

2014 Smart Grid R&D Program Peer Review Meeting

Smart Grid R&D Program Overview

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Smart Grid R&D Program

| FY 2013 Current | FY 2014 Enacted | FY 2015 Request |
|-----------------|-----------------|-----------------|
| 19,968 | 14,592 | 24,400 |

Challenges

- Increased variability and uncertainty on both demand and supply at distribution levels
- Bidirectional power flows due to high penetration of distributed resources
- More frequent outages with high severity caused by extreme weather
- Increased complexity introduced by voluminous data streams and big data management
- Interoperability between new technologies and with legacy components
- Secure communications

Modernizes the electric distribution grid through adaptation and integration of advanced information and communication technologies building on the ARRA Smart Grid Investment Grants and Smart Grid Regional Demonstrations, and supports the increasing demand for grid reliability and resiliency at state and local levels.

Scope

- **Microgrids** for energy surety
- **DER/DR/PEV Integration** for system efficiency
- **Advanced Distribution Automation Systems** for reliability
- **Crosscut**
 - Architecture & standards
 - Communications & outreach

Goals

Smarter, more resilient distribution grid

Self-healing

Consumer empowerment for full DR realization

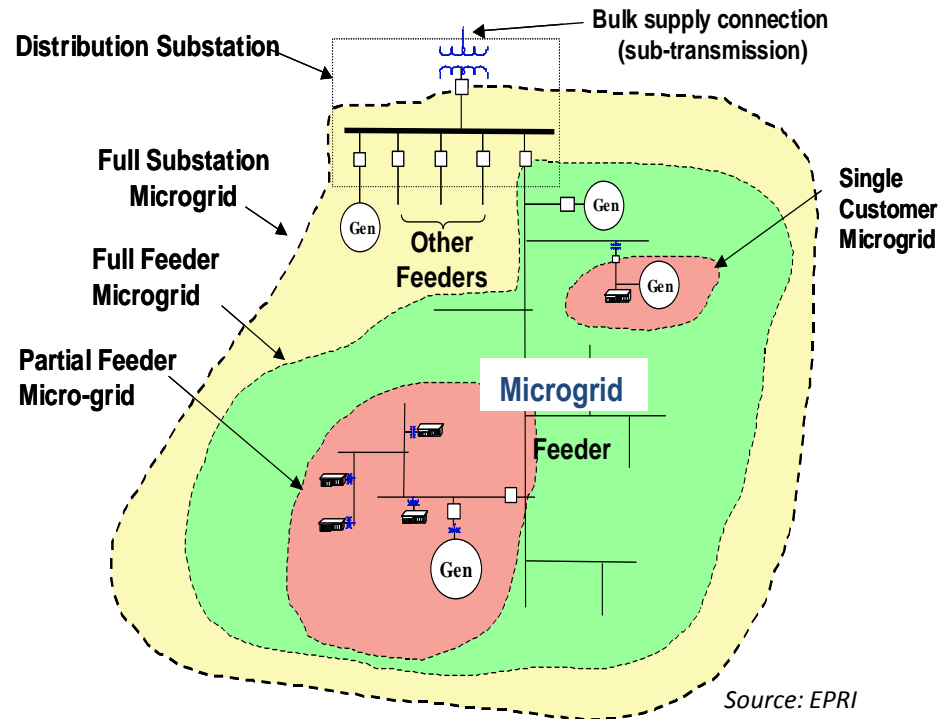
Benefits

- Grid Reliability and Resilience
- Reduced Peak Load and Consumption
- System Efficiency
- More Distributed Energy Resources

DOE Program's Definition of Microgrids

*Our definition:
A group of interconnected loads and distributed energy resources within clearly defined electrical boundaries that acts as a single controllable entity with respect to the grid. A microgrid can connect and disconnect from the grid to enable it to operate in both grid-connected and island mode.*

| | |
|-------------------------|--|
| Residential | Less than 10-kW, single-phase |
| Small Commercial | From 10-kW to 50-kW, typically three-phase |
| Commercial | Greater than 50-kW up to 10MW |

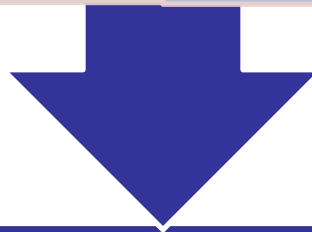


Microgrid R&D Guided by Stakeholder Recommendations

2011 Workshop

Defined the DOE 2020 targets: reducing outage time of critical loads by >98%; cost comparable to non-integrated baseline solutions (UPS + diesel genset); reduce emissions by >20%; improve system energy efficiencies by >20%

