CSN CARBON STORAGE NEWSLETTER

NOVEMBER 2016

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:

CARBON STORAGE PROGRAM DOCUMENTS and REFERENCE MATERIALS

NATIONAL ENERGY TECHNOLOGY LABORATORY

DOE/NETL HIGHLIGHTS

Diagram of Oxygen-Fired Pressurized Fluidized Bed Combustor

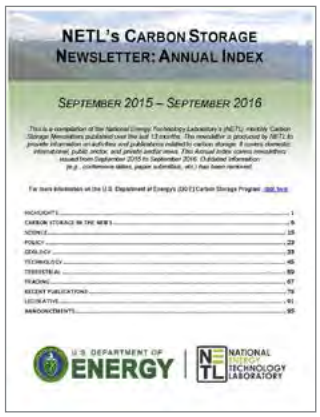
"DOE, Natural Resources Canada Announce Pilot Plant to Advance Oxy-Combustion Carbon Capture."

The U.S. Department of Energy (DOE) and Canada's Natural Resources Canada (NRCan) will open a new facility to test oxy-fired pressurized fluidized bed combustion (oxy-PFBC) to capture carbon dioxide (CO_2) emissions from a coal-fired power plant. The *1-megawatt thermal (MWth) facility*, located in Canoga Park, California, USA, will test oxy-PFBC as a means to more efficiently and economically capture CO_2 and help advance the commercialization of carbon capture, utilization, and storage (CCUS). The test plant is part of an ongoing collaboration between DOE, NRCan, and CametEnergy (NRCan's research and development [R&D] lab). The National Energy Technology Laboratory (NETL)-managed project, which is being led by the Gas Technologies Institute (GTI), received funding from *DOE's Office of Fossil Energy's (FE) Advanced Combustion Program*. From *energy.gov* on October 18, 2016.

ANNOUNCEMENTS

DOE Issues RFI for Oil and Gas R&D.

DOE's FE and NETL issued a *Request for Information (RFI)* for input on critical gaps in oil and natural gas technology that must be addressed through scientific research. The RFI seeks input on research needs in five areas, including CO_2 storage and enhanced oil recovery (EOR). *Submissions for this RFI (Reference Number DE-FOA-0001693) are due by December 16, 2016.*



2016 Carbon Storage Newsletter Annual Index Available.

This document is a compilation of NETL's Carbon Storage Newsletters published over the September 2015 to September 2016 timeframe. Outdated information (e.g., conference dates and paper submittals) has been removed.

DOE-Funded Technology Moves Forward to Large-Scale Testing.

A *second-generation CO_2 solvent technology project* funded by DOE will begin testing at the *Technology Centre Mongstad (TCM)* in western Norway. DOE has a bilateral Memorandum of Understanding (MOU) with the Royal Norwegian Ministry of Petroleum and Energy that covers fossil energy-related research to leverage each countries' investments in CCUS.

Team Formed to Study CCUS Technologies.

Japanese companies are collaborating with the International CCS Knowledge Center to assess the potential application of Japanese technologies in future CCUS projects in Saskatchewan, Canada. In addition to identifying potential global applications of the technologies, the consortium intends to show how the technologies could improve carbon capture system and air-quality control system applications for CCUS projects in Saskatchewan.

CCS Study Aims to Boost Industry.

A new study will explore carbon capture and storage (CCS) and the refinement and development of a financing option for the industrial CCS network in Teesside, England, known as the Teesside Collective. The study will also recommend a regulatory regime to manage the system, known as the Hybrid Incentive Model. The work will take account of existing documented work on industrial CCS financing, storage, and regulation.

PROJECT and BUSINESS DEVELOPMENTS

"Norway Unveils Plan to Develop Industrial CCS Portfolio."

The *Norwegian government unveiled plans* to develop its industrial CCS portfolio by supporting three large-scale industrial CCS demonstration projects. According to officials, if all three projects proceed to a final investment decision, they would have the potential to reduce Norway's carbon emissions by five percent. The Norwegian government also announced the approval of a three-year extension of the TCM CCS test facility, with a new agreement on the ownership and operation expected before the end of 2016. From *BusinessGreen* on October 6, 2016. (Subscription may be required.)

"First Fully Commercial CCSU Plant Launches Capturing CO_2 at $30 Per [Metric Ton]."

