

FY 2017 Budget Request

Office of Electricity Delivery and Energy Reliability



Assistant Secretary Patricia Hoffman

February 9, 2016

The Office of Electricity Delivery and Energy Reliability

The Office of Electricity Delivery and Energy Reliability (OE) leads the Department of Energy's efforts to ensure that our Nation's energy delivery system is affordable, reliable, and resilient. OE achieves this mission by developing new technologies that 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 with government and industry partners to bolster the resiliency of the energy infrastructure and assist with restoration efforts when major energy supply interruptions occur.

The FY 2017 request for OE advances Administration and Secretarial priorities (including the Quadrennial Energy Review [QER], Quadrennial Technology Review [QTR], and Mission Innovation) to safeguard and enhance the grid to address a range of vulnerabilities, including climate change, cyber threats, and aging infrastructure. The request plays a pivotal role in supporting the President's "All of the Above" energy strategy to advance the Nation's energy, economic, security, and environmental goals:

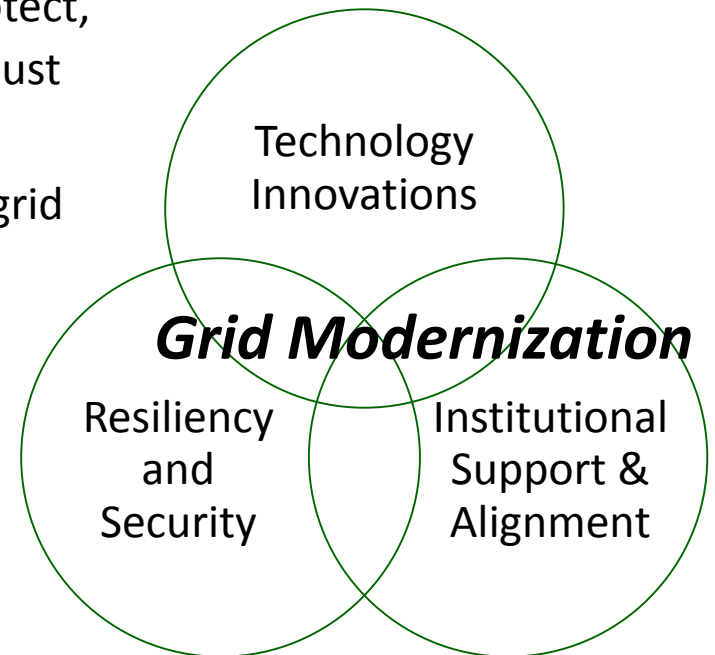
- *Secure the Nation's grid*
- *Ensure reliable & efficient electricity*
- *Promote & prepare resilient communities*
- *Drive the clean energy revolution*

The Office of Electricity Delivery and Energy Reliability

Investing in the Future of the Energy Infrastructure

Demonstrating a strong commitment to address the challenges and needs of the electric system of the future, OE's FY 2017 Request of \$262.3M will:

- Drive development of tools and technologies that measure, analyze, predict, and control the grid of the future
- Increase energy resiliency and security to better protect, prevent, and respond to all hazards with a more robust focus on cybersecurity and physical security
- Establish two new programs that will support state grid modernization efforts, and provide funding for energy-related preparedness
- Support a new Grid Institute focused on technologies related to critical materials for grid application



DOE's FY 2017 Grid Modernization Crosscut

(Dollars in Thousands)

Organization	Institutional Support and Alignment	Technology Innovation	Grid Security and Resilience	Total FY 2017 Request
Electricity Delivery and Energy Reliability ^a	26,650	107,250	52,900	186,800
Energy Efficiency and Renewable Energy	28,489	149,756	11,485	189,730
Energy Policy and Systems Analysis	1,000	—	—	1,000
Indian Energy Policy and Programs	1,000	—	—	1,000
Total, Grid Modernization	57,139	257,006	64,385	378,530

This coordinated program of activities accelerates the development of the technologies and tools to enable modernization of the grid to support U.S. economic growth, environmental quality and security objectives.

