NETL Accomplishments

2012

U.S. DEPARTMENT OF ENERGY | the ENERGY lab
NATIONAL ENERGY TECHNOLOGY LABORATORY

Mission

Advancing energy options to fuel our economy, strengthen our security, and improve our environment.

2012

Contents

Welcome to the 2012 NETL Accomplishments Report

Resolving the nation's energy challenges remains the primary focus of the exciting work being done at the National Energy Technology Laboratory (NETL). Our progress in 2012 was impressive, and here in NETL Accomplishments 2012 we share the results of those efforts.

On the national level, NETL made important contributions toward the President's all-of-the-above energy strategy as we focused research on making the most of our domestic resources. We are making significant contributions in next-generation power plants with near-zero emissions, capturing and permanently storing carbon emissions, and maximizing our energy assets with the smallest possible impact on our air, land, and waterways. For example, in 2012 NETL continued its leading role in the remarkable "shale boom" that is transforming our nation's energy profile. Technologies developed at NETL or with NETL support helped make possible the development of this domestic resource, and we are committed to efforts that ensure its environmental safety.

NETL Accomplishments 2012 contains a selection of our technical achievements and the recognition we received during the year. Although our work is integrated, for ease of reading the information is grouped in three broad areas: clean energy, reliable supply, and science and technology leadership. The report concludes with a historic look at some of our most significant accomplishments over the last quarter-century. These successes illustrate our commitment to advancing energy technologies that positively impact America's prosperity.

In clean energy, our goal is to reduce emissions and conserve energy while building a portfolio of technologies for sustainable energy production. We're developing economic, effective methods to capture and store carbon from power plants that use conventional technologies as well as pursuing advanced technologies, such as fuel cells and chemical looping combustion, that have inherently low emissions. In one notable 2012 accomplishment, the NETL-led Carbon Capture Simulation Initiative, released—a year ahead of schedule, in response to intense industry

interest—a set of computational tools and models to accelerate the development and deployment of carbon capture technologies.

Recognizing that a reliable supply of energy is the foundation of America's high standard of living, NETL conducts research to ensure that our energy supply remains uninterrupted and affordable. One of the ways in which we do this is by exploring new energy resources. In a noteworthy example from April 2012, NETL, along with ConocoPhillips and the Japan Oil, Gas and Metals National Corporation, completed an unprecedented demonstration of natural gas extraction from what could become a game-changing energy resource: methane hydrate. NETL is also helping conserve America's electricity usage by making advances in the areas of solid-state lighting and smart grid technologies.

NETL's proven leadership in science and technology is demonstrated not only through the patents and awards we've received, but also in the ways in which our research extends beyond the energy sector to provide far-reaching benefits. We're gratified that in 2012 one of our sorbent technologies was commercialized to make HVAC systems more efficient. We also managed a training program that is developing a skilled workforce capable of implementing a national clean energy smart grid. Our expertise stretched into the transportation sector as well, as NETL researchers evaluated and helped optimize nanocoatings to protect turbine engines, such as those used in aircraft. Within these pages you can read more about these and other successes of which we're rightfully proud.

From mitigating acid rain to enabling shale gas recovery, from improving health to creating jobs, NETL research has provided a tremendous return on investment for the American taxpayer. Our pledge is that the Laboratory researchers and professional staff who have made these achievements possible will continue to deliver the new technologies we need to maximize domestic energy supplies, improve the environment, and fuel the economic prosperity of these United States.

Clean Energy

Blue skies, clear water, and crisp, fresh air. The benefits of clean energy are obvious and can be achieved by making fossil fuel use more environmentally friendly as we transition to greener technologies. NETL's researchers strive to make our most abundant energy resources—coal, natural gas, and oil—burn cleaner to protect our planet.

Southern Company carbon capture project, Mobile County, AL.

Now Operational: Largest, Fully Integrated Carbon Capture and Storage Project in the United States—The Southeast Regional Carbon Sequestration Partnership (SECARB) has completed integration of the capture, transport, and injection systems for CO_2 emitted from the Southern Company coal-fired James M. Barry Electric generating plant in Bucks, AL. After capture, the CO_2 is being transported to an injection well 12 miles away where it is stored in a saline aquifer within the Paluxy Formation over 9,000 feet deep.

SECARB is one of seven NETL-managed regional partnerships studying the viability of carbon capture and storage as a greenhouse gas mitigation strategy. Up to 550 metric tons of CO_2 per day are being captured and compressed at Plant Barry by Mitsubishi Heavy Industries, which receives no federal funding. Operations will continue for approximately 2 years, with subsurface CO_2 plume movement being monitored through 2017 to ensure safe and permanent storage.

As one of the SECARB Phase III large-scale field tests, this demonstration has brought together disparate industries to capture, pipeline, and inject anthropogenic carbon into a stable geologic formation, providing lessons learned as carbon capture and storage technologies move ahead.

Carbon Capture and Storage from Biofuels Production Is First in Nation—In the first demonstration-scale project in the United States to use CO_2 from a biofuels plant, the Midwest Geological Sequestration Consortium is capturing CO_2

Schlumberger technicians and rig crew lower the monitoring instrumentation into a well. Image courtesy of the Illinois State Geological Survey.

from Archer Daniels Midland Company's ethanol production facility in Decatur, IL. After compression, the CO_2 is injected 7,000 feet deep into the Mount Simon sandstone reservoir.

The project team plans to inject 1,000,000 metric tons over a 3-year period. As part of the U.S. Department of Energy (DOE) Regional Carbon Sequestration Partnerships program managed by NETL, the demonstration is led by the Illinois State Geological Survey. Schlumberger Carbon Services is also a project partner.

Since November 2011, over 380,000 metric tons have been injected into the Mount Simon sandstone. Lessons learned from this

project are proving highly valuable toward future CO_2 geologic storage projects.

Carbon capture and storage is a strategy for reducing the amount of CO_2 emitted into our atmosphere. CO_2 separated from the emission stream of industrial and power-production sources can be used beneficially or stored permanently in deep geologic formations. Geologic storage of CO_2 prevents the greenhouse gas from escaping into the atmosphere and contributing to climate change.

Polaris™ Post-combustion CO_2 Membrane—Membrane Technology and Research, Inc. (MTR) of Newark, CA, developed an alternative approach to cryogenics for separating CO_2 from flue gas produced through fossil fuel production. Subjected to more than 4,000 cumulative hours of field testing at 2 operating coal-fired power plants as part of an NETL-administered, Recovery Act-funded project, this polymeric spiral-wound membrane exhibited very encouraging results, with test values that fell within the upper range of the objectives for the project.

Based on the field-test data obtained through a preliminary technical and economic analysis completed with support from the Electric Power Research Institute and WorleyParsons, it was forecast that the MTR technology could capture 90 percent of the CO_2 in flue gas from coal-fired power plants with a 40–45 percent increase in the cost of electricity (COE)—not far from the programmatic COE target of 35 percent at 90 percent capture.

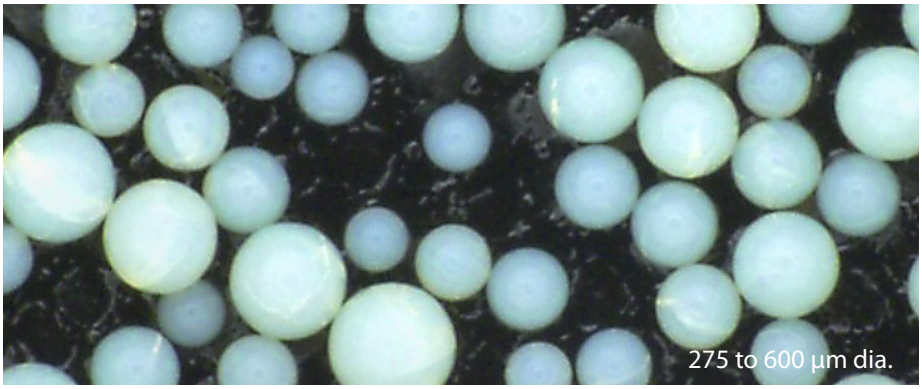
MTR engineers are now fabricating a pilot system that captures 20 tons of CO_2 per day, which will be subjected to a six-month period of validation testing.

The 8-inch diameter Polaris modules are installed in a membrane test system that was developed by MTR. Image courtesy of MTR.

DID YOU KNOW?

The Carbon Sequestration Leadership Forum (CSLF), an international body of 23 member nations dedicated to promoting the development and deployment of CO_2 capture and storage technologies, recognized and honored 3 NETL-supported projects in 2012: the Illinois Basin project, the Illinois Industrial Carbon Capture project, and the ARRA project in Pennsylvania with Air Products & Chemicals, Inc.