Carbon Clean Solutions Limited (CCSL) announced the launching of a new project that will capture more than 60,000 metric tons of CO_2 from a 10-megawatt coal-fired power station in India. Post start-up, the project is expected to capture CO_2 at a lower cost than is currently observed per metric ton of CO_2. CCSL successfully completed a pilot-testing program at TCM in May 2016, in which the results showed that use of CCSL's solvent reduced emission levels, lowered corrosion, and improved system reliability. From *Carbon Clean Solutions* on October 11, 2016.

"[Funding Awarded for Test Program on CO_2 Pipelines]."

DNV GL and Energy Pipelines CRC (EPCRC) were awarded funding for a CO_2 pipelines test program. Funded by the Norwegian CLIMIT Programme and the Australian Department of Industry, Innovation, and Science, the test program will address the existing knowledge gaps in the fracture control of high-pressure pipelines by conducting large-scale, fracture-propagation testing of dense-phase CO_2 pipelines at *DNV GL's Spadeadam test site* in the United Kingdom (UK). Scheduled to run from late 2016 to early 2019, the test program, titled "Improving the safety and efficiency of CO_2 pipelines by developing and validating predictive models for CO_2 pipeline design," will look to reduce future costs of CO_2 pipelines while also ensuring the required safety level. From *DNV GL Press Release* on October 20, 2016.

"MENA's First CCUS Project Now on Stream."

The first commercial-scale CCUS facility in the Middle East and North Africa (MENA) is operational and capable of storing up to 800,000 metric tons of CO_2 per year, according to officials. Developed by a joint venture between Abu Dhabi National Oil Company (ADNOC) and Masdar, the project captures CO_2 emissions from Emirates Steel Industries (ESI), compresses and dehydrates it, and then transports the CO_2 via underground pipeline for EOR injection into ADNOC onshore oilfields. Construction on the project began in July 2013. From *Masdar Press Release* on November 5, 2016.

"Lab Upgrade to Help Store Carbon Dioxide Underground."

An X-ray microscopy laboratory at Australian National University (ANU) received a $5 million upgrade. Funded by CO2CRC Limited and the Australian Government's Education Investment Fund, the renovated laboratory is part the Australian CCS Research Laboratories Network (CCSNET). According to officials, the new facilities enable the building of large-scale computer models that help explain the influence of complex layers of sedimentary rock on the effectiveness of CO_2 storage. From *Australian National University* on November 7, 2016.

LEGISLATION and POLICY

"[Legislation Introduced to Encourage Carbon Storage]."

A bill, titled "CO_2 Regulatory Certainty Act of 2016," was introduced to encourage carbon storage. The bill aligns tax guidelines with existing federal regulations to ensure taxpayers are better able to utilize the Section 45Q carbon storage tax credit. From *U.S. Senator For Montana Steve Daines Press Release* on October 5, 2016.

"Vietnam Commits to [Reductions] in Greenhouse Gas Emissions by 2030."

According to officials, Vietnam has reaffirmed its commitment to an eight percent reduction in greenhouse gas (GHG) emissions by 2030, with the potential to achieve a 25 percent reduction with additional support. The country will apply various methods to reach its GHG reduction goals and encourage green industry development, and will also conduct research to form a national carbon trading market. Vietnam announced its emission goal in 2015 when it submitted its Intended Nationally Determined Contribution (INDC) to the United Nations Framework Convention on Climate Change. From *VnExpress International* on October 19, 2016.

"UNFC Specifications for CO_2 Storage Have Been Approved."

Specifications have been developed for the application of the United Nations Framework Classification for Fossil Energy and Mineral Reserves and Resources 2009 (UNFC) to geologic storage projects. The specifications, developed by the United Nations Economic Commission for Europe (UNECE), are now operational following approval by UNECE's Committee on Sustainable Energy. The Oil and Gas Climate Initiative and the Society of Petroleum Engineers are working on a Storage Resource Management System that will align with the UNFC specifications. *More information on the application of UNFC-2009 to geologic storage projects is available on the UNECE website*. From *Carbon Capture Journal* on November 3, 2016.

EMISSIONS TRADING

"Sweden Proposes Measures to Strengthen Carbon Prices."

Sweden has proposed measures to strengthen carbon prices from 2020 and to address the excess credits in the European Union's (EU) Emissions Trading System (ETS), the country's climate minister announced. The proposals were presented to 13 EU environment ministers with the aim of capping carbon emissions. The proposals include removing some of the surplus of allowances via the EU ETS Market Stability Reserve (MSR), eliminating permits above a set ceiling, and possibly introducing an expiration date to cancel surplus permits after five years. From *Daily Mail Online* on October 17, 2016.