The Grid Modernization Initiative (GMI) addresses three broad areas including:

- **Technology (i.e., hardware):** Develop and demonstrate technologies for better measurement, integration, management and control of grid operations
- **Modeling and Analysis (i.e., software):** Develop and disseminate new and improved models for analysis, management, and optimization of grid performance
- **Institutional and Business:** Develop the analytical methodologies and frameworks for improving business models that can deliver to consumers the value and benefits of grid modernization

^aGrid Institute, ISER, State Energy Assurance, and Program Direction are not counted within the Grid Modernization Crosscut

Grid Modernization Initiative (OE: \$186.8M)

Changing Electricity Supply Mix

Threats to Resilience and Reliability

New Market Opportunities for Consumers

Information and Control Technologies

Aging Infrastructure

Grid Modernization Multi-Year Program Plan

Institutional Support (\$26.7M)

- Provides technical assistance to key decision-makers so they can address the high priority grid modernization challenges and needs identified by electric power industry stakeholders

Design and Planning Tools (\$24.9M)

- Develops the next generation of modeling and simulation tools needed for power system planning

System Operations, Power Flow, and Control (\$42.1M)

- Focuses on new control technologies to support new generation, load, and storage technologies

Sensing and Measurement (\$10.9M)

- Focuses on tools and strategies to determine the type, number, and placement of sensors to improve system visibility

Devices and Integrated System Testing (\$29.3M)

- Develops devices and integrated systems, coordinates integration standards and test procedures, and evaluates the grid characteristics of both individual devices and integrated systems to provide grid-friendly energy services

Security and Resilience (\$52.9M)

- Addresses physical and cybersecurity challenges and assesses ways to minimize risk and provide situational awareness during energy-related emergencies

Regional Demonstrations

Low Reserve Margin Demo

Clean Distribution Feeder

Grid Analytics Platform

OE Strategic Building Blocks

OE Programs

Clean Energy
Transmission and
Reliability

Smart Grid Research
and Development

Cybersecurity for
Energy Delivery
Systems

Energy Storage

Transformer Resilience
and Advanced
Components

National Electricity
Delivery

State Distribution-level
Reform

Multi-Year Program Plan

Devices and Integrated
Systems

Sensing and
Measurement

System Operations and
Control

Design and Planning
Tools

Security and Resilience

Institutional Support

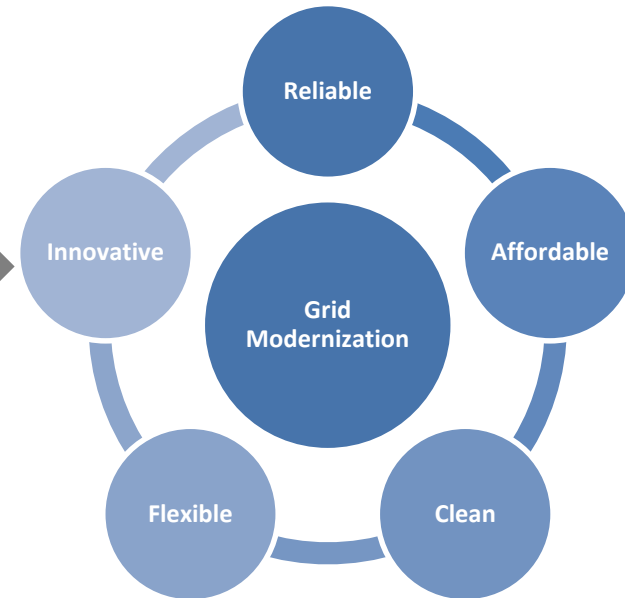
Regional Demonstrations

Low Reserve Margin
Demo

Clean Distribution
Feeder

Grid Analytics
Platform

Modernized Grid



Our path to a modernized grid to power American leadership in the 21st Century

FY 2017 OE Budget Highlights

The OE Budget Request of \$262M, an increase of 27.3%, includes \$177M of clean energy research and development as part of the President's proposal to advance Mission Innovation.

