Hawai‘i Natural Energy Institute Research Highlights

Grid Integration

Coconut Island DC Microgrid

OBJECTIVE AND SIGNIFICANCE: HNEI's Grid System Technologies Advanced Research Team (Grid*START*) has developed a DC-based microgrid test bed on Coconut Island, home to the University of Hawai‘i's Hawai‘i Institute of Marine Biology (HIMB). This project aims to demonstrate and assess the reliability, resilience, and energy efficiency of a DC microgrid serving two HIMB buildings. It will compare the efficiency of powering lighting, cooling, and plug loads with AC versus DC electricity during normal operations. Additionally, the microgrid will support critical building loads during grid supply interruptions and provide clean transportation options, such as an electric boat powered primarily by rooftop solar energy. The findings from this project can inform future DC-based microgrids in Hawai‘i and beyond.

Figure 1. DC microgrid project site, Coconut Island.

BACKGROUND: HIMB aims to serve as a model for sustainable systems, making it an ideal location for a microgrid test bed focused on renewable energy technology. Key objectives include implementing innovative and efficient clean energy technologies, creating a research platform for resilient DC microgrid technologies in a tropical coastal environment, and advancing solar-powered transportation solutions.

PROJECT STATUS/RESULTS: HNEI collaborated with the University of Indonesia (UI), which designed a new DC-DC converter (DCON) that transforms the voltage from the photovoltaic (PV) and battery energy storage system (BESS) 48 V DC bus to the 200-350 volts needed for various microgrid loads. The microgrid powers DC lighting, DC air conditioning, refrigeration, and other high-priority critical loads with minimal reliance on the grid, even during peak demand.

All components of the DC microgrid system have been successfully installed and commissioned in a dedicated electrical room. This room contains essential electrical components such as switches, breakers, controls, a BESS, DC-DC converters, and associated wiring. The 6.2 kW rooftop solar PV system and 8 kWh BESS have been seamlessly integrated into the DC microgrid. With the system controller properly programmed, the DC microgrid is fully operational and undergoing performance testing across a range of scenarios, including providing resilient energy supply to critical load centers in islanded mode.

Figure 2. DC microgrid components in the dedicated electrical room (left) and system's controller box (right).

HNEI Grid*START* upgraded the system with significant improvements. A real-time monitoring dashboard was developed for 24/7 on-site monitoring. The electric boat's performance was improved by upgrading to 18.2 kWh fixed batteries from 11.2 kWh swappable ones, while additional rooftop PV panels increased its charging capacity. To further improve resiliency, plans are underway to add bidirectional charging capability for the electric boat, which is expected to increase the microgrid's generation capacity by about 30% and triple its storage capacity. Initial lab tests for this unique functionality have been successfully completed.

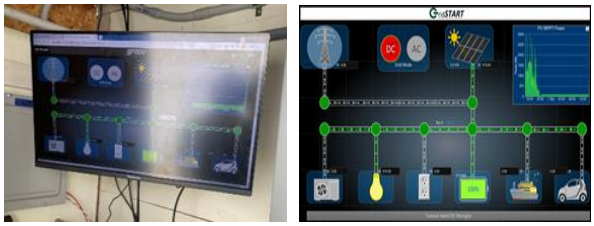

Figure 3. On-site dashboard and its screen.

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