



Grid Modernization Initiative

Office of Electricity Delivery and Energy Reliability


Office of Energy Efficiency and Renewable Energy

March 2, 2016



Why Grid Modernization?


The existing U.S. power system has served us well...
but our 21st Century economy needs a 21st Century grid.




Security Threats

A black and white photograph showing a city skyline at night, with the text "Security Threats" overlaid in white.

Changing Supply Mix

A black and white photograph showing two people installing solar panels on a roof, with the text "Changing Supply Mix" overlaid in white.

Extreme Events

A black and white photograph showing a damaged power line and a house, with the text "Extreme Events" overlaid in white.

New Market Opps.

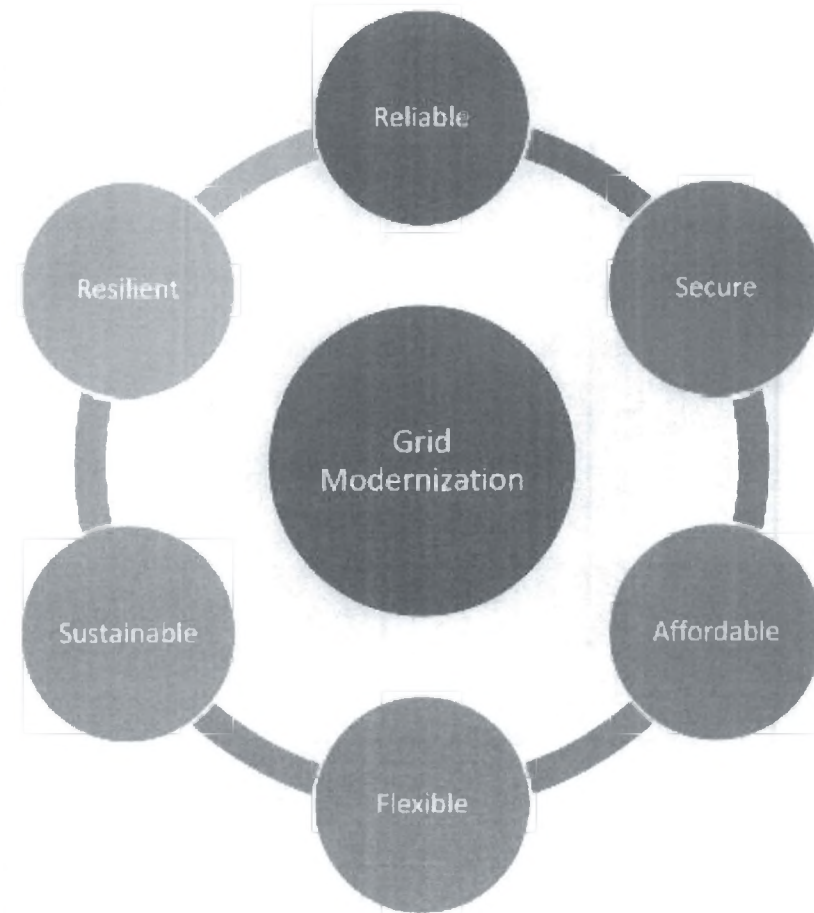
A black and white photograph showing a white SUV driving on a road, with the text "New Market Opps." overlaid in white.



Grid Modernization Initiative

The vision of DOE's Grid Modernization Initiative (GMI) is:

- A future grid that will solve the challenges of seamlessly integrating conventional and renewable sources, storage, and central and distributed generation.
- The future grid as a critical platform for U.S. prosperity, competitiveness, and innovation in a global clean energy economy.
- A future grid that will deliver **resilient, reliable, flexible, secure, sustainable, and affordable** electricity to consumers where they want it, when they want it, how they want it.





