U.S. DEPARTMENT OF ENERGY | OFFICE OF FOSSIL ENERGY | NATIONAL ENERGY TECHNOLOGY LABORATORY

CSN CARBON STORAGE NEWSLETTER

MAY 2017

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

DOE Announces Milestone for Industrial CCS Project.

The Illinois Industrial Carbon Capture and Storage (ICCS) project has begun operation by injecting carbon dioxide (CO_2) into a saline reservoir. Based in Decatur, Illinois, USA, and led by the Archer Daniels Midland Company (ADM), the U.S. Department of Energy (DOE)-funded, National Energy Technology Laboratory (NETL)-managed, large-scale demonstration project is demonstrating an integrated system for collecting CO_2 from an ethanol production plant and storing the CO_2 in an underground reservoir. The CO_2 will be stored in the Mt. Simon Sandstone in the Illinois Basin. From *energy.gov* on April 7, 2017.

Inter-Stage Piping in Compressor Facility
(Courtesy of Archer Daniels Midland Company)

Successful Completion of Carbon Capture Project Celebrated.

The DOE-funded Petra Nova Carbon Capture project located at the W.A. Parish power plant in Thompsons, Texas, USA, opened after being completed on-schedule and on-budget. The large-scale demonstration project was originally conceived as a 60-megawatt electric (MWe) capture project, but was expanded to a 240-MWe project without the need of additional federal investment. Performance testing of the project, which is a joint venture between NRG Energy and JX Nippon Oil and Gas Exploration Corporation, demonstrated a CO_2 capture rate of more than 90 percent. The CO_2 captured from the project will be used for enhanced oil recovery (EOR). From *energy.gov* on April 13, 2017.

Petra Nova Groundbreaking in 2014.

ANNOUNCEMENTS

11th IEAGHG Monitoring Network Meeting.

The International Energy Agency Greenhouse Gas R&D Program (IEAGHG) will be hosting their 11th Monitoring Network Meeting in Traverse City, Michigan, USA, on June 13-15, 2017. The theme of the meeting will be "The Cost and Value-Effectiveness of Monitoring: what key drivers are required to deliver an optimum outcome?"; a sub-theme will be the leveraging of oil and gas industry experience for CO_2 storage. The meeting agenda can be found on the *IEAGHG website*.

2nd International Workshop on Offshore Geologic CO_2 Storage.

Registration is open for the 2nd International Workshop on Offshore Geologic CO_2 Storage, to be held on June 19-21, 2017, at Lamar University in Beaumont, Texas, USA. The workshop will address and build on the *recommendations and topics raised at the first workshop*. Hosted by the University of Texas at Austin's Bureau of Economic Geology (BEG) and Lamar University's Center for Innovation, Commercialization, and Entrepreneurship (CICE), the workshop is also in collaboration with IEAGHG, the South African National Energy Development Institute (SANEDI), and the Carbon Sequestration Leadership Forum (CLSF).

RGGI Initiates Auction Process.

The states participating in the Regional Greenhouse Gas Initiative (RGGI) released the Auction Notice and application materials for CO_2 Allowance Auction 36, to be held June 7, 2017. The Auction Notice for the quarterly CO_2 allowance auction provides potential participants with the information needed to indicate an intent to bid. Auction 36 will offer 14,597,470 CO_2 allowances for sale at a reserve price of $2.15. There will also be a 10 million CO_2 allowance cost containment reserve (CCR), which will be accessed if the interim clearing price exceeds the CCR trigger of $10.00.

IEAGHG Information Papers Available.

IEAGHG produces Information Papers (IPs) on a variety of topics to provide timely reporting within the carbon capture and storage (CCS) arena. Most IEAGHG IPs are free to access and will be uploaded as they are published. Recent uploads include IPs on the *implications of the 2016 global carbon budget,* a *Zero Emission Platform (ZEP) report on CCS and Europe's contribution to the Paris Agreement,* and a *European Union (EU) project to advance environmental monitoring for offshore CO_2 storage projects*.

10 Years of CCS Research Available.

The Energy Technologies Institute (ETI) has released 10 years of CCS research, including videos, news, and other resources. According to ETI, the mission is to invest in innovation to reduce the cost of capture and reduce the risks of storage; build knowledge to understand the infrastructure requirements for CCS application in the UK; and build knowledge to create confidence amongst investors, policy makers, and industry towards CCS opportunities.

