ELECTRIC GRID RESEARCH

Project Summary

Application of Modal Analysis for Grid Operation (MANGO) on the Western Interconnection

Context

Electromechanical oscillations, also known as small signal stability problems, are one major threat to the stability and reliability of power grids in California and the western U.S. A poorly damped oscillation mode can become unstable, producing large-amplitude oscillations and leading to system breakup and large-scale blackout. Existing transmission capacity in the western US has been derated by 1000s of megawatts in order to provide a margin of safety for reliable operations.

Utilizing high speed, time-synchronized data from the expanding network of phasor measurements units (PMUs) throughout the Western Interconnection, methods have been developed to detect and analyze oscillation modes. This modal analysis has demonstrated the capability of capturing and displaying system dynamic trends in real time. Low damping indicates a deteriorating system situation.

Detection and analysis, however, is only a beginning. Until such time as automated control systems become available, mitigation of oscillations will require that grid operators take appropriate but, by no means obvious, actions that will increase the damping of potentially unstable oscillations.

Goals and Objectives

The primary goals of this project are to further enhance real time modal analysis techniques and to develop recommendations to improve damping of detected oscillations on the Western Interconnection through specific actions on operator controllable variables (e.g., generations, switchable shunts, and dispatchable loads). This research will result in a tool for grid operators that can potentially recover some of the “lost” transmission capacity, increasingly needed for the transport of electric power from renewable generators.

This project will identify the significant operator controllable variables, build a MANGO model, and provide a sensitivity analysis of these variables for the Western Interconnection. It will enable power grid operators of the Western Interconnection to use real-time information to damp oscillations, a function not currently available in power grid operations. Subject to the availability of phasor measurements, the developed MANGO technology will bring modal analysis and mitigation into the real-time grid operation arena.

Description

Previous work, funded by the Department of Energy (DOE), has established a MANGO procedure to aid grid operators with making decisions in response to oscillations once they are detected. The MANGO procedure provides control suggestions (such as increasing generation or decreasing loads) for operators to mitigate inter-area oscillations by increasing the damping factor. The procedure has been tested with a small simulation model and shows promising results for real world applications. Further fundamental research for MANGO is ongoing as a DOE funded effort.

This project focuses on implementation and demonstration of the MANGO procedure for the specific case of the Western Interconnection. This is a necessary step to bring the MANGO procedure into the CAISO and California utility control rooms.

First, the operator controllable variables for the Western Interconnections are to be identified. Then, a MANGO model will be developed to establish the relationship between the controllable variables and modal damping. Inherent in this model is a sensitivity analysis of the impact of changing a specific variable on the overall damping of the mode. Finally, a procedure is to be developed to recommend operator actions to mitigate inter-area oscillation modes.

Why It Matters

Oscillations are occurrences on the power grid with potentially extremely serious impacts such as wide area blackouts with costs estimated in the billions of dollars. With current tools, the primary method of control today is to restrict the flow of power on transmission lines by 1000s of megawatts, which limits the ability of the California and the Western Interconnection to economically exchange power and can lead to shortages.

Under conditions of system stress, oscillation modes can develop and system stability can rapidly deteriorate. Providing operators with both situational awareness and definite actions which can be taken to mitigate a situation will improve grid reliability and reduce the likelihood that random faults will cascade into widespread blackouts.

{More details}

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Participating Organizations

Principal Investigator:

Pacific Northwest National Laboratory

Research Partners:

California Independent System Operator;

Project Start Date: March 19, 2009

Project End Date: August 31, 2010

CIEE Contract No.: TRP-08-08

CEC Contract No.: 500-07-037

Reports

Final Report: *Application of Modal Analysis for Grid Operation (MANGO) on the Western Interconnection* (Not yet available)

Funding

Funds for this project came from a $370,000 award by the CIEE under a research contract 500-07-037 awarded to CIEE by the California Energy Commission (CEC) through the Public Interest Energy Research program (PIER)

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