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

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CARBON STORAGE NEWSLETTER

FEBRUARY 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

- Carbon Storage Educational Resources
- Program Reports, Plans, and Roadmaps
- Conference Proceedings
- Carbon Storage Portfolio
- Systems Analysis
- Peer Review
- Best Practices Manuals
- Fossil Energy Techlines

NATIONAL ENERGY TECHNOLOGY LABORATORY

DOE/NETL HIGHLIGHTS

Post-Combustion Carbon Capture Project Begins Commercial Operation.

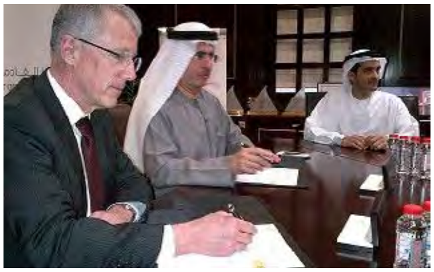
The post-combustion carbon capture *Petra Nova project* began commercial operation at the W.A. Parish Plant in Thompsons, Texas, USA, officials announced. The U.S. Department of Energy (DOE) provided funding and the National Energy Technology Laboratory (NETL) provided project management support for the project, which demonstrates how carbon capture technologies can support the flexibility and sustainability of fossil fuels at a commercial scale. The Petra Nova project has the potential to capture 1.6 million tons of carbon dioxide (CO_2) per year from an existing coal-fired power plant. From *energy.gov* on January 11, 2017.

Petra Nova Groundbreaking from September 2014

ANNOUNCEMENTS

NETL Signs MOU to Advance Fossil Energy Technologies.

Representatives from NETL and the Office of Fossil Energy (FE) signed a memorandum of understanding (MOU) with Dubai Electricity and Water Authority (DEWA) to collaborate on the advancement of fossil energy technologies and to foster assessments of technology options and economics.



Signing of the MOU in January 2017

Energy Collaboration Extended.

The Massachusetts Institute of Technology (MIT) and Italian energy company Eni renewed their collaboration on low-carbon research. The agreement also extends research support for three of the MIT Energy Initiative's (MITEI) Low-Carbon Energy Centers in the areas of solar energy; energy storage; and carbon capture, utilization, and storage (CCUS).

U.S.-China Energy Center Receives Funds.

The *Berkeley-Tsinghua Joint Research Center on Energy and Climate Change* received a donation that will be used to further its scientific research and analysis on clean energy solutions in areas such as low-carbon cities, carbon markets, and clean energy system planning and integration. The U.S.-China Energy Center was announced in 2015 as a partnership between Beijing's Tsinghua University and Lawrence Berkeley National Laboratory (LBNL). LBNL is managed by the University of California for *DOE's Office of Science*.

BERKELEY LAB

PROJECT and BUSINESS DEVELOPMENTS

CCS Membrane Technology Licensed.

Air Products and Chemicals, Inc. licensed CO_2 membrane technology developed by the Norwegian University of Science and Technology (NTNU). The fixed site carrier membrane will be used by Air Products as part of its PRISM gas-separation membrane technology offerings. According to Air Products' officials, the new technology is expected to benefit coal-fired power plants and the cement industry. From *The Chemical Engineer* on January 16, 2017. (Subscription may be required.)

Enhanced Oil Recovery Joint Industry Project Announced.

The development of work flows and methodology for simulating field-wide CO_2-enhanced oil recovery (EOR) projects will be the focus of Petronas' recent Joint Industry Project (JIP) Agreement. The research and development (R&D) project will include collaboration with researchers from Heriot-Watt University, Petronas Research, and UZMA Berhad, an international oil and gas service company. The study will concentrate on minimizing uncertainties affecting the predictions of hydrocarbon recovery and supporting simulation studies through the acquisition of physical data. Upon completion, the lessons learned will be applied to real field scenarios. From *The Star Online* on February 2, 2017.

LEGISLATION and POLICY

South Korean Government Added to Carbon Emissions Rights.