PROJECT and BUSINESS DEVELOPMENTS

Research Institutes Join Forces in CO_2 Storage Project.

European research institutes have joined forces on a project to increase field experience relevant to the geologic storage of CO_2. The project, named ENabling ONshore CO_2 storage in Europe (ENOS), will also look to refine techniques and tools used for site selection and to monitor and advance communication between science and society on CO_2 geologic storage. Launched in September 2016 and expected to run through August 2020, ENOS plans to enhance the development of onshore CO_2 storage, and several field pilots in various geologic settings will be studied. Financed by the EU's Horizon 2020 Program, ENOS is an initiative of CO_2GeoNet, the European Network of Excellence on the geologic storage of CO_2, and unites 29 organizations across 17 countries. From *Carbon Capture Journal* on April 25, 2017.

CCS Research Center Receives Funding.

The UK Carbon Capture and Storage Research Center (UKCCSRC) announced it will receive funding from the Engineering and Physical Sciences Research Council (EPSRC). The funding will help UKCCSRC ensure CCS plays an effective role in reducing net CO_2 emissions while securing affordable and controllable electricity supplies, low carbon heat, and competitive industries for the UK. The UKCCSRC core activities are delivered by the British Geological Survey, the University of Cambridge, the University of Edinburgh, Imperial College London, the University of Nottingham, and the University of Sheffield. From *UKCCS Research Center* on April 11, 2017.

Contracts Awarded for Carbon Capture.

Gassnova has awarded contracts for three companies to continue CO_2 capture studies with the plan of storing CO_2 from at least one of the facilities under a seabed in the North Sea. The full-scale carbon capture studies will be conducted at facilities located in Oslo, Norway. Statoil conducted a feasibility study and identified the Smeaheia area to the east of the Troll gas field and approximately 30 miles offshore as the storage site. From *Gassnova* on April 19, 2017.

Project Uses Carbon Dioxide Removal Technology.

Petronas launched its Terengganu Gas Terminal in Malaysia, which uses CO_2-removal technology. The terminal, according to Petronas officials, is capable of processing up to 700 million standard cubic feet per day of gas from the Malaysia-Thailand joint development area and from the North Malay Basin offshore Terengganu. Completed ahead of schedule, the project is part of the company's clean energy commitment in support of Malaysia's environmental agenda to reduce its carbon footprint by 2030. From *The Edge Markets* on April 21, 2017.

LEGISLATION and POLICY

Carbon Removal Studies to Inform Policy.

The University of Edinburgh School of GeoSciences will conduct carbon-removal studies that will be used to inform policy. The first project, Metrics for Emissions Removal Limits for Nature (MERLiN), will use models to investigate the impacts of reducing emissions now or in the future. In the second project, researchers will assess the global potential for using soil to store CO_2 removed from the atmosphere. From *The University of Edinburgh* on April 21, 2017.

Tax to Reduce GHG Emissions.

The House Committee on Appropriations in the Philippines authored a bill to help reduce greenhouse gas (GHG) emissions by passing a law imposing a tax on CO_2. House Bill (HB) 4939 follows Singapore's lead, which will begin taxing the emissions of CO_2 and other GHGs starting in 2019. HB 4939 seeks to impose a tax on the electricity bills of residential or household consumers. From *Business Mirror* on April 16, 2017.

EMISSIONS TRADING

Report Estimates Tax May Aid in Emission Reduction.

According to a report published by Lux Research, Canada's carbon tax plans have the potential to generate $120 billion in tax revenues by 2030. Beginning in 2022, a Canada-wide carbon tax of $50 per metric ton will implemented. The government is currently planning to directly invest $1.8 billion from its federal budget in clean technology companies. From *Financial Post* on April 20, 2017.

CLIMATE and SCIENCE NEWS

Company Pilots Plan to Store CO_2 in Diamond-Bearing Rock.

De Beers is piloting a project to capture and store CO_2 in the rock from which diamonds are extracted. According to the company, the project, which is due to start in 2019, is aiming to remove as much CO_2 as it emits within 5 to 10 years. The CO_2 will be stored in the kimberlite rock once all the diamonds have been removed; when mixed with CO_2, the kimberlite rock turns into a solid compound. From *Reuters* on May 4, 2017.

Agencies Sign Agreement to Monitor Carbon.

