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# CARBON STORAGE NEWSLETTER

JUNE 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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## DOE/NETL HIGHLIGHTS

### DOE Launches CCUS Initiative.

The U.S. Department of Energy (DOE) launched the *Carbon Capture, Utilization, and Storage (CCUS) Initiative*, which will focus on strengthening the framework for building collaborative partnerships on CCUS between the public and private sectors. The initiative will complement existing CCUS efforts led by the Carbon Sequestration Leadership Forum (CSLF), the International Energy Agency (IEA), the IEA's Greenhouse Gas Research and Development (R&D) Programme (IEAGHG), Mission Innovation, and the Global CCS Institute. The announcement was made at the 9th Clean Energy Ministerial (CEM9) in Copenhagen, Denmark. From *energy.gov* on May 24, 2018.



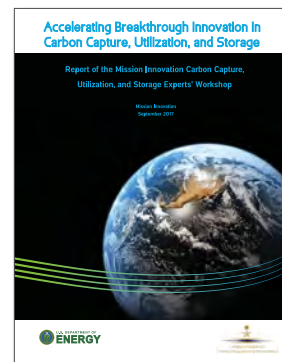
Petra Nova in Texas (USA) is the world's largest post-combustion carbon capture system, capturing CO<sub>2</sub> produced by burning coal for use in enhanced oil recovery (EOR).

### DOE Selects Carbon Storage Projects to Receive Federal Funding.

Three projects have been selected by DOE's Office of Fossil Energy (FE) to receive funding for cost-shared R&D under Phase II of Funding Opportunity Announcement (FOA) *DE-FOA-0001450, Carbon Storage Assurance Facility Enterprise (CarbonSAFE): Storage Complex Feasibility*. Projects selected under this FOA will determine the feasibility for commercial-scale storage complexes that can hold 50+ million metric tons (MMT) of carbon dioxide (CO<sub>2</sub>). The projects were selected as part of the *Carbon Storage Program* and will help inform the characterization and permitting of a commercial-scale complex with at least one storage site, ultimately demonstrating the potential for safe and secure storage in time for the anticipated deployment of transformative carbon capture technologies in the 2025 timeframe. From *energy.gov* on May 24, 2018.

### DOE Releases CCUS Experts' Workshop Report.

DOE's FE and Oak Ridge National Laboratory (ORNL) released a report of the Mission Innovation CCUS Experts' Workshop, which discussed basic R&D needs in CO<sub>2</sub> capture, CO<sub>2</sub> utilization, geologic storage, and crosscutting CCUS topics. Hosted by the United States in conjunction with Saudi Arabia, the workshop brought together worldwide CCUS experts from academia and industry. The report, titled "*Accelerating Breakthrough Innovation in Carbon Capture, Utilization, and Storage*," was released at the Mission Innovation CCUS Roundtable in Malmo, Sweden, where DOE officials took part in discussing the role of CCUS technologies in global decarbonization efforts. From *energy.gov* on May 23, 2018.



## ANNOUNCEMENTS

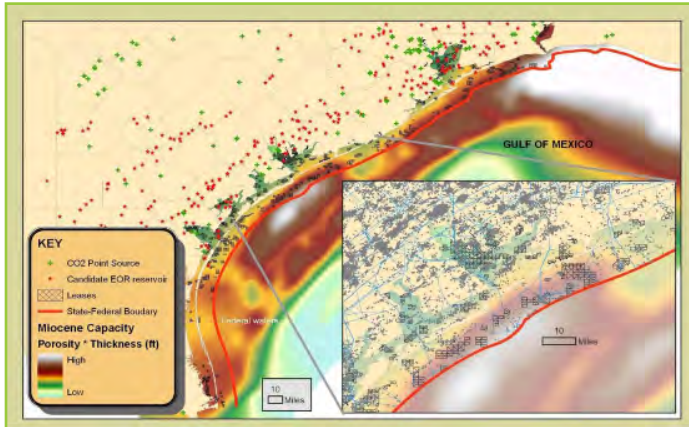
### SPE Releases CO<sub>2</sub> Storage Resources Management System Document.

