Carbon Sequestration Newsletter

September 2010

What's Inside?

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*, "Federal Task Force Sends Recommendations to President on Fostering Clean Coal Technology."**

The Interagency Task Force on Carbon Capture and Storage (CCS) delivered a series of recommendations for achieving the widespread, cost-effective deployment of CCS within 10 years to President Barack Obama on August 12, 2010. The report concludes that CCS technologies can be vital in reducing domestic greenhouse gas (GHG) emissions while preserving the option of using coal and other domestic fossil energy resources. The main findings of the report include: CCS is viable, a carbon price is critical, Federal coordination should be strengthened, and long-term liability could be a barrier to CCS deployment. The report contains input from 14 Federal agencies and departments, stakeholders, and CCS experts. In addition, the report addresses incentives for CCS adoption and a number of financial, economic, technological, legal, and institutional barriers to deployment; how best to coordinate existing Federal authorities and programs; and areas where additional Federal authority may be necessary. The task force was charged in February 2010 with proposing a plan to overcome the barriers to the widespread, cost-effective deployment of CCS within 10 years, and with a goal of bringing five to 10 commercial demonstration projects online by 2016. The Interagency Task Force on CCS is co-chaired by the U.S. Department of Energy (DOE) and the U.S. Environmental Protection Agency (EPA). (**See Recent Publications section for a portion of the Executive Summary and a link to the ñReport of the Interagency Task Force on Carbon Capture and Storage.ò**) August 12, 2010, http://www.fossil.energy.gov/news/techlines/2010/10035-CCS_Task_Force_Issues_Report.html.

***Fossil Energy Techline*, "Department of Energy Announces 15 Projects Aimed at Secure Underground Storage of CO_2."**

U.S. Energy Secretary Steven Chu announced the selection of 15 projects to develop technologies aimed at safely and economically storing carbon dioxide (CO_2) in geologic formations. The selections will receive $21.3 million over three years and will help reduce U.S. GHG emissions and develop and deploy near-zero-emission coal technologies. In addition, the projects will: (1) complement existing DOE initiatives to help develop the technology and infrastructure to implement large-scale CO_2 storage in different geologic formations across the Nation; and (2) complement ongoing efforts by developing and testing technologies that address critical challenges for geologic storage, including CO_2 injection, storage capacity, plume migration, and containment by caprock and other trapping mechanisms. August 11, 2010, http://www.fossil.energy.gov/news/techlines/2010/10034-DOE_Selects_CO2_Storage_Projects.html.

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Sequestration in the News

***Fossil Energy Techline*, "Secretary Chu Announces Six Projects to Convert Captured CO_2 Emissions from Industrial Sources into Useful Products."**

DOE selected six projects that aim to find methods of converting CO_2 emissions captured from industrial sources into useful products, such as fuel, plastics, cement, or fertilizers. The projects, which will be funded with $106 million from the American Recovery and Reinvestment Act of 2009 (Recovery Act) and $156 million in private cost-share, were initially selected for first phase funding in October 2009 as part of a $1.4 billion effort to capture CO_2 from industrial sources for storage or beneficial use. After performing experiments on innovative concepts and producing preliminary designs, the projects now enter a second phase involving the design, construction, and operation of their innovations at pilot scale, as well as the evaluation of the technical and economic feasibility of commercial application. For more information on DOE's Carbon Sequestration Research Program, click: http://www.fossil.energy.gov/programs/sequestration/index.html. July 22, 2010, http://www.fossil.energy.gov/news/techlines/2010/10027-DOE_Announces_Six_Projects_to_Conv.html.

***Texas Clean Energy Project News Release*, "Summit Power Begins FEED Study for Texas IGCC-CCS Project."**

The Summit Power group launched a pre-construction Front-End Engineering and Design (FEED) study for its Texas Clean Energy Project (TCEP) located in Penwell, Texas. Construction will begin on the project in the second half of 2011 following completion of the FEED study, which was formally launched on June 30, 2010. TCEP, which will be an integrated gasification combined cycle (IGCC) 400-MW plant, received a $350 million award to demonstrate the commercial integration of large-scale IGCC with CCS and serve as a model for carbon capture projects throughout the world. TCEP will reportedly capture nearly 3 million tons of CO_2 annually. July 22, 2010, http://texascleanenergyproject.com/news/Summit+Power+begins+FEED+study+for+Texas+IGCC-CCS+project.

***The Chemical Engineer*, "Teesside Industry Investigates CCS."**

A joint initiative has been formed by several process engineering companies in the Teesside region of the United Kingdom to investigate the potential of a joint CCS system. The group will examine methods to implement and progress previous studies on setting up an industrial CCS network that would capture CO_2 emissions from the local process companies and transport them for storage in depleted North Sea oil fields. The plan for the joint initiative is to determine how a CCS system would benefit those involved, while linking with one of the four CCS projects under consideration by the region's power plants. August 6, 2010, http://www.tcetoday.com/tcetoday/NewsDetail.aspx?nid=13019.

