Grid Modernization Initiative

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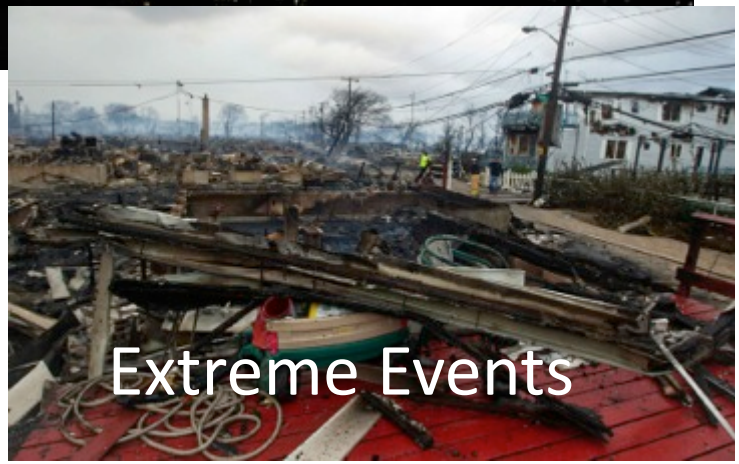
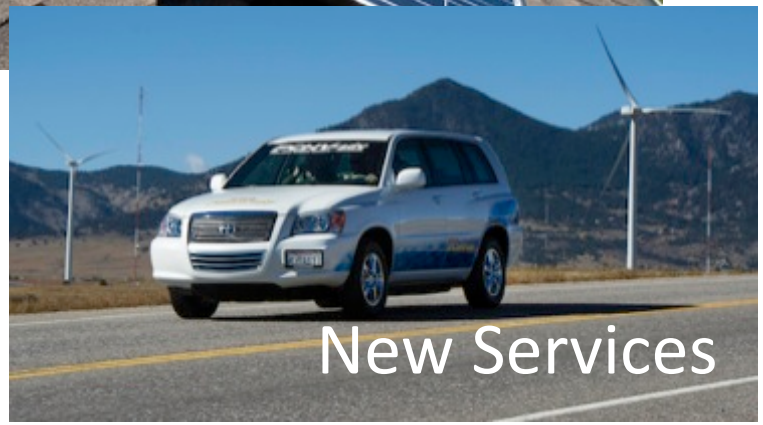
Why Grid Modernization?

The existing U.S. power system has served us well…

but our 21st Century economy needs a 21st Century grid.





Trends: Moving from the 20th Century to the 21st Century

The structure of the 20th century grid, however, cannot meet all the demands of the 21st century. Five key trends are driving this transformation:

- A changing mix of types and characteristics of electric generation
- Growing demands for a more resilient and reliable grid
- Growing supply- and demand-side opportunities for customers to participate in electricity markets
- The emergence of interconnected electricity information and control systems
- An aging infrastructure

Both Challenge and Opportunity

Grid Modernization Vision

- *Seamlessly **integrate conventional and renewable sources**, storage, and central and distributed generation*
- ***Platform** for U.S. prosperity, competitiveness, and innovation in a global clean energy economy.*
- ***Resilient, reliable, flexible, secure, sustainable,** and **affordable** electricity to consumers where they want it, when they want it, how they want it.*

Achieve Public Policy Objectives

- 80% clean electricity by 2035
- State RPS and EEPS mandates
- Access to reliable, affordable electricity
- Climate adaptation and resilience

Sustain Economic Growth and Innovation

- New energy products and services
- Efficient markets
- Reduce barriers for new technologies
- Clean energy jobs