Recommended further integration of component- and system-level R&D areas identified to better address common, crosscutting elements



2012 Workshop

Prioritized R&D topics in planning/design to include system architecture, modeling and analysis, and system design

Prioritized R&D topics in operations/control to include steady-state control and coordination, transient-state control and protection, and operational optimization



Office of Electricity Delivery
and Energy Reliability
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DOE Microgrid Workshop Report

August 30-31, 2011
San Diego, California

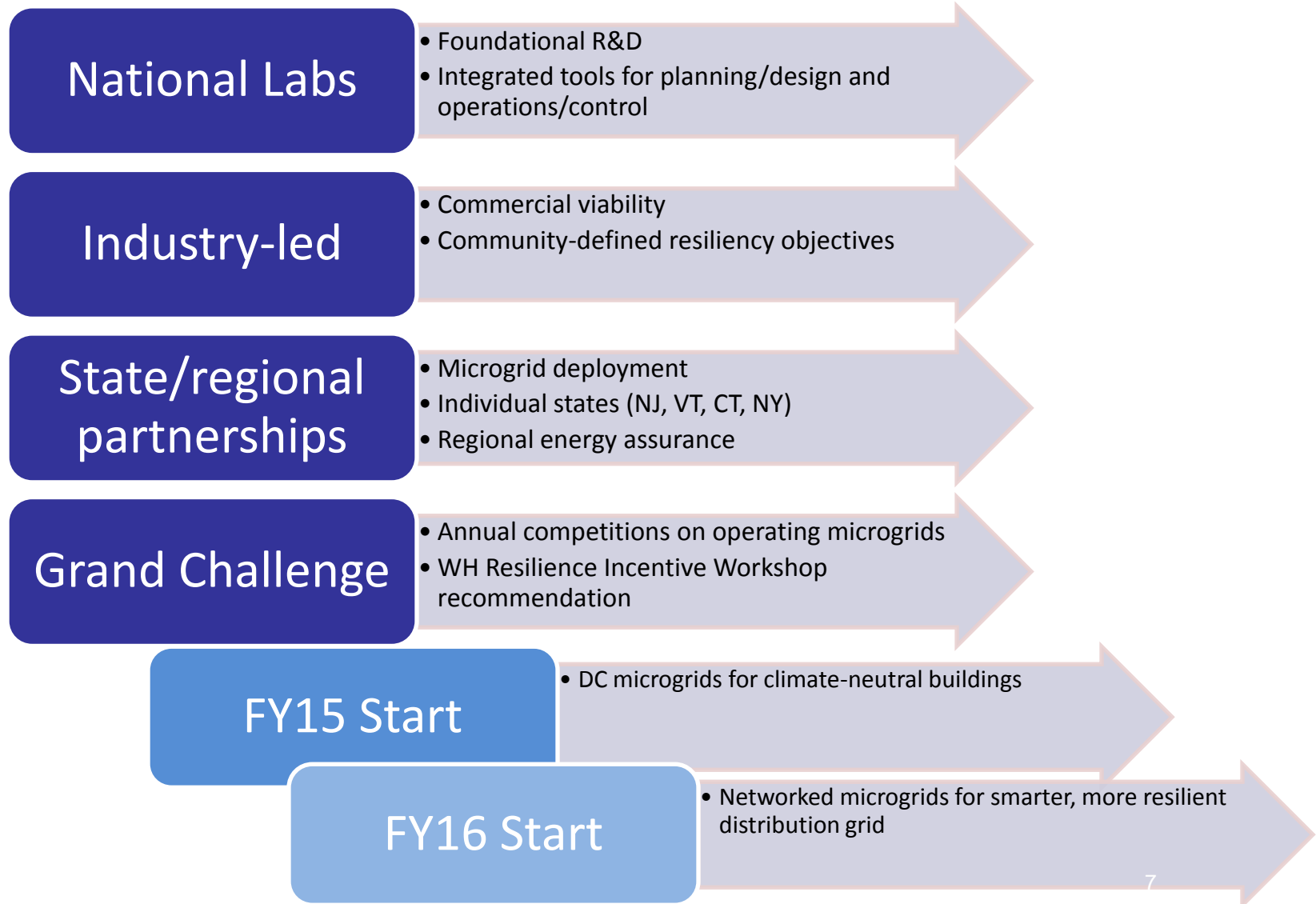


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Summary Report: 2012 DOE Microgrid Workshop

July 30-31, 2012
Chicago, Illinois

Implementation Pathway for Achieving Commercial Viability, DOE Performance Targets, and Community-Defined Resiliency Objectives