The South Korean government increased its carbon emissions quota to a total of 539 million tons and added 51 million tons to emission rights prior to the implementation of emissions trading. In addition, the government voted for its second three-year emission-trading plan, which will take place in 2018 to 2020. Under the plan, greenhouse gas (GHG) emission rights will be allocated in return for a payment equivalent to three percent of allowance. From *Business Korea* on January 25, 2017.

Hawaii Approves Carbon Credits Initiative.

The Hawaii State Board of Land and Natural Resources (BLNR) approved a carbon offset project in the state's forests. Hawaii's Department of Land and Natural Resources (DLNR) and its Division of Forestry and Wildfire (DOFAW) will issue a request for proposal (RFP) for private entities to create a carbon forestry project in the Pu'u Mali Restoration Area in the Mauna Kea Forest Reserve on Hawaii island. In addition, DLNR is in the process of creating a carbon offset pilot project in southern Maui. From *Hawaii Department of Land and Natural Resources News Release* on January 30, 2017.

Malaysia Carbon Credit Firm to Offset CO_2 Emissions.

As part of a United Nations' (UN) collaborative program, a Malaysian carbon credit rating company received 25 percent of the land mass in Kelantan, Malaysia, for use in reducing CO_2 emissions. A renewable and sustainable energy company received the project under UN's Reducing Environment from Deforestation and Degradation (REDD) initiative for a 30-year concession period with the Kelantan government. According to officials, the program will look to reduce forest emissions and enhance CO_2 stocks in the forest while contributing to national sustainable development. From *Free Malaysia Today* on February 1, 2017.

EMISSIONS TRADING

California Offers Plan to Extend Cap-and-Trade Program.

A group of California lawmakers introduced legislation to extend the state's cap-and-trade program. *AB 151* focuses on the future of California's program for requiring companies to purchase emission credits in order to emit GHGs into the atmosphere. From *The Los Angeles Times* on January 12, 2017.

CLIMATE and SCIENCE NEWS

Company Designs Carbon-Neutral Concrete.

A company led by McGill University developed technology that has the potential to store CO_2 emissions while also eliminating them from the cement manufacturing process. The company, Carbicrete, formulated a method to produce concrete that utilizes a process called "carbonation activation." During the process, the CO_2 is injected into the concrete while it is malleable. When placed inside a pressurized chamber, the permanent storage of CO_2 within the material results in carbon-negative concrete that is more durable than conventional concrete. From *McGill Tribune* on January 24, 2017.

Research Shows Coastal Wetlands Excel at Storing Carbon.

According to research conducted by University of Maryland scientists, intact coastal wetland ecosystems (e.g., mangrove forests, tidal marshes, seagrass meadows) are effective long-term carbon storage systems. In a research paper published in the journal *Frontiers in Ecology and the Environment*, the researchers noted that coastal wetlands have the potential to protect coastal communities from storm surges and erosion. The study was conducted by integrating previous data on a variety of coastal and marine ecosystems. By evaluating how each ecosystem captured CO_2 and how long it was stored, researchers found that coastal wetlands outperformed other marine systems. From *University of Maryland College of Computer, Mathematical, and Natural Sciences* on February 1, 2017.

JOURNAL ARTICLES

The salt-based catalytic enhancement of CO_2 absorption by a tertiary amine medium.

The following is a summary of the Abstract of this article: "Efficient methods are needed to limit the elevation of CO_2 levels in the atmosphere. Here, [the authors] propose an improved CO_2 [storage] method that uses new catalysts, specifically a series of tertiary amine nitrate salts, in an aqueous tertiary amine medium. [The authors] synthesized the new catalysts and characterized them by using ^1H and ^{13}C NMR, single crystal X-ray analysis, and FT-IR spectroscopy. The effects of the catalysts on CO_2 absorption were assessed by using a stopped-flow spectrophotometer, and their heats of absorption and CO_2 absorption capacities were measured with a differential reaction calorimeter (DRC) at high concentrations of the tertiary amine medium. The CO_2 hydration rate constants were determined under basic conditions and the catalysts were found to exhibit higher absorption of CO_2 (a highest value of 430 M^{-1} s^{-1}) than the tertiary amine medium (133 M^{-1} s^{-1}). The increased absorption of CO_2 and the low heat absorption energies of the new catalysts suggest that they could be used in post-combustion processes." Dharmalingam Sivanesan, Young Eun Kim, Min Hye Youn, Ki Tae Park, Hak-Joo Kim, Andrew Nirmala Grace, and Soon Kwan Jeong, *RSC Advances*. (Subscription may be required.)

