MICROGRIDS:
US DOE Overview

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Microgrids for Enhanced Resilience, Reliability, Economics, and Efficiency

**Resiliency**: crucial recovery centers during major disruption events

**Reliability**: mitigate utility service interruptions

**Economics**: arbitrage, demand management, controllable loads

**Efficiency**: renewables integration, combined heat and power

**Path forward**: seamless grid communication to enable grid services and provide low-cost solutions for grid management and damage mitigation
# U.S. DOE - Microgrid Program Areas

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<tr>
<th>Program Areas</th>
<th>Objectives</th>
<th>Goals</th>
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<tr>
<td>Remote, Off-grid Microgrids</td>
<td>• Active control of electrical and thermal energy</td>
<td>Reduce fuel usage by 50%, while lowering system life-cycle cost and improving reliability &amp; resiliency</td>
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<td>• Standardized methods for system designs and performance monitoring</td>
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<td>• Integration of local energy sources</td>
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<td>Grid-connected Microgrids</td>
<td>• Planning/design tools</td>
<td>Achieve the DOE program goals on reliability, efficiency, and costs, and meet community resiliency objectives</td>
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<td>• Operations/control tools</td>
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<td>• Integration w. distribution systems</td>
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<td>• Standardized cost/performance data</td>
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<td>Networked Microgrids</td>
<td>• Tools for planning and evaluation w. new modeling/simulation/optimization capabilities</td>
<td>Meet the defined reliability, resilience, and efficiency targets, during normal and extreme event conditions</td>
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<td>• Enabling implementation in cities and regionally</td>
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<td>Resiliency Tools</td>
<td>• Pre-event preparation</td>
<td>Advance the capabilities of distribution system tools for resiliency</td>
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<td>• During-event detection and mitigation</td>
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<td>• Post-event response, recovery, and remediation</td>
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<td>Standards and Testing</td>
<td>• New and revised microgrid standards</td>
<td>Coordinate development of standards for microgrid controllers and systems; validate the standards via testing</td>
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<td>• Standardized test methods &amp; testing</td>
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ROMDST: Remote Off-grid Microgrids Design Support Tool

Adapt DER-CAM to develop an optimization-based design support tool considering power flow for optimum mix of DERs.

Features

- Remote community microgrids
- Network constraints (AC OPF)
- N-1 security constraints
- Component part load efficiencies
- Interactive data visualization capabilities
- AC or DC architectures
- Multiple objectives
- Constraints on fuel availability
- Component library
- Network design
- Demonstration and Validation with Alaska communities
Field validation of resilience-based design and operation leveraging resources from multiple networked microgrids.

**Scope**

- Develop and demonstrate practical use of resilience metrics for coordinated operation; design to minimize outage and financial losses.
- Leverage rotational and virtual inertia of microgrid assets including hydro, diesel, energy storage, and μPMU-based sensing to enhance resilience of the overall distribution network.
- Rapidly prototype controllers as HIL and conduct cyber-vulnerability testing in a real-time cyber-secure environment.
- Field validate increasing resiliency of the distribution system by leveraging resources from multiple networked microgrids.
Microgrid Energy Management System Integration with DMS

An integrated system consisting of DMS, OMS, DERMS and μEMS controllers for efficient management of DERs.

Phase 1
- Developing an architecture of integrated system (functions, communication, control, interoperability, security)
- Developing use cases for new DMS functions
- Identifying the gaps in integration of DMS, OMS, μEMS, and DERMS
- Establishing the relationship between different components
- Developing test plan

Phase 2
- Lab demonstration
- Field implementation
Networked Microgrids
Optimal Design and Operations (OD&O) Tools

**Approach**

- Leverage development of past and ongoing projects (ROMDST, RDDT, Microgrid protection, GridLAB-D development, etc.)
- New developments in
  - Microgrid and distribution network protection modeling
  - Network, microgrid, device dynamics
  - Understanding/characterization of regulatory and business environments
  - Operations-based design and investment planning
- Create an offline OD&O tool for networked microgrids
- Perform software testing of OD&O
- Create several design test cases using OD&O
- Validate performance using numerical simulations and CIL/PHIL testing

**Improve distribution system (in this order)**

- **Resilience**—(to extreme events)
- **Reliability**—(normal/single failures, e.g., N-1)
- **Economics**—(combined investment and operations)
- **Efficiency**—(not too sure how this will really be incorporated)
Resiliency Tools

**Resilient Distribution Grid Design Tool**
Develop an open-source software, LPNORM, to enable distribution utilities to assess current resilience postures and determine resilient design upgrades.

**Distribution System Restoration Tool**
Develop an integrated system restoration tool to minimize outage sizes/durations, as well as associated economic and societal losses, caused by extreme weather events.

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**Graph**

Source: Department of Energy, Office of Electricity Delivery and Energy Reliability
Goals of IEEE 2030.7 & P2030.8

- Establish specifications and core function testing for microgrid controllers to enable interoperability of different controllers and components needed to operate controllers through cohesive, platform-independent interfaces.
- Allow for flexibility/customization of components and control algorithms while ensuring minimum requirements can be met.
- Focus on functional requirements and interoperability with various DER interfaces.
- Strive to establish comparative performance indices.
- Consider all electrical system interfaces.
- Facilitate wide adoption of standard microgrid controller functional and performance requirements.

Summary Status

- The 2030.7 and P2030.8 are poised to enable deployment of microgrids.
  - Can be used for RFPs, stakeholder understanding, etc.
- IEEE 2030.7 is now an approved standard.
- Balloting closed for IEEE P2030.8 (Jan 2018).
- The core functions for specification and testing are quantifiable dispatch and transitions.
Regional microgrid initiatives

New York
• **NY Prize** competition administered by New York State Energy Research and Development Authority (NYSERDA)
• Promote community microgrids to modernize NY’s grid
• 3 phase program:
  • 83 feasibility studies, $100k
  • 11 engineering design, $1M
  • build-out and monitoring, 2018/2019

New Jersey
• Town Center Microgrids program, administered by the Board of Public Utilities
• Promote community microgrids
• 2 phase program:
  • 13 feasibility studies, $200k
  • Engineering design

Multiple other northeastern states have developed microgrid programs
Regional microgrid initiatives

California
• CA leads some efforts: energy efficiency, EV sales
• Large **EPIC** grants to fund Microgrid research and demonstrations by California Energy Commission:
  • Demonstrate Business Case for Advanced Microgrids in Support of California’s Energy and GHG Policies ($50M)
  • Distribution System Modeling Tools to Evaluate Distributed Energy Resources ($9M)
• CA Storage Mandate; Microgrid Roadmap

Puerto Rico
• Effort to integrate DER and microgrids supported by ARPA-E (DOE)
  • Determine policy and technology options
  • Build new tool to assess grid-integration of DER
THE END

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