

Outline



- I. Drivers of Change
- II. Creating a Modern Grid
- III. GMI and GMLC
- IV. Portfolio of Work
- V. Samples of Energy Storage Work

Drivers of Change

Why do we need grid modernization?



Increasing Extreme Events



Increasing Security Threats



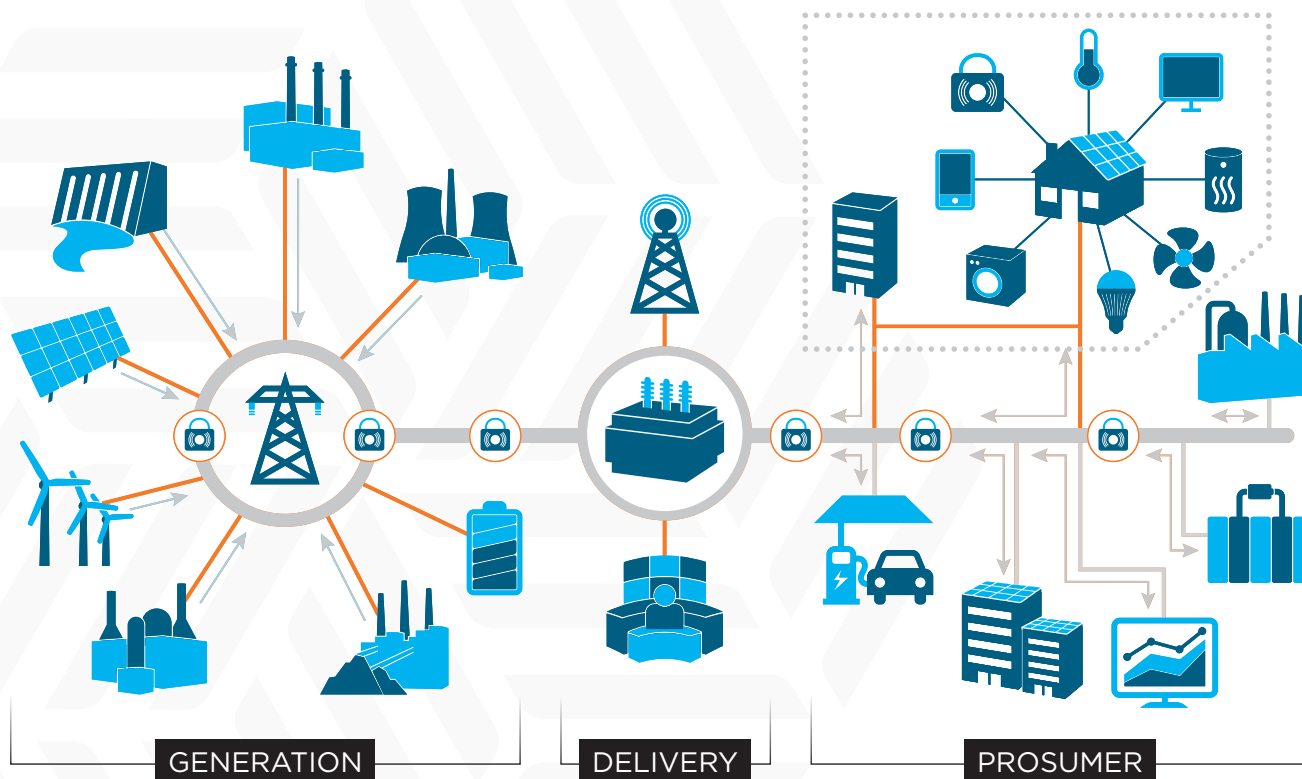
Growing Number of Prosumers



Changing Supply Mix

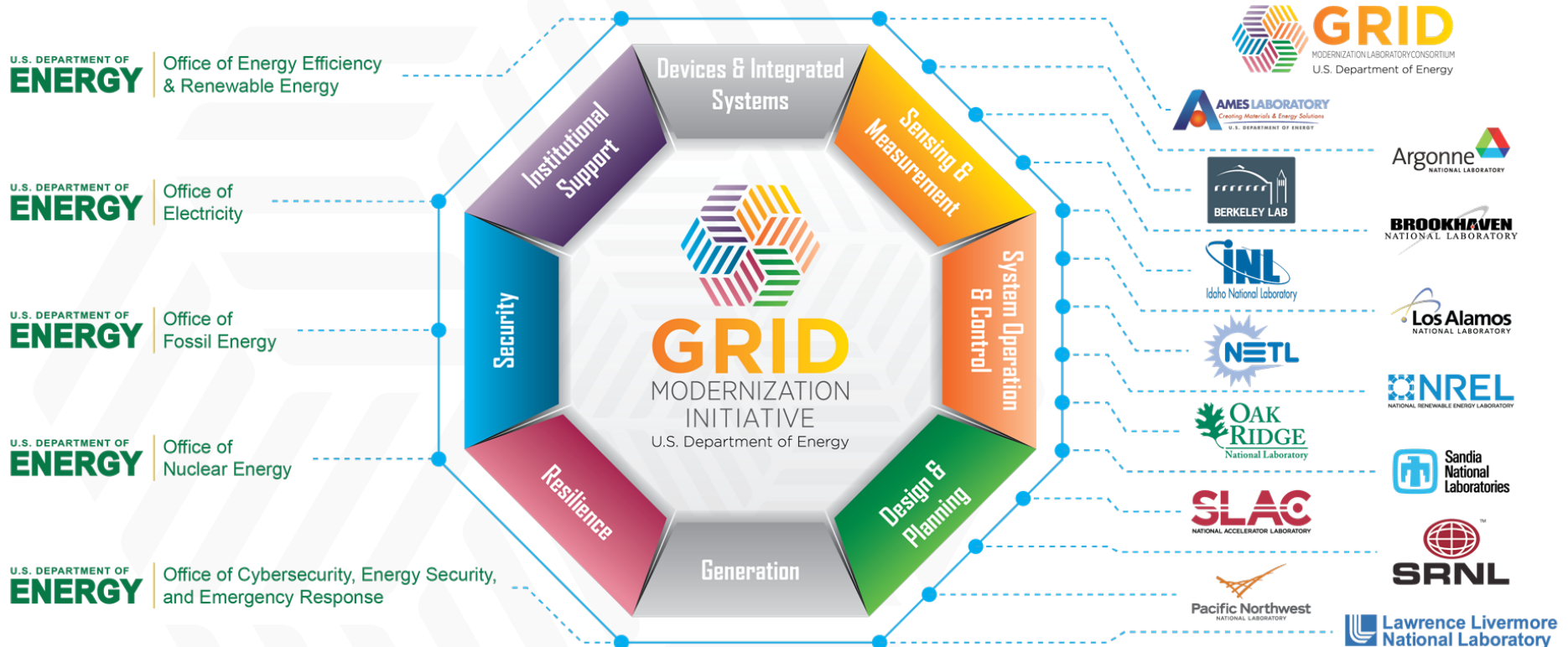
Creating a 21st Century Grid

Responding to the drivers of change



GMI and GMLC:

Efficiency. Synergy. Collaboration. Acceleration.



Portfolio of GMI Work



2016 Grid Modernization Lab Call (\$220M)

Design and Planning;
Devices and Integrated
Systems Planning;
Institutional Support;
Security and Resilience;
Sensing and
Measurement; and
Systems Operations,
Power Flow, and Control

Resilient Distribution Systems Lab Call (\$32M)

Enhancing the
resilience of
distribution systems,
including microgrids
and cybersecurity.

2019 Grid Modernization Lab Call (\$80M)

Resilience Modeling;
Energy Storage and
System Flexibility;
Advanced Sensors
and Data Analytics;
Institutional Support;
Cybersecurity; and
Generation