The UK Space Agency and CNES, the French government space agency, signed an agreement to monitor carbon via satellite. According to officials, the Micro-Carb cooperation agreement intends to characterize GHG fluxes on the Earth's surface and monitor how much carbon is being absorbed by oceans and forests. The UK Space Agency and CNES believe the mission, scheduled to launch in 2020, will lead to a longer-term operational system. From *UK Space Agency Press Release* on April 19, 2017.

Researchers Studying Earth's Natural Carbon Storage Process.

A Columbia University-led team of scientists are digging into the exposed sections of the Earth's mantle in Oman's al-Hajjar mountains to observe how CO_2 naturally petrified into limestone and marble millions of years ago. Half of the landscape in Oman's hills contain peridotite, a rock that removes CO_2 from the atmosphere and converts it into rock. Researchers believe the effort may help develop a drilling operation with a mechanism capable of processing the carbon-rich water and pump it into newly formed seabed. The seabed would then chemically absorb carbon from the water and cycle back the water to the surface to capture more atmospheric CO_2. From *Canada Journal* on April 15, 2017.

JOURNAL ARTICLES

Energy policy for low carbon development in Nigeria: A LEAP model application.

The following is the Abstract of this article: "This paper applied a scenario-based analysis to explore Nigeria's future energy demand, supply and associated GHG emissions from 2010 to 2040 using the Long-range Energy Alternative Planning (LEAP) model. The impact of different energy policies are analyzed for the Nigerian energy system by considering four scenarios: the reference scenario (REF), the low-carbon moderate scenario (LCM), the low-carbon advanced scenario (LCA), and the green optimistic scenario (GO). By considering aggressive energy policies and strategies from LCM to LCA, and even more aggressive options in the GO scenario, [the authors] find that under the REF scenario energy demand is expected to reach 3,075 PJ and a corresponding increase in GHG emissions of 201.2 Mt Co2e by 2040. More aggressive policy intervention by the Nigerian government, as in the GO scenario, would lead to a decrease in energy demand (2,249 PJ) and GHG emissions (124.4 Mt Co2e) in 2040. A cost-benefit and energy system analysis were also carried out in the study." **Nnaemeka Vincent Emodi, Chinenye Comfort Emodi, Girish Panchakshara Murthy, and Adaeze Saratu Augusta Emodi**, *Renewable and Sustainable Energy Reviews*. (Subscription may be required.)

Saturation time dependency of liquid and supercritical CO_2 permeability of bituminous coals: Implications for carbon storage.

The following is the abstract of this article: "Various types of lithospheric geological reservoirs are available for the safe and long-term storage of CO_2. The phase of CO_2 transitions between liquid and supercritical (mostly supercritical for depths greater than 800 m) when injected into the subsurface. This high-density super-critical phase prevents CO_2 molecules from upward diffusion toward the surface. Many questions arise in the context of coal seam sequestration with respect to its capacity, injectivity, plume movement, and leakage assessment. This work examines the effect of various saturation periods on the permeability evolution of porous coal. In this triaxial study, liquid and supercritical CO_2, along with N_2 were injected into a coal sample from the Jharia coal field (Jharkhand state, India). It was observed that the permeability reduction for liquid CO_2 was 25%, 13.5% and 1% for 0–20 h phase, 20–40 h phase and 40–60 h phase, respectively. For supercritical CO_2, the reduction was observed to be 42.5%, 38.4% and 11%, respectively, for the three saturation cycles. The findings highlight that while high CO_2 sorption in supercritical phase stores more of the adsorbate, the reduction in permeability slows down injection operation and the saturation induced coal expansion threatens the overall stability of the system." **Vikram Vishal**, *Fuel*. (Subscription may be required.)

Using Prokaryotes for Carbon Capture Storage.

The following is the Abstract of this article: "Geological storage of CO_2 is a fast-developing technology that can mitigate rising carbon emissions. However, there are environmental concerns with the long-term storage and implications of a leak from a CCS site. Traditional monitoring lacks clear protocols and relies heavily on physical methods. Here, [the authors] discuss the potential of biotechnology, focusing on microbes with a natural ability to utilize and assimilate CO_2 through different metabolic pathways. [The authors] propose the use of natural microbial communities for CCS monitoring and CO_2 utilization, and, with examples, demonstrate how synthetic biology may maximize CO_2 uptake within and above storage sites. An integrated physical and biological approach, combined with metagenomics data and biotechnological advances, will enhance CO_2 sequestration and prevent large-scale leakages." **Natalie Hicks, Unni Vik, Peter Taylor, Efthymios Ladoukakis, Joonsang Park, Frangiskos Kolisis, and Kjetill S. Jakobsen**, *Trends in Biotechnology*. (Subscription may be required.)

