GRID
MODERNIZATION
LABORATORY
CONSORTIUM
U.S. Department of Energy

PROJECT PORTFOLIO

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In a strategic partnership between the U.S. Department of Energy headquarters and 13 national laboratories, the Grid Modernization Laboratory Consortium brings together leading experts and resources to collaborate on national grid modernization goals. Coordinated through the GMLC as part of DOE's Grid Modernization Initiative, the projects summarized below are working to achieve the objectives outlined in DOE's **Grid Modernization Multi-Year Program Plan**.

GMLC Laboratories

Argonne National Laboratory (ANL)
Brookhaven National Laboratory (BNL)
Idaho National Laboratory (INL)
Lawrence Berkeley National Laboratory (LBNL)
Lawrence Livermore National Laboratory (LLNL)
Los Alamos National Laboratory (LANL)
National Energy Technology Laboratory (NETL)
National Renewable Energy Laboratory (NREL)
Oak Ridge National Laboratory (ORNL)
Pacific Northwest National Laboratory (PNNL)
Sandia National Laboratory (SNL)
Savannah River National Laboratory (SRNL)
SLAC National Accelerator Laboratory (SLAC)

Foundational Research Projects

Topic #	Title	Summary	Partners
1.1	**Foundational Metrics Analysis** *ANL, BNL, LBNL, LLNL, ORNL, NREL, PNNL, SNL, LANL*	Develop an integrated suite of grid modernization metrics that leverage current industry practice, emerging industry additions (e.g. extreme event metrics from NERC) and develop new metrics that reflect emerging grid attributes and architectures. Conduct baseline modernization assessments and provide on-going dashboard for policy makers, regulators and industry stakeholders.	North American Electric Reliability Corporation, National Association of Regulatory Utility Commissioners, Energy Information Administration
1.2.1	**Grid Architecture** *PNNL, ANL, NREL, ORNL, LANL, LBNL, LLNL, SNL*	Build a new stakeholder-driven architecture for grid modernization, provide it to the industry along with the tools they need to adapt it to their needs, and use it to inform the playbook for GMLC program managers.	GE-Alstom, Electric Power Research Institute, Inc., George Washington University, University of Tennessee-Chattanooga, Smart Grid Interoperability Panel, Omnetric Group, California Independent System Operator
1.2.2	**Interoperability** *PNNL, NREL, ANL, LBNL*	Provide strategic vision for interoperability endorsed by stakeholders with tools to measure interoperability maturity and the progress of related investments. Prioritize interoperability gaps and develop an overarching roadmap for stakeholder endorsement.	DOE Program Offices, Smart Grid Interoperability Panel, National Institute of Standards and Technology, Grid Wise Architecture Council, Electric Power Research Institute, Inc., Standards Organizations, Utilities, Vendors

Topic #	Title	Summary	Partners
1.2.3	**Grid Modernization Laboratory Consortium Testing Network (GMLC-TN)** *SNL, NREL, PNNL, ORNL, ANL, INL, LBNL, SRNL, BNL, LLNL*	Establish a federated lab-based resource for standards-based testing and validation of grid devices and systems. Develop and establish a related Grid Modernization Laboratory Consortium – Open Library (GMLC-OL), a public repository for validated component models, simulation tools and testing resources.	DOE Program Offices, Smart Grid Interoperability Panel, National Institute of Standards and Technology, Grid Wise Architecture Council, Electric Power Research Institute, Inc., Universities, Utilities, Vendors
1.2.4	**Grid Services and Technologies Valuation Framework** *ORNL, PNNL, NREL, LBNL, ANL, SNL, LANL*	Develop a widely accepted, well-tested valuation methodological framework for evaluating the collection of value streams (net benefits) that can be provided by different grid-related technologies and services.	Tennessee Valley Authority, Eastern Interconnection Planning Collaborative, National Association of Regulatory Utility Commissioners/ Eastern Interconnection States Planning Council
1.2.5	**Grid Sensing and Measurement Strategy** *ORNL, PNNL, NETL, LLNL, ANL, NREL, SNL, LBNL, LANL*	Identify measurement requirements along with associated data management and communication systems to enable full visibility of grid system state. This methodology will include defining the grid state, developing a roadmap along with a framework to determine sensor allocation for optimal results.	Electric Power Research Institute, Inc., Southern Company, Electric Power Board, Entergy, OSIsoft, Dominion, Tennessee Valley Authority, ComEd, North American Synchrophasor Initiative

