

2012 Smart Grid R&D Program Peer Review Meeting

Support of Renewable and Distributed System Integration and Microgrids

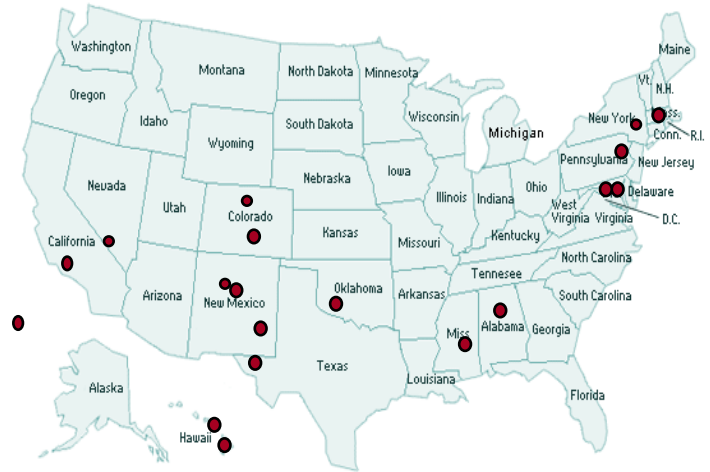
Mike Hightower
Sandia National Laboratories

June 7, 2012

Support RDSI and Microgrids

Objective

To address current shortcomings of power reliability and security, Sandia is investigating advanced microgrid approaches to locate more secure and robust distributed energy generation and storage sources near loads as a way to better manage power generation and to improve overall power reliability and security. Microgrids are equally applicable to military, industrial, and utility distribution applications.



Life-cycle Funding Summary (\$K)

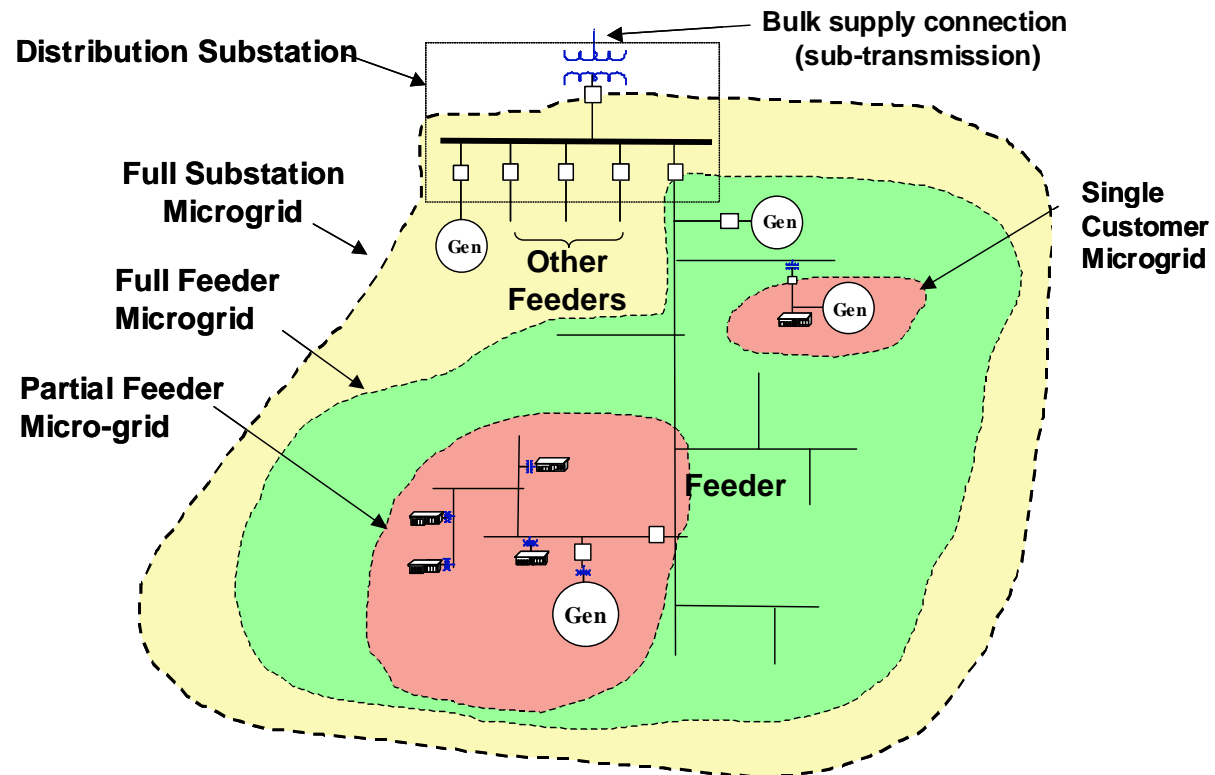
FY 09 to FY 11	FY12, authorized	FY13, requested	Out-year(s)
~\$2000K	\$870K	\$1000K	\$1000K

