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# CARBON STORAGE NEWSLETTER

MAY 2018

This newsletter is compiled by the National Energy Technology Laboratory to provide information on recent activities and publications related to carbon storage. It covers domestic, international, public sector, and private sector news in the following areas:

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## CARBON STORAGE PROGRAM DOCUMENTS and REFERENCE MATERIALS

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- ▷ Systems Analysis
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## DOE/NETL HIGHLIGHTS

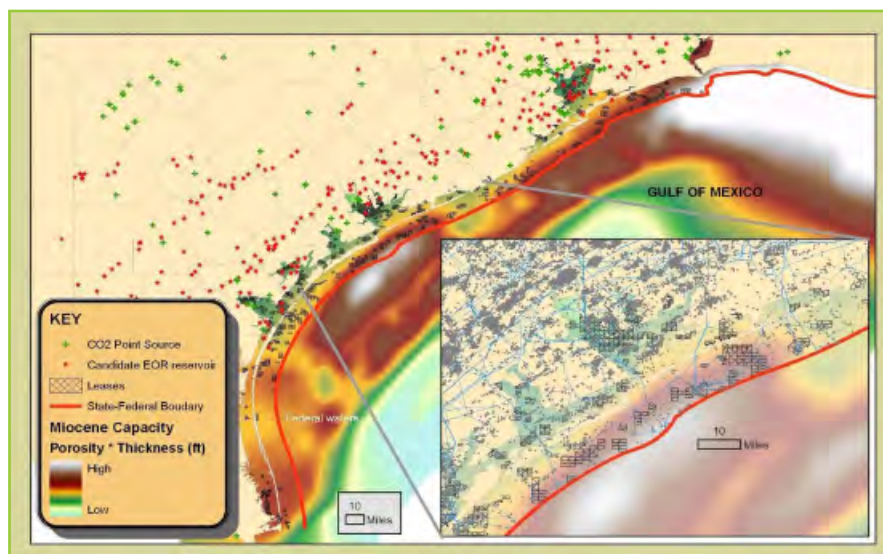
### *DOE Announces Federal Funding for Projects that Advance Associated Geologic Storage.*

The U.S. Department of Energy's (DOE) *Office of Fossil Energy (FE)* announced Federal funding for cost-shared research and development (R&D) projects that will address technical research needs and key challenges in advancing associated geologic storage within DOE's *Carbon Storage Program*. Under Funding Opportunity Announcement (FOA) DE-FOA-0001829, "*Developing Technologies for Advancement of Associated Geologic Storage in Basinal Geo-Laboratories*," the National Energy Technology Laboratory (NETL)-managed projects will advance technologies in storage complexes in diverse geologic settings, focusing on R&D specific to various basins representing diverse geologic settings throughout the United States where opportunities for associated storage exists. From *energy.gov* on April 10, 2018.

## ANNOUNCEMENTS

### *DOE-Supported Research Wins Award.*

A DOE-sponsored report, titled "Geological CO<sub>2</sub> Sequestration Atlas of Miocene Strata, Offshore Texas State Waters," received the *2018 John C. Frye Memorial Award in Environmental Geology*. The award, co-sponsored by The Geological Society of America (GSA) and the Association of American State Geologists (AASG), is for the best publication in the field of environmental geology published by a state geological survey or by GSA during the past three years. Initial research for the report, which was published by the Bureau of Economic Geology at the University of Texas at Austin, was supported by DOE project *DE-FE0001941*; DOE project *DE-FE0026083* supported the final publication efforts.



Carbon dioxide storage capacity in saline formations in the Gulf Coast region. Storage capacity is indicated in a "high to low" scale, as indicated by color contours.

### *DOE's ASFE Delivers Keynote.*

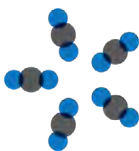
DOE's Assistant Secretary for Fossil Energy (ASFE) delivered keynote remarks at a National Coal Council (NCC) meeting. Topics discussed included the upgrading of existing coal-fired power plants, developing technologies for future coal plants, and early-stage R&D on carbon capture, utilization, and storage (CCUS).



