Office of Fossil Energy

Carbon Sequestration Newsletter

January 2013

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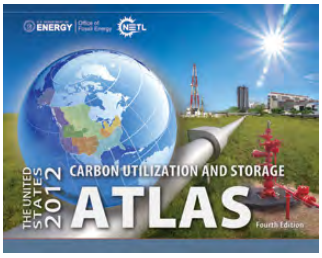
Introduction

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*, "DOE's Carbon Utilization and Storage Atlas Estimates at Least 2,400 Billion Metric Tons of U.S. CO_2 Storage Resource."**

According to the U.S. Department of Energy's (DOE) 2012 United States Carbon Utilization and Storage Atlas (Atlas IV), the United States has at least 2,400 billion metric tons of potential carbon dioxide (CO_2) storage resource in saline formations, oil and gas reservoirs, and unmineable coal. This CO_2 storage resource could potentially store hundreds of years' worth of greenhouse gas (GHG) emissions. Atlas IV states that more than 225 billion metric tons of storage resource has been identified in depleted oil and gas fields, which could accommodate storage of emissions from stationary sources while simultaneously improving the energy security of the United States by enhancing oil and gas recovery. Atlas IV was created by the Office of Fossil Energy's (FE) National Energy Technology Laboratory (NETL) with input from DOE's seven Regional Carbon Sequestration Partnerships (RCSPs) and American Recovery and Reinvestment Act (ARRA)-funded site characterization projects. The RCSPs are testing CO_2 storage potential and investigating best practices for CO_2 storage in a variety of geologic formations. The site characterization projects are furthering DOE efforts to assess the Nation's CO_2 storage resource by developing additional characterization data for possible storage reservoirs. The primary purpose of Atlas IV is to provide an update on the CO_2 storage potential in the United States and to showcase updated information about the RCSPs' field activities and new information from the site characterization projects. Atlas IV outlines DOE's Carbon Storage Program and its carbon capture, utilization, and storage (CCUS) collaborations, along with worldwide CCUS projects and CCUS regulatory issues. Atlas IV also presents updated information on the location of CO_2 stationary source emissions and the locations and storage potential of various geologic storage sites, and it provides information about the commercialization opportunities for CCUS technologies. The complete version of Atlas IV is available for download at: http://www.netl.doe.gov/technologies/carbon_seq/refshelf/atlasIV/Atlas-IV-2012.pdf. The NATCARB Viewer is accessible from: http://www.netl.doe.gov/technologies/carbon_seq/natcarb/index.html. December 19, 2012, http://www.fossil.energy.gov/news/techlines/2012/12061-DOE_Releases_Carbon_Storage_Atlas.html.



Sequestration in the News

***Carbon Capture Journal*, "UK Online CO_2 Storage Database to be Launched."**

The Energy Technology Institute (ETI) has agreed to a license with The Crown Estate and the British Geological Survey to host and further develop its

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

13131 Dairy Ashford Road, Suite 225
Sugar Land, TX 77478

1450 Queen Avenue SW
Albany, OR 97321-2198

2175 University Ave. South, Suite 201
Fairbanks, AK 99709

Traci Rodosta
304-285-1345
traci.rodosta@netl.doe.gov

Dawn M. Deel
304-285-4133
dawn.deel@netl.doe.gov

Visit the NETL website at:
www.netl.doe.gov

Customer Service:
1-800-553-7681

Sequestration in the News (Continued)

United Kingdom (UK) CO_2 Storage Appraisal project into a web-enabled database of mapped UK offshore CO_2 storage capacity. The online database contains geological data, storage estimates, risk assessments and economics of nearly 600 potential CO_2 storage units of depleted oil and gas reservoirs, and saline formations around the UK. Interested stakeholders will be able to access information concerning storage resource through the new, first-of-its-kind database, enabling them to make more informed, carbon capture and storage (CCS)-related decisions. The database is expected to go live in early 2013. December 15, 2012, http://www.carboncapturejournal.com/displaynews.php?NewsID=1070&PHPSESSID=l8dkjsha7qaa6s815mlrslvtq4.

***Callide Oxyfuel Project Media Release*, "Callide Oxyfuel Project Enters Demonstration Phase."**

Construction and commissioning of the coal-fired, low-emission Callide Oxyfuel Project has been completed, with the project now moving into the demonstration phase. The $208 million project aims to demonstrate how CCS technology can be applied to existing coal-fired power stations to produce electricity with lower emissions. The project is a joint venture between CS Energy, the Australian Coal Association Low Emission Technologies (ACALET), Xstrata Coal, Schlumberger, and Japanese participants (J-Power; Mitsui & Co., Ltd.; and IHI Corporation). Funding has been received from the Australian ($50 million under the Low Emissions Technology Demonstration Fund), Japanese, and Queensland governments, and the Japan Coal Energy Center (JCOAL) has provided technical support. December 15, 2012, http://www.callideoxyfuel.com/Portals/0/News/Callide%20Oxyfuel%20Project%20-%202012%20-%20OPENING%20EVENT%20-%20FINAL%20-%20Media%20release%20-%2015%20December%202012.pdf.

