

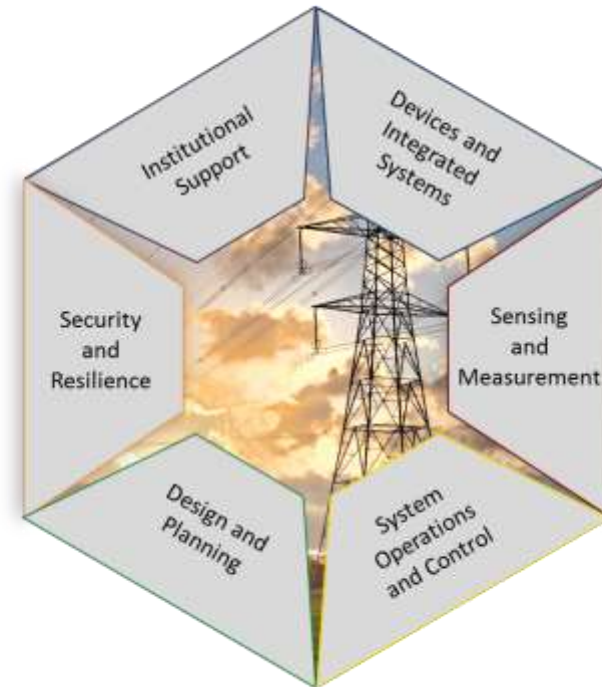
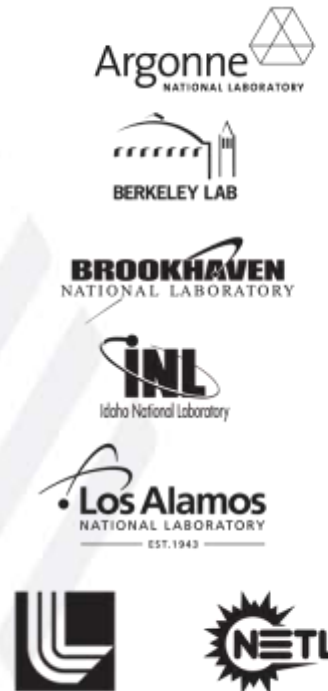
GMLC Accomplishments and Future Directions

