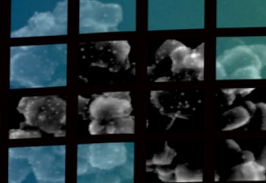


# NETL Accomplishments in Brief



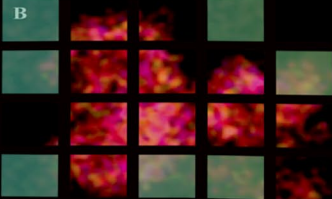
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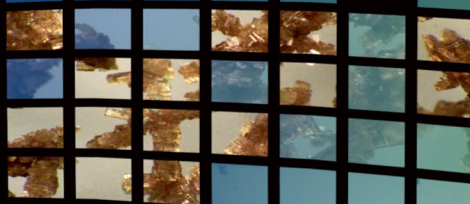


100nm

1nm

**100** Years of Innovation

**Carbon Sequestration Atlas**



**NETL-RUA** Regional



the **ENERGY** lab  
NATIONAL ENERGY TECHNOLOGY LABORATORY

# Mission

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



The  
**JASON**  
Project™



R&D 100 Awards



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## Letter from the Director

In 2010, the U.S. Department of Energy's (DOE) National Energy Technology Laboratory (NETL) celebrated its centennial anniversary of energy research, development, and commercialization for the people of the United States. For 100 years, NETL has developed technologies and processes that answer pressing energy issues and provide our Nation's policymakers with the scientific information they need to set sound energy policy.

On this occasion, NETL officially launched the NETL-Regional University Alliance (NETL-RUA). NETL-RUA was established to train the next generation of researchers, introduce advanced technologies to market, and spur economic development in our region. This partnership will help America meet today's critical energy challenges.

In addition to launching NETL-RUA, NETL realized a host of technical accomplishments, received recognition for our contributions to the energy industry, and released publications critical to fellow research organizations and other stakeholders. A full review of our 2010 accomplishments will be available this spring in the form of our *2010 NETL Accomplishments Report*. Until then, I invite you to review *NETL Accomplishments in Brief* to learn more about our researchers' diverse contributions to America's energy past, present, and future.

On behalf of NETL, thank you for your interest in our laboratory.

A handwritten signature in black ink, appearing to read 'Anthony V. Cugini'. The signature is stylized and fluid.