Fair design of CCS infrastructure for power plants in Qatar under carbon trading scheme.

The following is the Abstract of this article: "Qatar is currently the highest emitter per capita and targets emission reduction by exercising tight controls on gas flaring. In order to limit the emission under allowances, the power plants have two options: investing in CCS systems or buying carbon credits for the excess emissions above their allowances. However, CCS systems are expensive for installation and operation. In this paper, a mixed integer linear programming (MILP) model is developed for the design of integrated carbon capture, transport and storage infrastructure in Qatar under carbon trading scheme. [The authors] first investigate the critical carbon credit prices to decide under which price it is more beneficial to invest on CCS systems or to buy carbon credits via carbon trading. Then the fair design of the CCS infrastructure is obtained under two fairness scenarios: the same saving ratio and the game theory Nash approach. Fair cost distribution among power plants in Qatar is obtained by selecting the CO_2 resources (power plants) to be captured with available capture technologies and materials, designing the transportation pipeline network to connect the resources with the sequestration and/or utilization sites and determining the carbon trading price and amount among power plants. Under different fairness scenarios, the total costs are slightly higher than that from minimizing the total cost to obtain the fair cost distribution. Power plants with higher CO_2 emissions determine to install CCS system, while other power plants buy the carbon credits from domestic or international market to fulfil their carbon allowance requirements. The future work includes extending the current model by considering power generation distribution and designing the pipeline network with the selection of pump locations and pipe diameters." **Di Zhang, Yousef Alhorr, Esam Elsarrag, Abdul Hamid Marafia, Paola Lettieri, and Lazaros G. Papageorgiou**, *International Journal of Greenhouse Gas Control*. (Subscription may be required.)

Screening and techno-economic assessment of biomass-based power generation with CCS technologies to meet 2050 CO_2 targets.

The following is the Abstract of this article: "Biomass-based power generation combined with CO_2 capture and storage (Biopower CCS) currently represents one of the few practical and economic means of removing large quantities of CO_2 from the atmosphere, and the only approach that involves the generation of electricity at the same time. [The authors] present the results of the Techno-Economic Study of Biomass to Power with CO_2capture (TESBiC) project, that entailed desk-based review and analysis, process engineering, optimization as well as primary data collection from some of the leading pilot demonstration plants. From the perspective of being able to deploy Biopower CCS by 2050, twenty-eight Biopower CCS technology combinations involving combustion or gasification of biomass (either dedicated or co-fired with coal) together with pre-, oxy- or post-combustion CO_2 capture were identified and assessed. In addition to the capital and operating costs, techno-economic characteristics such as electrical efficiencies (LHV% basis), Levelized Cost of Electricity (LCOE), costs of CO_2 captured and CO_2 avoided were modelled over time assuming technology improvements from today to 2050. Many of the Biopower CCS technologies gave relatively similar techno-economic results when analyzed at the same scale, with the plant scale (MW_e) observed to be the principal driver of CAPEX (£/MW_e) and the cofiring % (i.e. the weighted feedstock cost) a key driver of LCOE. The data collected during the TESBiC project also highlighted the lack of financial incentives for generation of electricity with negative CO_2 emissions." **Amit Bhave, Richard H.S. Taylor, Paul Fennell, William R. Livingston, Nilay Shah, Niall Mac Dowell, John Dennis, Markus Kraft, Mohammed Pourkashanian, Mathieu Insa, and Jenny Jones**, *Applied Energy*. (Subscription may be required.)

JOURNAL ARTICLES *(cont.)*

Characterization and modeling of the alteration of fractured class-G Portland cement during flow of CO_2-rich brine.

