available online November 26, 2011, doi:10.1016/j.peccs.2011.11.002, <http://www.sciencedirect.com/science/article/pii/S0360128511000554>. (Subscription may be required.)

“Putting It All Together: The Real World of Fully Integrated CCS Projects.”

The following is the Abstract of this article: “This study examines the legal, regulatory and financial issues encountered in nine planned commercial-scale CCS research, development and demonstration (RD&D) projects under Phase III of the U.S. Department of Energy’s RCSP Program. In Phase III of the RCSP, financial issues dominated the outcomes in these projects, directly causing termination of three of the projects and contributing to termination in two others. Long-term liability and lack of coordination among regulatory authorities also posed significant barriers.” **Craig Hart**, *Belfer Center for Science and International Affairs*, Available online July 2011, <http://belfercenter.ksg.harvard.edu/files/Hart%20Putting%20It%20All%20Together%20DP%20ETIP%202011%20web.pdf>.

TECHNOLOGY

“A framework for environmental assessment of CO₂ capture and storage systems.”

The following is the Abstract of this article: “CCS is increasingly seen as a way for society to enjoy the benefits of fossil fuel energy sources while avoiding the climate disruption associated with fossil CO₂ emissions. A decision to deploy CCS technology at scale should be based on robust information on its overall costs and benefits. LCA is a framework for holistic assessment of the energy and environmental footprint of a system, and can provide crucial information to policy-makers, scientists, and engineers as they develop and deploy CCS systems. [The authors] identify seven key issues that should be considered to ensure that conclusions and recommendations from CCS LCA are robust: energy penalty, functional units, scale-up challenges, non-climate environmental impacts, uncertainty management, policy-making needs,

and market effects. Several recent life-cycle studies have focused on detailed assessments of individual CCS technologies and applications. While such studies provide important data and information on technology performance, such case-specific data are inadequate to fully inform the decision making process. LCA should aim to describe the system-wide environmental implications of CCS deployment at scale, rather than a narrow analysis of technological performance of individual power plants.” **Roger Sathre, Mikhail Chester, Jennifer Cain, and Eric Masanet**, *Energy*, Available online November 29, 2011, doi:10.1016/j.energy.2011.10.050, <http://www.sciencedirect.com/science/article/pii/S0360544211007171>. (Subscription may be required.)

“Life cycle assessment of CO₂ sequestration in magnesium silicate rock – A comparative study.”

The following is the Abstract of this article: “This paper addresses the energy and environmental implications of [storing] CO₂ from a coal power plant using magnesium silicate rock. An accounting type life cycle assessment (LCA) of the mineralization method under development at Åbo Akademi University (ÅAU), Finland, is presented and the results are compared with the process developed at NETL, formerly Albany Research Council (ARC) in the [United States]. The ÅAU process is a multi-staged route where CO₂ is [stored] via a process that first produces magnesium hydroxide, Mg(OH)₂ from Mg silicate. The Mg(OH)₂ produced is later reacted with CO₂ in a high temperature gas/solid pressurized fluidized bed (FB) reactor, forming pure, stable and environmentally benign MgCO₃ product. This study addresses the following important issues; (a) the material and energy requirements of [storing] 1 ton of CO₂ (t-CO₂) in mineral silicate, (b) the overall environmental burdens associated with CO₂ [storage] using serpentinite mineral, (c) the priorities and opportunities for reduction of energy requirements and environmental impacts associated with mineralizing CO₂, and (d) comparison of LCA results of the ÅAU mineralization process route with that of the mineralization process developed by NETL. Exergy calculations show that with heat recovery mineralizing 1 t-CO₂ using the ÅAU process requires 3.6 GJ/t-CO₂ while that of the NETL needs 3.4 GJ/t-CO₂. Applying results of exergy analysis in the life cycle inventory (LCI) models of the ÅAU and the NETL processes leads to 517 kg CO₂e and 683 kg CO₂e of [GHG] emissions (in CO₂ equivalents) respectively, for every ton of CO₂ mineralized in serpentinite.” **Experience Nduagu, Joule Bergerson, and Ron Zevenhoven**, *Energy Conversion and Management*, Available online November 29, 2011, doi:10.1016/j.enconman.2011.10.026, <http://www.sciencedirect.com/science/article/pii/S0196890411003074>. (Subscription may be required.)



TERRESTRIAL

“Application of eddy covariance to determine ecosystem-scale carbon balance and evapotranspiration in an agroforestry system.”