Mitigate Risks and Secure the Nation

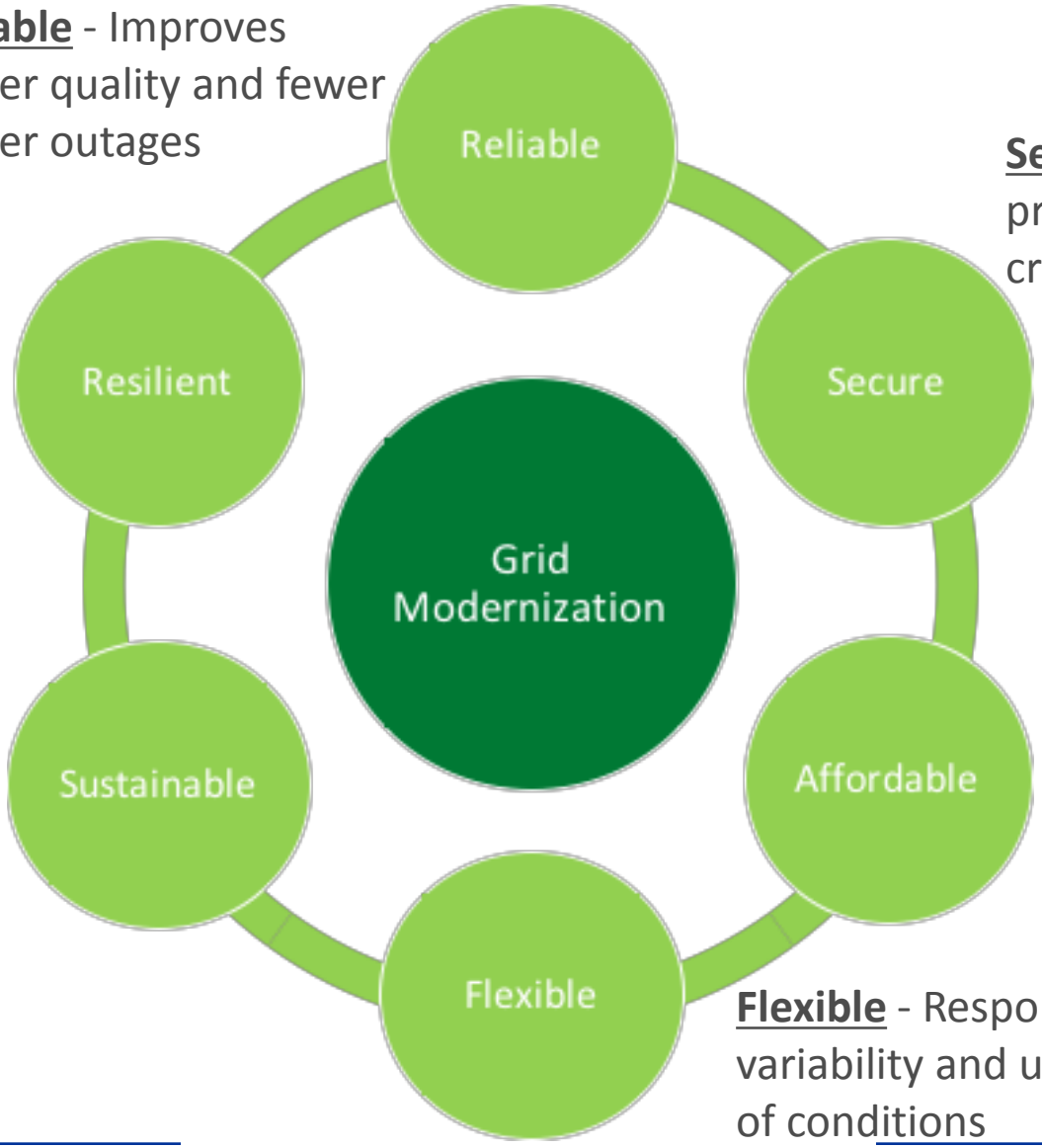
- Extreme weather
- Cyber threats
- Physical attacks
- Natural disasters
- Fuel and supply diversity
- Aging infrastructure

Key Attributes of a Modernized Grid

Reliable - Improves power quality and fewer power outages

Secure - Increases protection to our critical infrastructure

Resilient - Quick recovery from any situation or power outage



Affordable - Maintains reasonable costs to consumers.