"EPA Finalizes Voluntary CO_2 Trading Model for Clean Power Plan."

A voluntary carbon-trading model for Clean Power Plan compliance was finalized by the U.S. Environmental Protection Agency (EPA) and sent to the Office of Management and Budget (OMB) for review. Under the program, states could comply with the federal carbon regulations by entering an optional cap-and-trade program for emissions, earning additional credit for early investments in alternative energy through a finalized *Clean Energy Incentive Program*. From *Utility Dive* on November 7, 2016.

CLIMATE and SCIENCE NEWS

"Drones Create 3D Maps to Demonstrate Carbon Storage."

Drones are being used to create digital three-dimensional models of vegetation to measure biomass. According to researchers, the technology has the potential to be utilized as an effective auditing tool for the demonstration of carbon storage results of improved rangeland management practices. From *ScienceNetwork Western Australia* on October 8, 2016.

"Nano-Spike Catalysts Convert Carbon Dioxide Directly into Ethanol."

Scientists at DOE's Oak Ridge National Laboratory (ORNL) developed an electrochemical process capable of turning CO_2 into ethanol. Using a catalyst made up of carbon, copper, and nitrogen, the research team triggered a complicated chemical reaction by applying voltage, essentially reversing the combustion process. The CO_2 solution dissolved into water and turned into ethanol with a yield of 63 percent. Initial analysis claims the surface of the catalyst provides reactive sites to facilitate the CO_2-to-ethanol conversion and, given the technique's reliance on low-cost materials and the ability to operate at room temperature, that the process could be scaled up for industrially relevant applications. From *Oak Ridge National Laboratory News Release* on October 12, 2016.

"[Forest Carbon Storage Pilot Project Launched]."

A 1.2-million acre Ghanaian forest carbon storage pilot project was launched for new tradable forest carbon products. The planetary-scale project for the diverse forests of Ghana features direct continuous monitoring of GHGs for new trading products benefiting ecosystems, indigenous people, and stakeholders. From *PR Web* on November 7, 2016.

"Record Growth in Atmospheric CO_2 Despite Stable Anthropogenic Emissions."

According to model simulations, atmospheric CO_2 levels exceeded 400 parts per million (ppm) in 2015, which is 44 percent above pre-industrial levels and the highest level in at least the last 800,000 years. Despite no growth in CO_2 emissions for the third straight year, researchers believe the growth in atmospheric CO_2 concentration was caused by a smaller uptake of carbon in the terrestrial biosphere in response to warm and dry conditions over tropical land (caused by the El Niño event from May 2015 to June 2016). Reported emissions cannot be verified with independent data due to an inability to account for carbon fluxes in the natural environment; researchers believe it to take 5 to 10 years before global emissions can be confirmed with independent data. From *Phys.Org* on November 15, 2016.

JOURNAL ARTICLES

"Data integration, reservoir response, and application."

The following is the Abstract of this article: "The microseismic activity observed in and around a geologic formation undergoing CO_2 injection is a combination of natural, or 'background,' microseismicity plus that activity which is induced by injection operations. Since injection pressure within storage target formations are maintained safely below fracture pressure this induced activity typically originates at natural pre-existing zones of mechanical weakness presented by structural or stratigraphic features. The combination of mechanical properties and in situ stresses dictate the focal mechanism for microseismic emissions, an understanding of which facilitates the use of observed microseismicity for regulatory compliance and project management. Under favorable conditions microseismic activity may be unambiguously correlated with structural and/or stratigraphic features directly observed in seismic data, thus providing strong constraints to interpretation of observed microseismicity for focal mechanisms. However, in many cases, such as at the Illinois Basin–Decatur Project (IBDP), this direct correlation is elusive and other indirect support is required. Analysis of microseismicity at IBDP has been performed within the context of the integrated reservoir and mechanical earth models developed as part of the site characterization and monitoring program. The IBDP integrated modeling workflow involved continuous and geotechnically consistent data integration for geologic modeling, calibrated flow simulation, three-dimensional (3D) mechanical earth model, and coupled hydro-mechanical simulation. Using the coupled model, scenario-based forward modeling of microseismicity was performed for hypothetical focal mechanisms inferred from observed data. The experience gained at IBDP illustrates the importance of integrated modeling in the interpretation of microseismic activity for focal mechanisms and provides valuable insights into critical data gaps which could be the target of future basic research efforts." **Robert Will, Valerie Smith, Don Lee, and Ozgur Senel**, *International Journal of Greenhouse Gas Control*. (Subscription may be required.)

