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for Fossil Energy



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CARBON STORAGE PARTNER COMPLETES FIRST YEAR OF CO₂ INJECTION OPERATIONS IN ILLINOIS

Large-Scale Test to Inject 1 Million Metric Tons of Carbon Dioxide in a Saline Formation

A project important to demonstrating the commercial viability of carbon capture, utilization and storage (CCUS) technology has completed the first year of injecting carbon dioxide (CO₂) at a large-scale test site in Illinois.

Led by the Illinois State Geological Survey, the Illinois Basin–Decatur Project is the first demonstration-scale project in the United States to use CO₂ from an industrial source and inject it into a saline reservoir. The CO₂ is being captured from an ethanol produc-



tion facility operated by the Archer Daniels Midland Company in Decatur, Ill., and is being injected in a compressed “supercritical” state into the Mount Simon Sandstone reservoir some 7,000 feet below the surface. Injection operations were initiated November 17, 2011, with an average injection rate of 1,000 metric tons (1,100 short tons) daily.

Analysis of data collected during the characterization phase of the project indicated the lower Mount

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ATLAS ESTIMATES 2,400 BILLION METRIC TONS OF U.S. CO₂ STORAGE RESOURCE

The United States has at least 2,400 billion metric tons of possible carbon dioxide (CO₂) storage resource in saline formations, oil and gas reservoirs, and unmineable coal seams, according to a new Department of Energy (DOE) publication.

This resource could potentially store hundreds of years’ worth of industrial greenhouse gas emissions, permanently preventing their release into the atmosphere, says the 2012 edition of the Carbon Utilization and Storage Atlas (Atlas IV). Capturing CO₂ emissions from large power and industrial plants and putting it to beneficial use or storing it in deep geologic formations is a key element in national efforts to mitigate climate change.

Of particular importance is that over 225 billion metric tons of storage capacity has been identified in mature oil and gas fields which could accommodate storage of several decades of emission from stationary sources while simultaneously improving the energy security of the United States by enhancing oil and gas recovery.

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CARBON CAPTURE, UTILIZATION AND STORAGE DEMONSTRATIONS

Progress and Change in 2012

By Dr. Darren Mollot, Director, Clean Energy Systems

As we ring in the New Year, it's fitting to pause and reflect on the progress we made in 2012 in bringing clean coal technologies to the marketplace. Several years ago, President Obama set a goal of bringing 5 to 10 commercial clean coal demonstration projects online by 2016. Today, thanks to Administration investments and private capital, the United States is on track to meet this goal, and remains the world leader in clean coal technology development.

Here are some of the highlights of the Office of Fossil Energy's clean coal major demonstrations program in 2012.

Power Purchase Agreement Makes History

The nation's largest municipal utility, serving the City of San Antonio, entered into a long-term agreement in 2012 to purchase 200 megawatts (MW) of electricity annually from a first-of-its-kind, commercial-scale coal integrated gasification combined cycle (IGCC) poly-generation facility – the Texas Clean Energy Project (TCEP). The power purchase marks the first time in U.S. history that an electric utility will buy low carbon power from a commercial-scale, coal-based power plant with carbon capture.



Darren Mollot is director of Clean Energy Systems in the Office of Clean Coal.

Adding the “U” in CCUS

Additionally and importantly, the TCEP will put its captured CO₂ to use. Supported by Office of Fossil Energy investments, the TCEP project works economically because of its long-term off-take agreements with private companies for the urea and CO₂ the poly-generation project will produce. TCEP will be among the cleanest coal-powered plants in the world when it becomes operational in 2015, and it will get built – in part – because of the carbon capture, utilization and storage, or CCUS, approach. TCEP is not alone; in fact, all of the following large-scale projects are putting captured carbon to use:

- Summit Power (Texas Clean Energy Project): Will store 3 million metric tons of CO₂/year in enhanced oil recovery (EOR). CO₂ injection is a common method of EOR, in which the CO₂ is injected into abandoned oil wells to force oil out of the ground; captured CO₂ will also be used to produce urea; online in 2016.
- Hydrogen Energy California (HECA): Will store 2.5 million metric tons of CO₂/year in EOR; CO₂ will also be used in urea production; online in 2018.
- Southern Company (Kemper): Will store 3 million metric tons a year in EOR; online late 2014.
- NRG Energy (W.A. Parish): Will store approximately 1.4 million metric tons of CO₂/year in EOR; online 2014.
- Air Products & Chemical Inc. (Port Arthur): Will store 1 million metric tons of CO₂/year in EOR; online 2013.
- Leucadia Energy (Lake Charles): Will store 4.5 million metric tons of CO₂/year in EOR; online late 2014.

Construction Progress

By the end of 2012, construction was nearly complete at Air Products' state-of-the-art system to concentrate CO₂ from two steam methane reformer hydrogen production plants located in Port Arthur, Texas. The technology will remove more than 90 percent of the CO₂ from the process gas stream used in a world-class scale hydrogen production facility. The CO₂ will then be delivered to the Denbury pipeline for transport to Texas EOR projects in the West Hastings Field where a monitoring, verification and accounting program will ensure the injected CO₂ remains in the underground geologic formation. Commissioning, startup, and the operation of all components of the Air Products project are scheduled to occur in early 2013.