## ANNOUNCEMENTS (cont.)

**NETL Releases CCSI Toolset.**

NETL's *Carbon Capture Simulation Initiative (CCSI)* released the CCSI Toolset as open-source software, making it available for researchers in industry, government, and academia. The CCSI Toolset is a suite of computational tools and models designed to help maximize learning and reduce cost and risk during the scale-up process for carbon capture technologies.



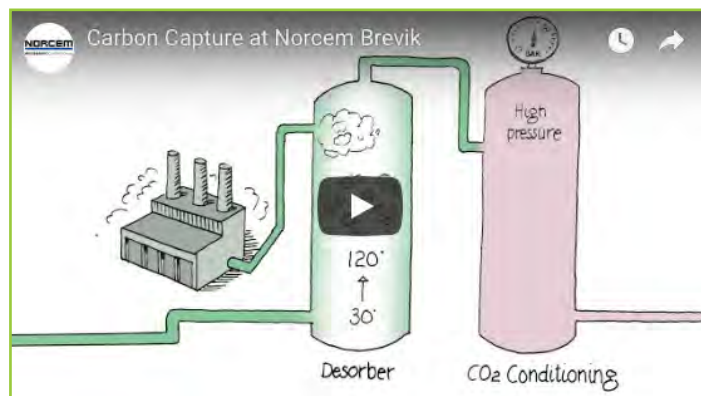
**CCSI**  
Carbon Capture Simulation Initiative

**Carbon XPRIZE Announces Finalists.**

Finalists have been announced for the final round in the Carbon XPRIZE, a global competition in which teams address technologies that convert carbon dioxide (CO<sub>2</sub>) emissions from power plants into valuable products. Each of the 10 finalists passed a first-round evaluation based on the amount of CO<sub>2</sub> they could convert into products, as well as the economic value, market size, and CO<sub>2</sub> uptake potential of those products.

**Film on CCS.**

Norcem, a Norwegian-based cement producer, released a film explaining the process of carbon capture and storage (CCS) at its Brevik cement plant in Norway.



Carbon Capture at Norcem Brevik  
(video courtesy of Wold Cement)

## PROJECT and BUSINESS DEVELOPMENTS

**CCS Centerpiece for New Hydrogen Supply Chain.**

According to the Global CCS Institute, CCS will be at the center of a new Australian-Japanese hydrogen supply chain. The Hydrogen Energy Supply Chain (HESP) Project, a joint venture between Australian and Japanese industries and governments, will build a pilot plant to produce hydrogen from Latrobe Valley brown coal for export to Japan. If successful, the pilot plant is expected to lead to a commercial-size plant that will incorporate CCS. From *Global CCS Institute Media Release* on April 12, 2018.



**GLOBAL  
CCS  
INSTITUTE**

**CO<sub>2</sub>-EOR Project Commences.**

Elk Petroleum Limited announced that its Grieve CO<sub>2</sub>-enhanced oil recovery (EOR) project has commenced oil production within start-up deadlines. According to independent engineers and reserve auditors, initial gross oil production is expected to be in the range of 1,100 to 1,200 barrels of oil per day (BOPD), with a projection to increase to approximately 2,100 BOPD, and the potential to achieve a peak gross production rate of more than 3,400 BOPD. From *Elk Petroleum Limited Media Release* on April 18, 2018.

**Japan CCS Site Shows Promise.**

According to project developers, a CCS test site in Japan has the potential for reducing CO<sub>2</sub> emissions from industries such as gas processing and cement and chemical production. The Tomakomai CCS test site, which stores the captured CO<sub>2</sub> below the seabed off Hokkaido island, focuses on industrial applications. The site's injection project, with a target of 300,000 metric tons of injected CO<sub>2</sub>, is scheduled to run until 2020. According to the site's developers, 150,000 metric tons of CO<sub>2</sub> have been injected to date. From *Reuters* on April 19, 2018.