Technical Scope

Sandia's microgrid research utilizes smart grid technologies to enable distributed energy generation and storage to be operated in both 'grid-tied and 'islanded' modes. This enables energy demand/response management, increased use of distributed and renewable energy technologies, and improved cost-effectiveness, and reliability. The program leverages DoD, DOE, and industry funding to develop and evaluate smart grid technologies at DoD and other sites and testbeds.

Significance and Impact

- Advanced microgrids designed to operate 'grid tied' and 'islanded'
- Supports enhanced
 - Use of distributed energy and storage technologies
 - System resiliency
 - System reliability
 - System security and safety
 - Utility benefits
- Scalable implementation of Smart Grid technologies to identify benefits and issues

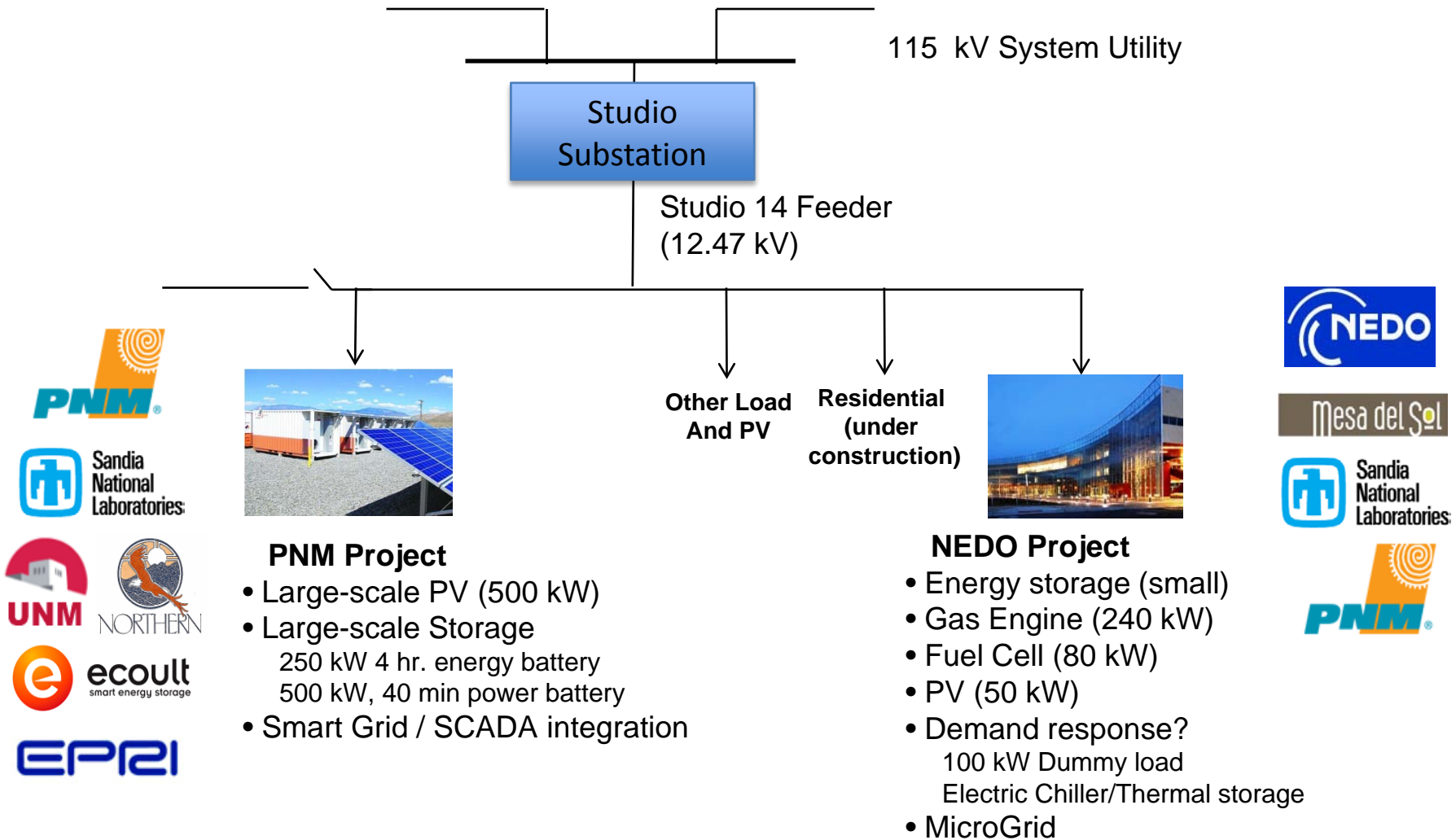


Advanced Microgrids – Supporting Use of Renewable, Distributed, and Smart Grid Technologies

Significance and Impact

- **Consequence modeling shows that significant reliability and security improvements available with advanced microgrids**
 - Automated microgrids show great flexibility - control, safety, and cyber security issues are not insurmountable
 - Can improve energy reliability in remote areas and on congested feeders
- **Advanced microgrids able to operate “islanded” and “grid – tied” can greatly improve the ROI of distributed energy**
 - Demand/response and ancillary services opportunities can be significant
 - Combined cooling, heat, and power (CCHP) have large potential
- **Multiple microgrids are often the best energy reliability approach at bases (coupling/networking can be even more beneficial and cost effective)**

Significance and Impact



Helping to accelerate Commercial Smart Grid Testing

Technical Approach & Transformational R&D

