Hawai'i Natural Energy Institute Research Highlights

International Support

Developing Renewable Energy Storage System for the Pacific Island Countries

OBJECTIVE AND SIGNIFICANCE: HNEI via its Grid System Technologies Advanced Research Team (Grid*START*) is providing technical assistance under contract to the World Bank for its *Developing Renewable Energy Storage System for the Pacific Island Countries (PICs)* project. The project objective is to support eleven PICs, namely Fiji, Kiribati, the Republic of Marshall Islands (RMI), Federated States of Micronesia (FSM), Nauru, Palau, Samoa, Solomon Islands, Tonga, Tuvalu, and Vanuatu, in designing a regional Battery Energy Storage Systems (BESS) policy framework and guidelines with underlying technical/commercial assessments for each PIC to support private sector participation in BESS development.

BACKGROUND: The PICs, each of which have set high power sector renewable energy (RE) penetration targets, face challenges inherent with the integration of RE resources on isolated island systems including addressing energy insecurity and price volatility due to heavy reliance on costly imported fossil fuels, challenging grid operations with related system reliability impacts, and increasing threats to energy resilience due to climate change. Energy storage systems, BESS in particular, will be key in achieving high RE penetration targets and mitigating PIC energy challenges ahead.

For PIC island grids, estimating grid-wide BESS requirements (i.e., aggregate BESS capacity (MW) and energy (MWh)) as a function of increasing variable renewable energy (VRE) penetration, can generally be grouped into four sequential phases of increased BESS deployment: 1) ~0-20% VRE, for grid services and renewable enablement; 2) ~20-30% VRE, for generation capacity deferral and/or fossil unit retirement; 3) ~30-70% VRE, for excess RE curtailment mitigation via energy shifting; and 4) ~70-90+%, for long duration energy shifting.

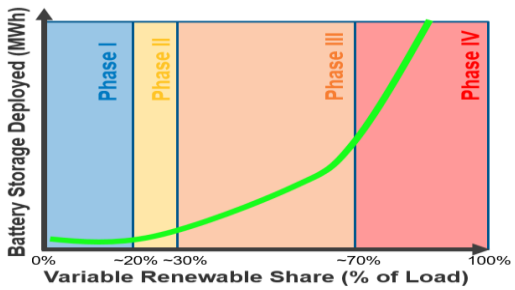

Figure 1. 4 phases of BESS deployment on island power grids.

In phase IV, island grid systems may be able to reach very high RE penetration levels without long duration storage if they have available firm RE resources (e.g., dispatchable hydro, biomass, geothermal, etc.). However, riding through inevitable multi-day events of low energy production by VRE resources requires a tremendous amount of energy storage in the absence of firm generation. As a consequence, the amount of BESS needed in a system and its associated costs increase exponentially as VRE penetration approaches 100%.

PROJECT STATUS/RESULTS: To assess policy-related, technical, and commercial aspects of BESS development in the PICs under this project, HNEI partnered with contractor Delphos International, undertaking three Tasks: 1) reviewing regional BESS policy frameworks and technical guidelines; 2) developing technical and commercial assessments for the private sector's participation in BESS under public-private partnerships (PPPs) and auction arrangements; and 3) designing PICs' BESS development roadmaps.

As part of Tasks 1 and 2, staff from HNEI's Grid*START* developed a spreadsheet-based model to evaluate alternative build-outs of VRE resources (solar and wind) for each PIC, along with necessary BESS capacity and energy needs to achieve increasing RE targets without excessive curtailment of RE produced. In Task 3, HNEI created a roadmap for the deployment of BESS in three specific countries (FSM, RMI, and Tuvalu) and assessed how the electrification of transportation in each country may impact the BESS and VRE needs evaluated in Tasks 1 and 2. Final reports were submitted to the World Bank in November 2022 and are available at https://www.hnei.hawaii.edu/publications/technical-reports.

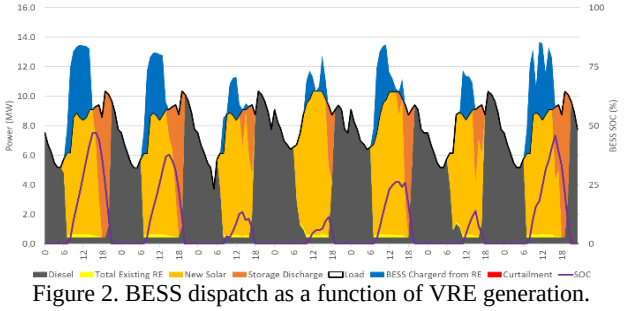

Figure 2. BESS dispatch as a function of VRE generation.

Funding Source: World Bank

Contact: Leon Roose, lroose@hawaii.edu

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Hawai'i Natural Energy Institute | School of Ocean & Earth Science & Technology
University of Hawai'i at Mānoa, 1680 East-West Road, POST 109 • Honolulu, HI 96822
Phone: (808) 956-8890 • Fax: (808) 956-2336 • www.hnei.hawaii.edu