Grid Modernization Initiative

12/6/2016

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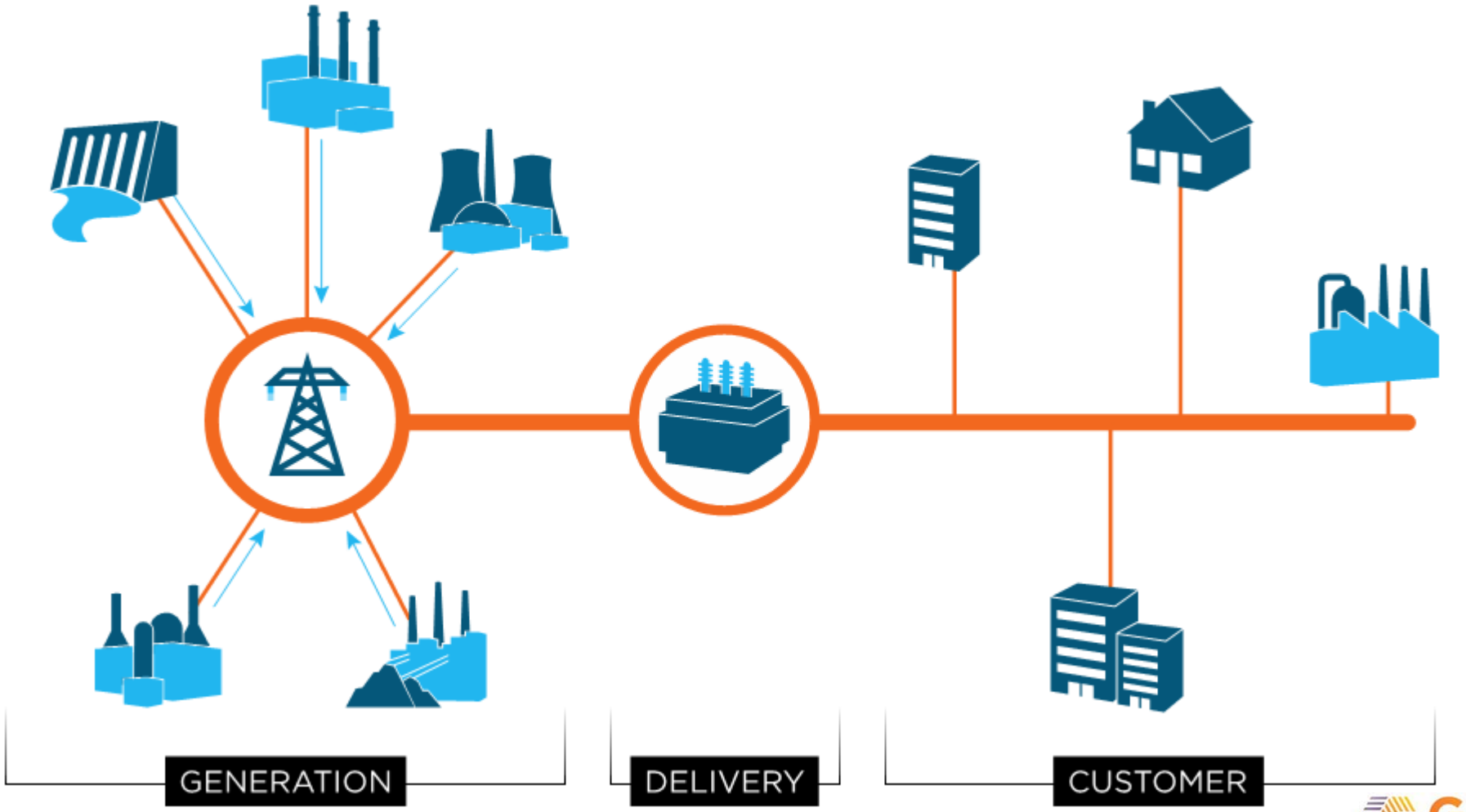
At a Glance

Developing the tools and technologies to measure, analyze, predict, protect, and control the grid of the future

- Department of Energy (DOE) is engaged in a department wide effort to accelerate the development of technology, modeling analysis, tools, and frameworks to help enable grid modernization adoption.
- This presentation addresses:
  - Grid of the Past/Future
  - Grid Modernization Initiative (GMI)
  - Grid Modernization Multi-Year Program Plan (MYPP)
  - Grid Modernization Laboratory Consortium (GMLC)
  - $220M Grid Modernization Lab Call
  - Accomplishments to date
  - Future Direction

The 20th Century Grid

The grid is one of the greatest engineering achievements of the last century



Drivers of Change

Why do we need grid modernization?