GMLC Leadership Team

Peer Review, September 2018

GMLC Accomplishments and Future Directions

- ▶ DOE perspectives
- ▶ GMLC Tech Team Progress and Prospects

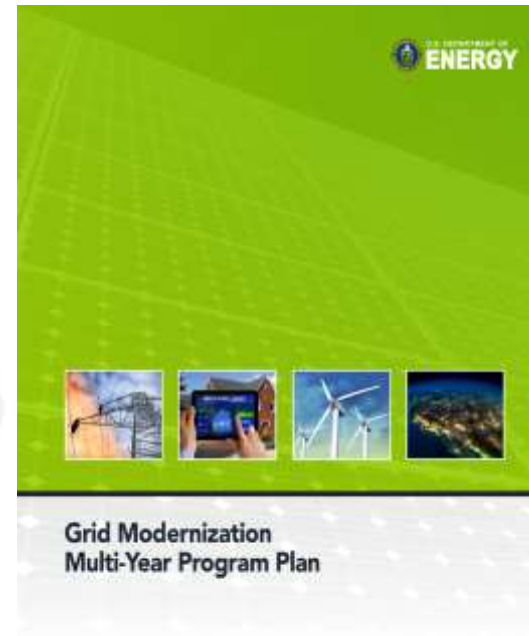


Grid Modernization FY15 to Present

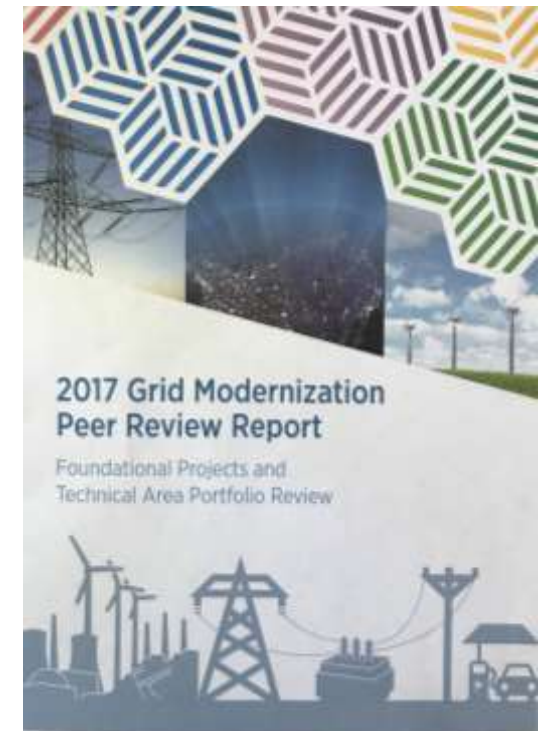


- ▶ Inaugural DOE Grid Modernization MYPP
- ▶ GMLC Project Portfolio (**\$88M / FY16**)
 - 6 foundational research projects
 - 13 cross-cutting projects
 - 10 strategic regional partnerships
- ▶ **GMI Program Specific Portfolio (\$132M / FY16)**
- ▶ 100+ Partners (Utilities, Vendors, Academia and states)
- ▶ Six Regional Workshops
- ▶ 2017 Peer Review
- ▶ FY17 Resilient Distribution Systems Awards (**\$32M**)
- ▶ Completing 10 Strategic Regional Partnerships

2015



2017

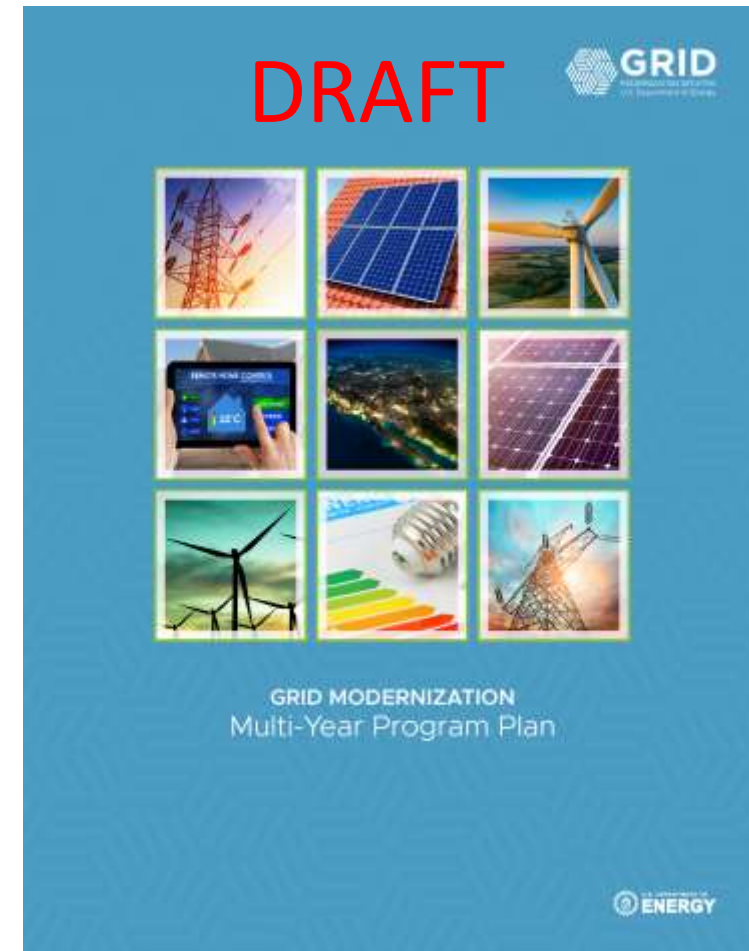


Themes of Updated MYPP (under construction)

► Emerging Themes

- Resilience spanning current grid paradigm and emerging cyber and high DER challenges
- Interdependence of energy systems
- Advanced control and architecture paradigms
- Advanced “all hazards” analytics
- Sensors and smart controllers for flexibility and resilience
- High performance planning tools to position for future complexities

