GMLC Overview for Electricity Advisory Committee February 2020

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Electricity Market Sector Manager

Pacific Northwest National Laboratory

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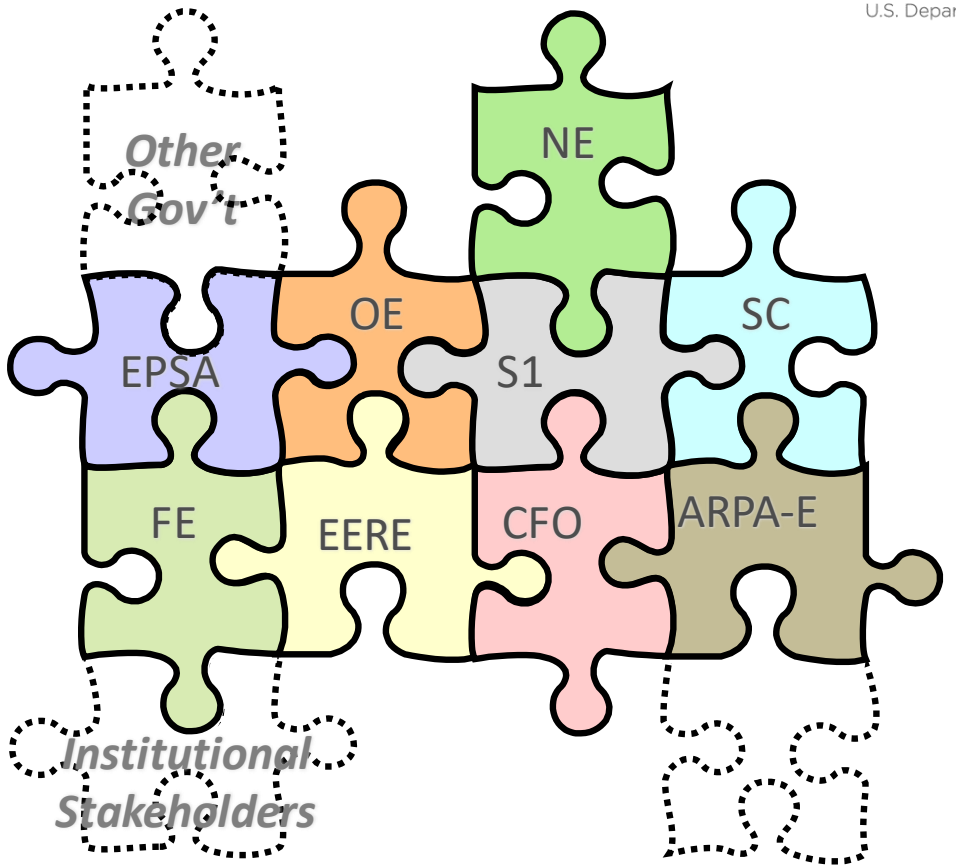
DOE Grid Modernization Initiative