Inorganic carbon dynamics and CO_2 flux associated with coal-mine drainage sites in Blythedale PA and Lambert WV, USA.

The following is the Abstract of this article: "Drainage from coal mines, where carbonate dissolution is driven by sulfuric acid, can result in a net transfer of geologically-bound carbon to the atmosphere. The flux and downstream evolution of dissolved inorganic carbon (DIC) is presented for two coal mine sites that discharge high concentrations of DIC (3.7–4.5 mM C) producing a total flux of DIC from the mine from 13 to 249 kg-C/year (18–364 metric tons of CO_2/year). More than 65% of the total DIC is lost via CO_2 evasion with the remaining DIC is exported downstream as dissolved species. The fate of the DIC depends upon the pH of the water which is controlled by evasion of CO_2, the concentration of pre-existing alkalinity, carbonate precipitation and dissolution, and metal hydrolysis reactions. The CO_2 concentrations and fluxes from the study sites are comparable to those estimated from literature data for other coal mine sites in the Appalachian region. The total flux estimated from a dataset of 140 coal mines was comparable in magnitude to the CO_2 emissions from a small coal-fired power plant. The extent of CO_2 degassing from mine waters is poorly constrained because (1) flux estimates can be biased low when acid waters are excluded in alkalinity-based estimates; (2) flux estimates can be biased high if non-carbonate alkalinity is present in the mine waters; and (3) mine waters react rapidly following discharge hampering the measurement process. The study sites presented illustrate the impact of coal mining as an anthropogenic influence on carbon cycling; however, more data are necessary to fully estimate the importance of this impact on regional scales." Dorothy J. Vesper, Johnathan E. Moore, and James P. Adams, *Environmental Earth Sciences*. (Subscription may be required.)

Potential gains from carbon emissions trading in China: A DEA based estimation on abatement cost savings.

The following is the Abstract of this article: "China has recently launched its pilot carbon emissions trading markets. Theoretically, heterogeneity in abatement cost determines the efficiency advantage of market based programs over command and control policies on carbon emissions. This study tries to answer the question that what will be the abatement cost savings or GDP loss recoveries from carbon emissions trading in China from the perspective of estimating the potential gains from carbon emissions trading. A [data envelopment analysis (DEA)] based optimization model is employed in this study to estimate the potential gains from implementing two carbon emissions trading schemes compared to carbon emissions command and control scheme in China. These two schemes are spatial tradable carbon emissions permit scheme and spatial–temporal tradable carbon emissions permit scheme. The associated three types of potential gains, which are defined as the potential increases on GDP outputs through eliminating technical inefficiency, eliminating suboptimal spatial allocation of carbon emissions permit, and eliminating both suboptimal spatial and temporal allocation of carbon emissions permit, are estimated by an ex post analysis for China and its 30 provinces over 2006-2010. Substantial abatement cost savings and considerable carbon emissions reduction potentials are identified in this study which provide one argument for implementing a market based policy instrument instead of a command and control policy instrument on carbon emissions control in China." Ke Wang, Yi-Ming Wei, and Zhimin Huang, *Omega*. (Subscription may be required.)

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 21st century." Matteo Muratori, Haroon Kheshgi, Bryan Mignone, Leon Clarke, Haewon McJeon, and Jae Edmonds, *International Journal of Greenhouse Gas Control*. (Subscription may be required.)

Comparing policy routes for low-carbon power technology deployment in EU – and energy system analysis.