***MiningWeekly.com*, "SA and World Urged to Accelerate Carbon-Capture Efforts."**

Following Cabinet endorsement in 2012 of the "Carbon Capture and Storage Roadmap," developed by the South African Centre for Carbon Capture and Storage as one of the options for mitigating CO_2 emissions, South Africa is working to raise the profile of its CCS initiatives in 2013. The endorsement followed a voluntarily commitment by South Africa to reduce CO_2 emissions by 34 percent in 2020 and by 42 percent in 2025 if technological and financial support is available. South Africa has already published a carbon atlas and initiated preparations for its first CO_2 injection test by 2016. If feasible, the next step would be the development of a demonstration plant. The roadmap is available at: http://www.sacccs.org.za/roadmap/. On February 13-15, 2013, the European Commission (EC), along with Eskom and EcoMetrix Africa, will host a conference in Johannesburg, South Africa, at ESKOM's Academy of Learning in Midrand where information on the Octavius research program will be discussed. The Octavius project is dedicated to the demonstration of energy-efficient CO_2 capture processes at industrial pilot plants. More information on the Octavius project is available at: http://www.octavius-co2.eu/Octavius/jcms/xnt_15158/octavius-fp7-project. January 9, 2013, http://www.miningweekly.com/article/sa-and-world-urged-to-accelerate-carbon-capture-efforts-2013-01-09.

Sequestration in the News (Continued)

***The Korea Herald*, "Korea to Establish Carbon Storage Technology Research Center."**

Korea's leading research institution, the Korea Advanced Institute of Science and Technology, and oil developer Saudi Aramco signed a Memorandum of Understanding (MOU) in Dhahran, Saudi Arabia, to establish a research center to develop technologies to capture, store, and utilize CO_2. The new facility will be located at the school's campus in Daejeon, South Korea, and financed equally by the two sides; the collaboration will initially run for six years and could be extended. The organizations will work to develop commercially viable processes for CCS, as well as utilization technologies like using and converting CO_2 to produce food, beverages, bio and renewable fuels, and chemical feedstock. January 9, 2013, http://www.eco-business.com/news/korea-to-establish-carbon-storage-technology-research-center/.

Announcements

DOE Approves Field Test for Promising Carbon Capture Technology.

DOE has approved a post-combustion membrane technology to advance to a large-scale field test. The technology successfully demonstrated the separation and capture of 90 percent of the CO_2 from a pulverized coal plant. Membrane Technology and Research Inc. (MTR) will next begin fabricating a 1-megawatt (MW) system capable of meeting DOE's program goals of capturing more than 90 percent of CO_2 from flue gas with a less than 35 percent increase in cost of electricity. The 1-MW system will be tested at DOE's National Carbon Capture Center (NCCC) in Wilsonville, Alabama. For more information, visit: http://www.fossil.energy.gov/news/techlines/2012/12057-DOE_Approves_Carbon_Capture_Field_.html.

2013 Midwest Carbon Sequestration Science Conference.

The Midwest Geological Sequestration Consortium (MGSC) has announced plans for their annual Project Advisory Meeting on October 7, 2013, at the I Hotel and Conference Center in Champaign, Illinois. This conference will include a full day of Illinois Basin Decatur Project (IBDP) research presentations covering all aspects of the MGSC Phase III research activities. The conference will also include a Sequestration Training and Education Program (STEP)-sponsored workshop and an optional tour of the IBDP site. Full meeting details will be distributed in June, with registration opening in July. To visit the MGSC website, go to: http://www.sequestration.org/.

12th International Conference on Greenhouse Gas Control Technologies.

GHGT-12 will be held on October 5-9, 2014, in Austin, Texas. This will be the first visit by the conference series to Austin, Texas, and more than 1,600 participants are expected to attend. The event will be hosted by the University of Texas at Austin and the International Energy Agency Greenhouse Gas (IEAGHG) R&D Program. An overview of GHGT-12 is available at: http://ghgt.info/index.php/Content-GHGT12/ghgt-12-overview.html.

Factbook – Bringing Carbon Capture and Storage to Market.

A factbook based on the September 2012 SBC Energy Institute report, titled, "Bringing Carbon Capture and Storage to Market," has been released, summarizing the status of existing technologies and the main research and development (R&D) priorities. In addition, the factbook also analyzes the economics of the main large-scale demonstration and deployment projects and gives the SBC Energy Institute's view of the future of CCS technologies and projects. To download the document, go to: http://www.globalccsinstitute.com/publications/factbook-bringing-carbon-capture-and-storage-market.

Short Course at SPE Americas.

The Society of Petroleum Engineers (SPE) is offering a one-day short course, titled, "GHG and CCS Regulatory and Legal Framework," on March 17, 2013, at the Hilton Galveston Island Resort in Galveston, Texas. In addition to reviewing the evolving regulatory and legal frameworks that will govern GHGs and the CCS industry, the course will also cover topics such as the United Nations Framework Convention on Climate Change (UNFCCC), the Kyoto Protocol, current international climate negotiations, surface and subsurface property rights issues for geologic storage, and remaining gaps in legislation and regulation. More information is available at: http://www.spe.org/training/courses/RLF.php.

openCCS: A Collaboratively Developed Handbook for Delivering CCS Projects.