GRID MODERNIZATION LABORATORY CONSORTIUM
U.S. Department of Energy

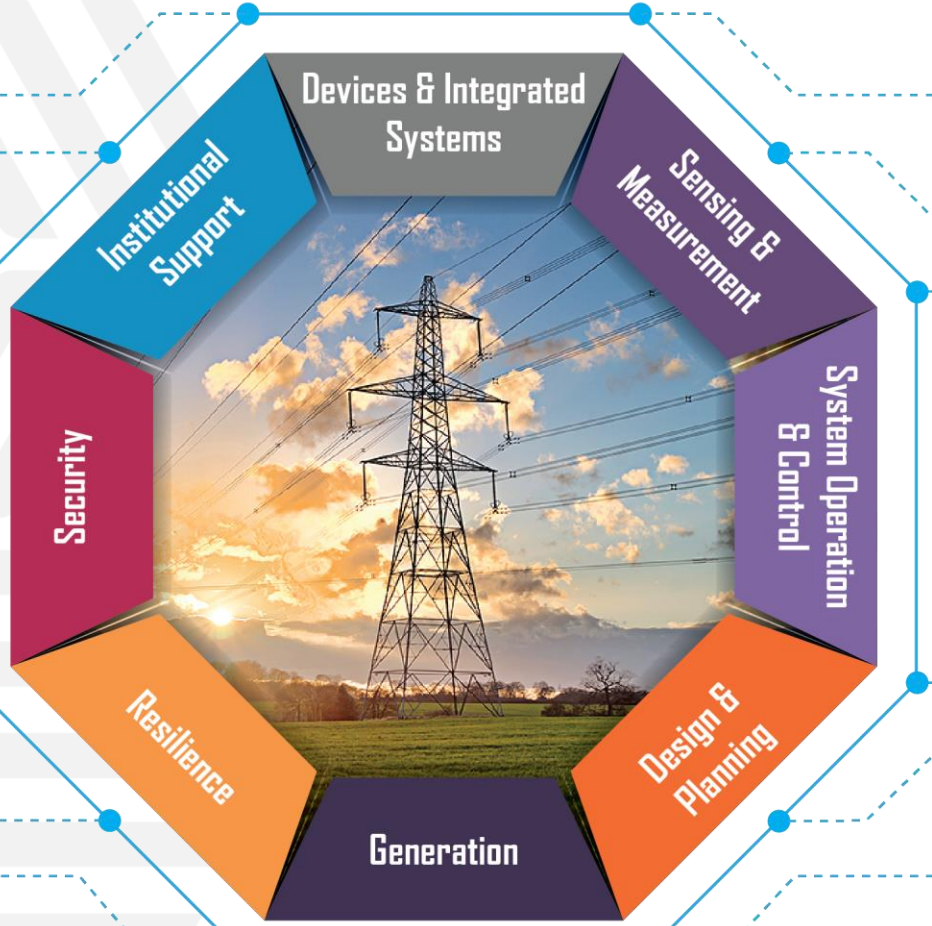
An aggressive five-year grid modernization strategy that includes

- Alignment of the existing base activities among DOE Offices
- An integrated Multi-Year Program Plan (MYPP)
- New activities to fill major gaps in existing base
- Development of a laboratory consortium with core scientific abilities and regional outreach



DOE's Grid Modernization Laboratory Consortium – 14 National Labs – 200+ Partners

GRID MODERNIZATION LABORATORY CONSORTIUM
U.S. Department of Energy



AMES LABORATORY
Creating Materials & Energy Solutions
U.S. DEPARTMENT OF ENERGY

Argonne NATIONAL LABORATORY

BERKELEY LAB

BROOKHAVEN NATIONAL LABORATORY

INL Idaho National Laboratory

Los Alamos NATIONAL LABORATORY

NETL

Lawrence Livermore National Laboratory

NREL NATIONAL RENEWABLE ENERGY LABORATORY

OAK RIDGE National Laboratory

Pacific Northwest NATIONAL LABORATORY

Sandia National Laboratories

SLAC NATIONAL ACCELERATOR LABORATORY

SRNL

DOE Grid Modernization Investments

- GMLC Lab Calls
- Competitive Funding Opportunities

DOE GMLC Lab Calls 2016 - 2019

Over 200 GMLC Partners

- 41 utilities
- 12 bulk system operators
- 67 vendors
- 33 Industry organizations
- 30 universities
- 29 federal, state and local entities

Devices and Integrated System Testing

GRID MODERNIZATION LABORATORY CONSORTIUM
U.S. Department of Energy

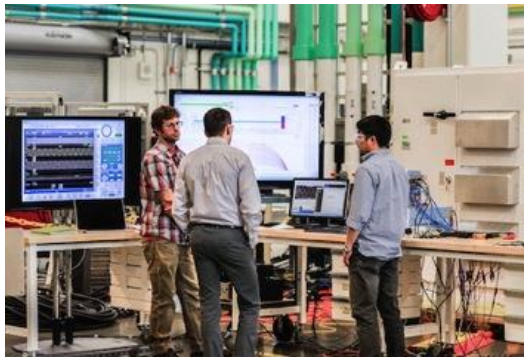
Expected Outcomes

- Develop standards and test procedures
- Build capabilities and conduct device testing and validation
- Conduct multi-scale systems integration and testing

