Safe, Clean, Sustainable Energy

How Pittsburgh's Resources, Research, and Education Make it Possible

Just south of Pittsburgh, Pa., within 60 miles of the vibrant city's gleaming downtown, are two of the three research laboratories that form the National Energy Technology Laboratory (NETL). Their proximity to Pittsburgh and to each other is no coincidence. Pennsylvania, the site of the first NETL lab, gave birth to America's energy industry, while the coalfields of West Virginia, the site of the second lab, fueled the nation's industrial expansion. The early research centers that grew into NETL were formed here—in America's energy heart—to make energy production and consumption as safe, clean, and sustainable as possible.

Over the decades, the wider Pittsburgh region has emerged as a world leader in energy research and innovation, and NETL has evolved along with it. Regional businesses, organizations, and academic institutions have partnered to drive Pittsburgh's transformation from gritty, industrial city to sophisticated energy hub. NETL has been an integral part of this continuing evolution, helping define and redefine energy production and consumption.

The smoggy skies of mid-twentieth-century Pittsburgh have given way to sunnier vistas thanks to regional energy research organizations.

Smoke Control Lantern Slide Collection, ca. 1940–1950, AIS 1978.22, Archives Service Center, University of Pittsburgh

Regional Energy Development

For more than two centuries, coal, oil, and natural gas production have attracted people and businesses to the Pittsburgh region. A nation dependent on abundant, affordable fossil fuels was a boon to these early industries, as well as to related businesses that flocked to join them: railways, shipping, and tool development, along with housing and training for industry workers.

NETL was born out of this early energy boom, when the U.S. Bureau of Mines was created to improve mining safety. The bureau's Pittsburgh Experiment Station, which would eventually become part of NETL, opened in 1912, a year when 2,360 men died in America's coal mines. To elucidate the dangers inherent in coal mining, and counter the widely held belief that coal couldn't propagate an explosion in the absence of methane gas, the station's early researchers demonstrated the combustibility of coal dust in a controlled explosion in an experimental mine in Bruceton, Pa. The demonstration led to changes in mining practices and the development of new technologies that saved countless lives. It also marked NETL as an important part of the Pittsburgh region's growing energy industry.

NETL joins forces with regional energy organizations to enhance national energy development.

Beyond fossil fuels, an abundance of other natural resources has contributed to the region's energy development. Lumber from the surrounding hardwood forests was important to early settlers, along with fresh water from the three rivers that now weave through the center of the metropolis. This bounty has helped make Pittsburgh the only city in the United States that's a leading employer across seven energy-related industries: coal, natural gas, nuclear, solar, wind, distribution, and green building.

Over its 100-year history, NETL has joined forces with players from many of these energy fields to enhance national energy development. NETL performs its own research, partners on research with others, and provides funding and project management for organizations that perform research on the laboratory's behalf. Some of that research resulted in technologies that have slashed air emissions from coal-fired power generation. Other technologies help locate old oil wells and coal mines or determine rock density to reduce risk during drilling operations. NETL and its partners have

fostered numerous technologies from concept to marketable product, which is paramount to successful energy research, bringing economic growth to the Pittsburgh region through each step of the process.

An example of how regional energy organizations partner and build upon each other's work is found in the development of natural gas from the Marcellus Shale. Three decades of collaborative research funded by NETL helped to unlock this unconventional resource, which is driving a new U.S. energy boom. EQT Corporation responded by opening a public-access compressed natural gas fueling station in Pittsburgh's historic Strip District, one of the first within the city limits. Meanwhile, Shell Chemicals is considering Horsehead Corporation's former zinc-smelting site in Monaca, Pa., as a location to process the "wet" portion of regionally produced shale gas.

