

## CSN

JULY 2017

CARBON STORAGE  
NEWSLETTER

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:

- ▷ DOE/NETL HIGHLIGHTS
- ▷ ANNOUNCEMENTS
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CARBON STORAGE PROGRAM  
DOCUMENTS and  
REFERENCE MATERIALS

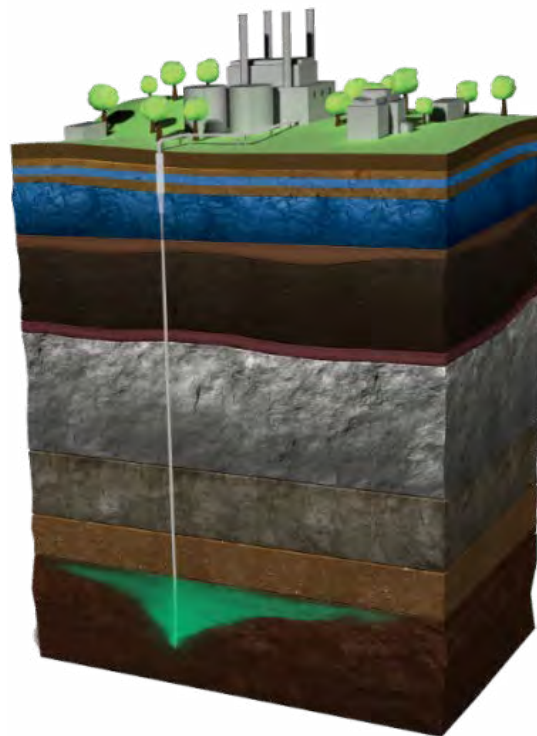
- ▷ Carbon Storage Educational Resources
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- ▷ Conference Proceedings
- ▷ Carbon Storage Portfolio
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## DOE/NETL HIGHLIGHTS

*NETL's Geologic Carbon Storage Risk Assessment Tools Recognized.*

The Carbon Sequestration Leadership Forum (CSLF) recognized the U.S. Department of Energy's (DOE) National Risk Assessment Partnership (NRAP) as a project that contributes to the advancement of carbon capture and storage (CCS) technology deployment. NRAP is one of approximately 50 such projects worldwide to be recognized over the past decade by CSLF, an international, ministerial-level organization focused on the development of CCS technology. Led by the Office of Fossil Energy's (FE) National Energy Technology Laboratory (NETL), NRAP is a multi-lab partnership developing a defensible, science-based methodology and platform for quantifying risk at carbon dioxide (CO<sub>2</sub>) storage sites to guide decision-making and risk management. A reason NRAP was selected as a CSLF-recognized project is the internationally used NRAP toolset, which comprises simulation tools designed to help evaluate the performance of geologic carbon storage sites related to potential risks. For more information, visit the [NRAP website](#). From [energy.gov](#) on June 13, 2017.



*Rendering of geologic carbon storage (not to scale).*

*DOE Investment in Carbon Storage.*

DOE's FE announced the availability of funds to advance new carbon storage projects that enable safe, cost-effective, and permanent geologic storage of CO<sub>2</sub>. Specifically, two Funding Opportunity Announcements (FOAs) under FE's [Carbon Storage Program](#) will look to advance the development and validation of storage technologies associated with enhanced oil recovery (EOR) operations or injection into a saline reservoir. The FOA "[Partnership for Offshore Carbon Storage Resources and Technology Development in the Gulf Mexico](#)" will look to facilitate offshore geologic CO<sub>2</sub> storage in the Gulf of Mexico by combining the capabilities and experience of industry, academia, and government. The FOA "[Technology Development to Ensure Environmentally Sustainable CO<sub>2</sub> Injection Operations](#)" will look to advance capabilities to assess CO<sub>2</sub> stored in the deep subsurface by addressing key knowledge and experience gaps in carbon storage technology. From [energy.gov](#) on June 16, 2017.