The following is the Abstract of this article: “The inclusion of belts of trees in the agricultural areas of south-western Australia is gaining popularity, through perceived benefits in water use, biodiversity and

TERRESTRIAL (CONTINUED)

carbon [storage]. However, water use and carbon assimilation are difficult to quantify at the ecosystem scale. In this research, [the authors] investigate the application of eddy covariance in a ‘belt and alley’ system. Footprint [modeling] indicated that the proportion of the signal from the tree belts was similar to the proportion of tree belts in the ecosystem. Eddy covariance units were installed in two adjacent fields: one containing belts of four-year-old oil mallee Trees 10 m wide planted 60 m apart; and one containing agricultural crops. Tree belts had little impact on wind direction or its standard deviation for any measurement height, and stationarity, integral turbulence and energy balance closure were similar for the two fields. Persistent upward wind flows were observed for wind directions aligned with the tree belts, suggesting the possibility of advection. For [the authors’] experimental site, removal of data for winds aligned with the tree belts had a negligible impact on fluxes of [CO₂] and water. During summer and autumn, the field containing oil mallees used 27 mm more water, and assimilated 0.93 Mg CO₂/ha more than the field without trees. Both daytime and night time CO₂ fluxes were greater in magnitude for the oil mallee field than the control field during summer. Water use by the trees was lower than other fields in the region where herbaceous perennials had been grown, and also lower than other estimates based on sap flow measurements. Further research will be necessary to determine the impact of spatial variability of water use on groundwater recharge at the catchment scale. Extra carbon storage associated with tree belts may increase their economic attractiveness to farmers in the region, but the impact of respiration after summer rainfall requires further investigation.” **P.R. Ward, S.F. Micin, and I.R.P. Fillery**, *Agricultural and Forest Meteorology*, Available online October 19, 2011, doi:10.1016/j.agrformet.2011.09.016, <http://www.sciencedirect.com/science/article/pii/S0168192311002929>. (Subscription may be required.)

“Loblolly and slash pine control organic carbon in soil aggregates and carbon mineralization.”

The following is the Abstract of this article: “The influence of soil aggregation as a means to protect soil organic carbon (SOC) from mineralization is unclear in sandy soils. The dominant forest cover types in the Lower Coastal Plain of the [United States] where sandy surface soils prevail are loblolly pine (*Pinus taeda*) and slash pine (*Pinus elliotii* var *elliotii*). The purpose of this study was to investigate the role aggregation plays in C incorporation and [storage] in sandy soils of the Lower Coastal Plain found under loblolly and slash pine ecosystems. Thirteen forest stands (seven loblolly pine; six slash pine) were used for this investigation. A sonic dismembrator was used to apply dispersive energy in order to destroy aggregates. The use of sonic energy was shown to be a valid tool for studying aggregates in sandy soils. The data showed that aggregates do not protect ASOC from mineralization in these sandy soils. Loblolly pine surface mineral horizons accumulated 131 [percent] more TSOC than slash pine soil horizons. Slash pine soils had a 27



[percent] higher specific mineralization rate than loblolly pine soils; and Diffuse Reflectance Fourier Transform spectra (DRIFTS) showed that soils under loblolly pine were more aromatic than those under slash pine – and became more aromatic as mineralization proceeded. Due to their dominance in the Lower Coastal Plain of the [United States], pine ecosystems play an important role in the conversion of atmospheric CO₂ into the TSOC pool. However, soil aggregation should not be considered a mechanism to protect SOC in these sandy soils when modeling soil carbon dynamics, even though slash pine systems show a slightly greater capacity to develop aggregates.” **E.I. Azuaje, N.B. Comerford, W.G. Harris, J.B. Reeves III, and S. Grunwald**, *Forest Ecology and Management*, Available online October 21, 2011, doi:10.1016/j.foreco.2011.09.030, <http://www.sciencedirect.com/science/article/pii/S0378112711005895>. (Subscription may be required.)

TRADING

Bloomberg, “Japan Aims to Start Bilateral Carbon Offset Program in 2013.”

Beginning in 2013, Japan will work with companies to reduce GHG emissions as part of a bilateral carbon offset program announced by the Ministry of Foreign Affairs of Japan (MOFA). The Japanese government has been preparing for the emission-cutting program by establishing energy management systems and forest protection projects with Japanese companies in developing countries. According to officials, feasibility studies to run the program in 28 countries have commenced, with plans to expand consultations with more nations in the future. For more details on the program, visit the MOFA website at: http://www.mofa.go.jp/policy/environment/warm/cop/lowcarbongrowth_vision_1111.html. November 29, 2011, <http://www.bloomberg.com/news/2011-11-29/japan-aims-to-start-bilateral-carbon-offset-program-in-2013.html>.