Other Grid Modernization Work: Program-Specific R&D Projects

Integrated Transmission, Distribution, and Communication Models

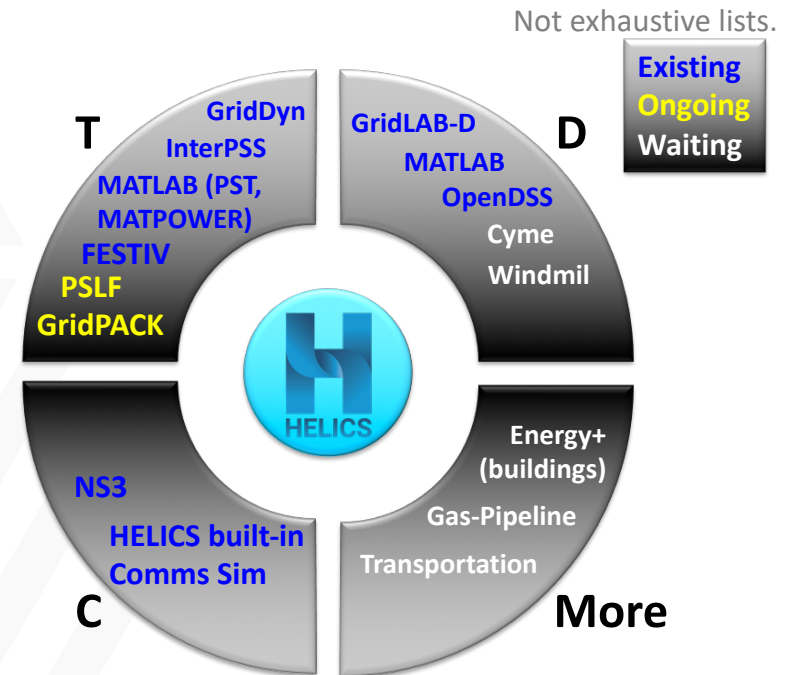
Project Description

The interdependency and interaction across transmission, distribution and communication systems can no longer be ignored, demanding integrated analysis of the end-to-end power grid.

This project developed a scalable co-simulation platform, enabling such integrated analysis to maximize flexibility and resilience of the grid.

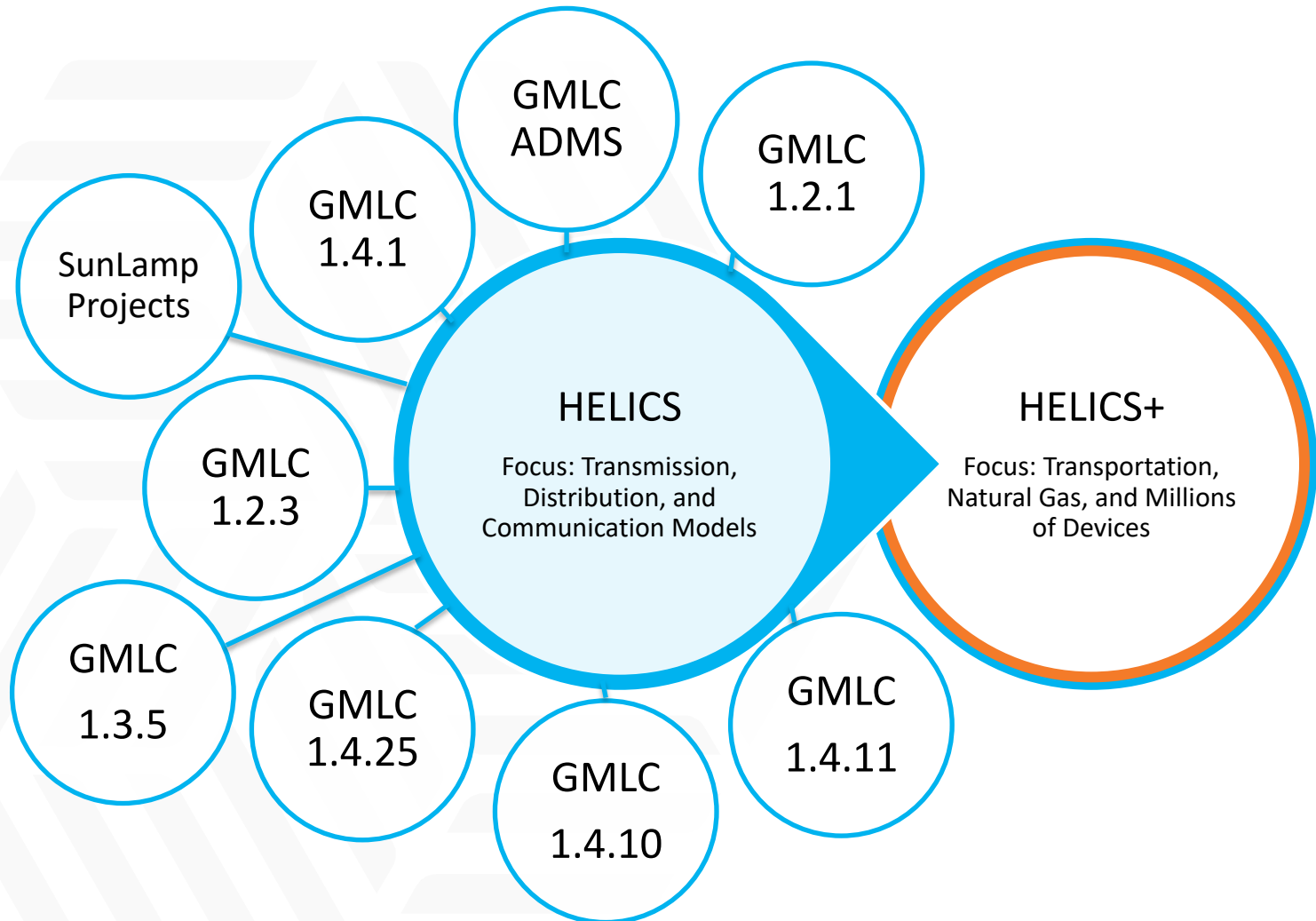
Value Proposition

- Fill current gaps in simulation and modeling technology that inhibits integrated planning across multiple domains.
- Bring together best-in-class simulation efforts from multiple national labs.
- Create HELICS™, an **open-source co-simulation platform**, enabling interactions between leading commercial & lab-developed simulators on a wide range of computing environments.