The Society of Petroleum Engineers (SPE) released the "*CO<sub>2</sub> Storage Resources Management System (SRMS)*," developed by a subcommittee of SPE's CCUS Technical Section, which engages in collaboration, knowledge sharing, and activities dedicated to the advancement of CCUS and the decarbonization of the petroleum industry. The document establishes technically based capacity and resources evaluation standards.

## ANNOUNCEMENTS *(cont.)*

### *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/FE RECS Program Accepting Applications.*

The 2018 Research Experience in Carbon Sequestration (RECS) Program is accepting applications from graduate students and early-career professionals interested in CCUS. Scheduled for July 22-28, 2018, in Birmingham, Alabama, USA, RECS 2018 provides the opportunity to gain hands-on field research experience in areas related to CCUS. The deadline to apply for the FE- and National Energy Technology Laboratory (NETL)-supported program is June 30, 2018.



### *Company Joins MIT Energy Initiative.*

IHI, a global engineering, construction, and manufacturing company, signed a three-year agreement to join the Massachusetts Institute of Technology Energy Initiative’s (MITEI) *Low-Carbon Energy Center* for CCUS. The center is one of eight Low-Carbon Energy Centers established by MITEI as part of *MIT’s Plan for Action on Climate Change*. In addition to funding research, IHI’s membership will support MIT’s technical assessment program, which analyzes the technical and economic potential of various CCUS technologies.

## PROJECT and BUSINESS DEVELOPMENTS

### *Norway Government Supports CO<sub>2</sub> Capture, Transport, and Storage Demonstrations.*

The Norwegian government announced funding for demonstration studies on how to capture, transport, and store CO<sub>2</sub> from a cement factory in Brevik, Norway. The announcement was made with the publishing of the government’s assessment of plans for a full-scale carbon capture and storage (CCS) demonstration project that would eventually result in CO<sub>2</sub> captured at industrial sites in Norway and transported for storage under the North Sea. In addition to the CO<sub>2</sub> transport and storage studies, the Norwegian government funding will also support engineering and design studies and up to two capture facilities. From *Business Green* on May 15, 2018.

### *Drax Power Station to Lead BECCS Trial.*

The Drax Group will lead a bioenergy with carbon capture and storage (BECCS) trial at its north Yorkshire power station. Drax will store the carbon in a compressed form onsite, where it has the potential to be sold for industrial processes. From *The Guardian* on May 21, 2018.

### *Power Plant Reaches CCS Milestone.*

NET Power, LLC, announced it has achieved a milestone in the large-scale development and deployment of CCS technologies at its supercritical CO<sub>2</sub> (sCO<sub>2</sub>) demonstration power plant and test facility located in La Porte, Texas, USA. The milestone validates the fundamental operability and technical foundation of NET Power’s power system, and involves the integrated operation of the full NET Power process. In addition, the achievement confirms the operation at commercial-scale of Toshiba’s 50-MWth combustor. Following testing, the combustor will be integrated with the turbine and power will be generated. NET Power produces pipeline-ready CO<sub>2</sub>. From *Global CCS Institute* on May 31, 2018.

## LEGISLATION and POLICY

### *CCUS Legislation Advanced by Senate Committee.*

Legislation that will promote coordination among Federal, state, and private entities on CCUS facilities and CO<sub>2</sub> pipelines was approved by the U.S. Senate Environment and Public Works (EPW) Committee. Under the Utilizing Significant Emissions with Innovative Technologies (USE IT) Act, the Clean Air Act would be amended to allow the U.S. Environmental Protection Agency (EPA) to support carbon utilization. In addition, the measure would clarify that CCUS facilities and CO<sub>2</sub> pipelines are eligible for expedited permitting review. From *Daily Energy Insider* on May 25, 2018.

