U.S. DEPARTMENT OF ENERGY
Office of Electricity Delivery and Energy Reliability

GLOBAL RESEARCH ALLIANCE

Battelle
The Business of Innovation

Smart Grid Development in the United States

Presentation to Asian Development Bank Partnership Forum on Innovation Technology and Solutions for Resilient and Smart Communities

Jeff Miller

Director, DOE Japan Office

United States Embassy Tokyo

Gerald Hane

Principal, Global Research Alliance

Vice President, Battelle Memorial Institute

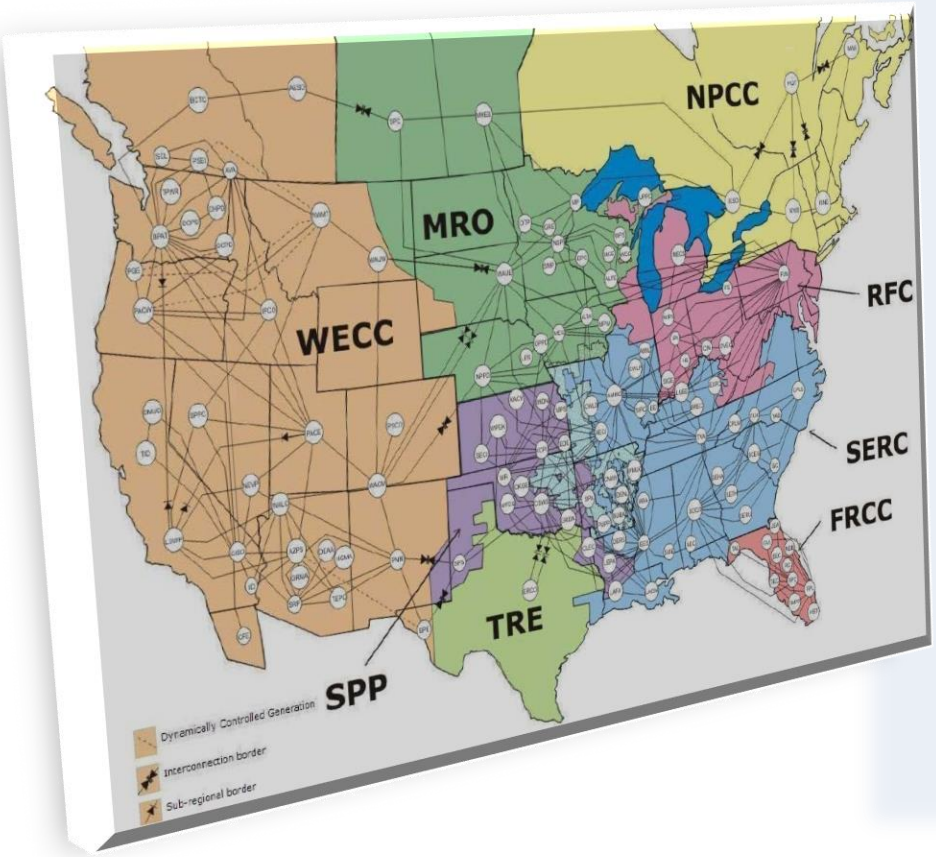
Outline

- Smart Grid Landscape in the U.S.
- Smart Grid Development by the U.S. DOE
- Microgrid Programs