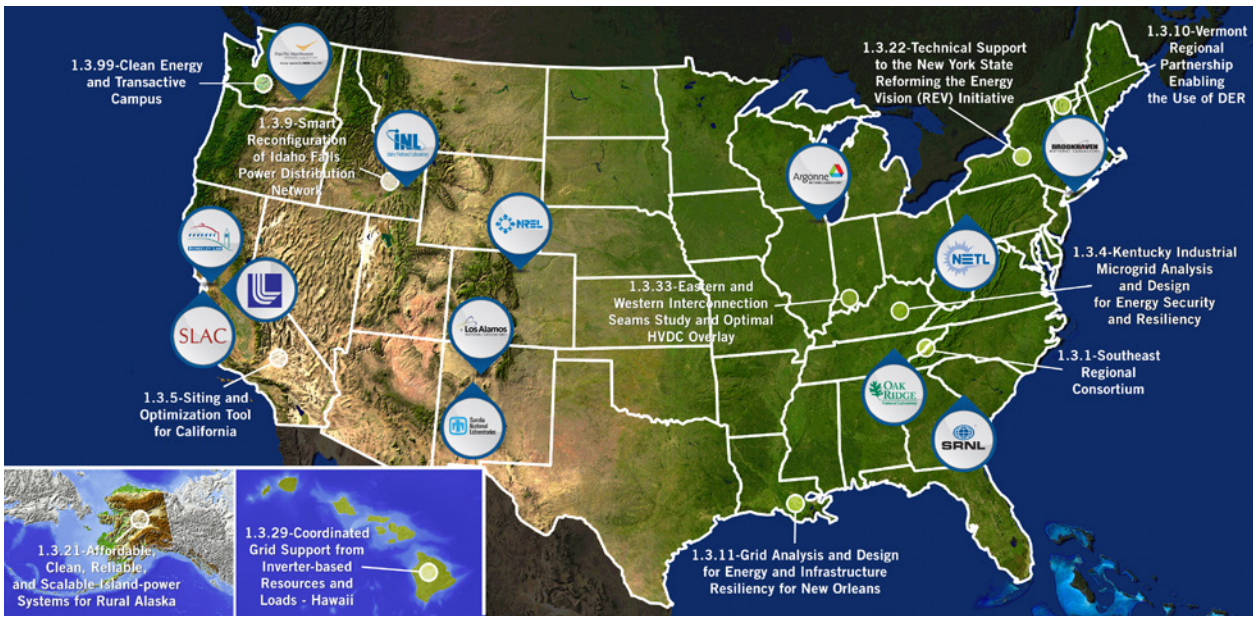
Crosscut R&D Projects

Topic #	Title	Summary	Partners
1.4.1	**Standards and Test Procedures for Interconnection and Interoperability** *NREL, PNNL, LBNL, SNL, ANL, ORNL, INL*	Build on prior efforts and leverage existing activities spanning multiple DOE programs that are developing interconnection and interoperability standards and test procedures to: harmonize requirements across jurisdictions; eliminate conflicting requirements across technology domains; and streamline conformance test procedures to the fullest extent possible.	DOE Program Offices, Smart Grid Interoperability Panel, National Institute of Standards and Technology, Grid Wise Architecture Council, Electric Power Research Institute, Inc., Standards Organizations, Utilities, Vendors
1.4.2	**Definitions, Standards and Test Procedures for Grid Services** *PNNL, NREL, ORNL, SNL, LBNL, ANL, INL, LLNL*	Enable and spur the deployment of a broad range of distributed energy resource (DER) devices by defining a test protocol to characterize their ability to respond to grid signals and define a standard set of grid services and "drive cycles" that describe the capabilities that DERs must have to provide them.	DOE Program Offices, Independent Test Labs, Electric Power Research Institute, Inc., Standards Organizations, Utilities, Vendors
1.4.4	**Advanced Sensor Development** *ORNL, PNNL, NETL, NREL, SNL, LBNL*	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.	Electric Power Research Institute, Inc., University of Tennessee, Southern Co, Electric Power Board, Entergy, Eaton, SmartSense, National Instruments, Dominion, Tennessee Valley Authority, CommEd, North American Synchrophasor Initiative