Federal Role

- Common approach across labs and industry testbeds for effective validation of emerging technologies
- Develop common interoperability and interconnection standards and test procedures for industry / vendor community

Framework for federated testing of systems at multiple test facilities



Sensing and Measurement

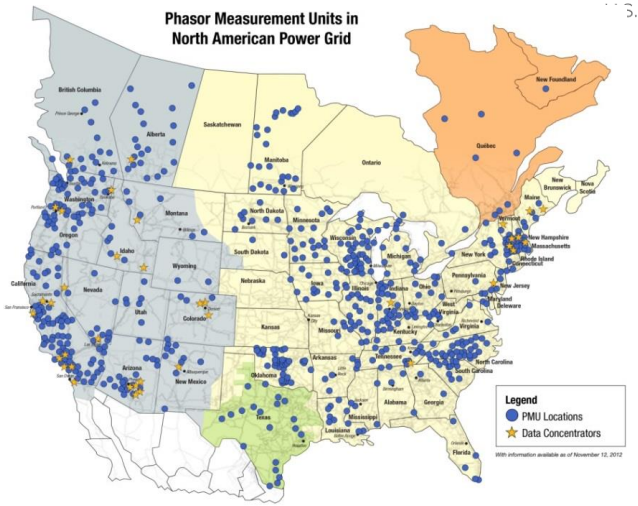
GRID MODERNIZATION LABORATORY CONSORTIUM
U.S. Department of Energy

Expected Outcomes

- Improve sensing for buildings and end-users
- Enhance sensing for distribution system
- Enhance sensing for the transmission system
- Develop data analytic and visualization techniques

Federal Role

- Transfer national lab scientific & national security data analytics to transform grid systems
- Leverage lab cyber expertise to design resilient SCADA and communication systems for emerging grid



Interoperability testing of advanced phasor measurement units from multiple vendors

System Operations, Control, and Power Flow

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U.S. Department of Energy

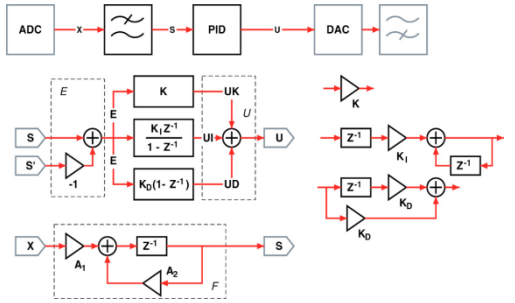
Expected Outcomes

- Develop architecture and control theory
- Develop coordinated system controls
- Improve analytics and computation for grid operations

Federal Role

- Utilize DOE's convening authority to provide leadership in providing a public/private vision of advanced grid architecture
- Advance fundamental knowledge for new control paradigms for emerging grid to support industry transformation
- Utilizing expertise developed at the national laboratories, deliver computational science, materials science & mathematics to transform integrated faster-than-real-time software platforms.

***Conventional** controls*



***Distributed** controls*

Design and Planning Tools

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U.S. Department of Energy

Expected Outcomes

- Deliver open software platform for adding advanced computation approaches to grid planning & design tools (50x speedup)
- Add capacity to model uncertainty in grid planning
- Incorporate system dynamics into planning tools to enhance resilience in face of increased system variability

Federal Role

- Leverage Lab system computational expertise to develop open platform for vendor engagement
- Leverage Lab system fundamental mathematics assets to incorporate uncertainty and system dynamics into grid tool sets