Sustainable - Facilitates broader deployment of clean generation and efficient end use technologies

Flexible - Responds to the variability and uncertainty of conditions

GMI's Integrated Technical Thrusts

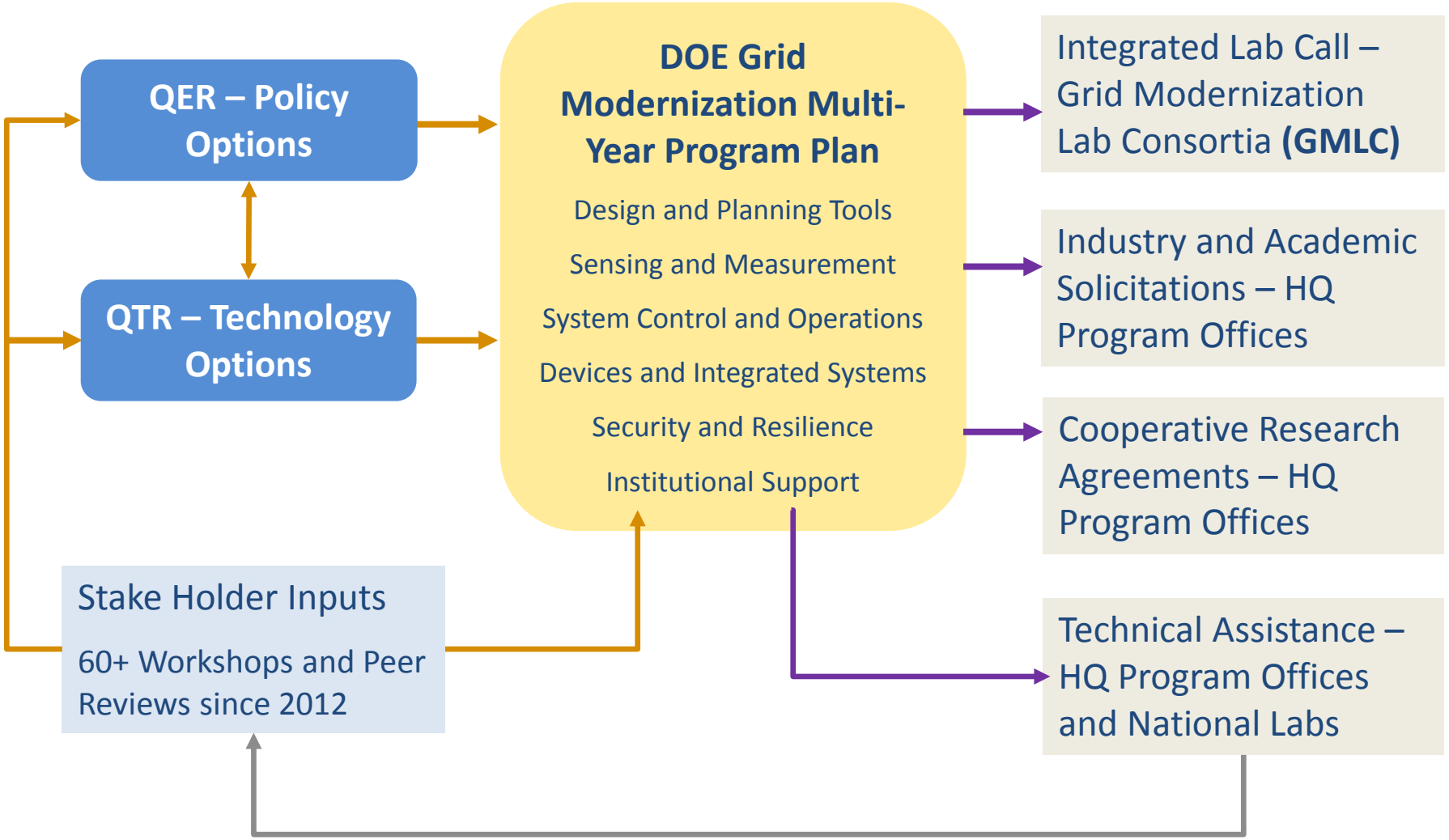
Institutional Support	• Tools and data to enable more informed decisions and reduce risks on key issues that influence the future of the electric grid/power sector
Design and Planning Tools	• **Integrate** transmission and distribution and system dynamics over a variety of time and spatial scales
System Operations, Power Flow, and Control	• A **new grid architecture** that coordinates and controls millions of devices and integrates with energy management systems
Sensing and Measurements	• Advanced low-cost sensors, analytics, and visualizations that enable **100% observability**
Devices and Integrated System Testing	• Increase grid **services and utilization** and validate high levels of variable generation integrated systems at multiple scales
Security and Resilience	• Advanced security (**cyber and physical**) solutions and real-time incident response capabilities