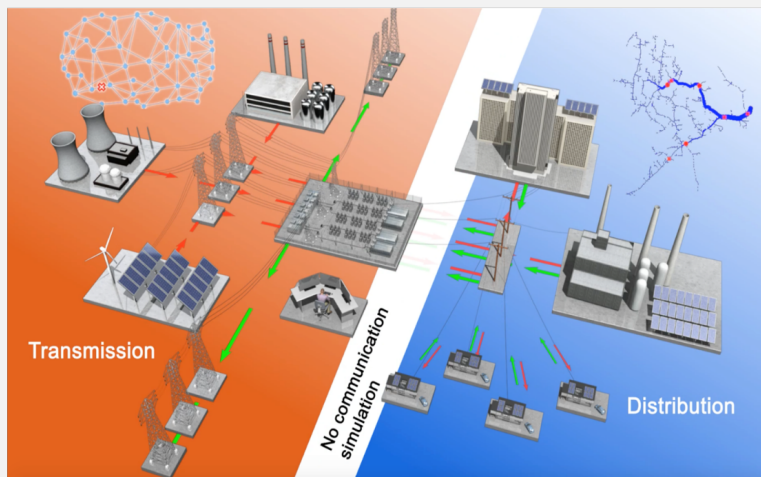


HELICS (Hierarchical Engine for Large-scale Infrastructure Co-Simulation)

Foundational Work Used in Other DOE Projects



Co-simulation Hub for Critical Energy Infrastructure



DESCRIPTION

Optimize co-simulation platform to better understand how energy infrastructure behaves in response to increasing distributed energy resources, extreme events and cyberthreats.

IMPACT

Improve management of interdependencies across energy infrastructure to drive resiliency.

PARTNERS

PNNL, LLNL, NREL, ANL, INL, NRECA, Avista, Interstate Natural Gas Assoc. of America, PJM, Exelon, Eaton/CYME, Delta Star, encoord, Washington State University, Clemson University

Advanced Distribution Management System Test Bed

Project Description

The goal of the Advanced Distribution Management System (ADMS) Test Bed project is to build a vendor-neutral test bed to evaluate existing and future ADMS functionalities in a realistic setting.

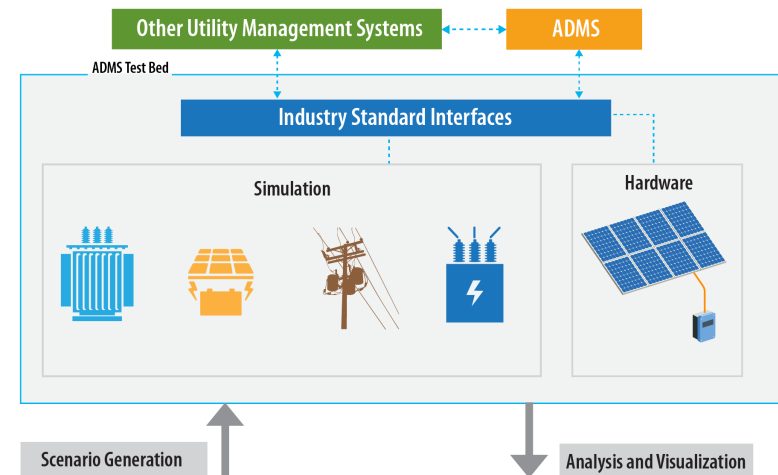
- ✓ Model large-scale distribution systems for evaluating ADMS applications.
- ✓ Integrate distribution system hardware in NREL's Energy Systems Integration Facility (ESIF) for hardware-in-the-loop (HIL) experiments.
- ✓ Develop advanced visualization capabilities.