The North American Electric Grid

U.S. Figures

22% of world consumption



3,200 electric utility companies

17,000 power plants

800 gigawatt peak demand

165,000 miles of high-voltage lines

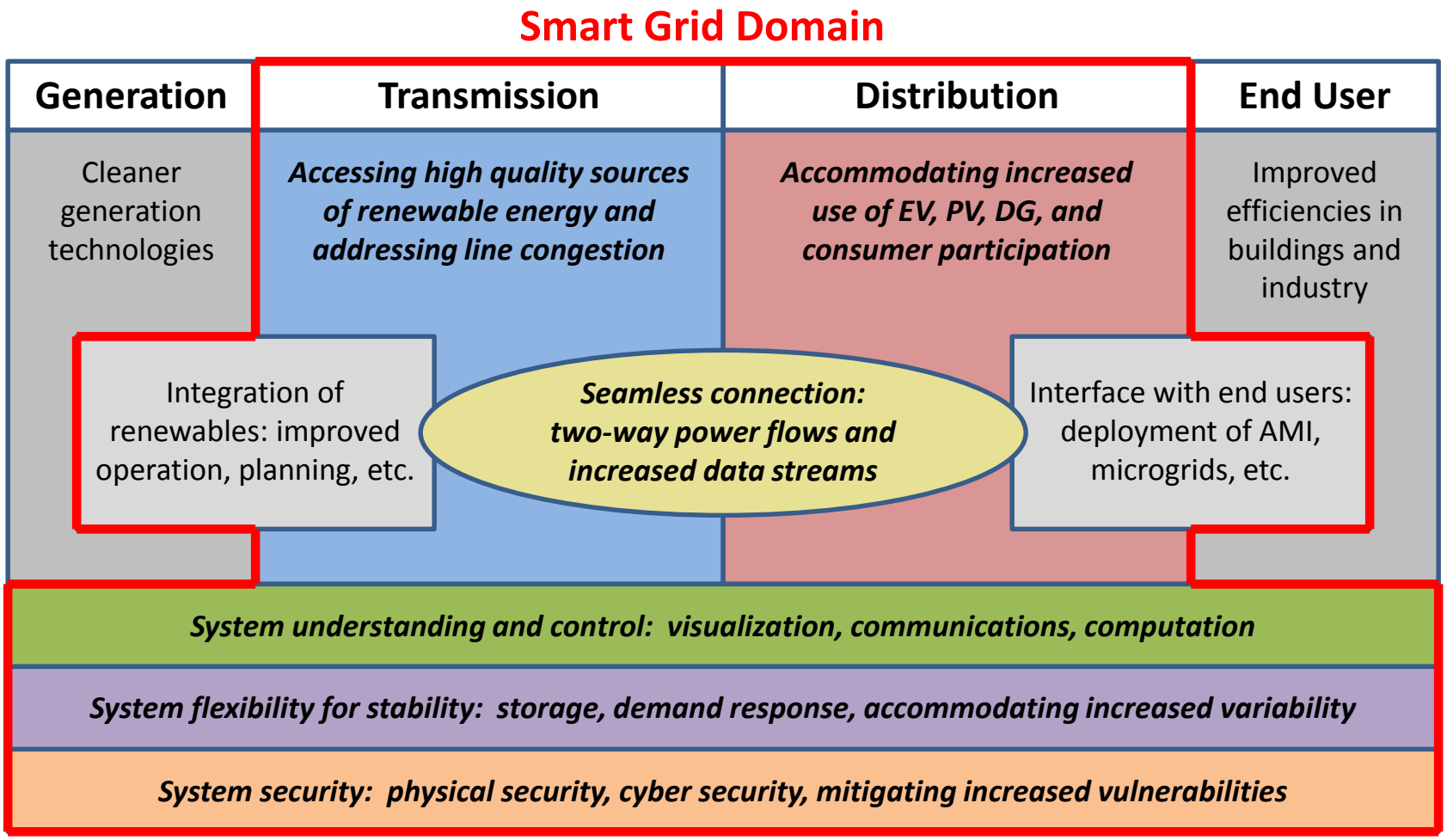
6 million miles of distribution lines

144 million meters

$1 trillion in assets

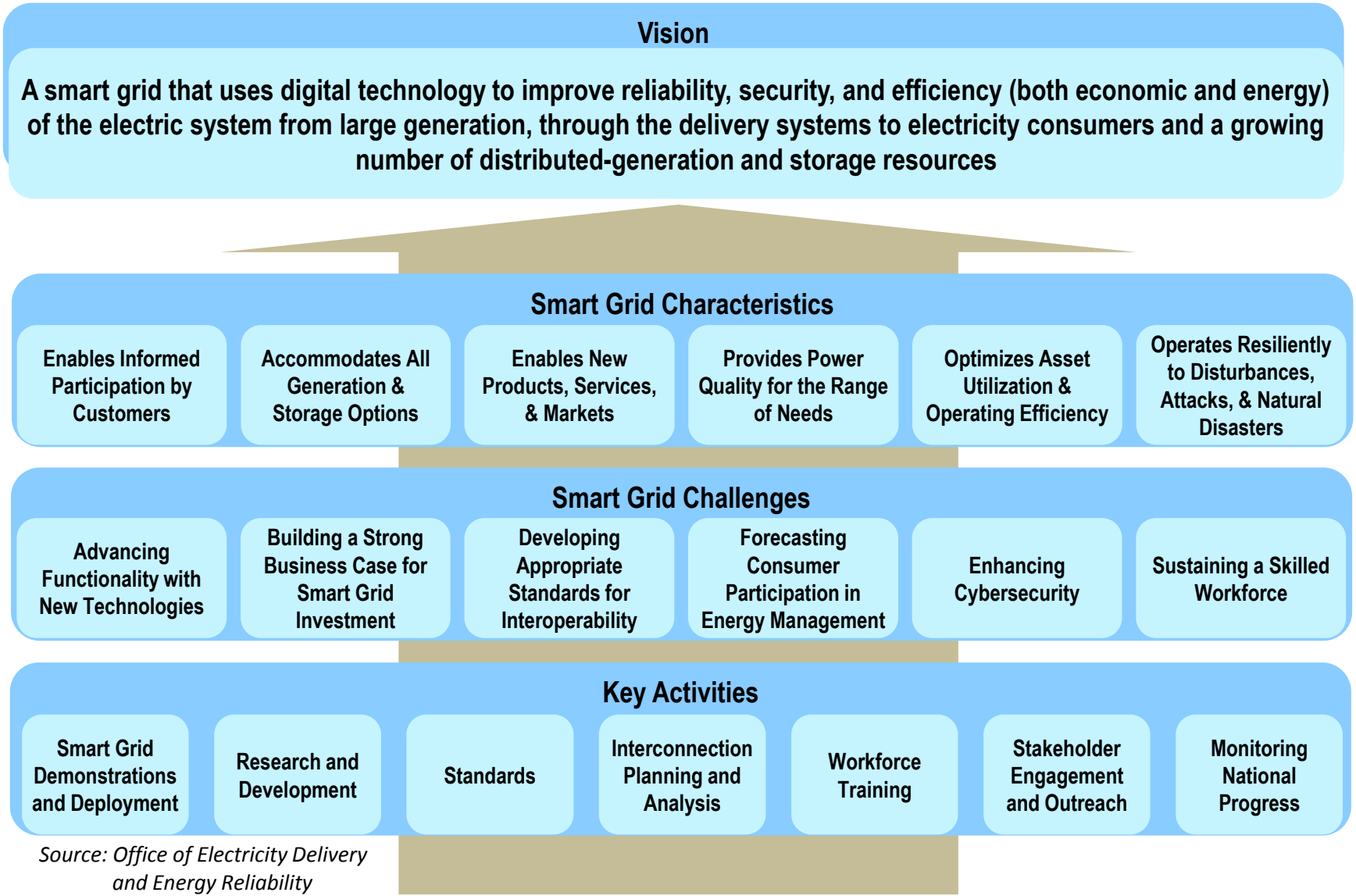
$350 billion annual revenues

Smart Grid Focus



Institutional issues/solutions must be considered in conjunction with these technology needs

DOE Smart Grid Implementation Plan



Source: Office of Electricity Delivery and Energy Reliability

Smart Grid Investment Grant (SGIG)

Deploying technologies for immediate commercial use supporting manufacturing, purchasing, and installation of smart grid technologies				
Customer Systems	**Advance Metering Infrastructure**	**Electric Distribution Systems**	**Electric Transmission Systems**	**Equipment Manufacturing**
				
• Displays • Portals • Energy management • Direct load controls	• Smart meters • Data management • Back office integration	• Switches • Feeder optimization • Equipment monitoring • Energy storage	• Wide area monitoring and visualization • Synchrophasor technology • Energy storage	• Energy devices • Software • Appliances

More than 99 projects, $3.4B Federal + $4.6B Private Investments

Smart Grid Demonstration Program (SGDP)

Smart Grid Demonstration Projects.

Total Value of $1.6 Billion.