The MYPP Advances the QER and QTR findings and state and regional needs

Drivers of change as identified in the QTR

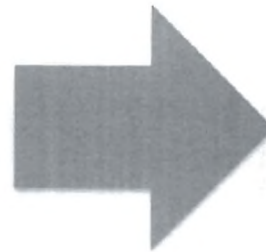
Changing Electricity Supply Mix

Growing Threats to Resilience and Reliability

New Market Opportunities for Consumers

Information and Control Technologies

Aging Infrastructure



Grid MYPP is a major deliverable of the QER

Devices and Integrated System Testing

Sensing and Measurement

System Operations, Power Flow, and Control

Design and Planning Tools

Security and Resilience

Institutional Support



GMI Will Have National Impact

Drivers of change

Changing
Electricity
Supply Mix

Threats to
Resilience and
Reliability

New Market
Opportunities
for Consumers

Information and
Control
Technologies

Aging
Infrastructure

MYPP

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*



GMI's Integrated Technical Thrusts

Institutional Support

- Provide tools and data that enable more informed decisions and reduce risks on key issues that influence the future of the electric grid/power sector

Technology Innovation

Design and Planning Tools

- Create grid planning tools that integrate transmission and distribution and system dynamics over a variety of time and spatial scales

System Operations, Power Flow, and Control

- Design and implement a new grid architecture that coordinates and controls millions of devices and integrates with energy management systems

Sensing and Measurements

- Advance low-cost sensors, analytics, and visualizations that enable 100% observability

Devices and Integrated System Testing

- Develop new devices to increase grid services and utilization and validate high levels of variable generation integrated systems at multiple scales

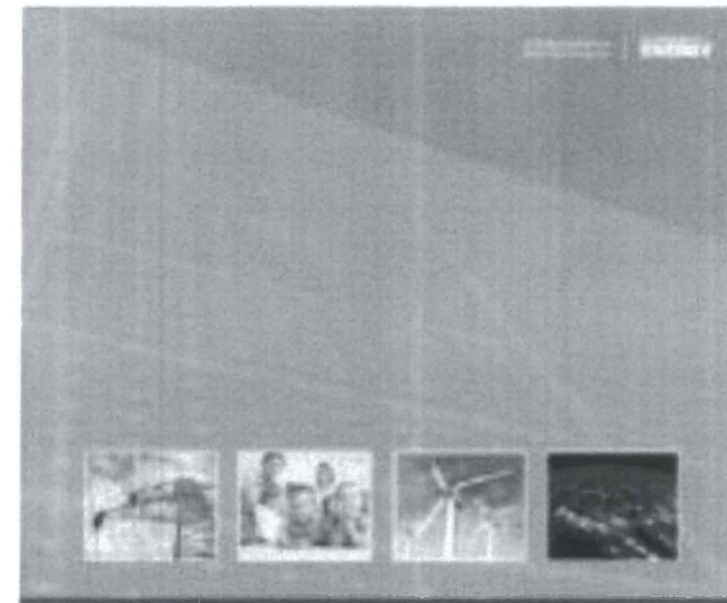
Security and Resilience

- Develop advanced security (cyber and physical) solutions and real-time incident response capabilities for emerging technologies and systems



DOE Grid Modernization Lab Call for FY16

- ***Category 1: Foundational Platform Activities***
 - Fundamental Analysis
 - Core Activities
 - Pioneer Partnerships
 - Technical Areas
 - *Proposals were coordinated across the GMLC-National Laboratory complex*
- ***Category 2: Program Office Specific Activities***
 - Topics that address their specific requirements for grid modernization
 - *Proposals solicited under in the category will undergo a traditional open lab call competition.*



