FINAL TECHNICAL REPORT

Executive Summary

Asia Pacific Research Initiative for Sustainable Energy Systems 2023

Office of Naval Research

Grant Award Number N000142412397

July 1, 2024 through May 12, 2025

HNEI
Hawaiʻi Natural Energy Institute
University of Hawaiʻi at Mānoa

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EXECUTIVE SUMMARY

This report summarizes work conducted under Grant Award Number N000142412397, the Asia Pacific Research Initiative for Sustainable Energy Systems 2023 (APRISES23), funded by the Office of Naval Research (ONR) to the Hawaiʻi Natural Energy Institute (HNEI) of the University of Hawaiʻi at Mānoa (UH). The work conducted under APRISES23 was intended to comprise research, development, testing, and evaluation (RDT&E) over a range of technical areas. These included: Alternative Fuels including marine fuels and hydrogen, and Resilient Energy Systems including development and demonstration of novel technologies for advanced smart microgrids, resource adequacy studies for the Hawaiʻi electrical grids, and expansion of reliability and resilience efforts to the broader Asia Pacific region initiated under the Asia Pacific Regional Energy System Assessment (APRESA) program (ONR N00014-17-1-2923). We also proposed that Makai Ocean Engineering, under subcontract to the University of Hawaiʻi, continue their efforts to develop high-performance, low-cost heat exchangers. However, due to a work stop order on May 12, 2025, funds were expended only in the areas of hydrogen and grid technology. A brief summary of results by area follows.

Under the "Alternative Fuels" task, HNEI utilized APRISES23 funding to complete a control software overhaul of the hydrogen dispenser, replace the primary control board of the electrolyzer, and implement power monitoring systems. Additionally, the team responded to the loss of technical support from one of our partners and tackled key planning efforts for the shutdown and transfer of hydrogen station assets. Briefings, tours, community engagement, and public outreach activities were also carried out.

Under the "Resilient Energy Systems" task, HNEI built on prior work exploring distributed energy resources, grid-edge controls, and electric vehicle (EV) integration to improve grid performance and cost effectiveness. This research, conducted by HNEI's Grid System Technologies Advanced Research Team (Grid***START***), continued efforts to extend the bidirectional EV charging demonstration project into the residential context through technoeconomic analysis. A limited effort to provide technical support for island utilities in the Asia Pacific region, established under the APRESA program, also occurred with APRISES23-funded activities focused on the Cook Islands and Palau. This work centered on the application of advanced modeling tools and

techniques, training workshops, and engagements with utilities and its energy regulators to strengthen host-country capabilities in system analysis, policy and regulation, and planning for small island grids in the context of maintaining secure energy systems during rapid energy transitions.

The bidirectional EV charging demonstration project at the University of Hawai‘i at Mānoa includes two advanced bidirectional chargers with novel control algorithms developed to optimize EV charge/discharge cycles for cost savings, fleet management, and potential grid services. Under APRISES23, detailed technoeconomic modeling was applied to a representative residential community with a total household load of 400 kW and assumed participation of fifteen EVs. Seven scenarios were simulated under three time-of-use (TOU) rate structures, ranging from baseline operation to combinations of PV, stationary storage, smart charging, and bidirectional EV integration. Results showed that while unidirectional charging provided modest cost benefits, bidirectional charging coupled with PV resources consistently achieved the largest reductions in electricity costs, in some cases exceeding 20% monthly savings under TOU tariff conditions. These findings underscore the potential of flexible, intelligently managed EV charging to provide significant household economic benefits.

Funding under HNEI’s APRESA program established the relationship framework for energy transition support and previous collaboration with Te Aponga Uira (TAU), the utility serving Rarotonga. Utilizing APRISES23 funds, HNEI introduced the Scenario Analysis Interface for Energy Systems (SAInt) modeling platform to TAU, facilitating its first integrated platform capable of production cost modeling combined with transmission and distribution power flow analytics. Preliminary scenario analyses evaluated the role of battery energy storage systems (BESS), demonstrating opportunities to reduce costs, limit curtailment of excess PV energy production, and use of storage as reserves.

In Palau, building on past work performed under APRESA, this award enabled the launch of a detailed PV hosting capacity study focused on the “Airport Feeder” of the Palau Public Utilities Corporation (PPUC) distribution system. This modeling effort provided a technical foundation for identifying integration limits and evaluating additional PV deployment scenarios.

This final report describes the research completed under each of these areas. Publications produced through these efforts are noted below and available on HNEI’s website at https://www.hnei.hawaii.edu/publications/project-reports/aprises-23/.