The following is the Abstract of this article: "The optimization energy system model JRC-EU-TIMES is used to support energy technology R&D design by analyzing power technologies deployment till 2050 and their sensitivity to different decarbonization exogenous policy routes. The policy routes are based on the decarbonized scenarios of the EU Energy Roadmap 2050 combining energy efficiency, renewables, nuclear or CCS. A 'reference' and seven decarbonized scenarios are modelled for EU28. [The authors] conclude on the importance of policy decisions for the configuration of the low carbon power sector, especially on nuclear acceptance and available sites for new RES plants. Differently from typical analysis focusing on technology portfolio for each route, [the authors] analyze the deployment of each technology across policy routes, for optimizing technology R&D. R&D priority should be given to those less-policy-sensitive technologies that are in any case deployed rapidly across the modelled time horizon (e.g. PV), but also to those deployed up to their technical potentials and typically less sensitive to exogenous policy routes. For these 'no regret' technologies (e.g. geothermal), R&D efforts should focus on increasing their technical potential. For possibly cost-effective technologies very sensitive to the policy routes (e.g. CSP and marine), R&D efforts should be directed to improving their techno-economic performance." Sofia Simoes, Wouter Nijs, Pablo Ruiz, Alessandra Sgobbi, and Christian Thiel, *Energy Policy*. (Subscription may be required.)

JOURNAL ARTICLES *(cont.)*

The allowance mechanism of China's carbon trading pilots: A comparative analysis with schemes in EU and California.

The following is the Abstract of this article: "The allowance mechanism is one of the core and sensitive aspects in the design of a carbon emissions trading scheme and affects the compliance cost for each entity covered under the scheme. By examining China's allowance mechanism from two aspects-allowance allocation and allowance distribution, this paper compares China's carbon trading pilots with the EU Emissions Trading Scheme and California Cap-and-Trade Program. The comparison identifies the unique features in allowance mechanism and particular issues that affect the efficiency of the pilots. The paper also recommends courses of action to strengthen China's existing pilots and to build valuable experiences for the establishment of the national cap-and-trade system in China." Ling Xiong, Bo Shen, Shaozhou Qi, Lynn Price, and Bin Ye, *Applied Energy*. (Subscription may be required.)

Design under uncertainty of carbon capture and storage infrastructure considering cost, environmental impact, and preference on risk.

The following is the Abstract of this article: "[The authors] present a stochastic decision-making algorithm for the design and operation of a CCS network; the algorithm incorporates the decision-maker's tolerance of risk caused by uncertainties. Given a set of available resources to capture, store, and transport CO_2, the algorithm provides an optimal plan of the CCS infrastructure and a CCS assessment method, while minimizing annual cost, environmental impact, and risk under uncertainties. The model uses the concept of downside risk to explicitly incorporate the trade-off between risk and either economic or environmental objectives at the decision-making level. A two-phase-two-stage stochastic multi-objective optimization problem (2P2SSMOOP) solving approach is implemented to consider uncertainty, and the ε-constraint method is used to evaluate the interaction between total annual cost with financial risk and an Eco-indicator 99 score with environmental risk. The environmental impact is measured by Life Cycle Assessment (LCA) considering all contributions made by operation and installation of a CCS infrastructure. A case study of power-plant CO_2 emission in Korea is presented to illustrate the application of the proposed modeling and solution method." Suh-Young Lee, Jae-Uk Lee, In-Beum Lee, and Jeehoon Han, *Applied Energy*. (Subscription may be required.)

Tracking the interaction between injected CO_2 and reservoir fluids using noble gas isotopes in an analogue of large-scale carbon capture and storage.