**CCS Plan for Vacated Gas Field.**

The Kinsale gas fields located off the Cork coast in Ireland may be used as a site to store carbon, according to officials. In production since 1978, the gas reserves at the Kinsale gas fields are expected to deplete by 2020 or 2021; Kinsale Energy is preparing a decommissioning plan for the fields for the Department of Communications, Climate Action, and Environment. State officials claim the empty gas fields have the potential to store CO<sub>2</sub> released from existing natural gas-fired power stations in East Cork, southwest Ireland. From *The Irish Examiner* on April 19, 2018.



Grieve CO<sub>2</sub>-Enhanced Oil Recovery (EOR) Project  
(courtesy of Elk Petroleum)

## LEGISLATION and POLICY

### *New Jersey Legislature Approves Zero-Emissions Credit Program.*

New Jersey (USA) lawmakers approved two sets of companion bills, one of which creates a zero-emissions credit program. *S2313* and *A3724* would provide plants with financial credit for producing carbon-free electricity. Both the zero-emissions credit program bills and the clean energy set of bills (*A3723* and *S2314*) will advance to the New Jersey governor. From *Daily Energy Insider* on April 16, 2018.

### *California to Extend Low-Carbon Fuel Standard.*

The California Air Resources Board (CARB) is looking to extend the Low-Carbon Fuel Standard (LCFS) Program through 2030 and to reduce the carbon intensity of fuels sold within California (USA) by 20 percent. In addition, CARB is planning to add new methodology to encourage companies to deploy CCS technologies. From *Scientific American* on April 30, 2018.

### *Carbon Pricing Proposal Released.*

The New York (USA) Independent Systems Operator (NYISO) released a *Carbon Pricing Straw Proposal* focused on aligning wholesale energy markets to reflect New York's carbon-reduction goals. New York is looking to reduce CO<sub>2</sub> emissions by 80 percent by 2050. The NYISO is the organization responsible for managing New York's electric grid and its competitive wholesale electric marketplace. From *Utility Dive* on May 1, 2018.



## EMISSIONS TRADING

### *RGGI States Release Auction Notice and Electricity Monitoring Report.*

The states participating in the Regional Greenhouse Gas Initiative (RGGI) released the Auction Notice and application materials for their 40<sup>th</sup> quarterly CO<sub>2</sub> allowance auction, to be held June 30, 2018. As indicated in the Auction Notice, the states will offer 13,771,025 CO<sub>2</sub> allowances for sale with a minimum reserve price of \$2.20. In addition, there is also a 10 million CO<sub>2</sub> allowance cost containment reserve (CCR) available, which will be accessed if the interim clearing price exceeds the CCR trigger price of \$10.25. The RGGI states also released the "*CO<sub>2</sub> Emissions from Electricity Generation and Imports in the Regional Greenhouse Gas Initiative: 2015 Monitoring Report.*" The seventh in a *series of annual monitoring reports*, this report summarized data for electricity generation, electricity imports, and related CO<sub>2</sub> emissions for the RGGI states. From *RGGI News Releases* on April 17, 2018, and April 27, 2018.



### *Carbon Credit Program Approved.*

The West Springfield Town Council (Massachusetts, USA) approved joining an intermunicipal carbon storage program known as the Tri-City Carbon Project. The approved deal authorizes the town to execute a contract with Bluesource, a global vendor of carbon credits, as well as an interim municipal agreement with Holyoke and Westfield (Massachusetts, USA). From *MassLive* on April 24, 2018.

## CLIMATE and SCIENCE NEWS

### *Researchers Study Potential of BECCS to Reduce CO<sub>2</sub> Emissions.*

DOE-funded research is using algae, eucalyptus, and bioenergy with carbon capture and storage (BECCS) to power and provide food to large regions of the world while simultaneously removing CO<sub>2</sub> emissions from the atmosphere. Scientists from Cornell, Duke University, and the University of Hawaii at Hilo combined two technologies (BECCS and microalgae production) to form a new, integrated algae bioenergy with carbon capture and storage (ABECCS) system, which can act as a CO<sub>2</sub> "sink" while generating food and electricity. The research appears in a paper, titled "*Integrating Algae with Bioenergy Carbon Capture and Storage (ABECCS) Increases Sustainability,*" which was published by the American Geophysical Union. From *Carbon Capture Journal* on April 13, 2018.