► Will reflect expanded DOE Grid Modernization Initiative Charter



Characterization and testing of energy technologies for providing grid services to improve system affordability, reliability and sustainability

Expected Outcomes

- ▶ Develop new grid interface devices to increase ability to provide grid services and utilization
- ▶ Coordinate and support the development of interconnection and interoperability test procedures for provision of grid services
- ▶ Validate secure and reliability grid operation with high levels of variable generation at multiple scales

Federal Role

- ▶ Common approach across labs and industry test-beds for effective validation of emerging technologies
- ▶ Develop common interoperability and interconnection standards and test procedures for industry / vendor community



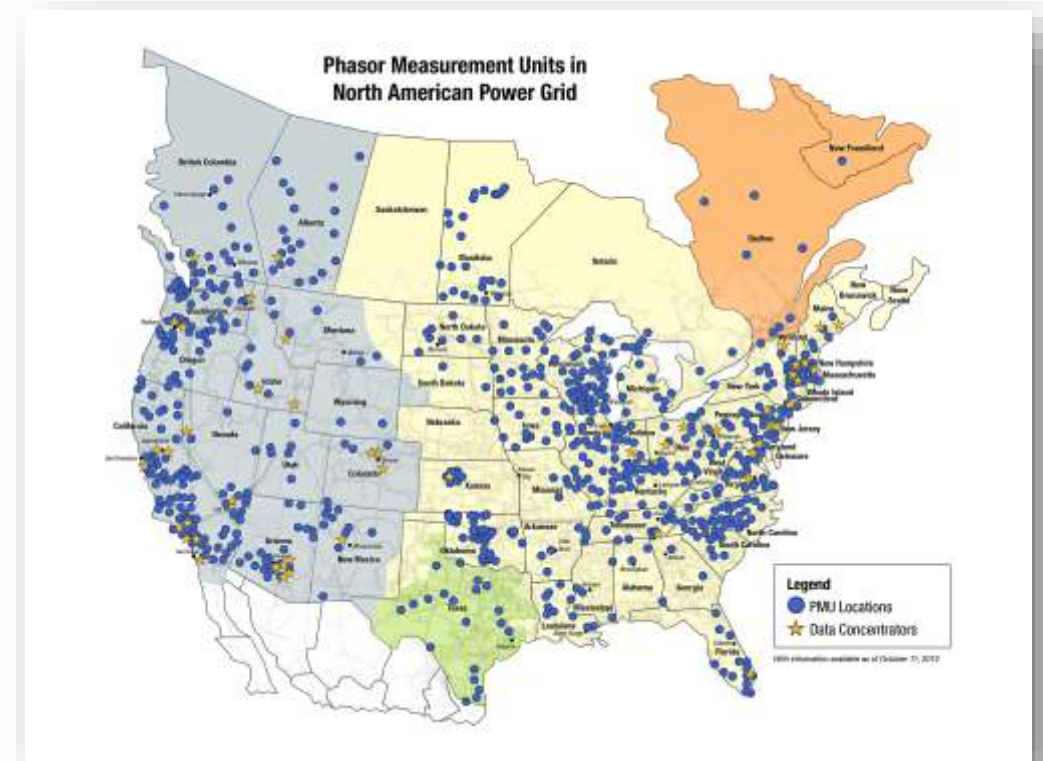
Sensor development and validation strategies to provide complete grid system visibility for resilience and prediction

Expected Outcomes

- ▶ Advance and integrate novel, low-cost sensors to provide system visibility
- ▶ Incorporate new data streams (e.g. weather)
- ▶ Develop real-time data management and data exchange frameworks that enable analytics to improve prediction and reduce uncertainty
- ▶ Develop next-generation sensors that are accurate through disturbances to enable closed-loop controls and improved system resilience

Federal Role

- ▶ Common approach across labs and industry test-beds for effective validation of emerging technologies
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System Operations and Control

Advanced real-time control technologies to enhance the reliability and asset utilization of transmission and distribution systems