## ANNOUNCEMENTS

### [Successful Demonstration of NETL-Supported Project.](#)

An NETL-supported project successfully concluded a six-month testing campaign at the Technology Centre Mongstad (TCM) in western Norway, a facility for testing and improving CO<sub>2</sub> capture. Approximately 14,000 metric tons of CO<sub>2</sub> were captured during testing. DOE and the Royal Norwegian Ministry of Petroleum and Energy have a bilateral Memorandum of Understanding (MOU) covering fossil energy-related research to leverage each country's investments in carbon capture, utilization, and storage (CCUS).



*NETL employees with hosts at Technology Centre Mongstad (February 2017).*

### [RGGI States Initiate Auction Process.](#)

The states participating in the Regional Greenhouse Gas Initiative (RGGI) released the Auction Notice and application materials for CO<sub>2</sub> Allowance Auction 37, to be held September 6, 2017. The Auction Notice for the quarterly CO<sub>2</sub> allowance auction provides potential participants with the information needed to indicate an intent to bid. Auction 37 will offer 14,371,585 CO<sub>2</sub> allowances for sale at a reserve price of \$2.15. There will also be a 10 million CO<sub>2</sub> allowance cost containment reserve (CCR), which will be accessed if the interim clearing price exceeds the CCR trigger of \$10.00.

### [ETI Report on CO<sub>2</sub> Storage Capacity in the UK.](#)

The Energy Technologies Institute (ETI) published a report, titled "[Taking Stock of CO<sub>2</sub> Storage](#)," which analyzes aspects of CCS that have changed since their previous report was published in 2013. Specifically, their research found that the United Kingdom (UK) has enough potential CO<sub>2</sub> storage sites to meet its needs out to 2050.

### [New Carbon Economy Consortium.](#)

The Center for Carbon Removal launched a "New Carbon Economy" consortium in partnership with several research institutions. The initiative will look to remove CO<sub>2</sub> from the atmosphere and convert it into valuable products and services. The partners of the consortium agreed to produce a roadmap that will outline the steps needed for translating relevant research into business and policy actions.

### [Report on Global Carbon Storage Market.](#)

A recently released report studies the global market for carbon storage in North America, Europe, China, Japan, Southeast Asia, and India. Specifically, the report focuses on top manufacturers in the global market, with capacity, production, price, revenue, and market share for each manufacturer.

## PROJECT and BUSINESS DEVELOPMENTS

### [DOE Contract Awarded for Subsurface CO<sub>2</sub> Monitoring.](#)

DOE awarded a contract to GroundMetrics, Inc. to monitor CO<sub>2</sub> in the subsurface in a new project in which the company will develop a continuous monitoring system to measure resistivity changes. While GroundMetrics uses its proprietary resistivity sensors and software for applications such as EOR, the technology can also be used for mapping CO<sub>2</sub> injection for CCS. If successful, the test will enable companies to better monitor CO<sub>2</sub> saturation, allowing them to improve operational efficiency and efficacy; verify monitoring, verification, and accounting (MVA); and maximize oilfield productivity. From *PR Web* on June 8, 2017.

### [Statoil Evaluating New CO<sub>2</sub> Storage Project.](#)

Statoil will evaluate the development of carbon storage on the Norwegian continental shelf (NCS). The storage project, which is part of Norway's efforts to develop full-scale CCS, will capture CO<sub>2</sub> from three onshore industrial facilities in Eastern Norway, transporting the CO<sub>2</sub> by ship to a nearby receiving plant. The CO<sub>2</sub> will then be pumped to onshore tanks prior to being sent via pipeline to several injection wells east of the Troll field on the NCS. The final choice for the receiving plant will be based on criteria such as safety, cost, and expansion flexibility. Gassnova assigned Statoil to evaluate the storage solution, which will have the potential to receive CO<sub>2</sub> from Norwegian and European emission sources. From *Carbon Capture Journal* on July 3, 2017.