### *UK Commits Funding for CCS.*

The United Kingdom (UK) government pledged funding for innovative CCUS technologies as part of an international challenge to invest in new ways of reducing the cost to make the technology commercially viable at scale. As part of the funding, a call for CCUS innovation will offer funding for projects up to 28 months, and further funding will be provided under an R&D program made up of 10 European nations. From *Energy Live News* on May 23, 2018.

### *Committee to Examine CCUS.*

A UK parliamentary committee will examine the government's plans to reduce CO<sub>2</sub> emissions and meet goals with CCUS technologies. The Business, Energy, and Industrial Strategy (BEIS) Committee in the House of Commons will observe the UK government's support for CCUS, inviting industry and other stakeholders to submit written opinions. CCUS was identified in the UK government's "*Clean Growth Strategy*," published in October 2017. From *Out-Law* on May 31, 2018.

## EMISSIONS TRADING

### *Joint Cap-and-Trade Auction Results Released.*

California (USA), Québec, and Ontario (Canada) released the results of the second joint cap-and-trade auction of carbon allowances involving three jurisdictions. All of the 90,587,738 current (2016 and 2018) vintage CO<sub>2</sub> allowances sold at a settlement price of \$14.65, while 6,057,000 of the 12,427,950 advance (2021) vintage allowances sold at a settlement price of \$14.53. More information on the auction is [available online](#). From *California Air Resources Board* on May 23, 2018.

### *RGGI Releases Two Reports.*

The states participating in the Regional Greenhouse Gas Initiative (RGGI) released two reports. Prepared by independent market monitor Potomac Economics, the "*Annual Report on the Market for RGGI CO<sub>2</sub> Allowances: 2017*" evaluates 2017 activity in the RGGI CO<sub>2</sub> allowance market, focusing on allowance prices, trading and acquisition of allowances in the auctions and the secondary market, participation in the market by individual firms, and market monitoring. The RGGI states also released the "*Compliance Summary Report*" for its third three-year control period, finding that, at the time of the report being published, 161 of the 163 power plants subjected to RGGI requirements met their compliance obligations. From *RGGI News Release* on May 24 and June 4, 2018.



### *Lawmakers Begin Cap-and-Trade Talk.*

An Oregon (USA) joint legislative committee began to develop policy for a statewide cap-and-trade program. The Joint Committee on Carbon Pricing initiated its work by holding discussions with experts on state and national environmental policies. Oregon state legislative leaders have committed to recommending a carbon-pricing policy during next year's legislative session. The Oregon legislature set a goal of reducing carbon emissions to 10 percent less than 1990 levels by 2020. From *The Dalles Chronicle* on May 23, 2018.

### *UN Issues Carbon Credits.*

The United Nations (UN) issued carbon credits to SABIC, a Saudi Arabian petrochemicals manufacturer, for a Clean Development Mechanism (CDM) project. Under the CDM, emission-reduction projects in developing countries can earn certified emission-reduction credits, which can be used to meet targets. From *SABIC News Release* on May 23, 2018.

## CLIMATE and SCIENCE NEWS

### *Science Advisors Examine CCUS.*

The European Union (EU) published the fourth scientific opinion of the European Commission's *Group of Chief Scientific Advisors*, examining the potential and possible implementation of CCUS technologies. The published opinions and recommendations draws on the best available scientific and technical evidence across Europe, as well as a comprehensive review of scientific literature. From *Carbon Capture Journal* on May 24, 2018.

### *Atmospheric CO<sub>2</sub> May Make Food Less Nutritious.*

According to a new study co-authored by the U.S. Department of Agriculture (USDA), potentially rising atmospheric CO<sub>2</sub> levels may be making food less nutritious by altering their chemical makeup and diluting vitamins and minerals. Specifically, the study, [published in \*Scientific Advances\*](#), found that rice exposed to elevated levels of CO<sub>2</sub> contains



lower amounts of several important nutrients. The USDA researchers exposed experimental rice fields in China and Japan to anticipated future levels of CO<sub>2</sub>, finding that most of the 18 varieties tested contained less protein, iron, and zinc than rice grown today. From *The New York Times* on May 23, 2018.