Anthony V. Cugini, Director  
National Energy Technology Laboratory

# 100

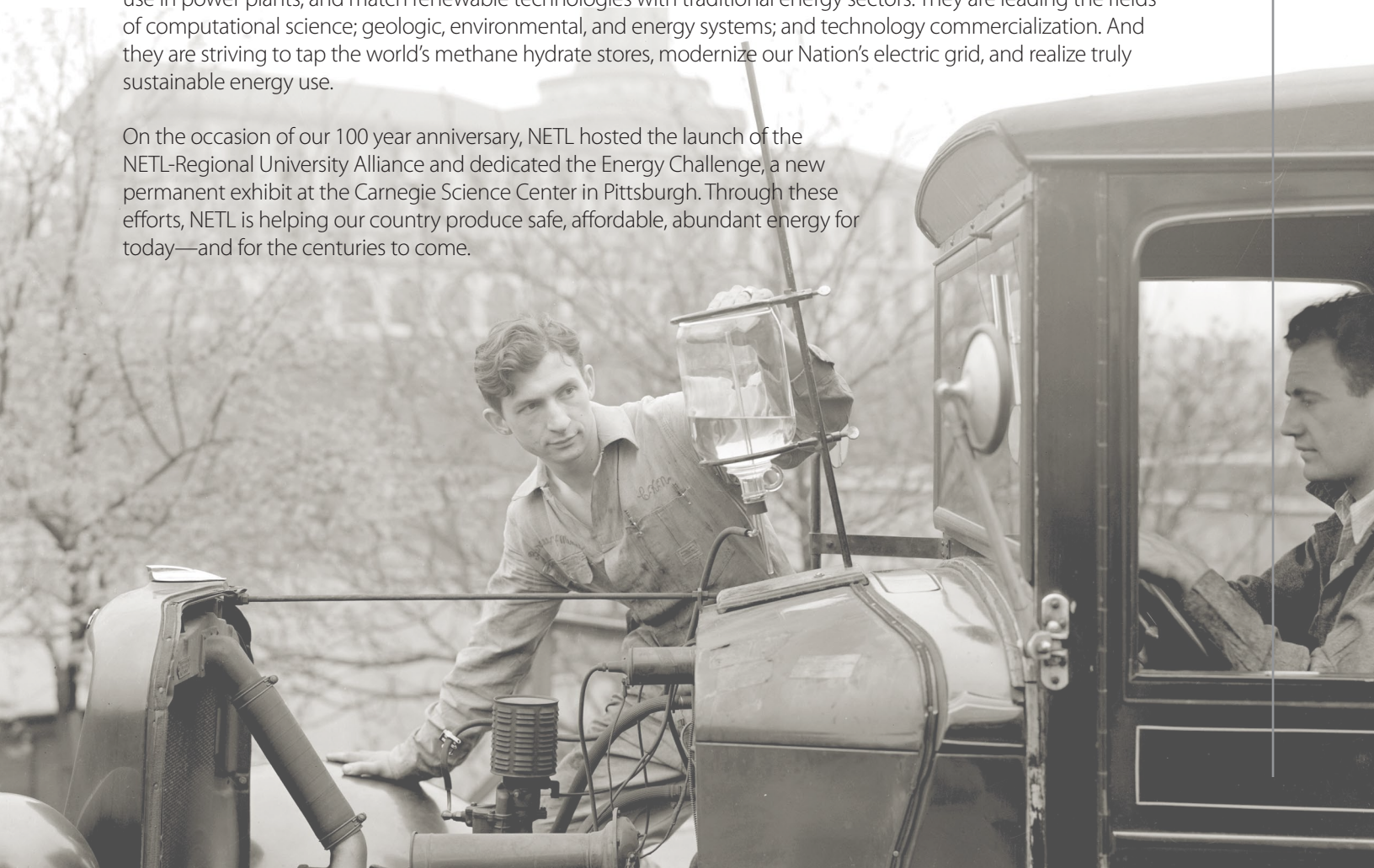
YEARS OF INNOVATION

## 100 Year Anniversary

For the last century, NETL has been on a quest to find energy answers. On May 16, 1910, the newly created U.S. Bureau of Mines established the Pittsburgh Experiment Station—NETL's first predecessor organization. Since then, our laboratory has evolved from a local organization with a single focus into a multi-faceted national laboratory within the Department of Energy.

Today, our researchers are developing technologies to manage man-made carbon dioxide emissions, reduce water use in power plants, and match renewable technologies with traditional energy sectors. They are leading the fields of computational science; geologic, environmental, and energy systems; and technology commercialization. And they are striving to tap the world's methane hydrate stores, modernize our Nation's electric grid, and realize truly sustainable energy use.

On the occasion of our 100 year anniversary, NETL hosted the launch of the NETL-Regional University Alliance and dedicated the Energy Challenge, a new permanent exhibit at the Carnegie Science Center in Pittsburgh. Through these efforts, NETL is helping our country produce safe, affordable, abundant energy for today—and for the centuries to come.



## 100 Year Anniversary



*NETL officials and representatives from the five universities form the Regional University Alliance Executive Committee.*

### NETL-Regional University Alliance

On October 13, 2010, NETL launched the NETL-Regional University Alliance (NETL-RUA), a partnership between NETL and five regional universities dedicated to developing and deploying advanced energy technologies. NETL-RUA—which includes Carnegie Mellon University, Penn State, the University of Pittsburgh, Virginia Tech, and West Virginia University—is leveraging the partners' combined facilities, specialty equipment, and staff to accelerate the development and commercialization of next-generation technologies. As NETL-RUA focuses on technology innovations to resolve our Nation's energy and environmental challenges, the Alliance will invigorate regional and national economies by spurring new high-tech and manufacturing jobs. By creating a culture of energy leadership through promotion of education and entrepreneurship, NETL-RUA will prepare the energy leaders of tomorrow.