ANNOUNCEMENTS

Geothermal Funding Opportunity Announcement Released.

DOE has announced a new Funding Opportunity Announcement (FOA) focused on advancing geothermal systems research and development (R&D) throughout the United States. The FOA, which marks an investment of up to $15 million to spur the design and validation of innovative methods for geothermal heat recovery, is seeking to reach out beyond traditional geothermal communities, including the carbon sequestration community. The FOA closing date is Friday, October 1, 2010, and the solicitation is available at: http://www1.eere.energy.gov/geothermal/financial_opps_detail.html?sol_id=358.

NETL Carbon Sequestration Project Portfolio Available Online.

The National Energy Technology Laboratory's (NETL) 2010 Carbon Sequestration Project Portfolio contains selected carbon sequestration program papers and publications; NETL's Best Practices Manuals (BPMs); DOE's Regional Carbon Sequestration Partnership (RCSP) fact sheets (Validation and Development Phases); Carbon Sequestration Focus Area fact sheets (pre-combustion capture; geologic carbon storage; monitoring, verification, and accounting [MVA]; simulation and risk assessment; and CO_2 utilization); and Recovery Act fact sheets. The portfolio is available at: http://www.netl.doe.gov/technologies/carbon_seq/refshelf/project%20portfolio/2010/index.html.

Regional Carbon Sequestration Partnership Annual Review.

The RCSPs will hold their Annual Review Meeting at the Sheraton Station Square in Pittsburgh, Pennsylvania, on October 5-7, 2010. For more information, visit the conference website at: http://www.netl.doe.gov/events/10conferences/rcsp/.

2009 Annual Report on the Market for RGGI CO_2 Allowances Now Available.

Potomac Economics, the independent market monitor for the Regional Greenhouse Gas Initiative (RGGI) CO_2 allowance market, released the "2009 Annual Report on the Market for RGGI CO_2 Allowances," which is based on data from RGGI CO_2 allowance auctions, the Commodity Futures Trading Commission (CFTC), the Chicago Climate Futures Exchange (CCFE), and the New York Mercantile Exchange (NYMEX). The complete report is available at: http://www.rggi.org/docs/MM_2009_Annual_Report.pdf.

CCS Forum.

On September 15, 2010, a half-day CCS forum will be held at The Geologic Society in London, England, to discuss the effect(s) carbon concerns can have on industry; current and future capture projects; and safe, cost-effective CO_2 storage. More information is available at: http://www.findingpetroleum.com/event/Carbon_capture_and_storage/365.aspx.

DOE and GWPC Water/Energy Symposium.

DOE's Office of Fossil Energy (FE) and the Ground Water Protection Council (GWPC) are sponsoring a Water/Energy Symposium on September 26-29, 2010, in Pittsburgh, Pennsylvania. Leaders from government, industry, academia, and others will discuss the relationship between water and energy and working together to deliver freshwater and clean energy. More information is available at: http://waterenergy2010.com/.

SCIENCE

***Science Daily*, "'Dry Water' Could Make a Big Splash Commercially, Help Fight [Climate Change]."**

At the 240th National Meeting of the American Chemical Society, scientists said that a substance known as "dry water" could potentially absorb and store CO_2. The scientists reported that the substance is known as dry water because it consists of 95 percent water and is a dry powder; each particle of powder contains a water droplet surrounded by modified silica, the material that makes up beach sand. The silica coating prevents the water droplets from combining and turning back into liquid form, resulting in a powder that can absorb gases to chemically form a hydrate. In laboratory-scale research, the scientists found that dry water, which resembles powdered sugar in appearance, absorbed more than three times as much CO_2 as ordinary, uncombined water and silica in the same amount of time. This ability to absorb large amounts of CO_2 as a hydrate could make it useful in addressing climate change, according to the scientists. In addition to CO_2 absorption, the scientists had previously demonstrated the ability to store methane (CH_4), which could be applied to collecting and transporting natural gas deposits. August 26, 2010, http://www.sciencedaily.com/releases/2010/08/100825174102.htm.

***The Independent*, "[Climate Change] Threatens Asian Rice Production: Study."**

According to a study conducted by researchers from the United States, the Philippines, and the Rome-based Food and Agriculture Organization (FAO), small rises in global temperatures have the potential to reduce rice production in Asia. The study looked at the impacts of rising daily

Science (Continued)

minimum and maximum temperatures on irrigated rice production from 1994 to 1999 in 227 fields in China, India, Indonesia, the Philippines, Thailand, and Vietnam. The data showed that the primary reason behind reduced rice yields was the rising daily minimum temperatures, which have cut the rice yields by 10 to 20 percent in several key locations over the past 25 years. As temperatures continue to rise, researchers expect the loss in production to increase. August 11, 2010, http://www.google.com/hostednews/afp/article/ALeqM5jQdV69W_J5hApCILihf6sFg0Xpng.