The Global CCS Institute (GCCSI) has released "openCCS," a platform for sharing methodologies, best practices, and lessons learned from experience with each component of an integrated CCS project. GCCSI's goal is for openCCS to improve over time through the contributions of CCS practitioners on topics such as: recommended project schedules, activities, and work breakdown structures; definitional pages to explain core CCS concepts; technical papers, methods, and guidelines; and aggregations of useful pages on other sites. To learn more, go to: http://www.globalccsinstitute.com/openccs. A slideshow overview of openCCS is available at: http://www.slideshare.net/globalccs/introduction-to-openccs-15612962.

Science

***Science Daily*, "Researchers Find First Evidence of Ice Age Wolves in Nevada."**

Researchers from the University of Nevada, Las Vegas, have unearthed fossil remains from a dire wolf (an extinct, Ice Age wolf species) in northwest Las Vegas, revealing the first evidence that the mammal once lived in Nevada. The fossil, which geologists estimate to be in the range of 10,000 to 15,000 years old, was discovered near the proposed Tule Springs Fossil Beds National Monument, an area known for Ice Age animal remains. The dire wolf is a larger relative of the gray wolf, and was present in North and South America for more than 1 million years; scientists believe the Ice Age mammal's extinction was due to competition from other wolf species and potential food scarcity approximately 10,000 years ago. December 13, 2012, http://www.sciencedaily.com/releases/2012/12/121213181107.htm.

***ClimateWire*, "Warmest Year Ever Recorded in Lower 48 States Came in 2012."**

According to the National Oceanic and Atmospheric Administration, 2012 was the warmest year ever recorded in the contiguous United States, as the average temperature in the lower 48 states reached 55.3 degrees Fahrenheit. This temperature was more than the previous record set in 1998 by one degree. The contiguous United States endured a record warm spring, its second warmest summer, fourth warmest winter, and an above average autumn. The government's temperature records for the contiguous United States date back to 1895. In addition, the research revealed that 2012 was the United States' second most extreme weather year on record, according to the U.S. Climate Extremes Index. The U.S. Climate Extremes Index tracks extreme weather activity by monitoring extremes of temperature and precipitation and tropical cyclones that make landfall. Finally, the researchers also stated that the global average temperature for 2012 appears to be the eighth warmest year in a record that goes back to 1880. January 9, 2013, http://www.eenews.net/climatewire/2013/01/09/2. (Subscription may be required.)

Policy

"A novel graphical approach to target CO_2 emissions for energy resource planning and utility."

The following is the Abstract of this article: "Many optimization techniques, both numerical and graphical, have recently been introduced for CO_2 emissions targeting. These targeting approaches have been applied to a wide range of applications including energy allocation and utility systems optimization. However, the trade-off between the operating cost and the associated CO_2 emissions cannot be easily assessed. This paper presents a new simple graphical approach to target CO_2 emissions associated with energy resources and utility systems. The principles of marginal energy cost and marginal CO_2 emissions are employed to construct two composite curves to be used as targeting tools. The CO_2 emissions composite curve (CO2CC) and cost composite curve (CCC) are used to determine the minimum cost associated with increasing energy demand whilst simultaneously meeting a given CO_2 emissions target. Multiple trade-off solutions so called Pareto optimal solutions can be generated using a range of emissions targets. The new graphical approach can be used to target CO_2 emissions related to utility systems and energy resources networks. Two case studies are used to demonstrate this targeting method." **Mohmmad A. Al-Mayyahi, Andrew F.A. Hoadley, and G.P. Rangaiah**, *Applied Energy*, Available in April 2013 edition, http://dx.doi.org/10.1016/j.apenergy.2012.11.077, http://www.sciencedirect.com/science/article/pii/S0306261912008872. (Subscription may be required.)

"The improvement of CO_2 emission reduction policies based on system dynamics method in traditional industrial region with large CO_2 emission."

The following is the Abstract of this article: "Some traditional industrial regions are characterized by high industrial proportion and large CO_2 emission. They are facing dual pressures of maintaining economic growth and largely reducing CO_2 emission. From the perspective of study of typological region, taking the typical traditional industrial region—Liaoning Province of China as a case, this study establishes a system dynamics model named EECP and dynamically simulates CO_2 emission trends under different conditions. Simulation results indicate, compared to the condition without CO_2 emission reduction policies, CO_2 emission intensity under the condition of implementing CO_2 emission reduction policies of 'Twelfth Five-Year Plan' is decreased by 11 [percent] from 2009 to 2030, but the economic cost is high, making the policies implementation faces resistance. Then some improved policies are offered and proved by EECP model that they can reduce CO_2 emission intensity after 2021 and decrease the negative influence to GDP, realizing the improvement objects of reducing CO_2 emission and simultaneously keeping a higher economy growth speed. The improved policies can provide reference for making and improving CO_2 emission reduction policies in other traditional industrial regions with large CO_2 emission. Simultaneously, EECP model can provide decision-makers with reference and help for similar study of energy policy." **Fujia Li, Suocheng Dong, Zehong Li, Shantong Li, and Yongkun Wan**, *Energy Policy*, Available in January 2013 edition, http://dx.doi.org/10.1016/j.enpol.2012.09.014, http://www.sciencedirect.com/science/article/pii/S0301421512007720. (Subscription may be required.)

