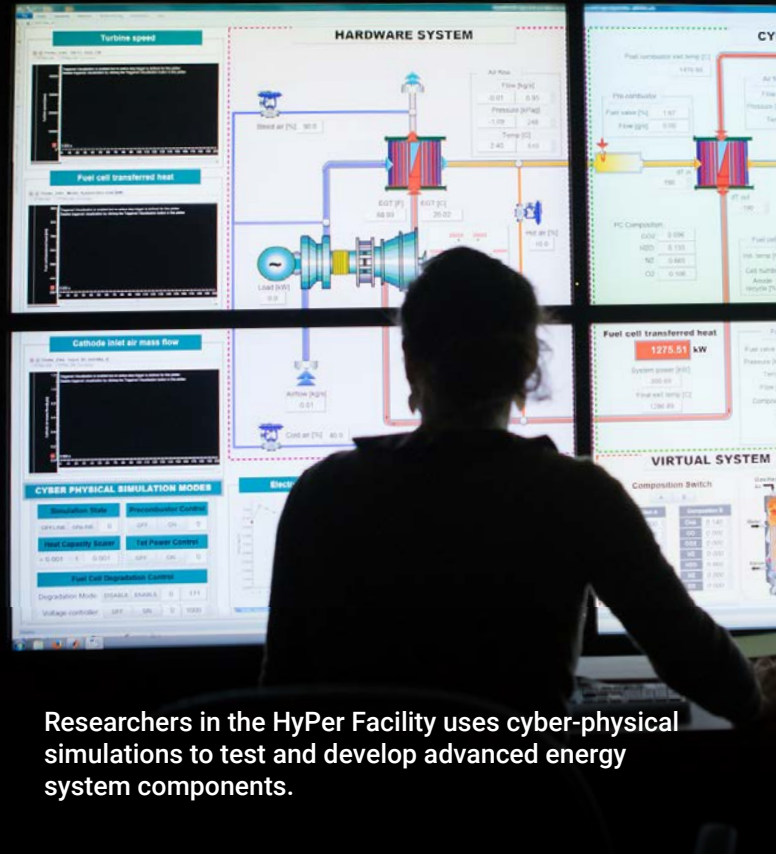


Grid Stability and Reliability

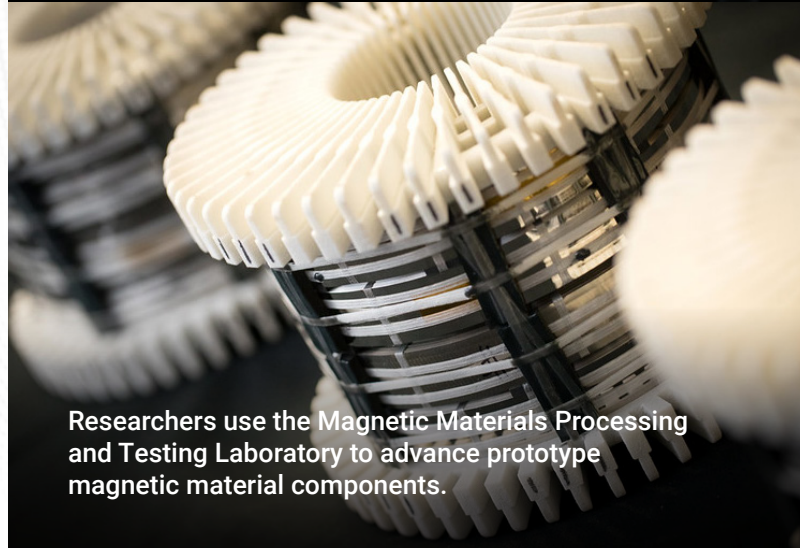
NETL advances technology that supports next-generation grid stability and reliability. Through innovations in sensing systems, computational modeling, and integrated energy systems, NETL supports the development of more intelligent, more secure energy infrastructure capable of adapting to evolving demands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

R&D Applications

- Smart Grid Planning and Modeling
- Hydrocarbon Resources in a Modern Grid
- Sensing and Infrastructure Monitoring
- Technoeconomic 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



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



Researchers use the Magnetic Materials Processing and Testing Laboratory to advance 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

Detecting 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.

Optimizing Integrated Energy Systems

Using advanced modeling and optimization frameworks, NETL researchers identify and refine novel Integrated Energy Systems, such as thermal energy storage paired with a coal power plant. Through the coupling of detailed process models with energy market signals, these workflows rigorously explore design spaces within the context of the specific grid and region of deployment. This framework integrates grid-scale market modeling with detailed process modeling to enable the optimization and valuation of hybrid, flexible energy systems beyond traditional technoeconomic analyses.

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 energy system, demonstrating how integrated energy systems rapidly adjust to fluctuating power demands while sustaining grid resilience and reliability.

Assessing Markets and Grid Infrastructure

NETL's market and energy system analysis supports the energy industry. Using an integrated analysis capability that federates energy industry-used market planning and operations data, NETL researchers use tools to evaluate the complex interplay between energy and fuels infrastructure and economic market systems. The capability produces informed R&D pathways, fuel security, deliverability, detailed reliability and affordability evaluations, and both domestic and international economic impact estimates. Systems analysis support allows stakeholders and partners to avoid blinders of siloed models, providing a more robust depiction of integrated energy and fuel systems that closely match real-world interactions and operations.

Publications

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- Rawlings, E. S., Susarla, N., Ghouse, J. H., Gooty, R. T., Dowling, A., Siirola, J., & Miller, D. C. (2023). *Simultaneous Design and Operation of a Coal-Fired Hybrid Energy System with Integrated Thermal Energy Storage*. National Energy Technology Laboratory; Sandia National Laboratories; Lawrence Berkeley National Laboratory; National Renewable Energy Laboratory. DOI: 10.2172/2350830. <https://doi.org/10.2172/2350830>.
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NETL is a U.S. Department of Energy (DOE) national laboratory dedicated to innovating and accelerating the nation's energy solutions in hydrocarbons, geothermal energy, and critical minerals production. The Lab further strengthens its impact by engaging with industry, academia, and other stakeholders through four strategically located Centers of Excellence: Coal, Critical Minerals & Advanced Alloys, Oil & Gas, and Geothermal. With research sites in Albany, Oregon; Morgantown, West Virginia; and Pittsburgh, Pennsylvania, NETL operates as one laboratory to create advanced energy technologies that support DOE's mission and enable affordable, reliable and, secure energy to fuel human prosperity.



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