New Market Opportunities

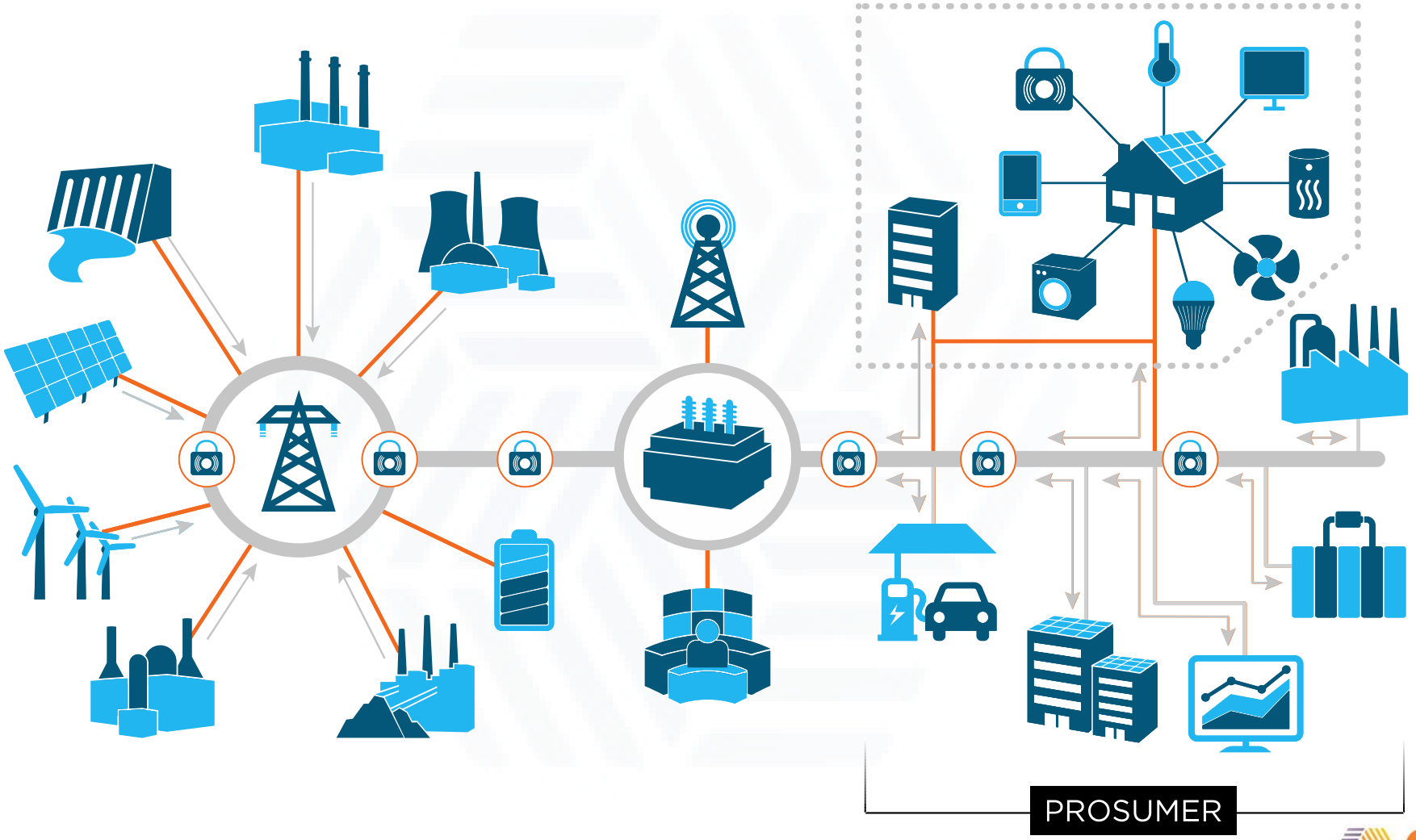
Security Threats

Extreme Events

Changing Supply Mix

Creating a 21st Century Grid

Responding to the drivers of change



Grid Modernization Initiative

Coordinates effort across the department, national laboratories, and external stakeholders

