Hawaiʻi Natural Energy Institute Research Highlights

Grid Integration & Energy Efficiency

Coconut Island DC Microgrid

OBJECTIVE AND SIGNIFICANCE: HNEI has developed a DC-based microgrid test bed on Coconut Island (Figure 1), home to the University of Hawaiʻi's Hawaiʻi Institute of Marine Biology (HIMB). The project aims to demonstrate and assess the reliability, resilience, and energy efficiency benefits of a DC microgrid serving two HIMB buildings. It will compare the efficiency of serving lighting, cooling, plug loads, and EV charging with AC versus DC supplied power during normal operations. It will also 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 Hawaiʻi and abroad.

Figure 1. DC microgrid project site, Coconut Island.

BACKGROUND: HIMB aims to serve as a model for sustainable systems, making it an ideal site for a microgrid test bed centered around renewable energy technology. This test bed will exemplify a remote area susceptible to energy disruptions while fulfilling critical power requirements. The project's key objectives encompass: 1) implementing innovative, efficient, and reliable clean energy technologies; 2) creating a research platform for studying resilient DC microgrid technologies in a tropical coastal environment; and 3) advancing solar DC-powered transportation solutions, both on land (e-cars) and at sea (e-boats).

HNEI's Grid System Technologies Advanced Research Team (Grid*START)* partnered with the Okinawa Institute of Science and Technology, Japan and PUES Corporation, Japan to develop a DC-powered e-car and e-boat (Figure 2), and portable emergency power source, all using swappable batteries. The e-mobility solutions are charged with solar energy from a 6.2 kW rooftop solar PV system coupled with an 8 kWh battery energy storage system (BESS). HNEI Grid*START* also collaborated with the University of Indonesia (UI). UI designed a new DC-DC converter (DCON) that 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 microgrid provides DC lighting, DC air conditioning, refrigeration, EV charging, and power for critical building loads, with minimal reliance on the grid during peak demand times.

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

PROJECT STATUS/RESULTS: The DC microgrid system located in a dedicated electrical room has been successfully installed and commissioned (Figure 3). This room houses numerous electrical components, including 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 for operation within the DC microgrid. With the system controller in place and properly programmed, the DC microgrid is now fully operational and undergoing performance testing across a range of scenarios, including resilient supply of energy to critical load centers in islanded mode.

HNEI Grid*START* is using the established microgrid infrastructure and operational data being collected as a pilot site to initiate extended microgrid research endeavors and associated new funding opportunities.

Figure 3. DC microgrid components in a dedicated electrical room (left) and system's controller box (right).

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