National Lab Microgrid Projects for Peer Review

| Microgrid R&D | Topic | Minutes |
|----------------------|--------------------------------------|---------|
| SNL/LBNL/PNNL | Microgrid Design Toolset Development | 60 |
| ORNL | Microgrid Controller Development | 30 |
| LBNL | CERTS Controller | 30 |
| PNNL/WSU | Microgrid as a Resilience Resource | 30 |
| PNNL | GridLAB-D Development and Analysis | 30 |
| MTU/ANL | Networked Microgrids | 30 |
| ORNL | Microgrid Test Bed | 30 |

Industry-Led Microgrid R, D & System Design

FY 2014
FOA

- **Advance microgrid system designs (<10MW) and control functionalities for implementation by communities to support achievement of:**
 - **Communities-defined resilience objectives**
 - **DOE program targets:** reducing outage time of critical loads by >98%; cost comparable to non-integrated baseline solutions (UPS + diesel genset); reduce emissions by >20%; improve system energy efficiencies by >20%
- **FOA closed on 28 Apr**
 - **\$7M DOE funding for ~6 awards** (\$1.2M per award)
 - **PoP: 2 years, including 18-month R&D and 6-month testing, data collection, and analysis**
 - **Awards NLT the end of September 2014**
- **Field demonstrations of system designs w. advanced controllers**
(potential FOA topic in FY16-17)

State/Regional Partnerships Supporting the CAP Strategy

Short-term

- Partner with States (NJ, VT, CT, NY) to deploy microgrids for rebuilding electric infrastructure by providing technical assistance and advanced R&D products
 - E.g., Ongoing partnerships with NJ on TransitGrid and rebuilding electric infrastructure post Sandy

Mid-term

- Expand multi-state and regional partnerships to promote microgrids for enhanced recovery and resilience of electric grid

Long-term

- Fully integrate a network of microgrids at customer sites and varying scales (feeders, substations) to support achieving a self healing distribution and transmission system

Microgrid Grand Challenge Competition

To recognize the current best operational microgrid in each of the six segments of critical facilities and services

Support:

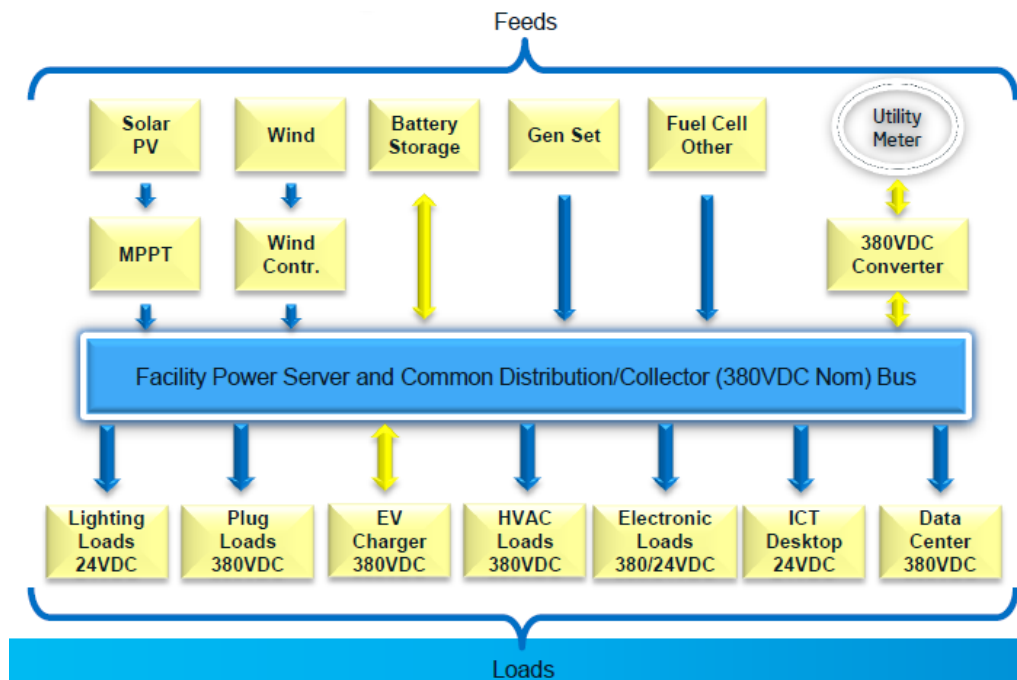
The DOE-led grand challenges to make the U.S. grid resilient; The DOE implementation of the President's Climate Action Plan

Award cash prizes for microgrids as a clean, efficient, cost-effective, and resilient power system

Plan to launch the Competition in June 2014

New Area under Study: DC Microgrid R&D

Interconnect localized group of electricity sources and loads that predominately generates, distributes, and uses electrical power in its native dc form



