U.S. DEPARTMENT OF
ENERGY

Office of
Electricity Delivery
& Energy Reliability

Microgrids and Distribution Utilities

Dan Ton, Power Systems Engineering Research & Development

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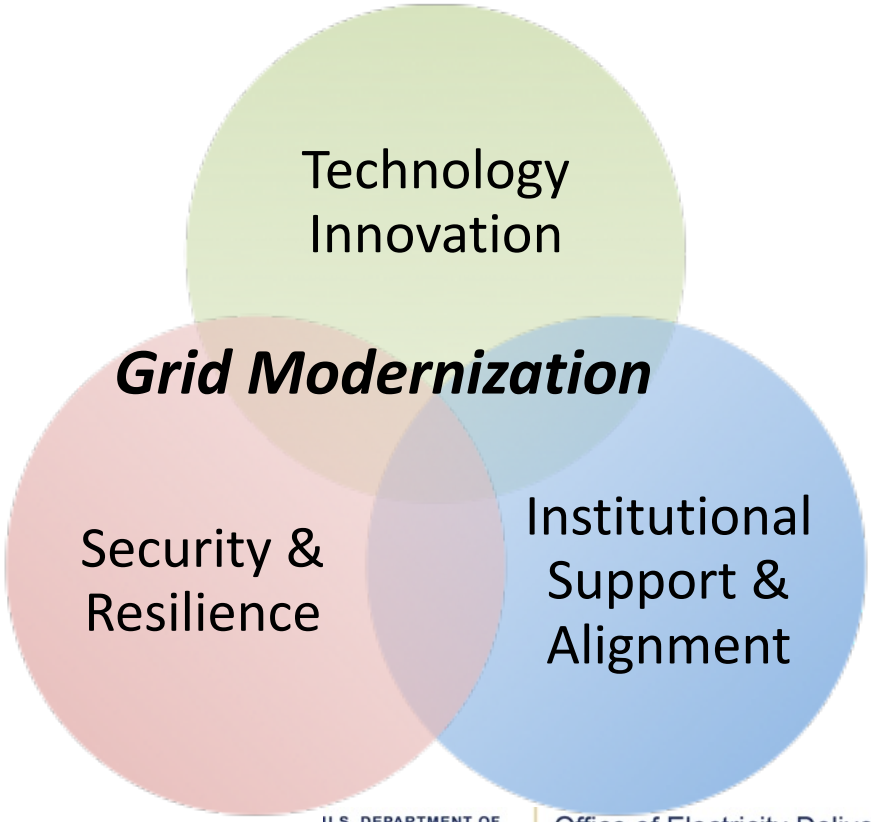
Office of Electricity

The Office of Electricity Delivery and Energy Reliability (OE) drives electric grid modernization and resiliency in the energy infrastructure.

