SAND2017-8218C

Microgrid Research & Development Topics

ıergy Exchange 2017
Tampa, Florida

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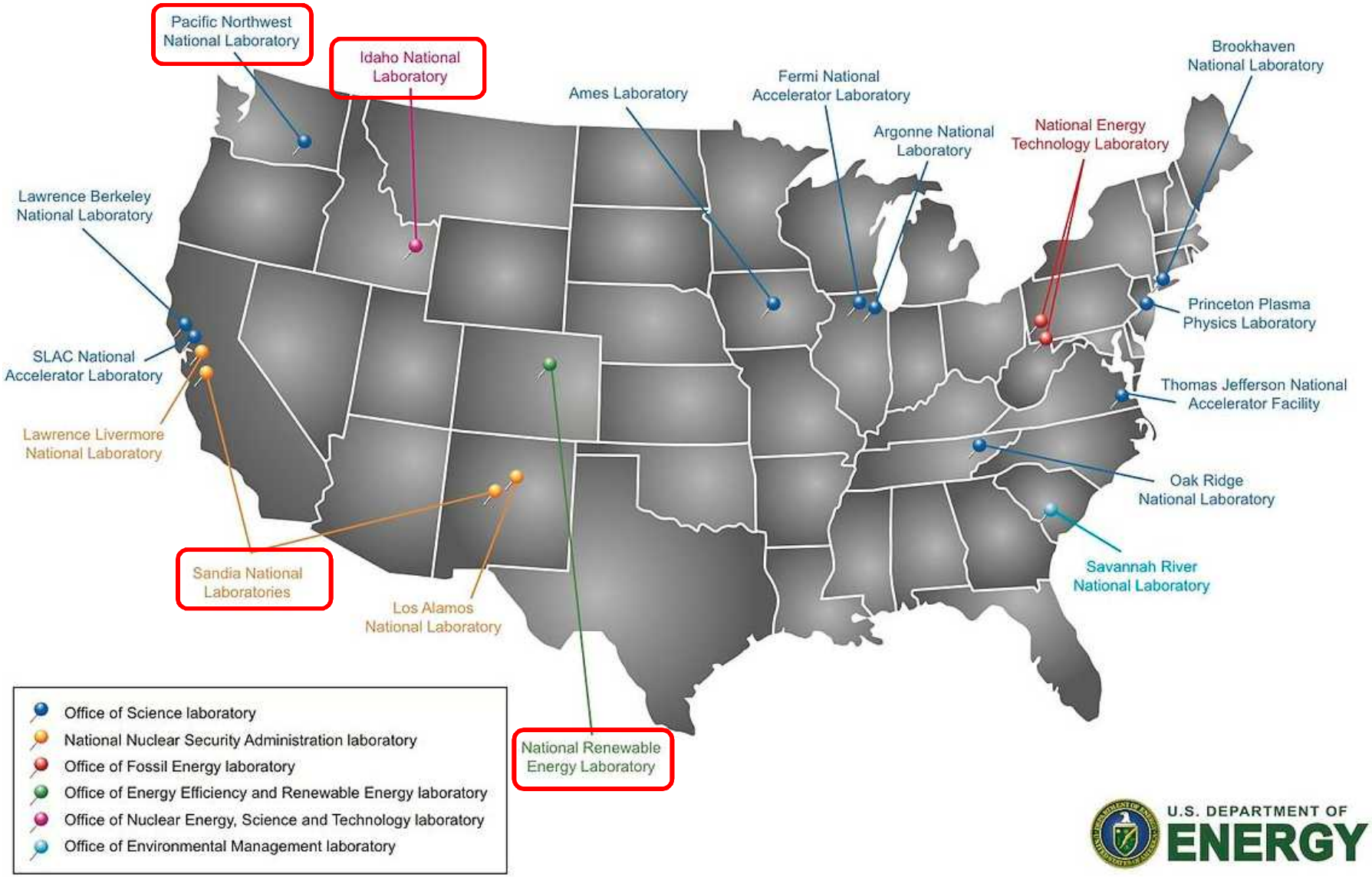
DOE National Labs and Microgrid R&D

