NATIONAL ENERGY TECHNOLOGY LABORATORY

ACCOMPLISHMENTS

Q1 FY25

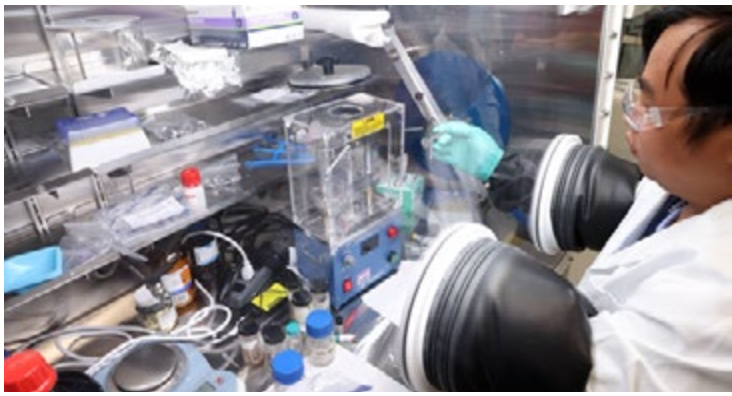
U.S. Department of ENERGY

NETL ACCOMPLISHMENTS

Quarter 1 – Fiscal Year 2025

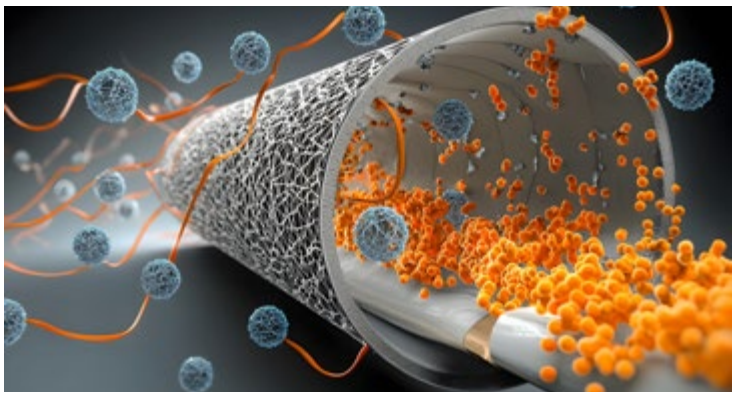
NETL-Performed

New NETL Catalytic Process Made High-Quality Graphite from Coal Waste Products



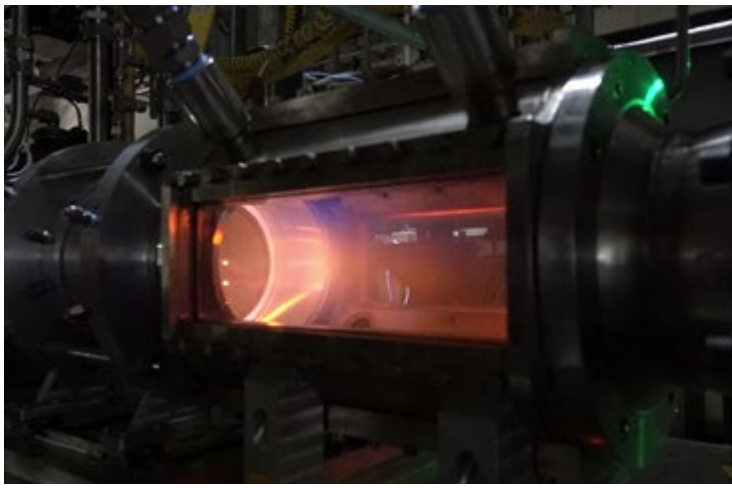
NETL's research unlocked a low-temperature synthesis process to make America's coal waste into critical mineral graphite with a lower processing intensity. This takes what would otherwise be an environmental liability and instead uses it to help address rising demand by adding to the domestic supply chain and address commercial market needs for several key industries as well. The novel process that NETL researchers developed focuses on using earth-abundant catalyst materials, such as iron, to facilitate the production of highly crystalline graphite. Coal of different ranks, coal waste, coal char, biochar and plastic waste have been demonstrated to work as feedstocks with this process.