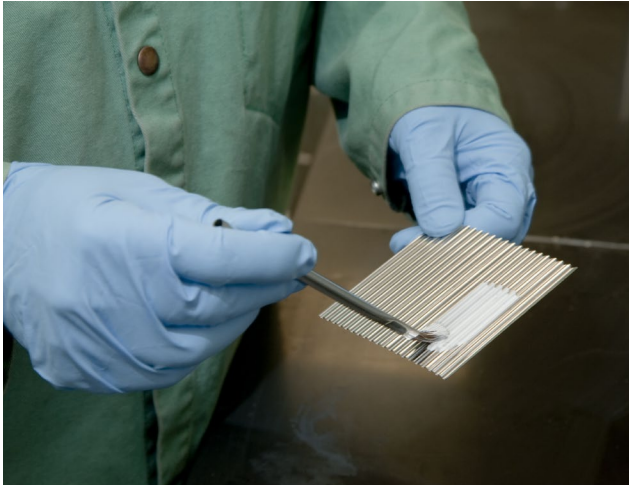


*NETL's new Energy Challenge exhibit at the Carnegie Science Center.*

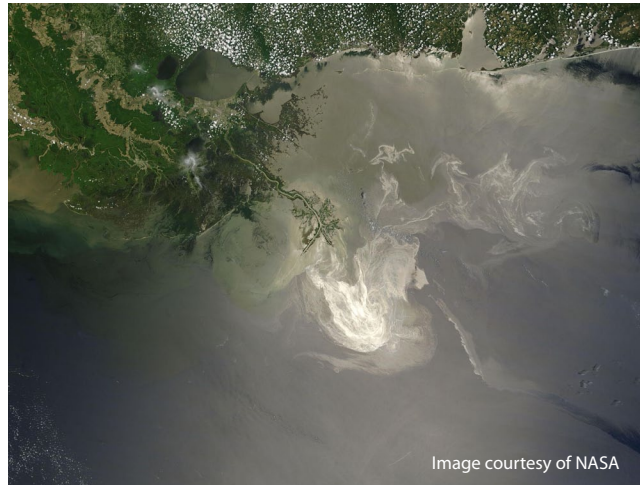
### The Energy Challenge

In 2010, NETL dedicated the Energy Challenge, a permanent educational exhibit at Pittsburgh's Carnegie Science Center. The Energy Challenge pits players against one another as they buzz in answers to multiple-choice questions. Designed to teach children and adults about the science of energy, the exhibit makes learning fun, drawing participants in with its game show style and animated videos. The Energy Challenge will help the Science Center's young visitors start thinking about careers in science and engineering. It will also teach adults and children how energy works, how we can conserve and reduce our energy use, and the importance of energy in our daily lives.

## Technical Awards



An NETL researcher paints cerium oxide/activator slurry onto the surface of a solid oxide fuel cell interconnect plate.



The Deepwater Horizon spill as seen by NASA's Terra satellite on May 24, 2010.

## 2010 R&D 100 Awards



Dr. Paul Jablonski and Dr. David Alman accepted an R&D 100 Award for the cerium oxide coating they developed to reduce oxidation rates in stainless steels and nickel superalloys. The advanced surface treatment extends the life of power plant components made from these metals.

Higher efficiency in energy production conserves fuel resources while protecting the environment, but higher efficiency generally means more severe operating conditions. Jablonski and Alman's coating will help reduce the frequency of expensive plant shutdowns by stemming the premature failure of components associated with such extreme conditions. The coating is applied as slurry via brushing, spraying, or dipping. This application method is simpler and less costly than alternative approaches, so the surface treatment also offers substantial savings.

The prestigious R&D 100 Awards are selected by an independent panel of judges and the editors of *R&D Magazine* and presented annually to the 100 most technologically significant products to enter the marketplace over the previous calendar year.

