Solar Resource Modeling and Forecasting

Due to the rapid growth in distributed PV systems, utility grid operation models and planning tools often lack the ability to account for the variability of distributed PV generation technologies and resources. Problems can also exist with the current methods for estimating solar resources and predicting PV system output. Existing solar resource models are based on lower resolution insolation data sets and usually provide only hourly resource values. It is recognized 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.

Advanced Modeling and Verification for High Penetration PV

Clean Power Research

Partners: NREL, SUNY, NYSERDA, LIPA, SMUD, NYPA, SEPA, SRP

Clean Power Research developed a portal for solar resource data (ca.solaranywhere.com) that provides high temporal and spatial resolution data for use in forecasting and planning tools. The high resolution data for California is available free of charge to anyone as part of this grant. The project also developed an algorithm for PV Output Variability through data collection and validation in various geographical locations and included the algorithm in PV modeling tools. A tool was also developed for calculating the economic value of distributed PV fleets and includes energy value, generation capacity value, environmental value, fuel price hedge value, T&D capacity value, and loss savings. The project was completed in April 2012.

Integrating PV into Utility Planning and Operation Tools Clean Power Research

Clean Power Research

Partners: CAISO, UCSD, EPRI, SUNY, SEPA

In this follow on project the Clean Power Research team is developing, validating and integrating PV fleet simulation tools that will enable utilities and independent system operators (ISOs) to cost-effectively integrate distributed PV resources into their planning, scheduling and operating strategies. The solar resource data on the SolarAnywhere portal (ca.solaranywhere.com) will continue to be processed with additional temporal and spatial resolution and inclusion of forecasting algorithm that generates data upon demand. The main focus of this project is the interface with CAISO and the use of solar forecasting data in their operations and planning to enable handling of increasing penetration of solar on the grid.

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

University of California, San Diego

Partners: EPRI, Enernex, CAISO, SDG&E

This 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. Geographic shading profiles along with one-year solar irradiance dataset (downscaled from metered 15 minute generation data to less than a second data) has been generated for locations throughout the state. A forecast of PV power output throughout California for up to 6 hours ahead will be developed. These high resolution (both temporal and spatial) resource maps and modeling tools will be a critical component in addressing high penetration PV.

High-Fidelity Solar Forecasting Demonstration for Grid Integration

University of California, San Diego

Partners: SDG&E, Green Power Labs, CAISO

This project will demonstrate that solar resource forecasting can be the most cost effective strategy for integrating large amounts of PV into distribution systems. Initially historical aggregate PV ramp rates will be analyzed and a baseline of solar forecast performance under the extreme ramps will be created. Additionally, sites for additional measurements to improve solar forecast accuracy will be proposed based on statistical analysis. For resource adequacy applications, the team will then improve and demonstrate forecasts for the marine layer meteorological conditions that affect a large fraction of solar PV in SDG&E territory on summer mornings. High resolution numerical weather prediction and statistical models will be developed and applied to improve forecast accuracy. Local applications of solar forecasting using sky imagery will also be demonstrated on five typical feeders with variations in PV penetration, location/meteorology, and voltage regulation equipment. On these feeders, fast demand response potential based on demand and solar forecasting and dynamic loading will be demonstrated. Through increased granularity in modeling distribution feeder voltages and their reaction to fluctuations in solar PV output, geographic diversity is expected to reduce previously observed impacts at high solar PV penetration.
Hardware and Software for High Penetration PV

Successful grid integration of high-penetration PV requires a 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.

Development and Analysis of a Progressively Smarter Distribution System

University of California Irvine
Advanced Power and Energy Program

Partner: PG&E

The goals of this project are to utilize modeling and simulation to quantify PV integration limitations on distribution circuits, assess advanced inverter strategies and to develop and evaluate progressively smarter distribution systems so that higher levels of PV can be accommodated. Monitored field data was used to develop and verify distribution circuit models. The team is evaluating advanced inverters, control strategies, standards and hardware necessary to enable and support increased PV penetration on the distribution system. Results from the project will be used to inform advanced standards.

Planning and Modeling for High Penetration

SunPower Corp.

Partners: AWS Truepower, Sandia National Lab, KEMA, California ISO

The SunPower team generated a higher solar resolution sample dataset based on meteorological information and delivered a preliminary methodology report that focused on the methods used to generate simulated solar resource data. A sample simulated dataset (15-minute, 1-minute and 1-second sample files) was generated using the developed methodology. The team produced specifications for representation of PV output variability in simulation as well as a baseline assessment report before pulling out of the project in June 2012.

