GRID MODERNIZATION INITIATIVE
PEER REVIEW

Planning and Design Tools
Portfolio Overview

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What is the problem?

- Rapid changes in grid outpacing current modeling and analytic capabilities

Expected Outcomes

- Drive development of next-generation tools that address evolving grid needs

Federal Role

- Attack strategic technology gaps in tools capabilities
- Partner with industry for demonstrations and to focus R&D
- Work with vendors to transition R&D into practice

Technology Gaps

- Simulating Interactions Across Domains
- Modeling Uncertainty
- Increase Resolution and Fidelity
- Computational speed
### Activities and Technical Achievements
#### MYPP Activity Description

<table>
<thead>
<tr>
<th>Activity</th>
<th>Technical Achievements by 2020</th>
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<tr>
<td>1. Scaling Tools for Comprehensive Economic Assessment</td>
<td>• Enhance performance of stochastic production cost modeling from 100 to 10,000 transmission nodes; expand to include distribution system.</td>
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<td>2. Developing and Adapting Tools for Improving Reliability and Resilience</td>
<td>• Scalable simulation framework that couples transmission, distribution, and communications systems for integrated modeling at regional scale.</td>
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<td>3. Building Computational Technologies and High Performance Computing (HPC) Capabilities to Speed up Analyses</td>
<td>• Scalable math libraries and tools for enhanced analysis; co-simulation frameworks to support coupling of tools and models, uncertainty quantification, and systems optimization.</td>
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Foundational Projects

Secure Communication Flows

Electrical Flows

Domain

Markets

Operations

Service Provider

Bulk Generation

Transmission

Distribution

Customer

Figure 3-1: The Smart Grid System

Interactions among the various components of the Smart Grid System are illustrated in the figure above. The grid is composed of multiple domains, including the Markets, Operations, Service Provider, and Customer domains. Secure communication flows and electrical flows are depicted between these domains. The figure highlights the interconnectivity and interdependencies of the various grid components, emphasizing the importance of coordination and integration for effective grid operation.
Create HELICS™, an open-source co-simulation platform, enabling interactions between leading commercial & lab developed simulators on a wide range of computing environments (HPC to laptop).
1.4.26 – Development of Multi-scale Production Cost Simulation (Lead: NREL)

- Develop scalable algorithms used for deterministic and stochastic PCM

1.4.17 - Extreme Event Modeling (Lead: LANL)

- Improve performance of tools for modeling cascading outages and develop new approaches for contingency analysis

1.4.18 - Computational Science for Grid Management (Lead: ANL)

- Applying DOE innovations in computational science to develop unified grid math library optimization, dynamics, and uncertainty
Regional Demonstration Projects

1.3.05 DER Siting and Optimization Tool for California (Co-Lead: LBNL and LLNL)

- DER tools integrating behind-the-meter adoption, distribution-transmission power flows, and visualization

1.3.33 Midwest Interconnect Study (Lead: NREL)

- Apply state-of-the-art tools to analyze economic efficiency and reliability benefits of transmission futures for the U.S.

1.3.21 Alaska Microgrid Partnership (Lead: NREL)

- First-time consortia of DOE Labs and Alaska organizations developing best practices and tools for microgrid design and deployment
Program-Specific Projects

**Transmission**

- GM0111 - Protection and Dynamic Modeling, Simulation, Analysis, and Visualization of Cascading Failures (Lead: ANL)

- GM0074 - Models and methods for assessing the value of HVDC and MVDC technologies in modern power grids (Lead: PNNL)

- WGRID-38: North American Renewable Integration Study (NARIS) (Lead: NREL)


**Distribution**

- GM0057 - LPNORM: A LANL, PNNL, and NRECA Optimal Resiliency Model (Lead: LANL)

- SI-1545 - Rapid QSTS Simulations for High-Resolution Comprehensive Assessment of Distributed PV Impacts (Lead: SNL)

- SI-1756 - Visualization and Analytics of Distribution Systems with Deep Penetration of Distributed Energy Resources (VADER) (Lead: SLAC)

- SI-1639: System Advisor Model (Lead: NREL)

**Multiple Domains**

- SI-1625 - CyDER: A Cyber Physical Co-simulation Platform for Distributed Energy Resources in Smart Grids (Lead: LBNL)

- GM0229 - Integrated Systems Modeling of the Interactions between Stationary Hydrogen, Vehicle and Grid Resources (Lead: LBNL)

**Load Modeling**

- GM0094 - Measurement-Based Hierarchical Framework for Time-Varying Stochastic Load Modeling (Lead: ANL)

- GM0064 - Open-Source High-Fidelity Aggregate Composite Load Models of Emerging Load Behaviors for large-Sale Analysis (Lead: PNNL)
Accomplishments and Emerging Opportunities

Accomplishments

• Formed working group to coordinate release and sharing of software and data
• All GMLC-led projects hosted stakeholder meetings / technical review committees
• PCM, Seams Study, NARIS projects are coordinating R&D and review committees
• HELICS™ specification and use-case documents
• Extreme Event Strategy Roadmap
• Initial version of DER Optimal Siting Tool prototype completed
• Reduced runtime for important grid calculation (SCACOPF) from 10 hours to 10 min using DOE research (StructJuMP)

Next Year

• Significantly increased industry and vendor engagement
• Completion of addition software tool prototypes
• Tools demos on HPCs with 10X to 100X improvements