Geology

"CO_2 capture from ethanol production and storage into the Mt Simon Sandstone."

The following is the Abstract of this article: "Under the Industrial Carbon Capture and Storage (ICCS) program, funded by ARRA, DOE is co-sponsoring the Archer Daniels Midland Company's (ADM's) large-scale CCS project in Illinois. FE's NETL manages this project, which receives $141.4 million in ARRA funding and another $66.5 million in private sector cost-sharing. This project, also referred to as the Illinois ICCS project, is under construction in Decatur, Illinois, and is scheduled to begin operations in 2013. The project team members are ADM, DOE, Schlumberger Carbon Services, Illinois State Geological Survey (ISGS), and Richland Community College (RCC). The Illinois

Geology (Continued)

ICCS project will demonstrate an integrated system for collecting up to 907,000 tonnes per year of CO_2 from ADM's ethanol plant in Decatur and geologically [storing] it in the Mt Simon Sandstone, a saline reservoir. The project scope includes the design, construction, and integrated operation of CO_2 compression, dehydration, and injection facilities, and monitoring, verification, and accounting [MVA] of the stored CO_2. Significant field work has been completed, i.e. design of the integrated CCS system, 3-D seismic survey and site characterization, and mechanical construction of the compression and dehydration facilities. This is the largest saline storage project under construction in the [United States]. This paper will provide an overview and benefits of the Illinois ICCS project, present the field work results, and highlight the current status and future plans." **Sai Gollakota and Scott McDonald**, *Greenhouse Gases: Science and Technology*, Available online October 15, 2012, doi:10.1002/ghg.1305, http://onlinelibrary.wiley.com/doi/10.1002/ghg.1305/abstract. (Subscription may be required.))

"Common attributes of hydraulically fractured oil and gas production and CO_2 geological [storage]."

The following is the Abstract of this article: "Areal footprints of current and future hydraulically fractured oil and gas reservoirs and potential CO_2 geological-[storage] intervals often overlap in sedimentary basins. Significant vertical separations between prospective subsurface volumes, however, will limit their interaction, particularly if the carbon-storage site is deeper than the hydrocarbon resource. Recent intense development of shale resources translates into a reduced need for [storage] capacity. It has also resulted in technological innovations directly transferable to the carbon-storage industry, in particular progress on well completion, such as new approaches to cementing, more mature horizontal drilling methods, and development of field-treatment techniques for saline water. In addition, knowledge collected by operators on stratigraphy and faults – for example, using 3D seismic – and on abandoned wells is directly useful in reducing risk in future carbon-storage projects. Both industries can benefit from development of regional transmission pipelines, pipeline rights-of-way, and a trained workforce. From a regulatory standpoint, hydraulic fracturing of shale and tight formations is not considered injection. Under the [U.S. Underground Injection Control (UIC)] program, because hydraulically fractured wells fall under the production category, they do not follow the same set of rules for protecting water resources as oil and gas industry disposal wells do (UIC Class II). Both subsurface uses share some risk elements, however. Environmental risks result mostly from abandoned wells and faults, poorly characterized for carbon storage, and from defective well completions and surface spills during oil and gas production. Operators of both fields are also concerned about disposal of large fluid volumes possibly generating seismic events." **Jean-Philippe Nicot and Ian J. Duncan**, *Greenhouse Gases: Science and Technology*, Available online September 14, 2012, doi:10.1002/ghg.1300, http://onlinelibrary.wiley.com/doi/10.1002/ghg.1300/abstract. (Subscription may be required.)

"Characterizing CO_2 storage reservoirs and shallow overburden for above-zone monitoring in Texas Gulf Coast EOR fields."

The following is the Abstract of this article: "Enhanced oil recovery (EOR) through CO_2 injection provides an excellent opportunity for commercial [storage] of anthropogenic CO_2. A fluvio-deltaic, deep-seated salt dome and a strand-plain, roll-over anticline from the Gulf Coast region are currently under investigation for the design and implementation of monitoring, verification, and accounting (MVA) plans, in coordination with the commercial surveillance of independent, large-volume (>1 million ton/year) CO_2-EOR operations. Characterization with wireline logs demonstrates the vertical extent and areal continuity of reservoir sands and geometries of faults that offset the reservoir. To develop the monitoring plan, [the authors] focused on several elements: (i) characterization of the zones above the confining unit for above-zone pressure monitoring, (ii) collection and development of input data for 'quick-look' dynamic modeling of CO_2 plume extent and pressure elevation, and (iii) identifying intersections of faults with wellbores in intervals above the regional confining unit for thermal monitoring. Other uncertainties addressed during characterization are the upper extent of faults and the juxtaposition of layers to assess the potential for cross-fault fluid migration. Successful use of such techniques for MVA, based on uniting elements of existing regulatory monitoring expectations, would lead to the establishment of commercial best practices for effective and rapid characterization of EOR sites in the Gulf Coast region." **Khandaker M. Zahid, Seyyed A. Hosseini, Vanessa Nuñez-López, and Susan D. Hovorka**, *Greenhouse Gases: Science and Technology*, Available online December 19, 2012, doi:10.1002/ghg.1320, http://onlinelibrary.wiley.com/doi/10.1002/ghg.1320/abstract. (Subscription may be required.)