Clean Energy

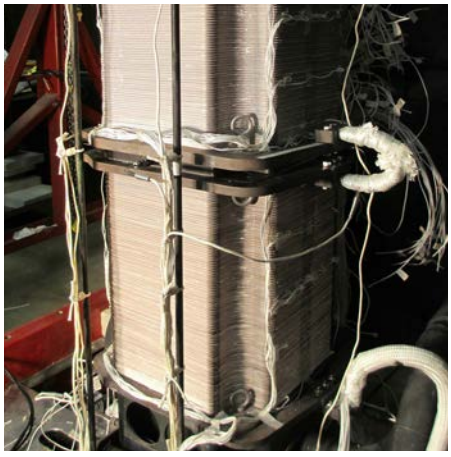


NETL won an Federal Laboratory Consortium award for its technology transfer efforts related to the CO_2-capturing BIAS process. This image shows one of several sorbents that are used during the process.

NETL-Patented Sorbent Exhibits Extraordinary Capacity for Removing Mercury, Arsenic, and Selenium from High-Temperature Syngas—Results of a 42-day test at the National Carbon Capture Center (NCCC) show that an NETL palladium-on-alumina sorbent removed virtually all of the mercury present in a slipstream of particulate-free sour syngas derived from gasification of Powder River Basin coal, and no breakthrough was observed.

The syngas was periodically monitored for mercury, arsenic, and selenium upon entering and exiting the sorbent reactor, and spent sorbent was analyzed for mercury and other elements. The extended exposure at 260 °C and 180 pounds-per-square-inch was the fifth in a series of increasingly challenging tests arranged by Johnson Matthey, technology licensee, to be conducted at the NCCC, which is operated by Southern Company in Wilsonville, AL. In each previous test, the R&D 100 award-winning sorbent removed nearly all of the trace contaminants. A sixth test is planned for 2013. Removing mercury and trace elements by sorbents at elevated temperatures preserves the high thermal efficiency of an integrated gasification-combined cycle power system.

Fuel Cell Designs Taking Shape for Central Power Generation—The Solid State Energy Conversion Alliance (SECA) Industry Team led by FuelCell Energy constructed and is now testing a 192-cell stack tower comprised of two 96-cell building blocks in which each cell has an active area of 550 square centimeters, making it the largest single Solid Oxide Fuel Cell (SOFC) stack ever operated. In previous tests, the tower's building blocks produced 16 kilowatts of DC power and exhibited a performance degradation rate of 1.4 percent per 1,000 hours during 3,500 hours of steady-state operation—well under the target limit of 2 percent per 1,000 hours. The tower design is the basis for a 60 kilowatt module incorporating most of the design elements used in scaling up to a 1 megawatt unit.



30 kW stack tower by FuelCell Energy. Image courtesy of FuelCell Energy.

Meanwhile, the SECA Industry Team led by LG Fuel Cell Systems has constructed and is testing a pressurized 20 kilowatt block that will serve as the basic repeat unit when scaling up to a 1 megawatt fuel cell system. After approximately 1,250 hours, the performance of this fuel cell block had degraded less than 1 percent per 1,000 hours. The same cell technology has been tested to over 16,000 hours in subscale test articles, also showing less than a 1 percent per 1,000-hour degradation rate. Screening has begun on next generation technology to improve long-term durability

SOFC achievements such as these are made possible with concepts and materials developed and evaluated by SECA Core Technology Program participants at universities, national laboratories, and businesses. For example, NETL demonstrated repeatable power density increases greater than 30 percent by infiltrating laboratory-scale cells with catalyst materials. Infiltration involves depositing a solution of catalyst precursors into a pre-sintered backbone of cathode material to form a discontinuous (particles) or continuous (film) coating upon thermal treatment. In addition to increased power density, extended performance tests lasting 1,500 hours showed enhanced stability—a key objective for achieving commercial viability of SOFC technology. This most recent success has attracted the interest of an industrial cell developer as well as a commercial firm for scaling up and supplying this innovative technology.

Dry Solids Feed Pump Opening New Avenues in Gasification—An innovative technology, developed by Pratt & Whitney Rocketdyne in collaboration with NETL, could make gasification more economically competitive by improving plant

Today's commercial dry-feed gasification systems are limited to processing pressures of about 450 pounds per square inch (psi); this novel pump more than doubles those pressures to 1,000 psi. Higher system pressures mean higher system efficiencies and less coal used to produce power and other products. Image courtesy of Pratt & Whitney Rocketdyne.

reliability, availability, and maintainability while additionally improving process efficiency and introducing low-rank Western coal as a viable feedstock option.

This first-of-a-kind, commercial-scale dry-solids feed pump prototype is designed as a reliable means of feeding coal directly into gasification processes operating at efficiency-boosting pressures without the energy penalty inherent with coal-water slurries. The prototype pump, commissioned by the Energy & Environmental Research Center in April 2012, will undergo 12–18 months of commercial-scale testing to determine the pump's flexibility in handling feed types, particle sizes, and pressure ranges.

If successful, Pratt & Whitney Rocketdyne will make the pump available to industry for commercial use, giving gasification the opportunity to make a difference in the economic and energy security of the United States and the world.

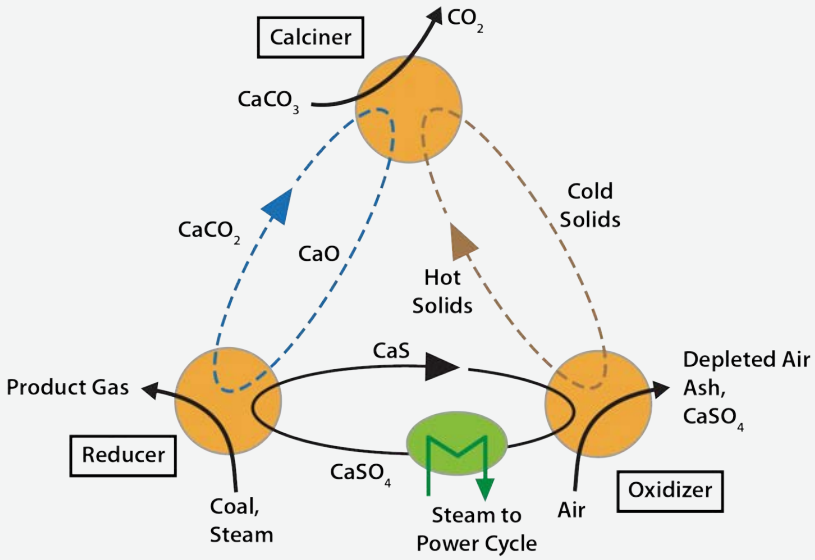


Diagram of the process for producing clean energy with limestone-based chemical looping.

Autothermal Operation Achieved for Limestone Chemical Looping Combustion—Researchers at ALSTOM Power have successfully achieved autothermal operation—self-sustained operation with coal, without external heat input—of their limestone chemical ($CACO_3$) looping combustion (LCL-C™) process.

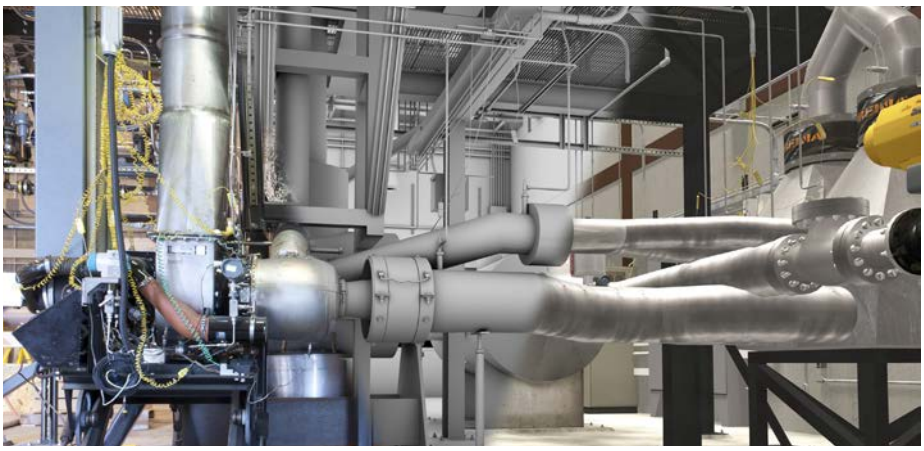
The ALSTOM process utilizes commercially proven circulating fluidized bed technology and low-cost, abundant limestone as both the oxygen carrier sorbent and sulfur capture reagent. The testing, which validated the process chemistry and technology concepts, was conducted in a 3-megawatt thermal prototype pilot plant.