Green and Sustainable Buildings

Pittsburgh's energy past, present, and future join and flourish in its beautiful buildings. Perhaps this is best seen at the Phipps Conservatory and Botanical Gardens, a complex of buildings and grounds anchored by a great steel-and-glass Victorian greenhouse. Phipps' newer Tropical Forest Conservatory, a lush retreat of tropical plants and waterfalls, is powered by a solid oxide fuel cell and cooled by NETL-funded underground "earth tubes," while computer-controlled shades adjust the amount of sunlight shining in and insulate at night. The conservatory's Center for Sustainable Landscapes is a net-zero-energy and -water "living building" that generates all of its own energy with renewable resources while capturing and treating its water onsite, making it one of the greenest buildings on Earth.

Phipps Conservatory: one of Pittsburgh's many older buildings reborn as cleaner, greener, modern structures.

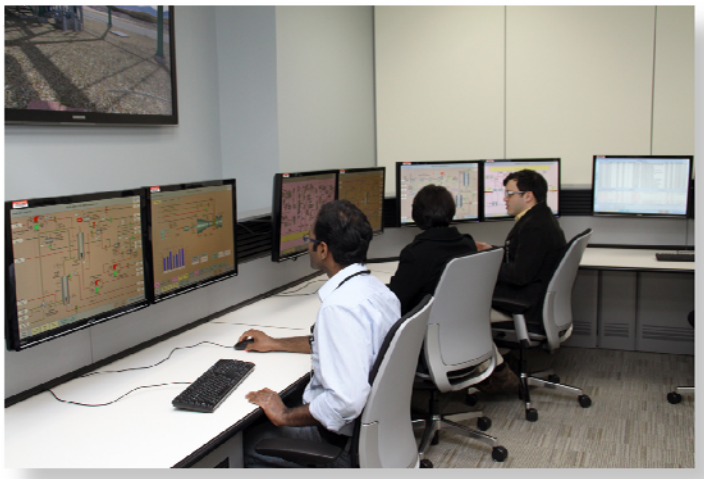
Many other Pittsburgh structures are being reborn rather than torn down—a true image of sustainability. Churches are becoming restaurants, production plants are becoming loft apartments, and run-down schools and fire houses are becoming night clubs or banks. Aquion Energy, started by a Carnegie Mellon University professor through a U.S. Department of Energy grant, is renovating a portion of the former Sony industrial facility in nearby Westmoreland County and will relocate there to increase production of its storage system for off-grid solar scenarios, which offers three times the life of the leading lead-acid battery pack, without the maintenance.

NETL doesn't lag behind its neighbors when it comes to green buildings. At its Pittsburgh site, NETL partnered with Constellation Energy to increase energy efficiency, lower energy costs, and reduce emissions of carbon dioxide, nitrous oxide, and sulfur oxide. A wind turbine now generates power for a laboratory building, solar overhead lights illuminate walking paths, and two Pittsburgh buildings were outfitted with green roofs, where vegetation allows absorption of sunlight to decrease the buildings' heating and cooling costs. Not to be outdone, NETL's Morgantown, W.Va., site boasts a new, four-story administrative support facility that was awarded a gold rating in the U.S. Green Building Council's Leadership in Energy and Environmental Design Certification Program. The 108,000-square-foot office building also meets the U.S. Environmental Protection Agency's Energy Star criteria for top-performing buildings in energy conservation.

Energy Education

If resources and research drive Pittsburgh's energy prowess, and its buildings display it, education sustains it. Through a variety of initiatives and partnerships, NETL is training energy workers, educating the next generation of energy scientists, and keeping the public and policymakers apprised of developments in the energy industry.

A shining example is AVESTAR™, a state-of-the-art training center developed to satisfy industry's growing need for training and experience in the operation and control of high-efficiency, near-zero-emissions power plants. Since the center's launch in 2011, the AVESTAR team—which includes NETL, Invensys Operations Management, West Virginia University, and Fossil Consulting Services—has continued to build its portfolio of dynamic simulators, virtual plant technologies, and advanced research capabilities. In July 2012, the team deployed a new 3-D virtual immersive training system for advanced integrated gasification combined cycle (IGCC) power plants with carbon capture. Wearing a head-mounted visor or wireless 3-D video glasses, users can interact with IGCC plant equipment in real-time, activate transparent views of equipment internals, display pop-up trends of key process variables, and experience equipment sound effects, malfunctions, and visual training scenarios.



