Hawaiʻi Natural Energy Institute Research Highlights

Grid Integration & Renewable Power Generation

Load and PV Data Synthesis

OBJECTIVE AND SIGNIFICANCE: The objective of the research activity is to synthesize a full set of disaggregated solar photovoltaic (PV) and customer load data from a limited number of field measurements to enable more realistic distribution feeder modeling and state analysis for circuits with high distributed PV penetration. Actual field metered measurements of customer load and PV system production is very limited today, yet effective circuit power flow modeling requires the representation of the individual time-varying energy production and demand profiles at all electrical buses. This work supports the development and testing of distributed control algorithms for distributed energy resources on a feeder with high penetration of distributed PV.

BACKGROUND: Under the earlier U.S. Department of Energy funded Maui Advanced Solar Initiative, HNEI deployed approximately sixty (60) distribution-level power monitoring devices to capture high resolution data at key nodal points located at distribution service transformers, PV inverters, and residential homes. In conjunction, a detailed electrical model was developed as shown in Figure 1. The rooftop PV systems and customer loads are marked with green and red circles, respectively. This feeder serves approximately 800 customers, with a total installed rooftop PV capacity of approximately 2 MW and a daytime minimum feeder load of 975 kW, a PV penetration level of more than 200%.

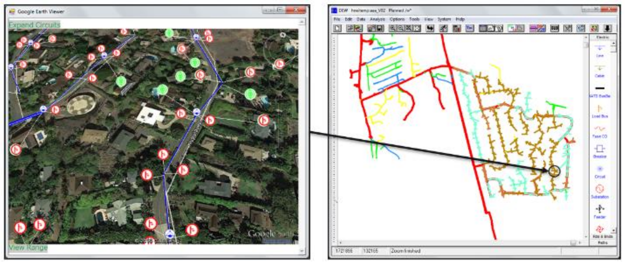

Figure 1. Maui Meadows distribution circuit.

PROJECT STATUS/RESULTS: HNEI's Grid*START* developed a spatial-temporal algorithm to estimate the PV generation at 280 nodal points based on limited field collected data of nearby PV systems. The PV data set (field and synthesized), total feeder net load, and measured net load at each distribution service transformer are the inputs to the stochastic data estimation method for synthesizing gross load at distribution service transformers where field data was not available. The data flow is shown in the diagram below.

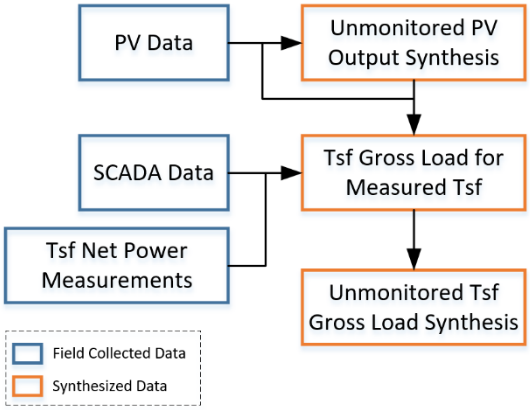

Figure 2. Data flow of PV and load data synthesis.

Validation of the synthesized load and PV data was achieved by injecting it along with the limited field measurements into the electrical model and comparing the voltages from the power flow with the voltages measured in the field. The results are illustrated in Figure 3 below with mean errors for each transformer voltage ranging between 0.16% to 1.47%.

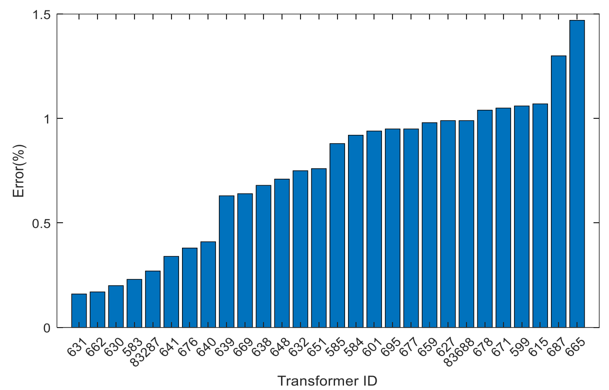

Figure 3. Voltage magnitude error between simulation and field measurement.

The results of this research will be reported in part in a manuscript that was submitted for IEEE's 2021 Conference on Innovative Smart Grid Technologies.

Funding Source: Office of Naval Research

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