Value Proposition

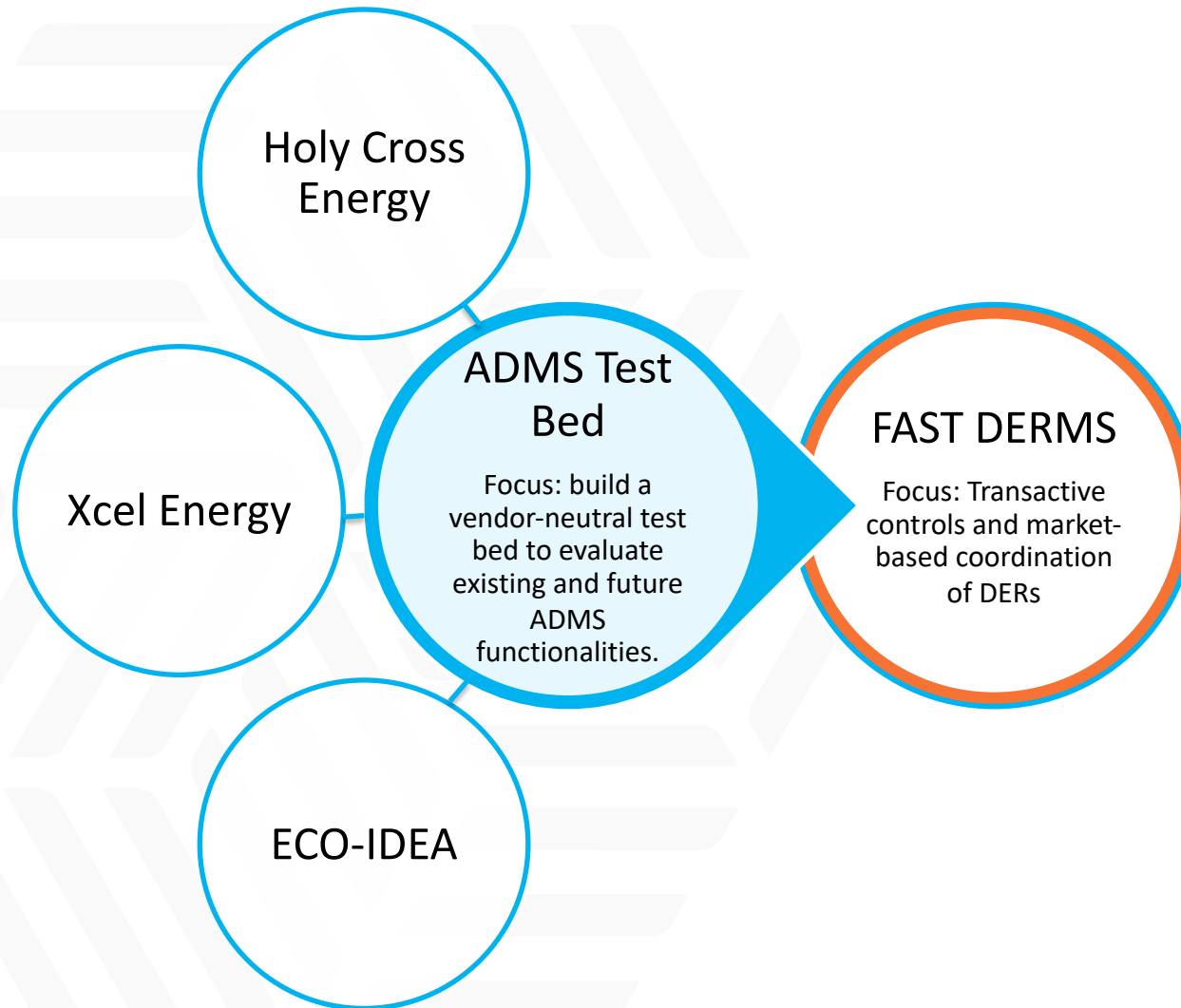
- Accelerate the adoption of ADMS by de-risking deployment through realistic pre-pilot laboratory evaluation.
- The ADMS testbed allows utilities and vendors alike to:
 - Evaluate interactions with hardware devices
 - Evaluate integration challenges of ADMS with legacy systems
 - Identify the right use-case and technical parameters for their specific distribution system
 - Evaluate and understand the impact of existing and new ADMS functionality under what-if hypothetical scenarios
 - Work closely with an Industry Advisory Board (IAB) to ensure that utility needs are met comprehensively through use cases

Project Objectives

- ✓ Enable utility partners, vendors, and researchers to evaluate existing and future ADMS use cases in a test setting that provides a realistic combination of multiple utility management systems and field equipment. Specific use cases:
 1. Evaluate performance of the ADMS Volt-Var optimization (VVO) application for different levels of model quality and different levels of measurement density
 2. Evaluate performance of peak load management coordinated across ADMS, distribution energy management systems (DERMS), and energy management systems (EMS)
 3. Evaluate data centric grid operations leveraging AMI data
 4. Evaluate automated FLISR applications in presence of DER