Technology Innovation

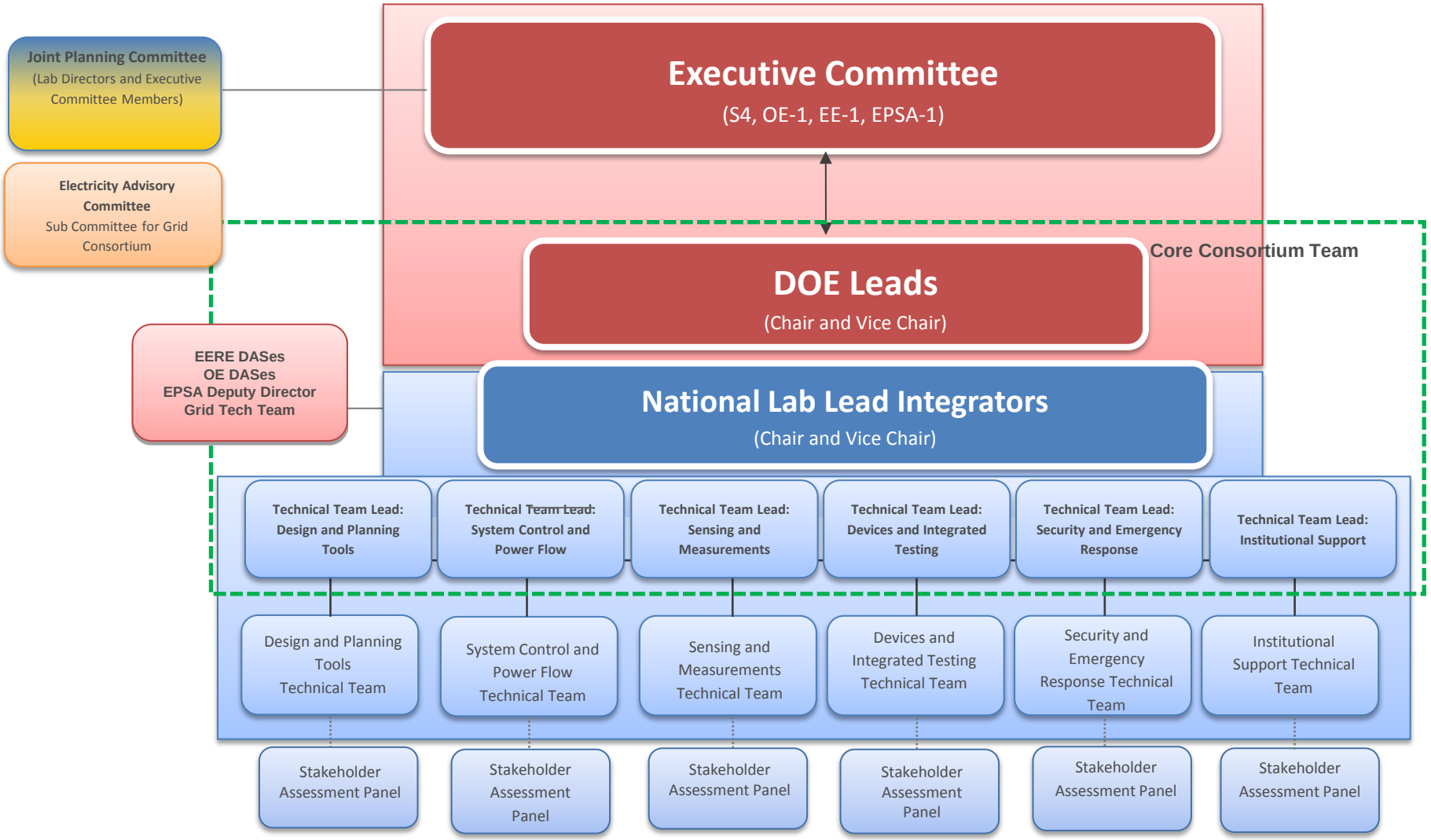
Impacts on Renewable Power

Institutional Support	• Enable regulators to **understand** the implications of high penetrations of solar installed behind the meter
Technology Innovation: Design and Planning Tools	• Help utilities plan for a system **with high penetrations** of wind, solar and geothermal systems.
Technology Innovation: System Operations, Power Flow, and Control	• **Forecasts** that improve operators ability to predict wind and solar - reduce the need for excess reserves.
Technology Innovation: Sensing and Measurements	• Better **visibility into the distribution system** will more clearly indicate where and when challenges with high penetration solar occurs.
