Planning and Modeling for High Penetration PV

Distributed PV systems are outside the scope of most utility planners and engineers, due to their small size and historically low market-penetration and utility personnel may not be familiar with the operational characteristics of these systems. In addition, due to the rapid growth in distributed PV systems, utility grid operation models and planning tools lack the ability to account for distributed PV generation technologies and resources. Problems also exist with the current methods for estimating solar resources and predicting PV system performance. Existing solar resource models are based on lower resolution insolation data sets and usually provide only hourly resource values. Only with the emergence of higher concentrations of PV onto distribution feeders has there been a recognition that rapid changes in atmospheric conditions over relatively small areas can have significant impacts on the aggregated PV system output and on the associated electricity distribution system.

Existing methods for predicting and planning for high penetration PV limit the ability of utilities to strategically locate this technology within their T&D systems. New solar resource and utility planning models provides utilities the means to identify optimal locations for high penetration levels of PV. As PV and other DG resources form a larger portion of the electricity generation mix, it will be increasingly important to have electric system planning, design, and operation modeling tools that provide utilities, the solar industry, and utility customers with the ability to accurately assess and forecast energy output and account for distributed PV systems.

Development and Analysis of a Progressively Smarter Distribution System

Principal Investigator: University of California Irvine—Advanced Power and Energy Program
Partner: PG&E

The goals of the University of California, Irvine (UCI) project are to utilize modeling and simulation to quantify PV integration limitations on distribution circuits and to develop and evaluate progressively smarter distribution systems so that higher levels of PV can be accommodated. Monitored field data will be used to develop and verify distribution circuit models and PV integration limits will be quantified for these circuits. The project will also evaluate advanced inverters, control strategies, standards, hardware and communications to enable and support increased PV penetration on the distribution system. Results from the project will be used to inform advanced standards.

Advanced Modeling and Verification for High Penetration PV

Principal Investigator: Clean Power Research
Partners: NREL, SUNY, NYSERDA, LIPA, SMUD, NYPA, SEPA, SRP

Clean Power Research is developing a free solar resource model (www.solaranywhere.com) that will provide high temporal and spatial resolution data for use in forecasting and planning tools. The team will integrate PV modeling capabilities with an open-source distribution engineering and analysis tool and create a PV value assessment tool for use by utilities to select and target the best locations for PV. These tools and data streams will be made publicly available for use by installers, manufacturers, utilities and others engaged in the transformation of the electric power grid into a clean energy marketplace.

Improving Economics of Solar Power through Resource Analysis, Forecasting and Dynamic System Modelling

Principal Investigator: University of California, San Diego
Partners: EPRI, ESA, Power Analytics, California ISO, SDG&E

The University of California, San Diego project focuses on providing utilities and the solar industry with electricity system planning, design, and operation modeling tools for accurately assessing and forecasting energy output from distributed PV systems. A one-year dataset of solar irradiances will be generated at 1 km resolution which will inform solar resource maps as well as forecast PV power output by zip code across the State of California up to 6 hours ahead. These high resolution (both temporal and spatial) resource maps and modeling tools will be a critical component in addressing high penetration PV resources.

Integration of Energy Efficiency, Demand Response, Energy Storage and PV

For utilities, energy efficiency and distributed PV can help defer the need to build additional peaking generation and T&D system infrastructure. For utility customers, distributed PV provides more control over energy prices. Installing a PV system is one of a number of options available to these customers. Their other choices include energy efficiency, energy storage, and demand response. Energy efficiency provides the most cost-effective means for addressing energy use within a home or business. Implementing energy efficiency measures not only reduces electricity demand but also helps reduce the size and required capital for a PV system. The choices available can leave customers at a loss to determine the optimum balance of energy efficiency measures and PV system type and size for the specific application. At present, there are no clear guidelines (especially in retrofit situations) on the energy efficiency measures that utility customers should consider prior to, or in conjunction with, procuring a PV system. Additionally, there is a critical gap in the ability of the current market to provide combined energy efficiency services along with PV services for the residential sector.

Beopt-CA (EX): A Tool for Optimal Integration of Energy Efficiency, Demand Response, Energy Storage, and PV for California Homes

Principal Investigator: Davis Energy Group
Partners: NREL, PG&E, E3, SunPower Corp.

This project will develop the Building Energy Optimizer for California Existing Homes (Beopt-CA (EX)) modeling tool that aims to facilitate the integration of energy efficiency, demand response, and energy storage with PV in the residential retrofit market. The project will use PG&E and SunPower data to validate the prototypes developed in the modeling tool. The tool will provide utility program managers and contractors with the means to optimize the integration of EE, DR, ES and PV. The team will also develop a recommended series of best practices.

Testing and Development of Hardware and Software for High Penetration PV

Successful grid integration of high-penetration PV requires robust grid, PV communications, control systems, and operational procedures. PV systems will need to be capable of dynamically interacting with varying frequency and voltage conditions on the grid including load and VAR (reactive power) control to improve reliability. New software and hardware tools will emerge in response to these needs. Field testing, and demonstrations are needed before these new tools can realize widespread market adoption.

Analysis of High-Penetration Levels of PV into the Distribution Grid in California

Principal Investigator: Southern California Edison
Partners: NREL, Salcon, CPR, Electrical Distribution Design

This project focuses on accelerating the placement of high levels of PV penetration into the existing distribution circuits and identifying new circuit configurations that will help increase penetration levels of PV. For the first year, the team will conduct, develop, and test new modeling, simulations, and testing of possible advanced hardware and software solutions. Laboratory testing will be conducted on advanced inverters and control systems. These advanced systems will be installed in projects in the Southern California Edison territory. During the second year, the team will evaluate the advanced technologies that were developed during the first year of the project.

High Penetration PV Initiative

Principal Investigator: Sacramento Municipal Utility District
Partners: HECO, NREL, SunPower Corp., New Energy Options, Areva, Irradiance and other consulting firms

SMUD, in partnership with Hawaiian Electric Company (HECO) will demonstrate new hardware and software tools that will provide communication and management between PV systems and utility controls using advanced metering infrastructure (AMI). The team will develop a software visualization tool that enables identification of high value locations for automated control of PV power output. These advanced tools will be installed at residential, commercial, and utility-scale deployments in California and Hawaii. The project will provide utilities with the tools to integrate increased levels of PV into the grid.

California Solar Initiative RD&D Program

The California Solar Initiative (CSI) Research, Development, Demonstration and Deployment (RD&D) Program has a $50 million budget and provides grant funding to further the CSI goals of creating a sustainable solar industry and installing 3,000 MW of solar capacity in California by the end of 2016. Itron on behalf of CPUC serves as Program Manager for the CSI RD&D Program with oversight provided by the California Public Utilities Commission (CPUC). Two competitive solicitations have been held to-date with awards to 17 projects. The projects presented here were awarded under the first solicitation which focused on grid integration. The overall goal of the RD&D funds is to help build a sustainable and self-supporting industry for customer-sited solar in California.

For more information on the program please visit: www.calsolarresearch.ca.gov

The CSI RD&D Program is managed by Itron on behalf of CPUC.