Foundational Work Used Outside of DOE



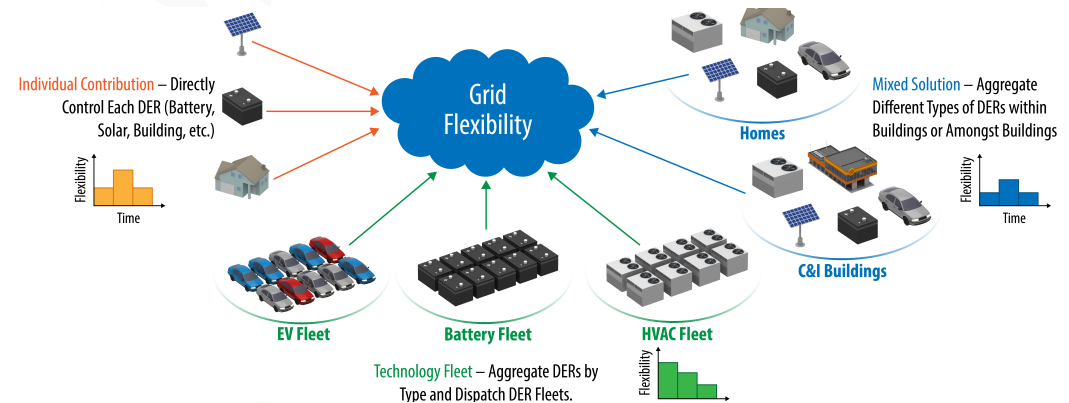
FAST-DERMS: Architecture for Secure and Transactive DER Management

DESCRIPTION

Develop federated architecture for transactive controls and market-based coordination of DERs (PV, storage, EVs, flexible loads, CHP,) for bulk power system services.

IMPACT

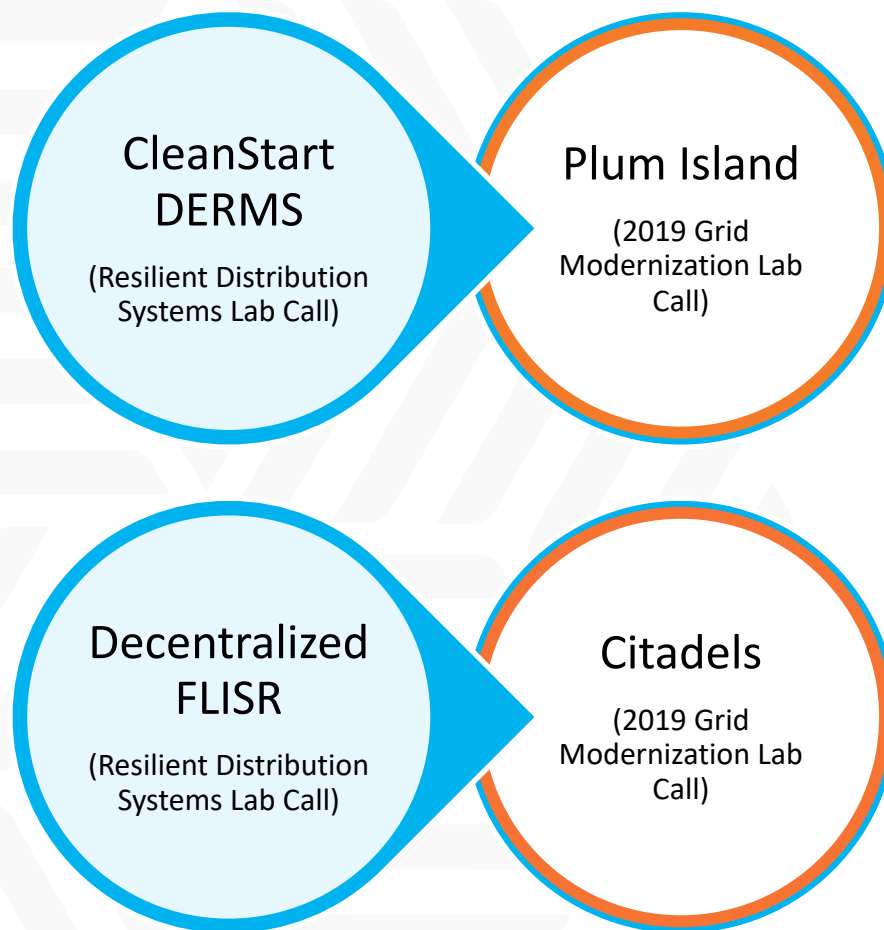
Aggregation and near real-time management of DERs using current control systems.