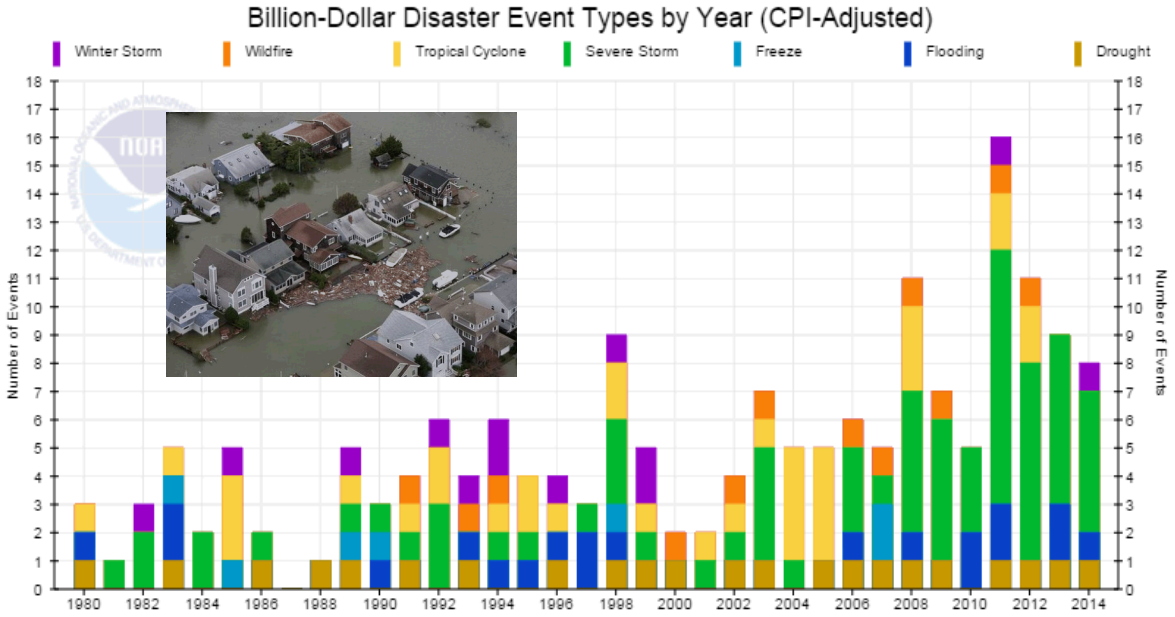


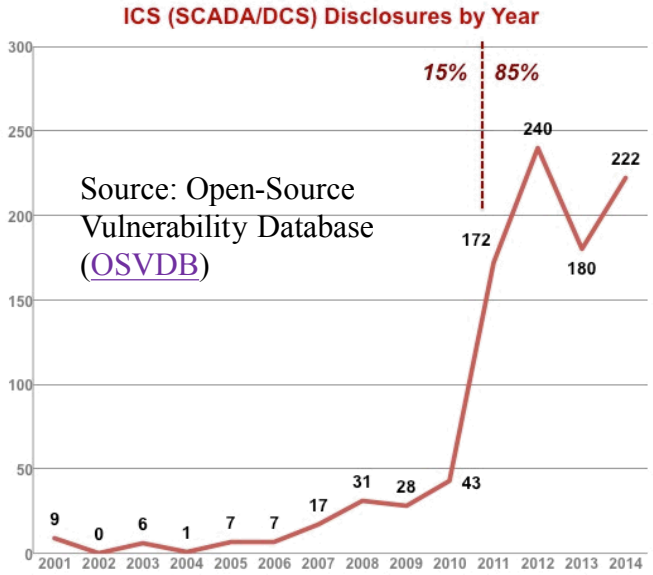
Sandia National Laboratories

- Large, multi-program research & engineering laboratory,
- Primary mission: nuclear weapons and national security
- Extensive capabilities in energy, including microgrids

Energy Infrastructure Resilience

- Energy infrastructure facing more frequent and significant natural and human (cyber and physical) threats
- Energy infrastructure resilience is a major focus area
  - Lower the effects of system disruptions
  - Accelerate recovery efforts