Grid Modernization
Multi-Year Program Plan

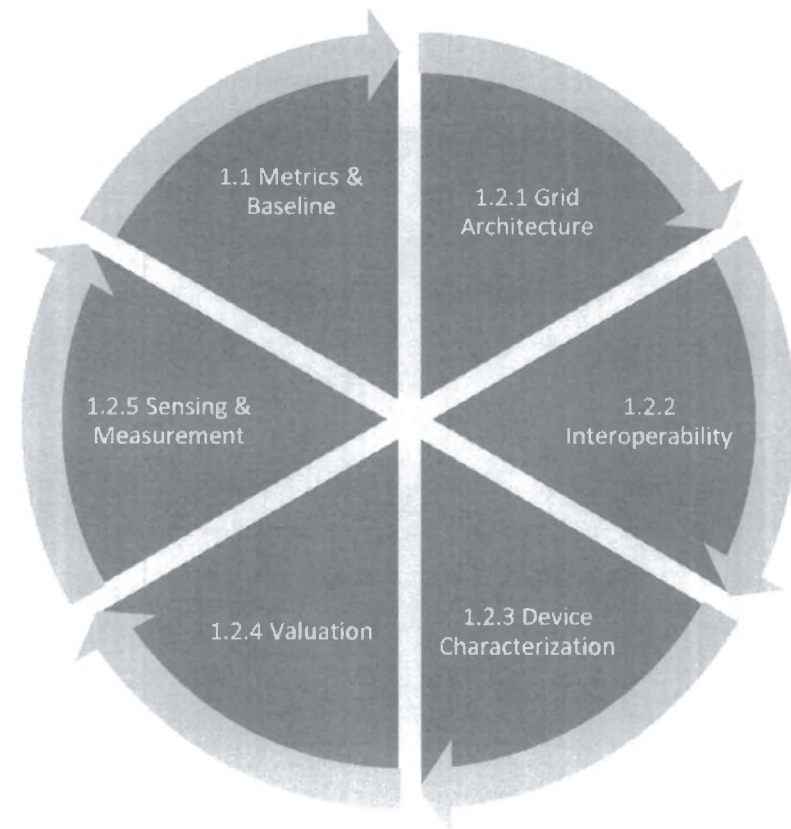
Updated: April 2014



Core Activities

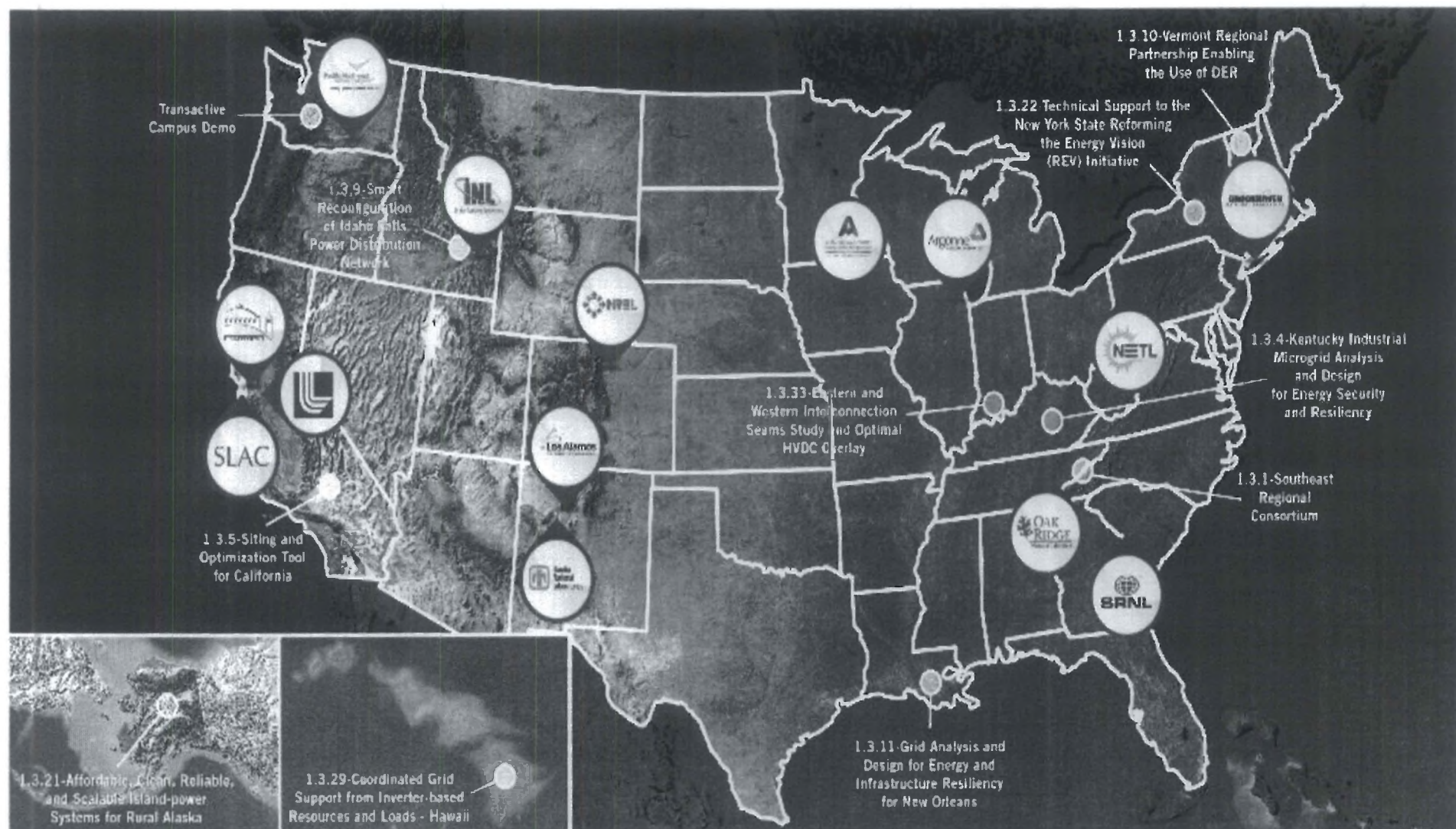
The Foundational Research projects provide the fundamental knowledge, metrics, and tools needed to support all the Cross-Cut R&D and regional partnerships. They provide the framework to enable an integrated DOE grid modernization strategy, including:

- **Metrics and Baseline**: fundamental metrics to guide and evaluate national progress in grid modernization;
- **Grid Architecture**: future grid and industry design elements to guide consideration of new industry paradigms;
- **Interoperability**: standards and protocols for interoperability and testing of all grid devices from high voltage to customer premises;
- **Device Characterization**: an integrated testing network that spans the National Labs as well as industry and academia;
- **Valuation**: a consensus framework for valuing emergent grid technologies and services; and
- **Sensing Strategy**: a strategy for observing and monitoring the future grid system in a way that meets expectations for predictive control, real-time operations and security.





State and Regional Engagement





Grid Frequency Support from Distributed Inverter-Based Resources in Hawaii

Drivers of change



Changing
Electricity Supply
Mix

Growing Threats
to Resilience and
Reliability



New Market
Opportunities for
Consumers



Information and
Control
Technologies

Aging
Infrastructure

- **Challenge:**
- HPUC Docket 2014-0192 ("the Docket"), states that because the Oahu system is now less resilient to contingency events, "new measures may be needed to maintain system stability such as ... DER-based solutions to support system stability." These issues will only worsen as continued deployment of PV and wind further displaces the conventional generation whose rotational inertia and primary frequency response traditionally stabilize the grid in the critical first few seconds following a major loss of load or generation Hawaii Public Utilities Commission, "Staff Report and Proposal, Docket No. 2014-0192," March 31, 2015.
- **Solution from MYPP:**
Develop, simulate, validate, and deploy practical solutions in Hawaii that enable distributed energy resources (DERs) to help mitigate bulk system frequency contingency events on the fastest time scale (milliseconds to seconds). Validate the ability of real hardware inverters to support grid frequency in an environment that emulates the dynamics of a HECO power system.
- **Partners:**
Hawaiian Electric Companies, Enphase Energy, Fronius USA, Forum on Inverter Grid Integration Issues, Energy Excelsior

Primary Technical Area of MYPP

Devices and
Integrated System
Testing





Vermont Regional Partnership Enabling the Use of DER

Drivers of change

★ Changing Electricity Supply Mix

Growing Threats to Resilience and Reliability

★ New Market Opportunities for Consumers

★ Information and Control Technologies

Aging Infrastructure

- **Problem today:**
The *Vermont Comprehensive Energy Plan* (CEP) sets forth an ambitious and pioneering vision that calls for Vermont to obtain 90% of its energy from renewable sources by 2050, with a near-term goal for DG to reach 1% of electricity sales in 2017, rising to 10% in 2032
- **What MYPP will address:**
Assist Vermont utilities in meeting the state's ambitious goal of obtaining 90% of its energy from renewable sources by 2050 through (1) DER integration, (2) DER control, 3) validation of wind and solar forecasting, and (4) techno-economic analysis of energy storage.
- **Partners:**
Green Mountain Power, VT Electric Cooperative, VT Electric Company, Univ of VT