### [Grant Signed to Develop CCS Demonstration Project.](#)

The Asian Development Bank (ADB) signed an MOU for a technical assistance grant to develop a large-scale CCS demonstration project. The National Development and Reform Commission (NDRC) of the People's Republic of China (PRC), who signed the MOU along with Yanchang Petroleum Group and Northwest University, had requested ADB to support the development of a Roadmap for CCS Demonstration and Deployment that identified potential early demonstration projects. The Yanchang CCS project was ranked as the closest to being ready and is being considered for a commercial-scale demonstration project by the Shaanxi provincial government. ADB's technical assistance project will address key barriers to large-scale CCS demonstration in the PRC by supporting the front-end engineering design of the Yanchang CCS project, including a feasibility study, environmental and social impact assessments, and monitoring. From *The Financial* on June 6, 2017.

## LEGISLATION and POLICY

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### *Bill to Expand Federal Tax Credits for Storage.*

A forthcoming bill will look to extend tax credits for carbon capture, as well as expand the federal reward for storage and re-utilization of captured carbon. Carbon stored underground is currently rewarded with a \$20/ton credit, while captured carbon used for EOR receives \$10/ton. The new measure would look to increase the credits to \$45 and \$35 per ton, respectively. In addition, the current statute places a 75-million-ton cap on the amount of captured carbon that qualifies for a tax credit; the new legislation would remove the cap and provide incentive for companies to invest in capture technologies. From *Morning Consult* on June 6, 2017.

### *Sweden Aims to Reduce Emissions by 2045.*

The Swedish government passed new policy framework to become a net-zero emitter of greenhouse gases (GHGs) by 2045. Based on the agreement in the Cross-Party Committee on Environmental Objectives last year, this follows a bill on the policy framework setting new goals alongside a policy council and an act introduced in March 2017. The new act is expected to come into effect in 2018, with the first action plan to be submitted in 2019. From *CTBR* on June 19, 2017.

### *Carbon Storage MOU Signed.*

Officials from Iran's Forests, Range, and Watershed Management Organization and the United Nations Industrial Development Organization (UNIDO) signed an MOU for the third phase of an international carbon storage program in four Iranian provinces. The MOU is expected to cover five regions in Yazd, North Khorasan, South Khorasan, and Golestan Provinces. The carbon storage project started in Iran in North Khorasan Province and is currently being implemented in approximately 300 other villages. From *Middle East North Africa Financial Network* on June 17, 2017.

## EMISSIONS TRADING

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### *China May Limit Carbon Market Launch.*

According to China's National Center for Climate Change Strategy and International Cooperation, China may limit its first stage of the launch of its nationwide carbon trading scheme to four sectors – power generation, cement, aluminum, and aviation. The nationwide launch of the national emissions trading platform was originally scheduled to also include the iron and steel, petrochemicals, chemicals, and papermaking sectors. China, which has already launched seven pilot regional trading schemes, is expected to launch the nationwide platform later this year. From *Nasdaq via Reuters* on June 30, 2017.

### *Nordics Consider Alternative to EU Emissions Trading System.*

A Nordic carbon price floor may be introduced to secure future green investments in the region, according to a strategic review by the Nordic Council, a geo-political inter-parliamentary forum for cooperation between Nordic countries. Talks of the potential plan came after representatives from the European Union (EU) member states, the European Parliament, and the European Commission met to discuss how the EU Emissions Trading Scheme (ETS) should look in the 2021 through 2030 timeframe. From *euobserver* on June 28, 2017.

## CLIMATE and SCIENCE NEWS

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### *New Technique Used to Measure CO<sub>2</sub> in Geologic Storage.*

A study led by the University of Edinburgh's School of Geosciences used a new technique to measure CO<sub>2</sub> released from CCS sites. Developed by researchers from Scottish Carbon Capture & Storage (SCCS), the technique measures tiny traces of inactive natural gases, known as noble gases, found in CO<sub>2</sub>, to depict whether the CO<sub>2</sub> is from just below ground or deep below. The technique enables scientists to fingerprint a sample and pinpoint its source. The study found that high levels of CO<sub>2</sub> recorded at a farm in Saskatchewan, Canada, arose from nearby wetlands and not from a CCS site at the nearby Weyburn Oil Field. From *Scottish Carbon Capture & Storage News* on June 22, 2017.