Demonstrate emerging technologies and alternative architectures to validate business models and address regulatory/scalability issues

Grid-Scale ES Applications

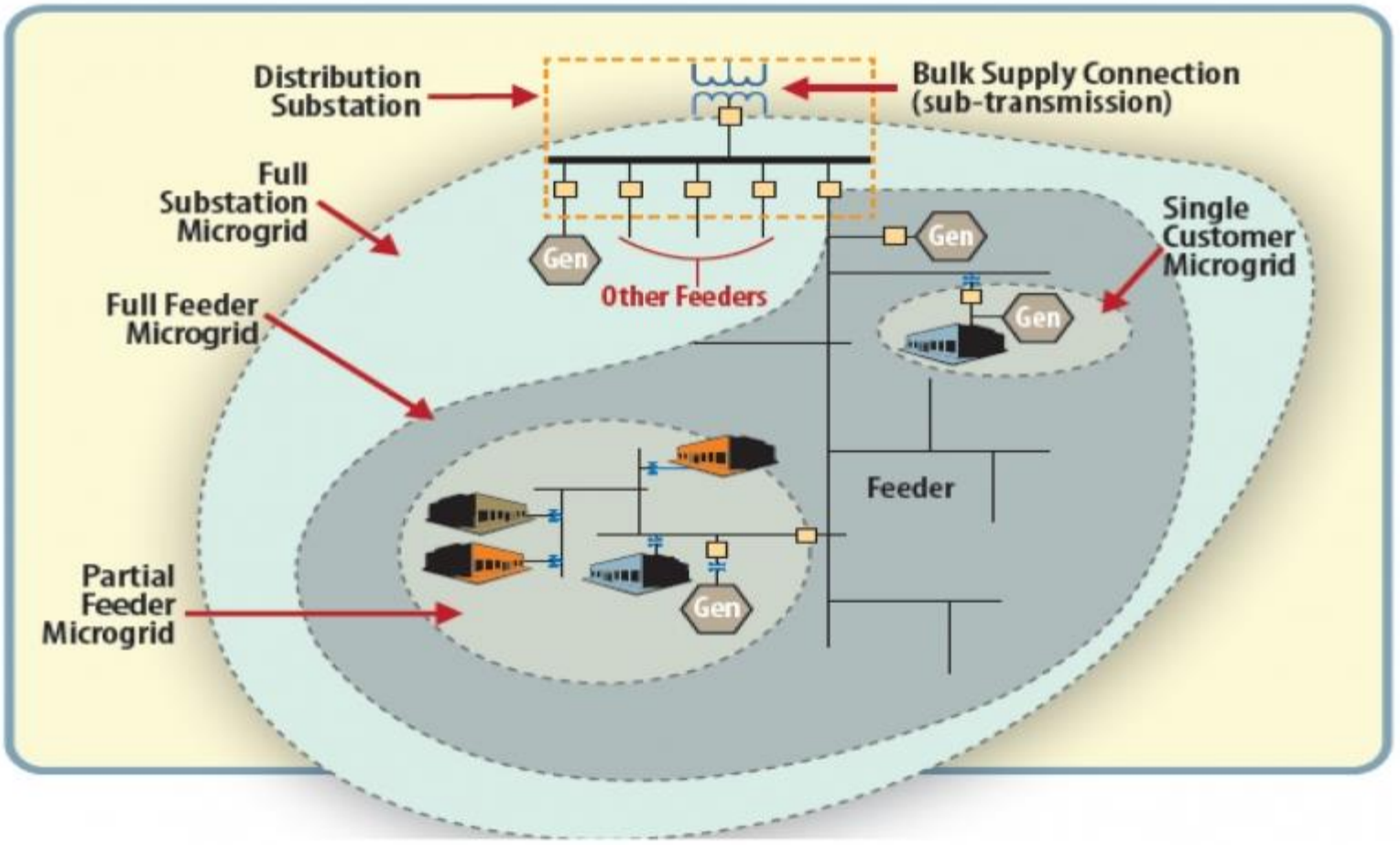
- Large Battery Systems (3 projects, 53MW)
- Compressed Air (2 projects, 450MW)
- Frequency Regulation (20MW)
- Distributed Projects (5 projects, 9MW)
- Technology Development (5 projects)

Smart Grid Regional Demonstrations

- 12 AMI
- 10 PEV charging points
- 10 HAN
- 9 In-home displays
- 9 SCADA improvements
- 8 Energy storage
- 8 Distribution automation