"The impact of trade openness on global carbon dioxide emissions: Evidence from the top ten emitters among developing countries."

The following is the Abstract of this article: "This study aims to analyze the relationship between CO_2 emissions, trade openness, real income and energy consumption in the top ten CO_2 emitters among the developing countries; namely China, India, South Korea, Brazil, Mexico, Indonesia, South Africa, Turkey, Thailand and Malaysia over the period of 1971–2011. In addition, the possible presence of the EKC hypothesis is investigated for the analyzed countries. The Zivot–Andrews unit root test with structural break, the bounds testing for cointegration in the presence of structural break and the VECM Granger causality method are employed. The empirical results indicate that (i) the analyzed variables are co-integrated for Thailand, Turkey, India, Brazil, China, Indonesia and Korea, (ii) real income, energy consumption and trade openness are the main determinants of carbon emissions in the long run, (iii) there exists a number of causal relations between the analyzed variables, (iv) the EKC hypothesis is validated for Turkey, India, China and Korea. Robust policy implications can be derived from this study since the estimated models pass several diagnostic and stability tests." **Hasan Murat Ertugrul, Murat Cetin, Fahri Seker, and Eyup Dogan,** *Ecological Indicators*. (Subscription may be required.)

"'Best practice' community dialogue: The promise of a small-scale deliberative engagement around the siting of a carbon dioxide capture and storage (CCS) facility."

The following is the Abstract of this article: "In New Zealand the Taranaki region has been identified as a likely place for [CO_2 storage] as a result of its oil and gas industry, potential storage reservoirs and skilled local workforce. As yet there are no plans to deploy the CCS technology in this particular region but this presented an opportunity for pro-active engagement with local stakeholders, including the urban community, farmers and landowners, local iwi (Māori), local and regional councils and the oil/gas industry. As an alternative to a standard consultation technique, a small-scale dialogue-based method was used, based on the principles of deliberative engagement. In this context, the emphasis was on developing an informed understanding of different viewpoints and solution-focused decision-making. This method of engagement was found to be cost-effective, revealed some unexpected viewpoints and identified some important precursors to risk perception in New Zealand. The empowerment of participants, assisted by independent scientists and the opportunity for facilitated dialogue, were key success factors. Moreover, the approach was valued by the wider community and perceived as a means to open up dialogue around other regional energy issues. In summary, small-scale deliberative engagement processes are a viable alternative or complement to standard community consultation techniques for engagement around the siting of CCS facilities." **Fiona J. Coyle**, *International Journal of Greenhouse Gas Control*. (Subscription may be required.)

JOURNAL ARTICLES *(cont.)*

"Case studies on the CO_2 storage and EOR in heterogeneous, highly water-saturated, and extra-low permeability Chinese reservoirs."

The following is the Abstract of this article: "The CO_2 storage and CO_2 EOR in reservoirs often face challenges due to a high heterogeneity, high levels of water saturation, or low permeability. Based on the evaluation method of the CO_2 storage capacity and EOR, three typical reservoirs representing these challenges are introduced to study their effect on the CO_2 EOR potentials and CO_2 storage capacities. The properties of these reservoirs were analyzed in detail, and geological models were built. The reservoir simulation method is adopted to analyze and validate the CO_2 injection process and the storage effect for different types of reservoirs. From the examples in this paper, the low permeability reservoirs appear to have a higher EOR potential and CO_2 storage capacity than highly heterogeneous reservoirs. These results support the premise of injecting CO_2 into reservoirs to decrease atmospheric [GHG] emissions while enhancing oil recovery." **Xiaoliang Zhao, Zhenhua Rui, and Xinwei Liao**, *Journal of Natural Gas Science and Engineering*. (Subscription may be required.)

"Evaluation of criteria for CO_2 capture and storage in the iron and steel industry using the 2-tuple DEMATEL technique."