## USGS Director's Award for Exemplary Service to the Nation



Three NETL employees have been honored with the U.S. Geological Survey's award for *Exemplary Service to the Nation*. Dr. Grant Bromhal, Dr. George Guthrie, and Dr. Frank Shaffer were recognized for contributions during the Deepwater Horizon oil spill response. NETL's expertise was called on to answer questions about the amount of oil leaking from the Macondo Well during a period of intense public scrutiny. NETL used its high speed particle imaging (HSPI) system to assess the oil leak rate, and resulting estimates were used by the Unified Command to set the level of response in the Gulf of Mexico. HSPI has long been used in a range of applications, from energy systems to cardiovascular medicine.

## Clean Air



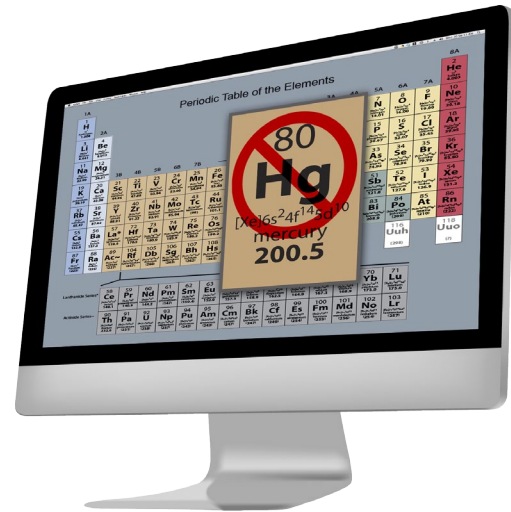
Great River Energy's Coal Creek Station in Underwood, ND.

### “Coal-Fired Project of the Year” Award

An innovative project demonstrating DryFinishing™ has been named 2010 Coal-Fired Project of the Year by the editors of *Power Engineering* magazine. The award honors technologies that “ushered in breakthrough solutions” in coal-fired, gas-fired, nuclear, renewable, and sustainable energy categories.

Nearly one-third of the electric power generated by coal in this country comes from plants that burn high-moisture coal. DryFinishing simultaneously dries and refines high-moisture coal and reduces potentially harmful emissions. The process not only uses power plant waste heat to reduce moisture, but also generates more energy from less coal.

The technology was developed with funding from the Clean Coal Power Initiative, managed by NETL, and was originally implemented at Great River Energy's Coal Creek Station in Underwood, ND. Great River Energy later expanded the project, building full-scale dryer modules for the entire Coal Creek Station. Cost of installation was low, and operations reduced station expenses by more than \$20 million annually.



### TOXECON™

An innovative technology that can help coal-based power plants comply with mercury emissions standards was successfully demonstrated in a recently concluded project. Under a cooperative agreement with NETL, WE Energies demonstrated the TOXECON™ process in a \$53 million project at the Presque Isle Power Plant in Marquette, MI.

TOXECON is a cost-effective option for capturing pollutants before they are emitted into the atmosphere.

The technology, which resulted from NETL research and was patented by the Electric Power Research Institute, significantly reduces mercury emissions, efficiently collects particulate matter from the power plant exhaust stream, and maximizes the use of coal combustion by-products.

During its 3-year demonstration period, TOXECON removed more than 90 percent of the mercury contained in the flue gas of three 90-megawatt units firing subbituminous Powder River Basin coal. Annually, the process is expected to capture 97 pounds of mercury and 250 tons of particulate matter at the Presque Isle plant.



## Carbon Capture and Sequestration



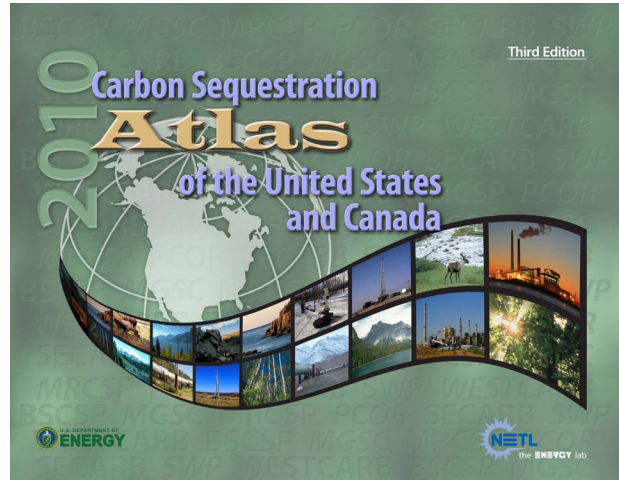
Research helicopter with SEQUIRE™ well finding technology.