RGGI News Release, “RGGI Auction Sells 27 Million CO₂ Allowances, Proceeds to Benefit Northeast and Mid-Atlantic Regional Economy.”

The Northeast and Mid-Atlantic states participating in the Regional Greenhouse Gas Initiative (RGGI) have announced the results of their 14th quarterly auction of CO₂ allowances. The final auction of the program’s first three-year control period, a total of \$51.5 million was generated from the sale of 27,293,000 CO₂ allowances. For the current control period (2009-2011), 63 percent of the 42,983,482 allowances offered were sold, ranging from \$1.89 to \$5.00 per allowance, with a clearing price of \$1.89. Overall, the first three-year control period brought cumulative auction proceeds of \$952 million, and, according to a recent report by an independent consulting firm, The Analysis Group, will result in \$1.6 billion in net economic benefit to the region through RGGI-funded programs designed to reduce energy bills and support local jobs. For more information on the first control period, go to: http://www.rggi.org/docs/PR120911_Auction14Results.pdf. The next RGGI auction, which will be the first of the second control period, is scheduled for March 14, 2012. December 9, 2011, http://www.rggi.org/docs/PR120911_Auction14Results.pdf.

RECENT PUBLICATIONS

“The Carbon Capture and Storage/Sequestration (CCS) Technologies Market 2012-2020.”

The following is a summary of this document: “CCS is an alternative and convenient technology to eliminate [CO₂] before it is released in the atmosphere. It is one of the most innovative clean energy markets which will experience stable growth rates in the next [10] years. Reduction in [CO₂] emission has received increasingly global attention in the past few years because of accelerating climate change issues. Visiongain calculates that global expenditure on CCS technologies in 2012 will total \$13.70bn. Though the CCS industry will be faced with the restraints of proving the effectiveness of CCS technologies on the large-scale, the negative public perception of the technology and the unsupportive legislative framework, the CCS market is likely to provide substantial opportunities for potential investors. This report offers an examination of the CCS market over the next decade, providing detailed market forecasts for each of the leading national markets and offering in-depth analysis of the opportunities and challenges facing companies in the CCS market throughout the world. The report also describes the most important technological changes within the CCS industry and assesses their importance for the growth of the market over the long-term. The various drivers and restraints of the market are evaluated in order to provide readers with specific insights into the future direction of the CCS market. How much is going to be spent in the leading national CCS markets for new and upgraded CCS infrastructure between 2012 and 2022? Who are the leading companies in the CCS industry? Where are the growth opportunities over the next decade - in which countries and with which type of technology? These critical questions and many more are definitively answered in this comprehensive report.” The report is available for purchase at: [http://www.visiongain.com/Report/720/The-Carbon-Capture-Storage-Sequestration-\(CCS\)-Technologies-Market-2012-2022](http://www.visiongain.com/Report/720/The-Carbon-Capture-Storage-Sequestration-(CCS)-Technologies-Market-2012-2022).

“Bridging the Emissions Gap.”

The following is from the Executive Summary of this document: “Global climate policy has advanced on several fronts over the past few years and this report deals with two developments of particular importance – The readiness of countries to pledge to new emission reductions, and the agreement among countries to an important global climate target...In their ‘Emissions Gap Report’ released in December 2010, the scientists reported that a gap was expected in 2020 between expected emissions and the global emissions consistent with the 2°C target, even if pledges were implemented fully. After receiving the report, policymakers requested UNEP to prepare a follow-up document which not only updates emission gap estimates, but more importantly, provided ideas on how to bridge the gap. This present report is a response to this request. To do the work UNEP has convened 55 scientists and experts from 28 scientific groups across 15 countries. This report first reviews and summarizes the latest scientific studies of the gap. It then tackles the question – How can the gap be bridged? – by examining the question from different vantage points: From that of global integrated assessment models, from bottom-up studies of individual economic sectors, and from published work on the mitigation potential in international aviation and shipping emissions. These different perspectives provide a rich body of information on how to plausibly bridge the emissions gap in 2020 and beyond.” To view the entire UNEP report, visit: http://www.unep.org/pdf/UNEP_bridging_gap.pdf.

“Developing CCS Projects Under the CDM.”