The following is the Abstract of this article: "Nowadays, the development and deployment of alternative iron-making breakthrough technologies along with CO_2 capture technology are receiving high priority to mitigate environmental concerns by reducing pollutants and GHG emissions. During the joint selection and successful implementation of CO_2 CCS technology with iron-making emerging technology in order to allow the continuous use of fossil fuel as a reliable source of energy on demand, decision-makers (DMs) face different uncertainties and barriers as trade-off conditions in a real world environment. This study aims to quantitatively prioritize and analyze the interactions between the complex factors and dimensions in respect of CCS implementation in the iron and steel industry. In addition, research evaluates the CCS systems with twenty-five influential success factors in terms of four prominent aspects of sustainability, namely, engineering, economic, environmental and social. To carry out the research, this study utilizes the modified 2-tuple DEMATEL technique, a Multi-criteria Decision Making (MCDM) tool and the Delphi method by proposing a favorable framework to determine the cause-and-effect relationships among these criteria. The results show that the criteria of energy for capture and storage, and CO_2 removal efficiency are the top two significant influencing factors in selecting CO_2 capture technology with breakthrough iron-making technologies. In addition, an intelligent network relationship map among the dimensions and the overall DEMATEL prominence-effect relationship diagram between the cause group and effect group of criteria have been illustrated clearly. A case study was conducted in an iron and steel manufacturing industry in Malaysia to illustrate the proposed framework and to demonstrate its usefulness and validity." **M. Abdul Quader, Shamsuddin Ahmed, Raja Ariffin Raja Ghazilla, Shameem Ahmed, and Mahidzal Dahari**, *Journal of Cleaner Production*. (Subscription may be required.)

"Thermodynamic analysis of a novel energy storage system with carbon dioxide as working fluid."

The following is the Abstract of this article: "Recently, energy storage system (ESS) with CO_2 as working fluid has been proposed as a new method to deal with the application restrictions of Compressed Air Energy Storage (CAES) technology, such as dependence on geological formations and low energy storage density. A novel ESS named as Compressed CO_2 Energy Storage (CCES) based on transcritical CO_2 Brayton cycle is presented in this paper. The working principle of CCES system is introduced and thermodynamic model is established to assess the system performance. Parametric analysis is carried out to study the effect of some key parameters on system performance. Results show that the increase of turbine efficiency is more favorable for system optimization and the effect of minimum pressures on system performance is more significant compared with maximum pressures. A simple comparison of CCES system, liquid CO_2 system and Advanced Adiabatic Compressed Air Energy Storage (AA-CAES) system is conducted. It is shown that the system efficiency of CCES is lower than that of AA-CAES system but 4.05 [percent] higher than that of liquid CO_2 system, while the energy density of CCES system is 2.8 times the value of AA-CAES system, which makes CCES a novel ESS with potential application." **Yuan Zhang, Ke Yang, Hui Hong, Xiaohui Zhong, and Jianzhong Xu**, *Renewable Energy*. (Subscription may be required.)

REPORTS and PUBLICATIONS

NRAP National Risk Assessment Partnership

"Well Integrity in CO_2 Storage Operations: Current Understanding and Open Questions."

The following is from the Executive Summary of this National Risk Assessment Partnership (NRAP) document: "Among the various risks associated with CO_2 storage in deep geologic formations, [wells] are an important pathway for fluid [releases] and potential groundwater contamination. Injection of CO_2 will typically create a pressure perturbation in the storage reservoir that covers a larger area than the CO_2 plume itself, and any wells that penetrate that pressure footprint are potential pathways for [release] of CO_2 and/or reservoir brine. Historically, the mechanisms and fate of [release] through and around wells have not been extensively studied, especially from the standpoint of quantitative risk assessment. However, since the publication of the review paper by Zhang and Bachu (2011), there have been important advances, with significant contributions from researchers associated with NRAP. The goal of this report is to summarize recent key advances in the state of knowledge, and to detail the efforts to develop tools that can estimate [release] over the long time scales that are relevant to carbon storage (10s to 100s of years). [Wells] are ubiquitous in regions with a long history of oil and gas exploration, yet until recently the construction, completion, plugging, and abandonment of these wells did not anticipate the potential use of geologic reservoirs for storage of supercritical CO_2. This report explores in detail the ability of abandoned wells to retain their integrity against [release] as well as the circumstances when that integrity may be compromised, with careful examination of the coupled physical and chemical processes involved. Understanding time-dependent [release] is complicated by the coupling of fluid flow, solute transport, chemical reactions, and geomechanical stresses, which will interact over decades or longer of site operations and post-injection monitoring. The design of a typical well incorporates several components to restrict unintended fluid migration that include cement, casing, tubing, and packers. Wells are typically constructed so that a loss of well integrity requires the breach of multiple barriers as well as [release] of fluids outside of the well. Barrier failures can originate from problems with the primary construction of the well (e.g., failure to place cement adequately or [connections] in the casing joints) or as a result of subsequent stresses to the well system that damage these barriers."