Primary Technical Areas for Demo

System Operations, Control and Power Flow





California Distributed Resource Planning

Drivers of change



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- **Challenge:**
AB 327 requires the electric utilities in California to file Distribution Resources Plans (DRPs) to identify optimal locations for the deployment of distributed resources
- **Solution from MYPP:**
Deliver an online open-access integrated distributed resource planning and optimization platform
- **Partners:**
CA Public Utility Commission
Pacific Gas & Electric
Southern California Edison
NYSEERDA
Metropolitan Washington Council of Governments
- **Expected impact:**
Identify meaningful behind-the-meter DER adoption patterns, potential microgrid sites and demand-side resources, and evaluate the impacts of high renewable penetration feeders on the distribution and transmission grid

Primary Technical Area of MYPP

Design and Planning
Tools





Grid Analysis and Design for Energy and Infrastructure Resiliency for New Orleans

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- **Challenge:**
- Coastal cities in the Southeastern United States face a range of severe weather threats, including hurricanes, floods, and tornadoes. These threats can cause significant damage and disruption to cities, including loss of life, business interruptions and economic losses, and failure of critical infrastructure services. Many of these impacts occur because of failures in the electrical power system, so maintaining effective operations of critical systems and services during a major extended power outage is a growing concern to these cities
- **Solution from MYPP:**
Conduct technical evaluations to assess energy and critical infrastructure vulnerabilities, and to identify cost effective options to improve the resiliency of both the electrical grid infrastructure and the community.
- **Partners:**
City of New Orleans, Rockefeller Institute, Entergy, US Army Corps of Engineers

Areas of MYPP

Security and
Resilience





Crosscutting Demonstrations

Demonstrations: Demonstrations will be based on active regional engagement starting in FY 2015 and FY 2016 to ensure the demonstration projects will be based on regional needs. Demonstration projects will co-optimize across multiple grid attributes including affordability, security, resilience, reliability, and integration of clean technologies. By their nature, the co-funded, demonstration projects will cut across all six technical areas (budgets are included in each technical area). DOE expects competitive awards in three types of demonstrations:

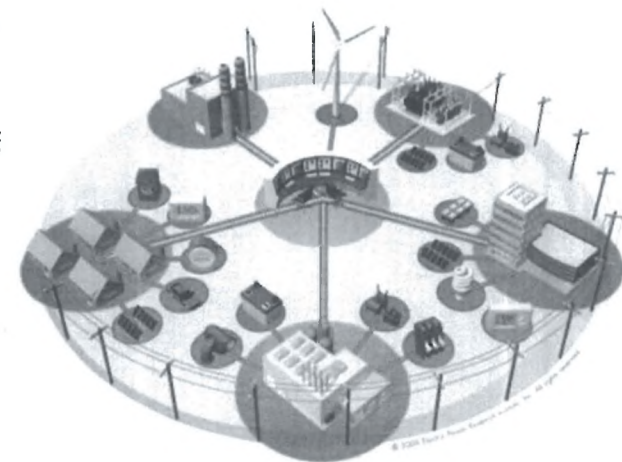
- **A transmission and distribution system operating reliably on a lean reserve margin**
- **Resilient distribution feeders with high percentages of low-carbon distributed energy resources**
- **An advanced modern grid planning and analytics platform**