Construction is now nearly 50 percent complete on Mississippi Power's Kemper County energy facility. This demonstration highlights a technology – the transport gasifier – derived from technology that has been used successfully for over 50 years in the petroleum refining industry. The transport gasifier has a fuel-flexible design projected to have higher efficiency and

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“Demonstrations” continued from page 2...

lower capital and operating costs on low rank coals than the currently available oxygen-blown entrained-flow gasifiers. The Kemper County energy facility will generate electricity with Mississippi lignite, and will capture at least 65 percent of the CO₂ produced. That CO₂ will then be sold for EOR.

The Illinois Industrial Carbon Capture and Storage (ICCS) project in Decatur, Illinois, the Department’s first large-scale industrial carbon capture and storage demonstration project, achieved several major milestones in 2012. Among them, construction of the CO₂ capture and storage facilities is approximately 60 percent complete and the National Sequestration Education Center is opened. The Center was funded in partnership with the Richland Community College and contains classrooms, training, and laboratory facilities, offering students associate degrees in sequestration technology. Once fully operational in 2013, the Illinois ICCS project will be able to store 1 million tons of CO₂ per year.

Parting Ways

Finally, the end of 2012 brought the departure of James Wood, Fossil Energy’s Deputy Assistant Secretary (DAS) for Clean Coal. He brought more than 30 years of industry experience to the position, and his vast knowledge of clean coal technologies will be deeply missed. We wish him well as he begins a new chapter in his career as Chairman and CEO of ThermoEnergy Corporation, a diversified technologies company involved in the development and sales of wastewater recovery and clean power generation technologies.

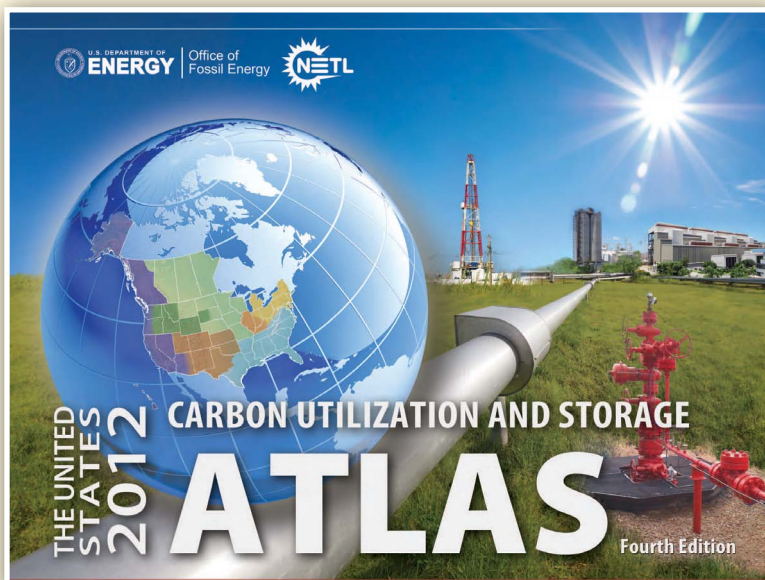
Scott Klara, Principal Deputy Assistant Secretary for Fossil Energy, will serve as Acting DAS for Clean Coal until a replacement can be named.

“Atlas” continued from page 1...

Atlas IV was created by the Office of Fossil Energy’s National Energy Technology Laboratory (NETL) with input from DOE’s seven Regional Carbon Sequestration Partnerships and nine Site Characterization projects. Comprising more than 400 organizations in 43 states and four Canadian provinces, the regional partnerships are testing CO₂ storage potential and investigating best practices for CO₂ storage in a variety of geologic formations.

The Site Characterization projects, funded by the American Recovery and Reinvestment Act of 2009, are furthering DOE efforts to assess the nation’s CO₂ storage resource by developing additional characterization data for possible storage reservoirs.

The primary purpose of Atlas IV is to provide an update on the CO₂ storage potential in the United States and to showcase updated information about the partnerships’ field activi-



ties and new information from the site characterization projects. Atlas IV outlines DOE’s Carbon Storage Program and its carbon capture, utilization, and storage (CCUS) collaborations, along with worldwide CCUS projects and CCUS regulatory issues. The atlas also presents updated information on the location of CO₂ stationary source emissions and the locations and storage potential of various geologic storage sites, and it provides information about the commercializa-

tion opportunities for CCUS technologies from the regional partnerships.

The data used to create the resource estimates in Atlas IV is available in interactive form on the National Carbon Sequestration Database and Geographic Information System (NATCARB) website.

View the atlas online at http://www.netl.doe.gov/technologies/carbon_seq/refshelf/atlasIV/Atlas-IV-2012.pdf.

“Injection” continued from page 1...

Simon formation has the necessary geological characteristics to be a good injection target, a conclusion supported thus far by data accumulated from continuous monitoring of the site. The results from various monitoring activities — including tracking the underground CO₂ plume; sensing subsurface disturbances; and continuous scrutiny of groundwater, shallow subsurface, land surface, and atmosphere around the injection site — show the Mount Simon Sandstone reservoir is performing as expected, with very good injectivity, excellent storage capacity, and no significant adverse environmental issues.