Policy

***U.S. Environmental Protection Agency News Release*, "EPA Proposes Rules on Clean Air Act Permitting for Greenhouse Gas Emissions."**

EPA is proposing two rules to ensure that businesses planning to build new, large facilities, or expansions to existing facilities, will be able to obtain Clean Air Act (CAA) permits that address their GHG emissions. Beginning in 2011, projects that will significantly increase GHG emissions will require an air permit as a result of EPA's GHG Tailoring Rule; the two proposed rules will help ensure these sources will be able to get permits regardless of where they are located. In the first rule, EPA is proposing to require permitting programs in 13 states to make changes to their implementation plans to make certain that GHG emissions are covered. The second rule proposes a Federal implementation plan, which would allow EPA to issue permits for large GHG emitters located in states that may not be able to develop and submit revisions to their plans before the Tailoring Rule becomes effective. EPA is working to finalize these rules prior to January 2, 2011. August 12, 2010, http://yosemite.epa.gov/opa/admpress.nsf/d0cf6618525a9efb85257359003fb69d/708bd315d348b5568525777d0060c5da!OpenDocument.

***U.S. Department of Commerce Press Release*, "U.S. Departments of Commerce and the Interior to Cooperate on Climate-Related Activities."**

The U.S. Departments of Commerce and the Interior (DOC/DOI) formalized an agreement to cooperate on climate-related activities involving science, services, mitigation, adaption, education, and communication. A Memorandum of Understating (MOU) was signed, providing a framework to build upon existing partnerships that bring together their best available climate science and services to inform adaption strategies and response decisions to manage America's oceans, coasts, the Great Lakes, and public lands. In addition, the MOU will support broader interagency coordination efforts through the U.S. Global Change Research Program. The MOU is available at: http://www.noaa.gov/climateresources/resources/doidocclimatemoufinal.pdf. August 3, 2010, http://www.commerce.gov/news/press-releases/2010/08/03/us-departments-commerce-and-interior-cooperate-climate-related-activi.

"Personal carbon trading: A policy ahead of its time?"

The following is from the Abstract of this article: "In 2008, the UK government undertook a review of personal carbon trading (PCT) and declared that it was 'an idea currently ahead of its time.' PCT is a radical policy proposal which would entail all adults receiving an equal, tradable carbon allowance to cover emissions from household energy and/or personal travel. The allowance would reduce over time, in line with national emissions reduction goals. The government's key concerns about PCT were its social unacceptability and high cost. This paper reviews the literature and identifies knowledge gaps, and then discusses whether these concerns are justified. Contrary to the government's conclusions, most research shows PCT to be at least as socially acceptable as an alternative taxation policy. People think it could be both fair and effective. Set-up and running costs for PCT will undoubtedly be higher than for alternative taxation policies. However, PCT could deliver benefits from individual and social change motivated by non-economic aspects of the policy. These potential benefits are outlined here. The conclusion is that PCT is a promising and timely policy idea." **Tina Fawcett**, *Energy Policy*, Available online July 18, 2010, doi:10.1016/j.enpol.2010.07.001, http://www.sciencedirect.com/science/article/B6V2W-50JPS6Y-4/2/642870d246f9a7d7344a993a687afdf2. (Subscription may be required.)

Geology

"Adsorption and strain: The CO_2-induced swelling of coal."

The following is the Abstract of this article: "Enhanced coal bed methane recovery (ECBM) consists in injecting CO_2 in coal bed methane reservoirs in order to facilitate the recovery of the methane. The injected CO_2 gets adsorbed at the surface of the coal pores, which causes the coal to swell. This swelling in confined conditions leads to a closure of the coal reservoir cleat system, which hinders further injection. In this work [the authors] provide a comprehensive framework to calculate the macroscopic strains induced by adsorption in a porous medium from the molecular level. Using a thermodynamic approach [the authors] extend the realm of poromechanics to surface energy and surface stress. [The authors] then focus on how the surface stress is modified by adsorption and on how to estimate adsorption behavior with molecular simulations. The developed framework is here applied to the specific case of the swelling of CO_2-injected coal, although it is relevant to any problem in which adsorption in a porous medium causes strains." **M. Vandamme, L. Brochard, B. Lecampion, and O. Coussy**, *Journal of the Mechanics and Physics of Solids*, Available online July 21, 2010, doi:10.1016/j.jmps.2010.07.014, http://www.sciencedirect.com/science/article/B6TXB-50KC70F-2/2/4b43148b0af4dfb43140abf414eedb4e. (Subscription may be required.)

