Hawai'i Natural Energy Institute Research Highlights

Grid Integration

Advanced Conservation Voltage Reduction Development and Demonstration

OBJECTIVE AND SIGNIFICANCE: HNEI's Grid System Technologies Advanced Research Team (Grid*START*) is demonstrating advanced conservation voltage reduction (CVR) at a U.S. Marine Corps (USMC) base in Okinawa, Japan. CVR reduces energy consumption and peak demand by seamlessly lowering voltage levels within acceptable ranges on distribution circuits.

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.

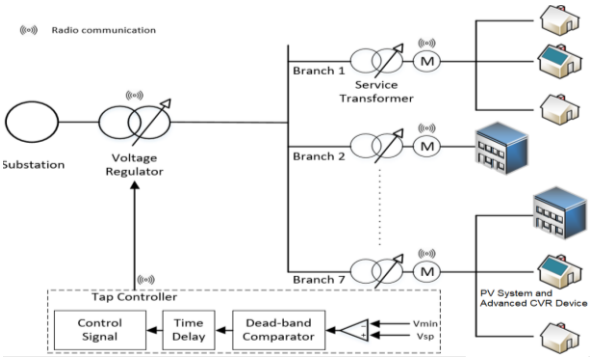

Figure 1. CVR demonstration system architecture.

PROJECT STATUS/RESULTS: 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 automated metering infrastructure (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.

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. Grid*START* 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.

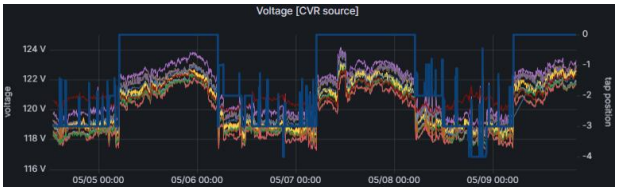

Figure 2. Voltage profiles with CVR on and off. The tap position (blue) at 0 indicates CVR is off.

In response to evolving cyber security requirements, the CVR system was separated from the USMC's AMI network. While the system faced challenges when typhoon Khanun caused a seven-month VR outage, operations have since resumed. Further maintenance issues were addressed with new hardware installed for the advanced CVR device during a planned feeder outage in October 2024. Moving forward, HNEI will focus on evaluating system coordination and analyzing CVR benefits across the various end-use load classes served by the project.

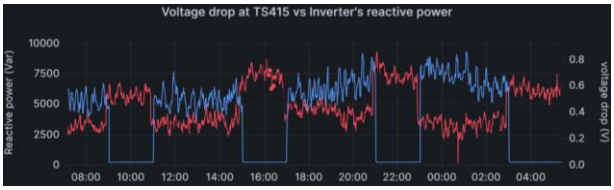

Figure 3. Voltage drop (red) is reduced when the advanced CVR controller is enabled, and reactive power (blue) is dispatched.

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