This patented process allows electricity production with at least 90 percent CO_2 capture at the lowest cost and energy penalty to date and will enable the clean, cost-effective, sustainable use of coal in new and retrofit applications. This project was conducted under the DOE Carbon Capture program, which is managed by NETL.

SECA

The NETL-managed Solid State Energy Conversion Alliance (SECA) is a public/private partnership working to develop solid oxide fuel cell (SOFC) technologies for coal-fired central power generation. When fueled with syngas produced by the latest coal gasification technology, SOFCs can achieve 45–60 percent efficiency while capturing virtually all of the carbon contained in the coal feed.

Clean Energy

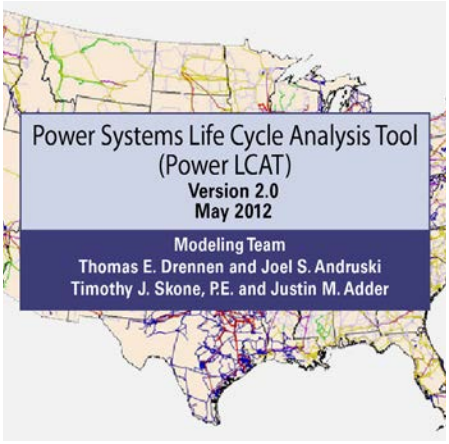


A virtual simulation of the Hyper facility shows the actual experimental facility (left), a 3-D scan of the experimental facility (middle), and a color-enhanced 3-D scan (right). This sequence of real data turned into virtual simulation is also representative of the process for inputting data from experimental runs into the virtual facility, allowing researchers to test advanced control strategies safely prior to implementation.

NETL Hyper-MESA Facilities Show Potential for a Clean Energy Future—Collaboration between NETL and Ames National Laboratory has led to innovative research and development of novel process control technologies to improve environmental performance and help reduce emissions during power systems operations.

With the NETL Crosscutting Research program taking the lead, this initiative is developing novel sensor placement and control methodologies to achieve seamless, integrated, automated, optimized, and intelligent power systems equipped for carbon capture and storage. This research endeavor will employ the NETL Hyper facility as a test platform for novel control approaches developed in partnership with Ames Laboratory as part of the Merged Environment for Simulation and Analysis (MESA) Lab project for power generation systems.

The MESA Lab—developed as a component of this research—will provide a platform for investigating sensor-placement algorithms, novel control strategies, sensor hardware, hardware-in-the-loop algorithms, and computational algorithms for improved plant performance.

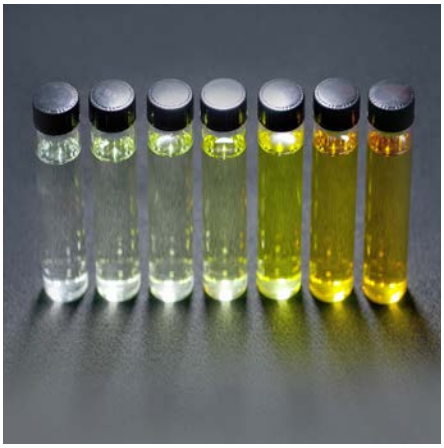


The novel Power LCAT, developed by NETL and Sandia National Laboratories, allows quicker, more versatile analyses of energy production technologies.

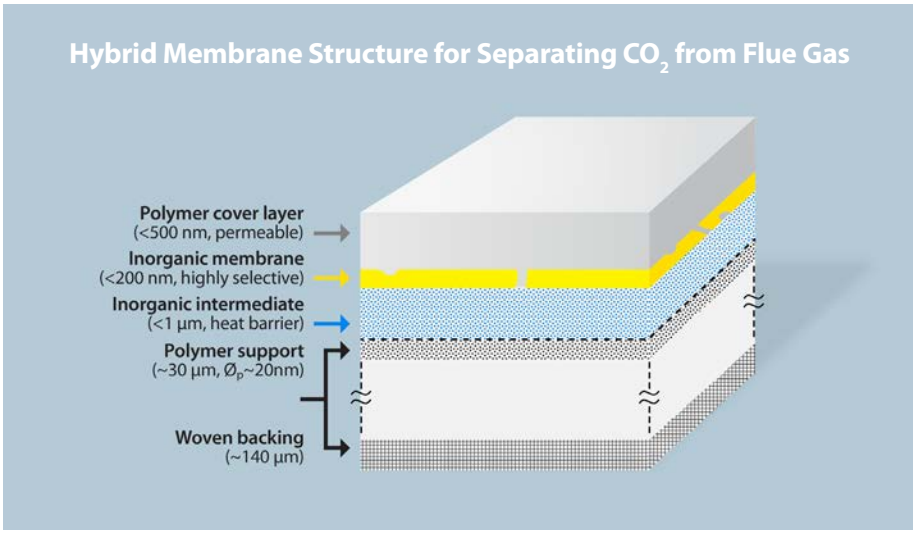
NETL Releases New Energy Analysis Tool—A new energy-production technology analysis tool available through NETL presents opportunities to help policy-makers, students, and interested stakeholders better understand the economic and environmental tradeoffs associated with various electricity production options. Developed in partnership with Sandia National Laboratories, the Power Systems Life Cycle Analysis Tool (LCAT) can be used to analyze the entire life cycle of an energy technology—from raw materials acquisition to final product transport.

Power LCAT covers a broad spectrum, with capabilities to compare 6 energy production technologies: natural gas combined cycle, integrated gasification combined cycle, supercritical pulverized coal, conventional pulverized coal, nuclear, and wind.

Based on NETL life cycle analysis reports, Power LCAT allows for a quick evaluation of sensitivities concerning key technical and financial assumptions, such as construction time; heat rates; capacity factors; fuel, capital, operations, and maintenance costs; and interest rates, taxes, and depreciation. For more information on downloading Power LCAT, visit the NETL Energy Analysis Models and Tools webpage.



Ionic liquids have properties, such as low vapor pressure, nonflammability, and a wide liquid temperature range, that make them useful in various applications, including synthesis, energy storage, and gas separation.



Schematic of the Ohio State hybrid membrane structure for separating CO_2 from flue gas. The membranes are designed to reduce energy costs associated with CO_2 separation.

NETL Demonstrates Synthesis Technique for Ionic Liquids for CO_2 Capture—Scientists at NETL have demonstrated a novel synthesis technique for ionic liquids that are designed for pre-combustion CO_2 capture.

The "one-pot" synthetic methodology produces a chemically diverse range of ionic liquids with good yields, high purity, and potentially lower costs than competing materials. Furthermore, the process allows researchers to examine how the physical and electronic changes in the ionic liquids relate to CO_2 sorption and separation properties. Consequently, the method may potentially reveal key structural relationships that give rise to high selectivity and high capacity in CO_2 sorbent materials.

Additional proof-of-concept was obtained by chemically modifying promising ionic liquids to form new materials with markedly different physical properties.

NETL Partner Develops Game-Changing Membranes for CO_2 Capture—From automobiles to x-ray machines, technology innovations usually fall into one of two camps: those that offer better performance than current state of the art and those that function more cost-effectively. A new CO_2 capture membrane developed at The Ohio State University with DOE funding is excelling at both and may be a game-changer for commercializing coal-fired power plants with carbon capture.