### *Volcanic Study Finds Coral Changes in High CO<sub>2</sub>.*

A large-scale experiment conducted off Papua New Guinea has found that potentially high levels of CO<sub>2</sub> could have an impact on coral reefs. [In a paper published in the journal \*Plos One\*](#), researchers from the Australian Institute for Marine Science (AIMS) and the University of Otago (New Zealand) studied 90 small coral communities, half of which were positioned close to two shallow-water volcanic CO<sub>2</sub> seeps (the other half – the control sites – were positioned a short distance away), for 13 months. The researchers found that the coral communities near the volcanic vents considerably changed. From *Cosmos Magazine* on May 31, 2018.



## JOURNAL ARTICLES

***An Integrated Carbon Policy-Based Interactive Strategy for Carbon Reduction and Economic Development in a Construction Material Supply Chain.***

The following is the Abstract of this article: "Carbon emissions from the construction material industry have become of increasing concern due to increasingly urbanization and extensive infrastructure. Faced with serious atmospheric deterioration, governments have been seeking to reduce carbon emissions, with carbon trading and carbon taxes being considered the most effective regulatory policies. Over time, there has been a global consensus that integrated carbon trading/carbon tax policies are more effective in reducing carbon emissions. However, in an integrated carbon reduction policy framework, balancing the relationship between emission reductions and low-carbon benefits has been found to be a critical issue for governments and enterprises in both theoretical research and carbon emission reduction practices. As few papers have sought to address these issues, this paper seeks to reach a trade-off between economic development and environmental protection involving various stakeholders: regional governments which aim to maximize social benefits, and producers who seek economic profit maximization. An iterative interactive algorithmic method with fuzzy random variables (FRVs) is proposed to determine the satisfactory equilibrium between these decision-makers. This methodology is then applied to a real-world case to demonstrate its practicality and efficiency." **Liming Zhang, Wei Yang, Yuan Yuan, and Rui Zhou, *Sustainability*.** (Subscription may be required.)

***Global Carbon Budget 2017.***

The following is from the Abstract of this article: "Accurate assessment of anthropogenic CO<sub>2</sub> emissions and their redistribution among the atmosphere, ocean, and terrestrial biosphere – the 'global carbon budget' – is important to better understand the global carbon cycle, support the development of climate policies, and project future climate change. Here [the authors] describe data sets and methodology to quantify the five major components of the global carbon budget and their uncertainties. CO<sub>2</sub> emissions from fossil fuels and industry (EFF) are based on energy statistics and cement production data, respectively, while emissions from land-use change (ELUC), mainly deforestation, are based on land-cover change data and bookkeeping models. The global atmospheric CO<sub>2</sub> concentration is measured directly and its rate of growth (GATM) is computed from the annual changes in concentration. The ocean CO<sub>2</sub> sink (SOCEAN) and terrestrial CO<sub>2</sub> sink (SLAND) are estimated with global process models constrained by observations. The resulting carbon budget imbalance (BIM), the difference between the estimated total emissions and the estimated changes in the atmosphere, ocean, and terrestrial biosphere, is a measure of imperfect data and understanding of the contemporary carbon cycle." **Corinne Le Quéré et al., *Earth System Science Data*.** (Subscription may be required.)

