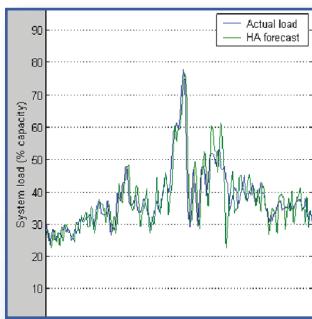
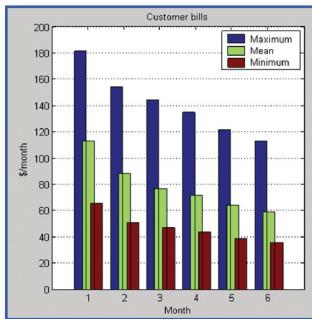




GridLAB-D™

The next revolution in power systems simulation

Coming soon from the U.S. Department of Energy's Office of Electricity Delivery & Energy Reliability



GRIDLAB-D is being developed by the U.S. Department of Energy (DOE) at Pacific Northwest National Laboratory (PNNL), in collaboration with industry and academia. A development release, expected to be completed in September 2007 includes:

- » End-use residential models including appliances and equipment models, all implemented with the latest agent-based simulation methods.
- » Distributed energy resource (DER) models, including distributed generation and storage models.
- » Models of supervisory control and data acquisition (SCADA), protection, and metering technologies.
- » External links to Matlab™.
- » Flexible data input/output (I/O), including file-based and database export and import.
- » Validation against other end-use models and standard distribution analysis tools.

GRIDLAB-D™ is a new power distribution system simulation and analysis tool that provides valuable information to users who design and operate distribution systems, and to utilities that wish to take advantage of the latest energy technologies. It incorporates the most advanced modeling techniques, with high-performance algorithms to deliver the best in end-use modeling. GRIDLAB-D is coupled with distribution automation models and software integration tools for users of many power system analysis tools.

Subsequent releases of GRIDLAB-D will include:

- » Appliance-based load shedding technology.
- » Retail market modeling tools, including contract selection, business, and operations simulation tools.
- » Commercial and industrial buildings support.
- » Load and population growth models.

The ability to couple the tool with many other tools offers unparalleled analysis capabilities.

GRIDLAB-D enables detailed analysis of:

- » Rate design to determine whether the price differentials are sufficient to encourage customer adoption.
- » The potential and benefit of deploying DER, such as Grid Friendly™ appliances (GFA).
- » The business case for technologies such as automated meter reading, distribution automation, or retail markets.
- » The interactions between multiple technologies, such as how underfrequency load-shedding remedial action strategies might interact with appliance-based load-relief systems.

With the ability to study distribution utility system behavior over periods of time that range from a few seconds to decades, GRIDLAB-D simulates the interaction between physical phenomena, business systems, markets and regional economics, and customer behaviors. The results include many power system statistics, such as reliability metrics (e.g., loss-of-load probability), and business metrics such as profitability, revenue rates of return, and per customer or per line-mile cost metrics.



What is GRIDLAB-D?

GRIDLAB-D is a flexible simulation environment that can be integrated with a variety of third-party data management and analysis tools. The core of **GRIDLAB-D** has an advanced algorithm that coordinates simultaneously the state of millions of independent devices, each of which is described by multiple differential equations. The advantages of this algorithm over traditional finite difference-based simulators are: 1) it handles unusual situations much more accurately; 2) it handles widely disparate time scales, ranging from sub-seconds to many years; and 3) it is very easy to integrate with new modules and third-party systems. The **GRIDLAB-D** system includes modules to perform the following system simulation functions:

- » Power flow and controls, including distributed generation and storage.
- » End-use appliance technologies, equipment, and controls.
- » Consumer behavior including daily, weekly, and seasonal demand profiles, price response, and contract choice.
- » Energy operations, such as distribution automation, load-shedding programs, and emergency operations.
- » Business operations, such as retail rate, billing, and market-based incentive programs.

How does GRIDLAB-D work?

GRIDLAB-D incorporates an extensive suite of tools to build and manage studies and analyze results, including:

- » Agent-based and information-based modeling tools that allow users to create detailed models of how new end-use technologies, DER, distribution automation, and retail markets interact and evolve over time.
- » Tools to create and validate rate structures, examine consumer reaction, and verify the interaction and dependence of programs with other technologies and wholesale markets.
- » Interfaces to industry-standard power systems tools and analysis systems.
- » Extensive data collection tools to permit a wide variety of analyses.