Technology Innovation: Devices and Integrated System Testing	• New devices to increase grid services that **validate high levels of variable generation** integrated systems at multiple scales
Technology Innovation: Security and Resilience	• **Advanced security (cyber and physical) solutions** for behind the meter solar as it continues to become more prevalent.

Connectivity to Other DOE Activities



Grid Modernization Laboratory Consortium



DOE 2015-16 Grid Modernization Lab Call

Topic Areas

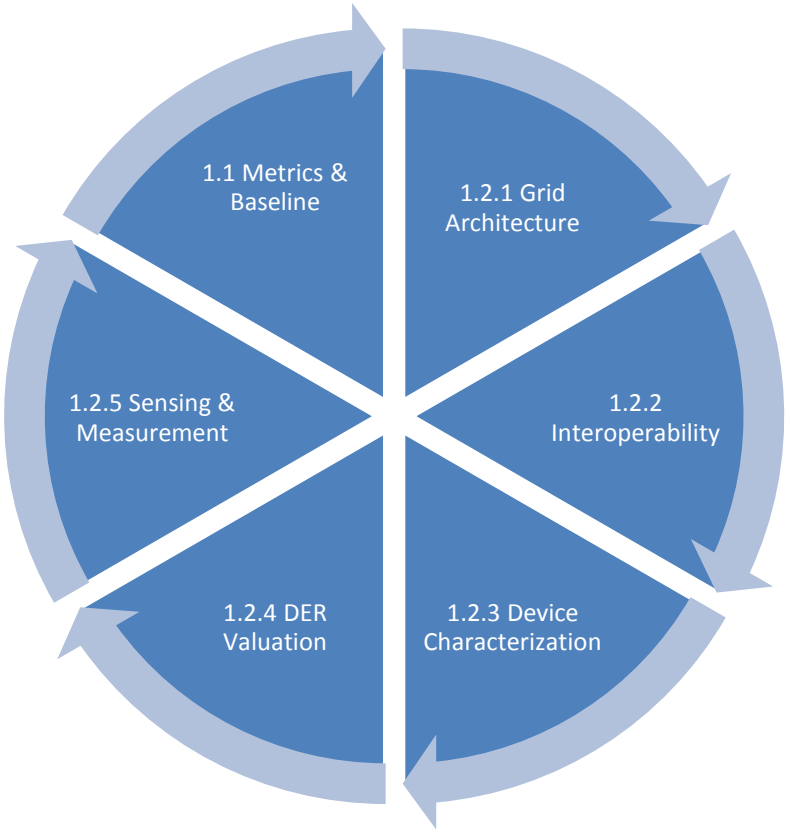
- Foundational Analysis for GMLC Establishment/Framework
- Core Activities
- Pioneer Regional Partnerships
- Technical Areas

GMI Multi-Year Program Plan and Lab Call
http://www.netl.doe.gov/business/solicitations
Select: **2016GMLabCall**

