



Building Partnerships and Catalyzing Industry to Modernize the Electric Grid

## Developing Innovative Technologies to Enhance Reliability, Ensure Resilience, and Increase Flexibility

The Office of Electricity Delivery and Energy Reliability (OE) provides national leadership to help ensure that the Nation's energy delivery system is secure, resilient, and reliable. OE works to develop new technologies to improve the infrastructure that brings electricity into our homes, offices, and factories, and the federal and state electricity policies and programs that shape electricity system planning and market operations.

OE also works to bolster the resiliency of the electric grid and assists with response, recovery, and restoration when major energy supply interruptions occur. And it advances the research, development and demonstration of innovative technologies, tools, and techniques to reduce risks to the Nation's critical energy infrastructure posed by cyber and other emerging threats.

OE is pursuing technologies to improve grid reliability, resiliency, efficiency, flexibility, functionality, and security; and making investments and sponsoring demonstrations aimed at bringing new and innovative technologies to maturity and helping them transition to market. These technologies are developed through strong collaborative efforts involving utilities, national laboratories, universities, and other electric power industry stakeholders.

### Grid Modernization is Critical for a Strong Economy and Secure Future

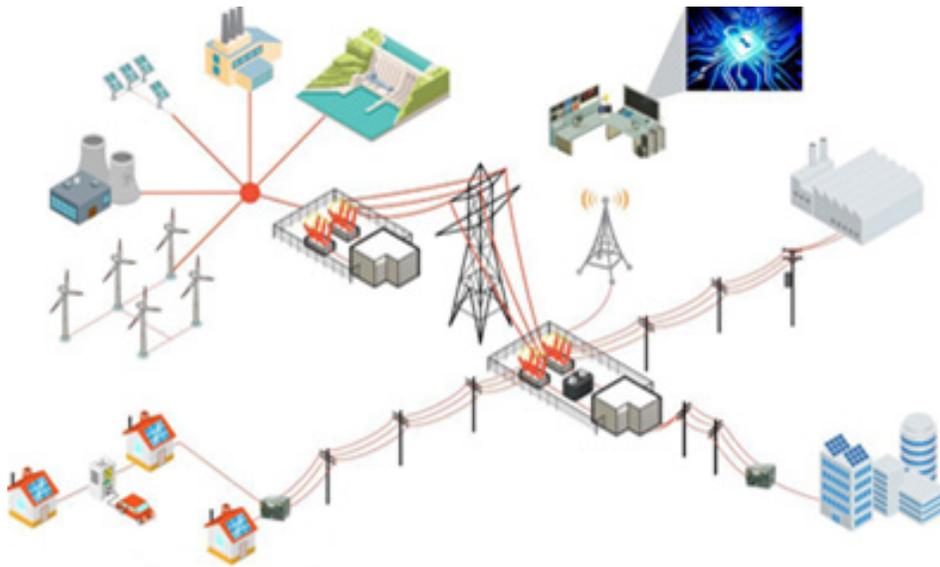
The U.S. electric power system is the centerpiece of the Nation's economy. Virtually every aspect of American commerce and industry depends on the continuous

OE R&D accelerates discovery and innovation in electric transmission and distribution technologies and supports the creation of "next generation" devices, software, tools, and techniques to help modernize the electric grid.

availability of affordable electric power. This incredible feat is achieved through an extensive infrastructure of more than 19,000 generators, 55,000 transmission substations, 642,000 miles of high-voltage lines, and 6.3 million miles of distribution lines that serves more than 145 million customers.

#### Advanced technologies and techniques are needed to:

- Integrate variable renewable resources and other new technologies that are centralized and distributed;
- Meet customer demands for high-quality power with high reliability in the face of growing threats;
- Enable customers to participate in electricity markets and manage their energy consumption;
- Facilitate the growing convergence of information and communication technologies with electricity control systems; and
- Manage aging grid assets, provide new and better capabilities, and reduce costs.



The electric grid is the heart of the nation's power system; it connects a vast network of generation sources and customer loads.

OE's R&D plays a pivotal role in the Department's Grid Modernization Initiative, a comprehensive effort to help shape the future of our nation's grid and solve critical challenges.

## OE is Driving Grid Modernization and Resiliency in the Energy Infrastructure

In recent years, OE successfully managed \$4.5 billion, of which \$3.4 billion was used to help industry accelerate the deployment of advanced technologies that are now keeping the lights on more reliably and efficiently and reducing costs.

In 2016, DOE launched the Grid Modernization Initiative (GMI), a comprehensive effort to help shape the future of our nation's grid with primary funding support coming from OE and the Office of Energy Efficiency and Renewable Energy. DOE National Laboratories are participating across GMI's technology areas in a coordinated strategic partnership called the Grid Modernization Lab Consortium (GMLC), which bring together leading experts and resources to collaborate on national grid modernization goals.

OE has made significant contributions to driving grid modernization and resiliency in the energy infrastructure and will continue to do so in the future. Examples of R&D program impacts are shown in the table below.

R&D Program Areas	Impacts on Grid Modernization
Cybersecurity for Energy Delivery Systems	Exposed security vulnerabilities for critical control systems, and produced methods and technologies for ensuring the grid operates safely and reliably, even in the face of cyber-threats.
Smart Grid R&D	Demonstrated technologies that allowed utilities to better view and measure conditions on the grid, communicate critical information to customers, and respond automatically to disturbances to minimize the duration and impact of outages.
Microgrid R&D	Advanced technologies and methods for isolating and reconnecting parts of the grid to ensure that critical loads will be served in the event of a large scale outage.
Energy Storage	Developed and demonstrated new energy storage technologies, such as batteries and flywheels that can be used to optimize the grid and provide backup power in emergencies.
Transformer Resilience and Advanced Components	Developed advanced components, such as superconducting wires and power electronic switches that can improve the efficiency and performance of the grid.
Transmission Reliability	Developed and demonstrated new technologies to measure and visualize power flows on the grid to improve controls and minimize the risk of large scale outages.
Advanced Grid Modeling	Leveraged advances in mathematics and computing to improve models and data analytics for grid applications that will enhance operator decision making and minimize the cost of operating the grid.