More than 32 projects, $620M Federal + $980M Private Investments

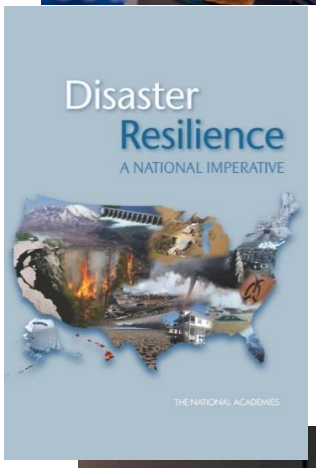
Microgrids Enhancing Grid Resilience

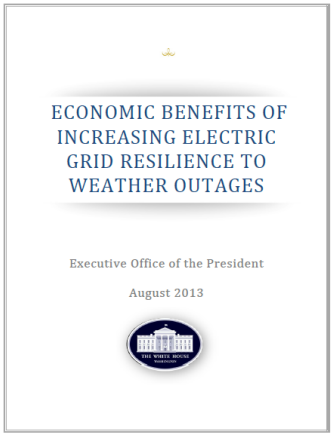


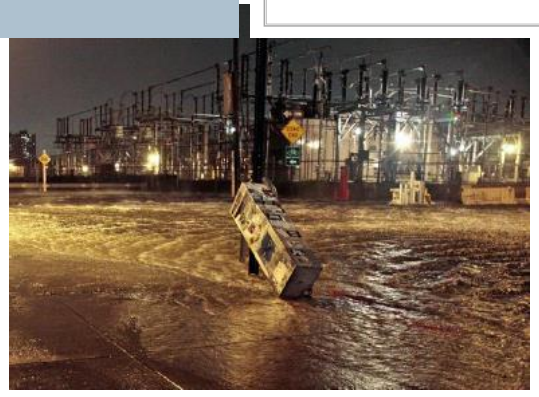
Microgrids are localized grids that can disconnect from the traditional grid to operate autonomously and strengthen grid resilience.

Microgrid and Resilience

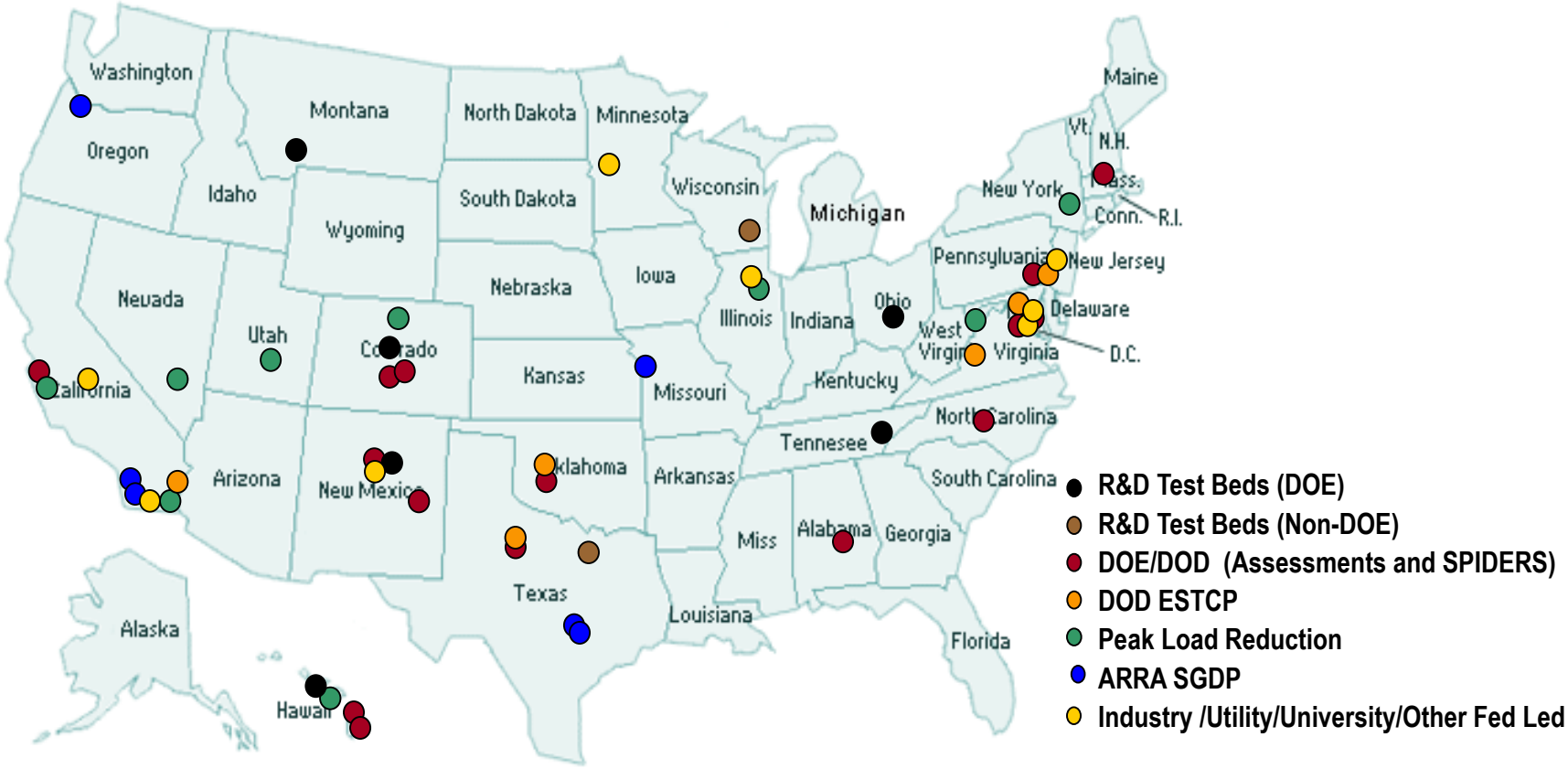
- In support of the Climate Action Plan and the Administration's National Disaster Resilience Initiative, the Departments of Energy (DOE), Defense (DOD), Homeland Security (DHS) and Federal Emergency Management Program enhanced attention to , microgrids in energy resilience.
- in September 2014 the Energy Department awarded more than $8 million for microgrid projects to help cities and towns better prepare for extreme weather events and other potential electricity disruptions.
- Each DOE project will be required to work with an entity or community to design microgrid systems of ≤10 MW which is enough to power a small community, and to design systems that protect critical infrastructure such as hospitals and water treatment plants.







