MICROGRIDS:
US DOE Overview

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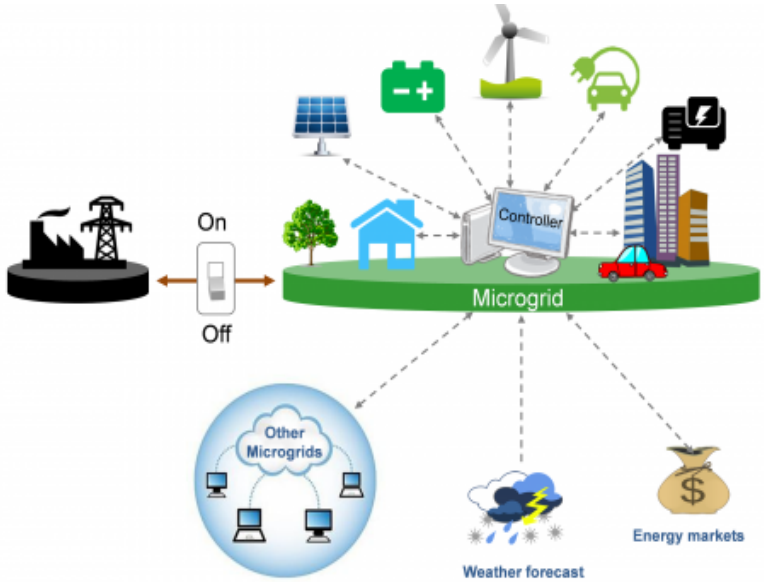
U.S. DEPARTMENT OF ENERGY

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

CORE

CROSSCUT

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

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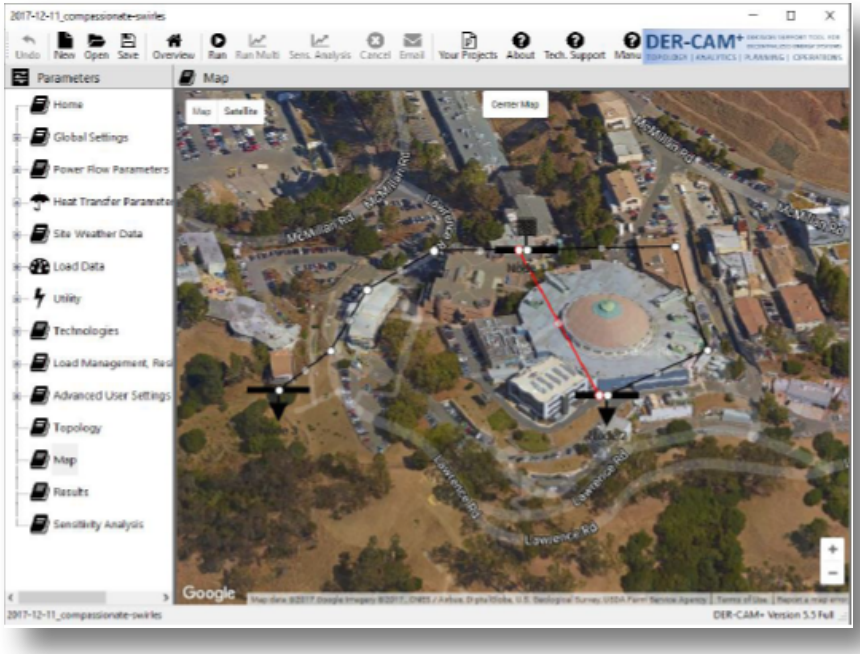
ROMDST:
Remote Off-grid Microgrids Design Support Tool

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



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RADIANCE – Resilient Alaskan Distribution system Improvements using Automation, Network analysis, Control, and Energy storage

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

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Microgrid Energy Management System Integration with DMS

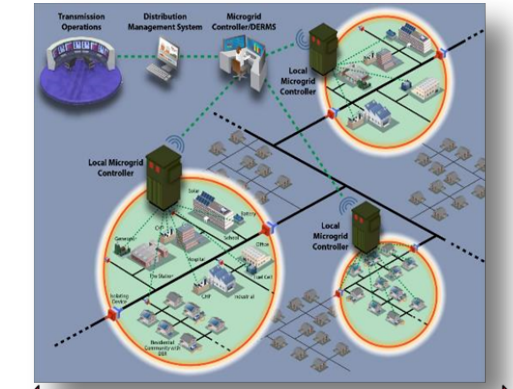
An integrated system consisting of DMS,OMS, DERMS and µEMS controllers for efficient management of DERs.