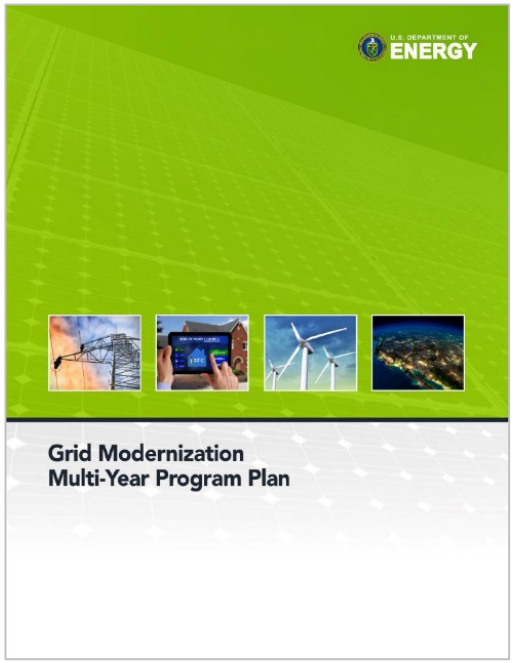
- Office of Electricity Delivery and Energy Reliability + Office of Energy Efficiency and Renewable Energy + Office of Energy Policy and Systems Analysis
- 13 Program Offices
- Funding: Grid Modernization Lab Call + other grid-related work
- Grid Modernization Laboratory Consortium (*see map*)

Attributes and Benefits of a Modernized Grid

- **More energy choices**
- **Fewer power outages**
- **Cost-effective**

Grid Modernization Initiative Approach

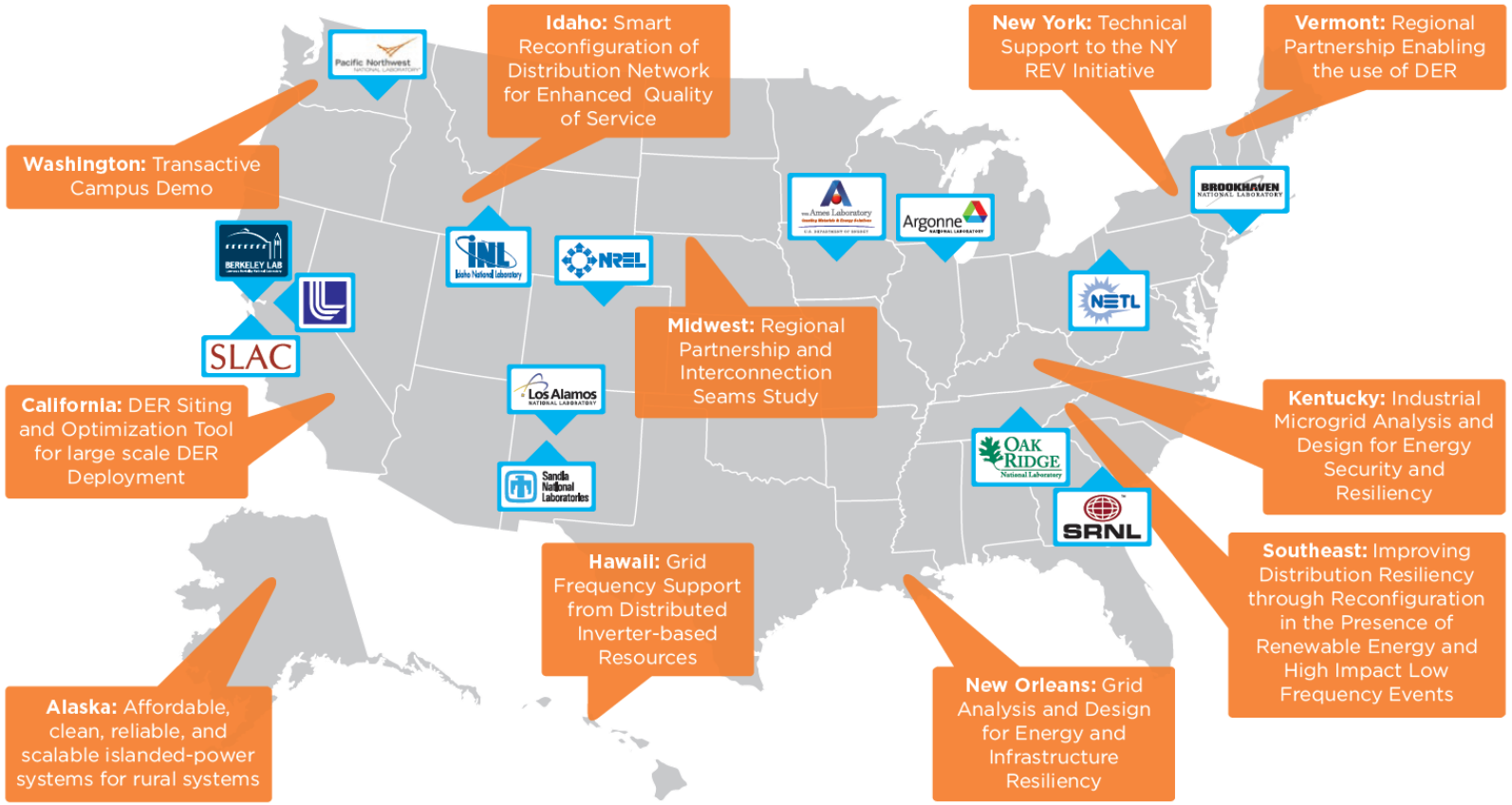
- Devices and Integrated Systems
- Sensing and Measurement
- System Operations and Control
- Design and Planning Tools
- Security and Resilience
- Institutional Support