Nearing the 1-year mark, 317,000 metric tons of CO₂ have been injected, about one third of the planned 1 million metric ton injection volume. The demonstration-scale project provides the opportunity to test how a real-world injection operation will perform where brief interruptions — such as planned maintenance of the compression equipment and conducting of various well tests, as required by regulations — will occur.

Successfully testing and demonstrating CCUS technologies under real-world conditions is an important step toward

eventual commercial deployment of the technology as an option in helping mitigate atmospheric carbon dioxide emissions.

The technologies applied and lessons learned from this project will also support industry in the region looking to develop CO₂ capture and transport infrastructure, whether it is for carbon storage or enhanced oil recovery in the depleted oilfields in the Illinois Basin.

The seven regional partnerships in the Regional Carbon Sequestration Partnerships program are investigating the merits of numerous CCUS approaches to determine those best suited for different regions of the country. The Midwest Geological Sequestration Consortium (MGSC) is investigating options for the 60,000 square mile Illinois Basin, which underlies most of Illinois, southwestern Indiana, and western Kentucky. Emissions in this area exceed 291 million metric tons of CO₂ yearly, mostly attributed to the region’s coal-fired power plants.

DEPARTMENT RELEASES STUDY ON NATURAL GAS EXPORTS

As part of a broader effort to further inform decisions related to LNG exports, the Department of Energy commissioned NERA Economic Consulting to conduct a third party study in order to gain a better understanding of how U.S. LNG exports could affect the public interest, with an emphasis on the energy and manufacturing sectors. The Department recently released that study and made it available for public review and comment. As this is not a Department of Energy product, the Department will be conducting its own review of the study as well as consideration of relevant comments made throughout the process prior to making final determinations.

Federal law generally requires approval of natural gas exports to countries that have a free trade agreement with the United States. For countries that do not have a free trade agreement with the U.S., the Department of Energy is required to grant applications for export authorizations unless the Department finds that the proposed exports “will not be consistent with the public interest.” Factors for consideration include economic, energy security, and environmental impacts.

On December 5, 2012, the Office of Fossil Energy posted the final NERA report into the 15 pending export application dockets, and invited the public to provide comment. The report and resulting comments will be taken into consideration as the Department makes its public interest determinations in each case. Following the closing of the reply comment period, the Department of Energy will begin to act on the pending applications on a case-by-case basis. The study will be one of the inputs considered during evaluation of those applications. The Energy Department expects to act first upon applications for which the applicants have commenced the pre-filing process at the Federal Energy Regulatory Commission (FERC) as of December 5, 2012, in the general order in which the Department received them. Following disposition of those applications that have pre-filed with FERC, the Energy Department expects to act upon the rest of the pending applications – and any others submitted - in the order received.

The LNG Study, along with initial comments, can be viewed online at http://www.fossil.energy.gov/programs/gasregulation/authorizations/export_study/export_study_initial_comments.html.

PETROLEUM RESERVES EMERGENCY SUPPLIES PROVIDE RELIEF DURING 2012

Established to provide a source of emergency petroleum supplies for the nation, both the Strategic Petroleum Reserve and the Northeast Home Heating Oil Reserve were called into action in late 2012. While the Strategic Petroleum Reserve has been used several times, this was the first time the Northeast Home Heating Oil Reserve had been used for an energy emergency.

Northeast Home Heating Oil Reserve

After slugging its way through the Caribbean and mid-Atlantic, Hurricane Sandy — the largest Atlantic hurricane on record — turned towards the northeastern U.S. and made landfall north of central New Jersey, on October 29. By then, it had been downgraded to a post-tropical cyclone with hurricane force winds. Dubbed Superstorm Sandy in the U.S., the storm caused massive damage that impacted 24 states. The most severe damage occurred in New York and New Jersey, mostly due to the storm surge. Extreme flooding wiped out not only homes and businesses, but also streets, tunnels, subways, piers, and power lines.

The energy infrastructure in the Northeast was devastated. Emergency responders quickly learned that their response efforts were hindered by the lack of electricity and fuel to power vehicles and equipment. The Department of Homeland Security asked for help.

The Office of Fossil Energy's Petroleum Reserves Office was called to service. As part of the government-wide response and recovery effort, President Obama declared on November 2 that Hurricane Sandy had created a severe energy supply interruption and directed the transfer of ultra-low sulfur diesel (ULSD) from the Northeast Home Heating Oil Reserve to the Department of Defense for distribution to emergency responders and for disbursement to communities affected by the storm. An agreement between the two federal agencies was put in place the same day.

"Today's announcement is part of the broader federal effort to respond to those impacted by Hurricane Sandy. This loan from the Northeast Home Heating Oil Reserve will help ensure state, local and federal responders in the impacted area have access to the diesel fuel they need to continue response and recovery efforts," said Secretary of Energy Stephen Chu.

