NATIONAL ENERGY TECHNOLOGY LABORATORY

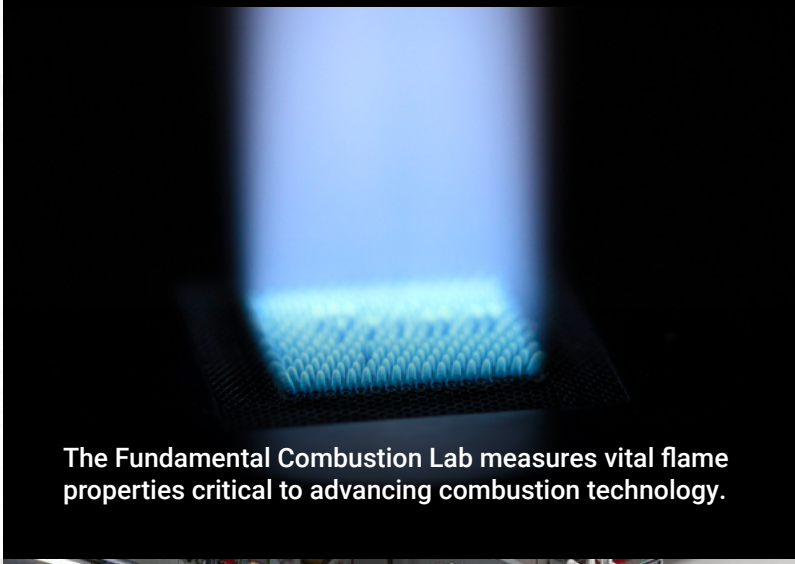
Power Generation Technologies Focusing on Fossil Energy

NETL is driving innovation to improve the efficiency, reliability and flexibility of the nation's fossil energy power generation systems. Through advancements in materials development, combustion science and system design, NETL delivers technologies that upgrade existing plants and enable future high-performance energy systems. These efforts help strengthen U.S. grid resilience, extend the life of critical infrastructure and support a stable, secure domestic energy supply.

R&D Applications

- Power Plant Efficiency
- Advanced Combustion Technology
- Sensors and Monitoring Technology
- Carbon Management
- Advanced Energy Materials
- Gasification Systems
- Grid Flexibility and Dispatchability
- Turbines and Materials Innovations

NETL's 50kw Circulating Fluidized Bed Reactor.



The Fundamental Combustion Lab measures vital flame properties critical to advancing combustion technology.

High-Performance Superalloy Development

NETL invented and patented a nickel-based superalloy (U.S. Patent No. 11,827,955B2) with more than 200% improved creep resistance over commercial alloys. This breakthrough enhances the durability of turbine components, enabling higher-temperature operation, lower maintenance and extended power plant life for coal-fired systems.

Research Highlights

Improvements for Existing Coal Plants and Advanced Combustion

Researchers are working to overcome advanced combustion's high cost and energy consumption challenges. NETL's Transport Oxy-Combustion (TROC) technology (U.S. Patent No. 8,689,709) removes almost all nitrogen from the air, yielding a stream that is approximately 95% oxygen. Existing coal plants provide valuable power grid stability, and technologies like TROC utilize legacy energy infrastructure while upgrading it for efficiency and reliability.

Advancing High-Efficiency Hybrid Power Systems

NETL's Hybrid Performance (HYPER) Facility is the only hardware-based cyber-physical simulator of an advanced hybrid power system worldwide. The facility enables realtime testing of next-generation control strategies for tightly coupled systems, such as fuel cell–gas turbine hybrids. By evaluating complex, nonlinear control algorithms on physical hardware, HYPER helps accelerate the development of efficient, flexible and reliable hybrid energy systems.

Turbine Research for the Modern Grid

NETL's advanced turbine research accelerates turbine performance, efficiency and cost-effectiveness. The research portfolio addresses component development for turbine systems fueled by multiple fuels, including natural gas, hydrogen and syngas, in combined cycle applications with pre- or post-combustion carbon capture and storage that could achieve greater than 65% combined cycle efficiency. NETL's advanced turbine systems ensure that power generation is meeting the demands of a modern grid.

Analyses of Advanced Coal Power Generation Systems

NETL researchers perform a variety of analyses on coal power generation technologies. NETL's baseline series provides detailed technical performance and cost data for coal-fired power generation technologies, including supercritical pulverized coal (PC). Additional work includes novel configurations for enhanced unit flexibility, advanced ultrasupercritical PC units, chemical looping and integrated gasification fuel cell technologies. These analyses establish technology cost and help identify optimal R&D avenues in support of secure, efficient coal power.

Publications

- Detrois, M., Antonov, S., Rozman, K. A., Hawk, J. A., & Jablonski, P. D. (2022). Improved creep and tensile properties of a corrosion resistant Ni-Based superalloy using high temperature aging and Nb/Ta additions. Metallurgical and Materials Transactions A, 53(7), 2600-2613.
- Leptinsky, S., Schmitt, T., Zoelle, A., Homsy, S., Woods, M., Shultz, T., ... & Hackett, G. (2023). Cost and Performance Projections for Coal-and Natural Gas-Fired Power Plants (No. DOE/NETL-2023/4382). National Energy Technology Laboratory (NETL), Pittsburgh, PA, Morgantown, WV, and Albany, OR (United States).
- Oakes, M., Konrade, J., Bleckinger, M., Turner, M., Hughes, S., Hoffman, H., & Shultz, T. (2022). Conceptual Design of Pulverized Coal Electricity Generating Units for Flexible Operation (No. DOE/NETL-2022/3315). National Energy Technology Laboratory (NETL), Pittsburgh, PA, Morgantown, WV, and Albany, OR (United States).
- Schmitt, T., Zoelle, A., Homsy, S., Fout, T., Shultz, T., Woods, M., & Hoffmann, J. (2021). Bituminous Coal and Natural Gas to Electricity:> 90% Capture Cases Technical Note (No. DOE/NETL-2022/3222). National Energy Technology Laboratory (NETL), Pittsburgh, PA, Morgantown, WV, and Albany, OR (United States).
- Theis, J. (2021). Quality guidelines for energy systems studies: cost estimation methodology for NETL assessments of power plant performance (No. NETL-PUB-22580). National Energy Technology Laboratory (NETL), Pittsburgh, PA, Morgantown, WV, and Albany, OR (United States).

NETL is a U.S. Department of Energy (DOE) national laboratory dedicated to advancing the nation's energy future by creating innovative solutions that strengthen the security, affordability and reliability of energy systems and natural resources. With laboratories in Albany, Oregon; Morgantown, West Virginia; and Pittsburgh, Pennsylvania, NETL creates advanced energy technologies that support DOE's mission while fostering collaborations that will lead to a resilient and abundant energy future for the nation.