Hawai‘i Natural Energy Institute Research Highlights

Grid Integration & Renewable Power Generation

Advanced Real-Time Grid Energy Monitor System (ARGEMS)

OBJECTIVE AND SIGNIFICANCE: The objective of this project is to develop a low-cost device and system that can provide enhanced situational awareness that allows tighter, localized coordination of distributed energy resources (DERs), such as rooftop solar photovoltaics (PV). This is important for Hawai‘i because as power generation and ancillary services become more decentralized, there is a need for enhanced measurement, data analytics, and controls near the grid edge. Field devices, such as advanced meters, line sensors, and secondary reactive power (var) controllers are all part of the grid modernization strategy of the local Hawai‘i utility, and many utilities abroad. This project has the potential to provide significant advancements in these areas beyond the commercial state of the art.

BACKGROUND: Grid edge technology has the potential to relieve voltage constraints with local context-aware volt/var control, identify and help mitigate local thermal violations through energy and load shifting, provide data for more refined and readily updated PV hosting capacity analysis, identify power quality issues, such as harmonic distortion from increasing amounts of power electronic devices, and assist in fault location and anomaly detection, such as pending transformer failure and unmetered loads. This system offers a high-tech, flexible research-to-commercialization platform that can be programmed to support these use cases and more. It offers high-fidelity voltage and current measurement, numerous communications options, low-latency event-driven messaging, precise GPS-based timing, backup power supply, and powerful processing for real-time data analysis–all in a small weather resistant enclosure.

PROJECT STATUS/RESULTS: ARGEMS devices have been successfully deployed at UH Mānoa, Arizona State University, Chulalongkorn University (Thailand), and in Okinawa, Japan. The latest version is shown in Figure 1 and examples of analysis and visualization are shown in Figure 2.

Figure 1. ARGEMS devices prior to shipment.

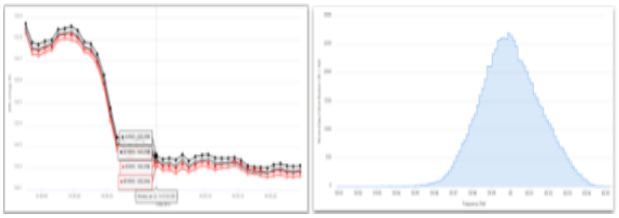

Figure 2. Analysis and visualization of real-time data.

A U.S. patent (#11,146,103) for the system was awarded to the University of Hawai‘i in October 2021. Discussions regarding potential use cases and demonstrations have been initiated with utilities in Hawai‘i, Alaska, and Thailand. The software stack is now well-documented and tested. Onboard power flow simulation capabilities have been established. Printed circuit board (PCB) design is well-refined. Commercial assembly indicated that costs are competitive with traditional distribution service transformer monitors.

The project has enabled and fostered new collaborations, funded research, and outreach. Research has included distributed volt/var control, optimal electric vehicle scheduling and charging, and novel methods of fault location. Fourteen undergraduate students and eight international interns have been involved in the project. The system has also been presented and shared through ThinkTech Hawai‘i, SOEST’s Open House, UH Sea Grant’s Voices of the Sea, IEEE Power and Energy Society, and Engineers and Architects of Hawai‘i.

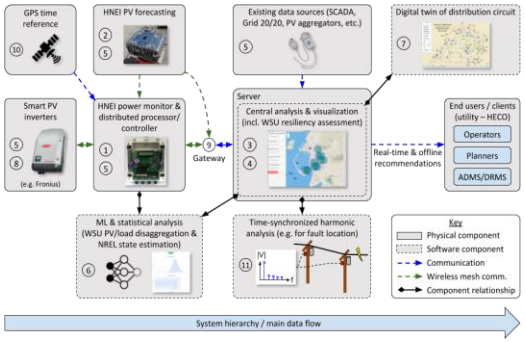

Figure 3. Application to real-time analytics and controls.

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Contact: Kevin Davies, kdavies@hawaii.edu

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