At its simplest, **GRIDLAB-D** examines in detail the interplay of every part of a distribution system with every other. **GRIDLAB-D** does not require the use of reduced-order models for the aggregate behavior of consumer or electrical systems, which averts the danger of erroneous or misapplied assumptions. It becomes an essential tool that enables industry and government planners to design more effective and efficient programs to manage load growth and improve system reliability.



Who will use GRIDLAB-D?

Today's power systems simulation tools don't provide the analysis capabilities needed to study the forces driving change in the energy industry. The combined influence of fast-changing information technology, novel and cost-effective DER, multiple and overlapping energy markets, and new business strategies result in very high uncertainty about the success of these important innovations.

GRIDLAB-D addresses common concerns expressed by utility engineers, regulators, various stakeholders, and consumers, including:

Rate structure analysis. Multiple differentiated energy products based on offering new rate structures to consumers are very attractive to utilities because they create the opportunity to reveal demand elasticity and give utilities the ability to balance supplier market power in the wholesale markets. The challenge is designing rate structures that are both profitable to utilities and attractive to consumers. **GRIDLAB-D** provides the ability to model consumer choice in response to multiple rate offerings (including fixed rates, demand rates, time-of-day rates, and real-time rates) to determine whether a suite of rate offerings is likely to succeed.

Distributed resources. The advent of new DER technologies, such as on-site distributed generation; building combined heating and power (CHP)

technologies; and GFA controls creates a number of technology opportunities and challenges.

GRIDLAB-D permits utility managers to better evaluate the cost/benefit trade-off between infrastructure expansion investments and distributed resource investments by including other economic benefits of DER (e.g., increased wholesale purchasing elasticity, improved reliability metrics, and opportunity to sell ancillary services products in wholesale markets).

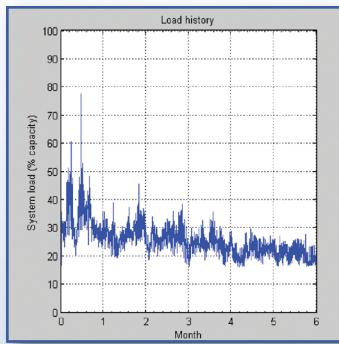
Peak load management. Many peak-shaving programs and emergency curtailment programs have failed to deliver the expected benefits. **GRIDLAB-D** allows modeling of consumer behavior to better understand its interaction with various peak-shaving strategies. The impact of consumer satisfaction on the availability of peak-shaving resources can be evaluated, and a more accurate forecast of the true available resources can be determined. **GRIDLAB-D** even allows the evaluation of consumer rebound effects following one or more curtailment or load-shed events in a single day.

Distribution automation design. **GRIDLAB-D** offers capabilities that support the design and analysis of distribution automation technology to allow utilities to offer heterogeneous reliability within the same system but manage power closer to the point of use.

GRIDLAB-D key features

POWER FLOW AND MARKETS

- » Power flow and controls
- » Distributed generation and storage
- » End-use appliances, equipment, and controls
- » Wholesale and retail markets
- » Incentive program cost/benefit



- » Multi-technology interactions
- » Control strategies/program stability analysis
- » Load growth/technology tradeoff analysis
- » Business models analysis.

POWER SYSTEM ANALYTICS TOOLS

- » End-use modeler
- » Data collection, metering, and logging
- » Study/experiment design and analysis
- » Load forecaster
- » Load growth modeler.

PRODUCTIVITY FEATURES

- » Matlab MEX module integration
- » Connectivity to any ODBC-compliant database for data archival/retrieval
- » Interfaces to Microsoft Excel and text files
- » Weather player/synthesizer
- » Third-party power systems tools interfaces
- » Data logging includes interval metering, transient events, tape recording/playback, and aggregators (sum, diff, mean, max, min, var, median) with and without time-integration.

Price and availability

Licensing: TBD

Availability: September 2007
(development release with power flow and residential end-use)

Technical support: 509-375-4369

For more information see our website at:

<http://www.pnl.gov/gridwise>

GRIDLAB-D was created by the U.S. Department of Energy (DOE) as a part of the GridWise™ program funded by the Office of Electricity Delivery & Energy Reliability. For more information on GridWise products and programs, please contact:

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GRIDLAB-D is being developed and maintained at Pacific Northwest National Laboratory (PNNL) in collaboration with industry and university partners. PNNL is operated for DOE by Battelle Memorial Institute under Contract DE-AC05-76RL01830. For more information, please contact:

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