### *British Forest to Test CO<sub>2</sub> Absorption.*

Scientists at the University of Birmingham's Institute of Forest Research (BIFoR) will expose a fenced-off section of mature woodland to elevated levels of CO<sub>2</sub> to measure the forests capacity to capture and absorb CO<sub>2</sub>. The Free Air Carbon Dioxide Enrichment (FACE) experiment will feed concentrated CO<sub>2</sub> through pipes at the top of a series of masts built into the woodland where it will be pumped into the foliage. To learn more about the decade-long experiment, located in Norbury Park in Staffordshire, West Midlands, visit [the University of Birmingham's website](#). From *Reuters* on June 21, 2017.

## JOURNAL ARTICLES

### *Carbon dioxide utilization in a microalga-based biorefinery: Efficiency of carbon removal and economic performance under carbon taxation.*

The following is the Abstract of this article: "Coal-fired power plants are major stationary sources of [CO<sub>2</sub>] and environmental constraints demand technologies for abatement. Although [CCS] is the most mature route, it poses severe economic penalty to power generation. Alternatively, this penalty is potentially reduced by Carbon Capture and Utilization, which converts [CO<sub>2</sub>] to valuable products, monetizing it. This work evaluates a route consisting of [CO<sub>2</sub>] bio-capture by *Chlorella pyrenoidosa* and use of the resulting biomass as feedstock to a microalgae-based biorefinery; [CCS] route is evaluated as a reference technology. The integrated arrangement comprises: (a) [CO<sub>2</sub>] biocapture in a photobioreactor, (b) oil extraction from part of the produced biomass, (b) gasification of remaining biomass to obtain bio-syngas, and (c) conversion of bio-syngas to methanol. Calculation of capital and operational expenditures are estimated based on mass and energy balances obtained by process simulation for both routes ([CCS] and the biorefinery). Capital expenditure for the biorefinery is higher by a factor of 6.7, while operational expenditure is lower by a factor of 0.45 and revenues occur only for this route, with a ratio revenue/operational expenditure of 1.6. The photobioreactor is responsible for one fifth of the biorefinery capital expenditure, with footprint of about 1000 ha, posing the most significant barrier for technical and economic feasibility of the proposed biorefinery. The Biorefinery and [CCS] routes show [CO<sub>2</sub>] capture efficiency of 73% and 48%, respectively, with capture cost of 139\$/t and 304\$/t. Additionally, the biorefinery has superior performance in all evaluated metrics of environmental impacts." **Igor Lapenda Wiesberg, George Victor Brigagão, José Luiz de Medeiros, and Ofélia de Queiroz Fernandes Araújo**, *Journal of Environmental Management*. (Subscription may be required.)

### *Flue gas injection into gas hydrate reservoirs for methane recovery and carbon dioxide sequestration.*

The following is the Abstract of this document: "Flue gas injection into methane hydrate-bearing sediments was experimentally investigated to explore the potential both for methane recovery from gas hydrate reservoirs and for direct capture and sequestration of [CO<sub>2</sub>] from flue gas as [CO<sub>2</sub>] hydrate. A simulated flue gas from coal-fired power plants composed of 14.6 mol% [CO<sub>2</sub>] and 85.4 mol% nitrogen was injected into a silica sand pack containing different saturations of methane hydrate. The experiments were conducted at typical gas hydrate reservoir conditions from 273.3 to 284.2 K and from 4.2 to 13.8 MPa. Results of the experiments show that injection of the flue gas leads to significant dissociation of the methane hydrate by shifting the methane hydrate stability zone, resulting in around 50 mol% methane in the vapor phase at the experimental conditions. Further depressurization of the system to pressures well above the methane hydrate dissociation pressure generated methane-rich gas mixtures with up to 80 mol% methane. Meanwhile, [CO<sub>2</sub>] hydrate and [CO<sub>2</sub>]-mixed hydrates were formed while the methane hydrate was dissociating. Up to 70% of the [CO<sub>2</sub>] in the flue gas was converted into hydrates and retained in the silica sand pack." **Jinhai Yang, Anthony Okwananke, Bahman Tohidi, Evgeny Chuvilin, Kirill Maerle, Vladimir Istomin, Boris Bukhanov, and Alexey Cheremisin**, *Energy Conversion and Management*. (Subscription may be required.)