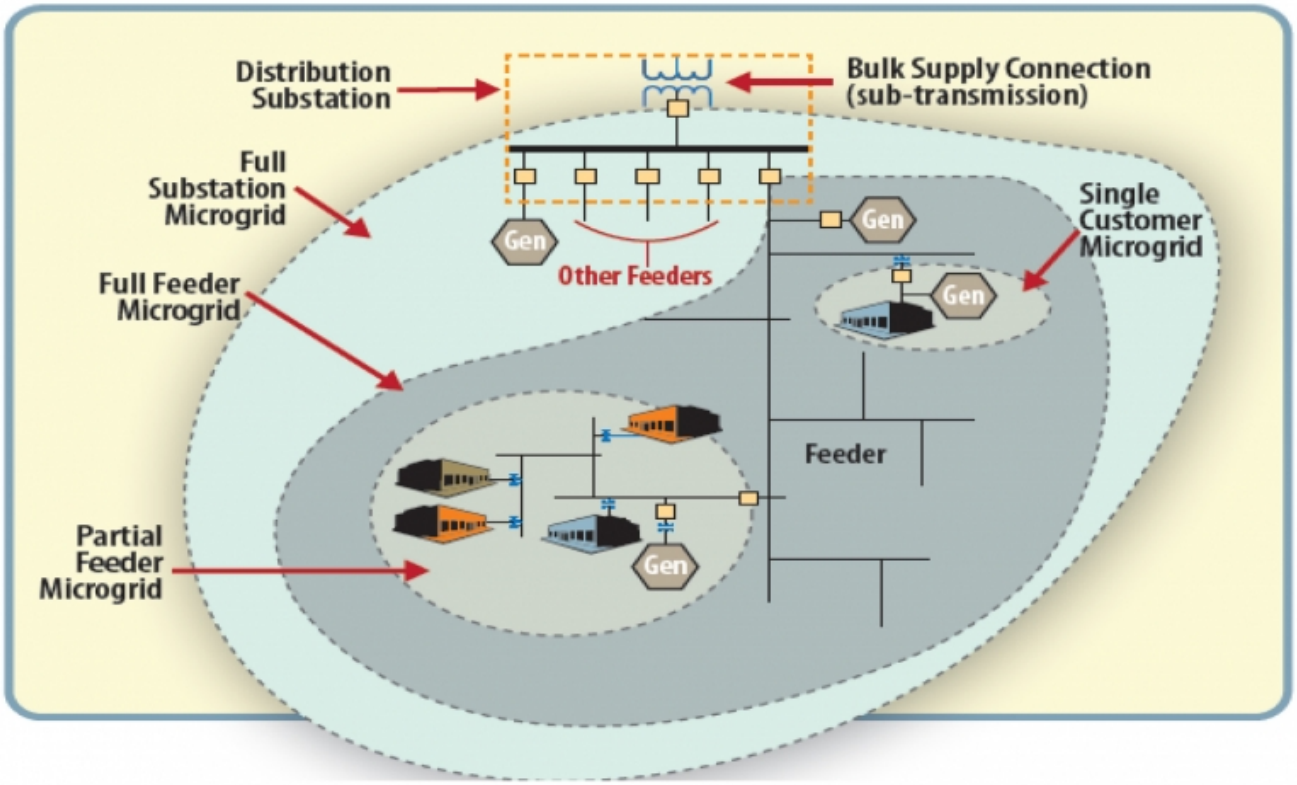
- OE leads the Department of Energy's efforts to ensure a resilient, reliable, and flexible electricity system.
- OE serves as the Energy Sector Specific lead for the Federal emergency response when activated by DHS/FEMA.



Microgrid Program – Vision

Vision

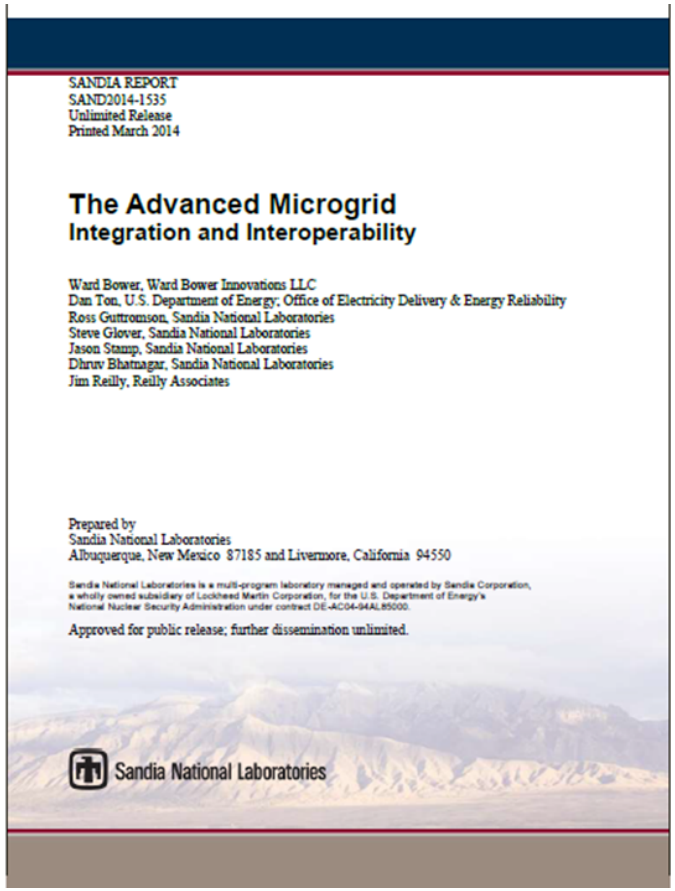
The Integrated Microgrid Program foresees the technical requirements for advancing the microgrid to a fully integrated entity within the distribution system, interacting seamlessly with the Distribution System Operator.