On November 3, agents of the Defense Logistics Agency-Energy, a part of the Department of Defense, began drawing down stocks from the Reserve. The fuel was distributed to state, local and federal responders in the New York/New Jersey area. The Department of Energy announced that additional supplies from the Reserve would be made available, as needed, to ensure continued response and recovery



efforts. DOE received two additional requests for loans on November 7 after a major snowstorm hit the Northeast on the heels of Superstorm Sandy. Those requests were promptly approved and loading was accomplished on November 12 and 25 (as scheduled by the recipient). In total, a little more than 120,000 barrels of ULSD was provided to support emergency relief efforts.

By late December, the Defense Logistics Agency had repaid its loan to the Reserve with equivalent quantities of ULSD. Should another energy supply emergency strike the Northeast this winter, the Northeast Home Heating Oil Reserve will be ready to help.

The Northeast Home Heating Oil Reserve was created in 2000 as a component of the Strategic Petroleum Reserve to respond to emergencies and supply disruptions in the home heating oil market. Its location in the Northeast — with 500,000 barrels stored in Groton, Conn., and 500,000 barrels stored in Revere, Mass. — provides a supply cushion to a region heavily dependent on heating oil to heat its homes. Additionally, the Reserve's stocks of ULSD can also be used in vehicles and equipment that utilize diesel fuel, an invaluable flexibility during a crisis. The 2012 loans were the first time the Northeast Home Heating Oil Reserve had been used to address supply interruptions.

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Strategic Petroleum Reserve

Maintaining drawdown capabilities at all times is a critical element to the success of the 696 million barrel Strategic Petroleum Reserve program. As the United States and other world leaders imposed sanctions on Iran to hinder Iran’s nuclear ambitions, the Strategic Petroleum Reserve was poised for a possible drawdown of supplies in early 2012. Iran’s threats to cut off oil flows through the Straits of Hormuz increased tensions further. Throughout this period, the Strategic Petroleum Reserve maintained a heightened readiness posture while the White House repeatedly stated that use of the Strategic Petroleum Reserve was an option if Iran took action against the oil markets. Although diplomacy staved off the need to take action, the Strategic Petroleum Reserve maintained its readiness to respond.

During the third week in August, Hurricane Isaac entered the Gulf of Mexico and reached the Louisiana Coast on August 28. The storm caused a 95 percent reduction in Gulf of Mexico crude oil production and delayed tankers carrying oil imports to terminals in Texas and Louisiana. As a result of supply interruptions before and during the storm, and damage to infrastructure resulting from the storm, several refineries along the Gulf Coast and the mid-Continent

Requests for Emergency Assistance From the SPR

- “Emergency Oil Loans” are sole-source contracts with refiners who have lost physical access to oil supplies and require crude to continue refinery operations.
- Instructions for requesting an emergency loan is posted on the SPR website at http://www.fossil.energy.gov/programs/reserves/spr/emergency_oil_requests.html.
- The SPR strives to process refiner emergency requests within one business day and initiate SPR oil deliveries as soon as possible thereafter.
- Delivery schedules are the responsibility of the requestor.

(that are dependent on pipeline deliveries from the Gulf Coast) were shut down and others had reduced runs. On August 30, the Strategic Petroleum Reserve was contacted by Marathon Petroleum Company, who requested a short-term loan of oil to compensate for its loss of crude supplies needed to run its Midwest refineries.

In its request to DOE, Marathon made clear that they were experiencing crude supply and logistical problems due to Hurricane Isaac. As part of a broader Federal effort to respond to those impacted by Hurricane Isaac, DOE agreed to the loan in order to provide Marathon with the crude oil it needed to operate its refineries. The contract required that Marathon return a comparable value of crude oil to the Strategic Petroleum Reserve within three months, plus a quantity of premium barrels (similar to interest). By helping to keep refineries open to produce necessary fuels for consumers, the Strategic Petroleum Reserve was able to make a positive contribution to recovery efforts.



PRIOR SPR RELEASES - QUICK FACTS

- To date, there have been only five occasions when there have been a drawdown and sale of oil from the SPR pursuant to the authority in EPCA.
- Twice the SPR has conducted test sales to ensure the readiness of the Reserve and its personnel to carry out a Presidentially-ordered drawdown. The first took place in 1985 and the second in the months immediately preceding 1991’s Operation Desert Storm.
- Oil has been released from the Strategic Petroleum Reserve 11 times under exchange arrangements (similar to loans) with private companies.

Learn more on the SPR’s previous uses at <http://www.fossil.energy.gov/programs/reserves/spr/spr-drawdown.html#1996Exchange>.

