Project Summary

Load Modeling Research

Context

Grid planning and operating decisions rely on simulations of dynamic behavior of the power system. Both technical and commercial segments of the industry must be confident that the simulation models and database are accurate and up to date. Having realistic models is very important to ensure reliable and economic power system operation. Inaccurate modeling in transmission expansion planning studies can lead either to failure to have enough transmission resources, raising the risk of shortages and disruptions, or to have too many resources, resulting in economic inefficiencies.

A power system model consists of generation, transmission power flow and load models. Load representation remains the least accurate of these three components. The situation today is that existing load models in dynamic programs do not correctly represent the actual load behavior observed in the system under many system conditions. The dynamic effects of the addition of residential and commercial PV systems on nearby customer loads are largely unknown. Finally, a phenomenon known as Fault Induced Delayed Voltage Recovery (FIDVR), generally understood to be caused by the stalling of residential air conditioners after a brief power instability, has become of increasing importance and is not reflected in current load models.

Goals and Objectives

The ultimate objective of this research was to improve the accuracy of dynamic load models used in power system analysis and simulation tools. Specific objectives included the development of:

- An accurate model of residential air conditioners,
- Potential solutions to FIDVR,
- Tools and methodologies for determining the mix and balance of different types of electrical loads, and
- A scoping study for the impact of increasing penetration of residential and commercial photovoltaic systems.

Description

This program was a coordinated effort by members of the Western Electricity Coordinating Council (WECC) to enhance the understanding of the behavior of loads, especially air conditioner, and to improve simulations of dynamic behavior of the power system. Specific tasks include:

- Testing of residential air conditioners and development of an accurate model,
- Testing and analysis of possible solutions for FIDVR,
- Development of improved load modeling techniques including methodology and tools for load composition.
- Evaluation of the merits of future load monitoring and development of a monitoring placement plan.
- Development of an uncertainty analysis for load modeling.
- A scoping study to assess solar generation characteristics and associated impacts on load modeling

Technical oversight was provided by the WECC Load Modeling Task Force in cooperation with a significant number of utilities, national laboratories, and system operators.

Key Results/Conclusions

Extensive testing of residential air conditioners resulted in both an accurate dynamic model and confirmation of air conditioners as the cause of FIDVR.

A new load composition structure was developed along with a tool for populating the structure. An uncertainty analysis was completed which led to a strong recommendation for future load monitoring to validate the structure.

Potential FIDVR solutions at the system level were analyzed and some existing devices that could be unit level solutions were tested. None were found to be completely satisfactory. Manufacturing standards were recommended to deal with the issue in the long term.

A scoping study of distributed PV was completed. It was determined that, as penetration increases, distributed PV could have significant impact on the grid. No suitable model currently exists, but a candidate approach was proposed. Testing of inverters is needed.

Why It Matters

The primary problem addressed, which was not adequately represented in the load models being used, is

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voltage instability in Southern California and the Southwest after a brief voltage disturbance. Improved load modeling provides improved predictability of damping and stability issues related to the California-Oregon Intertie and other major interties, critical to the security of the entire WECC system.

The improved models will lead to more reliable operation of the grid in the West, and reduce the risk (and costs) of widespread blackouts. Moreover, a better understanding of anticipated network behavior aid in planning for appropriate deployment of capital investments (including new controllers, protection, generation and transmission).

Participating Organizations

Principal Investigator:

Lawrence Berkeley National Laboratories

Research Partners:

Arizona Public Service
Bonneville Power Administration;
California Independent System Operator;
Electric Power Research Institute (EPRI) Solutions
Lawrence Berkeley National Laboratory
Pacific Northwest National Laboratory
Pacific Gas and Electric;
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Reports

Final Report: *Load Modeling Research*

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