Project Summary

Distribution Monitoring for Renewables Integration

Context

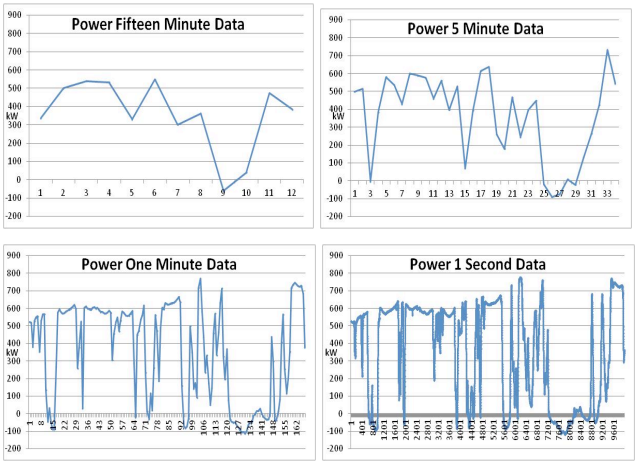
Large amounts of distributed generation (DG), especially solar, and electric vehicles may cause technical problems related to power quality, safety and reliability on electric distribution circuits. These impacts are not yet well understood. Early evidence suggests that significant infrastructure upgrades and operational changes in utility distribution systems may be required as DG penetration levels reach a critical threshold. New empirical information gathered from the field is needed to better define these requirements and the potential need for new technology developments. Data from distribution circuits must be collected and analyzed at higher resolution and with greater specificity so that the effects of distributed resources can be better understood and mitigated if necessary.

Project Description

This project is a collaborative effort to collect and analyze measurements from existing and new distribution line sensors and substation monitors to support the integration of renewable and distributed resources in the electric grid. Led by the California Institute for Energy and Environment (CIEE), the project has been designed and will be conducted in cooperation with four electric utilities. UC San Diego and UC Irvine will perform crucial steps in the collection, concatenation and analysis of the data, with technical support from OSIsoft.

Compared to transmission, distribution systems tend to lack visibility to operators, despite their considerable diversity, variability, and vulnerability to disturbances. This is because historically, the investment in extensive monitoring capabilities at the distribution level made little economic sense. But the interconnection of significant amounts of distributed generation and electric vehicles introduces new variables and uncertainties that require more empirical measurement.

With generation and loads that can vary markedly not just on an hourly basis but from minute to minute or even second to second, the behavior of distribution feeders must be examined more carefully.



Output variation from a PV array, as observed at different time resolutions, illustrates the need to look more closely at distribution systems: depending on the granularity of the measurement, the data tell a different story.

Image courtesy of San Diego Gas & Electric

The project will explore the following questions:

- What are the power and voltage profiles on different types of distribution circuits with different amounts and types of DG?
- What lessons can we learn from empirical feeder data regarding the most successful integration of distributed energy resources?
- What generalizations or extrapolations can be made from a subset of studied feeders to broader categories of distribution feeders?

ELECTRIC GRID RESEARCH PROGRAM

Project Summary

The project is structured as a two-phase effort. Phase I will aim to accomplish the following:

- Coordinate the collection of empirical field data currently being collected by four California utilities – PG&E, SCE, SDG&E, and SMUD – into a shared data repository that can continue to be expanded;
- Leverage existing ongoing distribution circuit monitoring studies, including ARRA projects, by sharing data in a cooperative framework;
- Analyze the data for information about the suspected and unforeseen performance of different distribution circuits at different penetration levels of DG and EVs;
- Establish a baseline of distribution circuit behavior against which future measurements can be compared;
- Test, validate and develop models of distribution circuits that can accurately predict impacts of distributed resources at high penetrations and inform mitigation efforts;
- Identify gaps in available data and develop a plan for Phase II, in which utilities would install additional monitoring equipment to obtain higher resolution data as needed for a more complete and representative sample of circuits.

Anticipated Benefits for California

Better knowledge of distribution circuit behavior will allow California's green energy policies to be implemented at least cost without degradation of electric service. This work will help California ratepayers avoid three risks: spending too much money on unnecessary distribution infrastructure upgrades; suffering a loss of power quality and reliability from too little infrastructure upgrades; or compromising our state's policy goals by restricting the implementation of clean and green energy. This work will provide the scientific knowledge base from which service quality, cost, and environmental benefit can be optimized.

Participating Organizations

Principal Investigator:

University of California, California Institute for Energy and Environment (CIEE) / i4Energy

Research Partners:

University of California, Irvine
University of California, San Diego

Research Advisors/Consultants:

California Independent System Operator (CAISO)
Pacific Gas & Electric Co. (PG&E)
Sacramento Municipal Utility District (SMUD)
San Diego Gas & Electric Co. (SDG&E)
Southern California Edison (SCE)

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$ 1,167,000

For more information, contact:

Dr. Alexandra von Meier, CIEE
(707) 322-3538
vonmeier@uc-ciee.org