"Coal lithotypes before and after saturation with CO_2; insights from micro- and mesoporosity, fluidity, and functional group distribution."

The following is the Abstract of this article: "Four lithotypes, vitrain, bright clarain, clarain, and fusain, were hand-picked from the core of the Pennsylvanian Springfield Coal Member (Petersburg Formation) in Illinois. These lithotypes were analyzed petrographically and for meso- and

Geology (Continued)

micropore characteristics, functional group distribution using FTIR techniques, and fluidity. High-pressure CO_2 adsorption isotherm analyses of these lithotypes were performed and, subsequently, all samples were reanalyzed in order to investigate the effects of CO_2. After the high-pressure adsorption isotherm analysis was conducted and the samples were reanalyzed, there was a decrease in BET surface area for vitrain from 31.5 m^2/g in the original sample to 28.5 m^2/g, as determined by low-pressure nitrogen adsorption. Bright clarain and clarain recorded a minimal decrease in BET surface area, whereas for fusain there was an increase from 6.6 m^2/g to 7.9 m^2/g. Using low-pressure CO_2 adsorption techniques, a small decrease in the quantity of the adsorbed CO_2 is recorded for vitrain and bright clarain, no difference is observed for clarain, and there is an increase in the quantity of the adsorbed CO_2 for fusain. Comparison of the FTIR spectra before and after CO_2 injection for all lithotypes showed no differences with respect to functional group distribution, testifying against chemical nature of CO_2 adsorption. Gieseler plastometry shows that: 1) softening temperature is higher for the post-CO_2 sample (389.5°C vs. 386°C); 2) solidification temperature is lower for the post-CO_2 sample (443.5°C vs. 451°C); and 3) the maximum fluidity is significantly lower for the post-CO_2 sample (4 ddpm vs. 14 ddpm)." **M. Mastalerz, A. Drobniak, R. Walker, and D. Morse**, *International Journal of Coal Geology*, Available online July 8, 2010, doi:10.1016/j.coal.2010.06.007, http://www.sciencedirect.com/science/article/B6V8C-50GMM7D-1/2/beabee1ae1c77a9901fa9ad4c23ef984. (Subscription may be required.)

"Corrective measures based on pressure control strategies for CO_2 geological storage in deep aquifers.ò

The following is the Abstract of this article: "A prerequisite to the wide deployment at an industrial scale of CO_2 geological storage is demonstrating that potential risks can be efficiently managed. Corrective measures in case of significant irregularities, such as CO_2 leakage, are hence required as advocated by the recent European directive on CCS operations. In this regard, the objective of the present paper is to investigate four different corrective measures aiming at controlling the overpressure induced by the injection operations in the reservoir: stopping the CO_2 injection and relying on the natural pressure recovery in the reservoir; extracting the stored CO_2 at the injection well; extracting brine at a distant well while stopping the CO_2 injection, and extracting at a distant well without stopping the CO_2 injection. The efficiency of the measures is assessed using multi-phase fluid flow numerical simulations. The application case is the deep carbonate aquifer of the Dogger geological unit in the Paris Basin. A comparative study between the four corrective measures is then carried using a cost-benefit approach. Results show that an efficient overpressure reduction can be achieved by simply shutting-in the well. The overpressure reduction can be significantly accelerated by means of fluid extraction but the adverse consequences are the associated higher costs of the intervention operations." **Thomas Le Guénan and Jérémy Rohmer**, *International Journal of Greenhouse Gas Control*, Available online June 19, 2010, doi:10.1016/j.ijggc.2010.05.009, http://www.sciencedirect.com/science/article/B83WP-50BKNG7-1/2/f52e3435cd1bc8a753209878ef714523. (Subscription may be required.)

Technology

ñValuing national and basin level geologic CO_2 storage capacity assessments in a broader context."

The following is the Abstract of this article: "By their very nature, early national and basin scale assessments of geologic CO_2 storage capacity must rely on simplifying assumptions and generalizations across a broad range of deep geologic structures. Key aspects of the technical literature and much of the public policy dialogue surrounding these assessments tend to emphasize the lack of detailed data and uncertainties at these scales. However, looking beyond the imperfections of data and methodology, the results of such assessments offer significant value in helping to understand the potential for CCS technologies to deploy across various regions of the world." **James J. Dooley**, *International Journal of Greenhouse Gas Control*, Available online August 2, 2010, doi:10.1016/j.ijggc.2010.07.002, http://www.sciencedirect.com/science/article/B83WP-50NY968-2/2/54fc0537707a9beb04d3e5c10a8bafd0. (Subscription may be required.)

