Hawai‘i Natural Energy Institute Research Highlights

Grid Integration & Renewable Power Generation

Advanced Conservation Voltage Reduction Development & Demonstration

OBJECTIVE AND SIGNIFICANCE: The objective of this project was to demonstrate conservation voltage reduction (CVR) as an effective ways to save energy. The main principle of CVR is that energy and peak demand can be lowered by up to 0.9% for each 1% reduction in voltage level.

BACKGROUND: The primary value proposition of CVR implementation – reduced energy use by more effective management of customer service voltage with an expected reduction in energy consumption in the range of 0.7% to 0.9% for every 1% reduction in voltage. Working in close collaboration with Marine Corps Facilities personnel in Okinawa, seven distribution service transformers on a branch of the 13.8 kV circuit serving the Plaza Housing complex was identified for CVR field test and evaluation.

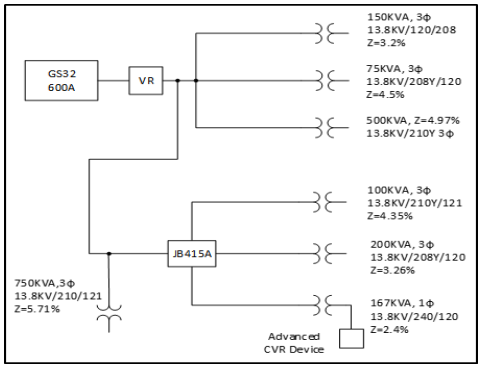

Figure 1. CVR Demonstration Single-Line Diagram.

The CVR controlled feeder section is isolated with a new voltage regulator (VR) to control the voltage at "downstream" service transformers, essentially behaving like a substation transformer load tap changer (LTC) for the section of the feeder under test. The LTC action of the VR shifts the voltage profile of the feeder up or down, but is unable to manage individual low or high voltage points along the feeder path. Voltage reduction by the LTC is thus constrained by the minimum voltage point along the feeder. HNEI has patented and field demonstrated a method of localized voltage management with an advanced CVR device to: (1) smooth the voltage profile; (2) boost the lowest voltage at a distribution service transformer, thereby allowing the LTC to further shift the entire feeder voltage down; and (3) provide maximum CVR benefit for all customers.

PROJECT STATUS/RESULTS: Utilizing HNEI hardware-in-the-loop (HIL) laboratory platform, testing and validation of the CVR control algorithm developed by HNEI's Grid*START*, including communication between the controller and field meters to be located at service transformers was completed.

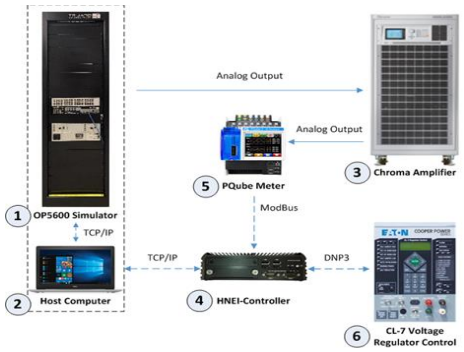

Figure 2. CVR real-time HIL test set-up.

Multiday real-time HIL simulations using field voltage measurements collected from the project site were used to ensure robust and reliable operations of the HNEI-controller and algorithm under a full range of load conditions.

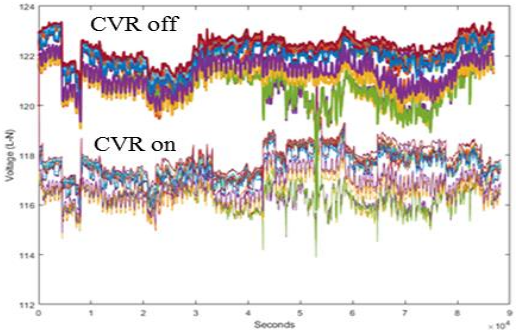

Figure 3. Voltage Profiles with CVR on and off.

Field design and construction of all CVR system components and a 5.8kW rooftop PV system is complete, with civil/structural work performed by Navy Seabees. Project operational commissioning is pending the lifting of COVID-19 travel restrictions.

Figure 4. Project construction by Navy Seabees and new PV system.

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