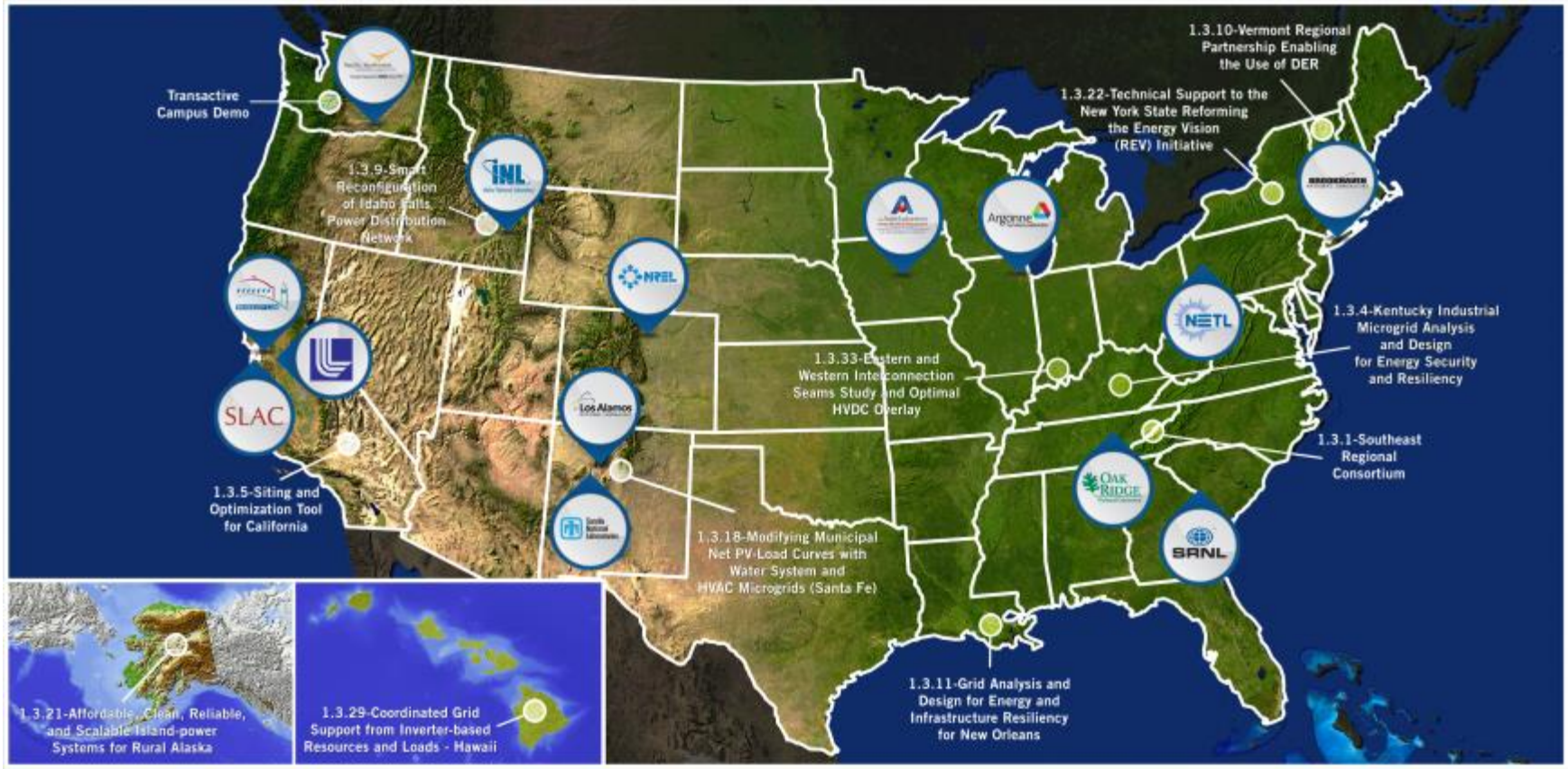
Foundational and Core R&D

Three-Year Foundational Research projects provide the fundamental knowledge, metrics, and tools needed to support all the Cross-Cut R&D and regional partnerships.

