Hawai‘i Natural Energy Institute Research Highlights

Grid Integration & Energy Efficiency

Advanced Conservation Voltage Reduction Development and Demonstration

OBJECTIVE AND SIGNIFICANCE: HNEI Grid*START* is demonstrating conservation voltage reduction (CVR) as an effective way to conserve energy on a U.S. Marine Corps (USMC) base in Okinawa, Japan. CVR works by seamlessly lowering the operating voltage within the acceptable operating band on distribution circuits serving customer loads, which can reduce customer energy use and peak demand.

BACKGROUND: The primary value of CVR implementation is reduced energy use by more effectively managing customer service voltage. CVR is expected to reduce energy consumption by 0.7% to 0.9% for every 1% reduction in voltage (i.e., CVR factor). In close collaboration with USMC Facilities personnel in Okinawa, seven distribution service transformers on a branch of the 13.8 kV circuit serving the Plaza Housing complex were selected for a CVR field test.

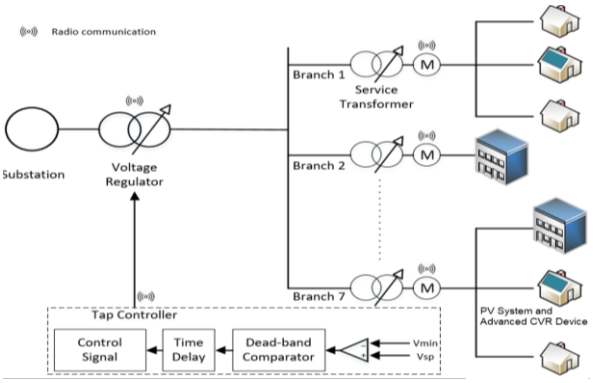

Figure 1. CVR demonstration system architecture.

To control the voltage at downstream service transformers, the CVR-controlled feeder section is isolated with a new voltage regulator (VR). The VR's load tap changer (LTC) can shift the voltage profile of the entire feeder down, but it is unable to manage individual low- or high-voltage points along the feeder path. This means that the minimum voltage point along the feeder limits voltage reduction by the LTC. To achieve greater CVR benefits, HNEI has patented and field-demonstrated a method of localized voltage management with an advanced CVR device. This device uses local measurements from an existing AMI meter to: 1) smooth the voltage profile by managing and regulating the reactive power output of inverters; 2) increase voltage at the critical minimum voltage point regulated by the VR; and 3) provide maximum CVR benefits for all customers.

PROJECT STATUS/RESULTS: The VR and associated CVR controller, as well as the advanced CVR device, were successfully installed and commissioned in the field. Communication challenges were addressed to improve the controller's performance and data collection capabilities. HNEI analyzed weekly measurement data from the USMC Camp Butler team to estimate the energy savings achieved by implementing CVR across the downstream transformers. The CVR assessment determined that the CVR factor for the feeder section serving the seven transformers ranges from 0.75% to 0.93%, translating to 1.82 to 2.26 MWh of energy savings per month.

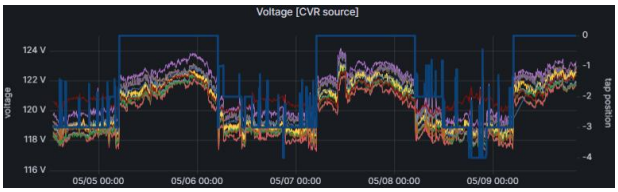

Figure 2. Voltage profiles with CVR on and off. The tap position (blue) at 0 indicates CVR is off.

During a typhoon, the VR was disconnected from the Plaza Housing distribution grid due to an apparent internal fault. Tests will be conducted to determine if the VR can be returned to service. If so, HNEI Grid*START* will continue collecting field data to further assess and evaluate the coordinated operation of the CVR controller, the VR, and the advanced CVR device at the low voltage point on the feeder. HNEI Grid*START* will also assess the CVR factor of the loads connected to each transformer to characterize the differential CVR benefits across alternative classes of end-use loads.

Figure 3. Voltage drop (red) is reduced when the advanced CVR controller is enabled and reactive power (blue) is dispatched.

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