

GRID MODERNIZATION INITIATIVE PEER REVIEW

Planning and Design Tools

Portfolio Overview

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Planning and Design Tools Summary



What is the problem?

 Rapid changes in grid outpacing current modeling and analytic capabilities

Expected Outcomes

 Drive development of nextgeneration 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



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



New planning and design tool capabilities



Algorithms and libraries

Foundational Projects





Foundational Projects



1.4.15 - Development of Integrated Transmission, Distribution and Communication Models (Lead: PNNL)



Create HELICS[™], an open-source cosimulation platform, enabling interactions between leading commercial & lab developed simulators on a wide range of computing environments (HPC to laptop).

Foundational Projects





Asynchronous Data and Event Flow Data authentication Data ingestion Data authentication conversion. curation, archival conversion, query Modular viz Streaming data Google Map Archived data /isual verification Forecast data Other viz tools System models GridPACK Parameters PETSc New solvers for SUNDIALS Optimization Other existing **Dynamics &** Uncertainty Solvers

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 4 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 <u>Cascading</u> <u>Failures (</u>Lead: ANL)
- GM0074 Models and methods for assessing the value of <u>HVDC and MVDC</u> <u>technologies</u> in modern power grids (Lead: PNNL)
- WGRID-38: North American Renewable <u>Integration</u>
 <u>Study</u> (NARIS) (Lead: NREL)
- SI-1631: Assessing the Value and Impact of <u>Dispatchable</u> <u>Concentrating Solar</u> Power in a SunShot Future (Lead: NREL)

Distribution

- GM0057 LPNORM: A LANL, PNNL, and NRECA Optimal <u>Resiliency Model (</u>Lead: LANL)
- SI-1545 <u>Rapid QSTS</u> Simulations for High-Resolution Comprehensive Assessment of Distributed <u>PV Impacts</u> (Lead: SNL)
- SI-1756 <u>Visualization and</u> <u>Analytics</u> of Distribution Systems with Deep Penetration of <u>Distributed Energy</u> <u>Resources (VADER) (Lead:</u> SLAC)
- SI-1639: System Advisor Model (Lead: NREL)

Multiple Domains

- SI-1625 CyDER: A Cyber Physical <u>Co-simulation</u> Platform for <u>Distributed Energy</u> <u>Resources</u> in Smart Grids (Lead: LBNL)
- GM0229 Integrated Systems Modeling of the Interactions between <u>Stationary Hydrogen,</u> <u>Vehicle and Grid Resources</u> (Lead: LBNL)

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Load Modeling

- GM0094 Measurement-Based Hierarchical Framework for Time-Varying <u>Stochastic Load</u> <u>Modeling (</u>Lead: ANL)
- GM0064 Open-Source High-Fidelity Aggregate Composite Load Models of <u>Emerging Load</u> <u>Behaviors</u> 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