### *Afforestation Increases Carbon Stock in Soil: Research.*

According to research by scientists from the Xinjiang Institute of Ecology and Geography (China), afforestation can increase soil organic carbon (SOC) and nitrogen stocks in arid and semi-arid regions. The research, which was published in the journal *Science of The Total Environment*, evaluated the influences of afforestation on SOC and nitrogen stocks in topsoil in arid and semi-arid regions around the world. The data showed that afforestation increased SOC stock by 131 percent, providing a scientific basis for the restoration and improvement of soil fertility in arid and semi-arid regions as well a reference for carbon storage and emission reduction. From *Xinhua* on April 25, 2018.

### *Technology Demonstrates Simplified Conversion of CO<sub>2</sub> into Storable Renewable Energy.*

Researchers from Southern California Gas Company (SoCalGas) and Opus 12, a clean-energy startup, demonstrated a new process of converting CO<sub>2</sub> in raw biogas to methane, simplifying the process of storing surplus renewable electricity as renewable natural gas. Opus 12 used a new electrolyzer technology to show the CO<sub>2</sub> can be converted to methane using renewable electricity. The research is part of SoCalGas' development of power-to-gas (P2G) technologies, a method of storing excess renewable energy using existing infrastructure. From *SoCalGas News Release* on April 19, 2018.

### *Study Focuses on Land Use, Agricultural Practices Impact on CO<sub>2</sub> Storage.*

According to research conducted by scientists from Iowa State University, changes in land use and agricultural practices may impact the amount of CO<sub>2</sub> stored in midwestern soils. Published in the journal *Global Change Biology*, *the study* models how changes in midwestern land use since 1850 have impacted CO<sub>2</sub> storage. Specifically, the study focuses on the storage of CO<sub>2</sub> from terrestrial sources (e.g., soil, plants) during crop production. According to the data compiled, land use changes from 1850 to 2015 reduced billions of tons of CO<sub>2</sub> storage capacity in plants and soil. From *Iowa State University News* on May 1, 2018.



## JOURNAL ARTICLES

### *World Bank CCS Program Activities in Botswana – Results and Lessons Learned.*

The following is from the Abstract of this article: "The World Bank Carbon Capture and Storage Trust Fund (CCS TF) was established in 2009 to support CCS capacity and knowledge building in developing countries. CCS TF Phase 1 support for CCS in Botswana included an allocation of USD 1.4 million and had the objective of supporting the Government of Botswana in the following areas: [1] Identifying potential geological reservoirs that can be utilized to store CO<sub>2</sub> captured from coal-fired power plants; [2] Evaluating institutional and regulatory arrangements for CCS deployment in the country and recommendations for reinforcing institutional capacity; and [3] Providing training, education and capacity building at all stages throughout implementation, including a Study Tour for key individuals. For all three studies, the WB selected Environmental Resources Management Southern Africa (Pty) Ltd (ERM) as the lead consultant, in association with Wellfield Geosciences (Botswana) and Carbon Counts Company (UK) Ltd. The completed geological assessment found that there may be technical potential for geological storage of CO<sub>2</sub> in Botswana's geological formations within the Kalahari Karoo Basin, including three areas of interest -- the Passarge Basin, the Lephephe Graben and the Mmashoro Low. There is, however, a general lack of CO<sub>2</sub> storage-relevant geological data that needs to be developed, if a more accurate assessment of CO<sub>2</sub> storage potential is to be undertaken. The Passarge Basin was seen to be worthiest of additional investigation, which could be done through the re-examination of existing data or through new geological exploration. The Mashoro Low and Lephephe Graben are in close proximity to the centers of current coal-bed methane (CBM) exploration, suggesting that the integration of CBM exploitation and CO<sub>2</sub> storage processes could be considered." **Brendan Beck and Natalia Kulichenko-Lotz**, *Energy Procedia*. (Subscription may be required.)