### Perfluorocarbon Tracers

The ability to detect and track the movement of CO<sub>2</sub> in underground geologic storage reservoirs—an important component of carbon capture and storage technology—has been successfully demonstrated at a New Mexico test site.

The SEQUIRE™ tracer technology, developed by NETL scientists, was successfully tested at the San Juan Basin coalbed test site. SEQUIRE™ uses perfluorocarbon tracers to provide a verifiable way to measure CO<sub>2</sub> movement and provide leak detection.

In 2009, the patent-pending technology earned *R&D Magazine's* prestigious R&D 100 Award, emblematic of one of the 100 most significant products introduced to the marketplace during the past year. It received its first R&D 100 Award in 2007 as a major breakthrough in carbon storage and was touted as the only commercially available technology capable of searching vast areas for abandoned oil and gas wells in reservoirs having the potential to store CO<sub>2</sub>.

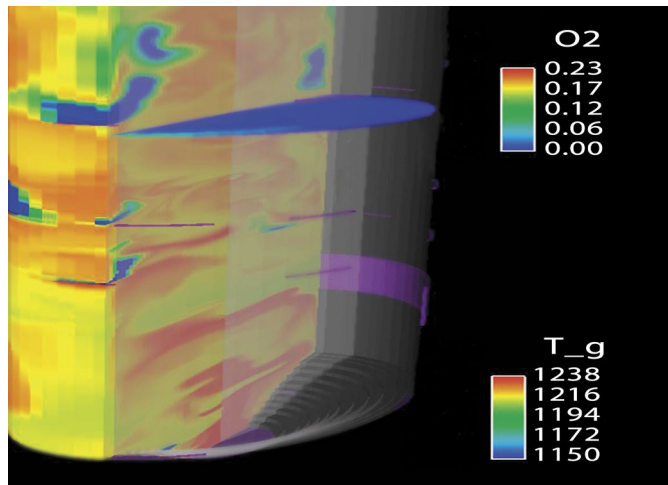


### Third Carbon Sequestration Atlas Released

There could be as much as 5,700 years of CO<sub>2</sub> storage potential in geologic formations in the United States and portions of Canada, according to the latest edition of NETL's *Carbon Sequestration Atlas of the United States and Canada (Atlas III)*.

*Atlas III* updates previously released U.S. and Canadian CO<sub>2</sub> storage data and provides new information on the activities of DOE's seven Regional Carbon Sequestration Partnerships. *Atlas III* also outlines DOE's Carbon Sequestration Program, international CCS collaborations, worldwide CCS projects, and CCS regulatory issues. There are two editions of the atlas available: an interactive version located at the National Carbon Explorer (NATCARB) website [www.natcarb.org/index.html](http://www.natcarb.org/index.html) and a print version available for viewing and downloading at the NETL website [www.netl.doe.gov/technologies/carbon\\_seq/refshelf/atlasIII/index.html](http://www.netl.doe.gov/technologies/carbon_seq/refshelf/atlasIII/index.html).

## Coal Gasification



NETL's MFIX software simulates a gasification system.

## NETL Launches Online Gasification Resources

NETL's Gasification Technologies Program supports research and development to convert carbon-based materials into synthesis gas, known as syngas, while sequestering 90 percent of the CO<sub>2</sub> stream and minimizing impact to the cost of electricity. Gasification offers an alternative to more established means of converting feedstocks such as coal and biomass into electricity and other products. In fact, it is poised to become the technology of choice for future coal-based plants, which will co-produce power, fuels, and chemicals with near-zero emissions.

Two major gasification resources are now available on the NETL website. The first, a new public resource database called "Gasifipedia," is a comprehensive online collection of resources to promote better understanding of gasification technology. The second, "The World Gasification Database," documents the worldwide growth of gasification. It contains gasification plant data, describes the current world gasification industry, and identifies near-term planned capacity additions. It also reveals that worldwide gasification capacity has continued to grow for the past several decades and is now at 70,817 megawatts thermal of syngas output at operating plants with a total of 412 gasifiers.