New programs requested in FY 2017:

- Grid Institute (\$14.0M)
- State Distribution-level Reform (\$15.0M)
- State Energy Assurance (\$15.0M)

Substantial increases to:

- Energy Storage (\$44.5M, +\$24.0M)
- Transformer Resilience and Advanced Components (\$15.0M, +\$10.0M)
- Infrastructure Security and Energy Restoration (\$17.5M, +\$8.5M)



Mission Innovation includes twenty countries that have committed to double their respective clean energy R&D investment over five years.

OE FY 2017 Budget Request

(Dollars in Thousands)

Program/Activity	FY 2015 Enacted	FY 2016 Enacted	FY 2017 Request	FY 2017 vs. FY 2016
Clean Energy Transmission and Reliability	34,262	39,000	30,300	-8,700
Smart Grid	15,439	35,000	30,000	-5,000
Cybersecurity for Energy Delivery Systems	45,999	62,000	45,500	-16,500
Energy Storage	12,000	20,500	44,500	+24,000
Transformer Resilience and Advanced Components	—	5,000	15,000	+10,000
Grid Institute	—	—	14,000	+14,000
National Electricity Delivery	6,000	7,500	6,500	-1,000
State Distribution-level Reform	—	—	15,000	+15,000
Infrastructure Security and Energy Restoration	6,000	9,000	17,500	+8,500
State Energy Assurance	—	—	15,000	+15,000
Program Direction	27,606	28,000	29,000	+1,000
Subtotal, Electricity Delivery and Energy Reliability	147,306	206,000	262,300	+56,300
Rescission of prior year balances	-331	—	—	—
Total, Electricity Delivery and Energy Reliability	146,975	206,000	262,300	+56,300

Highlights of the FY 2017 Request

Grid Institute

FY 2016 Enacted	FY 2017 Request	FY 2017 vs. FY 2016
---	14,000	+14,000

The Grid Clean Energy Manufacturing Innovation Institute will be part of the larger multi-agency National Network for Manufacturing Innovation. It will focus on projects that facilitate the transition of innovative material processes and production technologies for grid application to industry.

The FY 2017 request provides the first year of funding for the Grid Institute. A primary focus will be on accelerating innovations in industrial metals into grid application, but other technological advances that support development of next-generation components will be included.

Potential topic areas for the Grid Institute include manufacturing of:

- Alloys with lower resistance and higher strength for use in overhead transmission lines
- Metal matrix composites with improved magnetic properties for use in high frequency power electronic systems
- Metal laminates with thinner insulation for more energy efficient transformer cores



Processing of alloys to optimize permeability and loss

State Distribution-level Reform

FY 2016 Enacted	FY 2017 Request	FY 2017 vs. FY 2016
---	15,000	+15,000

The State Distribution-level Reform program will assist states, through competitive awards, with identifying and addressing issues related to undertaking reforms whether they are structural, policy, or regulatory in nature

New in FY 2017, the State Distribution-level Reform program will help state officials to utilize DOE's national laboratories, associated academic institutions, and other subject matter experts to develop targeted solutions for regionally specific issues:

- Competitively award 5 to 10 cooperative agreements for a 2 year performance period
- Potential topics of interest:
 - Grid architecture
 - New regimes for data access and data sharing
 - Distribution system planning

Highlights of the FY 2017 Request
State Energy Assurance

FY 2016 Enacted	FY 2017 Request	FY 2017 vs. FY 2016
---	15,000	+15,000

The State Energy Assurance program is designed to help states, localities, and tribes increase their capacity to prepare for energy disruptions. This new program will provide funds via competitive regional cooperative assistance awards that would be used by OE's state, local, tribal, and territorial stakeholders for planning, training, and exercising in advance of energy emergencies.