Where We Are – Where We Are Going

PAST 2011 - 2015	PRESENT 2016- 2017	FUTURE 2018 - 2020
Workshops	Microgrid Controller / DMS Simulations	Collaborations
Use Cases	IEEE Standards	DMS Field Demonstrations
Microgrid Controller	Metrics and Testing	Regulatory Reform

Advanced Microgrid Concept


SANDIA REPORT
SAND2014-1535
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The Advanced Microgrid
Integration and Interoperability

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Sandia National Laboratories

Advanced Microgrid

- Objectives
- Operational modes
- System architecture
- Technical challenges
- Development impacts
- Ownership
- Microgrid applications
- Standards and codes
- Controllers
- References

"An advanced microgrid is one that provides functions at the PCC beyond basic islanding (disconnect) and synchronization (reconnection) functions. An Advanced Microgrid interacts with the larger grid (macrogrid) cooperatively managing power flows across the PCC optimizing benefits for both the microgrid and macrogrid."

Microgrid Workshops

2011 Workshop	
Defined DOE 2020 targets	Recommended integration of component and system level R&D
2012 Workshop	
Prioritized R&D topics - planning/design	Prioritized R&D topics – operations/control

Develop commercial scale (<10 MW) microgrid systems capable of meeting 2020 targets:

- Reduce outage time of critical loads by >98% at a cost comparable to non-integrated baseline solutions (uninterruptible power supply + diesel generator)
- Reduce emissions by >20%
- Improve system energy efficiencies by >20%

Microgrid Program – Research Projects

Design and Planning Tools

- Microgrid Design Optimization Using DER-CAM
- Impact Analysis Microgrid Interconnection with Distribution System

System Control and Power Flow

- Guidelines for DMS for Grid Modernization
- Grid Interactive Microgrid Controllers & Aggregated DER

Device and Integrated Testing

- Microgrid Controller HIL Test Bed
- Microgrid EMS and DMS – modeling and simulations

Standards

- IEEE p2030.7 Standard for Specification of Microgrid Controllers
- IEEE p2030.8 Standard for Testing of Microgrid Controllers

Microgrid Controller Design and Testing

Microgrid Research, Development, and System Design (DE-FOA-997)

FOA Objective

Advance microgrid system designs (<10MW) and control functionalities to support achievement of DOE program targets and community-defined resilience objectives

>$12M in total investment (OE: 59%; Cost share 41%);
2-year project period of performance, including 18-month R&D and 6-month testing, data collection and analysis

Hardware in the Loop (HIL) Testing

Digital real-time simulation allows researchers to study multiple scenarios in near real conditions and without risk. They can integrate a power amplifier to introduce more realism and perform tests using real power flow between the simulated environment and real hardware. This is known as Power-Hardware-In-the-Loop (PHIL) simulation.

Purpose

- Provide standardized and independent testing
- Reduce deployment cost for new devices and solutions
- Perform research
- Investigate safety issues
- Facilitate standards development

Conduct testing of:

- Both system level and device level
- Microgrid energy management
- Microgrid control and operation
- Communication
- Protection

Standards

IEEE P2030.7 *Standard for the Specification of Microgrid Controllers*.

- PAR Approved by IEEE SA on June 11, 2014
- Working Group formed – FOA Awardees encouraged to participate
- Projected Completion Date – August 2017

IEEE P2030.8 *Standard for the Testing of Microgrid Controllers.*

- PAR Approved by IEEE SA on June 11, 2015
- Working Group formed – FOA Awardees encouraged to participate
- Projected Completion Date – May 2018

Structuring DMS Project

Objectives

- Develop integrated control and management systems for distribution systems
- Address high penetrations of interconnected DER.

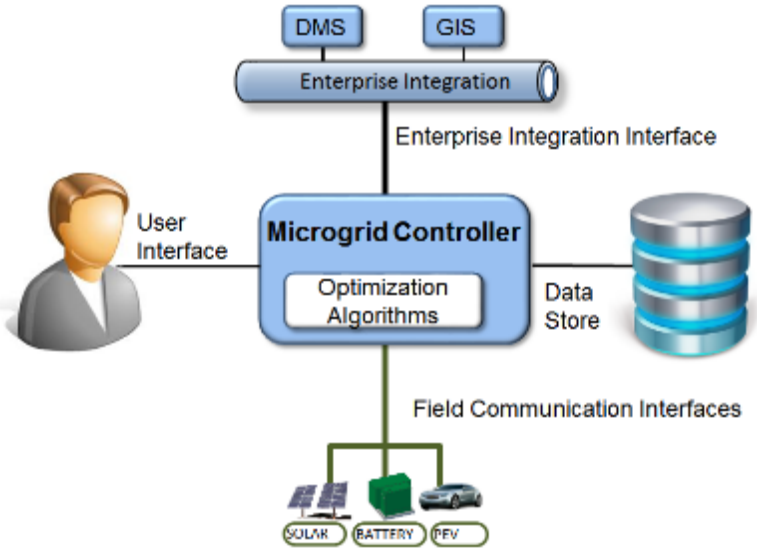
Project built on 2015 reports

- Argonne National Laboratory (ANL)
- Electric Power Research Institute (EPRI)