***Diffusivity of Carbon Dioxide in Aqueous Solutions under Geologic Carbon Sequestration Conditions.***

The following is the Abstract of this article: "Accurate assessment of the long-term security of geologic carbon sequestration requires knowledge of the mobility of [CO<sub>2</sub>] in brines under pressure and temperature conditions that prevail in subsurface aquifers. Here, [the authors] report Raman spectroscopic measurements of the rate of CO<sub>2</sub> diffusion in water and brines as a function of pressure, salinity, and concentration of CO<sub>2</sub>. In pure water at 50 ± 2°C and 90 ± 2 bar, [the authors] find the diffusion coefficient, D, to be (3.08 ± 0.03) × 10<sup>-9</sup> m<sup>2</sup>/s, a value that is consistent with a recent microfluidic study but lower than earlier [pressure, volume, and temperature (PVT)] measurements. Under reservoir conditions, salinity affects the mobility of CO<sub>2</sub> significantly and D decreased by 45% for a 4 M solution of NaCl. [The authors] find significant differences of diffusivity of CO<sub>2</sub> in brines (0–4 M NaCl), in both the absolute values and the trend compared to the Stokes–Einstein prediction under [the authors'] experimental conditions. [The authors] observe that D decreases significantly at the high CO<sub>2</sub> concentrations expected in subsurface aquifers (~15% reduction at 0.55 mol/kg of CO<sub>2</sub>) and provides an empirical correction to the commonly reported D values that assume a tracer concentration dependence on diffusivity." **Pradeep N. Perera, Hang Deng, P. James Schuck, and Benjamin Gilbert, *The Journal of Physical Chemistry*.** (Subscription may be required.)

***Impacts of SO<sub>2</sub> gas impurity within a CO<sub>2</sub> stream on reservoir rock of a CCS pilot site: Experimental and modelling approach.***

The following is the Abstract of this article: "In order to evaluate chemical impacts of [sulfur dioxide (SO<sub>2</sub>)] impurity on reservoir rock during CO<sub>2</sub> capture and storage in deep saline aquifers, several batch reactor experiments were performed on laboratory scale using core rock samples from the pilot CO<sub>2</sub> injection site in Heletz. In this experiment, the samples were exposed to pure N<sub>2</sub>(g), pure CO<sub>2</sub>(g), and CO<sub>2</sub>(g) with an impurity of 1.5% SO<sub>2</sub>(g) under reservoir conditions for pressure and temperature (14.5 MPa, 60°C). Based on the set-up and the obtained experimental results, a batch chemical model was established using the numerical simulation program TOUGHREACT V3.0-OMP. Comparing laboratory and simulation data provides a better understanding of the rock-brine-gas interactions. In addition, it offers an evaluation of the capability of the model to predict chemical interactions in the target injection reservoir during exposure to pure and impure CO<sub>2</sub>. The best match between the geochemical model and experimental data was achieved when the reactive surface area of minerals in the model was adjusted in order to calibrate the kinetic rates of minerals. The simulations indicated that SO<sub>2</sub>(g) tends to dissolve rather quickly and oxidizes under a kinetic control. Hence, it has a stronger effect on the acidity of the brine than pure CO<sub>2</sub>(g) and as a result, increased mineral dissolution and caused the precipitation of sulfate and sulfide minerals. Ankerite, dolomite, and siderite, the most abundant carbonates in the sandstone rock sample, are subject to stronger dissolution in the presence of SO<sub>2</sub> gas. The performed simulations confirmed a slower dissolution rate for ankerite and siderite than for dolomite. The model reproduced the precipitation of pyrite and anhydrite as observed in the laboratory. The dissolution of dolomite observed in the batch reaction test with pure N<sub>2</sub> is assumed to be due to slight contamination with oxygen and modelling supported this. The inclusion of SO<sub>2</sub> increased the porosity over that of the pure CO<sub>2</sub> case, and is thus considered to increase the permeability and injectivity of the reservoir as well. Exposure to SO<sub>2</sub> also increased the concentration of trace elements. The calibrated kinetic parameters determined in this study will be used to model the injection and long-term behavior of CO<sub>2</sub> at the Heletz field site, and may be used for similar geologic reservoirs." **Maryeh Hedayati, Andrew Wigston, Jan Lennard Wolf, Dorothee Rebscher, and Auli Niemi, *International Journal of Greenhouse Gas Control*.** (Subscription may be required.)