Reduce the “unacceptably high risk” of mission impact from an extended electric grid outage by maintaining energy delivery*

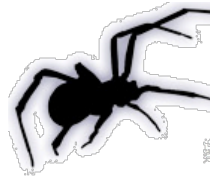
- **Develop and Demonstrate:**
 - Secure microgrid generation & distribution
 - Cyber-security of electric grid
 - Smart Grid technologies & applications
 - Integration of distributed & intermittent renewable sources
 - Demand-side management
 - Improved energy system safety, security, reliability, and cost-effectiveness
- **Results in:**
 - Technically sound, commercially viable secure advanced microgrid with mixed generation including renewables
 - Complete DoD installation with a secure, advanced microgrid capable of islanding
 - Template for mission critical asset energy security for an entire installation with cost and performance data needed to accelerate technology transition to commercial use

Technical Approach

Conceptual Designs/Assessments	Small Scale Microgrid Demos	Large Scale Microgrid Demos	Operational Prototypes
<ul style="list-style-type: none"> • Two more sites FY12, DoD/DOE • West Point - FY12, DoD • Creech AFB - FY12, DoD/DOE • Osan AFB – FY12, DoD • Philadelphia Navy Yard – FY11, DOE OE/PIDC • Cannon AFB – FY11, DOE OE/DoD • Vandenberg AFB – FY11, DOE FEMP • Kirtland AFB – FY10, DOE OE/DoD • Camp Smith – FY10, DOE FEMP • Ft. Bliss – FY10, DOE FEMP • Ft. Carson – FY10, DOE FEMP • Indian Head NWC – FY09, DOE OE/DoD • Ft. Devens (99th ANG) – FY09, DOE OE/DoD • Ft. Belvoir – FY09 DOE OE/FEMP • Maxwell AFB – FY09, DoD/DOE • Ft. Sill – FY08, Sandia LDRD 	<ul style="list-style-type: none"> • Maxwell AFB – FY12, DoD/DOE • Ft. Sill – FY11, DoD w/ SNL serving as advisor 	<p>SPIDERS JCTD – FY11 - 14, DOE/DoD</p> <ul style="list-style-type: none"> • Ft Carson - FY13 • Hickam AFB – F13 • Kirtland AFB– FY 14? <p>Coupled microgrid</p>	<ul style="list-style-type: none"> • Ft. Belvoir – CCHP DoD/DOE FY 14 • Camp Smith - FY14