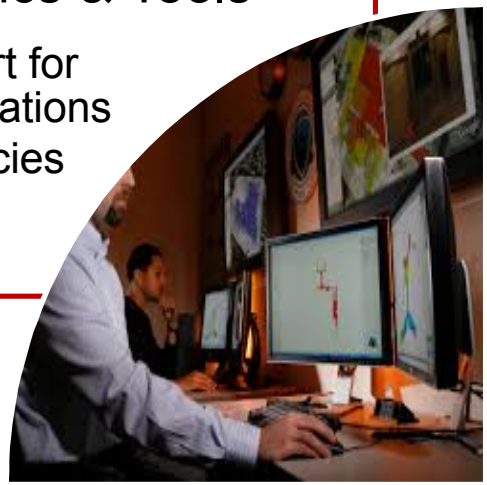




Key Microgrid R&D Challenges

Methods, Metrics & Tools

- Decision support for planning & operations
- Inter-dependencies
- LP-HC events



Enabling Technologies

- Control and Protection
- Power Electronics
- Cybersecurity
- Energy Storage

Lab and Field Demonstrations

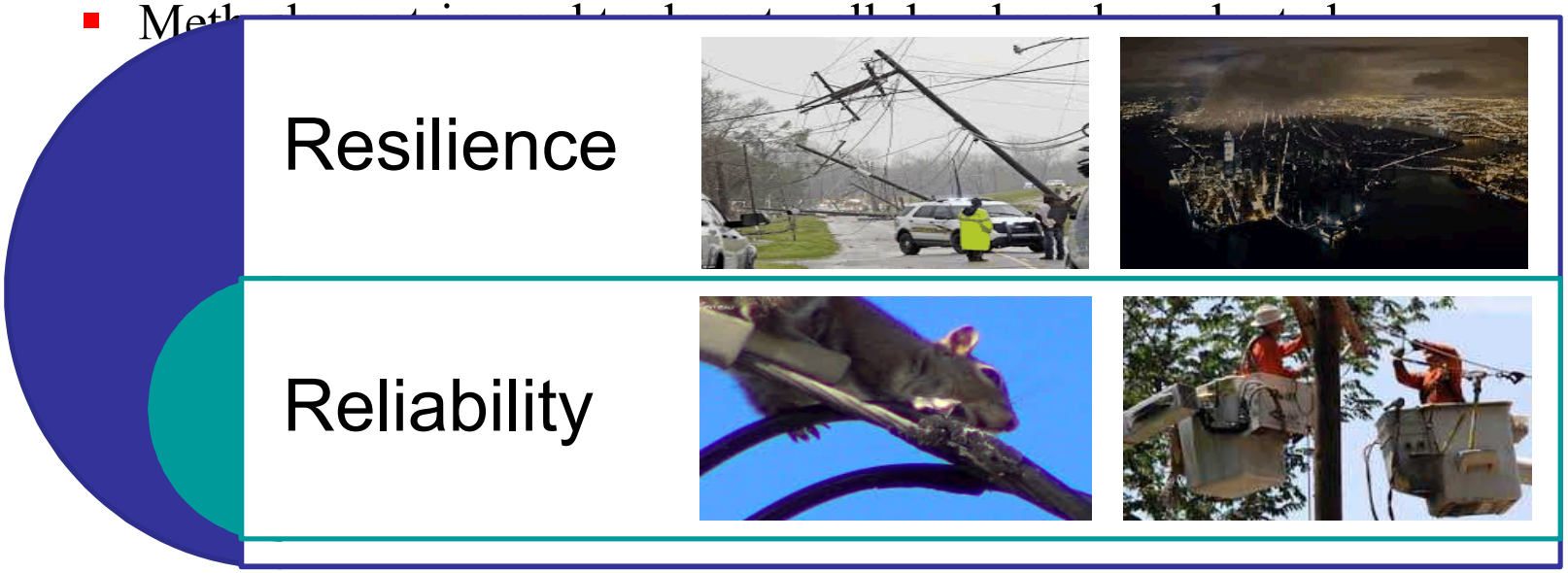
- Technology Validation and refinement
- Industry Adoption

Standards and Regulation

- Interoperability
- Grid interconnection
- Safety and security

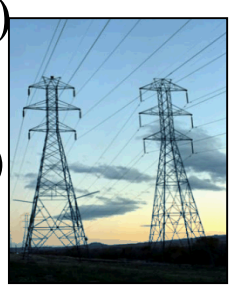
Methods and Tools: Reliability Vs. Resilience