Integration

- Distribution management system (DMS)
- Microgrid energy management systems (µEMS)
- Distributed energy resource management system (DERMS)

Microgrid Controller Interfaces



Structuring DMS Project

Scope

- Identify gaps and enabling technologies for integrating DMS, µEMS and DERMS
- Identify and define the interactive functions of controllers to fill those gaps
- Conduct a proof-of-concept simulation to evaluate the effectiveness of integrating the three control and management systems
- Establish the criteria for selecting a testing site(s) to verify the integration of the three control and management systems in field operations at a distribution utility.

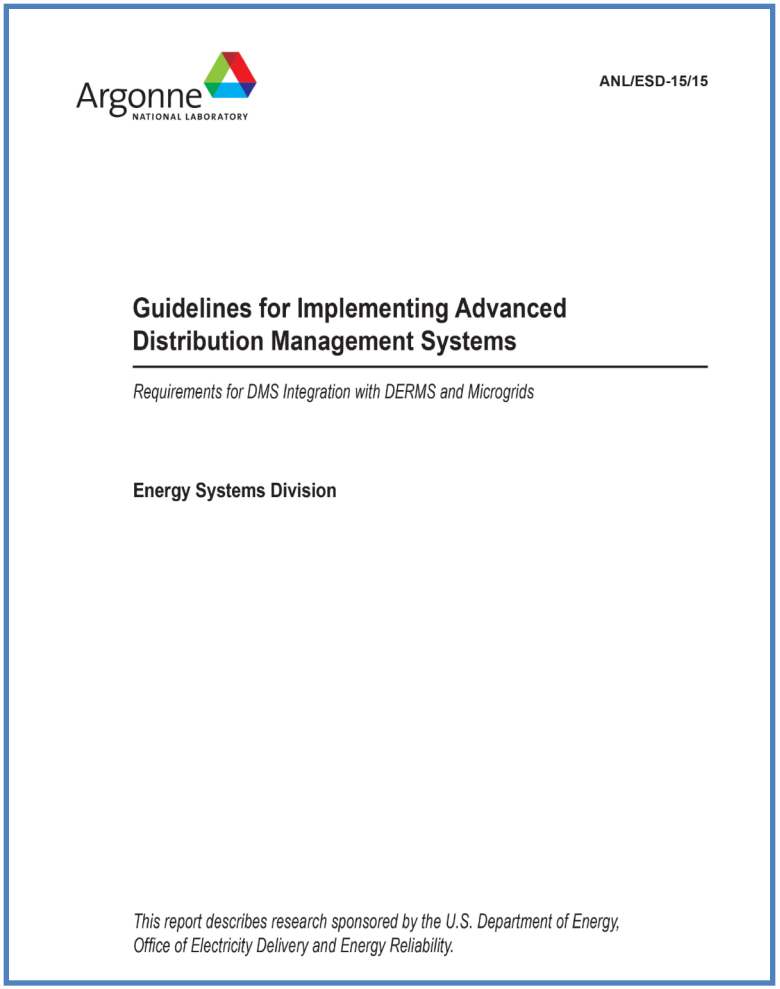
Deliverable

Recommendations for Field Sites for Demonstration Projects to validate the operational viability and effectiveness of integrated control and management systems.

Project team members

- Argonne National Laboratory
- Electric Power Research Institute
- National Renewable Energy Laboratory

Distribution Management System



Argonne NATIONAL LABORATORY

ANL/ESD-15/15

Guidelines for Implementing Advanced Distribution Management Systems

Requirements for DMS Integration with DERMS and Microgrids

Energy Systems Division

This report describes research sponsored by the U.S. Department of Energy, Office of Electricity Delivery and Energy Reliability.