Grid Modernization Activities

Working across the country

- Grid Modernization Lab Call
  - $220M
  - 13 national laboratories
  - 88 projects
  - 100+ partners
- Future work with other partners
  - Universities
  - Vendors
  - Utilities
  - National laboratories



A Sample of our Project Partners

Characterizing and Testing of Energy Technologies

Improving device communication to systems

Devices and Integrated Systems | Sensing and Measurement | System Operations and Control | Design and Planning Tools | Security and Resilience | Institutional Support

Expected Outcomes

- ✓ Develop new grid interface devices to increase ability to provide grid services and utilization.
- ✓ Coordinate and support the development of interconnection and interoperability test procedures for provision of grid services.
- ✓ Validate secure and reliability grid operation with high levels of variable generation at multiple scales.

Project Example

Grid Frequency Support from Distributed Inverter-Based Resources in Hawaii

Develop, simulate, validate, and deploy practical solutions that enable distributed energy resources (DERs) to help mitigate bulk system frequency contingency events on the fastest time scale. Validate the ability of real hardware inverters to support grid frequency in an environment that emulates the dynamics of a HECO power system.

Developing and Deploying Sensor Strategies

omplete system visibility

Devices and Integrated Systems	**Sensing and Measurement**	System Operations and Control	Design and Planning Tools	Security and Resilience	Institutional Support

Expected Outcomes

- ✓ Advance and integrate novel, low-cost sensors to provide system visibility.
- ✓ Incorporate new data streams (e.g. weather).
- ✓ Develop real-time data management and data exchange frameworks that enable analytics to improve prediction and reduce uncertainty.
- ✓ Develop next-generation sensors that are accurate through disturbances to enable closed-loop controls and improved system resilience.

Project Example

Advanced Sensor Development

Increase visibility throughout the energy system including transmission, distribution and end-use by developing low-cost, accurate sensors. Additionally, next generation asset monitoring devices will help determine state of grid components prior to failure.

Creating Advanced Real-Time Control Technologies

Enhance the reliability and asset utilization of transmission and distribution systems

Devices and Integrated Systems	Sensing and Measurement	System Operations and Control	Design and Planning Tools	Security and Resilience	Institutional Support

Expected Outcomes

- ✓ Deliver an architecture, algorithms, and control frameworks for a clean, resilient and secure grid.
- ✓ Advanced operations software platform for predictive operations & real-time adaptive control.
- ✓ New power flow control device hardware and concepts.
- ✓ Advance fundamental knowledge for new control paradigms.

Project Example

Multi-Scale Integration of Control Systems (EMS/DMS/BMS)

Create an integrated grid management framework for the end-to-end power delivery system – from central and distributed energy resources at bulk power systems and distribution systems, to local control systems for energy networks, including building management systems.

Driving Next Generation of Tools

Cost-benefit trade-offs and accurately design for deployment of new additions

Devices and Integrated Systems | Sensing and Measurement | System Operations and Control | **Design and Planning Tools** | Security and Resilience | Institutional Support

Expected Outcomes

- ✓ Incorporate uncertainty and system dynamics into planning tools to accurately capture effects of renewable generation.
- ✓ Computational tools, methods and libraries that enable 1000x improvements in performance for analysis and design.
- ✓ Couple grid transmission, distribution, and communications models to understand cross-domain effects.