***Transnational transfer of carbon emissions embodied in trade: Characteristics and determinants from a spatial perspective.***

The following is the Abstract of this article: "Based on the multi-regional input-output analytical framework and spatial econometric regression models, this paper analyzes embodied global emissions in trade, so as to unravel the characteristics of spatial emissions transfer for 39 countries from 1995 to 2011, and investigates the determinants of transnational transfer of the global emissions in trade changes from a spatial perspective. One important finding from this study is that the global emissions in trade primarily have flown from developing to developed countries and regions. Notably, however, for those countries endowed with rich natural resources and developed economy like Canada, they have become the net carbon exporters in trade. Another important finding is that such important determinants as energy and industrial structure have spatial spillover effects on the emissions embodied in trade changes. Regarding climate policies, [the authors'] results suggest that the increase in the share of clean energy could curtail the impact of trade on global carbon emissions. Notably, [the authors'] study also finds that improving energy efficiency would not lower the emissions embodied in global trade because the forecasted reduction in energy use and thus carbon emissions that may be lost due to the sum of consumer and market responses." **Zhangqi Zhong, Lei Jiang, and Peng Zhou, *Energy*.** (Subscription may be required.)

## JOURNAL ARTICLES *(cont.)*

### *Value of performance baseline in voluntary carbon trading under uncertainty.*

The following is the Abstract of this article: "Voluntary carbon trading has long been criticized for producing a large number of non-additional offsets. The reason for this production lies primarily in the use of a project-based baseline that misrepresents the business-as-usual (BAU) emissions of individual projects. Performance baseline however, as an alternative baseline approach, does not rely on evaluating individual BAU emissions. Instead, it uses a pre-defined emission threshold for a class of project activities. This paper compares the effects of the two baseline approaches on sectoral emission mitigation and compliance costs by modeling dynamic emission abatement behaviors. In the context of the U.S. commercial building sector, the modeling results indicate that while both baseline approaches are capable of reducing sectoral emissions, the use of performance baseline is especially advantageous under private cost information and uncertain market environments. The performance baseline should be stratified by region to ensure the equity in offset allocation in sectors that are highly diversified in emission magnitudes." **Xiaoyu Liu and Qingbin Cui**, *Energy*. (Subscription may be required.)

### *General public reactions to carbon capture and storage: Does culture matter?*

The following is the Abstract of this article: "[The authors scrutinize CCS] technology from a cross-cultural perspective. The reaction of the public to CCS will considerably affect the development of the technology. Previous research has identified general and local mechanisms in how the general public reacts to CCS. Researchers have noticed that differences exist between countries, but the effects of cross-cultural differences have not been explored in detail. [The authors] argue that it is crucial to understand how public perceptions of the technology emerge and form in their individual contexts or embedded in large-scale cultural frameworks. Public reaction to CCS is structured in two dimensions—risk perception and benefit perception—and [the authors] design a model with individual and national cultural level predictors. [The authors] indicate that effects of individual level variables such as familiarity with technology, or sociodemographic variables such as education, are important but their effects are likely mediated and confounded by the cultural setting people operate in. The results show that, in parallel with other factors such as trust, risk perception is affected by cultural dimensions such as uncertainty avoidance and the society's short-term or long-term orientation. [The authors] provide a framework to understand why and how societies challenge the technology." **Farid Karimi and Arho Toikka**, *International Journal of Greenhouse Gas Control*. (Subscription may be required.)