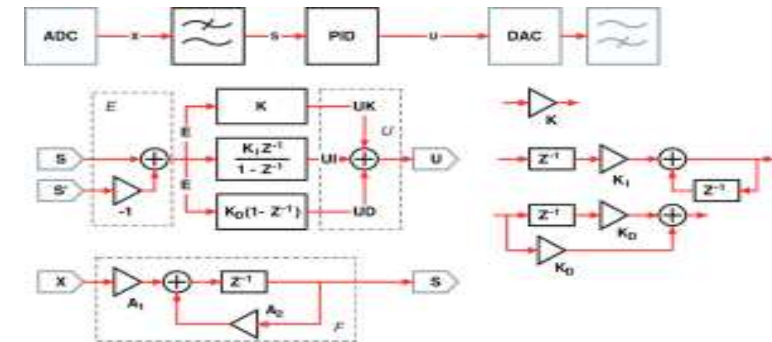
Expected Outcomes

- ▶ Deliver an architecture, algorithms, and control frameworks for a clean, resilient and secure grid
- ▶ Advanced operations software platform for predictive operations & real-time adaptive control
- ▶ New power flow control device hardware and concepts
- ▶ Advance fundamental knowledge for new control paradigms

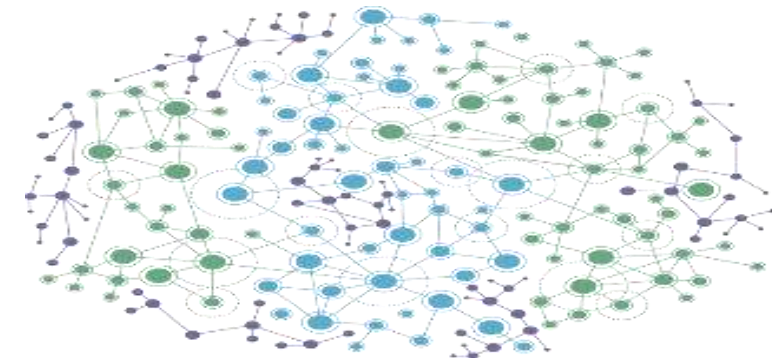
Federal Role

- ▶ Convening authority to shape vision of advanced grid architecture
- ▶ Advance fundamental knowledge for new control paradigms for emerging grid to support industry transformation
- ▶ Deliver computational science, materials science & mathematics from National Laboratories to develop integrated faster-than-real-time software platforms and power electronics control schemes