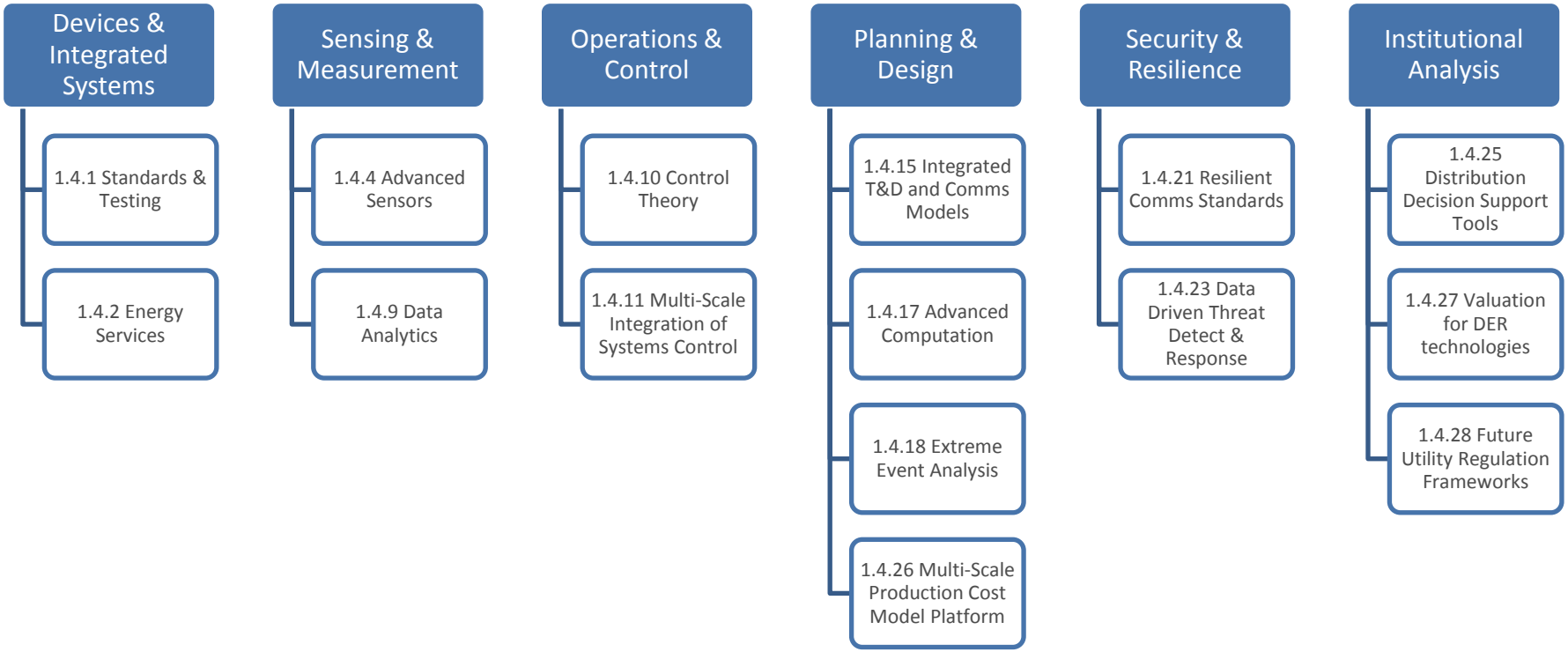
- **Future grid and industry design elements to guide consideration of new industry paradigms**
- **Standards and protocols for interoperability and testing**
- **Integrated testing network that spans the National Labs, industry and academia**
- **A strategy for observing and monitoring the future grid system in a way that meets expectations for predictive control, real-time operations and security**