Topic #	Title	Summary	Partners
1.4.9	**Distributed Analytics** *LANL, SNL, LBNL, ORNL, LLNL, NREL, ANL*	Develop a low cost scalable infrastructure for integrating disparate high fidelity data sources. Use machine learning methodologies to assist in transforming data into actionable intelligence. This platform will allow multiple entities to collaborate on data utilization.	Oncor, PJM, United Technologies Research Center
1.4.10	**Control Theory** *LANL, PNNL, ANL, INL, NREL, SNL, LLNL*	Develop new control solutions including topologies, algorithms and deployment strategies for transitioning the power grid to a state where a huge number of distributed energy resources are participating in grid control to enable the grid to operate with lean reserve margins. The theory effort will recognize the need to engage legacy control concepts and systems as we transition to more distributed control.	Oncor, PJM, United Technologies Research Center
1.4.11	**Multi-Scale Integration of Control Systems (EMS/DMS/BMS)** *ANL, BNL, LANL, LLNL, NREL, PNNL, SNL*	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.	GE-Alstom Grid, Duke Energy, PJM
1.4.15	**Development of Integrated Transmission, Distribution, and Communication (TDC) Models** *PNNL, LLNL, NREL, ANL, ORNL, SNL, INL*	Build on best-in-class Lab capabilities to develop an integrated, flexible, open source framework for coupling TDC models and simulations. Validate framework and models on hardware testbed. Demos with partners will include distributed/wide area controls and DER.	Southern California Edison, National Grid, PJM, Peak Reliability, National Rural Electric Cooperative Association, California Independent System Operator, New York Independent System Operator, Electric Reliability Council of Texas
1.4.17	**Extreme Event Modeling** *LANL, PNNL, LLNL, ANL, BNL, NREL, ORNL, SNL*	Improve preparation, planning, and response to extreme events such as hurricanes, electromagnetic pulse, etc. Focus on developing analysis prototype demonstrating up to 500x performance improvements in modeling cascading events and probabilistic N-k contingency analysis.	PJM, Dominion, Electric Reliability Council of Texas, North American Electric Reliability Corporation, Federal Energy Regulatory Commission, IEEE Cascading Failure Working Group, University of Tennessee-Knoxville-Center for Ultra-Wide-Area Resilient Electric Energy Transmission
1.4.18	**Computational Science for Grid Management** *ANL, PNNL, NREL, SNL, LLNL, LANL*	Address increasing computational complexity and reduced time-to-solution requirements for grid planning and operations via new scalable solvers, dynamics, and uncertainty analysis. This builds upon existing DOE-funded work (GridPack, M2ACS Program, PETSc and SUNDIALS libraries).	PJM, Independent Service Operators-New England

Topic #	Title	Summary	Partners
1.4.23	**Threat Detection and Response with Data Analytics** *INL, LBNL, LLNL, ORNL, PNNL, SNL*	Develop technologies and methodologies to protect the grid from advanced cyber and all-hazard threats through the collection of disparate data and the employment of advanced analytics for threat detection and response.	Electric Power Board, National Rural Electric Cooperative Association
1.4.25	**Distribution System Decision Support Tools** *NREL, LBNL, PNNL*	Develop tools, identify gaps and provide technical assistance/training targeted at state regulators and small/medium utilities (e.g., co-ops and municipal utilities) on advanced distribution system planning for a modernized grid that incorporates high levels of DER.	American Public Power Association; National Rural Electric Cooperative Association; Interstate Renewable Energy Council; Pedernales Electric Cooperative; National Grid; Arizona Public Service Company; Black and Veatch
1.4.26	**Development and Deployment of Multi-Scale Production Cost Models (PCM)** *NREL, SNL, ANL, PNNL, LLNL*	Develop ability to more accurately estimate economic impact of renewables, storage, and other technologies. Research scalable methods for deterministic and stochastic PCM, higher resolution grid models, applications of uncertainty quantification and high performance computing. New capabilities will be deployed with system planners through PCM workshops.	Midcontinent Independent Service Operators, Energy Exemplar, PJM Interconnect, National Rural Electric Cooperative Association
1.4.29	**Future Electric Utility Regulation** *LBNL, NREL, PNNL, SNL, LANL, NETL*	Provide technical assistance and policy analysis to state Public Utility Commissions considering incremental and fundamental changes to electric utility regulation; enhance utility financial analysis modeling tools focused on ratemaking and regulatory issues that arise with increased penetration of DER.	National Association of Regulatory Utility Commissioners