Key components of this program include:

- Approximately 10 awards will be competitively awarded to teams of local, state, regional, tribal and territorial entities. These awards will be used to further or improve the capabilities of the regions and states to characterize energy sector supply disruptions; communicate among the local, state, regional, Federal and industry partners; and identify gaps that can be used to inform energy planning and emergency response training programs
- National laboratory expertise and capability would be available to the awardees as well as for use in real-world energy emergencies

Highlights of the FY 2017 Request

Energy Storage

FY 2016 Enacted	FY 2017 Request	FY 2017 vs. FY 2016
20,500	44,500	+24,000

The Energy Storage program develops and demonstrates new and advanced energy storage technologies that will enable the stability, resiliency, and reliability of the future electric utility grid, as well as increase the deployment of variable renewable energy resources.

The FY 2017 Request supports work on materials research, device development, demonstrations, and grid analysis to help transition selected energy storage technologies from R&D to industrially relevant scales, safety, and costs:

- Initiate 3–4 new highly leveraged, cost-shared demonstrations encompassing 8MW+ of energy storage assets per QER and QTR recommendations
- Focus R&D efforts on prototyping new aqueous soluble organic flow battery chemistries capable of halving the cost relative to the current vanadium/vanadium (V/V) technology
- Expand the Energy Storage Safety Forum to include reliability efforts focused on development of accelerated testing metrics for energy storage and power conditioning systems
- Develop a suite of regulatory tools and energy storage valuation models for regulators, utilities, and developers



UET vanadium flow battery in Avista, Washington

Transformer Resilience and Advanced Components

FY 2016 Enacted	FY 2017 Request	FY 2017 vs. FY 2016
5,000	15,000	+10,000

The Transformer Resilience and Advanced Components (TRAC) program focuses on increasing the resilience of transformers and other critical components (i.e., grid hardware), and developing cost-effective, next-generation components that are inherently more resilient with advanced capabilities needed in the future grid

In FY 2017, TRAC activities support the Administration's strategy on resilience and physical security, and align with the outcomes of the 2015 QTR:

- Issue a competitive solicitation for next-generation transformer prototypes with enhanced flexibility and functionality to encourage standardization and increase interchangeability
- Expand modeling and testing of transformers to include other critical assets, such as circuit breakers and relays, to understand failure mechanisms from the impact of geomagnetic disturbances (GMD) and electromagnetic pulses (EMP)

Infrastructure Security and Energy Restoration

FY 2016 Enacted	FY 2017 Request	FY 2017 vs. FY 2016
9,000	17,500	+8,500

The ISER program **enhances the security and resilience of the Nation's energy infrastructure** (electricity, petroleum, and natural gas) by working with industry, trade associations and governments to prepare for, respond to, and recover from all threats and hazards.

The FY 2017 budget request reflects ISER's commitment to expand Energy Sector security and resilience through full coordination with our government and industry partners in the delivery of analysis, training, data, tools and exercises to sector stakeholders:

- Develop and implement training models to create a Nation-wide energy responder network
- Evaluate and strengthen DOE's capabilities to respond to energy emergencies through exercises with national-level partners in government and industry
- Transform EAGLE-I, a situational awareness tool for national power outages, into an integrated system for electricity and fuel data acquisition, modeling, and visualization
- Develop an effective, timely, and coordinated cyber incident management capability as part of its all-hazards approach to incident coordination for the energy sector
- Investigate, in partnership with industry, new and emerging threats to the energy infrastructure including those posed by EMPs, GMDs, and black-starts

Highlights of the FY 2017 Request

Smart Grid R&D

FY 2016 Enacted	FY 2017 Request	FY 2017 vs. FY 2016
35,000	30,000	-5,000

The Smart Grid program focuses primarily on the development of innovative technologies, tools, and techniques to modernize the distribution portion of the electric delivery system.

The FY 2017 Request supports four focus areas to manage the complexity from increasing deployments of distributed generation, electric vehicles, microgrids, and demand-side management, as well as to strengthen resiliency against increasing weather disaster events posed by climate change.