OHIO STATE DEVELOPS GAME-CHANGING CO₂ CAPTURE MEMBRANES IN DOE-FUNDED PROJECT

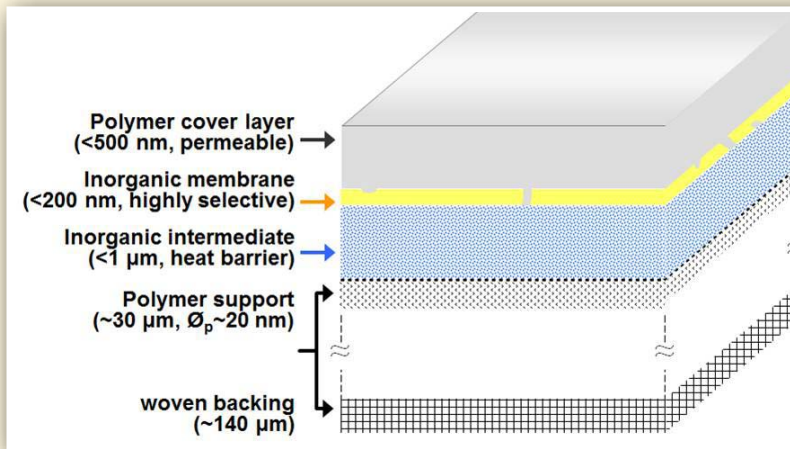
Novel Composite Membranes Developed for Carbon Capture, Utilization, and Storage

Researchers at The Ohio State University have developed a groundbreaking new hybrid membrane that combines the separation performance of inorganic membranes with the cost-effectiveness of polymer membranes. The breakthrough technology has vast commercial potential for use at coal-fired power plants with carbon capture, utilization, and storage (CCUS).

Before the carbon dioxide (CO₂) generated at a power plant can be securely stored or put to beneficial use, it must first be separated from the flue gas stream. Unfortunately, the energy cost of current separation technologies is too high to make rapid commercial deployment of CCUS technologies feasible. To overcome this barrier, high-performance membrane separation is a focus of FE's Carbon Capture Program, under which the Ohio State project is managed.

Membranes consist of thin layers of either polymer (organic, plastic) or inorganic (metal, ceramic) materials that are permeable to the molecules they are meant to capture, such as water, CO₂, or oxygen. The layers are generally deposited on a membrane support structure. Polymer membranes are mass produced and very cost effective, while inorganic membranes are expensive to produce but exhibit much better performance.

To illustrate how membranes are more energy efficient than other separation methods, scientists sometimes use a familiar substance: seawater. Pure water can be obtained by boiling the seawater and condensing the salt-free vapor, but boiling requires heat, which means using energy. Alternatively, membrane processes for separating salt from water don't require heat, making them more cost effective and environmentally friendly. Separating CO₂ from flue gas is



similar. Energy is still required for pre- and post-separation processes, such as compressing the gas, but for the key process of separating the CO₂, new membrane technologies pioneered by FE's National Energy Technology Laboratory (NETL) and its research partners are designed to eliminate most of the energy costs.

Ohio State's new hybrid membrane consists of a thin, inorganic "zeolite Y" layer sandwiched between an inorganic intermediate and a polymer cover. These three layers sit atop a polymer support, which in turn rests on a woven backing. According to NETL project manager José Figueroa, "Combining inorganic and organic membrane materials in a hybrid configuration is a breakthrough that could potentially lower costs associated with clean coal technologies."

Ohio State researchers realized a first prototype by combining new nanotechnology characterization and fabrication methods with state-of-the-art manufacturing techniques. In the laboratory, they were able to slash the zeolite Y growth rate from 8 hours to less than 15 minutes and reduce ceramic processing time from 43 hours to 20 minutes, resulting in inorganic/organic membrane development within one hour. They have also achieved adhesion of the inorganic intermediate layer onto a polymer support.

The Ohio State team, which has emphasized the membrane's broader separation applications in their reports, received funding for the project beginning October 1, 2011, and presented their first results at the NETL Carbon Capture and Storage meeting July 9–12, 2012. The promising results follow previous success the team has had in making continuous, intact inorganic layers on polymer supports and developing new membrane-production techniques.

Learn more about this project in a Department of Energy blog piece at <http://energy.gov/articles/ohio-state-develops-breakthrough-membranes-carbon-capture-utilization-and-storage>

RESEARCH PROJECTS ADDRESSING TECHNICAL CHALLENGES TO ENVIRONMENTALLY ACCEPTABLE SHALE GAS DEVELOPMENT SELECTED BY DOE

Fifteen research projects aimed at addressing the technical challenges of producing natural gas from shales and tight sands, while simultaneously reducing environmental footprints and risks, have been selected to receive a total of \$28 million in funding from the Office of Fossil Energy (FE).

The projects, valued at just over \$36.6 million over two years, add to the research portfolio for FE's Ultra-Deepwater and Unconventional Natural Gas and Other Petroleum Resources Research Program, which develops technologies and strategies to improve the safety and minimize the environmental impacts of oil and natural gas exploration and production.

The projects will address research needs primarily in four categories: (1) reduced environmental impacts, (2) improved water handling and treating methods, (3) enhanced characterization of shales, and (4) improved understanding of the hydraulic fracturing process.

Projects range from testing innovative technologies for cleaning fracture flowback water, to finding new ways to improve casing cement jobs, to increasing the understanding of the relationship between underground water disposal and induced seismicity.

Approximately \$8.6 million of the total value of the projects is provided via cost-share by the research partners, in addition to \$28 million in federal funds. The research contracts will be administered by the Research Partnership to Secure Energy for America (RPSEA), under the management of FE's National Energy Technology Laboratory.