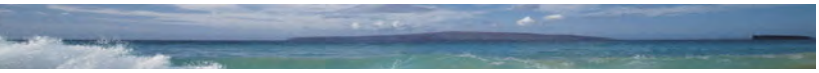
"Modeling the geoelectric and seismic reservoir response caused by carbon dioxide injection based on multiphase flow simulation: Results from the CO_2SINK project."

The following is from the Abstract of this article: "Results from crosshole geoelectric and surface seismic monitoring for geological storage of CO_2 were investigated by forward [modeling] within the framework of the CO_2SINK project. Selected geological and petrophysical parameters reflect the conditions of the CO_2SINK site. CO_2 saturation distributions were derived from multiphase flow [modeling], whereas the alteration of geophysical rock properties by CO_2 was obtained from laboratory experiments. Crosshole geoelectric [modeling] was performed for three electrode combinations and three time-dependent CO_2 migration scenarios with different reservoir permeabilities. The magnitude and alteration of [modeled] resistances were analyzed in the pre-inversion domain. Time-lapse alterations were observable on the synthetic data, with diverse characteristics dependent on applied electrode configuration. Analysis of the alterations showed the opportunity to differentiate migration scenarios within the constraints of the ambient noise level. The synthetic time-lapse seismic reflection experiment was performed for the anticline used for CO_2 storage. The geological model incorporates the structural framework, as determined from the seismic interpretation, and velocities derived from seismic processing and velocity logs. Common depth point (CDP) processing of synthetic shot gathers of a baseline and repeat experiment provided the data for a difference stack section exhibiting a CO_2 induced time-lapse signature. Interpretation of the signature in conjunction with the underlying CO_2 distribution has shown that lateral extent of the plume may be accurately detected. The vertical plume extent is concealed in the waveform coda and is unlikely to be retrievable from standard seismic processing." **Peter Bergmann, Ursula Lengler, Cornelia Schmidt-Hattenberger, Rüdiger Giese, and Ben Norden**, *Chemie der Erde*, Available online July 10, 2010, doi:10.1016/j.chemer.2010.05.007, http://www.sciencedirect.com/science/article/B7CW6-50H3RPH-1/2/403437431b085159fa4a69d9f4cb431b. (Subscription may be required.)

Technology (Continued)

"Modeling of the CO_2 process- and transport chain in CCS systems- Examination of transport and storage processes."

The following is the Abstract of this article: "Given the development of power plants with integrated capture of CO_2 and the subsequent storage of this captured CO_2 (CCS) the future fossil fuel-based energy system will most likely consist of very different types of processes and units. Past studies mostly focused on a very specific part of this CCS system. The effects and reactions on bordering processes were often only rudimentally considered. Due to these complex interactions between individual parts of a CCS system it is necessary to examine the [behavior] of the whole system in order to achieve secure and efficient operation. This article intends to highlight problems that will occur when such interactions are not considered and examined properly. This work presents an approach for the examination of a system consisting of a power plant, capture unit, transport system and CO_2 storage facility. A number of typical problems are shown, with focus on the examination of thermodynamic [behavior] of the captured CO_2 in a pipeline followed by a well in a saline aquifer storage site. It is shown that, under special conditions, the combination of a CO_2 pipeline and a well down to a saline aquifer will not work due to phase changes and pressure conditions, which would lead to operational problems or at the very least to partial destruction of either the pipes or the sedimentary storage rock." **Michael Nimtz, Matthias Klatt, Bernd Wiese, Michael Kühn, and Hans Joachim Krautz**, *Chemie der Erde*, Available online June 19, 2010, doi:10.1016/j.chemer.2010.05.011, http://www.sciencedirect.com/science/article/B7CW6-50BKDX0-1/2/17cfa8a2c2d9911ace7b3a8ecc90b9ae. (Subscription may be required.)



Terrestrial

"Permanent shallow subsoil CO_2 flux chambers for monitoring of onshore CO_2 geological storage sites."

The following is from the Abstract of this article: "Public concern over the possibility of migration of stored CO_2 to the surface with resulting damage to vegetation or hazard to humans and animals is a matter which will need to be addressed to be able to satisfy likely regulatory requirements for onshore CO_2 storage in a number of jurisdictions. While soil CO_2 concentration is readily measured continuously and in situ with current technology, the measurement of CO_2 flux at depths below the soil A horizon may be a more sensitive and meaningful technique for early detection of a near surface CO_2 plume. [The authors] describe a system for the continuous measurement of soil CO_2 flux at a depth of approximately 1.3 m and present results from three instruments deployed at the Otway Basin Pilot Project in Victoria, Australia and one development system deployed at Sutton, near the Australian Capital Canberra." **C. Bernado and D.F.de Vries**, *International Journal of Greenhouse Gas Control*, Available online July 1, 2010, doi:10.1016/j.ijggc.2010.05.011, http://www.sciencedirect.com/science/article/B83WP-50F36PP-1/2/da85c8678bfe96c710dbcfbc2edd8b57. (Subscription may be required.)