PARTNERS

NREL, LBNL, PNNL, ORNL, Southern Company, ComEd, SDG&E, Entergy, NYPA, Centrica, Oracle, EPRI, Iowa State University, and University of North Carolina (Charlotte)

Building Off Previous Work



CleanStart DERMS

Project Description

Develop and implement a DER Management System integrated application, which provides a separate communications, analytics and control layer, purely for a black-start and restoration application

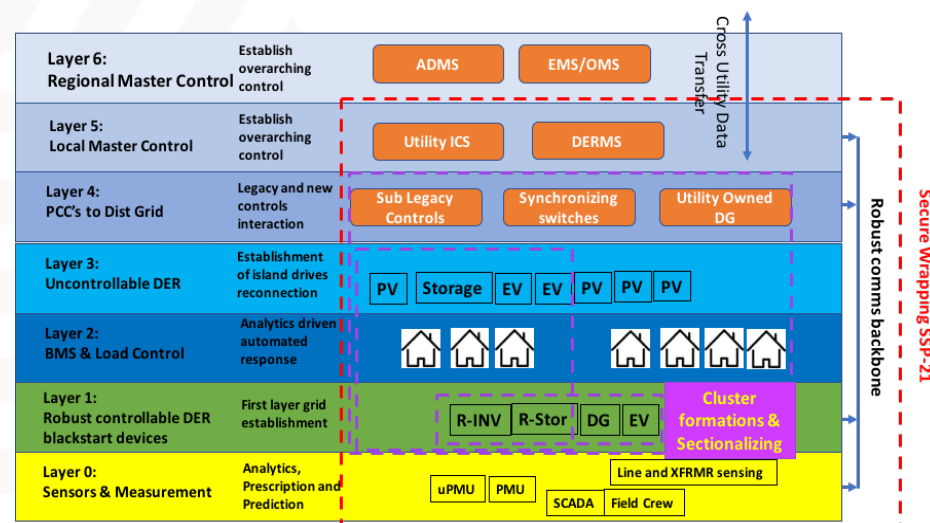
Solution will demonstrate the start of a microgrid following an outage (cyber or physical)

Value Proposition

- Black start and restoration at present is a centralized bulk system driven solution whereas DER is by nature decentralized
- Key innovations
 - DER controls as a mechanism for black start and restoration
 - Cross utility coordination and effective useful information/resource transfer
- Product will be transformational to utilities experiencing a rapid DER influx, considering both controlled and uncontrolled resources as part of the resilient resources to be utilized in widescale events

Project Objectives

- ✓ Minimize the outage time for the maximum number of customers using the greatest contribution from distributed and clean energy resources
- ✓ Implement methods for coupling and validation of predictive analytics and advanced controls for resilience
- ✓ Provide support services from DER back to the transmission system during critical outages
- ✓ Demonstrate a CEDS funded cybersecurity technology showing integration with the resilient DER architecture (CES-21/SSP-21)



Increasing Distribution Resiliency Using Flexible DER and Microgrid Assets Enabled by OpenFMB

Project Description

This project will accelerate the deployment of resilient, and secure distribution concepts through the flexible operation of traditional assets, DERs, and microgrids.

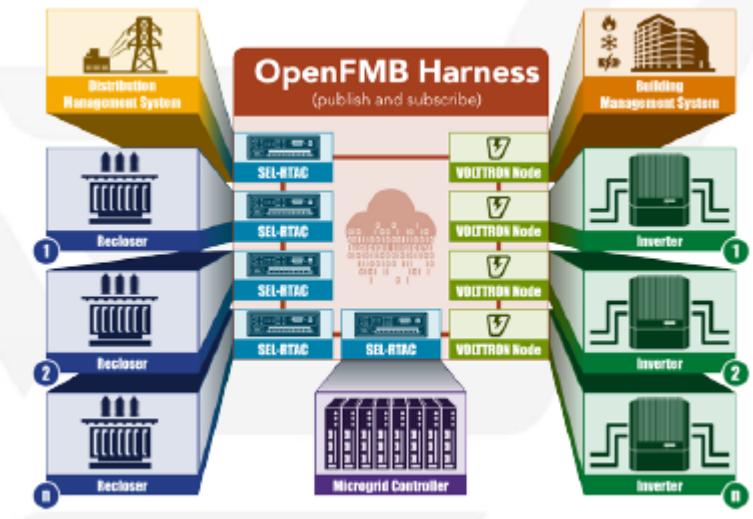
Centralized DMS functions will be coordinated with decentralized DERs and microgrids using OpenFMB, a reference architecture for security and interoperability.