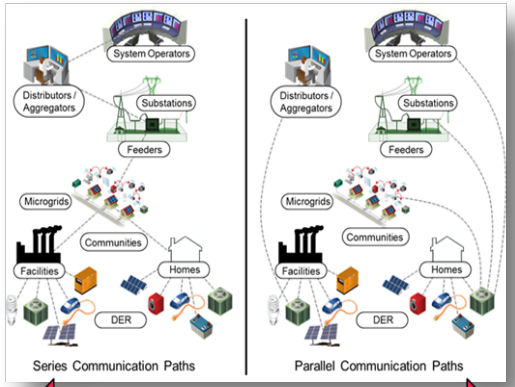
Phase 1

- 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





Phase 1

Stakeholder Advisory Group → Solution Design → Test Approach

- Gap analysis
- State-of-art in DMS technology
- Control architecture
- Functional requirements

- Structure test approach and plan
- Performance metrics
- Design test setup
- Engage with vendors and utilities

Phase 2

HIL Performance Verification Testing → Site Demo

System Design and Simulation

Performance Assessment & Impact Analysis

Develop, test, and demonstrate integrated control and management systems for distribution systems

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Networked Microgrids
Optimal Design and Operations (OD&O) Tools

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)

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

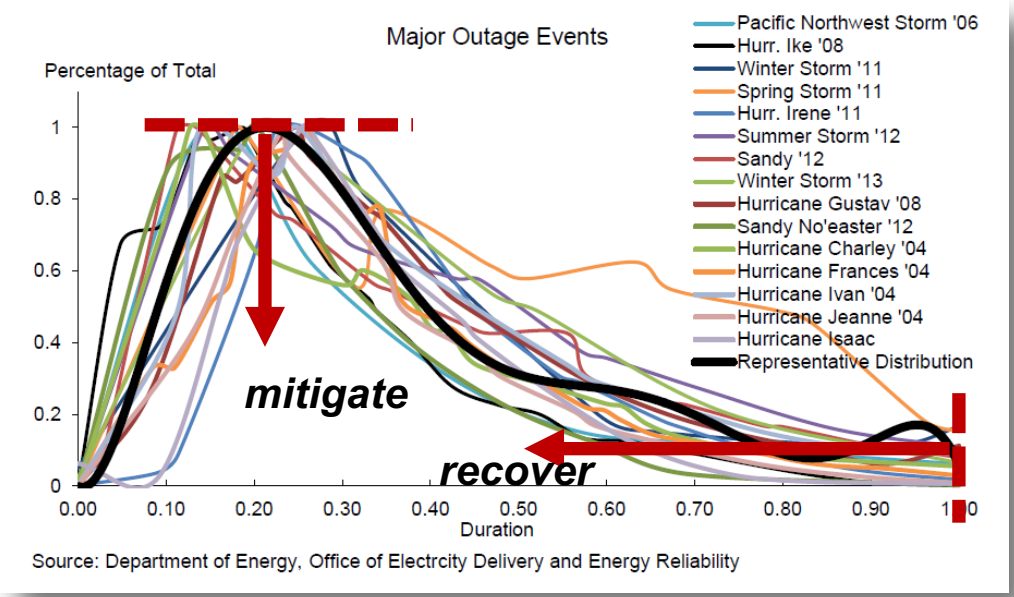
Resiliency Tools

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.



Source: Department of Energy, Office of Electrcity Delivery and Energy Reliability

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IEEE Standards for Microgrid Controllers

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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