Trading

Carbon Market Update, August 17, 2010	
CCX-CFI 2010 ($/tCO$_2$) $0.10 (Vintage 2009)	EU ETS-EUA DEC 2010 ($/tCO$_2$) $18.64 (Converted from € to US$)

***The Province*, "B.C. to Adopt Cap-and-Trade Program for Greenhouse Gas Emissions in 2012,"** and ***The Vancouver Sun*, "B.C. to Unveil New Greenhouse Gas Emissions Rules."**

British Columbia will set its own limits on GHG emissions and allow industries to store or trade their carbon credits in a new cap-and-trade program outlined by the Western Climate Initiative (WCI). The program, due to come into effect in 2012, is part of the plan to reduce CO_2 emissions to 15 percent below 2005 levels by 2020. The regulations in British Columbia will lead to limits on 40 large industrial operations; those who emit above those limits will have to buy carbon credits, which project to cost $33 a tonne by 2020. In addition, other emissions sources, including transportation, residential, and commercial, will be included in the program by 2015. British Columbia joined WCI in 2007 and introduced the Greenhouse Gas (Cap-and-Trade) Act in April 2008. For more information on GHG emissions in British Columbia, visit: http://www.livesmartbc.ca/learn/emissions.html. July 27, 2010, http://www.theprovince.com/technology/adopt+trade+program+greenhouse+emissions+2012/3329676/story.html, and July 28, 2010, http://www.vancouversun.com/technology/unveil+greenhouse+emissions+rules/3334656/story.html.

"Integration of CCS, emissions trading and volatilities of fuel prices into sustainable energy planning, and its robust optimization."

The following is the Abstract of this document: "In this paper, a new approach has been proposed that allows a robust optimization of sustainable energy planning over a period of years. It is based on the modified energy flow optimization model (EFOM) and minimizes total costs in planning capacities of power plants and CCS to be added, stripped or retrofitted. In the process, it reduces risks due to a high volatility in fuel prices; it also provides robustness against infeasibility with respect to meeting the required emission level by adopting a penalty constant that corresponds to the price level of emission allowances. In this manner, the proposed methodology enables decision makers to determine the optimal capacities of power plants and/or CCS, as well as volumes of emissions trading in the future that will meet the required emission level and satisfy energy demand from various user-sections with minimum costs and maximum robustness. They can also gain valuable insights on the effects that the price of emission

Trading (Continued)

allowances has on the competitiveness of RES and CCS technologies; it may be used in, for example, setting appropriate subsidies and tax policies for promoting greater use of these technologies. The proposed methodology is applied to a case based on directions and volumes of energy flows in South Korea during the year 2008." **Jamin Koo, Kyusang Han, and En Sup Yoon**, *Renewable and Sustainable Energy Reviews*, Available online August 2, 2010, doi:10.1016/j.rser.2010.07.050, http://www.sciencedirect.com/science/article/B6VMY-50P0DM2-8/2/e07be401f98e1438d2623016776ddeb0. (Subscription may be required.)

Recent Publications

"Report of the Interagency Task Force on Carbon Capture and Storage."

The following is from the Executive Summary of this document: "CCS refers to a set of technologies that can greatly reduce CO_2 emissions from new and existing coal- and gas-fired power plants, industrial processes, and other stationary sources of CO_2. In its application to electricity generation, CCS could play an important role in achieving national and global GHG reduction goals. However, widespread cost-effective deployment of CCS will occur only if the technology is commercially available and a supportive national policy framework is in place. In keeping with that objective, on February 3, 2010, President Obama established an Interagency Task Force on Carbon Capture and Storage composed of 14 Executive Departments and Federal Agencies. The Task Force, co-chaired by DOE and EPA, was charged with proposing a plan to overcome the barriers to the widespread, cost-effective deployment of CCS within [10] years, with a goal of bringing five to [10] commercial demonstration projects online by 2016. Composed of more than 100 Federal employees, the Task Force examined challenges facing early CCS projects as well as factors that could inhibit widespread commercial deployment of CCS. In developing the findings and recommendations outlined in this report, the Task Force relied on published literature and individual input from more than 100 experts and stakeholders, as well as public comments submitted to the Task Force. The Task Force also held a large public meeting and several targeted stakeholder briefings. While CCS can be applied to a variety of stationary sources of CO_2, its application to coal-fired power plant emissions offers the greatest potential for GHG reductions. Coal has served as an important domestic source of reliable, affordable energy for decades, and the coal industry has provided stable and quality high-paying jobs for American workers. At the same time, coal-fired power plants are the largest contributor to U.S. GHG emissions, and coal combustion accounts for 40 percent of global CO_2 emissions from the consumption of energy. EPA and Energy Information Administration (EIA) assessments of recent climate and energy legislative proposals show that, if available on a cost-effective basis, CCS can over time play a large role in reducing the overall cost of meeting domestic emissions reduction targets. By playing a leadership role in efforts to develop and deploy CCS technologies to reduce GHG emissions, the United States can preserve the option of using an affordable, abundant, and domestic energy resource, help improve national security, help to maximize production from existing oil fields through enhanced oil recovery (EOR), and assist in the creation of new technologies for export." The complete report is available at: http://www.fossil.energy.gov/programs/sequestration/ccstf/CCSTaskForceReport2010.pdf.