- **Advanced Distribution Management System (ADMS)** will develop an integrated software platform that enables integration of functionalities and applications across vendors for optimization and management of the entire distribution system, and will develop next generation applications to meet the future of the grid needs
- **Transactive Control** supports activities to enhance simulation tools, generate test cases, and validate tools using the initial test cases
- **Microgrid R&D** supports field demonstrations of microgrid designs with advanced controllers to achieve a commercially viable microgrid, implementation of a design decision support tool for remote microgrids, and coordination and optimization of multi-microgrid operations
- **Resilient Electric Distribution Grid R&D** supports national labs to test resilient distribution grid tools (for system design and planning and for system restoration), and supports cities and utilities in deploying smart grids for climate preparedness and resilience

Highlights of the FY 2017 Request

Cybersecurity for Energy Delivery Systems

FY 2016 Enacted	FY 2017 Request	FY 2017 vs. FY 2016
62,000	45,500	-16,500

Cybersecurity for Energy Delivery Systems (CEDs) supports research on cutting edge cybersecurity solutions, information sharing to enhance situational awareness, and implementing tools to aid industry to improve their cybersecurity posture.

The FY 2017 request reflects the critical need to accelerate and expand efforts to strengthen the energy infrastructure against cyber threats and mitigate vulnerabilities:

- Issue a research call for national laboratories and a solicitation for energy sector-led R&D that strengthens energy delivery control system cybersecurity
- Support the next Cybersecurity Risk Information Sharing Program (CRISP) Operational Pilot, focused on improving the enrichment of the participant data with U.S. Government information and increasing the speed of information sharing
- Continue to expand the utility volunteers to demonstrate the Cybersecurity Capability Maturity Model (C2M2) data analytics and benchmarking methodologies, building on existing benchmarking work and laying the foundation for the C2M2 web portal
- Develop innovative solutions to use for reconstitution after a large-scale cyber event
- Complete implementation of the Virtual Energy Sector Advanced Digital Forensics Analysis Platform and transition it to the private sector

Clean Energy Transmission and Reliability

FY 2016 Enacted	FY 2017 Request	FY 2017 vs. FY 2016
39,000	30,300	-8,700

The Clean Energy Transmission and Reliability (CETR) program's goal is to improve energy system decision making for operations and planning of the electricity transmission system and to mitigate risks to interconnected energy infrastructure systems.

Transmission Reliability (\$12.3M)

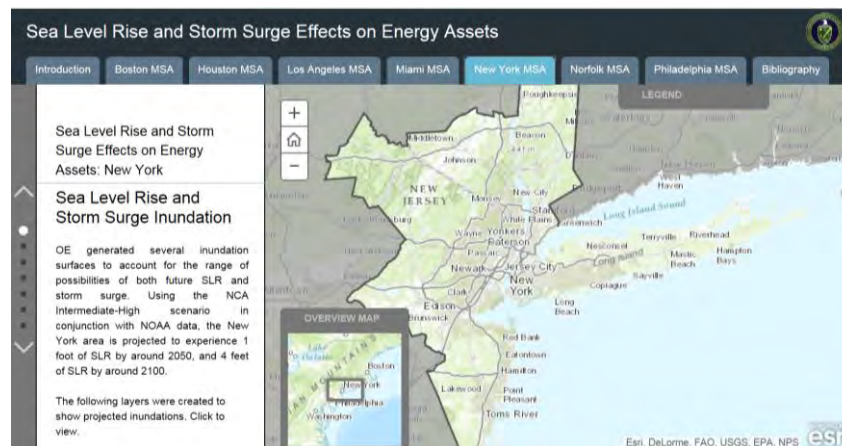
- Develop and test methods for validating power system models using real-time data in a real-world environment to support operations and improve reliability

Advanced Modeling Grid Research (\$12.0M)

- Develop and test advanced computational capabilities for simulating power system behavior in a real-world environment, per QTR recommendation to advance algorithms to support grid operations

Energy Systems Risk and Predictive Capability (\$6.0M)