Pioneer Regional Partnerships



Topic #	Title	Summary	Partners
1.3.1	**Southeast Consortium** *ORNL, SRNL*	Increase utility clean energy portfolios and improve power system network resiliency to ensure increased reliability along with improved responsiveness under extreme conditions by eliminating outages or enabling faster restoration of power to critical loads.	University of Tennessee, Electric Power Board, Southern Company, Tennessee Valley Authority, University of North Carolina-Charlotte, Duke Energy, Santee Cooper, Clemson
1.3.4	**Industrial Microgrid Analysis and Design for Energy Security and Resiliency** *ORNL, SNL*	Investigation, development, and analysis of the risks, costs, and benefits of a microgrid utilizing renewable energy systems at the UPS WorldPort and Centennial Hub facilities. Develop roadmap to help industries evaluate microgrid adoption by defining institutional and regulatory challenges associated with development of industrial-based resilient systems.	United Parcel Service, Waste Management, Burns & McDonnell, Harshaw Trane, Louisville Gas and Electric, State of Kentucky
1.3.5	**DER Siting and Optimization Tool for California** *ANL, BNL, LBNL, LLNL, NREL, SLAC*	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.	California Public Utility Commission, Pacific Gas and Electric, Southern California Edison, Metropolitan Council of Governments, New York State Energy Research and Development Authority
1.3.9	**Smart Reconfiguration of Idaho Falls Network** *PNNL, INL*	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.	Idaho Falls Power, Schweitzer Engineering Labs, Washington State University, Utah Associated Municipal Power Systems
1.3.10	**Vermont Regional Partnership Enabling the Use of DER** *SNL, NREL*	Assist Vermont utilities in meeting the state's ambitious goal of obtaining 90% of its energy from renewable sources by 2050 through (1) DER integration, (2) DER control, (3) validation of wind and solar forecasting, and (4) techno-economic analysis of energy storage.	Green Mountain Power, Vermont Electric Cooperative, Vermont Electric Company, University of Vermont
1.3.11	**Grid Analysis and Design for Resiliency in New Orleans** *SNL, LANL*	Conduct technical evaluations to assess energy and critical infrastructure vulnerabilities, and to identify cost effective options to improve the resiliency of both the electrical grid infrastructure and the community.	City of New Orleans, Rockefeller Institute, Entergy, U.S. Army Corps of Engineers
1.3.21	**Alaska Microgrid Partnership** *NREL, PNNL, LBNL, SNL*	Develop a design basis framework and programmatic approach to assist stakeholders in their efforts to reduce diesel fuel consumption by at least 50% in Alaska's remote microgrids without increasing system lifecycle costs, while improving overall system reliability, security, and resilience.	Alaska Energy Authority, University of Alaska-Fairbanks, University of Alaska-Anchorage, Renewable Energy Alaska Project, Intelligent Energy Systems

Topic #	Title	Summary	Partners
1.3.22	**Technical Support to the New York State REV Initiative** *BNL, LBNL, PNNL, INL*	Provide objective technical assistance by a team of National Lab experts to NYS agencies and policy makers on significant policy issues including retail market design, rate design, customer engagement, utility planning/ operations, DER integration, cyber security.	New York State Energy Research and Development Authority, New York State Smart Grid Consortium, Modern Grid Solutions, ICF International, Regulatory Assistance Project
1.3.29	**Grid Frequency Support from Distributed Inverter-Based Resources in Hawaii** *NREL, SNL*	Develop, simulate, validate, and deploy practical solutions in Hawaii that enable DERs to help mitigate bulk system frequency contingency events on the fastest time scale (milliseconds to seconds). Validate the ability of real hardware inverters to support grid frequency in an environment that emulates the dynamics of a Hawaiian Electric Company power system.	Hawaiian Electric Companies, Enphase Energy, Fronius USA, Forum on Inverter Grid Integration Issues, Energy Excelerator
1.3.33	**Midwest Interconnection Seams Study** *NREL, PNNL, ANL, ORNL*	Convene industry and academic experts in power systems to evaluate the HVDC and AC transmission seams between the U.S. interconnections and propose upgrades to existing facilities that reduce the cost of modernizing the nation's power system.	Southwest Power Pool, Midcontinent Independent System Operator, Western Area Power Administration, Solar Energy Industries Association, Minnesota Power, Xcel Energy, Tetra Tech, Transgrid Solutions, Utility Variable-Generation Integration Group, Bryndan Associates
1.3.99	**Clean Energy and Transactive Campus** *PNNL*	Research, development, and demonstration of transactive controls for energy management across multiple buildings and devices to (1) advance understanding of transactive control implementation in building loads and distributed energy resources (renewable energy, battery storage, etc.), and (2) define implementation of transactive control and transactive energy concepts at scale to foster broader adoption.	Washington Department of Commerce, Washington State University, University of Washington, City of Richland, Bonneville Power Administration, Seattle City Light, Puget Sound Energy, Emerson, Avista Corp., Eaton, First Energy, Southern Company