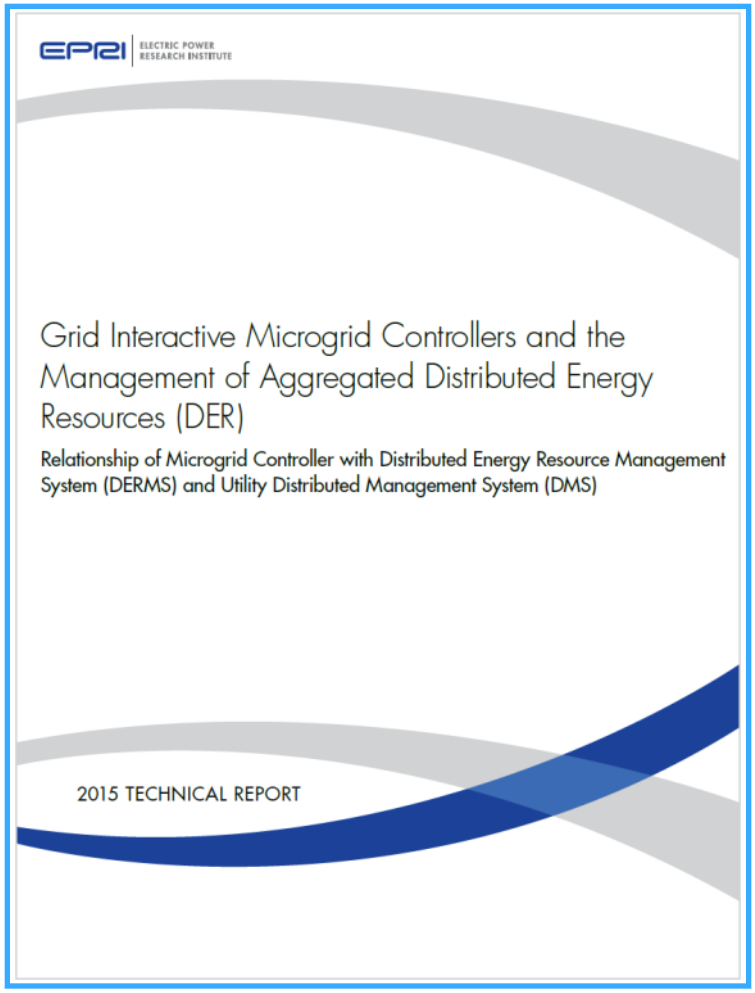
Responsibilities of microgrid for DMS

- Microgrid controllers are responsible for maintaining real power exchange, healthy voltage profiles at the active POCs when connected to the distribution grid
- Microgrids should automatically disconnect from the distribution grid in any grid fault condition beyond the threshold of ride-through

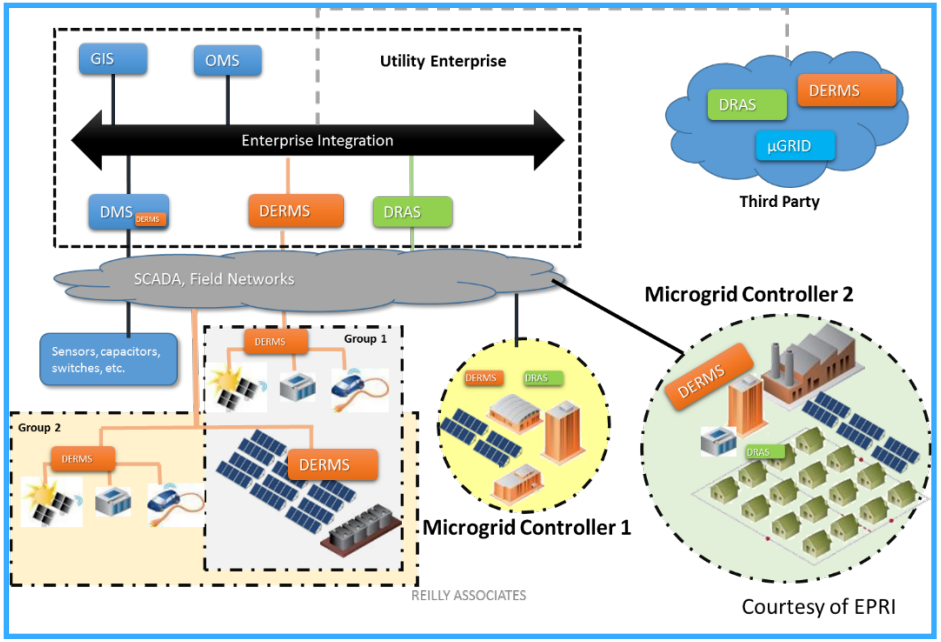
Responsibilities of DMS for microgrid

- DMS should provide operation guidance, including the voltage ranges and power exchange fluctuation tolerance around the scheduled targets at active POCs to the microgrids
- DMS can initiate emergency requests to microgrids for clearly defined specific emergency support, including support through wheeling

Grid Interactive Microgrid Controller



Microgrid Controller and DMS Relationship



Courtesy of EPRI

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THANK YOU.

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