The following is a summary of this document: “Taking into account this backdrop, this report sets out some of the key considerations for implementing CCS projects under the [Clean Development Mechanism (CDM)] and potentially other forms of climate finance in the future. The aim is to provide the reader with the necessary basic information to begin identifying and [conceptualizing] CCS projects under the CDM, begin building the business case, evaluating methodological aspects, and identifying regulatory issues and risks for establishing such a project in a developing country.” To download this Global CCS Institute report, go to: <http://www.globalccsinstitute.com/publications/developing-ccs-projects-under-clean-development-mechanism>.

“ROAD CCS Project: Non-confidential FEED study report.”

The following is a summary of this document: “ROAD (Rotterdam Capture and Storage Demonstration Project) is one of the largest integrated demonstration projects in the world for the capture and storage of CO₂, based on a new coal-fired power station located outside of Rotterdam, the Netherlands. ROAD recently completed its front end engineering and design (FEED) studies and cost estimations for the project and has prepared a special report for the Global CCS Institute [summarizing] the main results of the FEED study for the capture plant as performed by Fluor. This report includes topics such as technology selection, process flow diagrams, heat and mass balances, layout designs, cooling studies, capital and [operation and maintenance (O&M)] cost estimates and project schedules. The report aims to help other CCS projects, particularly those using post-combustion capture technology, to design and cost their own capture plant. The report is also likely to be useful to regulatory, permitting and other stakeholders who want to gain an understanding of what considerations project proponents give to the range of decision factors, including environmental performance of technologies.” To download this Maasvlakte CCS Project CV report, go to: <http://www.globalccsinstitute.com/publications/road-ccs-project-non-confidential-feed-study-report>.

RECENT PUBLICATIONS (CONTINUED)

“Proceedings from CCS Cost Workshop.”

The following is a summary of this document: “More than 50 studies have been released in the past five years that provide estimates of the costs for operating a CCS equipped power plant in a variety of regions around the world. There are also many other studies that examine only variants or elements of CCS technologies such as different chemical choices, heat integration issues, retrofits, storage or transport issues or technologies still in the [research and development (R&D)] stage...At the 10th International Conference on Greenhouse Gas Control Technologies in 2010, the need to establish an Expert Group on CCS costs was identified in response to the growing number of reports regarding the costs of CCS...An initial Steering Group was formed to [organize] the first meeting of the group. The inaugural meeting was held on March 22-23, 2011, hosted by [IEA]. The current understanding of the costs of CCS presented at that meeting and the agreed outcomes for the Group to take forward are included in this document. This work program consists of efforts to improve both the transparency of CCS cost calculations and the broader challenges associated with conveying messages around costs to the broader community.” To download the proceedings, go to: <http://www.globalccsinstitute.com/publications/proceedings-ccs-cost-workshop>.

“Legal and regulatory developments related to carbon capture and storage between November 2010 – June 2011.”

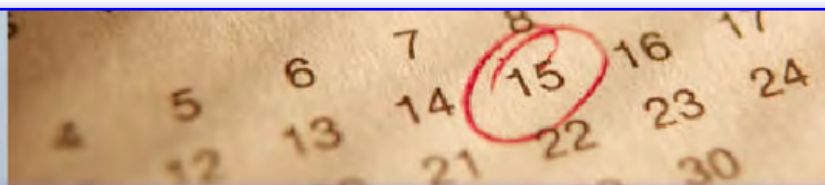
The following is a summary of this document: “As a part of the Policy, Legal and Regulatory (PLR) team’s research and preparatory activity for the drafting of the Global Status of CCS Report 2011, a legal and regulatory scan of the CCS legal and regulatory environment was commissioned from Baker & McKenzie. The study is aimed at providing a comprehensive overview of international, regional, national and sub-national legal and regulatory developments; including details of negotiations currently in progress, the signaled intent of future CCS legal and regulatory decisions and the status of implementation of regulation in a number of countries. Fifty-one jurisdictions were surveyed in total, including the [European Union’s (EU)] Member States, Federal, and state level jurisdictions in Australia and the [United States] and those developing nations which are the focus of the Institute’s capacity development activities. The Institute’s PLR team worked closely with Baker & McKenzie to develop the scope and format of the research; ensuring a detailed final report and accompanying legislation tables, as well as a process which is potentially replicable in the future.” To download the Baker & McKenzie report, go to: <http://www.globalccsinstitute.com/publications/legal-and-regulatory-developments-related-carbon-capture-and-storage-between-november-2>.

LEGISLATIVE ACTIVITY

The State Column, “State Rep. Jerome Delvin Introduces Bill to Streamline Greenhouse Gas Reporting.”