Current Microgrid Landscape



Federal programs, institutions, and the private sector are increasing microgrid development and deployment. The number of successfully deployed microgrids will verify the benefits and decrease implementation risks further expanding the market for microgrids.

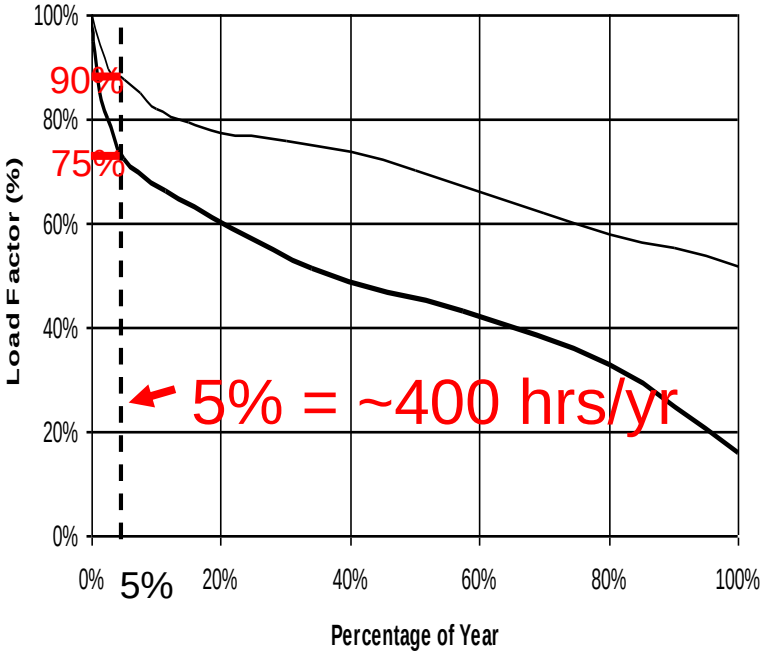
Where are Resilient Microgrids Valuable in the US?