Grid Security and Resilience

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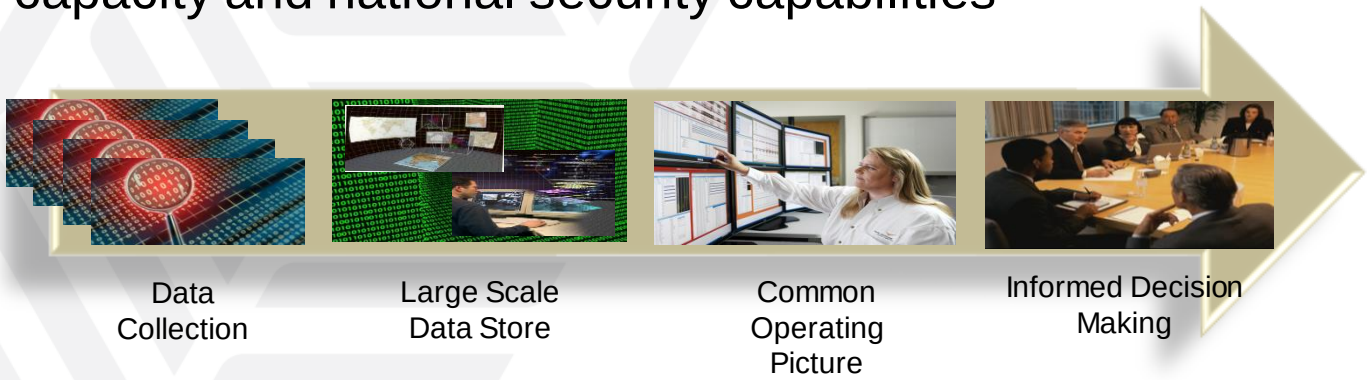
U.S. Department of Energy

Expected Outcomes

- Improve ability to identify threats and hazards
- Increase ability to protect against threats and hazards
- Increase ability to detect potential threats and hazards
- Improve ability to respond to incidents
- Improve recovery capacity time

Federal Role

- Enable secure utility situational awareness leveraging national lab analytics capacity and national security capabilities



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Expected Outcomes

- Improve match of thermal generation to emerging grid characteristics
- Advance next generation modular thermal generation
- Validate options for hybrid thermal /variable generation concepts
- Identify role of energy storage in hybrid thermal generation

Federal Role

- Characterize system level architecture trends
- Conduct modeling on challenges of the future system requirements for flexibility and resilience to support planning for alternate generation and fuels concepts

EEI Wildfire Task Force Engagements (Aug – present)

EEI WILDFIRE TARGET TOPICS

- **Electric Grid Technologies**
  - Better / faster "downed line" technology
  - Better / more accurate (incipient fault) detection
  - Near real-time auto shutdown
  - Faster / more intelligent reclosers
- **Big Data Sources and Methods**
  - Satellite remote sensing data to determine "heat spots", vegetation on slopes, forest health, etc.
  - Drones and related technology to support electric infrastructure inspections and / or forest health conditions
- **Big Data Analytics**
  - Improvements / more accurate modeling / predictive capabilities for weather, fuel sources, fire spread, etc.
  - Near real-time identification of fire starts (e.g. machine learning for high resolution camera feeds)
  - Improvements in / near real-time Lidar data processing speeds and analysis results

DOE GRID MOD POTENTIAL LINKS

1. Emerging project on arc detection in substations [OE Sensor Program]
2. Satellite imaging for biomass characterization [BETO/EERE]
3. Satellite imaging for hurricane damage assessment and flooding [ISER/CESER]
4. HPC contingency analysis [AGM / OE]
5. ML analytic platforms for anomaly detection [GMLC]
6. NASPI work on downed conductor (SDG&E) [AGM / OE] to assess consequence analysis
7. Wildfire-energy Resiliency Enhancement with Physics informed A.I. Models for Critical Infrastructures [GMLC proposed]
8. Sensing roadmap [GMLC]
9. Optical sensors for incipient fault detection [GMLC]
10. Integrated transmission and distribution planning tools [GMLC]
11. Co-simulation platform to link grid consequence models to FEMA / USDA tools [GMLC]
12. Interdependency studies gas & electric for resilience [NAERM]