### *Carbon dioxide storage schemes: Technology, assessment and deployment.*

The following is the Abstract of this article: "[CCS] is the only technology available to mitigate large-scale [GHG] emissions from fossil fuel based power and industrial sectors in the near future. When technology to capture CO<sub>2</sub> is relatively mature and commercially available for power and industrial sectors, safe, reliable and long-term storage of captured CO<sub>2</sub> remains a key uncertainty affecting wide-spread deployment of [CCS] technology yet. In this paper, the authors assessed techno-economic aspects of geological CO<sub>2</sub> storage options, from CO<sub>2</sub> transportations, various geological storage approaches, to CO<sub>2</sub> leakage monitoring. Compared with depleted oil/gas reservoirs and coal seams, deep saline aquifers possess much larger storage capacities and may be possibly near many CO<sub>2</sub> emission sites due to widespread distributions. If CO<sub>2</sub> storage is combined with enhanced industrial production (e.g. oil, natural gas), it has a greater potential to reducing the overall cost of CO<sub>2</sub> storage. Potential CO<sub>2</sub> leakage may be the main barriers to the development of CO<sub>2</sub> geological storage. It is recommended to make full use of big data mining approach in selection and approval of CO<sub>2</sub> geological sites, estimation of storage capacities, assessment of potential leakage risks, awarding of carbon credits, as well as analysis of public acceptations. At the same time, as a leakage-free CO<sub>2</sub> storage option, CO<sub>2</sub> mineralization & industrial utilization is to trap CO<sub>2</sub> permanently in stable minerals by reactions with metal oxides and forming stable carbonates. These CO<sub>2</sub> mineralization & industrial utilization schemes need to guarantee sustainable or environmentally friendly processes and satisfy basic principles of industrial ecology if implemented on a large industrial scale. Currently, most of CO<sub>2</sub> storage schemes are still in the early stage of technological development and are still far from large-scale commercialization. The high cost, high energy penalty, safety and reliability, and policy uncertainties are main barriers for the implement of carbon storage schemes." **Zhihua Zhang and Donald Huisingsh**, *Journal of Cleaner Production*. (Subscription may be required.)

### *Combined positron emission tomography and computed tomography to visualize and quantify fluid flow in sedimentary rocks.*

The following is the Abstract of this article: "Here [the authors] show for the first time the combined positron emission tomography (PET) and computed tomography (CT) imaging of flow processes within porous rocks to quantify the development in local fluid saturations. The coupling between local rock structure and displacement fronts is demonstrated in exploratory experiments using this novel approach. [The authors] also compare quantification of 3-D temporal and spatial water saturations in two similar CO<sub>2</sub> storage tests in sandstone imaged separately with PET and CT. The applicability of each visualization technique is evaluated for a range of displacement processes, and the favorable implementation of combining PET/CT for laboratory core analysis is discussed. [The authors] learn that the signal-to-noise ratio (SNR) is over an order of magnitude higher for PET compared with CT for the studied processes." **M. A. Fernø, J. Gauteplass, L. P. Hauge, G. E. Abell, T. C. H. Adamsen, and A. Graue**, *Water Resources Research*. (Subscription may be required.)