Visit the Gasifipedia website at: [www.netl.doe.gov/technologies/coalpower/gasification/gasifipedia/TOC.html](http://www.netl.doe.gov/technologies/coalpower/gasification/gasifipedia/TOC.html).

## Energy Efficiency



Clean Cities aims to reduce petroleum consumption by promoting alternative fuels and advanced vehicle solutions.

## Clean Cities Initiative Wins Golden Bullet Award

DOE's Clean Cities partnership, including offices at multiple NETL locations, was awarded the 2010 "Golden Bullet Award" by the Alternative Fuels and Vehicles Institute for success in deploying alternative fuel and advanced technology vehicles. Established in 1993, the Clean Cities initiative provides tools and resources that support local decisions to voluntarily adopt practices to reduce petroleum use in transportation. Clean Cities manages investments made by federal, state, and local governments, as well as transit authorities, in clean vehicles and alternative fuel infrastructure. Twenty-five cost-shared projects will put more than 9,000 alternative fuel and energy efficient vehicles on the road, establish 542 refueling locations, and install more than 1,000 electric charging stations nationwide. These projects include natural and renewable gas, propane, ethanol, biodiesel, electricity, and hybrid technologies and will displace 38 million gallons of petroleum annually.

The initiative is part of the Vehicle Technology Program within DOE's Office of Energy Efficiency and Renewable Energy. Clean Cities supports 87 local coalitions that promote the growth of alternative fuels and energy efficient vehicles.

For more information, visit the Clean Cities website at: [www1.eere.energy.gov/cleancities](http://www1.eere.energy.gov/cleancities).



## Recovery Act Milestone: 300,000 Homes Weatherized

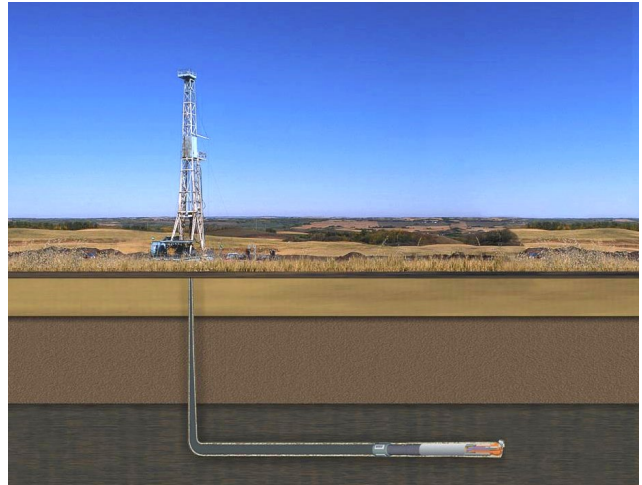
In January of 2011, U.S. Department of Energy Secretary Steven Chu announced that states and territories across the country have weatherized more than 300,000 low-income homes under the Recovery Act, a major milestone in the Department's efforts to reduce home energy bills for families.

The weatherization program, which NETL helps manage, is helping families save money on their energy bills by improving home energy efficiency with upgrades like insulation, air-sealing, and more efficient heating and cooling systems. The program has also trained a new generation of clean energy workers and currently employs more than 15,000 people.

"Through the weatherization program," said Secretary Chu, "we are laying the groundwork for a broader efficiency industry in the United States that will help grow our economy while saving money for American families."

Weatherization assistance reduces energy consumption for low-income families 35 percent on average, saving families about \$400 on their heating and cooling bills in the first year alone. Nationwide, the weatherization of 300,000 homes is estimated to save \$161 million in energy costs in just the first year.

## Reliable Supply



*Horizontal drilling can reach isolated pockets of oil gas, greatly reducing the "drilling footprint" above ground.*

## Shale Gas Technology Breakthroughs

A paper presented at the Society of Petroleum Engineers 2010 Technical Conference and Exhibition titled "Thirty Years of Gas Shale Fracturing: What Have We Learned?" recognizes NETL for its leadership in the development of technology drivers for shale gas production. Authored by George E. King of the Apache Corporation, the paper states that advancements resulting from NETL research, demonstration, and development have directly contributed to the growth of U.S. shale gas production, which now amounts to nearly 14 percent of dry natural gas produced in the United States; by 2035 that share could reach 45 percent.