### *Exergy and economic analyses of indirect coal-to-liquid technology coupling carbon capture and storage.*

The following is the Abstract of this article: "Coal-to-liquids (CTL) technology has been developed steadily for producing gasoline and diesel fuels as the demand for energy security issue and liquid fuels in China outpaces production capacities. In this light, given the importance of CO<sub>2</sub> emissions in climate change, CCS is considered as an integral part of CTL processes. In this study, CTL coupling with CCS technology (CTL-CCS) were simulated using the Aspen Plus software. Based on it, this study conducted exergy and economic analyses to the CTL-CCS system for five different coal types, including anthracite, meager, lean, coking and gas. Results show that the exergy utilization ratios ranged from 40.3% to 43.7%, revealing only a limited effect of the choice of coal type; although anthracite, meager, and gas coal were marginally better. Results also indicate the largest sources of exergy loss to be firstly from gas generation and secondly from the combined process of synthesis and separation. The economic analysis compared the cost, net present value, internal rate of return, and payback period. The cost of liquid fuel produced by CTL-CCS system was in the range from 4117 to 5627 yuan RMB/t, indicating economic feasibility. The system using lean coal revealed the best economic performance, while those using coking coal and gas coal were the second best performers. This research suggests that gas coal can achieve relatively reasonable values for both the exergy utilization ratio and cost in comparison to other coal types processed through a coupled CTL-CCS system." **Li Zhou, Maosheng Duan, and Yadong Yu**, *Journal of Cleaner Production*. (Subscription may be required.)

## REPORTS and OTHER PUBLICATIONS

***Performance Evaluation and Integration of Multiple CO<sub>2</sub> Leak Detection Monitoring Technologies.***

The following is from the Executive Summary of this National Risk Assessment Partnership (NRAP) document: "Monitoring, mitigation and verification (MMV) is an indispensable part of an integrated geologic [CCS] project. Developing a reliable MMV network is of vital importance in order to avoid threats to public health, the environment, and economic investments in sequestration in case of significant leakage. The large spatial extent of sites and the several decades-long duration required for MMV present a great challenge. The availability of several technologies (soil gas, surface flux, eddy covariance, perfluoro-carbon tracers, seismic, pressure monitoring, groundwater chemistry, etc.) allow such networks to be established. However, the large numbers of monitoring devices, operating practices, failure modes, and leakage scenarios dictate the need for an overseeing mechanism that will help to integrate and interpret the signals from the network. This project was carried out to develop such an integrating mechanism utilizing a Bayesian belief network (BBN). A well-established and calibrated BBN can statistically characterize the reliability of a given leakage signal, combining evidence from multiple measurements in a weight-of-evidence framework. Both false positives and false negatives are intended to be reduced, and eliminated if possible, through application of this statistical tool. Once developed, the BBN can be used to predict the probability that a future leak of a given size will be detected. In future studies the final product from this project can also be used to design an MMV network that optimizes detection capabilities for a given expenditure of available resources, and as part of an integrated risk model that includes adaptive management options should leakage be detected."

***Why Carbon Pricing Matters: A guide for implementation.***

The following is the Preface of this World Business Council for Sustainable Development (WBCSD) document: "Carbon pricing is an accepted concept for managing carbon emissions and many jurisdictions are looking to implement one instrument or another. Many resources describing different carbon pricing mechanisms exist. However, they tend not to be comparative and are relatively high-level. WBCSD and its members believe that carbon pricing is now regarded as one of the most efficient means of driving the transition to

a low-carbon world. As an increasing number of jurisdictions have adopted or are considering adopting carbon pricing, this document focuses on the 'what' and 'how' rather than the 'why.' Policymakers need to choose the most suitable carbon pricing instruments and design them appropriately. This document aims to guide policymakers who are considering carbon pricing mechanisms in their choice of instruments and some key design principles. In the process, this document hopes to stimulate further and more detailed discussions between policymakers and business leaders on how best to implement the carbon price so that it can incentivize low-carbon innovation and investment, create a global level playing field and support the attainment of the [United Nations Framework Convention on Climate Change (UNFCCC)] 2°C goal in a sustainable way."



wbcasd

## 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

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