- **Military bases** where power shutdown would pose unacceptable security risks
- **Federal facilities**, including research laboratories, where wavering energy reliability could mean loss of data and millions of dollars in lost time
- **Hospitals** that need to seamlessly deliver patient care, regardless of weather or other conditions
- **Large data centers** that are the heart of most organizations' business operations
- **Research-driven colleges and universities** that need to safeguard and maintain years of faculty work
- **Local governments** that need to offer operational assurance to large businesses in their district, as well as attract new companies for stronger job creation
- **Commercial campus** settings where 24/7 power reliability is crucial for protecting long-term investments such as research and development
- A **densely populated urban area**, such as Manhattan, where concentration of energy use is high and significant scale justifies connecting multiple buildings as part of a microgrid network

Renewable and Distributed Systems Integration (RDSI)

- 9 demonstration projects in 8 states to integrate use of DER to provide at least 15% peak demand reduction on distribution feeder or substation
- Projects are either microgrids or are developing technologies that will advance microgrids
- Systems must be capable of operating in both grid parallel and islanded modes
- $55 million of DOE funds over five years (total value of awards will exceed $100 million, including participant cost share)

Lower Peak Demand Reduces Infrastructure Investments



25% of distribution & 10% of generation assets (transmission is similar), worth 100s of billions of US dollars, are needed less than 400 hrs/year!

Renewable and Distributed Systems Integration Projects

- **Chevron Energy Solutions**—CERTS Microgrid Demo at the Santa Rita Jail - large-scale energy storage, PV, fuel cell
- **SDG&E**—Borrego Springs Microgrid - demand response, storage, outage management system, automated distribution control, AMI
- **U of HI**—Transmission Congestion Relief, Maui - intermittency management system, demand response, wind turbines, dynamic simulations modeling
- **UNLV**—"Hybrid" Homes - Dramatic Residential Demand Reduction in the Desert Southwest - PV, advanced meters, in-home dashboard, automated demand response, storage
- **ATK Space System**—Powering a Defense Company with Renewables - Hydro-turbines, compressed air storage, solar thermal, wind turbines, waste heat recovery system
- **City of Fort Collins**—Mixed Distributed Resources - PV, bio-fuel CHP, thermal storage, fuel cell, microturbines, PHEV, demand response

- **Illinois Institute of Technology**—The Perfect Power Prototype - advanced meters, intelligent system controller, gas fired generators, demand response controller, uninterruptable power supply, energy storage
- **Allegheny Power**—WV Super Circuit Demonstrating the Reliability Benefits of Dynamic Feeder Reconfiguration - biodiesel combustion engine, microturbine, PV, energy storage, advanced wireless communications, dynamic feeder reconfiguration
- **Con Ed**—Interoperability of Demand Response Resources - demand response, PHEVs, fuel cell, combustion engines, intelligent islanding, dynamic reconfiguration, and fault isolation

Energy Surety Microgrid Projects (Funded by DOE OE, DOE FEMP, and DoD)

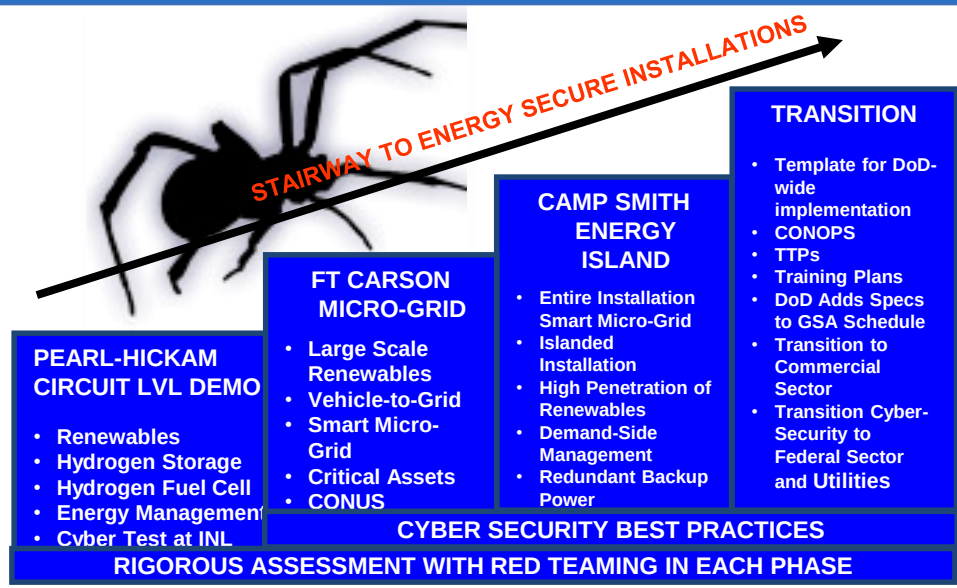
Conceptual Designs/Assessments	Small Scale Microgrid Demos	Large Scale Microgrid Demos	Operational Prototypes