In the 1980s and early 1990s, NETL collaborated with industry to advance horizontal drilling techniques. The first air-drilled 2,000-foot horizontal Devonian shale well was completed by NETL and its partners in the Appalachian Basin. NETL also worked with industry to test hydraulic fracturing. During well demonstrations, technical barriers and research needs were identified, and NETL worked with industry to develop high-efficiency "down-hole" tools. Today, due to NETL's early leadership in fracture mapping—a technique using seismic responses to identify the orientation and extent of hydraulically created fractures companies can successfully map hydraulic fractures, including those in the Marcellus shale and other gas plays currently under development.



## Gas Hydrates

In January of 2010, the National Research Council congratulated NETL for its “consistent and effective” leadership in research efforts associated with methane hydrate. The report, titled “Assessment of the Department of Energy’s Methane Hydrate Research and Development Program” compliments NETL’s gas hydrate program on the “overall high caliber of the research, the breadth of investigations undertaken, the training of new, highly qualified personnel under the program’s auspices, and the successful collaboration between federal agencies conducting research on methane hydrate . . .”

Methane hydrate is a naturally occurring, solid combination of methane and water found in Arctic permafrost areas and under the sea along most of the world’s continental margins. It holds enormous volumes of pure methane, the primary component of natural gas. Realizing the science and technology needed to locate and produce gas from hydrate would boost U.S. and international economies and energy security by providing new supply options to address post-2030 gas demand. In addition, understanding potential methane hydrate destabilization is significant to addressing ongoing climate change issues.

## Water-Energy



Image courtesy of Decanter Machine, Inc.

## Hyperbaric Centrifuge

Every year, U.S. coal producers discard up to 2 billion tons of moisture-laden fines (small, coarse coal particles) in containment ponds or impoundments as slurry. In some cases, slurry water is evaporated to stabilize the deposits before they are recovered in surface reclamation; in other cases, the waste coal is left unrecovered for technological, operational, market, and other reasons.

A new technology could turn this waste coal into a viable energy resource. The hyperbaric centrifuge technology, developed by Dr. Roe-Hoan Yoon of Virginia Tech with support from NETL, was demonstrated as part of NETL’s Hydrogen and Fuels program. The technology is aimed at separating the fine coal particles from water, allowing their recovery for energy while simultaneously cleaning up the environment and providing jobs in the coal-cleaning industry. The technology represents a major step forward in clean coal separation. Presently, coal fines must be discarded by even the most advanced coal cleaning plants because the leftover moisture content in conventional dewatering systems leaves it unmarketable. Improvements realized under the hyperbaric centrifuge have the potential to enable the reuse of billions of tons of waste, including 70 million to 90 million tons of fine coal refuse currently added to slurry impoundments each year.

## Outreach/Education



Students load polyethylene beads into a cold flow simulator.

## Collaborating with the JASON Project

The  
**JASON**  
Project™



*Operation: Infinite Potential*, the JASON Project's multimedia energy curriculum unit developed with NETL assistance, won three coveted CODiE Awards from the Software & Information Industry

Association (SIIA). The SIIA pool of educators and technology experts recognized "Operation: Infinite Potential" as the Nation's "Best K-12 Instructional Solution," "Best Online Instructional Solution," and "Best Education Game or Simulation" for 2010.

Founded by the National Geographic Society, the JASON Project puts students in contact with practicing explorers and researchers. Resulting curricula become available through print, video, games, and free online resources to tens of thousands of teachers and millions of students in the United States and worldwide.

## Our Vision for the Future



NETL's past successes have contributed to our nation's energy safety and security. We have now entered our next century of innovation and the grand challenge it presents: America's transition to an energy portfolio that is environmentally acceptable, sustainable, and capable of tapping the full potential of our nation's energy resources.