The projects selected include:

- GSI Environmental, Inc. (Houston, TX) — DOE share: \$1,542,193; Recipient share: \$510,000; Duration: 1 year
- CSI Technologies, Inc. (Houston, TX) — DOE share: \$4,005,930; Recipient share: \$2,700,000; Duration: 2 years
- The University of Texas at Austin (Austin, TX) — DOE share: \$963,792; Recipient share: \$259,123; Duration: 2 years
- University of Southern California (Los Angeles, CA) — DOE share: \$1,741,215; Recipient share: \$506,027; Duration: 2 years
- Colorado State University (Fort Collins, CO) — DOE share: \$1,395,949; Recipient share: \$289,898; Duration: 2 years
- Southern Research Institute (Birmingham, AL) — DOE share: \$2,488,919; Recipient share: \$289,898; Duration: 2 years
- Ohio University (Athens, OH) — DOE share: \$1,936,630; Recipient share: \$500,160; Duration: 2 years
- Battelle Memorial Institute (Columbus, OH) — DOE share: \$1,569,592; Recipient share: \$402,732; Duration: 2 years
- Drexel University (Philadelphia, PA) — DOE share: \$1,574,690; Recipient share: \$395,060; Duration: 2 years
- Colorado School of Mines (Golden, CO) — DOE share: \$286,984; Recipient share: \$106,796; Duration: 3 years
- The University of Texas, Bureau of Economic Geology (Austin, TX) — DOE share: \$1,300,504; Recipient share: \$325,144; Duration: 2 years
- Oklahoma State University (Stillwater, OK) — DOE share: \$1,529,702; Recipient share: \$383,850; Duration: 2 years
- Texas A&M University (College Station, TX) — DOE share: \$883,507; Recipient share: \$220,877; Duration: 2 years
- Texas A&M University (College Station, TX) — DOE share: \$622,115; Recipient share: \$155,528; Duration: 2 years
- Gas Technology Institute (Chicago, IL) — DOE share: \$6,201,731; Recipient share: \$1,565,000; Duration: 2 years

Learn more about the selected projects at http://www.fossil.energy.gov/news/techlines/2012/12058-DOE_Selects_RPSEA_Projects.html.

ARRA-FUNDED ICCS PROJECT ADVANCES IN LOUISIANA

An innovative project in Louisiana demonstrating a key carbon capture, utilization and storage (CCUS) technology moved forward in late 2012 when contracts were signed to use products produced once the plant is operating.

The \$2.5 billion Lake Charles Clean Energy (LCCE) LLC gasification plant at the Port of Lake Charles, La., will use commercially proven gasification technology to cleanly manufacture industrial products from petroleum coke. An integral part of the overall project is a U.S. Department of Energy effort to simultaneously store carbon dioxide (CO₂) while increasing oil production in a process called enhanced oil recovery (EOR).

LCCE, a subsidiary of Leucadia Energy LLC, said it secured long-term commercial contracts with BP Products North America Inc., Air Products and Chemicals Inc., and Denbury Onshore LLC, a subsidiary of Denbury Resources Inc. The contracts are an important step in securing third party financing prior to plant construction.

BP will purchase most of the facility's methanol production, and Air Products will purchase all of LCCE's hydrogen and argon; Air Products will also provide the air-separation units that will supply oxygen for the project. Denbury will purchase all of the captured CO₂ for use in its Gulf Coast EOR operations to boost its current production level of more than 35,000 barrels of oil per day.

The Leucadia project was one of three selected by DOE in 2010 to receive funding from the American Recovery and Reinvestment Act (ARRA) as part of the Industrial Carbon Capture and Storage initiative, a \$1.4 billion effort to capture CO₂ from industrial sources for storage or beneficial use. The overall Lake Charles project is expected to provide up to 1,500 construction jobs during the 3- to 4-year con-

struction period, which begins in 2013, and more than 160 permanent jobs after completion.

The project will ultimately capture and store approximately 4.5 million tons of CO₂ per year, which will be used for EOR in oilfields in Louisiana and Texas. The CO₂ will be delivered through a 12-mile connector pipeline to an existing Denbury interstate CO₂ pipeline. As part of the DOE project, Denbury will also undertake a monitoring, verification, and accounting program to confirm permanent storage of more than 1 million tons per year of CO₂ injected into the West Hastings oilfield in Brazoria County, Texas, in a commercial EOR operation.

DOE's CCUS effort at Lake Charles, which will be managed by the Office of Fossil Energy's National Energy Technology Laboratory, includes team members Leucadia; Denbury; Kellogg, Brown, and Root; Turner Industries; Black & Veatch; and The University of Texas Bureau of Economic Geology. DOE's share of the CCUS project is approximately \$261 million.

LCCE reports that the Lake Charles petroleum-coke-to-chemicals gasification plant will be the first of its kind in the nation. The company expects to be one of the world's lowest-cost producers of methanol and hydrogen, as well as a low-cost producer of related products used in the chemical and refining industries.

A corollary benefit of the project is that any developed infrastructure could potentially enable other industrial and power plant sources of CO₂ in the Lake Charles area to commercially use CO₂ in related EOR operations. Success of the project will promote greater environmental sustainability and energy security by reducing carbon emissions and increasing domestic energy supplies.