New microgrid power distribution topologies in buildings

Source: EMerge Alliance

Scoping study being conducted jointly with the EERE BTO in FY14 to define needs, benefits, and opportunities for potential new projects in FY15

Other Smart Grid R&D Focus Area Projects for Peer Review

| Architecture & Standards | | |
|---------------------------|---|----|
| PNNL | GWAC Transactive Energy Framework | 30 |
| NREL | Smart Grid Pre-Standard Testing Support | 30 |
| Distribution Automation | | |
| Alstom Grid | Integrated Smart Distribution RD&D | 30 |
| Communications & Outreach | | |
| SDG&E | Smart Grid Data Access | 30 |

Smart Grid R&D Program Planning for FY 2015

Microgrids for commercial viability, reliability, and resiliency

Continue R&D pathway to support achieving the DOE program goals (in reliability, efficiency, CO2 reduction, and cost effectiveness) and implementing the DOE CAP strategy, leading to creating a smarter and more resilient grid and community.

Advanced Distribution Management System for the grid of the future

Develop new architectures that integrate new/existing applications across the utility enterprise to accommodate rapid and complex communications/interactions between D&T; develop operational control strategies using advanced analytics.

Resilient Electric Grid R&D for enhanced grid resilience

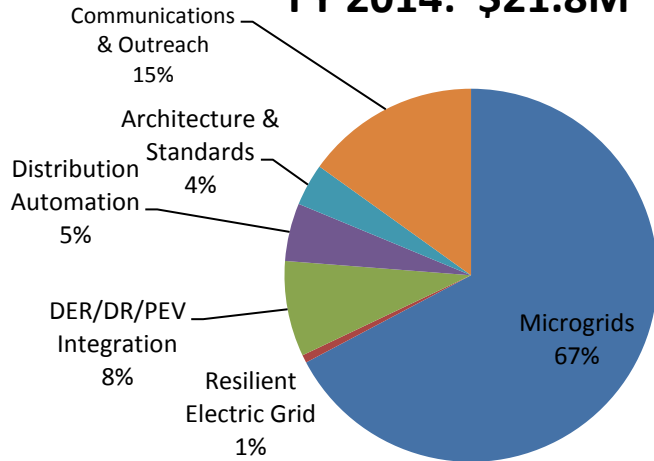
Implement high-priority R&D projects identified in the resilient grid roadmap, developed in a broad stakeholder workshop in 2014 and finalized during the QER in 2015.

Transactive and Distributed Controls for economical and flexible stability

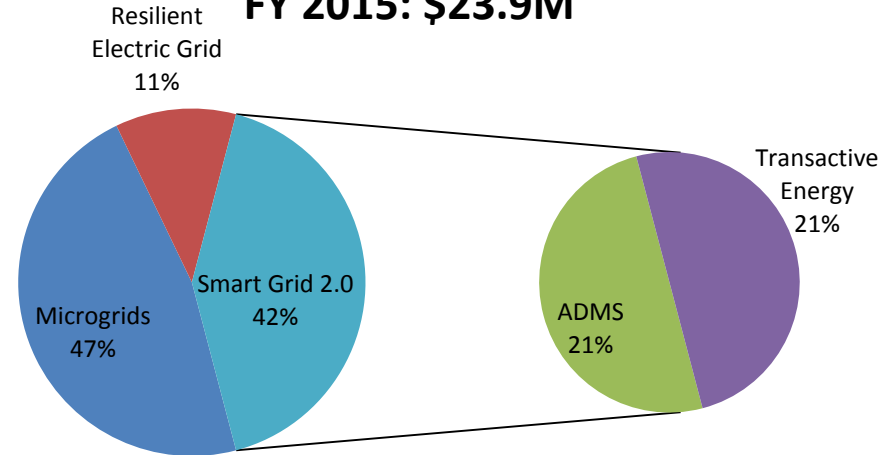
Develop simulation tools for the impact of transactive control, develop optimization algorithms for economic/engineering controls, and assess the impact of feeder designs and architectures on the value of energy and services.

Program Funding

FY 2014: \$21.8M*



FY 2015: \$23.9M



*Includes prior funding of \$7.2M set aside for microgrid FOA

| FY 2014 Funding by Sector | |
|----------------------------|------------|
| Sector | % |
| National Labs | 39 |
| Competitively Awarded FOAs | 57 |
| Other | 4 |
| Total | 100 |

| FY 2015 Funding by Sector | |
|----------------------------|------------|
| Sector | % |
| National Labs | 74 |
| Competitively Awarded FOAs | 24 |
| Other | 2 |
| Total | 100 |

Questions?