- Advance risk and decision science for energy systems by improving the statistical characterization of two wide-area natural hazards that disrupt energy systems-damaging thunderstorm events and large ice accumulation events-thus improving planning and investment and response to disruptions



Visualizing energy infrastructure exposure to storm surge and sea-level rise
<http://energy-oe.maps.arcgis.com/apps/MapSeries/index.html?appid=244e96e24b5a47d28414b3c960198625>

Highlights of the FY 2017 Request

National Electricity Delivery

FY 2016 Enacted	FY 2017 Request	FY 2017 vs. FY 2016
7,500	6,500	-1,000

The National Electricity Delivery (NED) program, in support of the QER, helps state, regional, and tribal entities to develop, refine, and improve their programs, policies, and laws related to electricity while mitigating market failures. In addition, NED implements a number of legal authorities, such as coordination of transmission permitting by Federal agencies, periodic transmission congestion studies, permitting of cross-border transmission lines, and authorization of electricity exports.

The FY 2017 request:

- Maintains the suite of tools (including the Energy Zones Mapping Tool) at the Federal, state, and local levels
- Provides technical assistance on electricity-related topics to states, public utility commissions, tribes, and other regional and Federal entities
- Coordinates Federal permitting of new transmission infrastructure that crosses the Canadian or Mexican border with the U.S. or involves Federal lands
- Reviews of national transmission plans and assesses barriers to their implementation
- Produces white papers on key subjects relating to Regulated Utility Business Models

FY 2016 Solicitations

Program	Solicitation
Clean Energy Transmission and Reliability Transmission Reliability	Synchrophasor application for transmission operators
	University research - Advanced synchrophasor technology research
	University research - Economic and technical intersections for the grid
Clean Energy Transmission and Reliability Advanced Modeling Grid Research	University research - NSF Joint solicitation on mathematical methods computation
Smart Grid R&D	Low Cost Sensors
	Smart Grid Challenge for Cities and Communities
Cybersecurity for Energy Delivery Systems	Virtual Energy Sector Advanced Digital Forensics Analysis Platform
	Cybersecurity Risk Information Sharing Program (CRISP) - deploy sensors on utility operational networks to facilitate the timely sharing of cyber threat information and integrate situational awareness tools
	Advanced Control Concepts
	Industry R&D for energy delivery control system cybersecurity
Transformer Resilience and Advanced Components	Next Generation Transformers - Phase 1

FY 2017 Solicitations

Program	Solicitation
Clean Energy Transmission and Reliability Transmission Reliability	University research - Human cognition for electricity systems
	University research - Big data applications for synchrophasor data
Clean Energy Transmission and Reliability Advanced Modeling Grid Research	Industry - Developing and deploying tools based on past innovation from programs which recommend actions to operators under dynamic and abnormal conditions
Clean Energy Transmission and Reliability Energy Systems Risk and Predictive Capability	University research - Analytical products supporting risk-informed decision making in energy system planning
Smart Grid R&D	Field Demos of Microgrid System Designs with Advanced Controllers
	Local Electricity Delivery Infrastructure
Cybersecurity for Energy Delivery Systems	Industry R&D for energy delivery control system cybersecurity
	Cybersecurity Risk Information Sharing Program (CRISP)
Energy Storage	Initiate 3-4 highly leveraged, cost-shared demonstrations in conjunction with states, utilities, and storage providers
	University research focused on the continued development of next generation storage technologies
Transformer Resilience and Advanced Components	Next Generation Transformer - Phase 2
	Modular Adaptive Grid Integration Converter (MAGIC)
	Applied Materials Research
Grid Institute	Focus on projects that facilitate the transition of innovative material processes and production technologies for grid application to industry
State Distribution-level Reform	Competitive cooperative agreements to help states identify and address issues related to undertaking distribution-level reform
State Energy Assurance	Competitive cooperative agreements to teams of state, local, tribal, and territorial stakeholders for planning, training, and exercising in advance of energy emergencies