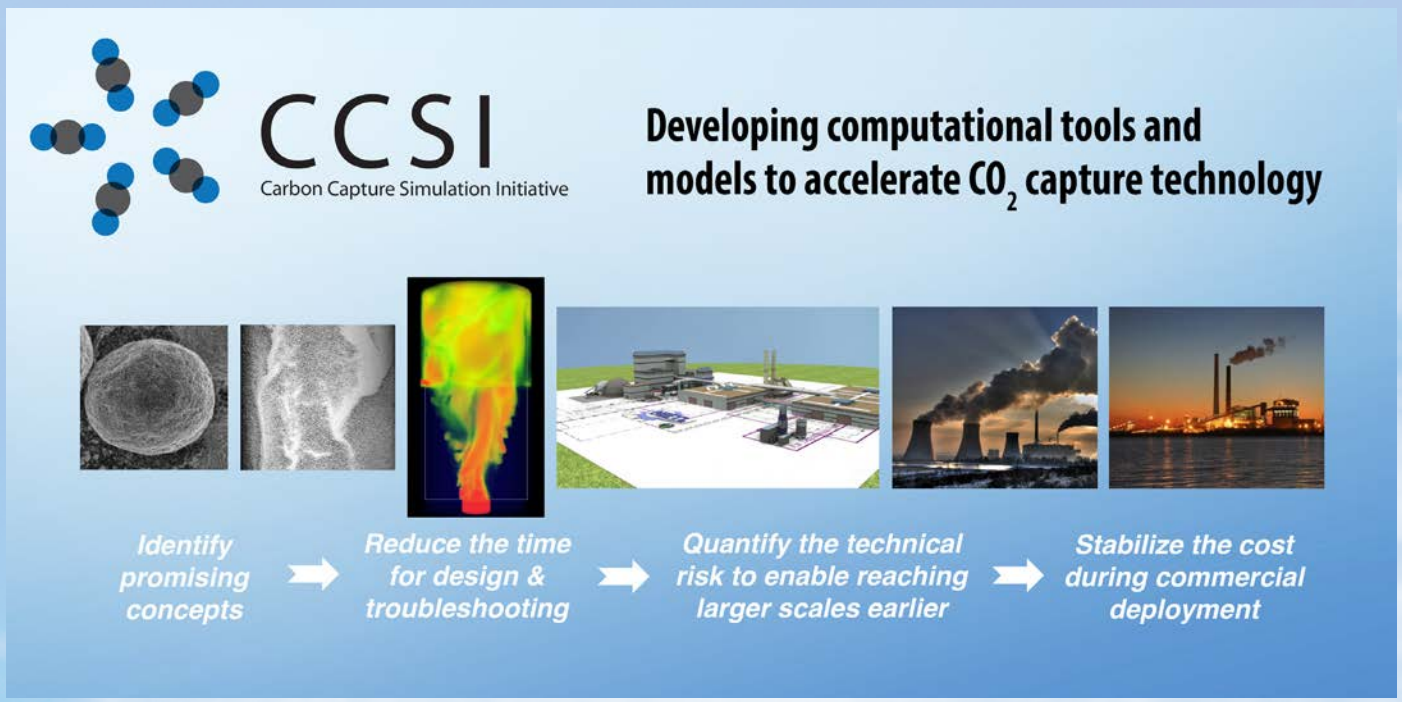
The new membrane combines the separation performance of inorganic membranes with the cost-effectiveness of polymer membranes. The Ohio State high-performance, low-cost hybrid model—consisting of a thin, inorganic "zeolite Y" layer sandwiched between an inorganic intermediate and a polymer cover—is a breakthrough that could potentially lower the costs associated with clean coal technologies, including carbon capture and storage (CCS).

CCS will be a key element in national efforts to mitigate climate change, but the energy cost of current separation technologies is too high for rapid commercial deployment. Because it is designed to eliminate most of the energy costs of separation, this new membrane could be a key player in enabling commercialization of CCS.

DID YOU KNOW?

Through NETL, Ohio State is testing chemical looping with coal to produce electricity. In their process, coal is reacted with iron oxide (instead of air) to produce heat. This process produces very little NO_x and yields a nearly pure stream of CO_2 that is easily captured.

feature article



NETL Tools Speed Ideas to Market

Carbon capture and storage—the capture of CO_2 at point sources, such as coal-fired power plants, followed by injection into permanent underground storage sites—are key components in our nation's strategy to manage CO_2 emissions. However, rapid deployment of carbon capture and storage technologies will require the development of new approaches to quickly scale up laboratory concepts for commercial deployment.

One approach to accelerating technology adoption is through the use of computational modeling, which involves developing and solving mathematical equations and computer codes to simulate the real-life behavior of engineered and natural systems. Computational models are developed to study and help solve problems in complex systems because they are able to consider the effects of multiple independent variables. The use of these models allows researchers to develop technologies in a more efficient, timely, and cost-effective manner. Computational modeling is being successfully used in a variety of disciplines, ranging from aerospace engineering to drug development and urban design. Meteorologists routinely use predictive computational models to provide our daily weather forecasts.

Several initiatives undertaken by NETL and its partners are using predictive computational modeling to address the challenges associated with CO_2 capture and storage. In 2012, the Carbon Capture Simulation Initiative (CCSI) and the National Risk Assessment Partnership--both public-private partnerships led by NETL–released their first set of software tools and models aimed at carbon capture technology development and CO_2 storage security.

CCSI Delivers First Toolset To Accelerate Carbon Capture Technologies

The first version of the CCSI Toolset, a suite of 21 computational tools and models, will 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 having early access to these tools.

The CCSI Toolset works with commercial and open-source software currently used by

industry and includes new software tools and models developed to fill technology gaps. The tools are highly versatile; in addition to their uses in developent of carbon capture technologies, they can be used to accelerate the development of related technologies used for refining, chemicals production, and oil and natural gas production. The Toolset has been well received by CCSI industry partners, with multiple partners executing nonexclusive licensing agreements.

Under NETL's leadership, CCSI was formed to provide technology developers and plant operators with a validated suite of models and simulation tools to accelerate the commercialization of carbon capture technologies from discovery to development, demonstration, and ultimately widespread deployment to hundreds of power plants.

The use of the Toolset could dramatically reduce the 20–30 years of development time usually required for commercial energy technology deployment. Further, the Toolset enables industry to use science-based models with pilot-scale data to reach larger scales more quickly and with greater confidence, thereby reducing the time and expense of scale-up.

NRAP
National Risk Assessment Partnership

NRAP Releases First-Generation Integrated Assessment Models for Risk Quantification

Full-scale carbon storage requires the injection of millions of tons of CO_2 into geologic formations. The effectiveness of carbon storage depends on the ability of a specific site to store CO_2 permanently. Carbon storage risk analysis is complicated by variables among geologic storage sites, such as geology, existing wellbores, and subsurface faults or fractures. In addition, the characteristics of a site change over time, as do the risks associated with it. A significant challenge to geologic carbon storage is predicting and addressing risks to the safety and health of our citizens, the environment, and individual property.

To address these concerns, NRAP was formed to develop and deploy state-of-the-art computational tools to accelerate commercialization of carbon storage technologies. The partnership has completed first-generation predictive models that, for the first time, offer a means to quantitatively forecast the probability of complications that could arise from specific CO_2 storage sites. The computational tools will be used to calculate risk profiles that not only quantify the likelihood of long-term risks and liabilities but also help design efficient monitoring programs for risk-based standards. The NRAP Toolset will benefit project operators in refining risk-based strategies and quantifying potential long-term liabilities, and stakeholders will benefit from knowing that a strong science-based approach has predicted long-term safety.

The NRAP project is led by NETL and leverages core capabilities in science-based prediction for engineered natural systems across five national laboratories, with participation also from the NETL-Regional University Alliance. In addition to development of computational tools, NRAP will also develop monitoring and mitigation protocols to reduce uncertainty in the predicted long-term behavior of a storage site.

NETL Publications

Much of what NETL gains through research and development is shared through online publications. Some of these include, Best Practices Manuals for carbon storage, the North American Carbon Storage Atlas produced through the North American Carbon Atlas Partnership, the National Carbon Sequestration Database and Geographic Information System (NATCARB), and the NETL Energy Data Exchange (EDX).

Reliable Supply

Our nation is brimming with natural resources available to fuel our energy needs. As our demand for energy increases, production, too, must increase. Modeling and monitoring ensure more efficient energy production so we can maximize our resources while minimizing environmental impact.

Field Trial Moves Our Nation Closer to Tapping Methane Hydrate and Managing Carbon Emissions—In April 2012, ConocoPhillips, the Japan Oil, Gas and Metals National Corporation, and NETL completed an unprecedented demonstration of natural gas extraction from what could become an extremely significant energy resource—methane hydrate.

At a test well on the Alaska North Slope called Iġnik Sikumi ("fire in the ice" in the Inupiaq language), ConocoPhillips scientists and engineers safely produced a steady flow of natural gas using the company's laboratory-tested method of trading CO_2 for methane. This was the first field trial of methane hydrate production using CO_2 exchange, which the team hopes will eventually couple the production of methane hydrate as an energy source with the permanent storage of CO_2 to address climate change.

The long-term goal of DOE's methane hydrate research is to develop safe, reliable, affordable methods for tapping the natural gas that lies within these structures. Estimates show that the energy content of methane hydrate deposits exceeds that of all other fossil fuels combined and could help meet our nation's energy needs for decades to come.

When ice molecules form a series of cages with natural gas locked inside, the structure is known as methane hydrate. Some have nicknamed it "fire in the ice."