The AVESTAR center provides the training needed to develop a workforce well-prepared to operate and control high-efficiency, near-zero-emissions power plants.

In a another partnership, called the NETL Regional University Alliance (NETL-RUA), NETL and URS Corporation support basic and applied energy and environmental research by researchers and students at five nationally recognized universities: Carnegie Mellon University, Penn State, the University of Pittsburgh, Virginia Tech, and West Virginia University. NETL-RUA members share resources and develop ideas to take technology concepts from the lab to the real world in less time, facilitating the transition to future energy systems. The student participants gain valuable experience prior to graduation, while establishing a connection to the Pittsburgh region's vast community of energy businesses.

With the region's rich energy experience, Pittsburgh has become a popular place to bolster energy-related awareness efforts. Facilitating collaboration in the region is the Energy Alliance of Greater Pittsburgh, with nearly 100 local manufacturers, energy producers, utilities, financial institutions, and research and non-profit organizations; their public awareness campaign, Energy to the Power of Pittsburgh, focuses on the region's energy sector and the more than 60,000 jobs it provides at 1,700 establishments. When the National Academy of Sciences and the National Academy of Engineering chose energy as the first topic of its groundbreaking Science & Engineering Ambassadors Program, Pittsburgh was naturally selected as the pilot city; a dozen of the region's leading energy scientists, including four from NETL, were tapped as Science & Engineering Ambassadors to interpret and communicate scientific research to the non-technical public.

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Conferences and Energy Campaigns

It should come as no surprise that the vitality of the Pittsburgh region, fueled by its energy assets, inevitably catches the attention of conference organizers nationally and worldwide. Some of these conferences tackle issues on a world scale, while others cover "everything energy." In recent years, these conferences have included—

- American Institute of Chemical Engineers (AIChE) Annual Meeting—An annual, week-long forum for chemical engineers to discuss subjects pertinent to cutting-edge research and breakthrough technologies. The Pittsburgh region's leadership in sustainability, higher education, and government-industry-academia partnerships specifically drew the meeting to Pittsburgh in 2012, and NETL organized one of the key energy-related topical conferences within the larger meeting: *Accelerating Fossil Energy Technology Development Through Integrated Computation and Experimentation*.

- International Pittsburgh Coal Conference—An international gathering hosted by the University of Pittsburgh, devoted to all aspects of coal, energy, and the environment. The conference has been held annually since 1973, usually in Pittsburgh, but also in China (1997), Australia (2001), Japan (2004), South Africa (2007), and Turkey (2010). NETL is typically a key sponsor and in 2012 organized and led a series of business and technical information sessions titled *Clean Coal Demonstration and Commercial Projects*.
- G-20 Summit on Financial Markets and the World Economy—A periodic gathering of heads of government, finance ministers and central bank governors, and employment and labor ministers from the G-20 major economies. When President Obama hosted the summit in 2009, Pittsburgh was selected as the location because of its economic renaissance, which owes, in large part, to Pittsburgh's energy sector.

When the British destroyed Fort Duquesne in 1758, during the Seven Years War, and built Fort Pitt at the confluence of the Allegheny and Monongahela Rivers, they couldn't have foreseen how the fort would give rise to a small village that would grow to become the cosmopolitan city that Pittsburgh is today. Pittsburgh has survived two and a half centuries of sometimes wrenching change to transform itself with a balanced, innovation-driven economy based on its historic strengths.

NETL is proud of its role in helping the greater Pittsburgh region emerge and reemerge as America's leading provider of energy solutions. Continued collaboration among regional research organizations will power strong economic and energy-technology development well into the future. When resources and innovation combine, Pittsburgh can energize the world.

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