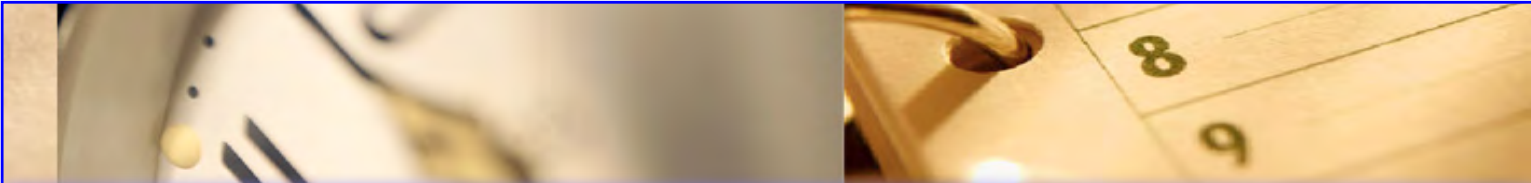
A bill to align Washington state’s GHG reporting requirements with those of the Federal government has been introduced. Washington state currently requires all businesses that emit 10,000 MT CO₂ equivalent or more per year to report, while the Federal threshold is 25,000 MT CO₂ equivalent per year. In 2008 and 2010, the Washington Legislature passed two bills authorizing the state’s GHG reporting program and directing the Department of Ecology to recover the costs of collecting, storing, and reporting certain information. The first

set of fees would be collected after the series of reports have been submitted in 2013. However, the newly introduced S.B. 5999 would eliminate the need for the fee by allowing business to file a single Federal report and give a copy to the state, effectively removing state GHG reporting requirements and requiring anyone reporting GHGs to the U.S. Environmental Protection Agency (EPA) to also submit the report to the Department of Ecology. In addition, the bill would remove all language, as well as the fees, regarding state rules for reporting GHGs, and revise the requirement for the Department of Ecology to share state GHG reports to sharing the EPA GHG reports with the local air authority where the reporting entity operates. To view S.B. 5999, visit: <http://apps.leg.wa.gov/billinfo/summary.aspx?bill=5999>. December 14, 2011, <http://www.thestatecolumn.com/washington/state-rep-jerome-delvin-introduces-bill-to-streamline-greenhouse-gas-reporting/>.



EVENTS

January 25-26, 2012, **ESCO Europe 2012**, *Millennium Gloucester Hotel & Conference Center, London, UK*. Focusing exclusively on the energy services company industry, this conference aims to develop energy efficiency measures to combat potential climate change. One of the topics to be discussed is the goal of working towards delivering 60 percent reductions in carbon emissions in London. To download the conference brochure, visit: http://www.esco-europe.eu/Default/Home_2_7859.aspx.



EVENTS (CONTINUED)

January 25-26, 2012, **Coal Symposium: Responding to Regulations, Enhancing Operational Efficiency & the Latest Word on Clean Coal Technology**, *Calgary TELUS Convention Center, Calgary, Alberta, Canada*. This symposium offers strategies for responding to provincial and Federal emissions regulations, information for building new and retrofitting old coal power plants, proactive public engagement tactics for the long-term viability of coal power generation in Canada, and insight on groundbreaking economical and technological advancements for clean energy in Canada and around the world. More details are available at: <http://www.canadianinstitute.com/2012/324/coal-symposium>.

February 5-7, 2012, **3rd International Conference on Climate Change and Sustainable Management of Natural Resources**, *Gwalior, Madhya Pradesh, India*. This conference will examine the evidences and causes of potential climate change; its impacts on humans and ecosystems; technological, social, ethical, and political responses; and strategies for adaptation. To learn more, go to: <http://www.itmuniversity.ac.in/TIMS/ABOUT-INTERNATIONAL-CONFERENCE.php>.

February 7, 2012, **Carbon Capture and Storage: Demonstration Programs and the Pathway to 2050**, *Central London, UK*. This seminar will assess the requirements for CCS deployment in the UK. Discussions will consider the technical challenges and feasibility of post-combustion CCS, as well as FEED study findings and the barriers that will need to be overcome in order to make the technology commercially viable. To download an agenda, click: <http://www.westminsterforumprojects.co.uk/forums/event.php?eid=323>.