Technology

"Measurement of CO_2 Diffusivity for Carbon [Storage]: A Microfluidic Approach for Reservoir-Specific Analysis."

The following is the Abstract of this article: "Predicting CO_2 security and capacity in [storage] requires knowledge of CO_2 diffusion into reservoir fluids. In this paper [the authors] demonstrate a microfluidic based approach to measuring the mutual diffusion coefficient of [CO_2] in water and brine. The approach enables formation of fresh CO_2–liquid interfaces; the resulting diffusion is quantified by imaging fluorescence quenching of a pH-dependent dye, and subsequent analyses. This method was applied to study the effects of site-specific variables—CO_2 pressure and salinity levels—on the diffusion coefficient. In contrast to established, macro-scale pressure–volume–temperature cell methods that require large sample volumes and testing periods of hours/days, this approach requires only microliters of sample, provides results within minutes, and isolates diffusive mass transport from convective effects. The measured diffusion coefficient of CO_2 in water was constant (1.86 [±0.26] × 10^{-9} m^2/s) over the range of pressures (5–50 bar) tested at 26°C, in agreement with existing models. The effects of salinity were measured with solutions of 0–5 M NaCl, where the diffusion coefficient varied up to [three] times. These experimental data support existing theory and demonstrate the applicability of this method for reservoir-specific testing." **Andrew Sell, Hossein Fadaei, Myeongsub Kim, and David Sinton**, *Environ. Sci. Technol.*, Available online October 23, 2012, doi:10.1021/es303319q, http://pubs.acs.org/doi/abs/10.1021/es303319q. (Subscription required.)

Technology (Continued)

"A study of the effects of friction, heat transfer, and stream impurities on the decompression behavior in CO_2 pipelines."

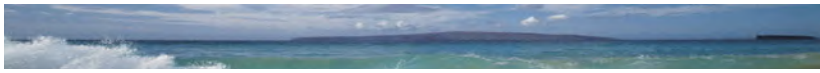
The following is the Abstract of this article: "A transient multi-phase outflow model is employed to study the effects of heat transfer and friction on the decompression behavior in CO_2 pipelines. The model's predictions are compared to measurements obtained from a number of shock tube experiments for gaseous phase CO_2 as well its various mixtures, typical of those found in the different capture technologies. Particular attention is paid to studying the impact of the stream impurities on the CO_2 mixtures saturation pressures and the decompression wave speeds given their direct influence on the pipeline's propensity to running ductile fractures." **Haroun Mahgerefteh, Solomon Brown, and Sergey Martynov**, *Greenhouse Gases*: *Science and Technology*, Available online September 24, 2012, doi:10.1002/ghg.1302, http://onlinelibrary.wiley.com/doi/10.1002/ghg.1302/abstract. (Subscription may be required.))

"Model verification and evaluation of the rich-split process modification at an Australian-based post combustion CO_2 capture pilot plant."

The following is from the Abstract of this article: "The [Commonwealth Scientific and Industrial Research Organization (CSIRO)] is involved in three CO_2 capture pilot plants operating at different coal-fired power stations throughout Australia. The most recently completed of these is the Tarong CO_2 capture pilot plant located at Tarong power station, Nanango, Queensland. The first phase of the experimental program with this pilot plant included operation with monoethanolamine (MEA). This involved parametric studies, process modifications, and finally implementation of [24-hour] operation. Operation of the pilot plant has shown MEA to be effective in capturing CO_2 from the flue gas from Tarong Power Station. CO_2 capture efficiencies of up to 94 [percent], and regeneration energies as low as 3.6 MJ/kgCO_2 have been achieved..." **Ashleigh Cousins, Aaron Cottrell, Anthony Lawson, Sanger Huang, and Paul H.M. Feron**, *Greenhouse Gases: Science and Technology*, Available online September 24, 2012, doi:10.1002/ghg.1295, http://onlinelibrary.wiley.com/doi/10.1002/ghg.1295/abstract. (Subscription may be required.)

"Upscaling and its application in numerical simulation of long-term CO_2 storage."