"Impact of the Marcellus Shale Gas Play on Current and Future CCS Activities."

The following is from the Introduction of this document: "The Marcellus Shale is a major geologic formation underlying significant portions of New York, Ohio, Pennsylvania, and West Virginia. Although it is a very tight formation, it contains a massive quantity of natural gas, thus making it of great economic importance. This paper covers the geology of the Marcellus Shale (extent, depth, gas producing potential, properties, etc.), the techniques used to produce the gas, and the potential for CCS in the Marcellus Shale or adjacent formations. Because of the low permeability of shale units, hydraulic fracturing and horizontal drilling were developed in the Barnett Shale of Texas during the 1990s; these were the key enabling technologies that made recovery of shale gas economically viable. These technologies have been applied to the Marcellus Shale and other shale gas basins. In addition to gas production from the Marcellus Shale and other gas shale basins in the [United States], this paper discusses the impact of shale gas exploration and production on the potential for CCS in the Marcellus and other units in the Appalachian Basin." The complete report is available at: http://www.netl.doe.gov/technologies/carbon_seq/refshelf/Marcellus_CCS.pdf.

"Development and innovation in carbon dioxide (CO_2) capture and storage technology."

The following is from a summary of this two-volume document: "The fossil-fuel power sector and energy-intensive industries are major producers of CO_2 emissions, contributing to rising global CO_2 levels that have been linked to climate change. CCS technology is therefore being developed for application to power plants and in CO_2-intensive industries to reduce the carbon footprint of these activities, in order to mitigate the potentially harmful effects of climate change. CO_2 capture options range from post- and pre-combustion separation to advanced combustion-based options, which are applicable to both new-build power plant or as a retrofit to existing plant, and can also be adopted in other industries. CO_2 storage options range from geological sequestration in deep saline aquifers and [utilization] of CO_2 for enhanced oil and gas recovery, to mineral carbonation and biofixation. Developments and innovations in this field are aimed at increasing the effectiveness and lowering the cost of capture, and at verifying the safety and efficacy of storage/sequestration. Developments and innovation in [CO_2] capture and storage technology, Volumes 1 and 2, provide a comprehensive reference on the state of the art of research, development and demonstration of CCS technology in the power sector and in industry. With its distinguished international team of

Recent Publications (Continued)

contributors, Developments and innovation in [CO_2] capture and storage technology, Volumes 1 and 2, will be a standard reference for professional and manager in the power sector and related industries, as well as to academics and researchers in this important field." To view Volume 1, titled, "Carbon dioxide (CO_2) capture, transport and industrial applications," click: http://www.woodheadpublishing.com/en/book.aspx?bookID=1552. To view Volume 2, titled, "Carbon dioxide (CO_2) storage and utilization," go to: http://www.woodheadpublishing.com/en/book.aspx?bookID=2047.

Legislative Activity

***Reuters*, "New Climate and Energy Policies Could Create 2.5 Million Jobs, Hold Down Energy Costs."**

According to a new report from the Center for Climate Strategies, new Federal GHG emissions and energy policies could generate up to 2.5 million new jobs and create $134 billion in economic activity in the United States. Based on economic impacts of climate policies developed by 16 states, the report calls for the implementation of 23 policy approaches that aim to reduce emissions; be cost-effective; and improve energy, health, environment, and economic development. More specifically, the report suggested policies focus on the creation of new clean energy sources for heat and power, improved energy efficiency and industrial processes, transportation and land use improvements, agriculture and forestry conservation, and expanded recycling and waste energy recovery under a national framework. According to the report, and assuming all 23 actions are implemented, the resulting GHG reductions would surpass proposed national targets, reducing U.S. emissions to 27 percent below 1990 levels by 2020. The full report is available at: http://advanced.jhu.edu/academic/government/energy-policy-report/. July 22, 2010, http://www.reuters.com/article/idUS153522+22-Jul-2010+PRN20100722.