### *Subsurface CO<sub>2</sub> storage estimation in Bakken tight oil and Eagle Ford shale gas condensate reservoirs by retention mechanism.*

The following is the Abstract of this article: "This paper describes the CO<sub>2</sub> geological sequestration process in unconventional reservoirs in northern and southern United States such as Bakken tight oil and Eagle Ford shale gas condensate reservoirs. The hysteresis modelling and retention mechanism was performed in this research and this is one of the efficient and proven method to store CO<sub>2</sub> in the subsurface. This can be achieved through CO<sub>2</sub> EOR process while injecting CO<sub>2</sub>, the fluid will be trapped in the pore spaces between the impermeable rocks and oil can be recovered simultaneously. A total of four cases was taken for the analysis, such as the Bakken and Eagle Ford reservoirs with CO<sub>2</sub> huff-n-puff process and another two cases with CO<sub>2</sub> Flooding. Injection pressure, injection rate, injection time, number of cycles, [CO<sub>2</sub>] soaking time, fracture half-length, fracture conductivity, fracture spacing, porosity, permeability, and initial reservoir pressure as is taken as inputs and cumulative oil production, and oil recovery factor was taken as outputs. The reservoirs were modelled for 30 years of oil production and the factor year was taken as Decision Making Unit (DMU) and the models was calculated at each year. The retention was successfully calculated in all four models and percentage of retention above 90% was observed in all four cases and the injection pressure has the most dominating effect on the CO<sub>2</sub> geological sequestration. It was also revealed that the CO<sub>2</sub> huff-n-puff performance in Bakken reservoir is not that much more effective since the retention rate decreases during soaking period and flooding was found to be a suitable method in this formation. Even in Eagle Ford formation, the average performance of CO<sub>2</sub> flooding process is better than the huff-n-puff, but the latter process was quite effective in this shale gas condensate reservoir." **Venkat Pranesh**, *Fuel*. (Subscription may be required.)

### *An innovative computationally efficient hydromechanical coupling approach for fault reactivation in geological subsurface utilization.*

The following is the Abstract of this article: "Estimating the efficiency and sustainability of geological subsurface utilization, i.e., CCS requires an integrated risk assessment approach, considering the occurring coupled processes, beside others, the potential reactivation of existing faults. In this context, hydraulic and mechanical parameter uncertainties as well as different injection rates have to be considered and quantified to elaborate reliable environmental impact assessments. Consequently, the required sensitivity analyses consume significant computational time due to the high number of realizations that have to be carried out. Due to the high computational costs of two-way coupled simulations in large-scale 3D multiphase fluid flow systems, these are not applicable for the purpose of uncertainty and risk assessments. Hence, an innovative semi-analytical hydromechanical coupling approach for hydraulic fault reactivation will be introduced. This approach determines the void ratio evolution in representative fault elements using one preliminary base simulation, considering one model geometry and one set of hydromechanical parameters. The void ratio development is then approximated and related to one reference pressure at the base of the fault. The parametrization of the resulting functions is then directly implemented into a multiphase fluid flow simulator to carry out the semi-analytical coupling for the simulation of hydromechanical processes. Hereby, the iterative parameter exchange between the multiphase and mechanical simulators is omitted, since the update of porosity and permeability is controlled by one reference pore pressure at the fault base. The suggested procedure is capable to reduce the computational time required by coupled hydromechanical simulations of a multitude of injection rates by a factor of up to 15." **M. Adams, T. Kempka, E. Chabab, and M. Ziegler**, *Computers & Geosciences*. (Subscription may be required.)