The following is the Abstract of this article: "Numerical simulations of long-term geological CO_2 storage could be particularly useful in predicting the capacity, security, and other consequences of CO_2 [storage]. The physics of this flow is essentially a multiphase multicomponent phenomenon in a strongly heterogeneous medium necessitating the need for a computationally prohibitive resolution to capture the various physical processes at all scales. Upscaling is an important step in these simulations when going from geostatistical models featuring strong heterogeneities to the simulation models which in practice are limited because of computational restrictions. Although many different upscaling techniques exist, including dynamic and steady-state methods, thorough analyses of their application to CO_2 [storage] are not yet established. This review aims to highlight the recent developments in the application of upscaling to the modeling of long-term CO_2 storage and provide insights into aspects that could prove valuable to numerical simulations." **Wasim A. Akber Hassan and Xi Jiang**, *Greenhouse Gases*: *Science and Technology*, Available online October 26, 2012, doi:10.1002/ghg.1306, http://onlinelibrary.wiley.com/doi/10.1002/ghg.1306/abstract. (Subscription may be required.)



Terrestrial

"CO_2 uptake by a soil microcosm."

The following is the Abstract of this article: "[Storage] of CO_2 via biological [formations] is a matter of great scientific importance due to the potential lowering of atmospheric CO_2. In this study, a custom built incubation chamber was used to cultivate a soil microbial community to instigate chemoautotrophy of a temperate soil. Real-time atmospheric CO_2 concentrations were monitored and estimations of total CO_2 uptake were made. After careful background flux corrections, 4.52 ± 0.05 g CO_2 kg^{-1} dry soil was [stored] from the chamber atmosphere over 40 [hours]. Using isotopically labeled $^{13}CO_2$ and GCMS–IRMS, labeled fatty acids were identified after only a short incubation, hence confirming CO_2 [storage] for soil. The results of this in vivo study provide the ground work for future studies intending to mimic the in situ environment by providing a reliable method for investigating CO_2 uptake by soil microorganisms." **Kris M. Hart, Seth F. Oppenheimer, Brian W. Moran, Christopher C.R. Allen, Vassilis Kouloumbos, Andre J. Simpson, Leonid A. Kulakov, Leon Barron, and Brian P. Kelleher,** *Soil Biology and Biochemistry*, Available in February 2013 edition, http://dx.doi.org/10.1016/j.soilbio.2012.10.036, http://www.sciencedirect.com/science/article/pii/S0038071712004154. (Subscription may be required.)

Trading

***Commodities Now*, "Carbon Market Activity Highest on Record."**

According to Bloomberg New Energy Finance, carbon market transaction volumes across the world grew by 26 percent in 2012 to approximately 10.7 billion metric tons, which is equivalent to approximately one-third of the world's total emissions of CO_2. Trading activity has increased by approximately 25 percent each year since 2010 and trading in the last quarter of 2012 increased 70 percent compared to the average of the three previous quarters (2012 Q4 accounted for 36 percent of the total annual volume). The increase in trading activity in the European Union Emission Trading Scheme (EU ETS) was caused by increased use of auctioning to distribute allowances and increased volatility resulting from the European Commission's attempts to support prices in the EU ETS by withholding allowances from the market. The increase in trading of UN offsets was attributable to the rush to acquire these credits before the

Trading (Continued)

end of the year and to take advantage of low prices. Bloomberg New Energy Finance expects the value of the market to return to approximately $105 billion in 2013 (a similar level to 2009 and 2010). January 3, 2013, http://www.commodities-now.com/news/environmental-markets/13450-carbon-market-activity-highest-on-record.html.

***Business Green*, "California Carbon Trading Scheme Gets Underway."**

California's emissions cap-and-trade scheme officially went into effect on January 1, 2013. The trading scheme establishes a statewide limit on total emissions of 162.8 million metric tons of CO_2 and imposes emission allowances on approximately 350 companies generating more than 25,000 metric tons of CO_2 a year. Each of the companies covered by the scheme must carry allowances. The majority of the allowances will be provided to companies for free, but some allowances will be auctioned. Any firm that exceeds the emissions cap would be required to purchase additional allowances. The scheme is central to California's plans to reduce GHG emissions to 1990 levels by the end of the decade. January 3, 2013, http://www.eco-business.com/news/california-carbon-trading-scheme-gets-underway/http://www.eco-business.com/news/california-carbon-trading-scheme-gets-underway/.

"CCS projects as Kyoto Protocol CDM activities."

The following is the Abstract of this article: "The December 2011 decision by the meetings of the UNFCCC in Durban, South Africa, to adopt modalities and procedures for [CO_2] capture and geological storage as clean development mechanism (CDM) project activities under the Kyoto Protocol was the culmination of many years of international negotiation. The Durban CCS decision establishes a practical international standard for managing CCS projects that ensures a high level of environmental protection. It is an important official recognition by the UNFCCC that CCS is a technology capable of achieving deep cuts in [GHG] emissions in developing countries and sets an important precedent for the inclusion of CCS projects within emerging international markets and other financing and technology support mechanisms outside of the CDM. This paper analyses the Durban CCS decision and the implications for project proposals." **Tim Dixon, Gregory Leamon, Paul Zakkour, and Luke Warren**, presented at the 11th Greenhouse Gas Control Technologies conference held at the Kyoto International Conference Center, Japan, November 18-22, 2012, https://www4.eventsinteractive.com/iea/viewpdf.esp?id=270035&file=%5C%5CDCFILE01%5CEP11%24%5CEventwin%5CPool%5Coffice27%5Cdocs%5Cpdf%5Cghgt%2D11Final00641%2Epdf. (Subscription may be required.)

