Hawaiʻi Natural Energy Institute Research Highlights

Grid Integration & Renewable Power Generation

Sustainable Grid Platform with Enhanced System Layer and Fully Scalable Integration

OBJECTIVE AND SIGNIFICANCE: The objective of this project is to support the long-term goal of designing highly scalable technologies for distribution systems to operate reliably and securely with extremely high penetration of distributed energy resources. The results from this three year project, conducted by HNEI as a subawardee to the University of Central Florida (UCF), will provide a scalable solution that can be adapted to grids of various sizes, and facilitates the integration of additional distributed energy resources.

BACKGROUND: The project overview is summarized in Figure 1. The expected outcomes of this project includes:

- A modular, plug-and-play and scalable Sustainable Grid Platform (SGP) for real-time operation and control of the distribution network;
- Advanced distribution operation and control functions to manage extremely high penetration solar PV generation (installed PV capacity > 100% of distribution feeder peak load) in a cost-effective, secure, and reliable manner; and
- Software and Hardware-in-the-loop (HIL) test platform.

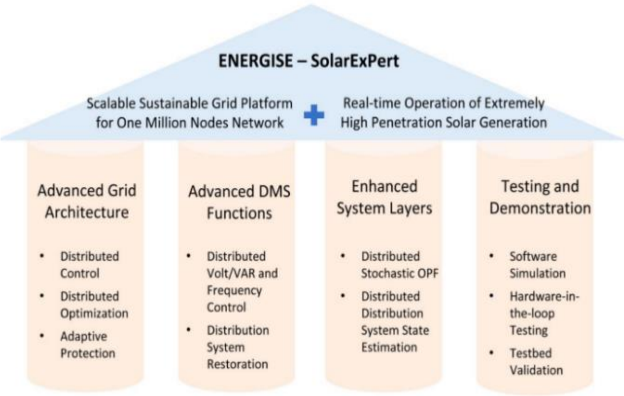

Figure 1. SolarExPert project overview

HNEI's Grid*START* developed, tuned, and calibrated the detailed electrical model of a very high PV penetrated distribution feeder on the island of Maui based on an extensive collection of field measured data previously captured in the course of U.S. Department of Energy (DOE) and Office of Naval Research funded research projects. This high-fidelity electrical model is used in the testing and tuning of the open source software of the SGP and advanced distribution management system functions developed by UCF.

PROJECT STATUS/RESULTS: In this, the third and final year of the project, a distribution circuit PV hosting capacity estimation approach based on stochastic analysis was developed. The high-fidelity model of Maui island distribution feeder with extremely high penetration distributed PV was utilized to determine the impacts of advanced inverter control functions on PV hosting capacity. Uncertainties in the location and size of the future installed PV systems are considered based on historical PV data. The PV size sampling result is shown in Figure 2.

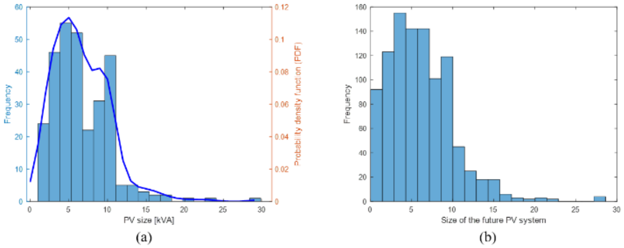

Figure 2. (a) histogram of the 295 installed PV systems and the estimated probability distribution; (b) histogram of the sizes of the future PV systems.

The PV hosting capacity analysis focused on feeder voltage quality, particularly on voltage rise as a function of installed PV capacity relative to local load. The hosting capacity improvement with advanced solar PV inverter Volt/VAR and Volt/Watt optimization control algorithms are illustrated in Figure 3. The boundaries determine the minimum and the maximum hosting capacity.

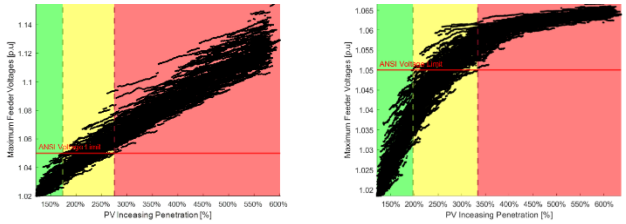

Figure 3. The PV hosting capacity of the Maui test feeder: (a) without the voltage control algorithm; (b) with the advanced Volt/VAR and Volt/Watt control algorithm.

This project was successfully completed in August 2020. Final reports to DOE are being prepared.

Funding Source: U.S. Department of Energy

Contact: Leon Roose, lroose@hawaii.edu

Last Updated: October 2020

Hawaiʻi Natural Energy Institute | School of Ocean & Earth Science & Technology
University of Hawaiʻi at Mānoa, 1680 East-West Road, POST 109 • Honolulu, HI 96822
Phone: (808) 956-8890 • Fax: (808) 956-2336 • www.hnei.hawaii.edu