Load Control System Reliability

Project Fact Sheet

This technology research and development project is aimed at applying advances in intelligent control, signal processing, and information technologies to the challenges of improved reliability and efficiency of the nation's electric grid.

The National Energy Technology Laboratory (NETL) is managing this and other electric grid R&D projects on behalf of the DOE Office of Electricity Delivery and Energy Reliability (OE).

Goals

For this project, efforts will be focused on developing two technologies that fundamentally change how power systems are controlled. The goals are to:

- Develop real-time control strategies that can be applied to intelligent consumer loads to enhance the stability and efficiency of the nation's electric transmission grid. Montana Tech intends to change the grid operating paradigm to also include next-generation intelligent loads. As a grid becomes overloaded, intelligent loads will automatically adjust to maintain grid stability and frequency.
- Develop measurement-based stability-assessment tools that can be used to automatically detect impending erratic conditions of a power system in real time. As seemingly unrelated grid fluctuations (in power flow, voltage, frequency, etc.) begin to occur, the proposed new "tools" will alarm operators and provide critical information to avoid instability.

How Does it Work?

The U.S. electric grid is the world's largest and most complex engineering machine. Even with today's technology, detecting an approaching instability is still very difficult. Because of the potentially catastrophic effect of unstable power swings, protection systems automatically shut down the grid resulting in a blackout. The more heavily loaded the grid, the more likely an unforeseen contingency will cause an unstable response.

Load control technologies will automatically control intelligent loads to counteract unstable swings and voltage dips thus bringing the system out of an unstable response. Modulating key loads for just a few minutes can have a significant impact on maintaining grid stability.

Measurement-based stability assessment uses time-synchronized grid voltage and frequency measurements and advanced signal processing algorithms to monitor grid stability in real time. Time-synchronized measurements (down to one microsecond resolution) are made possible by the newly developed Phasor Measurement Unit (PMU) technology. Because a typical instability condition takes many minutes or even hours to become evident, early detection of discrete and seemingly disparate grid fluctuations would provide operators critical time to adjust grid settings.

Team:

Montana Tech

Montana State University

MSE Technology Apps

University of Wyoming

Pacific Northwest National Laboratory (PNNL)

Bonneville Power Authority

The Electric Power Group (EPG)

Northwestern Energy

Period of Performance:

4/2006 – 4/2008

Cumulative Project Funding:

Non-DOE:	$475,000 (20%)
DOE:	$1,900,000 (80%)
Total:	$2,375,000

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Links:

Montana Tech:

http://www.mtech.edu/tech_research.htm

Office of Electricity Delivery and Energy Reliability:

http://www.oe.energy.gov

NETL:

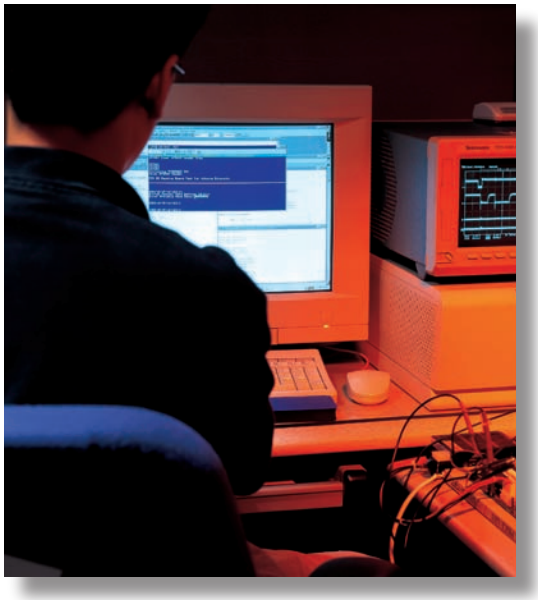
www.netl.doe.gov

MGI:

www.netl.doe.gov/moderngrid

What are the Benefits?

The primary benefits of both technologies are improved grid reliability, and the ability to more safely and effectively operate today's grid at higher loading conditions. The alternative to using these and other advanced control technologies is to upgrade or build more grid infrastructure (e.g., more transmission lines). The proposed advanced control technologies have significant cost saving advantages over infrastructure construction.



What are the Primary Applications?

The load control technologies being developed during this project can be applied to many types of intelligent consumer loads, such as the GridFriendly appliances developed by DOE. One such device is a clothes dryer with a heating coil that can automatically turn on and off based upon a control signal. The technology developed under this project will provide the algorithms required to control the heating coil to improve the stability of the grid. The controller will sense grid operating status and command the coil to turn on or off while also accommodating consumer interests.

The primary application of measurement-based stability assessment tools is in the control centers of transmission operating electric utilities. PMU technology is presently being implemented in control centers throughout the US. Availability of PMU data at the control center enables the implementation of advanced measurement-based stability assessment technologies.

What are the Status and Accomplishments to Date?

Initial advanced signal processing algorithms that estimate the small-signal stability state of a system using PMU measurements have been developed. The algorithms are currently being tested in the western North American power system through a partnership with the Bonneville Power Administration. Prototype visualization software is being developed through a partnership with the Electric Power Group.

Load control research has recently been initiated.

What is the Market Potential?

The market potential of these advanced control technologies should be measured against the increased asset utilization that they enable. Because the alternative is the construction of new transmission resources, the potential return on investment is significant.