GLOBAL MARKETING AGREEMENT MAKES CLEAN COAL-GASIFICATION TECHNOLOGY COMMERCIALY AVAILABLE

A new alliance between KBR LLC and Southern Company subsidiary Southern Generation Technologies LLC to market an advanced gasification technology developed with support from the U.S. Department of Energy gives electric utilities another option to generate clean, efficient, low-cost electricity using coal. The technology, called Transport Integrated Gasification or

TRIG™, is based on a proven technology — KBR's fluid catalytic cracking technology, which has been used in petroleum refineries for decades — and can be used for both integrated gasification combined cycle (IGCC) power generation and the production of fuels and chemicals. The agreement gives KBR exclusive global licensing rights for power generation in addition

to its existing rights in industrial applications of TRIG.

According to KBR, the TRIG gasifier can be configured in a cost-efficient air-blown design for use in advanced IGCC power plants. In these plants, coal is not burned as in conventional power plants; instead, IGCC plants use

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“TRIG” continued from page 9...

heat, pressure, and steam to convert coal to a synthesis gas (syngas). The syngas is then cleaned to remove impurities and sent to a gas turbine where it undergoes combustion to produce electricity. The hot exhaust gas from the gas turbine is used to generate steam, which is then fed to a steam turbine to produce additional electricity.

Compared to traditional power plants, IGCC offers many advantages, including increased efficiency, which translates into lower-cost electricity for consumers. Environmental contaminants are also easier to remove, and the system makes it possible to concentrate carbon dioxide (CO₂), providing for more efficient removal and subsequent storage or use — an important approach to reducing greenhouse gas emissions. Energy experts predict that IGCC will play a key role in future clean-coal electricity generation.

A barrier to widespread use of IGCC technology is that most existing coal-gasification technologies perform best on bituminous coal — a hard coal with relatively high energy content and low moisture — but they are less efficient and more expensive to operate when processing lower-rank coals, such as sub-bituminous coal and lignite, which make up more than half of the world’s coal reserves. The strength of the TRIG system is its advanced circulating fluidized bed gasifier, which makes it particularly well-suited for low-rank or high-ash coals.

A unique feature of the TRIG process is that coal that is not initially converted to syngas can be cycled back through the process again, for a second round of gasification. This allows a higher carbon conversion rate at a lower temperature, and results in lower production, operation, and maintenance costs. These features are especially important in countries such as China or India, which are currently developing their coal-power production. Before signing the new marketing agreement, Southern Company and KBR licensed TRIG to the Tian Ming Electric Power Company in China for a facility now under construction.

Southern Company and KBR developed key components of the TRIG technology at the Power Systems Development Facility (PSDF) in Wilsonville, Ala., in a partnership extending over 15 years. DOE conceived the PSDF as the premier advanced coal power research and development facility in the world, where researchers could economically demonstrate and evaluate innovative power system components on a semi-commercial scale. The facility’s success resulted in the facility becoming home, in 2009, to the National Carbon Capture Center to accelerate development of cost-effective carbon-capture technologies and ensure continued use of coal for power generation.

TRIG technology is being deployed by another Southern Company subsidiary, Mississippi Power, at their DOE-supported IGCC facility under construction in Kemper County, Miss. Using the abundant lignite in a nearby coal seam as a feedstock, and employing state-of-the-art emissions controls, Plant Ratcliffe is expected to have lower emissions of sulfur dioxide, particulate matter, and mercury than conventional coal plants, and will also capture 65 percent of produced CO₂, which will then be injected into depleted oil wells in a process called enhanced oil recovery. Using CO₂ in this way will offset plant costs, increase domestic oil production, and result in plant CO₂ emissions comparable to a similarly sized natural gas power plant.

DOE APPROVES FIELD TEST FOR PROMISING CARBON CAPTURE TECHNOLOGY

A promising post combustion membrane technology that can separate and capture 90 percent of the carbon dioxide (CO₂) from a pulverized coal plant has been successfully demonstrated and received Department of Energy approval to advance to a larger-scale field test.

In an \$18.75 million project funded by the American Recovery and Reinvestment Act of 2009, Membrane Technology and Research Inc. (MTR) and its partners tested the Polaris™ membrane system, which uses a CO₂-selective polymeric membrane (micro-porous films which act as semi-permeable barriers to separate two different mediums) material and module to capture CO₂ from a plant’s flue gas. Post-combustion separation and capture of CO₂ is challenging due to the low pressure and diluted concentration of CO₂ in the waste stream; trace impurities in the flue gas that affect removal processes; and the amount of energy required for CO₂ capture and compression.

Because the Polaris membranes are 10 times more permeable to CO₂ than conventional materials (reducing the membrane area required), and use a slipstream of combustion air as a sweep gas, the system has great potential for reduced energy requirements, reasonable capture costs and greater efficiencies for post-combustion capture, all important factors for retrofitting existing coal-based plants.

Learn more about this project at
http://www.fossil.energy.gov/news/techlines/2012/12057-DOE_Ap-proves_Carbon_Capture_Field_.html

CCSI DELIVERS FIRST TOOLSET

The Carbon Capture Simulation Initiative (CCSI), a public-private partnership led by the Office of Fossil Energy's National Energy Technology Laboratory, has released the first CCSI Toolset, a suite of 21 computational tools and models to enable the rapid development and deployment of new carbon capture technologies. The availability of the first CCSI Toolset comes a year ahead of the original release date and is the result of intense industry interest in getting early access to these tools.