## JOURNAL ARTICLES *(cont.)*

### *Carbon capture and storage across fuels and sectors in energy system transformation pathways.*

The following is the Abstract of this article: "CCS is broadly understood to be a key mitigation technology, yet modeling analyses provide different results regarding the applications in which it might be used most effectively. Here [the authors] use the Global Change Assessment Model (GCAM) to explore the sensitivity of CCS deployment across sectors and fuels to future technology cost assumptions. [The authors] find that CCS is deployed preferentially in electricity generation or in liquid fuels production, depending on CCS and biofuels production cost assumptions. [The authors] consistently find significant deployment across both sectors in all of the scenarios considered here, with bioenergy with CCS (BECCS) often the dominant application. As such, this study challenges the view that CCS will primarily be coupled with power plants and used mainly in conjunction with fossil fuels, and suggests greater focus on practical implications of significant CCS and BECCS deployment to inform energy system transformation scenarios over the 21<sup>st</sup> century." **Matteo Muratori, Haroon Kheshgi, Bryan Mignone, Leon Clarke, Haewon McJeon, and Jae Edmonds**, *International Journal of Greenhouse Gas Control*. (Subscription may be required.)

### *Management and dewatering of brines extracted from geologic carbon storage sites.*

The following is the Abstract of this article: "Subsurface pressure management is a significant challenge in geologic CO<sub>2</sub> storage. Elevated pressure generated from the injection of supercritical CO<sub>2</sub> can be managed by the withdrawal of brine from saline formations before or during CO<sub>2</sub> injection; however, management of the extracted brines is non-trivial because they may have high concentrations of dissolved solids and other contaminants. Dewatering a brine can reduce the volume needing disposal; in addition, water separated from the brine can be a source of usable low salinity water. This review will summarize the composition of brines extracted from select domestic geologic CO<sub>2</sub> storage sites, will calculate the minimum of work of dewatering, and will provide a critical review of developed and developing desalination/dewatering technologies that could be applied to brines extracted from saline formations before or during geologic CO<sub>2</sub> storage operations. Herein are also highlighted, when appropriate, the similarities and the differences between dewatering brines produced from oil/gas operations and brines extracted from geologic CO<sub>2</sub> storage. Since a source of steam or natural gas is likely unavailable/unsuitable for dewatering brines extracted during CO<sub>2</sub> storage, the ideal treatment processes should have a high electrical efficiency and, if possible, should be able to take advantage of the inherent elevated temperature of these brines." **Jason T. Arena, Jinesh C. Jain, Christina L. Lopano, J. Alexandra Hakala, Timothy V. Bartholomew, Meagan S. Mauter, and Nicholas S. Siefert**, *International Journal of Greenhouse Gas Control*. (Subscription may be required.)

### *Research on the efficiency of carbon trading market in China.*

The following is the Abstract of this article: "In 2014, China proposed medium and long-term low carbon development goals in China-U.S. Joint Statement on Climate Change that the emission of [CO<sub>2</sub>] would reach its peak and the proportion of non-fossil energy accounted for the primary energy consumption would increase to 20% in 2030. In order to achieve these goals, the unified carbon emission trading system should be put into effect by 2017, the implementation of the unified carbon emission trading system depends on the effectiveness of the current carbon trading market in China. On the basis of the effective market theory and fair game model, the unit root test and the run test are developed to analyze the carbon emission market of four representative cities in China. The results show that (1) the carbon trading market in China has only achieved weak efficiency, while the semi strong efficiency and the strong efficiency have not been reached; (2) with the expansion of the market scale, the increase of trading volume, the carbon trading market would converge from the state of inefficiency to weak form efficiency gradually, and the carbon trading market in China shows signs of restoring market efficiency." **Xin-gang Zhao, Lei Wu, and Ang Li**, *Renewable and Sustainable Energy Reviews*. (Subscription may be required.)

**REPORTS and OTHER PUBLICATIONS*****Empirical Analysis of Seismicity Induced by Brine Injection in the U.S. Bureau of Reclamation Paradox Valley PVU#1 Well and Development of an Induced Earthquake Simulation Model.***