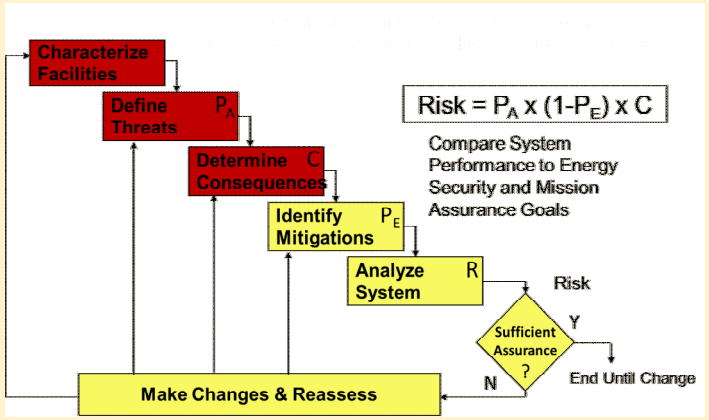
- **Reliability** focuses on minimizing the probability of disruptions
  - Focused on likely events (e.g., N-1 conditions)
  - Concepts are well established and widely adopted by industry
- **Resilience** focuses on minimizing consequences of disruptions
  - Considers ability to prepare, withstand, respond & recover from major disruptions
  - Meth[illegible]



SNL Infrastructure Security Risk Assessment Methodologies (RAMs) – Ca. 2000's

- RAM-D (Dams)
- RAM-T (Transmission Systems)
- RAM-W (Municipal Water Systems)
- RAM-C (Communities)
- RAM-CF (Chemical Facilities)
- RAM-E (Energy Systems)
- RAM-FAA (Airspace facilities)
- BioRAM (bio hazards)
- RAM-CI prototype (all sectors)
- …



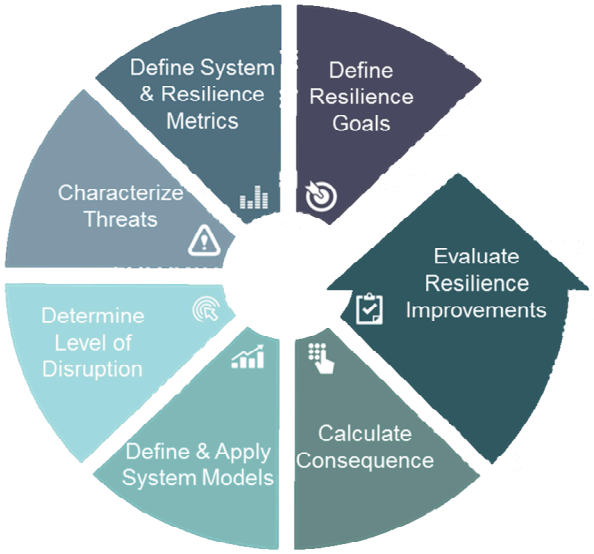


Energy Surety Framework

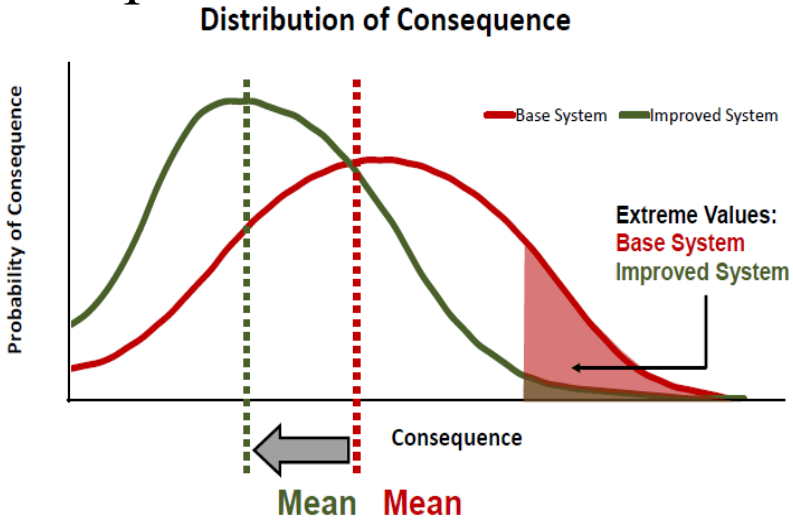
Performance Characteristic	Definition
Safety	Safe supplies of energy to end user
Security	Protection of energy supply infrastructure
Reliability	Can provide energy when and where needed
Sustainability	Can be maintained for long durations with minimal impact on resources
Cost Effective	Provided at affordable cost
Resiliency	Ability to prepare for and adapt to changing conditions and withstand and recover rapidly from disruptions