The following is the Abstract of this article: "[The authors] investigate experimentally the alteration of fractured class-G cement flowed by CO_2-rich brine. The experiment mimics a mechanically damaged rough-walled fractured cement annulus at temperature 60 °C and pressure 10 MPa. The experiment consists of flowing a reservoir-equilibrated brine mixed with CO_2 (partial pressure of 2.3 MPa) through the fracture of average aperture 14 μm at constant flow rate (100 μL min−1). This flow rate corresponds to pressure gradient representative of an average in situ hydrodynamic condition. Results indicate an intense alteration of the cement with a large removal of mass at the scale of the sample. However, the fracture alteration patterns are triggered by the initial heterogeneity of the fracture aperture; the aperture of the low aperture zones tends to decrease due to calcite precipitation whereas preferential paths develop in the zones of higher aperture associated. Nevertheless, the expected large permeability increase triggered by the mass removal is mitigated by the precipitation of a low density Si-rich amorphous material. The alteration rate will decrease with time because of the increasing distance of diffusion between the fracture where the reactants are actively renewed by advection and the portlandite and C-S-H dissolution fronts. The different zones of reaction can be adequately modeled by a simple 1D diffusion-reaction model using published kinetics coefficients and extrapolation to larger times than the experiment time can be drawn. Altogether, and in addition to the previous studies of the alteration of fractured well cement annulus, this study shows that the leakage potential is strongly controlled by the initial distribution of the aperture along the fracture: low aperture zones will tend to self-heal while localized flow in connected high aperture paths will be perennial." **H. Abdoulghafour, P. Gouze, L. Luquot, and R. Leprovost**, *International Journal of Greenhouse Gas Control*. (Subscription may be required.)

CO_2 Accounting and Risk Analysis for CO_2 Sequestration at Enhanced Oil Recovery Sites.

The following is the Abstract of this article: "Using CO_2-EOR is a promising technology for emissions management because CO_2-EOR can dramatically reduce sequestration costs in the absence of emissions policies that include incentives for [CCS]. This study develops a multiscale statistical framework to perform CO_2 accounting and risk analysis in an EOR environment at the Farnsworth Unit (FWU), Texas. A set of geostatistical-based Monte Carlo simulations of CO_2–oil/gas–water flow and transport in the Morrow formation are conducted for global sensitivity and statistical analysis of the major risk metrics: CO_2/water injection/production rates, cumulative net CO_2 storage, cumulative oil/gas productions, and CO_2 breakthrough time. The median and confidence intervals are estimated for quantifying uncertainty ranges of the risk metrics. A response-surface-based economic model has been derived to calculate the CO_2-EOR profitability for the FWU site with a current oil price, which suggests that approximately 31% of the 1000 realizations can be profitable. If government carbon-tax credits are available, or the oil price goes up or CO_2 capture and operating expenses reduce, more realizations would be profitable. The results from this study provide valuable insights for understanding CO_2 storage potential and the corresponding environmental and economic risks of commercial-scale CO_2-sequestration in depleted reservoirs." **Zhenxue Dai, Hari Viswanathan, Richard Middleton, Feng Pan, William Ampomah, Changbing Yang, Wei Jia, Ting Xiao, Si-Yong Lee, Brian McPherson, Robert Balch, Reid Grigg, and Mark White**, *Environmental Science and Technology*. (Subscription may be required.)

A big data study on emitting companies' performance in the first two phases of the European Union Emission Trading Scheme.

The following is the Abstract of this article: "As CO_2 emissions are quantified by allowances and traded in markets, wise trading strategies will bring emitting companies higher profits or lower costs. Based on the big data of Community Independent Transaction Log (CITL), this article hereby presents a micro study on the emitting companies' efforts in increasing profits and saving costs during the allowances trading in the first two phases of the European Union Emission Trading Scheme (EU ETS). The efforts are measured by an after-action factor of trading performance, which is built on a series of behavior and monetary variables. By comparison, demanders of the emitting companies are more inclined to reach a higher trading performance, while that inclination is heterogeneous among the suppliers. In addition, emitting companies with lower emission levels had a better trading performance. With a higher proportion of low-emitting companies, the manufacturing sector had a better trading performance than the energy sector. The effect of the trading requirement on trading performance are investigated via a quantile regression mode. Results suggest that: (1) the selling requirement of suppliers has a positive effect on their trading performance, while the effect becomes weaker when the selling requirement increases; (2) the buying requirement has a positive effect on the demanders' trading performance only when the requirement is high, and the effect becomes stronger as the requirement increases; and (3) when the buying requirement is at a lower level, demanders' trading performance becomes worse as the requirement grows. The conclusion is that the emission level, industrial sector and trading requirement do have influences on the trading performance of emitting companies in emission trading." **Yin-Peng Liu, Jian-Feng Guo, and Ying Fan**, *Journal of Cleaner Production*. (Subscription may be required.)