Project Example

California Distributed Resource Planning

Deliver an online open-access integrated distributed resource planning and optimization platform.
Identify meaningful behind-the-meter DER adoption patterns, potential microgrid sites and demand-side resources, and evaluate the impacts of high renewable penetration feeders on the distribution and transmission grid.

Securing and Ensuring Flexible Capability

Pathway to multi-scale security and resilience for the system

Devices and Integrated Systems | Sensing and Measurement | System Operations and Control | Design and Planning Tools | **Security and Resilience** | Institutional Support

Expected Outcomes:

- ✓ Holistic grid security and resilience from devices to micro-grids to systems.
- ✓ Inherent security designed into components and systems, not security as an afterthought.
- ✓ Security and resilience addressed throughout system lifecycle and covering the spectrum of legacy and emerging technologies.

Project Example:

Grid Analysis and Design for Energy and Infrastructure Resiliency for New Orleans

Conduct technical evaluations to assess energy and critical infrastructure vulnerabilities, and identify cost effective options to improve the resiliency of both the electrical grid infrastructure and the community.

Enabling and Supporting Regulators and Utilities

Making more informed decisions and reduce risk on key issues

Devices and Integrated Systems | Sensing and Measurement | System Operations and Control | Design and Planning Tools | Security and Resilience | **Institutional Support**

Expected Outcomes

- ✓ Accelerated state & federal policy innovation due to enhanced state and gegional technical assistance.
- ✓ States adopt changes to their regulatory model that better align utility interests with grid modernization and/or clean energy policy goals.
- ✓ Methods for valuation of DER technologies and services are defined and clearly understood by stakeholders to enable informed decisions on grid investments and operations.

Grid Modernization Lab Call Program Review

November 30-December 1, 2016

- Review of 29 Foundational Projects
- Large amount of data sharing and possible collaboration between projects in the lab call
- Energy storage continues to be a focus on DER planning and offsetting peak load on the grid.
- Reviewing the projects and entire portfolio of eighty-eight projects in GMI's Peer Review
  - April 18-21, 2017

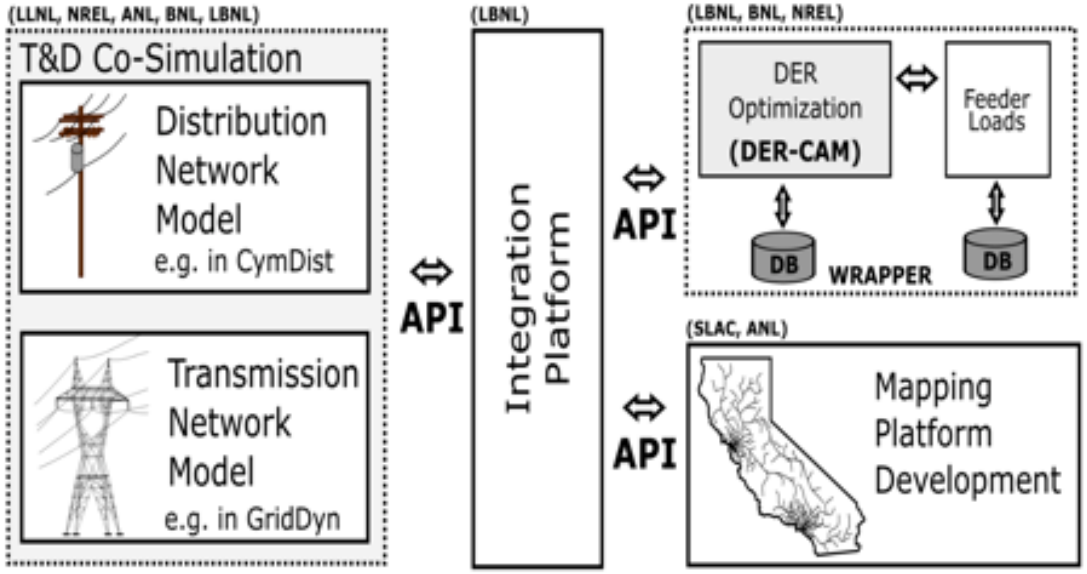
DER Siting and Optimization Tool to Enable Large Scale Deployment of DER in California (1.3.05)

Deliver to stakeholders an integrated distributed resource planning and optimization platform, hosted online, able to identify meaningful behind-the-meter DER adoption patterns, potential microgrid sites and demand-side resources, and evaluate the impacts of high renewable penetration feeders on the distribution and transmission grid.