NETL Researchers Converted Coal Tar Pitch Into Graphene for Improved Supercapacitors



NETL researchers developed a low-cost process for converting coal tar waste into a high-quality graphene material that can increase performance of energy-storing supercapacitor systems by up to 55%. Supercapacitors are often used to regulate power fluctuations between the electrical grid and intermittent renewable power sources such as windmill and photovoltaic farms. They are also used for short term energy storage as uninterruptable power sources. Graphene has long been considered an ideal supercapacitor electrode material, but its use in commercial devices is limited because there are few methods for producing high-quality graphene at a large scale at a low cost.

NETL Modular Combustor Shed New Light on Rotating Detonation Engine Technology



NETL researchers successfully operated a new modular rotating detonation engine (RDE) combustor that offers full optical access to the fuel/air injectors, the combustion channel and across the exhaust duct. This will assist with acquiring crucial measurements to help accelerate the development of highly efficient RDE technology for power generation. RDEs are an advanced type of combustion system that could yield higher efficiency and performance than traditional power generation systems. They operate by creating detonation waves that rotate around the inside of a modified gas turbine combustion chamber, subsequently increasing the gas pressure — like a piston but without moving parts — before sending the high-pressure, high-temperature gas to the turbine. Maximizing and utilizing this pressure gain would permit gas turbine-based systems to produce more power for the same amount of fuel compared to conventional systems.

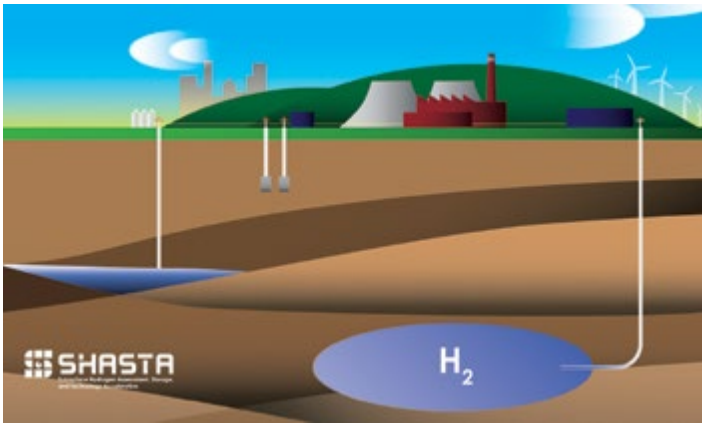
NETL-Launched Web Application Made Data Accessible for Carbon Storage Permitting and Risk Assessment

NETL's new CO_2-Locate web application, now available on NETL's Energy Data Exchange (EDX), offers decision makers access to a wide swath of information needed to help create a net-zero carbon emissions power sector. The application is one of several new, innovative tools developed with funding from the Bipartisan Infrastructure Law. Safe and effective geologic carbon storage requires data to inform commercial and regulatory decisions. The CO_2-Locate web application helps users review specific areas for injection, evaluate potential for monitoring wells, support risk assessments and analyze environmental and social justice metrics to help transition toward a sustainable future.

NETL Helped Update EPA's Online Oil and Gas Equipment and Services Provider Directory To Assist with Methane Emission Reduction

As a result of NETL's collaboration through an interagency agreement with the U.S. Environmental Protection Agency's (EPA) Methane Emission Reduction Program, the U.S. oil and gas industries now have expanded access to information about private sector providers of advanced methane monitoring technologies for use in selecting, plugging and mitigating leaks from marginal conventional wells that dot much of the nation's oil and gas-producing regions. NETL collected information about current methane detection, quantification and monitoring instrument technologies by reviewing an array of published articles and documents and then organized and formatted the information. EPA integrated the information into the EPA Natural Gas STAR Program's Oil and Gas Equipment and Service Providers Directory, a long-standing resource that facilitates connections between operators and service providers.