Resilience Methods and Metrics

- Methodology to define process steps and analyses



- Metrics to quantify performance and compare options



- Writing the resilience textbook, but much more work remains
  - Validate methods and tools, adapt to a variety of scenarios
  - Transition to industry, as well as policy and regulatory entities

Design, Planning and Operations Tools

- DOE/OE Resilient Distribution Systems R&D program is developing decision support tools that transition to industry over time

Sandia National Laboratories

Pacific Northwest NATIONAL LABORATORY

GridLAB-D

DER-CAM+ DECISION SUPPORT TOOL FOR DECENTRALIZED ENERGY SYSTEMS

TOPOLOGY | ANALYTICS | PLANNING | OPERATIONS

BERKELEY LAB
Lawrence Berkeley National Laboratory

CSEISMIC

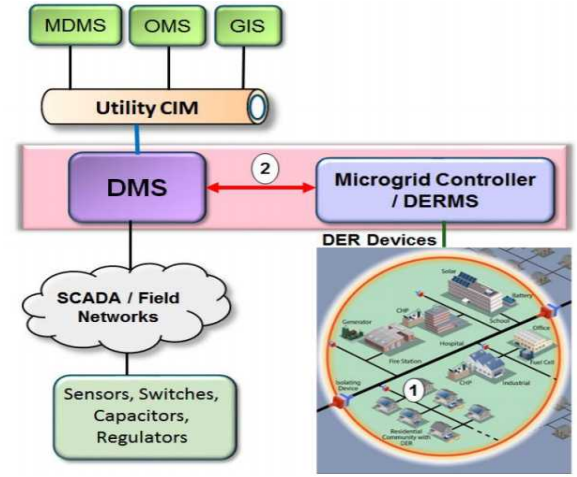
OAK RIDGE National Laboratory

One example: DOE → Industry

HOMER ENERGY

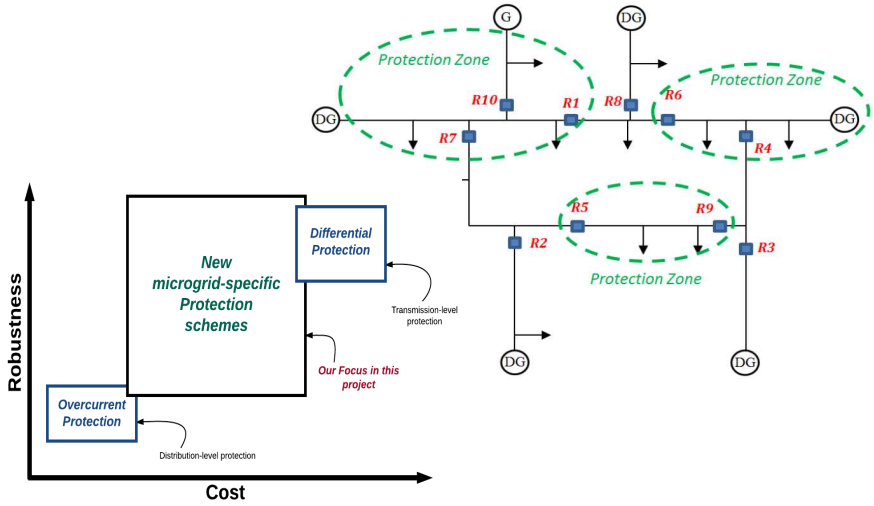
Examples of Enabling Technologies Gaps

- Microgrid Controllers

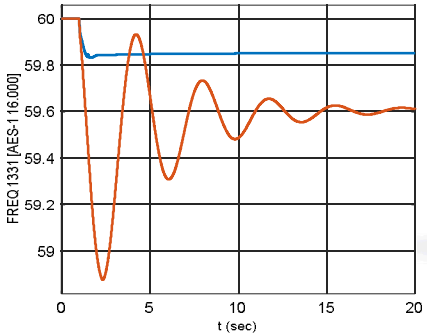


courtesy: EPRI