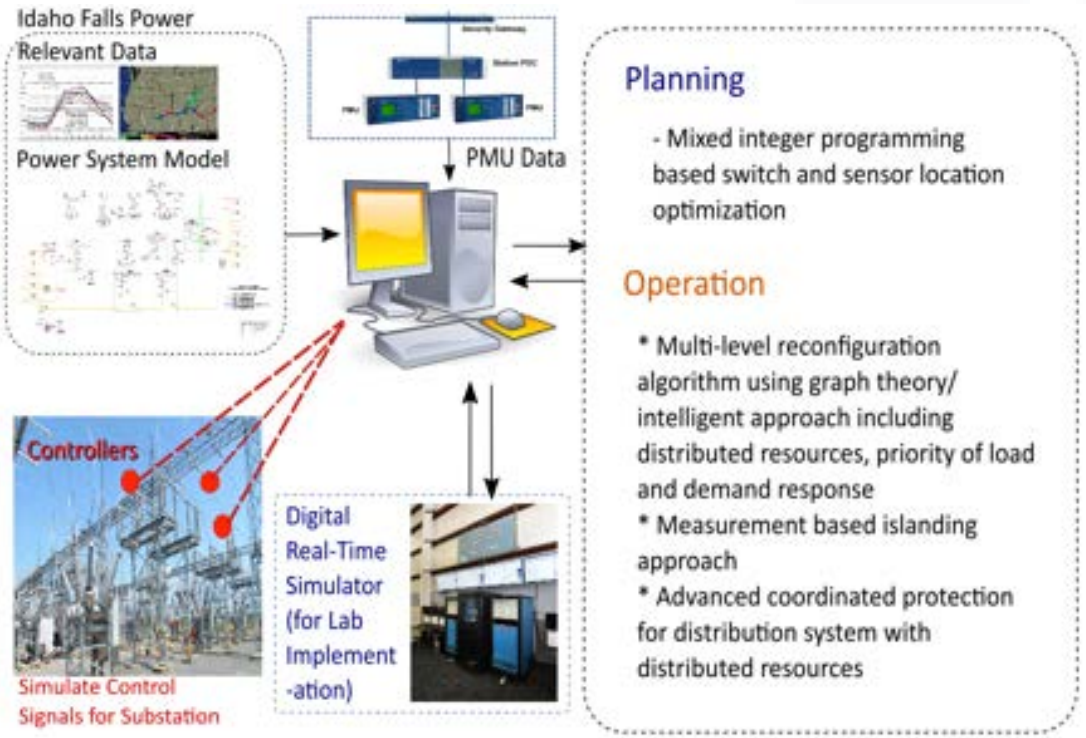
PoP: FY16/17

Labs: ANL, BNL, LBNL, LLNL, NREL, SLAC

Partners: California PUC, PG&E, SCE, Metropolitan Council of Governments, NYSERDA



Smart Reconfiguration of Idaho Falls Network



Improve physical security of the Idaho Falls distribution system by testing smart reconfiguration, intelligent DR utilizing loads as a resource, controlled islanding, black start procedures for emergency service, and resynchronization in the presence of DERs.

PoP: FY16/17

Labs: PNNL, INL

Partners: Idaho Falls Power, Schweitzer Engineering Labs, Washington State Univ, Utah Associated Municipal Power Systems

Relationships to Other Grid Projects

CyDER	Provide data sharing for interconnection and short-term operations real-time data.
Alaska Microgrid Partnership	Provide information for the survey in microgrid modeling tools. (1.3.5)
Technical Support to NY Rev	Provide access to DER-CAM and all other developments achieved. (1.3.5)
Development of T,D,C Models	Identify real-world Transmission, Distribution and Communication issues for further investigation and improvement. (1.3.5) and (1.3.9)
Definition, Standards, and Testing – Grid Services	Provide results from device testing activities with smart switches, advanced measurement-based protection and reconfiguration schemes with HIL. (1.3.9)
Control Theory Research R&D	Provide results from device testing activities with smart switches, advanced measurement-based protection and reconfiguration schemes with HIL for development of advanced control systems for the modern power grid. (1.3.9)
GMLC Testing Network	Contribute to development of power system protection and restoration testing models (non-proprietary) and resources. (1.3.9)

Questions?

Thank you!

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Contact gmi@hq.doe.gov for updates and funding opportunities.
http://energy.gov/gmi