DOE Microgrid Initiative Overview

Merrill Smith
Smart Grid R&D Program

Promotes the development of an efficient, fully integrated “smart” grid through the adaptation and integration of digital information and communication technologies into the Nation’s electricity delivery system.

<table>
<thead>
<tr>
<th>Dollars in Thousands</th>
<th>FY 2011</th>
<th>FY 2012 Planning</th>
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</thead>
<tbody>
<tr>
<td>FY 2011</td>
<td>23,000</td>
<td>19,924</td>
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</table>

R&D Areas Guided by MYPP* on:
› Renewable & distributed systems integration
› **Microgrids**
› Integration of Plug-in Electric Vehicles (PEVs)
› Modeling & Analysis
› Advanced communications & controls
› Foundational standards and best practices
› Demand response and consumer acceptance

Enhancing Security and Reliability Through the Use of Microgrids

DOE’s Goal: lead national efforts to modernize the electric grid, enhance security and reliability of the energy infrastructure, and facilitate recovery from disruptions to energy supply.

<table>
<thead>
<tr>
<th>Attributes</th>
<th>DOE Goals</th>
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<tbody>
<tr>
<td>Energy Efficiency</td>
<td>Increase efficiency of the electric delivery system through reduced energy losses.</td>
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<tr>
<td>System Efficiency</td>
<td>Reduce peak price and price volatility of electricity, increased asset utilization and provide accessibility to a variety of fuel sources.</td>
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<td>Reliability</td>
<td>Strengthen grid stability and reduce the frequency and duration of operational disturbances.</td>
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<tr>
<td>Security</td>
<td>The energy infrastructure is hardened to detect, prevent and mitigate external disruptions to the energy sector.</td>
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Microgrid Enhanced Distribution

- Ease of CHP application
- Supports increase of renewables—firms intermittent resources
- Arbitrage of energy price differentials
- Enhance G&T by use of plug-and-play DER for peak shaving
- Enhance reliability with international islanding
- High local reliability
- Energy during outages
# Defining Microgrids

<table>
<thead>
<tr>
<th>Microgrid Definition</th>
<th>Key Attributes</th>
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| A microgrid is 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 or island-mode. | 1. Grouping interconnected loads and distributed energy resources  
2. Can operate in both island mode or grid-connected  
3. Can connect and disconnect from the grid  
4. Acts as a single controllable entity to the grid |
Microgrid Benefits

- Enables Grid Modernization
  - Key component of grid modernization
  - Enables integration of multiple Smart Grid technologies

- Enhances the integration of DER
  - Facilities integration of combined heat and power (CHP)
  - Promotes energy efficiency and reduces losses by locating generation near demand
  - Potential to reduce large capital investments by meeting increased consumption with locally generated power. (Local generation lowers investment in the macrogrid)
  - Encourages third-party investment in the local grid and power supply
  - Potential to reduce peak load
Microgrid Benefits cont’d

▪ Meets End User Needs
  – Ensure energy supply for critical loads.
  – Power quality and reliability controlled at the local level
  – Promotes demand-side management and load leveling
  – Promotes community energy independence and allows for community involvement in electricity supply.
  – Designed to meet local needs and increase customer (end-use) participation

▪ Supports the Macrogrid
  – Enables a more flexible macrogrid by handling sensitive loads and the variability of renewables locally
  – Enhances the integration of distributed and renewable energy resources including CHP
  – Potential to supply ancillary services to the bulk power system
  – Potential to lower carbon footprint by maximizing clean local generation
  – Potential to resolve voltage regulation or overload issues
Microgrid Related Funding

FY 2011 and prior

- Renewable and Distributed Systems Integration
- Consortium for Electric Reliability Technology Solutions (CERTS)
- The Distributed Energy Resources Customer Adoption Model (DER-CAM)
- Energy Surety Microgrids
- Smart Power Infrastructure Demonstration for Energy, Reliability, and Security (SPIDERS)
- Standards Development – Interconnection and Interoperability

FY 2012-2013

- Microgrid Development
  RD&D to reach 2020 microgrid performance targets *
  on costs, reliability, system energy efficiencies, and emissions

  Industry workshop held
  August 30-31, 2011, to define needed research areas and activities – Follow on June 2012

  *Develop microgrid systems capable of reducing outage time of required loads by >98%; cost comparable to non-integrated baseline solutions (UPS + diesel genset); reduce emissions by >20%; improve system energy efficiencies by >20%
Microgrid Potential Opportunities

- **Opportunities**
  - Military Installations
  - Hospitals and other critical facilities
  - Universities

- **Drivers**
  - Energy Security and Reliability
  - Renewable Energy Mandates and Directives
  - Costs (peak load reduction, demand charges)
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)

25% of distribution & 10% of generation assets (transmission is similar), worth 100s of billions of US dollars, are needed less than 400 hrs/year!
RDSI 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 Microgrids
Electric Power Reliability Impacts Mission Performance

DOE and DOD jointly fund Sandia National Laboratory to work with military bases to develop energy surety microgrid concept designs

- Power disruptions occur as many as 50-300 times per year on some bases
- Critical mission functions only take 10-20% of base load, but critical missions often on several different feeders
- Renewables often unable to operate during outages
- Under maintained and poorly specified back up generation

With distributed generation and storage, electric power can be provided when the grid is down.

Storage and generation on load side to match energy performance and readiness needs.

Microgrids could address and correct these issues.
# Energy Security Microgrid Projects

(Funded by DOE OE, DOE FEMP, and DoD)

<table>
<thead>
<tr>
<th>Conceptual Designs/Assessments</th>
<th>Small Scale Microgrid Demos</th>
<th>Large Scale Microgrid Demos</th>
<th>Operational Prototypes</th>
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<tbody>
<tr>
<td>Camp Smith – FY10, DOE FEMP</td>
<td>Ft. Sill – FY09, DoD w/ SNL serving as advisor</td>
<td>Camp Smith</td>
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<tr>
<td>West Point FY12, DoD/DOE</td>
<td></td>
<td>Ft Carson</td>
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<td>Indian Head NWC – FY09, DOE OE/DoD</td>
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<td>Hickam AFB</td>
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<tr>
<td>Ft. Sill – FY08, Sandia LDRD</td>
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<tr>
<td>Ft. Bliss – FY10, DOE FEMP</td>
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<td>Ft. Carson – FY10, DOE FEMP</td>
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<td>Ft. Devens (99th ANG) – FY09, DOE OE/DoD</td>
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<td>Ft. Belvoir – FY09 DOE OE/FEMP</td>
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<td>Cannon AFB – FY11, DOE OE/DoD</td>
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<td>Vandenberg AFB – FY11, DOE FEMP</td>
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<td>Kirtland AFB – FY10, DOE OE/DoD</td>
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<tr>
<td>Maxwell AFB – FY09, DoD/DOE</td>
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**Map showing location of projects:**

- Philadelphia Navy Yard
- Camp Smith
- West Point
- Indian Head NWC
- Ft. Sill
- Ft. Bliss
- Ft. Carson
- Ft. Devens
- Ft. Belvoir
- Cannon AFB
- Vandenberg AFB
- Kirtland AFB
- Maxwell AFB
- SPIDERS JCTD
- Camp Smith
- Ft Carson
- Hickam AFB
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.
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.
Microgrid Resources

- Office of Electricity Delivery and Energy Reliability
  http://www.oe.energy.gov

- Smart Grid
  http://www.smartgrid.gov

- Sandia National Laboratory – Energy Systems

- Berkley Lab (DER-CAM and International Symposium)
  http://der.lbl.gov/

- Microgrid workshop results
  http://www.e2rg.com/reports