Project Objectives

- ✓ This project will develop and test a flexible architecture that coordinates decentralized and centralized assets within a central distribution management system.
- ✓ The team will use an open-source reference platform, called OpenFMB, for security and interoperability.

Value Proposition

- The system will be operated as a collection of dynamic segments with adaptive settings DERs will be engaged as active elements in the control system.
- The concept is extensible to any combination of centralized and decentralized control systems, and not specific to FLISR.
- Such flexibility encourages the installment of more DERs, to further improve the grid and its resilience.



Plum Island Black Start

DESCRIPTION

Test and validate GML-developed technologies to leverage energy storage and DERs to improve black start practices following significant outages.

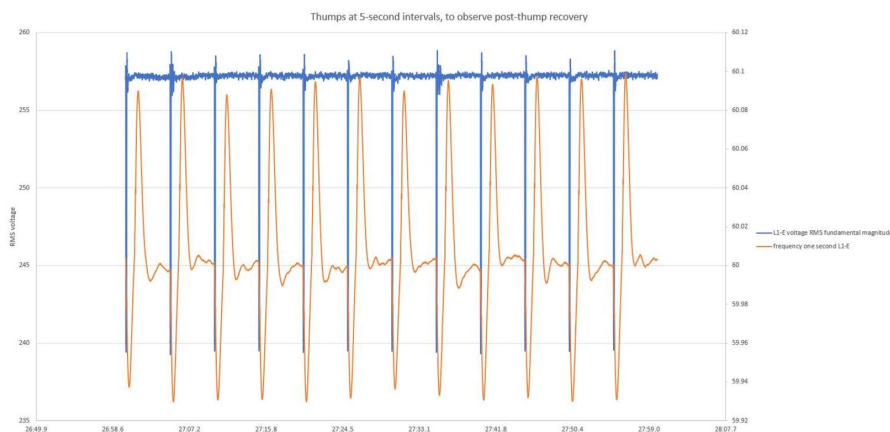
IMPACT

Expand the toolbox for grid operators to re-energize infrastructure in black start scenarios.

PARTNERS

LLNL, PNNL, INL, DARPA, DHS, Southern Company, Electric Power Board of Chattanooga, DTE, AEP, Riverside Public Utilities

Graph 6: 5-second interval between thumps, to observe post-thump recovery



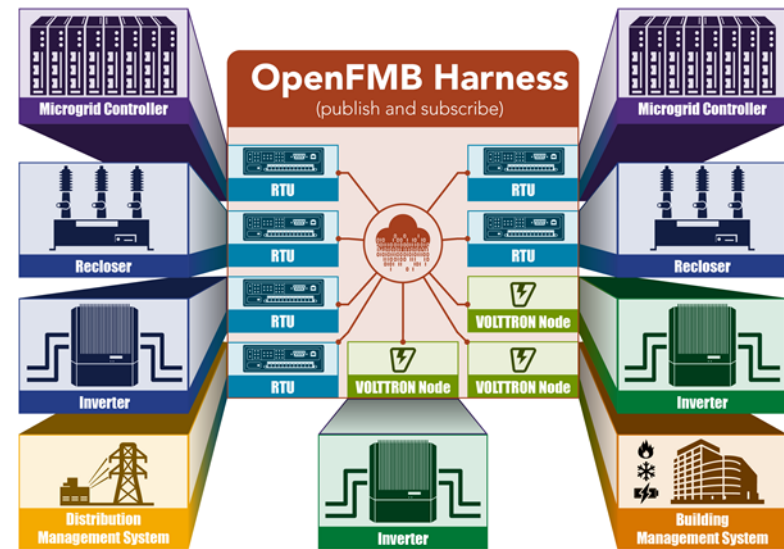
Citadels: Improving Microgrid Control and Utilization

DESCRIPTION

Develop architecture and control technology to enable microgrids, and their distributed energy resources, to operate using collaborative autonomy concepts in an OpenFMB architecture.

IMPACT

Expand utilization and effectiveness of networked microgrids for grid resiliency use cases.



PARTNERS

PNNL, LLNL, ORNL, SNL, Electric Power Board of Chattanooga, ComEd, Avista, Duke Energy, City of Riverside Public Utilities, Entergy, Southern Company