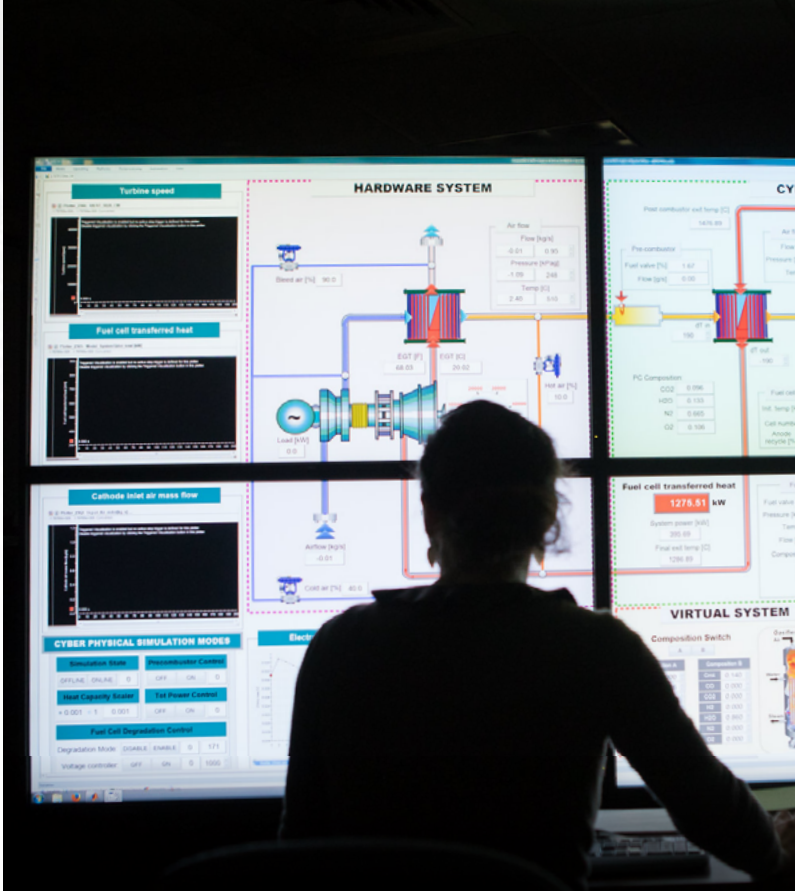
NATIONAL ENERGY TECHNOLOGY LABORATORY

Grid Stability and Reliability

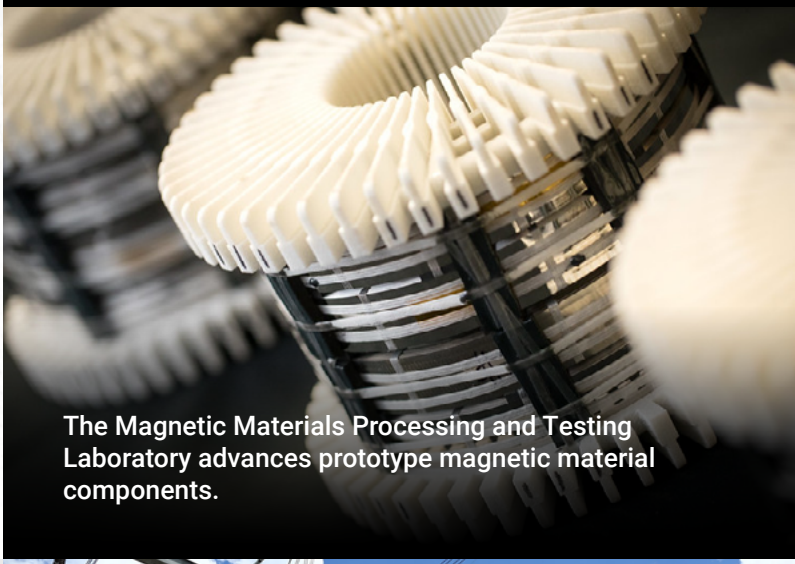
NETL advances technology that supports next-generation grid stability and reliability. Through innovations in sensing systems, computational modeling and integrated energy systems, NETL supports the development of more intelligent, more secure energy infrastructure capable of adapting to evolving demands and diverse energy sources. NETL can help reduce barriers to energy deployment through modeling, techno-economic assessment and rapid demonstration capabilities.