Recent Publications

"2012 United States Carbon Utilization and Storage Atlas."

The following is the Foreword of this document: "[DOE/NETL] is proud to release the fourth edition of the United States Carbon Utilization and Storage Atlas (Atlas IV). Production of Atlas IV is the result of collaboration among carbon storage experts from local, State, and Federal agencies, as well as industry and academia. Atlas IV provides a coordinated update of CCUS potential across the United States and other portions of North America. The primary purpose of Atlas IV is to update the CO_2 storage potential for the United States and to provide updated information on the RCSPs field activities and new information on the [ARRA-funded] Site Characterization projects. In addition, Atlas IV outlines DOE's Carbon Storage Program, DOE's CCUS collaborations, worldwide CCUS projects, and CCUS regulatory issues; presents updated information on the location of CO_2 stationary source emissions and the locations and storage potential of various geologic storage sites; and further provides information about the commercialization opportunities for CCUS technologies from RCSPs. A key aspect of CCUS deals with the amount of carbon storage potential available to effectively help reduce GHG emissions. As demonstrated in Atlas IV, CCUS holds great promise as part of a portfolio of technologies that enables the United States and the rest of the world to effectively address climate change while meeting the energy demands of an ever increasing global population. Atlas IV includes the most current and best available estimates of potential CO_2 storage resource determined by a methodology applied consistently across all of the RCSPs. A CO_2 storage resource estimate is defined as the fraction of pore volume of porous and permeable sedimentary rocks available for CO_2 storage and accessible to injected CO_2 via drilled and completed wellbores. Carbon dioxide storage resource assessments do not include economic or regulatory constraints; only physical constraints are applied to define the accessible part of the subsurface. Economic and regulatory constraints are included in geologic CO_2 capacity estimates. The data in Atlas IV is current as of November 2012. It will be updated every two years as new data are acquired and methodologies for CO_2 storage estimates improve. Furthermore, it is expected that, through the ongoing work of the RCSPs, data quality and conceptual understanding of the CCUS process will improve, resulting in more refined CO_2 storage resource estimates." The full Atlas is available at: http://www.netl.doe.gov/technologies/carbon_seq/refshelf/atlasIV/Atlas-IV-2012.pdf.

"Carbon Capture and Storage (CCS) for Coal-Fired Plants – Opportunity Assessment and Key Country Analysis to 2025."

The following is the Summary of this document: "This report provides the retrofit potential and new market potential for the global CCS market in terms of revenues and capacity. It also discusses the key drivers and restraints impacting the market. The report provides an in depth analysis of key global CCS markets– the US, Canada, the UK, Germany, Poland, Australia, China and Japan. It provides the retrofit potential and new market potential for CCS and the regulations in each of these countries. The report also provides an overview of key players in global CCS market." The full report is available for purchase at: http://www.reportlinker.com/p01057651-summary/Carbon-Capture-and-Storage-CCS-for-Coal-Fired-Plants-Opportunity-Assessment-and-Key-Country-Analysis-to.html.

Recent Publications (Continued)

"Development of a measurement, monitoring and verification technical framework for geological storage of CO_2 in Australia: Feedback report."

The following is from the Introduction of this document: "Primary objectives of this report are to: (1) provide feedback on the input and discussions involving selected stakeholders regarding issues associated with the development of a nationally consistent [measurement, monitoring, and verification (MMV)] technical framework in Australia, and (2) present options for addressing the identified key issues and potential implications for the development of a national MMV technical framework. The report is structured as follows: summary of the key findings of the literature review; summary of the key findings of the stakeholder engagement activities on the issues and challenges for a national framework; options for addressing the key issues associated with the development of a national MMV technical framework; conclusions on the level of support and how to progress for the development of a national MMV technical framework; the Consolidated Literature Review is included in Appendix A; and a list of stakeholder organizations that attended the workshop, participated in interviews, and responded to questionnaires is included in Appendix B." The report is available for download at: http://www.globalccsinstitute.com/publications/development-measurement-monitoring-and-verification-technical-framework-geological.

Legislative Activity

***U.S. Senator Bernie Sanders News Release*, "Congress Must Act on Global Warming: Sanders Cites Record U.S. Heat in 2012."**