### *Managing Forest Soils for Carbon Sequestration: Insights From Modeling Forests Around the Globe.*

The following is the Abstract of this article: "Soil carbon (C), a fundamental component of soil organic matter (SOM), is commonly recognized as one of the key parameters of soil quality. It has been linked to ecosystem productivity because it is a sensitive indicator for monitoring programs. It is a critical pool in the carbon cycle, and through its influence on many fundamental biological and chemical processes, it plays a pivotal role in nutrient release and availability. Through its role in soil aggregation, it influences soil porosity and thus gas exchange reactions and water storage and availability for plants and microorganisms. However, several processes can deplete or alter SOM in different ways (acid rain, atmospheric deposition, fire, intensive harvesting, etc.). Such phenomena can prevent forest soils from reaching their potential for biomass production and C sequestration, therefore reducing their contribution to climate change mitigation and adaptation strategies. However, the long-time scales involved in forest soil ecological processes make it difficult to study the effects of forest management on soil C. An alternative is to use 'virtual experiments' through ecological models. In this chapter an overview is provided of the most important factors altering soil C in forests soils, showcasing three examples of how ecological modeling can be used to better define forest management plans to maximize soil C sequestration." **Juan A. Blanco**, *Soil Management and Climate Change*. (Subscription may be required.)

## JOURNAL ARTICLES *(cont.)*

### *Consumption-based accounting and the trade-carbon emissions nexus.*

The following is the Abstract of this article: "This paper considers a recently developed consumption-based carbon emissions database from which emissions calculations are made based on the domestic use of fossil fuels plus the embodied emissions from imports minus exports, to test directly for the importance of trade in national emissions. Comparing such consumption-based emissions data to conventionally-measured territory-based emissions data produces several useful conclusions. For example, most countries are net importers of carbon emissions—their consumption-based emissions are higher than their territory-based emissions. Also, while low and high income countries tend to have the largest ratios (of consumption-based emissions to territory-based emissions), the majority of middle-income countries have ratios greater than one as well. Furthermore, China alone is responsible for over half the global outflows of carbon via trade. The econometric estimations—which were robust across income levels—determined that: (i) trade was significant for consumption-based emissions but not for territory-based emissions; (ii) exports and imports offset each other so that exports lower consumption-based emissions, whereas imports increase them; and (iii) the fossil fuel content of a country's energy mix is more important (likely significantly so) for territory-based emissions than for consumption-based emissions; and (iv) domestic fossil fuel prices (oil, gasoline) had a negative impact on territory-based emissions but were insignificant for consumption-based emissions. Hence, there is a wedge between (i) the emissions a country is responsible for—consumption-based emissions—and (ii) the emissions that a country's domestic policies affect—territory-based emissions. So, countries should have both an interest and a responsibility to help lower the carbon intensity of energy in countries that are particularly important for global carbon transfers—China and India." **Brantley Liddle**, *Energy Economics*. (Subscription may be required.)

### *Dynamics of China's carbon prices in the pilot trading phase.*

The following is the Abstract of this article: "This paper is the first to investigate empirically the link between carbon prices and macro risks in China's cap-and-trade pilot scheme. Using data from four pilot markets in Beijing, Guangdong, Hubei, and Shenzhen from 2014 to 2016, [the authors] demonstrate that the carbon price in Hubei is weakly linked to international prices of natural gas. [The authors'] results also indicate that energy, utilities, industrial and materials sector indices are positively related to the allowance prices in Shenzhen and Guangdong, suggesting that higher emitters in the region may have factored the carbon price into their production mix. [The authors] find no statistically significant relationship in the Beijing pilot. Overall, the findings suggest that China's carbon market is currently in an early stage of development, as the carbon price fundamentals are weak and the markets are comparatively less efficient than the European trading scheme in an informational sense. The findings of the paper have policy implications for the upcoming integration of regional markets into the national carbon market." **John Hua Fan and Neda Todorova**, *Applied Energy*. (Subscription may be required.)