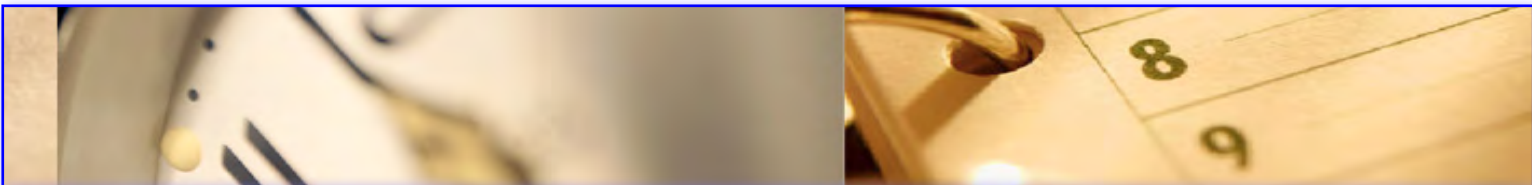
February 7-9, 2012, **Carbon Management Technology Conference**, *Caribe Royale Hotel & Convention Center, Orlando, Florida, USA*. This inaugural conference draws professionals from all engineering disciplines to share their expertise on the reduction of GHG emissions and adaptation to changing climate. The conference will focus on engineering perspectives regarding key issues, including technologies, strategies, policies, and management systems. More information is located at: <http://www.spe.org/events/cmtc/2012/index.php>.

February 27-28, 2012, **Platts' 6th Annual European Carbon Capture and Storage**, *London Hilton Tower Bridge Hotel, London, UK*. Providing attendees an overview of European CCS and its development, this conference also covers the latest policy developments and deployment challenges, such as finance, public awareness, and storage liability. In addition, projects from around the world will be showcased in their various stages. For a detailed program, visit the conference website at: <http://www.platts.com/ConferenceDetail/2012/pc265/index>.

March 12-14, 2012, **Optimising Enhanced Oil Recovery**, *Venue to be Determined, Abu Dhabi, United Arab Emirates*. While the focus of this conference is on maximizing oil production by discussing efficient EOR strategies used worldwide, it commences with a one-day session dedicated to the development, technology, investment, and strategy of making CCS a reality. Topics covered include deployment of CCS facilities, CO₂ capture and EOR case studies, and CO₂ transportation strategies. For more information, go to: <http://v11.vutrevx.com/exchange-sites/Whitmore%20Group/59/events-pdfs-eu/eor2-mktg-agenda.pdf>.

April 24-25, 2012, **Carbon Capture and Storage Conference**, *Venue to be Determined, Calgary, Alberta, Canada*. This event provides an opportunity for attendees to hear from regulators, scientists, and industry players on the latest in CCS-related legislation, overcoming geologic challenges, devising business models for commercialization, gaining public acceptance, and other topics. Visit: <http://www.canadianinstitute.com/2012/338/carbon-capture-and-storage-conference/> for more details.

April 30-May 2, 2012, **11th Annual Conference on Carbon Capture, Utilization, and Sequestration**, *David L. Lawrence Convention Center, Pittsburgh, Pennsylvania, USA*. The intent of this conference is to: (1) provide a forum for the exchange of experience among scientific and engineering communities working on such technologies and systems; (2) facilitate the necessary dialogue between technology developers/purveyors, industry, and the public on the development and deployment of viable technologies; and (3) share experience on developing the necessary capacity within the public and private sector to move the technology base forward. More information is available at: <http://www.carbonsq.com/>.



EVENTS (CONTINUED)

May 21-23, 2012, **Global Conference on Oceans, Climate, and Security**, *Seaport Hotel and World Trade Center, Boston, Massachusetts, USA*. This three-track conference will focus on mitigating the effects of potential climate change on coastal and ocean ecosystems, as well as the security interests of the Nation. Included is a Science and Technology Needs track, which will discuss, among other topics, technologies and innovations, modeling solutions and simulations, and emerging sciences. For more information, visit: <http://www.gcocs.org/>.

November 18-22, 2012, **International Conference on Greenhouse Gas Technologies 11 (GHGT-11)**, *Kyoto International Conference Center, Japan*. This will be the second visit to Kyoto by the GHGT conference series, with more than 1,600 delegates expected to attend. A formal agenda has not yet been developed; however, planning for GHGT-11 is underway, with a call for papers open through February, 20, 2012. Visit: <http://www.ghgt.info/index.php/Content-GHGT11/ghgt-11-overview.html> for more details.

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To learn more about DOE's Carbon Sequestration Program, please contact John Litynski at john.litynski@netl.doe.gov, or Dawn Deel at dawn.deel@netl.doe.gov.