The following is from the Abstract of this NRAP document: "The U.S. Bureau of Reclamation (USBR) has been injecting brine in the deep PVU#1 well located in the Paradox Valley in Colorado continuously for the last 25 years. Injection-induced seismicity in the shallow crust surrounding the well has been monitored by the Paradox Valley seismic network operated by USBR since 1985. The long duration, high fluid volumes and flow rates, the depth of injection, and the large number of recorded earthquakes make this project an ideal case to investigate several aspects of fluid-induced seismicity important to the development by NRAP of a toolset to assess hazard and risk from earthquakes that may be induced by subsurface injection of CO<sub>2</sub>. The toolset currently under development includes both short-term seismic hazard forecasting based on empirical analysis of earthquakes recorded during and after injection, and a physics-based simulation approach to assess hazard and risk before injection begins. Empirical analyses of time- and space-dependent frequency-magnitude distributions of earthquakes that occurred in the vicinity of the PVU#1 well between July 1996 and March 2012 show that the overall level of activity progressively decreased over the four phases of continuous injection during this period; but the Gutenberg-Richter b-value, which characterizes the relative numbers of large to small events, remained approximately constant. The b-value during continuous injection was significantly lower than that during initial injection trials carried out between 1991 and 1995, corresponding to a relatively larger number of small events during this period. Spatial analysis indicates that seismicity associated with interpreted faults that are favorably aligned for shear failure within the prevailing tectonic stress field is characterized by relatively low b-values. The results of these analyses inform the development of time-dependent empirical short-term induced seismicity hazard forecasting methods, and will be used to calibrate and validate the simulation-based hazard assessment method."

***CCS for industry – Modelling the lowest-cost route to decarbonizing Europe.***

The following is a summary of this Zero Emissions Platform (ZEP) document: "ZEP modelled the lowest-cost route to decarbonizing Europe by looking at CCS for industries as refining, steel and cement. After modelling the lowest-cost route for decarbonising European power, ZEP turned its attention to industry. With direct industry-related emissions accounting for a quarter of total EU CO<sub>2</sub> emissions, it is clear that Europe must look beyond the power sector to include core industries such as refining, steel and cement. Not only is CCS the only option for substantially reducing CO<sub>2</sub> emissions in these industries, but the costs of CO<sub>2</sub> transport and storage – 10-30% of the total CCS costs – can be significantly reduced by clustering power and industrial emitters."

***Global Carbon Capture and Storage Market 2017-2021.***

The following is from a summary of this document: "The use of CCS technology is one of the novel ideas that help reduce the amount of CO<sub>2</sub> released into the atmosphere by fossil fuel-dependent industries such as power generation and oil and gas processing. The basic functioning of the CCS technology includes capturing the CO<sub>2</sub> before its release into the atmosphere and then transporting and storing it in an environmentally safe location. Technavio's analysts forecast the global [CCS] market to grow at a CAGR of 9.18% during the period 2017-2021. The report covers the present scenario and the growth prospects of the global [CCS] market for 2017-2021. To calculate the market size, the report analyzes business dimensions with an eye on individual growth trends and contribution of upcoming market segments... Technavio's report, Global Carbon Capture and Storage Market 2017-2021, has been prepared based on an in-depth market analysis with inputs from industry experts. The report covers the market landscape and its growth prospects over the coming years. The report also includes a discussion of the key vendors operating in this market."

***Challenges related to carbon transportation and storage – showstoppers for CCS?***

The following is from the Introduction of this Global CCS Institute document: "As two of the authors have described in previous work, CCS technologies can become an important tool in a wider carbon mitigation portfolio in the coming decades. That earlier study concentrated mostly on challenges related to capturing carbon, with a special focus on the United States (U.S.). However, transportation and storage infrastructure is required to remove CO<sub>2</sub> captured from power plants and industrial installations, and to inject the CO<sub>2</sub> into deep saline geological formations or depleted oil and gas fields for permanent sequestration. Transportation can be undertaken using pipelines or (if in an offshore environment) ships, and storage facilities are analogous to those used for temporary or seasonal natural gas storage. The U.S. has a substantial network of CO<sub>2</sub> pipelines and injection facilities that has been developed over four decades for use in oil production in a process known as EOR. Unlike the U.S., the European Economic Area (EEA) has not developed such an infrastructure and consequently Europe needs to start from scratch if CCS is to be deployed at scale as a decarbonization tool. Existing European oil and gas transport and production infrastructure does, however, offer some potential for re-use in some limited circumstances..."

## 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.



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