Events

September 13-17, 2010, **2010 CO_2 Capture Technology R&D Meeting**, *Sheraton Station Square Hotel, Pittsburgh, Pennsylvania, USA*. This meeting provides a public forum to present CO_2 capture technology development status and accomplishments. Topics to be covered include post-, oxy-, and pre-combustion carbon capture technologies – including post-combustion solvent, sorbent, and membrane technologies – and CO_2 compression technologies. For registration information, visit the conference website at: http://www.netl.doe.gov/events/10conferences/co2capture/#mtg.

September 15-17, 2010, **10th International Conference on Clean Energy**, *Salamis Bay Conti Hotel, Famagusta, North Cyprus*. This conference provides a platform to discuss two topics: the depletion of fossil fuels and the resulting potential environmental problems. Other topics to be discussed include climate change, renewable energy sources, environmental impacts, and risk analysis and economics. To learn more, visit the conference website at: http://icce2010.emu.edu.tr/proceedings.html.

September 19-23, 2010, **10th International Conference on Greenhouse Gas Control Technologies**, *RAI, Amsterdam, The Netherlands*. Attendees of this conference, which is held every two years, will contribute to discussions on overcoming the barriers to implementing GHG mitigation technologies, as well as technological and policy-related developments. For more information, visit the conference website at: http://www.ghgt.info/GHGT10.html.

September 27-18, 2010, **EXPPERTS 2010**, *Hotel Pullman Berlin Schweizerhof, Berlin, Germany*. In its fifth year, this event discusses the best available technologies and strategies for reducing power plant emissions. In addition, the technical and financial viability of CCS will be investigated for both coal- and gas-fired plants. To learn more, visit the conference website at: http://www.arena-international.com/expperts2010/index.html.

Events (Continued)

September 29-30, 2010, **Carbon Capture and Storage Summit**, *Capital Hilton, Washington, DC*. The 4th Annual CCS Summit will provide a forum to discuss the continuing development of commercialized CCS technologies. Topics to be discussed include: the impact of legislation on CCS; legal, regulatory, and liability issues surrounding CCS; CO_2-enhanced oil recovery (EOR); and the acceleration of CO_2 transport infrastructure. For a full list of topics, visit the conference website at: http://www.carboncapturesummit.com/index.html.

October 12-14, 2010, **2010 SPE Eastern Regional Meeting**, *Morgantown, West Virginia, USA*. The technical sessions at this meeting will cover topics such as CCS and gas storage; production operations, optimization, monitoring, and control; formation evaluation; and the drilling of wells. More information can be found by visiting the conference website at: http://www.spe.org/events/erm/2010/.

October 19-20, 2010, **Carbon Capture and Storage Symposium 2010**, *Chifley at Lennons, Brisbane, Queensland, Australia*. The Carbon Capture and Storage Symposium 2010 features cases studies of local and global initiatives and projects related to CCS, including policy and regulatory frameworks, business models and strategies in a low carbon economy, technical presentations on low emissions technologies, site selection, and expert-led panel discussions. Detailed information can be obtained at: http://www.carbon-capture.com.au/Event.aspx?id=329858.

October 25-26, 2010, **Coal Power Plant Fundamentals**, *The Adolphus Hotel, Dallas, Texas, USA*. This Electric Utility Consultants, Inc. (EUCI) introductory course details the basic workings of a coal-fired power plant, covering all major systems from coal handling to the switchyard. For more information, including a detailed program agenda, view the course brochure at: http://www.euci.com/pdf/1010-coal-power.pdf.

October 27-28, 2010, **Emissions Regulations and Control Technologies for Fossil-Fuel Power Plants**, *The Adolphus Hotel, Dallas, Texas, USA*. This EUCI course will provide a basic understanding of how emission control technologies reduce emissions. In addition, the CAA will be discussed and CO_2 emissions standards will be reviewed. For more information, including a detailed program agenda, view the course brochure at: http://www.euci.com/pdf/1010-emisisons.pdf.

November 14-17, 2010, **2010 Behavior, Energy & Climate Change Conference**, *Hyatt Regency, Sacramento, California, USA*. The fourth annual Behavior, Energy & Climate Change (BECC) Conference focuses on the practical applications of social and behavioral research to achieve viable solutions for meeting long-term energy and GHG emissions reduction targets. Topics to be discussed include current policy issues; program/communication strategies; and collaboration across government, utility, business, and research sectors in order to accelerate the transition to an energy efficient, low-carbon economy. For more information, visit the conference website at: http://www.beccconference.org/.

For subscription details...

Please visit http://listserv.netl.doe.gov/mailman/listinfo/sequestration, enter your email address, and create a password. This will enable you to receive a pdf version of the Carbon Sequestration Newsletter at no cost.
To view an archive with past issues of the newsletter, see: http://www.netl.doe.gov/technologies/carbon_seq/refshelf/subscribe.html.

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