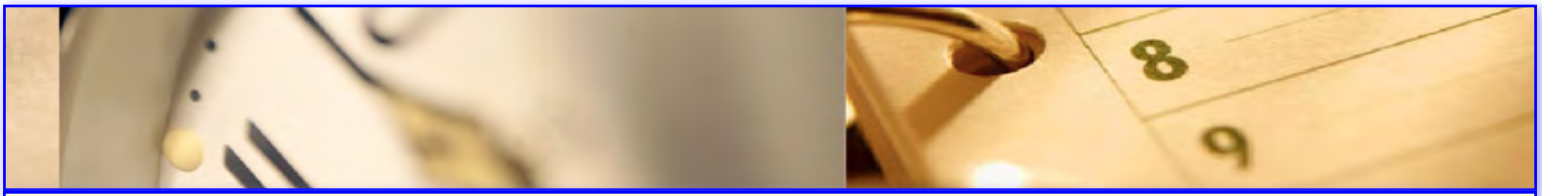
U.S. Senator Bernie Sanders (I-Vt.) said that he plans to introduce legislation to address potential climate change. The legislation would include a transparent fee on GHG emissions and call for investment in efficiency, sustainable energy, advanced transportation infrastructure, and clean energy R&D. The legislation also would end fossil fuel subsidies and tax breaks. The plan follows an early announcement by the National Climatic Data Center that the annual U.S. temperature in 2012 was 55.32 degrees Fahrenheit, one degree warmer than the old record set in 1998. January 9, 2013, http://www.sanders.senate.gov/newsroom/news/?id=98fbf36e-0ac2-4702-b6ef-08a2c3a0a5d5.

Events

February 7-9, 2013, **International Conference on Energy Resources and Technologies for Sustainable Development**, *Howrah (near Kolkata), West Bengal, India*. The theme of the conference is the utilization of energy resources through alternative energy technologies for cleaner environment and sustainable development. Topics to be discussed include, but are not limited to: energy resources; clean coal technology and integrated gasification combined cycle (IGCC); combustion system modeling and analysis; and energy policy, planning, and economics. To learn more, visit the conference website at: http://www.icertsd.com/.

February 14-16, 2013, **The International Conference on Climate Change and Local Wisdom: Living in Harmony within Our Built Environment**, *Training Center Auditorium, Alauddin Islamic State University, Makassar, Sulawesi Selatan, Indonesia*. Several issues will be examined in this conference, including: expressing the value of local wisdom in design and collaboration with technology in the anticipation of potential climate change; mainstreaming the education of local wisdom to optimize preservation; and how the government, other formal institutions, and Islamic values accommodate and contribute to the adaption to potential climate change. More information is available at: http://genius-loci-conference.com/.

February 28, 2013, **Westminster Energy Environment and Transport Forum**, *Central London, UK*. This forum will cover the options for taking carbon capture and storage technology forward as part of the wider work that is being undertaken to secure future energy supplies and to reduce carbon emissions. Planned sessions include examining the progress and next steps in technology development, deployment costs, the barriers to successful commercialization, and the wider impact and deployment of the technology. To download the latest agenda, visit: http://www.westminsterforumprojects.co.uk/forums/event.php?eid=487.



Events (Continued)

March 7-9, 2013, **2013 NELA National Conference: Delivering a Low Carbon Future**, *The Sebel Albert Park, Melbourne, Victoria, Australia*. This National Environmental Law Association (NELA) conference brings together different aspects of clean energy law, such as environment and climate change lawyers and those involved in environment protection, resources and energy regulation and planning, carbon and biodiversity credits, and emissions trading. Topics to be discussed include the role of state governments in planning a low-carbon future. To download the full program, visit the conference website at: http://nelaconference.com.au/.

March 20-21, 2013, **RECS Market Meeting 2013**, *Hotel Melia Berlin, Berlin, Germany*. The third edition of this annual event offers insight into the renewable energy market in Europe. Included in the program is a pre-conference workshop explaining the workings of the electricity tracking and certificate system in the renewable energy market. The meeting itself includes a panel discussion and will cover topics such as new policy and national developments, corporate social responsibility, and the voluntary market. For the complete program, visit the conference website at: http://www.recsmarket.eu/Home.aspx.

May 13-16, 2013, **12th Annual Conference on Carbon Capture, Utilization & Sequestration**, *David L. Lawrence Convention Center, Pittsburgh, Pennsylvania, USA*. This conference will provide a forum for the exchange of experience among U.S. and international scientific and engineering communities working on such technology and systems; facilitate the necessary dialogue between technology developers/purveyors, industry, and the public on the development and deployment of viable technologies; and 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/.

May 27-30, 2013, **Impacts World 2013**, *Potsdam, Germany*. This conference aims to develop a new vision for potential climate impact research by laying the foundations for regular, community-driven synthesis of potential climate change impact analyses. As a discussion-based conference, scientists and decision makers from local and international levels will be brought together to initiate a coordinated climate impact research agenda. To learn more, click: http://www.climate-impacts-2013.org/index.php?article_id=1.

June 4-6, 2013, **7th Trondheim CCS Conference (TCCS-7)**, *Trondheim, Norway*. The 7th Trondheim Conference will focus on R&D regarding CCS. The objective of the conference is to bring forward, present, and discuss work undertaken within R&D institutions, universities, and industry. Topics include: pre-combustion capture, post-combustion capture, CO_2 utilization and industrial CO_2 applications, transport, storage, novel technologies, public acceptance and communication, and CCS value chain issues. For more information, please visit: http://www.sintef.no/Projectweb/TCCS-7/.

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.

To learn more about DOE's Carbon Storage Program, please contact Traci Rodosta at traci.rodosta@netl.doe.gov, or Dawn Deel at dawn.deel@netl.doe.gov.