DOE Major Activities— Demos

- **Lean Bulk Power Systems**

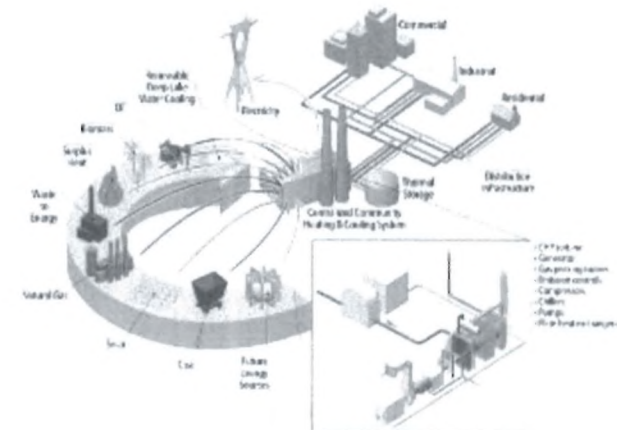
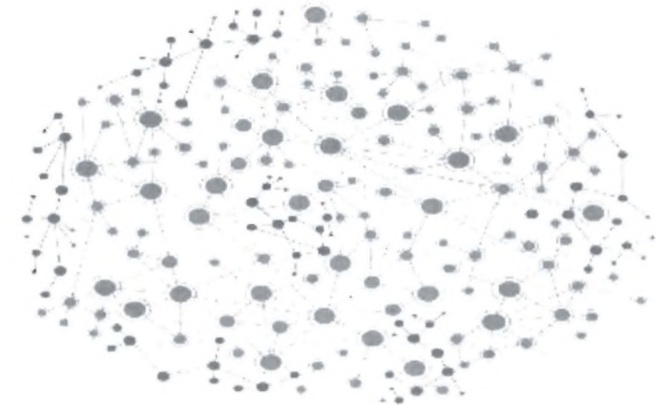
- **Reliable:** Maintain reliable operations with a 10% transmission reserve margin or lower
- **Affordable:** New operations capability for grid operators to safely run system closer to “edge” for increased asset utilization and to leverage distribution-level grid services will require less generation reserve
- **Secure:** Incorporate advance physical and cyber security measures for the integration of large numbers of devices. Deploy predictive operations tools to detect and mitigate risk in real-time.
- **Clean:** Real-time tools enhance wind resources with high transmission asset utilization and management of system dynamics. Leverage of demand reduces emission from standby generation.
- **Resilient and Flexible:** Reduce outages by order of magnitude with improved prediction, detection, and distributed controls





DOE Major Activities (continued)

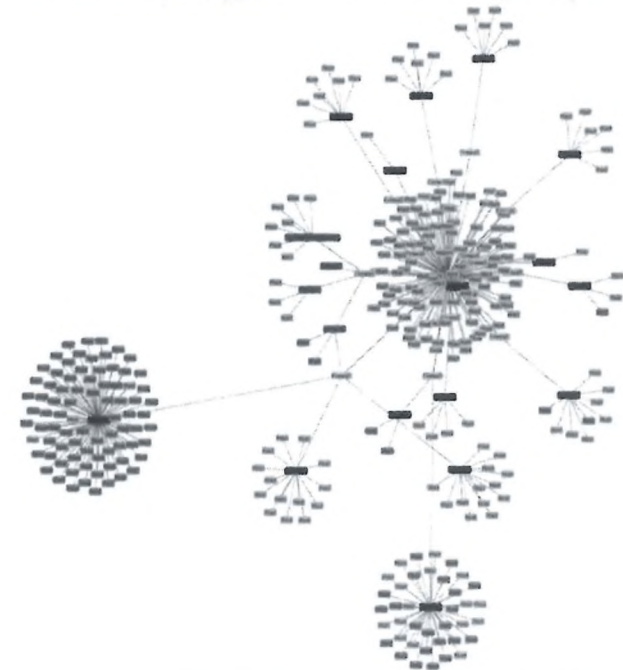
- **Clean Distribution Systems**
 - **Reliable & Resilient:** Coordinated microgrids control for resilience (e.g., 20% fewer outages, 50% shorter recovery time)
 - **Affordable:** Distributed, hierarchical control for clean energy and new customer-level innovation for asset utilization
 - **Secure:** Cyber resilient design of responsive loads and controls. Automation for outage detection and topology awareness for state estimation.
 - **Clean and Flexible:** Demonstrate reliable and affordable feeder operations with greater than 50% distributed energy resources (DER) penetration. Engage interactive efficiency concepts in buildings.





DOE Major Activities (continued)

- **Major Achievement #3 – Grid Planning and Analytics**
 - **Reliable & Resilient:** Use coupled T&D grid planning models with 1000x speed-up to address specific grid issues
 - **Affordable:** Work with States to more rapidly evaluate new business models, impacts of policy decisions
 - **Secure:** Ensure high-level cybersecurity for all data-driven and operational models
 - **Clean:** Develop with stakeholders new data-driven approaches to DER valuation and market design
 - **Flexible:** Accommodate a multitude of system operation and planning options





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