"A Critical Review of the Impacts of [Releasing] CO_2 Gas and Brine on Groundwater Quality."

The following is the Abstract of this NRAP document: "This report is a summary of modeling efforts, in combination with laboratory batch and column experiments and a review of current literature, undertaken to determine the effect of CO_2 and brine [release] from deep storage reservoirs on the quality of overlying groundwater [formations]. For two [formation] types (i.e., carbonate and unconsolidated sand and gravel [formations]), "no-impact" thresholds were determined to evaluate the results of the laboratory and modeling. Modeling and laboratory results emphasized the importance of site-specific data and analysis for determining potential impacts of CO_2 and brine intrusion into overlying groundwater [formations]. "No-impact" thresholds were variable between the two studied sites, and were mostly more conservative than the U.S. Environmental Protection Agency (EPA) maximum contaminant levels (MCLs). The [formation] calcite and clay content, as well as the storage reservoir salinity and organic and trace metals contents are all crucial site-specific data that must be collected for successful evaluation by the developed models. Using these inputs, the site-specific reduced-order models (ROMS) were able to predict [formation] response and the degree of impact due to leaking CO_2. Results have indicated that the risk to [formations] is site-specific, and directly proportional to the mass of CO_2 or brine [released]. Several questions remain unanswered, in particular, related to [formation] recovery time, partitioning of organic matter between phases, and the limitations of existing ROMs to infinite buffering capacity, requiring further investigation to enhance understanding of the impact of [releasing] CO_2 and brine on groundwater [formations]."

"Reduced-Order Model for Estimating Impacts from CO_2 Storage [Release] to Alluvium [Formations]: Third-Generation, Combined Physical and Chemical Processes."

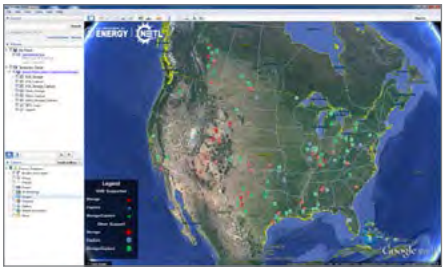
The following is from the Executive Summary of this NRAP document: "NRAP is developing a science-based toolset for the quantitative analysis of the potential risks associated with changes in groundwater chemistry from CO_2 injection. In order to address uncertainty probabilistically, NRAP is developing efficient, ROMs as part of its approach. These ROMs are built from detailed, physics-based process models to provide confidence in the predictions over a range of conditions. The ROMs are designed to reproduce accurately the predictions from the computationally intensive process models at a fraction of the computational time, thereby allowing the utilization of Monte Carlo methods to probe variability in key parameters. This research developed ROMs that describe changes in diluted groundwater chemistry if CO_2 and brine were to [release] into an overlying alluvium [formation] similar to the High Plains [formation], Haskel County, Kansas, USA. The protocol allows uncertainty and variability in [formation] heterogeneity, fluid transport and geochemical reactions to be collectively evaluated to assess potential changes in groundwater pH, total dissolved solids (TDS), As, Ba, Cd, Pb, benzene, naphthalene, and phenol concentrations by developing a scaling function that can be applied to correct the output from the hydrology ROM for geochemical reactions. The hydrology ROM takes into account the uncertainties in brine and CO_2 [release, formation] heterogeneity and fluid transport, whereas the geochemical scaling function considers the uncertainties in chemical reactions. Inclusion of chemical correction increases trace metal plumes by 10 to 100 times, suggesting that CO_2 [release] leaches trace metals from the [formation] sediments and should be considered. Corrections are needed for other trace metals, such as chromium, iron, manganese, and zinc. In contrast to the observed increases in trace metal plume volumes, inclusion of bio-degradation greatly reduces plume volumes for organics."

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_2. 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_2 in the subsurface and identifying the geologic reservoirs appropriate for CO_2 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.

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