Grid Modernization Lab Call: Proposed Pioneer Partnerships



Crosscutting R&D

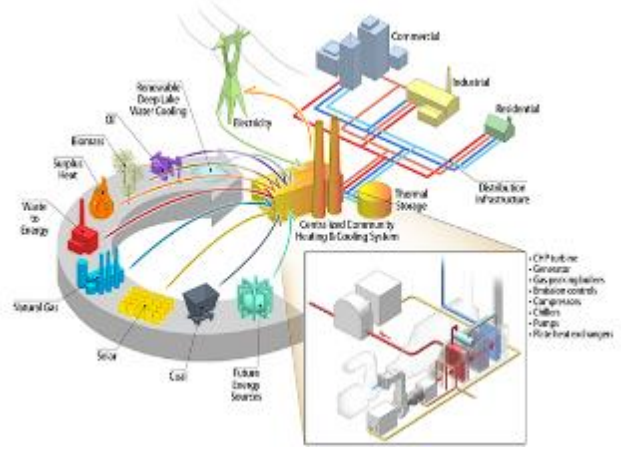


DOE Targets—Demos

- **#1 – 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 advanced physical and cyber security measures for the integration of large numbers of devices.
  - **Clean**: Real-time tools enhance wind resources with higher transmission asset utilization and management of system dynamics. Leverage of demand reduces emission from standby generation.
  - **Resilient**: Reduce outages by order of magnitude with improved prediction, detection, and distributed controls

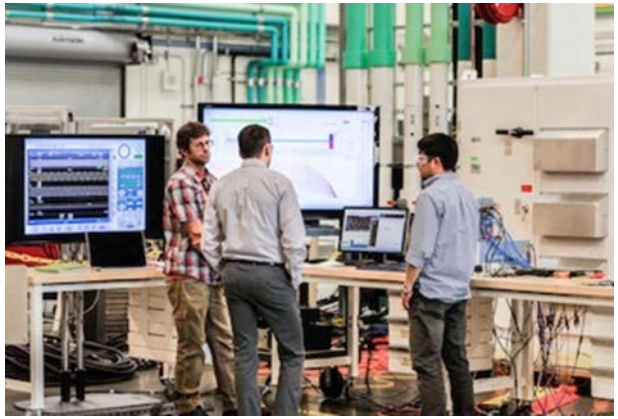
DOE Targets (continued)

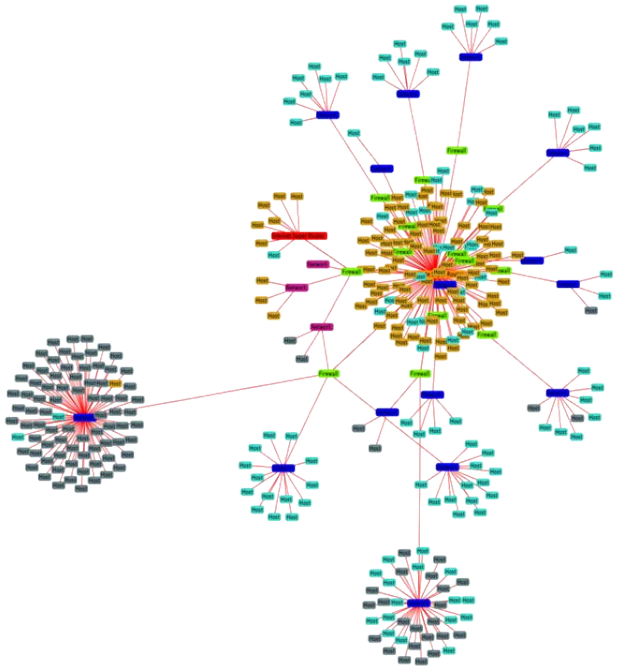
- **#2 – Clean Distribution Systems**
  - **Reliable & Resilient**: Coordinated microgrids control for resilience (e.g., 20% fewer outages, 50% shorter recovery time)
  - **Affordable**: Distributed, hierarchical control for clean energy and new customer-level innovation for asset utilization
  - **Secure:**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



DOE Targets (continued)

- **#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





Key Take-Aways

- A major multi-year integrated effort
- NASPI efforts critical foundation for success
- FY15 funding $190M, FY16 request $342M

- Request to NASPI
  - Comments on the MYPP
  - Feedback on the FY16 Lab Call activities
  - Topics, timing, applicability?
  - Participation in Technical workshops
    - Next one ….probably January