Technical Approach & Transformational R&D



FT CARSON ADVANCED MICROGRID

- Large Scale PV (50%)
- Vehicle-to-Grid
- Only Critical Assets
- CONUS Homeland Defense Demo
- COOP Exercise
- 3MW

PEARL HARBOR / HICKAM AFB CIRCUIT LEVEL DEMONSTRATION

- Renewables (20% PV)
- Storage – Flow battery
- Energy Management
- Peak Shaving
- 1 MW

CAMP SMITH ENERGY ISLAND

- Entire Installation Smart Microgrid
- Islanded Installation
- High Penetration of Renewables
- Demand-Side Management
- Redundant Backup Power
- Makana Pahili Hurricane Exercise
- 4 MW

TRANSITION

- Template for DoD-wide implementation
- CONOPS
- TTPs
- Training Plans
- DoD Adds Specs to GSA Schedule
- Transition to Commercial Sector
- Transition Cyber-Security to Federal Sector and Utilities

CYBER-SECURITY

Technical Accomplishments

■ From Military Base Evaluations

- Advanced microgrid Concept of Operations (CONOPS) developed for broad range of microgrid sizes (FY09-FY12)
- Defined approaches and costs for addressing critical mission, priority, and non-priority loads (FY09-FY12)
- Developing training manuals and guidance on advanced microgrids evaluation and conceptual design with West Point (9/12)

■ From Microgrid Testing and SPIDERS program

- Four final designs to assess if major improvements in conceptual designs are needed (FY12) and assess operational issues (10/12-FY14)
- Developed microgrid cyber security strategy (FY11)
 - ◆ DoD compliant, working on CyberCOM and NSA approval
- Evaluating protective relaying design for safety (5/12)
- Integrated Dynamic Simulation Consequence modeling to enable stakeholder input for critical and priority load shedding issues (FY11)

Technical Accomplishments

■ From Mesa del Sol (NM)

- Small advanced microgrid performance data collection, presentation, and evaluation (5/12)
- Cyber security for commercial microgrid applications (8/12)
- All sky monitoring assessment for improved microgrid control with high penetration of PV (7/12)
- Coupled microgrid control and performance evaluation (FY12-FY13)

■ From Center for Energy Transformation and Innovation (VT)

- VT- 90% homes with smart meters by 2013, 90% of all energy supply will be from renewables by 2050
- Pursuing three advanced utility microgrids including Washington DC (7/12)
- Working with utilities on Smart Meter/Smart Grid interface (9/12)
- Support building Regional PV Test Center @ IBM in Burlington (10/12)

Technical Accomplishments Relative to Performance Targets

- **Advanced Microgrid efforts support DOE Smart Grid long-term cost and performance goals**
 - Hickum AFB demonstration in winter 2012 will have 20% renewables, flow battery, and integrated distributed generation
 - Maxwell, Hickum, and Mesa del Sol microgrids should show >98% reduction in outage times during demonstrations in FY12-FY13
 - Camp Smith and Ft. Carson demonstrations in FY13 and FY14, with high PV penetration and demand response capability should show higher than 15% load factor reduction
 - Demonstrations at Maxwell, Hickum, Ft. Carson, Mesa del Sol, and Camp Smith in FY12-FY14 will be monitored to assess SAIDI reductions

Project Team Capabilities & Funding Leverage

■ DoD collaboration and funding leverage

- OSD, USACOE, Military Services, DOE/FEMP – technical and programmatic collaboration
- Other DOE funding for assessments - \$2M
- DoD funding for assessments and SPIDERS construction- \$30M
- Sandia funding - \$7M

■ Mesa del Sol and CETI collaboration and funding leverage

- EPRI, UNM, NM, VT, UVM, PNM, Green Mountain Power, Efficiency VT, IBM, NEDO, HECO- technical and programmatic collaboration
- NEDO funding - \$30M
- VT funding - \$1M
- Sandia funding - \$5M
- Other DOE funding - \$3M

Contact Information

Mike Hightower
Distinguished Member of the Technical Staff
Sandia National Laboratories
1515 Eubank SE, MS 1108
Albuquerque, NM 87123

Phone: 505-844-5499
Fax: 505-844-0968
Cell: 505-850-8630
Email: mmhight@sandia.gov