Hawai‘i Natural Energy Institute Research Highlights

Grid Integration & Renewable Power Generation

Dynamic Load Bank for Islanded Grid Solutions

OBJECTIVE AND SIGNIFICANCE: Under this joint project between HNEI and Maui Electric Company (MECO) a custom controlled Dynamic Load Bank (DLB) was deployed with the objective of demonstrating a reliable and inexpensive means to prevent the baseload diesel generators from operating below their minimum dispatch level during periods of high solar generation. The system enabling the grid connection of additional rooftop PV on Moloka‘i island, beyond that originally allowed by the utility. Continuing research in controls is intended to deliver additional grid value from this asset, such as rapid response to system dynamic events. Project lessons will support enabling high penetration of distributed PV systems on microgrids and island power systems.

BACKGROUND: Among the challenges faced by utilities to integrate very high levels of rooftop solar PV on isolated island grids is maintaining a minimum reliable operating level of diesel generators during times of high PV production. High PV production can force generators below their required minimum operating point, with the uncontrolled “excess energy” produced by the PV systems degrading grid reliability and operating risk to unacceptable levels.

Moloka‘i reached its system-wide rooftop PV hosting capacity in 2015, resulting in a 700 kW queue of new customer applications for rooftop PV. Analysis showed that the potential for excess energy production by proposed rooftop PV systems held in the queue would occur very infrequently. By absorbing a mere 3.9 MWh of excess solar energy with the DLB, additional annual production of a significant 1.1 GWh of clean solar energy is enabled, with a commensurate reduction in fossil energy use.

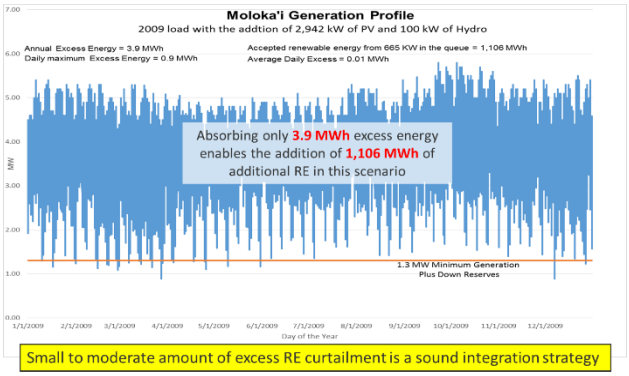

Figure 1. Analysis showing infrequent events of rooftop PV annual excess energy production requiring mitigation by the DLB.

Functioning as a grid “safety valve” to manage infrequent events of excess solar energy production, the DLB solution allowed the grid connection of approximately 100 new customer-sited rooftop PV systems at a cost far below that of energy storage, while ensuring adequate operating reserves and grid stability on the island. The installed DLB and its controller are shown in Figure 2.

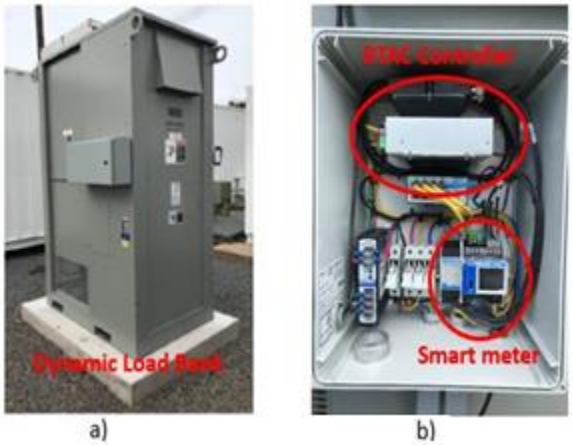

Figure 2. a) The DLB installed at MECO power plant on Moloka‘i; b) RTAC controller with the smart meter used for tests.

PROJECT STATUS/RESULTS: DLB control algorithms for excess energy absorption were developed, lab tested, and validated via grid simulation. The DLB system was then installed, tested, and placed in service at the MECO power plant on Moloka‘i. Successful operation of the DLB allowed 700 kW of new customer-sited distributed PV to be grid tied, following a 3-year period of no new PV system additions. HNEI Grid***START*** is continuing its valued partnership with MECO to develop additional grid stabilizing control algorithms that can rapidly react to system disruptions, such as sudden loss of generation or load rejection events. Stacking added functionality such as automatic frequency response will increase both utility and customer value return on the very modest investment in DLB technology.

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