The following is the Abstract of this article: "Industrial scale [CCS] technology relies on the secure long term storage of CO_2 in the subsurface. The engineering and safety of a geological storage site is critically dependent on how and where CO_2 will be stored over the lifetime of the site. Hence, there is a need to determine how injected CO_2 is stored and identify how injected CO_2 interacts with sub-surface fluids. Since July 2008 ~1 Mt of CO_2 has been injected into the Cranfield EOR field (MS, USA), sourced from a portion of the natural CO_2 produced from the nearby Jackson Dome CO_2 reservoir. Monitoring and tracking of the amount of recycled CO_2 shows that a portion of the injected CO_2 has been retained in the reservoir. Here, [the authors] show that the noble gases (^{20}Ne, ^{36}Ar, ^{84}Kr, ^{132}Xe) that are intrinsic to the injected CO_2 can be combined with $CO_2/^3He$ and $\delta^{13}C_{CO2}$ measurements to trace both the dissolution of the CO_2 into the formation water, and the interaction of CO_2 with the residual oil. Samples collected 18 months after CO_2 injection commenced show that the CO_2 has stripped the noble gases from the formation water. The isotopic composition of He suggests that ~0.2%, some 7 kt, of the injected CO_2 has dissolved into formation water. The $CO_2/^3He$ and $\delta^{13}C_{CO2}$ values imply that dissolution is occurring at pH = 5.8, consistent with the previous determinations. $\delta^{13}C_{CO2}$ measurements and geochemical modelling rule out significant carbonate precipitation and [the authors] determine that the undissolved CO_2 after 18 months of injection (1.5 Mt) is stored by stratigraphic or residual trapping. After 45 months of CO_2 injection, the noble gas concentrations appear to be affected by CO_2-oil interaction, overprinting the signature of the formation water." Domokos Györe, Stuart M.V. Gilfillan, and Finlay M. Stuart, *Applied Geochemistry*. (Subscription may be required.)

Carbon Sequestration in Olivine and Basalt Powder Packed Beds.

The following is the Abstract of this article: "Fractures and pores in basalt could provide substantial pore volume and surface area of reactive minerals for carbonate mineral formation in geologic carbon sequestration. In many fractures solute transport will be limited to diffusion, and opposing chemical gradients that form as a result of concentration differences can lead to spatial distribution of silicate mineral dissolution and carbonate mineral precipitation. Glass tubes packed with grains of olivine or basalt with different grain sizes and compositions were used to explore the identity and spatial distribution of carbonate minerals that form in dead-end one-dimensional diffusion-limited zones that are connected to a larger reservoir of water in equilibrium with 100 bar CO_2 at 100°C. Magnesite formed in experiments with olivine, and Mg- and Ca-bearing siderite formed in experiments with flood basalt. The spatial distribution of carbonates varied between powder packed beds with different powder sizes. Packed beds of basalt powder with large specific surface areas sequestered more carbon per unit basalt mass than powder with low surface area. The spatial location and extent of carbonate mineral formation can influence the overall ability of fractured basalt to sequester carbon." Wei Xiong, Rachel K. Wells, and Daniel E. Giammar, *Environmental Science and Technology*. (Subscription may be required.)

REPORTS and OTHER PUBLICATIONS

National Risk Assessment Partnership (NRAP) Phase I Accomplishments: 2011-2016.

The following is from the Executive Summary of this National Risk Assessment Partnership (NRAP) document: "NRAP brings together scientists and engineers from five DOE national laboratories (NL), to develop insights into the environmental risk behavior of long-term CO_2 storage in geologic formations. Through stakeholder involvement, the NRAP program also benefits from the perspective of industry, government, non-government organizations, and academia regarding research needs on this topic. Phase I of the NRAP effort has recently concluded and this report summarizes the results of this 6-year effort. Phase I was focused on quantification of risk and related uncertainties, using the approach detailed in this report… Improving the science base to build confidence for long-term CO_2 storage decisions was another key aspect that was studied by the project personnel. The main results for this part of the effort are: [development of physics based models of geologic carbon storage (GCS), systems and system components; demonstration of the validity and limitations of reduced complexity models, and integrated assessments models; computational and experimental analysis to address key system uncertainties; and simulation of long term carbon storage system performance, in the context of those uncertainties]. An important set of products from NRAP's Phase I effort is the set of tools that can be used to explore environmental risk behavior at CO_2 storage sites. The NRAP toolset is comprised of ten simulation tools representing important components of the engineered geologic system related to understanding the risk for and associated with potential fluid migration and induced seismicity."