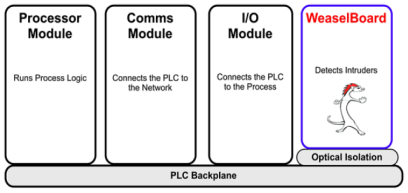
- Microgrid Protection



- Low Inertia Systems and Grid-Forming Inverters



- ICS Cybersecurity

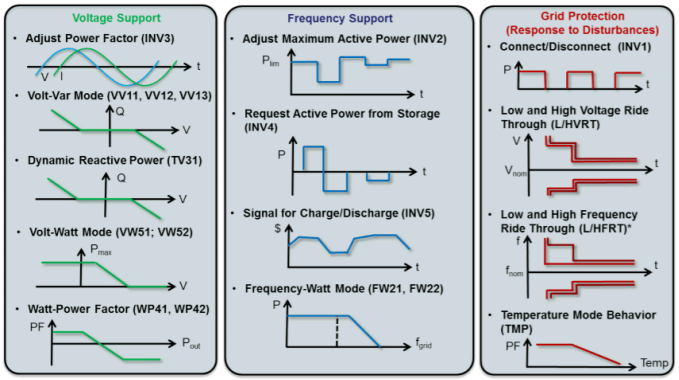


More info:

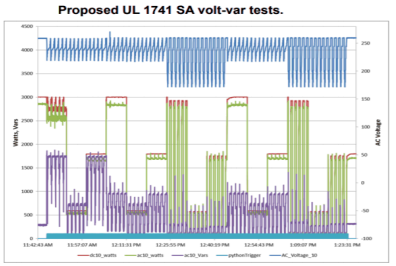
Standardization

- Proto-testing procedures & tools. Some examples among others:
  - MIT-LL Hardware-in-the-Loop Laboratory Testbed and Open Platforms (HILLTOP)
  - Sandia Advanced Inverter Testing Protocols / SunSpec System Validation Platform (SVP)
- Microgrid controller standards
  - IEEE P2030.7 Standard for the Specification of Microgrid Controllers
  - IEEE P2030.8 Standard for the Testing of Microgrid Controllers
  - NIST/SGIP PAP-24 Microgrid Operational Interfaces

MIL-LL HILLTOP



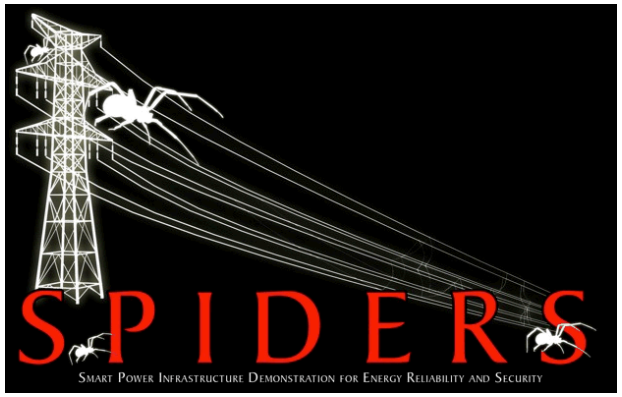
Sandia Testing Protocols and SunSpec SVP

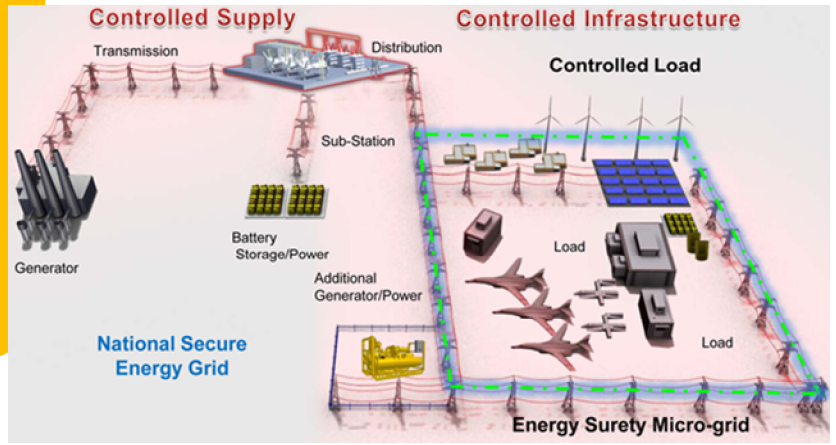


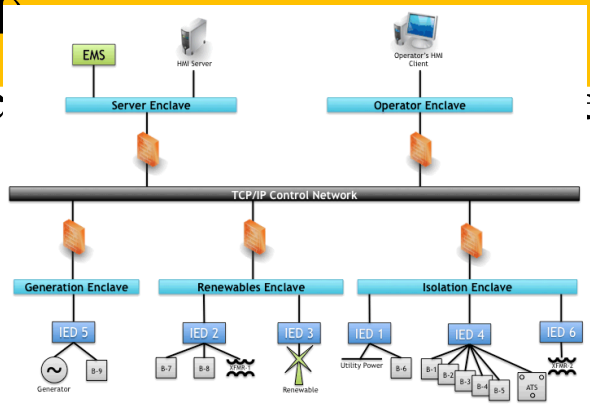
Full-scale Demonstrations – Military

Smart Power Infrastructure Demonstration for Energy Reliability and Security (SPIDERS) JCTD project