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

Southern California Edison/NREL

Partners: NREL, Satcon, 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 phase of this project, the team conducted modeling, simulations, and testing of possible advanced hardware and software solutions. Laboratory testing has been conducted on advanced inverters and control systems, and these advanced systems will be installed in projects in the Southern California Edison territory. During the second phase, the team will evaluate the advanced technologies that were developed during the earlier project.
Utility Planning and Modeling for High Penetration PV

Distributed PV systems are often 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. 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 provide utilities with 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 and others in the solar industry, with the ability to accurately assess and forecast energy output and account for distributed PV systems.

High Penetration PV Initiative
Sacramento Municipal Utility District

Partners: HECO, NREL, EPRI, New Energy Options, Areva, Siemens Irradiance and other consulting firms

SMUD, in partnership with Hawaiian Electric Company (HECO) is demonstrating new hardware and software tools that provide communication and management between PV systems and utility controls using advanced metering infrastructure (AMI). The team is developing a software visualization tool that enables identification of high value locations for distributed PV. The tools developed through this project are being tested and validated at residential, commercial, and utility-scale deployments in California and Hawaii. The project will provide utilities the with tools to integrate increased levels of PV into the grid.

Tools Development for Grid Integration of High PV Penetration
BEW Engineering

Partners: SMUD, HECO/MECO/HELCO, PG&E, Roseville Electric

This research targets the development of methodologies and software for evaluating high-penetration PV on the distribution grid and builds on work conducted under the Sacramento Municipal Utility District (SMUD) CSI RD&D #1 project. The BEW team will explore a nodal approach for locating PV strategically by integrating the distribution grid and a global visual mapping tool into an expanded locational value analysis. The visual map locates potential PV development areas such as roof space and vacant lots. The nodal approach aggregates and assesses impacts across the system from a strategic development and grid enhancement perspective. The methodology and process will be used by utilities to facilitate expansion of PV into the grid without negatively impacting system performance. The four utility partners will select different feeder configurations to demonstrate, evaluate, and validate high PV penetrations under steady-state, contingency, and dynamic scenarios. The project also plans to conduct case studies for evaluating PV penetrations on the distribution grid.
Interconnection Studies

Investor-owned utilities in California use the Rule 21 Tariff for interconnection, operating and metering requirements for distributed PV systems under 2 MW. The procedures for interconnection include a series of screens to identify whether a PV project can qualify for a simplified interconnection process or whether a detailed study is required. Interconnection requirements are considered to be quite conservative and can result in delays and added costs for interconnection of distributed PV that may not negatively impact the grid or the customer. A clear, data driven and streamlined interconnection process will lead to greater adoption of PV both in California and across the nation.

Quantification of Risk of Unintended Islanding and Re-Assessment of Interconnection Requirements in High-Penetration of Customer-Sited Distributed PV Generation

General Electric International, Inc., Energy Consulting
Partners: PG&E

This collaborative project will quantify the risks of unintended islanding in distribution circuits with high penetration of customer-sited distributed PV generation. The GE/PG&E team will use full-scale laboratory testing to determine the risks to both utility and customer equipment that may result from an unintended islanding situation. Additionally, the team will review PG&E’s interconnection requirements with respect to islanding and provide recommendations on potential changes based on the findings from this project. The results of this research will inform PG&E’s interconnection requirements and also will be of value to the other utilities (both investor-owned and publicly-owned). This research can also inform the CPUC in making decisions regarding interconnection requirements relating to anti-islanding operations of PV inverters (Rule 21).

Screening Distribution Feeders: Alternatives to the 15% Rule

Electric Power Research Institute, Inc.
Partners: NREL, Sandia National Lab, Clean Power Research

This project is developing an interconnection screening methodology that takes into account individual distribution feeder characteristics. Distribution modeling and simulation techniques will be used to determine the level of PV that can be accommodated on individual feeders without impacting distribution system operations. This measure of “hosting capacity” is expected to become more critical as PV deployment increases. The utility partners will help to detail which tools and penetration screens are most commonly used and which procedures have been most effective for evaluating PV interconnection requests in California. The utilities will also help review distribution feeder classification methods currently used in California to identify and map areas with additional capacity for hosting PV. Factors that are known to be important to feeder hosting capacity will be used to develop a higher-level screening methodology that can then be applied to other distribution systems without necessitating the need for detailed analysis.

LEARN MORE:
One stop for all solar in California: GoSolarCalifornia.ca.gov
CSI RD&D website: calsolarresearch.ca.gov

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