One-of-a-Kind Well Pad Monitor Set To Protect Air Quality During Marcellus Shale Gas Recovery—A team of NETL-Regional University Alliance (NETL-RUA) researchers has designed and field-tested a portable monitoring system that can help ensure that Marcellus shale drilling sites comply with environmental regulations.

NETL-RUA's Marcellus shale gas well monitor is carried in a portable case and is powered by the sun. Image courtesy of C. Tatachar, WVU Office of Research.

The system is capable of measuring dust, volatile organic compounds, light, and sound coming from well pad operations and is unique in its usability. Its radio transceiver, monitoring device, and battery are packaged in a case small enough to be carried on an all-terrain vehicle and handled by a single technician. A 2- by 5-foot solar panel, also easily managed by one person, powers the system, which is monitored remotely via cell phone signal from its operator's office computer.

Thousands of Marcellus shale gas wells have been drilled or permitted across the northeastern United States, and effective environmental monitoring is essential to the responsible management of this important energy resource.

The monitoring system developed by the NETL-RUA is designed to be inexpensive, off the shelf, and useful in a wide variety of drilling contexts. With it, well operators will be able to track the impact of their operations around the clock to detect and address problems early on.

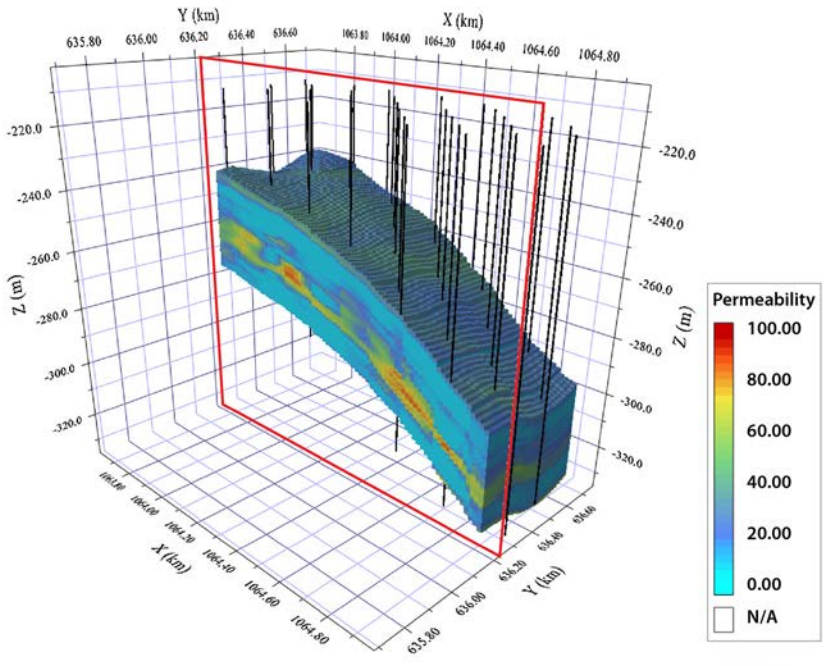
Dynamic Line Rating Improves Infrastructure—An NETL-managed project is demonstrating and validating best practices for collecting real-time transmission line data and is developing a dynamic rating based on the line loading (the current), solar radiation, ambient temperatures, and wind blowing across the conductors.

As part of this demonstration, Oncor Electric Delivery Company is streaming dynamic line rating data to their internal grid operations control room and also to the

A dynamic line rating system gives operators an accurate, in-the-moment measurement of how much power a line may safely carry. Image courtesy of Oncor Electric Delivery Company.

Electric Reliability Corporation of Texas for real-time assessment of eight transmission circuits within the Texas grid. The results are used in the Security-Constrained Economic Dispatch process, which gives grid operators an accurate, in-the-moment measurement of how much a line is sagging and how much more power can be pushed through the line.

As power demands grow, dynamic line rating will allow operators to provide more power to homes, businesses, and industry using the transmission infrastructure in place today. The project, which is part of DOE's Office of Electricity Delivery and Energy Reliability Smart Grid Demonstration program, is the largest known installation of dynamic rating equipment.



Permeability model visualization for Section 32 in Bridgeport Reservoir.

Chemical Synergy Increases Illinois Basin Oil Production—Working with University of Illinois researchers and NETL, operators for Rex Energy Corporation (Bridgeport, IL.) reported that use of an alkali-surfactant-polymer (ASP) formulation increased the effectiveness of water flooding in a 15-acre test field in the Lawrence Field of the Illinois Basin, leading to a rise in oil production. Researchers injected into the reservoir an alkali and a surfactant to reduce the tension between the oil and injected water, and also a polymer to control the oil's mobility. This helped release the oil that was previously difficult to extract, increasing yield from 16 barrels per day to 65–75.

Like other mature U.S. fields, Lawrence is approaching its limit of economically recoverable crude, despite the significant amount of oil remaining in its formations, having exceeded the extraction capabilities of traditional oil recovery methods. Using ASP floods, an estimated 130 million barrels of oil could be recovered from the Lawrence Field.

Reliable Supply

First-of-a-Kind Smart Grid Proves Highly Effective—Engineers at Chevron Energy Solutions, a subsidiary of Chevron Corporation, successfully integrated existing backup generators and solar, wind, and fuel cell power with a battery bank and upgraded older equipment to new energy-efficient equipment at the high-security Santa Rita Jail in Alameda County, CA.

This new Consortium for Electric Reliability Technology Solutions (CERTS) power-management system allows the 113-acre facility to operate independently from the electrical grid for several hours and reduces peak demand at the facility by about 15 percent. The first-of-its-kind smart grid ensures uninterrupted power while shaving approximately $100,000 from peak-hour operational costs, improving grid stability, and avoiding the emission of 3,200 tons of greenhouse gases per year.

NETL managed implementation of the CERTS microgrid technology, which monitors and controls the system. CERTS demonstrations pave the way for future commercial applications and benefit the economy by reducing the peak load burden on the grid.

The battery bank at the Santa Rita Jail contains between 100 and 200 individual batteries connected as a system capable of powering the facility for up to 8 hours independent of the electrical grid. Image courtesy of Chevron.

New LED Driver Enables Solid-State Lighting Advancement—A project managed by NETL on behalf of the Office of Energy Efficiency and Renewable Energy is producing illuminating results.

The new drivers from Philips Lighting boast 90 percent energy efficiency. Image courtesy of Philips Lighting Electronics of North America.

Philips Lighting Electronics of North America, located in Rosemont, IL, has developed a new family of light-emitting diode (LED) drivers for use in a wide variety of LED lighting applications, including outdoor applications. The new drivers are switch-mode power supplies and boast design improvements over today's drivers that render them smaller and more cost-efficient. Additionally, the new drivers are expected to have efficiencies of 90 percent or higher, a notable advancement.

Driver efficiency, along with thermal and light-extraction efficiencies, are key elements in making highly advanced solid-state lighting (SSL) luminaires. By 2030, SSL could potentially reduce national lighting electricity use by nearly one half—representing the output of 50 1,000-megawatt power plants and an annual savings of $30 billion (2012 dollars).

Hydrogen Turbine Critical to Clean Power Production—NETL's Hydrogen Turbine program's industrial partner, GE Energy, has successfully completed full-scale testing of the pre-commercial high-hydrogen turbine combustion system intended for coal-based integrated gasification combined cycle power generation. The system incorporates a new premixed fuel injector design essential for developing gas turbine technologies

Turbines have been the world's energy workhorses for generations. They are needed to provide secure power production that is clean, efficient, and affordable, and they are adaptable to CO_2 capture as well.

that support reliable, affordable, and environmentally friendly electric power generation.

The testing exceeded the program's requirements for low-NO_x emissions at specific firing temperatures and validated a manufacturing process that has potential for industrializing future combustion hardware—a key step toward commercializing the technology.

The turbine nozzles used in the full-scale testing included more than a dozen enhancements derived from computational modeling and combustion rig test experiments included in the NETL-funded Hydrogen Turbine Development project. The cumulative technology research and development has improved mechanical design, manufacturability, emissions, and operability of the complex turbine combustion system.

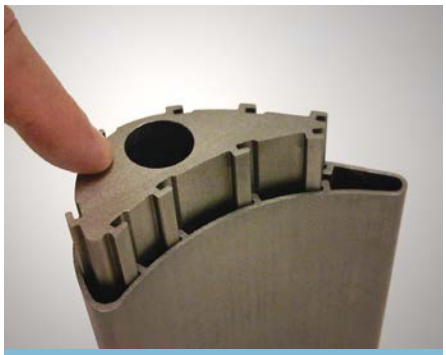
Innovative Compressor Design Has Potential To Extend Productive Life of Stripper Wells—With funding from the NETL-supported Stripper Well Consortium, OsComp Systems has developed a low-cost, wet-gas compressor at laboratory scale. The compressor design decreases the energy required to compress and transport natural gas, lowers operating costs, and improves efficiencies of well site operations.