Resilient Distribution Systems Projects

Topic #	Title	Summary	Partners
1.5.1	**Grid Resilience and Intelligence Platform (GRIP)**	Anticipate, absorb, and recover from grid events by demonstrating predictive analytics capabilities, combining state-of-the-art artificial intelligence and machine learning techniques and by demonstrating control of DERs.	National Rural Electric Cooperative Association, Southern California Edison, Packetized Energy, Vermont Electric Coop, Tesla, California Edison Commission, University of California Berkeley, Stanford University, University of Vermont
1.5.2	**Resilient Alaskan Distribution System Improvements Using Automation, Network Analysis, Control, and Energy Storage (RADIANCE)**	Enhance resilience methods for distribution grids under harsh weather, cyber-threats, and dynamic grid conditions using multiple networked microgrids, energy storage, and early-stage grid technologies.	Siemens Corporation, Washington State University, Florida State University, New Mexico State University, Microgrid Solutions, City of Cordova, Cordova Electric Cooperative, Alaska Center for Energy and Power, Alaska Village Electric Cooperative

Topic #	Title	Summary	Partners
1.5.3	**Increasing Distribution Resiliency Using Flexible DER and Microgrid Assets Enabled by OpenFMB**	Accelerate the deployment of resilient and secure power distribution concepts through the flexible operation of traditional electrical generation assets, DER, and microgrids using OpenFMB.	Anderson Civic Center, Muscatatuck Urban Training Center, Avista Utilities, Duke Energy, GE Grid Solutions, University of North Carolina Charlotte, University of Tennessee, Smart Electric Power Alliance
1.5.4	**Integration of Responsive Residential Loads into Distribution Management Systems**	Research and validate open-source home energy management systems to support distribution resiliency use cases and end-to-end interoperability.	Electric Power Research Institute, National Rural Electric Cooperative Association, Southern Company, Tennessee Valley Authority, Duke Energy, Con Edison, Electric Power Board, Jackson EMC
1.5.5	**CleanStart-DERMS**	Validate and demonstrate, at scale, a DER-driven mitigation, blackstart, and restoration strategy for distribution feeders by integrating an applied robust control, communications, and analytics layer to achieve a coordinated hierarchical solution.	Smarter Grid Solutions, EnSync, Winston Chung/EnerBlu, SolarEdge, PingThings, Riverside Utility, Southern California Public Power Authority, Pacific Gas and Electric, Southern California Edison, University of California Riverside
1.5.6	**Designing Resilient Communities**	Focuses on effective integrated resource planning and metrics, control systems, and inverter-dominated islanding with storage and regional consortia.	CPS Energy, City of San Antonio, University of Texas at San Antonio, National Grid, City of Buffalo, Synapse Energy, 100 Resilient Cities Organization
1.5.7	**Laboratory Value Analysis Team**	Use a cross-cutting approach to provide an efficient, consistent framework and approach in conducting the benefit/cost analysis of each RDS project, impacts analysis (e.g., potential benefits to region) and broader synthesis of results from all projects.	NA

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CONTACTS

Carl Imhoff
Pacific Northwest National Laboratory
carl.imhoff@pnnl.gov
509.375.4328

Juan Torres
National Renewable Energy Laboratory
juan.torres@nrel.gov
303.275.3094

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