### *Making the Communication of CCS more "Human."*

The following is the Abstract of this article: "CCS communication has proven a tough challenge, particularly for the difficulty in raising interest for the technology, which is still unknown to the majority of the population, and for the complexity of conveying information about its potential for reducing emissions. In this paper [the authors] present a research based effort for bringing CCS nearer to people, through visual material developed taking into account emotional needs related to the technology. The production of a short introductory film on CCS is illustrated and its testing with a sample of 700 high school students." **Samuela Vercelli, Salvatore Lombardi, Federica Modesti, Maria Chiara Taretello, Maria Grazia Finio, Davide De Angelis, Sabina Bigi, Livio Ruggiero, and Stefano Pirrotta**, *Energy Procedia*. (Subscription may be required.)

### *A fast and robust TOUGH2 module to simulate geological CO<sub>2</sub> storage in saline aquifers.*

The following is the Abstract of this article: "A new TOUGH2 module to simulate geological CO<sub>2</sub> storage (GCS) in saline aquifers is developed based on the widely employed ECO2N module of TOUGH2. The newly developed TOUGH2 module uses a new non-iterative fugacity-activity thermodynamic model to obtain the partitioning of CO<sub>2</sub> and H<sub>2</sub>O between the aqueous and gas phases. Simple but robust thermophysical correlations are used to obtain density, viscosity, and enthalpy of the gas phase. The implementation and accuracy of the employed thermophysical correlations are verified by comparisons against the national institute of standards and technology (NIST) online thermophysical database. To assess the computation accuracy and efficiency, simulation results obtained with the new TOUGH2 module for a one-dimensional non-isothermal radial and a three-dimensional isothermal system are compared against the simulation results obtained with the ECO2N module. Treating salt mass fraction in the aqueous phase as a constant, along with the inclusion of a non-iterative fugacity-activity thermodynamic model, and simple thermophysical correlations, resulted in simulations much faster than simulations with ECO2N module, without losing numerical accuracy. Both modules yield virtually identical results. Additional field-scale simulations of CO<sub>2</sub> injection into an actual non-isothermal and heterogeneous geological formation confirmed that the new module is much faster than the ECO2N module in simulating complex field-scale conditions. Owing to its capability to handle CO<sub>2</sub>-CH<sub>4</sub>-H<sub>2</sub>S-N<sub>2</sub> gas mixtures and its compatibility with TOUGHREACT, this new TOUGH2 module offers the possibility of developing a fast and robust TOUGHREACT module to predict the fate of CO<sub>2</sub> in GCS sites under biotic conditions where CO<sub>2</sub>, CH<sub>4</sub>, H<sub>2</sub>S, and N<sub>2</sub> gases can be formed." **Babak Shabani and Javier Vilcáez**, *Computers & Geosciences*. (Subscription may be required.)

## REPORTS and OTHER PUBLICATIONS

*Analysis of Field Vertical Seismic Profiling (VSP) Data: Cranfield 3D-VSP Project.*

The following is from the Executive Summary of this National Risk Assessment Partnership (NRAP) document: “The investigations in this report address one of the priority research topics of the NRAP Strategic Monitoring Working Group—the research need of quantifying and improving temporal and spatial resolution of monitoring data, in this case three-dimensional (3D) borehole based seismic data. The resulting Cranfield 3D vertical seismic profiling (VSP) study consists of two different investigations of VSP technology as it applies to the storage of anthropogenic CO<sub>2</sub>. These investigations are firstly, an examination of the subsurface spatial resolution of 3D-VSP technology compared to more expensive, lower frequency 3D surface seismic technology, including the potential economic and technical value for subsurface monitoring of large volumes of anthropogenic CO<sub>2</sub>. The second investigation relates to the value of least-squares, reverse-time migration processing for coping with the sparse distribution of VSP seismic sources and the avoidance of processing artifacts that may mimic low offset faults or other subsurface discontinuities. Such artifacts could result in the incorrect estimation of higher project risk, greater geologic uncertainty, and could result in negative impacts to project schedule or budget. The key findings of this report relate the relative spatial resolution of reflections at the reservoir depth (which are used to monitor the storage of CO<sub>2</sub>) and in above zone monitoring intervals (AZMI), which are used to monitor for leakage. For the Cranfield data set, this study found that the 3D-VSP data have only slight improvements over conventional 3D surface seismic in the resolution of the high amplitude, continuous reflector for the Tuscaloosa injection formation, but that a real advantage of 3D-VSP is found in the improved imaging of weakly reflective, discontinuous reflectors in a potential AZMI. At Cranfield such reflectors above the injection formation form an important zone for leakage monitoring. At other sites, the reservoir interval may consist of weakly reflective seismic events whose imaging could be improved by 3D-VSP. This improvement in imaging is essential in being able to detect and quantify changes in subsurface properties related to seismic monitoring.”