CCSI meets an urgent need to take carbon capture concepts from the laboratory to the power plant more quickly, at lower cost, and with reduced risk. The U.S. Energy Information Administration projects that, by 2035, world energy demand will increase by 47 percent. While significant advances have been made in the development of alternative energy sources, the United States and the world will continue to rely on coal-fired power plants to meet rising energy demands. Coal is an economically viable fuel option, but, like all fuels, its use comes with an environmental cost. In 2011, utility coal plants in the United States emitted 1.7 billion tons of CO₂, representing 34 percent of all U.S. CO₂ emissions, making coal-fired power plants the single largest source of CO₂ in the country. For our nation to remain competitive, it is imperative to quickly develop and deploy technologies to extract and use coal as safely, cleanly, and economically as possible.

CCSI was formed to provide technology developers and plant operators with a validated suite of models and simulation tools to enable the rapid development and deployment of new carbon capture technologies. The use of such tools could dramatically reduce the 20–30 years of development time usually required for commercial technology deployment. “The CCSI Toolset delivers new capabilities for integrating multi-scale modeling, optimization and uncertainty quantification, which will significantly impact the way carbon capture processes are developed,” said David Miller of NETL, technical lead of CCSI.

Typically, several incremental steps are taken during scale-up, ensuring that the technical risk in each step is as small

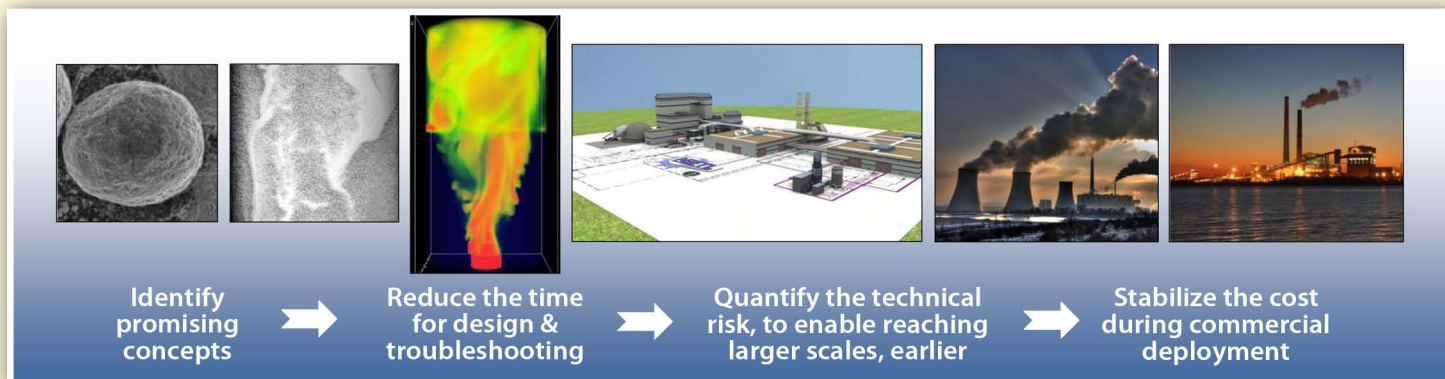
as possible. “The complementary CCSI approach, which is based on advanced modeling and simulation, has the potential to dramatically reduce this development time,” said Dr. Madhava Syamlal, CCSI Project Director. “Science-based models can be used with pilot-scale data to reach larger scales more quickly, and with greater confidence, thereby reducing the time and expense of scale-up.”

The current release consists of new tools for process synthesis and optimization, to help identify promising concepts more quickly; new physics-based models of potential capture equipment and processes that will reduce the time to design and troubleshoot new systems; a framework to quantify the uncertainty of model predictions; and various enabling tools that provide new capabilities, such as creating reduced-order models from reacting multiphase flow simulations and running thousands of process simulations concurrently for optimization and uncertainty quantification.

The CCSI Toolset works with commercial and open-source software currently in use by industry and includes new software tools developed to fill technology gaps. The tools are highly versatile; in addition to their use in the development of carbon capture technologies, they can be used to accelerate the development of technologies for refining, chemicals production, and oil and natural gas production. The toolset has been well received by CCSI's industry partners, with multiple members making immediate plans for tool adoption.

“Because carbon capture systems are not yet required at any of the 600-plus plants across the country, CCSI works closely with industry to make the tools easier to adapt to existing design technologies. These tools will make it easier for utility companies to meet such requirements if and when they are enacted, and could help companies doing business in countries where controls are already in place,” said Dr. Syamlal.

The total cost savings that could be realized by using the CCSI toolset to scale up and widely deploy just one carbon capture technology is estimated at approximately \$500 million.



Upcoming Events

<http://www.fossil.energy.gov/news/events/index.html>

January 28-30

16th Annual Energy, Utilities & Environment Conference

Phoenix, Arizona

February 15-17

American Association for the Advancement of Science

Boston, Mass.



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Comments are welcome and may be submitted to the editor.