Conventional Controls



Distributed Controls



Design and Planning Tools

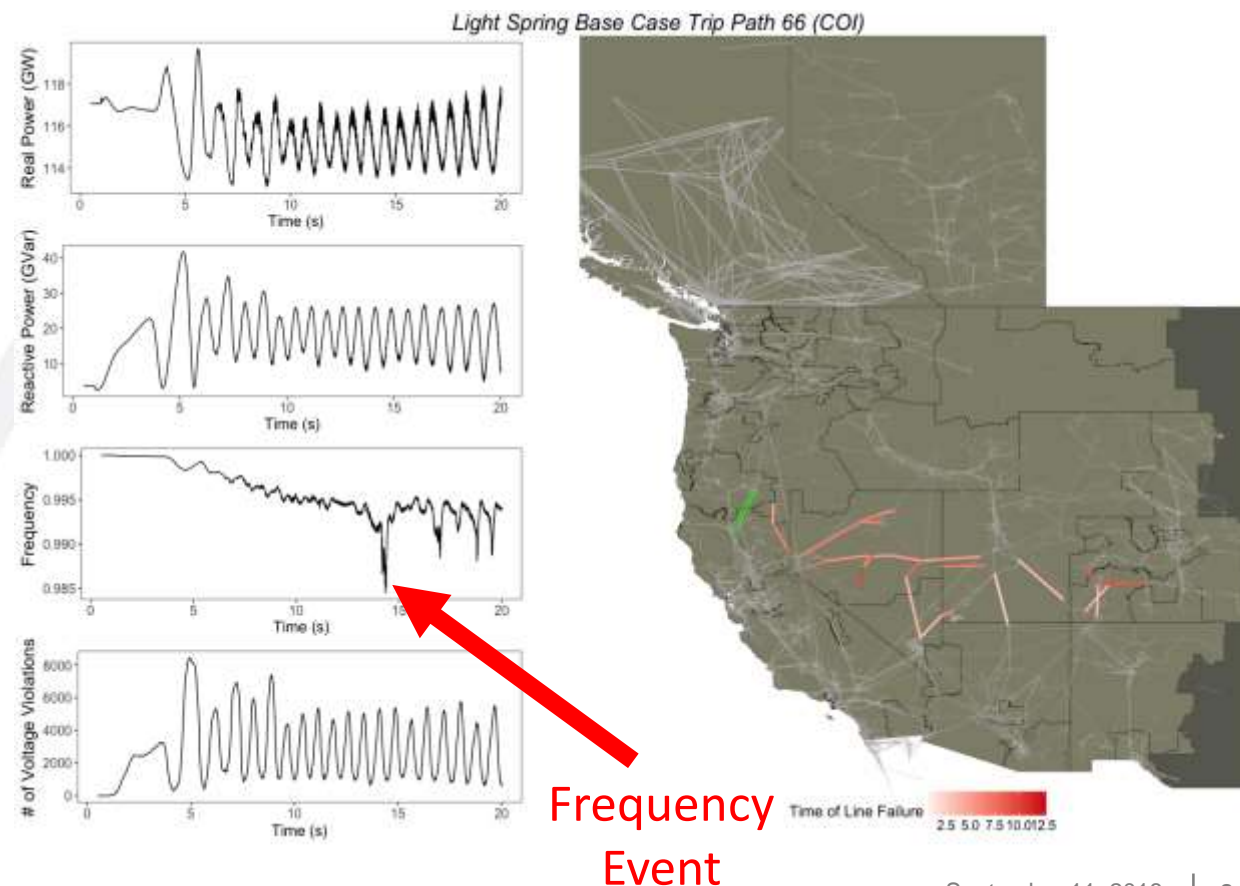
Drive next generation of planning and design tools to more accurately perform cost-benefit trade-offs and improve grid reliability and resilience

Expected Outcomes

- ▶ Software framework to couple grid transmission, distribution, and communications models to understand cross-domain effects
- ▶ Incorporate uncertainty and system dynamics into planning tools to accurately model renewables, extreme events, etc.
- ▶ Computational tools, methods, and libraries that enable 1000x improvements in performance for analysis and design

Federal Role

- ▶ Attack strategic gaps in tools capabilities
- ▶ Partner with industry to demonstrate value
- ▶ Work with vendors to transition R&D into practice



Providing a pathway to comprehensive multi-scale security and resilience for the nation's power grid

Expected Outcomes

- ▶ Holistic grid security and resilience, from devices to micro-grids to systems
- ▶ Inherent security designed into components and systems, not security as an afterthought
- ▶ Security and resilience addressed throughout system lifecycle and covering the spectrum of legacy and emerging technologies

Federal Role

- ▶ Lead and establish security and resilience research programs to develop technology solutions and best practice guidance
- ▶ Improve adoption of security and resiliency practices, and provide technology-neutral guidance
- ▶ Inform stakeholders of emerging threats and help address threats appropriate for government response



Institutional Support

Enable regulators and utility/grid operators to make more informed decisions and reduce risks on key issues that influence the future of the electric grid/power sector

Expected Outcomes

- ▶ Accelerated state & federal policy innovation due to enhanced State and Regional technical assistance
- ▶ States adopt changes to their regulatory model that better align utility interests with grid modernization and/or clean energy policy goals
- ▶ Methods for valuation of DER technologies and services are defined and clearly understood by stakeholders to enable informed decisions on grid investments and operations

Federal Role

- ▶ Provide independent, unbiased technical assistance (e.g., information and analysis tools) that address key grid-related policy, regulatory, and market issues
- ▶ Create an over-arching stream of grid-related “institutional” analysis, workshops, and dialogues to raise awareness of the need for grid modernization