- Deployed and demonstrated microgrids with increasingly capability at three locations: Pearl Harbor/Hickam AFB (HI), Ft Carson (CO), and Camp Smith (HI
- Inc ecture

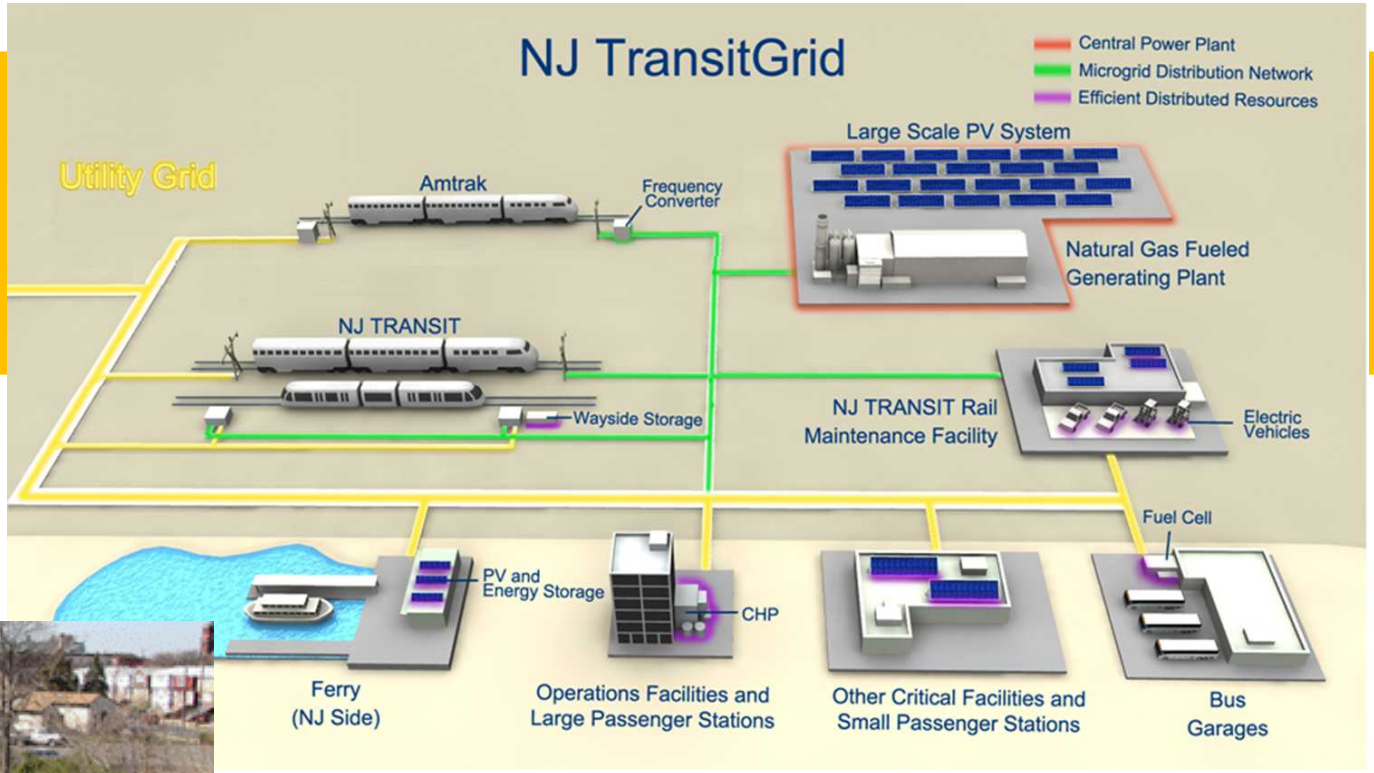






Full-scale Demonstrations – NJ TransitGrid

NJ TransitGrid Transportation Microgrid



Questions? Comments?

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