Conventional compressors are not optimized to handle wet gas, but OsComp's hybrid

Prototype testing showed the hybrid compressor's efficiency is more than 30 percent higher than conventional compressor technology. It is also one-tenth the size, so it reduces the overall footprint of well site operations.

compressor uses an advanced rotary design coupled with gas-cooling capabilities that allow it to handle wet or dry gas. The innovative technology is capable of exceeding a 40:1 compression ratio, uses less fuel gas than previous compressors, and dramatically reduces the footprint of compression operations. In addition to its use for stripper wells—wells that produce less than 10 barrels of oil or 60,000 cubic feet of gas per day—the technology could be applied to small-scale liquid natural gas, enhanced oil recovery, mobile compression, sour aggressive gas, and compressed natural gas for the refueling industry.

The success of this collaboration has earned OsComp two additional projects to explore further development of the compressor technology and to perform field demonstrations through NETL-supported programs.



Promising New Turbine Airfoil

Florida Turbine Technologies, Inc., is developing their proprietary spar-shell concept as part of an NETL-administered Small Business Innovation Research Phase III project for improved blade cooling and overall performance in next-generation gas turbines. The spar-shell cooling technology, which is expected to improve the efficiency of gas turbines, will be demonstrated in the first stage of a Siemens 208 megawatt SGT6-5000F engine at Siemens' Berlin test facility in 2013.

feature article

Ultra-deepwater and Unconventional Resources

AltelaRain unit modules and treatment towers. This technology is now treating wastewater from Marcellus shale activities, making extraction of this resource more environmentally sound.

Research Demonstrates the Breadth of NETL's Energy Commitment

NETL has a long record of initiating technologies that make producing our fossil energy resources safer, cleaner, and more economic. Our nation relies on the energy produced by fossil fuels for more than 80 percent of our energy needs, so we can't do without them at the present time. But we must make their production and use safe and environmentally benign.

Addressing Hydraulic Fracturing

In the area of unconventional resources, a technology known as hydraulic fracturing (fracking) is unlocking abundant supplies of domestic natural gas. However, the practice is also generating environmental concerns, which NETL is addressing in a variety of ways. For instance, fracking requires water, which picks up various salts and contaminants during the process. This "produced water" must be treated to remove pollutants before it can be reused or discharged into the environment.

A water-treatment technology validated by NETL is being used by Altela, Inc., in the two water treatment plants they opened in Pennsylvania in the fall of 2012. The plants provide low-cost and environmentally friendly treatment, recycling, and disposal of liquid waste from hydraulic fracturing well operations. Altela's unique, patented water desalination process, called AltelaRain®, cleanses produced water so that it exceeds the Pennsylvania Department of Environmental Protection's Chapter 95 water quality requirements. Each of Altela's water treatment facilities can process up to 12,000 barrels of wastewater per day—about 500,000 gallons per facility.

In a separate 2012 project involving hydraulic fracturing, NETL researchers observed and monitored fracture growth through borehole microseismic measurements during an active hydraulic fracturing job. Using these observations, along with geomechanical properties corresponding to the Marcellus and adjacent formations, NETL verified that hydraulically generated fractures behaved as predicted by commercially available fracture models and remained thousands of feet below drinking water aquifers. The results were reported in the Society of Petroleum Engineers' journal *Production & Operations* (Volume 27, Number 1, pp. 8–19). Next steps for the project involve developing models that can account for the behavior of pre-existing fractures as well as considering the potential for generated fractures to intersect pre-existing (legacy) wellbores, features that currently are unavailable through commercial software.

DID YOU KNOW?

FracFocus, a national hydraulic fracturing chemical registry, was developed with NETL support by the Ground Water Protection Council and the Interstate Oil and Gas Compact Commission. By December 2012, 9 states had endorsed FracFocus for regulatory compliance and over 34,000 well records were registered and available publically, along with fracturing regulations and technology information.

Shown ready to be launched, the autonomous underwater vehicle "Marlin" performs inspections of undersea energy platforms faster, safer, and more affordably than previous inspection methods. Image courtesy of Locheed Martin.

Working with RPSEA

The Energy Policy Act of 2005 instructed the Department of Energy to identify a consortium that would implement a research program to develop, demonstrate, and bring to commercialization technologies for the exploration and production of ultra-deepwater and unconventional natural gas and other petroleum resources.

Under DOE, NETL selected the Research Partnership to Secure Energy for America (RPSEA), a consortium now numbering over 180 members, to initiate and manage proposals approved by the Office of Fossil Energy for supporting companies to accomplish the goals set by DOE. Safety and environmental sustainability are underscored for all proposals considered.

As part of RPSEA's ultra-deepwater research and development portfolio, Lockheed Martin developed an autonomous underwater vehicle (AUV) capable of remotely inspecting subsea drilling and production structures up to four times faster than other methods—and at significantly lower cost. Called the Marlin®, this AUV contains unique 3D imaging sonar, advanced sensors, software, and special navigation capabilities that allow surface operators to direct the AUV to rapidly inspect structures up to 1,000 feet beneath the surface.

The 10-foot long AUV is highly maneuverable and able to operate in tight spaces, sprint up to four knots, and cruise for up to 18 hours, all without endangering divers or operators of tethered undersea inspection apparatus, traditional inspection methods. Before the Marlin, when a maintenance issue arose or weather damage occurred in an oil or gas rig, companies needed two weeks or more to adequately inspect their rigs and pipelines before production levels could return to normal. This translates into lost productivity for those companies. Now the Marlin can quickly generate accurate, high-resolution, 3D, geo-referenced models, giving users a clear view of subsea structures. Two Marlins are currently available for lease from Lockheed Martin.

RPSEA also has projects in unconventional resources. One project—an important study completed in 2012 by the University of Texas–Permian Basin (UTPB)—shows that residual oil zones, called ROZs, below the water-oil contact in reservoirs in the Permian Basin in New Mexico and Texas may contain up to 100 million barrels of oil that potentially could be recovered to increase domestic supply, reduce imports, and increase U.S. energy security.

Ordinarily, oil wells—including those in ROZs—are capped and abandoned when oil production falls below the point of profitability. However, UTPB researchers were able to better identify and characterize these untapped ROZs and determined that this immense resource is amenable to enhanced oil recovery techniques, such as CO_2 flooding. This is only one of several Office of Fossil Energy-supported RPSEA research projects that will help recover this valuable resource.

These and many other ultra-deepwater and unconventional oil and natural gas projects underway at NETL demonstrate the Laboratory's commitment to investigating, researching, developing, and assisting in the commercialization of state-of-the-art technologies to make our nation's energy affordable, available, and environmentally safe.

Science & Technology Leadership

As the ENERGY lab, NETL strives for solutions to our nation's energy challenges. Making our accomplishments available to companies large and small leads to technological advances that benefit the public through secure and affordable energy options.

Licensing of Sorbent Technology Promises To Save Energy and Money for Consumers—An NETL-developed solid sorbent technology is being used in the first commercial retrofit system that removes CO_2 and organic contaminants from circulating air in commercial and public buildings, saving energy and improving air quality.

Boston-based start-up Enverid Systems, Inc., will incorporate the sorbent as the CO_2-removal mechanism in its EnClaire™ system, a technology designed to reduce the need for air replacement in heating, ventilation, and air conditioning (HVAC) systems. Current commercial sorption processes require high-temperature regeneration, making them energy intensive and costly. In contrast, NETL's sorbent regenerates at low temperature, saving energy and lowering costs.

HVAC is one of the largest draws of electric power in the United States. In many cities, it represents more than half the power load on the electric grid. During peak daytime hours, especially during extreme weather, HVAC demands can stress the grid and contribute to power failures and rolling blackouts. Many efforts are underway to improve the efficiency and reduce the power consumption of HVAC systems.

Smart Grid Workforce Training Produces Successful Graduates—NETL has served as the project management organization on 52 American Recovery and Reinvestment Act (ARRA) smart grid workforce training projects awarded in 2010 and worth $195 million.

The training program provides an opportunity to facilitate the development of a well-trained, highly skilled workforce capable of implementing a national clean-energy smart grid. It provides a chance for colleges and universities, including community colleges, to develop new curricula and training activities in areas needed to achieve the next generation of skilled technicians, engineers, and managers for the electric power workforce.

Smart grid workforce training projects increase workforce capacity and capabilities by addressing skills shortages in a variety of power sector disciplines.