***Global Carbon Account 2018.***

The following is the Introduction of this document: “This overview presents key trends regarding the implementation of explicit carbon pricing policies throughout the world in 2018. A timeline, a world map, a detailed table and a graph provide comprehensive information on the jurisdictions that have implemented or plan to implement explicit carbon pricing policies, the type of instrument chosen, the sectors and fuels covered, the pricing levels, and the use of revenues.”

## ABOUT DOE'S CARBON STORAGE PROGRAM

The **Carbon Storage Program** advances the development and validation of technologies that enable safe, cost-effective, permanent geologic storage of CO<sub>2</sub>. The Carbon Storage Program also supports the development of best practices for CCS that will benefit projects implementing CCS at a commercial scale, such as those being performed under NETL's Clean Coal Power Initiative and Industrial Carbon Capture and Storage Programs. The technologies being developed and the small- and large-scale injection projects conducted through this program will be used to benefit the existing and future fleet of fossil fuel power-generating facilities by developing tools to increase our understanding of the behavior of CO<sub>2</sub> in the subsurface and identifying the geologic reservoirs appropriate for CO<sub>2</sub> storage.

The [Carbon Storage Program Overview](#) webpage provides detailed information of the program's structure, as well as links to the webpages that summarize the program's key elements.

### Carbon Storage Program Resources



The [National Energy Technology Laboratory's CCS Database](#) includes active, proposed, and terminated CCS projects worldwide. The information is taken from publically available sources to provide convenient access to information regarding efforts by various industries, public groups, and governments towards development and eventual deployment of CCS technology. NETL's CCS Database is available as a Microsoft Excel spreadsheet and also as a customizable layer in Google Earth.

Newsletters, program fact sheets, best practices manuals, roadmaps, educational resources, presentations, and more are available via the [Carbon Storage Program Publications webpage](#).

Get answers to your carbon capture and storage questions at NETL's [Frequently Asked Questions webpage](#).

## ABOUT NETL'S CARBON STORAGE NEWSLETTER

Compiled by the National Energy Technology Laboratory, this newsletter is a monthly summary of public and private sector carbon storage news from around the world. The article titles are links to the full text for those who would like to read more.



### National Energy Technology Laboratory

The [National Energy Technology Laboratory \(NETL\)](#), part of DOE's national laboratory system, is owned and operated by the U.S. Department of Energy (DOE). NETL supports DOE's mission to advance the national, economic, and energy security of the United States.

1450 Queen Avenue SW  
Albany, OR 97321-2198  
541-967-5892

3610 Collins Ferry Road  
P.O. Box 880  
Morgantown, WV 26507-0880  
304-285-4764

626 Cochran's Mill Road  
P.O. Box 10940  
Pittsburgh, PA 15236-0940  
412-386-4687

Program staff are also located in Houston, Texas and Anchorage, Alaska.

**WEBSITE:** [www.netl.doe.gov](http://www.netl.doe.gov)

**CUSTOMER SERVICE:** 1-800-553-7681

### Contacts

Traci Rodosta  
304-285-1345  
[traci.rodosta@netl.doe.gov](mailto:traci.rodosta@netl.doe.gov)

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There are several ways to join the conversation and connect with NETL's Carbon Storage Program:



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