Hawai‘i Natural Energy Institute Research Highlights

Grid Integration

Dynamic Load Bank for Islanded Grid Solutions

OBJECTIVE AND SIGNIFICANCE: A joint HNEI Grid***START*** and Maui Electric Company project deployed a custom controlled Dynamic Load Bank (DLB) to deliver a practical, reliable and inexpensive means to prevent the baseload diesel generators from operating below their minimum dispatch level while enabling the grid connection of significantly more rooftop PV on Moloka‘i island. Extended research in DLB controls development was aimed 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 that could not be grid connected. HNEI Grid***START***’s 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, annual production of a significant 1.1 GWh of solar energy is enabled (with a commensurate reduction in fossil energy use).

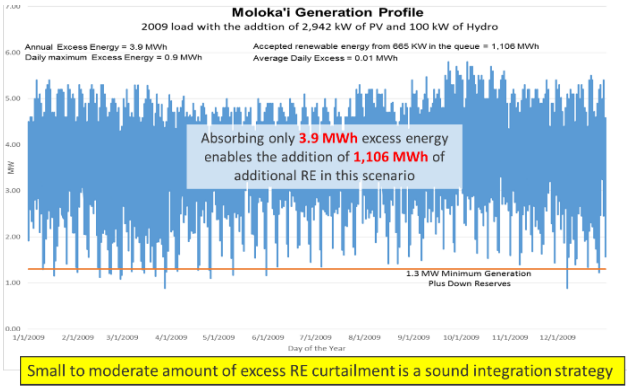

Figure 1. Analysis showing infrequent events of rooftop PV annual excess energy production requiring mitigation by the DLB.

In contrast, investment in a battery energy storage system to capture the 3.9 MWh of excess solar energy production annually is not economically justified. Functioning as a grid “safety valve” to manage infrequent events of excess solar energy production, the low-cost DLB solution allows the grid connection of approximately 100 new customer-sited rooftop PV systems while ensuring adequate operating reserves and grid stability on the island. The installed DLB and its controller are shown in Figure 2.

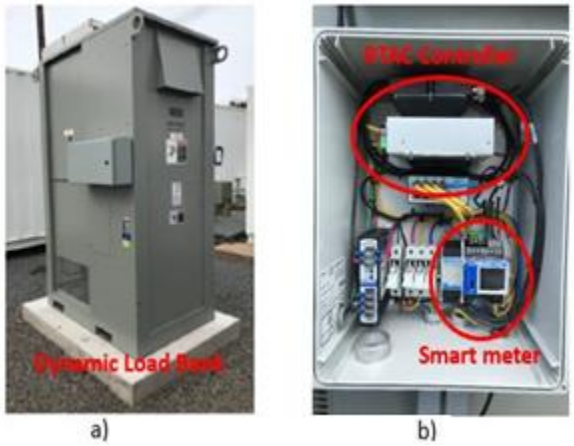

Figure 2. a) The DLB installed at Maui Electric Company power plant on Moloka‘i; b) RTAC controller with the smart meter used for tests.

PROJECT STATUS/RESULTS: Control algorithms for excess energy management enabled 725 kW of additional distributed PV on Moloka‘i. Field tests showed the DLB could support fast frequency response, with frequency readings accurate to ±0.1 Hz and mean communication latency of 450 ms, potentially improvable with protocol changes. However, since the existing BESS already provided sufficient grid stability and engineering resources were limited, further DLB integration was not pursued. HNEI Grid***START*** values its partnership with Maui Electric Company, Ltd. (MECO, currently Hawaiian Electric Company, Inc.) in advancing renewable energy and providing Moloka‘i residents with a cleaner energy future.

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