R&D Applications

- Smart Grid Planning and Modeling
- Fossil Energy Resources in a Modern Grid
- Sensing and Infrastructure Monitoring
- Techno-Economic and Systems Analyses
- Sensing Systems
- Artificial Intelligence (AI) and Machine Learning (ML)
- Advanced Diagnostics and Predictive Maintenance
- Cybersecurity for Energy Systems
- Integrated Energy Systems and Dispatch Optimization



The HyPer Facility uses cyber-physical simulations to test and develop advanced energy system components.



The Magnetic Materials Processing and Testing Laboratory advances prototype magnetic material components.

Award-Winning Technology for Energy Infrastructure Monitoring

The Transformer Watchman is a groundbreaking sensor technology that won an R&D 100 Award in 2023. The technology is an integrated fiber optics-based sensor system that continuously monitors energy systems to provide warnings of potential dangers or failures. The Watchman reduces service downtime, improves safety, ensures operational efficiency and protects national energy infrastructure.

Research Highlights

Advancing Solid Oxide Fuel Cell Energy Systems

NETL researchers used cyber-physical methodologies for the first successful hardware rapid-load turndown (under 10 seconds) in an integrated solid oxide fuel cell-gas turbine (SOFC-GT) energy system, demonstrating how integrated energy systems rapidly adjust to fluctuating power demands while sustaining grid resilience and reliability.

DISPATCHES Optimizes Integrated Energy Systems

NETL researchers developed DISPATCHES — a mathematical framework—to identify a flexible, dynamic design approach that is responsive to grid market signals, resulting in highly efficient, cost-effective, tightly coupled hybrid energy systems. This could include hybridizing existing generation facilities (such as nuclear and coal plants) and incorporating advanced technologies, such as advanced modular reactors.

UltraSonic Photonics Detects Potential Infrastructure Failures

UltraSonic Photonics, a 2024 R&D 100 Award recipient, uses ultrasonic waves and optical fiber sensing to monitor large-scale infrastructure. The innovation incorporates AI and ML to study the characteristics of healthy and degraded infrastructure to properly identify points of failure. With this technology, experts can check for changes in readings that may indicate damage to pipelines, bridges and other crucial energy infrastructure.

Markets and Grid Infrastructure Interdependence Collaborative (MAGIIC) Assessment

NETL has developed an integrated analysis capability called MAGIIC, which integrates industry-utilized market planning and operations data with tools to evaluate the complex interplay between infrastructure and economic market systems.. The tool can produce informed R&D pathways, detailed reliability evaluations and economic impact estimates. It avoids the blinders of single-function models, allowing for a more robust depiction of systems that closely match the real world.

Publications

- Aspitarte, L., & Woodside, C. R. (2024). A techno-economic survey of energy storage media for long-duration energy storage applications. Cell Reports Sustainability, 1(1). https://doi.org/10.1016/j.crsus.2023.100007.
- Eslick, J., Noring, A., Susarla, N., Okoli, C., Allan, D., Wang, M., Ma, J., Zamarripa-Perez, M. A., Iyengar, A., & Burgard, A. (2023). Technoeconomic Evaluation of Solid Oxide Fuel Cell Hydrogen-Electricity Co-Generation Concepts. DOI: 10.2172.1960782. https://doi.org/10.2172/1960782.
- Rowan, S., Kim, D., Belarbi, Z., Wells, A., Hill, D., Dutta, B., Bayham, S., Bergen, R., & Chorpening, B. (2023). Hydrogen Safety Review for Gas Turbines, SOFC, and High Temperature Hydrogen Production. DOI: 10.2172.1969531. https://doi.org/10.2172/1969531.
- Sun, C., Lu, P., Wright, R., & Ohodnicki, P. R. (2022). U.S. Patent No. 11,268,984. Washington, DC: U.S. Patent and Trademark Office.
- Zhang, B., Harun, N. F., Zhou, N., Oryshchyn, D., Colon-Rodriguez, J. J., Shadle, L., ... & Tucker, D. (2025). A real-time distributed solid oxide electrolysis cell (SOEC) model for cyber-physical simulation. Applied Energy, 388, 125607. https://doi.org/10.1016/j.apenergy.2025.125607.

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.