The Strategic Training and Education in Power Systems (STEPS) initiative focuses on cross-disciplinary electric power systems training programs leading to degrees or certificates that span the breadth of science, engineering, social science, and economics to help transform the traditional power system into a national smart grid. The program boasts over 55,000 students, with over 17,000 graduates in 2012 alone and will have additional student participation and graduations in 2013 and 2014.

Delta Air Lines is evaluating nanocoatings to protect compressor blades in their aircrafts' engines.

NETL Research Results in New U.S. Patents—Researchers at NETL received nine patents in 2012 for innovations that address the nation's energy challenges. Deployment of these technologies will enhance energy efficiency, improve metallurgical processes, and allow for better emissions monitoring and control. Here are NETL's 2012 patents:

- An integrated process for removing pollutants from fossil fuel combustion systems.
- Two patents related to stainless steel compositions and heat treatment processes to enhance stainless steel durability.
- A metallurgical melting process to produce defect-free metal ingots.
- Three patents related to catalysts that make it easier to reform hydrocarbon fuels.
- A method to measure the circulation rate of coal solids in gasification reactors.
- A process for CO_2 separation and purification.

NETL pursues patent protection for NETL-developed technologies to protect U.S. taxpayers' investment in energy-related research. The NETL Technology Transfer Office manages the process, identifying those technologies with the greatest commercial potential. The office also fosters the development and deployment of new technologies by moving inventions from the laboratory into the commercial marketplace. These activities lead to cleaner air, more efficient power plants, and lower energy production costs—all of which have a direct impact on U.S. energy consumers.

NETL-Industry Collaboration Helps Nanocoating Technology Take Off—During aircraft operation, gas turbine engines are continuously exposed to erosive environments that damage engine components and impair operating efficiency. To address this issue, researchers at MDS Coating Technologies designed and optimized a wear-resistant nanostructured coating that has been demonstrated to reduce erosion of compressor airfoils in aeroturbines, leading to increased fuel efficiency.

Development of this technology was supported by Energy Efficiency and Renewable Energy's Nano-Manufacturing Initiative. The project was a collaboration between NETL's Office of Research and Development and MDS.

In 2012, MDS received Federal Aviation Administration approval, allowing for application of the coating to commercial aviation engines. Delta Air Lines plans to apply the coating technology to a portion of their fleet engines in 2013. The nanocoating promises the U.S. commercial aviation industry significant fuel savings. Considering that U.S. commercial aviation is projected to consume an average of approximately 19 billion gallons of fuel per year from 2013 through 2022, U.S. commercial aviation could realize fuel savings approaching 100 million gallons annually and cost savings greater than $300 million per year at today's jet fuel prices.

feature article

How Regional Coordinators from NETL Keep Energy Flowing

In October 2012, Hurricane Sandy made landfall in New Jersey, impacting the most densely populated area of the United States. The Superstorm was one of the strongest to hit the northeast in decades, causing billions of dollars worth of damage.

NETL employees were called in to assist with the post-storm disaster response and recovery. Jay Hanna and Bob Reed are the regional coordinators for DOE's emergency responses under the Office of Electricity Delivery and Energy Reliability in FEMA Regions II (NY, NJ, Puerto Rico, and U.S. Virgin Islands) and III (DC, PA, DE, WV, VA, and MD), respectively—the areas battered most by the storm. Rob Gross, Katy Kweder, and Ryan Watson, regional or backup coordinators for other regions, reported to stations in the worst of the damaged areas to help Jay and Bob.

Their response focused on restoring electricity service to the 8.5 million customers who lost power and addressing critical fuel shortages—which exacerbated the overall recovery effort—caused by damage to the petroleum infrastructure near New York Harbor and Long Island. The storm made landfall just a few days before the election, adding additional complexity to the response effort, as many of the usual polling locations became temporary shelters and mass feeding locations.

Jay was deployed to the FEMA Region II Regional Response Coordination Center (RRCC) and the Joint Field Office in New Jersey 3 days before the storm made landfall. For 19 straight days, Jay supported federal response operations and returned later for an additional week of recovery work. He and the other federal responders worked 18-hour days and slept under their desks, in supply closets, and in their cars when not on duty during the early part of the response effort. Although conditions eventually improved, there was still little fuel for the responders' cars, and the hotels, restaurants, and other businesses had no electricity. Even with these difficulties, Jay coordinated energy issues with other federal responders to help with emergency medical support, feeding and sheltering survivors, providing emergency backup power to critical facilities, ensuring fuel was available for first responders, and helping with other vital activities. Additionally, Jay communicated the status of the energy sector to other responders and government leaders, helping speed other sectors' return to normalcy.

Early predictions for the path of the storm and potential for impact to Region III meant that FEMA activated their RRCC in Philadelphia, PA, several days before landfall. Bob and Rob, the regional coordinator for the Gulf Coast portion of Region VI—covered the RRCC's 24-hour operations during pre-landfall and through several days after landfall. The major impact for Region III was in eastern Pennsylvania and West Virginia, both of which handled emergency response with state resources. Soon, Rob was deployed to FEMA Region II's RRCC in Colts Neck, NJ, to assist Jay before transitioning to the state's Emergency Operations Center in Trenton. He remained there for the duration of his deployment.

Katy—the regional coordinator for Region IV, the southeastern United States—assisted Jay at New York's state operations center in Albany, focusing on problems in New York State, and she was later deployed to the New York joint field office in Queens for additional recovery work. Ryan—Katy's backup for Region IV—was deployed to New York for a week to help develop the long-term recovery plan for the New York energy infrastructure.

For the first time since Jay became a regional coordinator 8 years ago, he needed to help coordinate military air transport of restoration crews from Energy Department Power Marketing Agencies from the western United States to assist utilities with the most significant electricity infrastructure damage. Overall, about 200 of these crews and their trucks, cranes, and other equipment entered the region, supplementing the other private-sector crews, to facilitate restoration of electricity, most notably on substation and transmission facilities.

Although NETL involvement in disaster recovery is not well known, it hasn't gone unnoticed. In particular, Jay received the Secretary's Appreciation Award from Energy Secretary Steven Chu for his efforts.

"Superstorm Sandy was especially bad because it impacted our homes and families, too," Jay said. "It was tough on everyone, not just the responders, but I'm happy that I could make a difference to those who saw the most storm damage."

During the tidal surge on the northern barrier island of New Jersey, corrosive saltwater, mud, sand, and debris flooded the substations. With significant assistance from substation electrician crews from DOE's Bonneville Power Authority, components in the substations were cleaned, refurbished, or replaced so power could be restored to the vicinity following the Superstorm.

Houses on the northern barrier island of New Jersey were destroyed by the tidal surge from Superstorm Sandy.

Technical Awards

Accolades recieved by the Laboratory confirm that our research successes benefit the nation. Prestigious awards conferred to NETL in 2012 honor our technologies and our researchers who propel energy science toward a brighter tomorrow.

NETL-RUA researcher John Kitchen stands with Secretary of Energy Steven Chu and White House Science and Technology Advisor John Holdren after being presented with a 2012 PECASE award.

NETL-RUA Engineer Earns Presidential Award—NETL-RUA researcher Dr. John Kitchin of Carnegie Mellon University's Department of Chemical Engineering was awarded a 2012 Presidential Early Career Award for Scientists and Engineers, or PECASE, for his work in carbon capture technology development.

PECASE awards are the highest honor bestowed by the U.S. government on outstanding scientists and engineers in the early stages of their research careers. Awardees are selected for their pursuit of innovative research at the frontiers of science and technology and their commitment to community service.

Dr. Kitchin was recognized for being the first to electrochemically separate oxygen from air using an alkaline ion exchange membrane. This advance could replace cryogenic air distillation as a more affordable method of producing oxygen for oxycombustion power generation, one of the most promising technologies for helping to cut CO_2 emissions in fossil-based power plants to nearly zero.

During the presentation ceremony at the White House, President Obama met with Dr. Kitchen and 95 other 2012 PECASE winners, saying "Discoveries in science and technology not only strengthen our economy, they inspire us as a people. The impressive accomplishments of today's awardees so early in their careers promise even greater advances in the years ahead."

NETL Captures Three Sustainability Awards—DOE challenged employees to meet sustainability goals by initiating environmental, energy, and economic improvements. NETL staff exceeded these goals, earning three Departmental Sustainability Awards for its efforts.

