Hawai‘i Natural Energy Institute Research Highlights

Grid Integration & Renewable Power Generation

Coconut Island DC Microgrid

OBJECTIVE AND SIGNIFICANCE: HNEI is developing a DC-based microgrid on Coconut Island (Figure 1), home to the University of Hawai‘i’s Hawai‘i Institute of Marine Biology (HIMB), located in Kāne‘ohe Bay, O‘ahu. The project objective is to demonstrate and assess the reliability, resilience, and energy efficiency benefits of a DC microgrid serving two HIMB buildings. The system is intended to support critical building loads during grid supply interruptions and provide clean transportation options powered primarily by rooftop solar energy. The project results and lessons can be applied in future DC-based microgrids in Hawai‘i and abroad.

Figure 1. DC microgrid project site, Coconut Island.

BACKGROUND: Among HIMB’s goals is for the island and its research facilities to serve as a model for sustainable systems. Thus, it is an ideal site for a renewable energy technology-based microgrid test bed that represents a remote location vulnerable to energy disruption, yet serving mission critical power needs. Key project goals include: 1) adoption of innovative energy efficient and reliable clean energy technologies; 2) establishment of a research platform to study resilient DC microgrid technologies (e.g., microgrid controller, energy storage, DC powered appliances, etc.) in a tropical coastal environment; and 3) development of solar powered DC all-electric land (E-car) and sea (E-boat) transportation solutions.

International partnerships with the Okinawa Institute of Science and Technology (OIST), Japan, PUES Corporation (PUES), Japan, and University of Indonesia (UI), Indonesia are central to this project. A DC-powered e-car, e-boat (Figure 2), and portable emergency power source using a novel swappable battery energy storage system were co-developed with OIST and PUES. The swappable batteries used in these e-mobility solutions are supplied primarily by energy from a new 6.2 kW rooftop solar PV system coupled with an 8 kWh battery energy storage system (BESS). These energy resources, along with minimal grid power, also supply DC lighting, DC air conditioning, and building critical loads within the microgrid.

Figure 2. Collaborative e-boat and e-car development.

The partnership with UI has yielded a new version of a UI designed DC-DC converter (DCON) (Figure 3), which transforms the voltage of the PV and BESS 48 V DC bus to the 200-350 volts required by the various DC microgrid loads. The DCONs deployed and under test in this project are a significant advancement of predecessor technology earlier deployed in a UI sited DC microgrid.

Figure 3. University of Indonesia DCON devices.

PROJECT STATUS/RESULTS: The e-boat and e-car solutions are operational and under test and evaluation by HNEI’s Grid***START*** team. The 6.2 kW rooftop solar PV system and 8 kWh BESS are now installed and fully commissioned. While COVID-19 restrictions on project site-based work impacted progress from early 2020 through much of 2021, the remaining primary microgrid elements, including custom microgrid controls, electrical equipment such as the DCONs, switches, protection, metering, wiring, and all DC loads, are currently being installed and commissioned. Full DC microgrid operation is anticipated in Q1 2022.

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