Ready for CCS retrofit: The potential for equipping China's existing coal fleet with carbon capture and storage.

The following is from the Executive Summary of this International Energy Agency (IEA) document: "Retrofitting CCS on existing coal-fired power stations in People's Republic of China (hereafter referred to as 'China') represents a major opportunity, with significant benefits for emission reductions. In total, some 310 gigawatts (GW) of existing coal-fired power capacity meet a number of basic criteria for being suitable for a retrofit. This number is likely to increase, as new efficient plants are being commissioned during the next several years. Regardless of how much retrofitting will finally be required in a low-emissions pathway, this analysis indicates that there is ample potential available. Simultaneously the world's leader in renewable electricity capacity and the world's largest emitter of energy-related CO_2, China emitted some 8.6 billion [metric tons] in 2014. Around half of these emissions were from coal-fired power stations. China currently has around 900 GW of installed coal-fired power capacity, representing almost 50% of global coal-fired capacity, and has nearly 200 GW under construction. The existing power plants considered in this study represent potential emissions of 85 billion [metric tons] of CO_2 ($GtCO_2$), if they continue to operate at current load factors for the remainder of their lives, even if smaller units are retired early. Despite such massive emissions, the Chinese coal-fired power fleet is on average one of the world's most efficient, as over two thirds of the capacity was built since 2005. As a result, the average operational efficiency of the Chinese coal fleet increased six percentage points in the last ten years, bringing it to the same level as that in OECD countries. Through its 'Intended Nationally Determined Contribution' (INDC) under the UNFCCC framework, China has committed to peaking CO_2 emissions by 2030. The enduring emissions from China's coal-fired power plants present a challenge to efforts to reduce [GHG] emissions beyond any peak. Coal use is also being shaped by policies to control local pollutants, which make low carbon electricity and power plant upgrades more attractive. A part-solution can be found in retrofitting existing coal-fired power stations with CCS, which can reduce their emissions rate by around 85%. The emissions of a CCS-retrofitted coal plant are equivalent to less than a quarter of that of a combined cycle gas plant. In the best conditions, equipping a power plant with CCS only requires investment in the equipment for CO_2 capture, transport and storage and not in the power plant itself. In other situations, the power plant can be upgraded at the same time as CCS retrofit, delivering several additional decades of lifetime to the plant. In both cases, a CCS retrofit can avoid the need to write-off otherwise productive generating capacity, or otherwise limit its use, and be a cheaper option than a new low-carbon generation capacity."

REPORTS and OTHER PUBLICATIONS *(cont.)*

Carbon Capture And Storage (CCS) Market Analysis By Application (EOR, Industrial & Agriculture), By Capture Technology (Pre-Combustion, Industrial, Oxy-Firing & Post-Combustion), Competitive Strategies, And Segment Forecasts, 2014 – 2025.

The following is from a summary of this report: "The rising energy demand globally has led to the increasing uses of fossil fuels, the major source of carbon emission. Though many alternate technologies such as wind, solar and nuclear are now in practical use or under development, CCS is the most viable technology currently available to mitigate [GHG] emissions from large scale fossil fuel usage. Currently, over 22 CCS projects are in operation globally and another 14 planned projects are expected to be functional in the next few years. However, the global CCS industry is still at its nascent stage in comparison to the amount of [CO_2] emitted yearly. Some of the factors such as inconsistent government regulations and economic slowdown in the past few years are the main factors responsible for the slow growth of the market. The current regulatory [framework] is not designed prominently to address some of the special issues that arise in the CCS industry such as cautious monitoring [and] long-term stewardship and the need for thorough site characterization."

Global Carbon Capture and Storage Market 2017-2021.

The following is from a description of this document: "The use of CCS technology is one of the novel ideas that help reduce the amount of CO_2 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_2 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 [compound annual growth rate (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. The market is divided into the following segments based on geography: Americas, APAC, EMEA. 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."

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

National Energy Technology Laboratory

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