Gregg Sawl was recognized as an Exceptional Service/Sustainability Champion in his role as NETL's energy manager. His commitment to sustainability was evidenced in a variety of new construction projects and energy management initiatives, and through renovations to meet federal guidelines for sustainable buildings. Under Sawl's leadership, NETL reduced the energy intensity of its buildings by 23 percent.

In the Environmental Management System category, the NETL EMS/Sustainability Team earned an award by implementing and

Since its dedication in 2008, the Technology Support Facility at NETL's Morgantown, WV, site has received a gold rating from the U.S. Green Building Council certifying Leadership in Energy and Environmental Design and was recognized as a top-performing building in energy conservation.

reaching goals within its own environmental management system. Along with other accomplishments, NETL reduced routine nonhazardous waste by 15 percent, hazardous waste by 30 percent, and direct and indirect greenhouse gas emissions by 13 percent.

The NETL Site Operations Division earned a Water Resources award by exceeding the 2020 water intensity reduction goal of 26 percent—9 years ahead of schedule. The Lab's water intensity was slashed 44 percent through site-wide reductions in potable water usage, incorporation of closed-loop cooling systems, development of rainwater harvesting systems, and other initiatives.

Paul Turner accepts the Secretary of Energy Achievement Award from Dr. Stephen Chu on behalf of the NETL Coronary Stents Team.

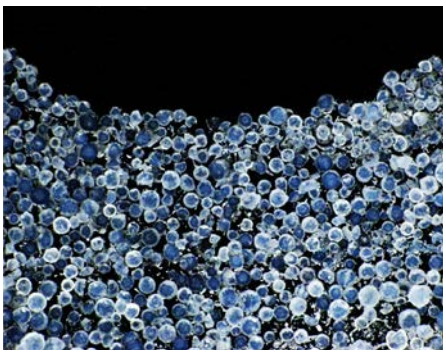
NETL Team Earns U.S. Secretary of Energy Achievement Award—NETL's Coronary Stents Team was recognized with a U.S. Secretary of Energy Achievement Award for exceptional performance in carrying out DOE's mission.

The team was honored for its work in formulating a unique platinum-chromium stainless steel alloy that served as the basis for a new generation of coronary stents used to treat patients with coronary artery disease. The NETL team, Paul Turner, Paul Jablonski, and Ed Argetsinger, jointly developed the alloy with Boston Scientific, which then designed an advanced stent that is stronger, thinner, more flexible, and easier to see on x-ray than conventional stents.

Since its introduction in 2010, Boston Scientific's platinum-chromium stent series has become the leading stent platform in the world, with more than $4 billion in sales. Its development has created 300 new jobs at Boston Scientific and 150 jobs within the company's manufacturing and distribution networks, all of which are located in the United States.

Each year, the Secretary of Energy presents Honor Awards "to those within our workforce who have risen to the challenge and achieved notable mission successes during the previous year." The Honor Awards, one of which is the Achievement Award, are the highest internal, non-monetary recognition DOE employees can receive.

NETL's BIAS Process Earns R&D 100 Award—Producing clean energy is a compelling issue that can only be solved by innovation. Every year there are new energy challenges, and every year NETL works to create solutions. In 2012, one of these solutions was recognized by *R&D Magazine* as among the 100 most technologically significant products introduced into the commercial marketplace. Earning the Laboratory an R&D 100 Award was its Basic Immobilized Amine Sorbent (BIAS) process, encompassing a portfolio of patented and patent-pending sorbent technologies for the capture of CO_2 from flue gas streams.



NETL's award-winning BIAS sorbents increase the capture rate of CO_2 in fossil fuel power plants, a key approach to reducing carbon emissions and mitigating climate change.

Many power plants lack the technology required to produce the cleanest forms of energy. But the application of NETL's low-cost, regenerable amine-based sorbents offer many advantages over existing CO_2 capture technologies: increased CO_2 capture capacity, reduced corrosion, lower energy requirements and costs, and minimized water usage. The process can also be retrofitted to older power plants that currently burn coal, as well as applied to new, more efficient pulverized coal-fired power plants.

While primarily envisioned as a post-combustion CO_2 capture method for power generation point sources, BIAS sorbents also show potential for other applications, such as natural gas cleanup, systems for life support and/or entering confined spaces, and air-capture systems.

NETL-RUA
Regional University Alliance

DID YOU KNOW?

The NETL-Regional University Alliance (NETL-RUA) is an applied research collaboration that combines NETL's expertise with the broad capabilities of five nationally recognized universities—Carnegie Mellon, Penn State, the University of Pittsburgh, Virginia Tech, and West Virginia University—and URS Corporation. This partnership joins facilities, equipment, professional staff, and other resources to accelerate the development of innovative energy and environmental technology.

A Legacy of Benefit

Taking NETL Technology to Market

Since our laboratory's earliest research days, transferring technology from development to demonstration to commercialization has been at the heart of NETL's mission.

We have confronted each decade's most pressing fossil energy challenges and pursued innovations that companies could take to market to benefit us all. Looking back, we see that our efforts have increased domestic energy supplies and reduced pollution while keeping costs in check. They have also stretched the boundaries of science and engineering to provide other benefits equally important to our nation's citizens.

Here is an historic look at some of our most significant accomplishments from the last quarter-century.

Shale Gas Recovery

Widely recognized as having helped stimulate today's shale gas boom, three decades of NETL-supported research led to the commercialization of horizontal drilling, hydraulic fracturing, microseismic monitoring, and other technologies needed to recover hard-to-reach shale gas plays. In 2011, shale gas production accounted for nearly 32 percent of the dry natural gas produced in the United States and has saved the U.S. economy nearly $400 billion over the last 4 years.

Coronary Stents Alloy

In 2000, NETL was asked by Boston Scientific to develop a new material for coronary stents. We delivered a unique platinum-chromium alloy that laid the groundwork for a new line of Boston Scientific stents that are strong, flexible, and highly visible on x-ray. Since its introduction in 2010, the series has become the leading stent platform in the world.

Acid Rain Mitigation

When acid rain became the number one environmental threat of the 1980s, NETL tackled the problem through programs that developed and demonstrated such solutions as wet scrubbers and advanced combustion control systems. These and other technologies with roots in NETL programs are now used in 75 percent of U.S. coal power plants to control sulfur dioxide and nitrogen oxide emissions. Largely as a result of our efforts, these acid rain precursors have been dramatically reduced and the effects of acid rain neutralized across much of North America.

Enhanced Oil Recovery

To increase domestic energy supplies, NETL has dedicated resources to the science of enhanced oil recovery. From waterflooding to CO_2 injection to thermal and chemical treatments, our laboratory investigations and field demonstrations have helped bring these technologies to market. Today, enhanced oil recovery contributes more than 10 percent of U.S. crude oil production, and that percentage will continue to grow as primary and secondary oil resources become scarcer.

Coalbed Methane Recovery

Methane trapped in our nation's coal seams once posed a deadly hazard to miners. When found, it was burned off or vented into the air, contributing to industrial greenhouse gas emissions. After all, unburned methane is ten times more proficient at warming the atmosphere than CO_2. NETL engineers, however, saw the potential for turning this dangerous waste gas into an industrial asset and pursued technologies to realize that goal. Today, coalbed methane accounts for 6 percent of domestic dry natural gas production.

Titanium and Cast-Steel Armor

NETL and Department of Defense scientists worked together for nearly two decades to develop and perfect a low-cost titanium alloy to meet challenging U.S. and Swedish army specifications. They also developed a steel-casting technique for a new kind of armor with outstanding dimensional stability and high yield characteristics. U.S. soldiers in Iraq and Afghanistan have benefitted from the lightweight, ballistically efficient armor produced through these lower-cost manufacturing processes.

What's on the Horizon

In the next quarter-century, NETL will build on these successes and continue bringing critical innovation to bear on fossil energy production. Look for our technologies to help control mercury and CO_2 emissions in our nation's power plants, address the water impacts of shale gas recovery, and realize the next promising fossil fuel resource, methane hydrate. These solutions will make a difference for our nation—and for you.

National Energy Technology Laboratory

1450 Queen Avenue SW
Albany, OR 97321-2198
541-967-5892

420 L Street
Suite 305
Anchorage, AK 99501
907-271-3618

3610 Collins Ferry Road
P.O. Box 880
Morgantown, WV 26507-0880
304-285-4764

626 Cochrans Mill Road
P.O. Box 10940
Pittsburgh, PA 15236-0940
412-386-4687

Granite Tower, Suite 225
13131 Dairy Ashford
Sugar Land, TX 77478
281-494-2516

WEBSITE
www.netl.doe.gov

CUSTOMER SERVICE
1-800-553-7681

Scan this with your smartphone to link to NETL's website.