Hawai‘i Natural Energy Institute Research Highlights

Grid Integration & Energy Efficiency

Assessing Dynamic Response of Converter-Dominated Power Systems

OBJECTIVE AND SIGNIFICANCE: This project aims to develop local expertise in developing and validating modeling and control solutions for today’s power grid, which is increasingly integrating inverter-based resources (IBR). The overarching technical goal is to identify the type and detail of converter models required to accurately represent power system dynamical phenomena across multiple time scales for converter-dominated power systems (CDPS). The Hawai‘i power grid serves as an exceptional testbed for investigating the complex dynamics and transitional states between CDPS and the broader power grid. This positions the project as critically important for Hawai‘i, as it is poised to drive significant progress in these areas. The initiative strategically targets these complexities to enhance the stability, efficiency, and resilience of Hawai‘i’s power infrastructure, ensuring its readiness for the evolving demands of a sustainable energy future.

BACKGROUND: HNEI previously collaborated with the Natural Energy Laboratory of Hawai‘i Authority (NELHA) on their microgrid analysis project, which evaluated microgrid options for NELHA’s Hawai‘i Ocean Science and Technology (HOST) Park. The HOST Park features the world’s most extensive seawater distribution system, which relies heavily on converter-based generation and complex loads, including significant variable frequency drives (VFDs), photovoltaic (PV) arrays, and a hydrogen production facility equipped with a converter-driven electrolyzer (198 kW) and mobile storage of up to 300 kg of compressed hydrogen. These features make the HOST Park an ideal example of a CDPS integrated with the larger grid. NELHA agreed to collaborate with HNEI to use the HOST Park’s power system as the case study for this project. Key project tasks include: 1) installing new power quality meters and data collection, 2) generating, calibrating, and validating baseline models, and 3) using the models to study salient dynamics of converter-based generation and loads within the HOST Park power system.

PROJECT STATUS/RESULTS: HNEI, working closely with NELHA, developed a detailed single-line diagram of the HOST Park research campus microgrid (Figure 1). This allowed HNEI researchers to identify various distribution systems components, such as transformer sizes and their set-up, and VFD load information for water pumps and PV system components such as inverters and panels. Following this effort, HNEI pinpointed three critical locations and successfully deployed power quality meters on them, along with all necessary data acquisition components.

Figure 1. Overview of the NELHA HOST Park’s electrical load sections (schematic on Google Earth overlay).

Figure 2 shows the deployed equipment and the structure for data transfer, as well as the utilized software for data recording and analysis. A draft model of the NELHA research campus microgrid has been created in PowerFactory. Currently, HNEI is utilizing the gathered data to calibrate and fine-tune the model.

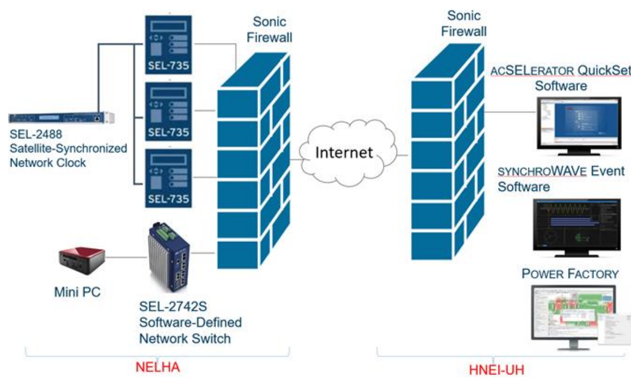

Figure 2. Overview of all installed equipment with data transfer infrastructure and associated software utilized for the project.

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