The technical advancements required to meet this challenge are underway at NETL. We are taking the path to achieving scalable renewable energy by looking to coal, natural gas, and oil as transition fuels. This means integrating fossil-energy platforms with renewable energy resources, realizing ever-greater efficiency in our power production and use, and developing an integrated grid structure to transmit electrical power more efficiently and reliably.

NETL's research program is organized around core elements that recognize the systems-design and integration issues posed by a global transition of energy technologies.

- Carbon capture and storage—NETL is a leader in technology development aimed at safely, economically, and permanently storing CO<sub>2</sub> from fossil-based energy systems. We target the 2020 timeframe for moving needed technologies to market.
- Advanced fossil-fuel power systems—Tomorrow's affordable, ultra-clean, ultra-efficient power systems are under development today. The Office of Fossil Energy's research and development program, implemented by

NETL, targets 90 percent carbon capture and storage at electricity costs that approach today's supercritical pulverized coal plant costs without carbon capture.

- Existing coal plants—Applying carbon capture to existing coal-fueled power plants through retrofitted technologies imposes an enormous economic penalty. NETL aims to reduce today's incremental capital and operating costs by approximately 50 percent, averaged across the existing fleet, through advanced postcombustion capture and compression.
- Methane hydrates and gas shale—These technically and economically challenging resources are under intense investigation at NETL. Our researchers also continue to advance the cost-effective, environmentally sound exploration of domestic oil and natural gas.
- The Smart Grid—Through 2009, NETL's Modern Grid Strategy team led development of a national vision to upgrade our electricity distribution system to a 21st-century Smart Grid. NETL is now accelerating America's transition to the grid through implementation-strategy development, key analyses, and technology innovation. NETL also participates actively in ongoing stakeholder communities consisting of federal government, academic, and industry organizations.
- Energy efficiency—Energy efficiency in both supply and demand is critical to America's future. NETL works on both sides of the equation by increasing power-



production efficiencies and making strides in demand-side efficiencies. NETL works closely with state energy programs and weatherization projects. Our partners develop, evaluate, and deploy high-efficiency building, vehicle, industrial, and appliance technologies—all of which are key to slashing energy consumption and consumer costs.

NETL also manages \$15.5 billion in American Reinvestment and Recovery Act (ARRA) funding for the Office of Fossil Energy, the Office of Energy Reliability and Renewable Energy, and the Office of Electricity Delivery and Energy Reliability. NETL's ARRA activities give independent organizations the opportunity to make significant strides in energy research while they create more than 160,000 job years by the program's 2015 expiration date.

The successes our project partners realize will jump-start new industries for clean transportation, building technologies, industrial efficiencies, and renewable energy. They will translate into achievements for the Regional Carbon Sequestration Partnerships and Smart Grid program, and they will augment intergovernmental programs at the state level.

In addition to conducting sponsored research programs, NETL is committed to acting as a catalyst for regional development. The primary vehicle for this work is our newly formed Regional University Alliance for Energy Technology Innovation, or NETL-RUA. This program combines NETL's fossil energy expertise with the broad capabilities of five regional institutions: Carnegie Mellon

University, Pennsylvania State University, the University of Pittsburgh, Virginia Tech, and West Virginia University.

NETL-RUA will help our nation develop a workforce highly skilled in the energy field, providing stimulus for high-tech job creation and economic development. Deployment of new technologies stemming from this Alliance will be aided by key partnerships with the region's commercial energy sector and serve as the basis for regional economic development and nationwide job creation.

Rebuilding our nation's energy infrastructure based on resources with ultralow environmental impact will require decades of technology development and commercialization. NETL is working to help America achieve this complex energy transition. With our scientific, engineering, and administrative talent, we continue to implement the partnerships and manage the programs that can accomplish the mission of providing affordable, reliable, and environmentally safe energy for the 21st century.



**National Energy Technology Laboratory**

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

2175 University Avenue South  
Suite 201  
Fairbanks, AK 99709  
907-452-2559

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](http://www.netl.doe.gov)

**CUSTOMER SERVICE**

1-800-553-7681



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**NATIONAL ENERGY TECHNOLOGY LABORATORY**