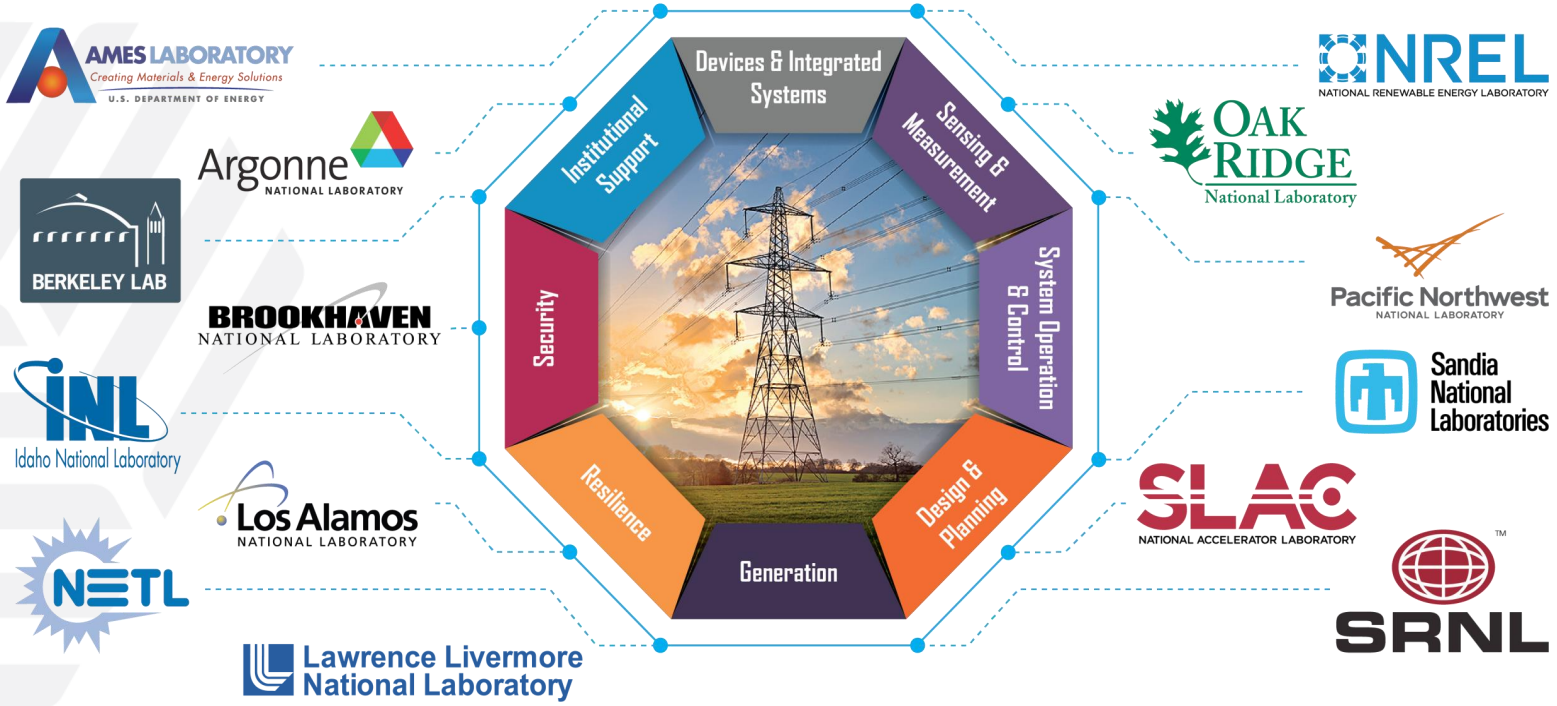
Typical Industry Engagements

- Annual IEEE PES meeting sessions
- Annual IEEE ISGT meeting
- GMLC Peer Reviews
- DistribuTech sessions and booth (starting 2020)
- Updates by invitation
  - EPRI R&D meetings
  - NARUC and regional meetings
  - Educational Congressional hearings and caucus sessions
- XLab Grid Modernization Summit
- Membership entity outreach
  - NRECA
  - EEI
  - LPPC
  - EPRI
  - NERC and regional reliability councils

Engagement Message to Industry at DistribuTECH

GRID MODERNIZATION LABORATORY CONSORTIUM
U.S. Department of Energy

1. Join in upcoming funding opportunities
2. Participate in project advisory groups
3. Attend annual peer reviews
4. Follow progress on the website
   - gmlc@doe.gov
5. Participate in industry outreach for MYPP updates



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