REPORTS and OTHER PUBLICATIONS

Review of UK Energy Policy.

The following is from the Executive Summary of this UK Energy Research Center (UKERC) document: "This review takes stock of UK energy policy ahead of the Autumn Statement, the Industrial Strategy and the Emissions Reduction Plan that is expected in 2017. It is an evidence-based commentary covering the major components of the energy system and the links between them. The focus of the review is not only on progress with emissions reductions to tackle climate change, but also on synergies and trade-offs with other policy goals: security, affordability and (due to the recent creation of [the Department of Business, Energy, and Industrial Strategy (BEIS)]) industrial development. The UK has a world leading policy framework for emissions reduction in the Climate Change Act, including legislated carbon budgets to 2032. This does not have to be affected by Brexit. In October, ten years on from his landmark report, Lord Nicholas Stern reiterated that clean, green development is the only route to global economic growth. As the Committee on Climate Change have noted, there has been good progress with emissions reductions so far. This has been driven by changes in the electricity system and reductions in energy demand, some of which have been policy driven. But this progress will not last into the 2020s unless policies are significantly strengthened in this Parliament. As [the authors] discuss in this review, priority areas for action include energy efficiency, low carbon heat, the investment framework for low carbon power and citizen engagement."

Pathways to a low carbon future.

The following is from the Introduction of this Energy UK document: "A low carbon society is a long term project requiring a vision to take us through the transition and transformation necessary, with buy-in from government, all political parties, the public, business and industry. A whole system approach that considers the interactions between heat, power and transport must be adopted to deliver an infrastructure that is fit for purpose to achieve high energy efficiency, low carbon heat, power and transport and a highly flexible and secure energy system. Long term predictable policy and planning will lay the foundations for the investment needed to create a modern, efficient and sustainable low carbon society. The Climate Change Act (2008) set an ambitious commitment to reduce [GHG] emissions in the UK by at least 80 percent of 1990 levels by 2050. The UK has so far delivered on its interim targets through the Carbon Budget process, mainly through reducing emissions in the power sector. The period 2028 – 2032 (known as the fifth carbon budget) is set to be more challenging as it requires action from both the heat and transport sector, and further decarbonization of power. This paper presents Energy UK's recommendations that government should consider as a minimum necessary to set the country on track to deliver its fifth carbon budget. Some recommendations highlight the increasing interdependencies between sectors, industries, customers and providers, and demonstrate the need to use a whole system approach to ensure a holistic vision and capture the role of each and all stakeholders..."

China-Australia CCUS Integrated International Cooperation Demonstration Project.

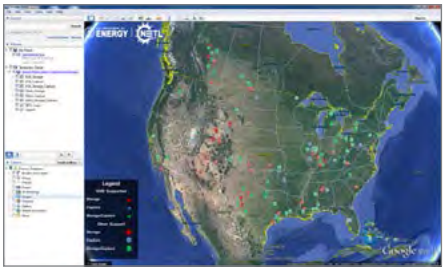
The following is from the Introduction of this document: "Yanchang Petroleum has been engaging in CO_2 capture, utilization and sequestration (CCUS) for a coal conversion project in northern Shaanxi Province since 2010. The pilot experiment for CO_2 flooding and sequestration (known as CO_2-EOR) was initially completed in the Jingbian and Wuqi counties, Shaanxi Province. By July 2015, Yanchang Petroleum had built the skid-mounted injection stations for CO_2-EOR to serve five well groups in Chang-6 Oil Reservoir of Qiaojiawa Block, Jingbian County, with the cumulative injection volume of 48,000 tonnes (t) liquefied CO_2. Yanchang also built the skid-mounted injection stations for CO_2-EOR to serve five well groups in Chang-4+5 Oil Reservoir of Yougou Block in Wuqi County, with a cumulative injection volume of 2,767.8t liquefied CO_2. Both injection projects are ongoing. Safe and secure storage of CO_2 is the cornerstone of CO_2 geological sequestration (herein sequestration). After injection of CO_2 into the reservoir, the location and state of CO_2 migration in the reservoir needs to be determined. Additionally, the permanency and effectiveness of sequestration must be evaluated..."

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

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626 Cochrans Mill Road
P.O. Box 10940
Pittsburgh, PA 15236-0940

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

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

420 L Street, Suite 305
Anchorage, AK 99501

1450 Queen Avenue SW
Albany, OR 97321-2198

Contacts

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

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