• Philadelphia Navy Yard – FY11, DOE OE/PIDC
• Camp Smith – FY10, DOE FEMP
• West Point FY12, DoD/DOE
• Indian Head NWC – FY09, DOE OE/DoD
• Ft. Sill – FY08, Sandia LDRD
• Ft. Bliss – FY10, DOE FEMP
• Ft. Carson – FY10, DOE FEMP
• Ft. Devens (99th ANG) – FY09, DOE OE/DoD
• Ft. Belvoir – FY09 DOE OE/FEMP
• Cannon AFB – FY11, DOE OE/DoD
• Vandenberg AFB – FY11, DOE FEMP
• Kirtland AFB – FY10, DOE OE/DoD
• Maxwell AFB – FY09, DoD/DOE
	• Maxwell AFB – FY09, DoD
	• Ft. Sill – FY09, DoD w/ SNL serving as advisor
		• SPIDERS JCTD – FY11, DOE/DoD
		  • Camp Smith
		  • Ft Carson
		  • Hickam AFB
			• H.R. 5136 National Defense Authorization Act

SPIDERS: Smart Power Infrastructure Demonstration for Energy, Reliability, and Security

Objective

- **Improve reliability** for mission-critical loads by connecting generators on a microgrid using existing distribution networks.
- **Reduce reliance on fuel** for diesel power by using renewable energy sources during outages.
- **Increase efficiency** of backup generators through coordinated operation on the microgrid.
- **Reduce operational risk** for energy systems through a strong cyber security for the microgrid.
- **Enable flexible electrical energy** by building microgrid architectures that can selectively energize loads during extended outages.



Technical Scope

DoD, DOE, and DHS collaborate to design and implement three separate microgrids supporting critical loads at DoD bases. Each one is slightly larger and more complex in scope than the previous. The sites include:

- Joint Base Pearl Harbor Hickam
- Fort Carson
- Camp Smith

A key part of the project is the standardization of the design approach, contracting, installation, security, and operation of these microgrids to support future applications.

USDOE Microgrid Research, Development, and System Design

Awardee	Project
ALSTOM Grid, Inc. Redmond, Washington	Research and design of community microgrid systems using portions of the former Philadelphia Navy Yard as a test bed.
Burr Energy, LLC Little Falls, Minnesota	Design and build a resilient microgrid to allow the Olney, Maryland Town Center to function normally as a "lights-on" district for weeks in the event of a regional outage. A second microgrid in nearby Prince George's County, Maryland.
Commonwealth Edison Company Chicago, Illinois	Develop a controller capable of controlling two or more interconnected microgrids. The project includes police and fire department headquarters, transportation infrastructure, healthcare facilities, and private residences.
Electric Power Research Institute Knoxville, Tennessee	Develop a commercially-viable standardized microgrid controller that can allow a community to provide continuous power for critical loads.
General Electric Company Niskayuna, New York	Develop an enhanced microgrid control system by adding new capabilities, such as frequency regulation in Potsdam, New York, including emergency service providers, utilities, and other essential services, during power disruptions.
TDX Power, Inc. Anchorage, Alaska	Develop a microgrid control system on Saint Paul Island, an island located in the Bering Sea hundreds of miles from mainland Alaska. The system will incorporate a wide range of energy resources in grid-connected and islanded modes.
The University of California Irvine (UCI)	Develop a generic microgrid controller intended to be readily adapted to manage a range of microgrid systems to pave the way for the development of open source industry standards.

Summary

- Expanding interest in the US Government to gain more complete value from the benefits of microgrids.
- Energy resilience and the maintenance of critical services are viewed as particularly essential.
- Ensuring appropriate incentives for participation by energy suppliers as well as users is are very important for diffusion.
- Designing and optimizing microgrid systems can be substantially improved by modeling based on real world data.

Jeff Miller

Director, DOE Japan Office

United States Embassy Tokyo

Gerald Hane

Principal, Global Research Alliance

Vice President, Battelle Memorial Institute