NETL Advanced Landmark Research To Store Hydrogen in Subsurface



Researchers at NETL and the University of California San Diego completed a series of studies that found hydrogen — a low-carbon fuel with tremendous potential to help the United States meet its climate change goals — can be stored in the subsurface without significantly altering the layer of protective shale caprock, which seals the storage reservoir and prevents the migration of the gas. These initial studies suggest that the extent of reactions activated by hydrogen with caprock is minor under the temperature and pressure conditions that would represent underground hydrogen storage, according to the paper, "Initial Laboratory Measurements Probing Hydrogen Interactions with Eagle Ford Shale and Pyrite: Potential Implications for Subsurface Hydrogen Storage."

Stanford University Recognized 17 NETL Researchers in Annual Top 2% of Scientists Worldwide List

An analysis published by Stanford University included 17 current and former NETL researchers in the top 2% of global scientists, demonstrating the level of talent and expertise the Lab is bringing to bear on the nation's decarbonization goals. The analysis comprised lists according to single-year impact and career-long impact.

Interactive Gas Turbine CO_2 Emissions Map Underscored Importance of NETL's Advanced Turbine Work

NETL published an interactive map showing data on gas turbines installed in the United States from 2010-2023 that tracks trends in installation and annual CO_2 emissions, demonstrating that the Lab's research and development of near-zero-emissions advanced turbine technology is helping to change the way the nation generates power. The map collects data representing select gas turbines operating in the United States, allowing users to easily see how many tonnes per year of CO_2 the units emit, as well as the monthly emissions for a specific site. Users can also see each plant's power output and the type of turbine technology it uses. In addition, the map displays current CO_2 and hydrogen infrastructure, such as pipelines and storage sites, which serves as a valuable tool for industry when considering proximity to infrastructure for future investments.

NETL-Awarded/Managed

NETL-Supported Lower-Cost Supercritical CO_2 Turbine Technology Successfully Demonstrated

An NETL-supported project, which could offer a path to lower-cost power generation, successfully demonstrated a supercritical turbine technology in a pilot plant that can produce enough power to supply electricity to approximately 4,000 homes — the largest-scale demonstration of the technology ever accomplished. The project demonstrated operation of the supercritical CO_2 pilot plant at "simple cycle max" conditions, producing approximately 4 megawatts. Researchers achieved the breakthrough at the Supercritical Transformational Electric Power Demo test facility in San Antonio, Texas.

NETL, Partners Completed First Direct Air Capture Field Test at National Carbon Capture Center

NETL expertise and oversight played a significant role in completing the first successful field test of a direct air capture (DAC) technology at the National Carbon Capture Center (NCCC). DAC is an emerging technology that works by processing air from the atmosphere rather than from carbon dioxide (CO_2) point sources (for instance, fossil-energy power plants and industries), thereby addressing both current and legacy emissions. DAC technologies are integral components in U.S. plans to address climate change and achieve an economy-wide net-zero-emissions economy by 2050. Results of the field test, which was completed in July at the NCCC in Wilsonville, Alabama, advanced the development of a system that has potential to lower the cost of DAC while reducing atmospheric levels of CO_2, a greenhouse gas.

NETL Supported Completion of the World's Largest Membrane-Based Carbon Capture Testing Facility

Membrane Technology and Research (MTR) Carbon Capture announced the completion of a carbon capture testing facility at the Wyoming Integrated Test Center in Gillette, Wyoming. The facility, which is the largest membrane-based carbon capture facility in the world, is designed to capture approximately 55,000 tonnes of CO_2 per year with the MTR Carbon Capture Polaris™ membrane process that uses no chemicals, very little water, and does not require heat or steam input. The Large Pilot Testing of the MTR Membrane Post-Combustion CO_2 Capture Process project is a cooperative agreement between MTR and NETL.

NETL-Managed UCLA Research Significantly Reduced CO_2 Emissions in Cement Production

Researchers at the University of California Los Angeles (UCLA), in a project NETL manages, developed and demonstrated a new approach for making ordinary Portland cement replacement in concrete that can significantly reduce CO_2 emissions and is already being commercialized for use in U.S. cement plants. The new process uses calcium hydroxide ($Ca(OH)_2$) for mineralization in the cement-making process and reduces the use of Portland cement in concrete production. $Ca(OH)_2$ is a colorless crystal or white powder and is produced when calcium oxide is mixed with water. It can be produced thermally and electrochemically without CO_2 emissions.