Hawai‘i Natural Energy Institute Research Highlights

Grid Integration & Energy Efficiency

Maui Near-Term Reliability and Kahului Retirement Analysis

OBJECTIVE AND SIGNIFICANCE: The Kahului Power Plant (KPP) was once scheduled to retire by the end of 2024, but delays in procurement and construction of replacement resources have pushed that date back to 2027. In addition, the Mā‘alaea M10-M13 diesel generators have been identified for retirement in 2027 due to lack of replacement parts. Both units will need to be retired due to emissions compliance and air permitting regulations. The objective of this study was to update the 2021 and 2022 analysis and reevaluate Maui reliability if one or both of the plants are retired and evaluate potential mitigations necessary to preserve system reliability. The results of this analysis were briefed in 2022 to the Hawai‘i Public Utility Commission (PUC) and the Maui Accelerating Clean Energy & Decarbonization Technical Working Group (ACET) and are expected to have important implications for power system planning and policy for Maui.

KEY RESULTS: Stochastic analysis, using the tools developed by the HNEI-Telos Energy team, was conducted. It was found that either the KPP or M10-13 retirements without deployment of other generation sources would significantly reduce system resource adequacy as measured by loss of load expectation (LOLE). However, the analysis showed that partial deployment of proposed hybrid solar + storage projects would improve system reliability compared to current reliability levels, but that additional resources beyond the 80 MW currently under construction will be necessary to meet reliability requirements if both plants are retired.

The number and size of proposed replacement projects, the retirement timeline, and the ability to extend KPP and/or M10-M13 operation, if necessary, makes the reliability risk on Maui less acute than the situation on O‘ahu, but time is running out for new replacement resources to be available in time.

BACKGROUND: KPP is a 36 MW steam oil power plant located in Kahului, Maui. It is comprised of four separate steam oil generators and is over 72 years old. Maui Electric Company (MECO) has frequently proposed retirement of the plant over the past decade, but had not been able to develop and procure replacement resources due to project delays and regulatory limitations. Currently, there is a proposed transition plan by the utility comprising deployment of utility scale solar + storage hybrid resources and upgrades to the transmission system. According to Hawaiian Electric (HECO):

“The KPP Transition Plan has several key components: (1) the Stage 1 and Stage 2 RFP projects will provide capacity and energy replacement and grid services; (2) the K3 and K4 generating units of KPP will be converted and repurposed to synchronous condensers to replace critical voltage support service and synchronous inertial response provided by KPP, among other essential grid services; (3) the Waena Switchyard project will maintain functionality and reliability of the transmission system serving Maui in the absence of KPP, avoid circuit overloads, and reliably integrate new renewable resources; and (4) contingency plans that include DER grid service programs and a review of generator maintenance schedules as needed.”[1]

The retirement of KPP has been planned for several years and in 2021 HNEI conducted a detailed evaluation of its replacement with the proposed Stage 1 and Stage 2 solar + storage projects. These projects included 135 MW of solar with 540 MWh of storage, along with a 40 MW, 160 MWh standalone battery in Waena. Projects were originally anticipated to come online between 2022 and 2023, but project delays and supply-chain constraints have occurred – cancelling some projects and pushing online dates back to 2024 or potentially 2025. Additional projects being proposed face growing community opposition and increased project costs. The Lahaina wildfire and reconstruction efforts may also further challenge new replacement resources.

In addition, since the reliability analysis conducted in 2021, HECO was notified replacement parts may no longer be available for the M10-M13 diesel units. According to the manufacturer, “the engines have manufactured for more than about 40 years ago, some engine-related parts might no longer be available for supply due to the business closing at our suppliers and if there is no alternative way to produce parts anymore. So in that case we will officially inform you that the parts cannot be supplied as an response to your each RFQ.”[2]

[1] HECO Kahului Power Plant Transition Plan, April 5, 2021, Docket No. 2021-0024.
[2] HECO letter to the PUC, March 21, 2022, Docket No. 2021-0024.

HECO notified the PUC that they only have parts on hand to service the units through the first half of 2024. After that date, HECO anticipated a potential end of life around 2025-2026. Given the project delays and uncertainty in the Stage 1 and 2 solar + storage projects and the uncertainty in the future of KPP and M10-13 generating units, HNEI was asked by the Commission to reevaluate grid reliability on Maui in 2022.

HECO's final Integrated Grid Planning (IGP) Inputs and Assumptions were finalized after the 2022 analysis was completed. As such, HNEI completed a reevaluation of the retirement plans with new load growth forecasts as an input into the efforts to assess load flexibility on Maui. This 2023 analysis was largely consistent with earlier analyses and identified portfolios of resources capable of replacing the aging fossil fuel generators.

Since this analysis was completed, wildfires on Maui have devastated the community and focused attention on the utility's plans for the future.

PROJECT STATUS/RESULTS: To assess the reliability (specifically resource adequacy) of the Maui system with the KPP and M10-13 retirement and replacement solely with variable renewable energy and energy storage, HNEI and Telos Energy conduced a resource adequacy analysis. This process was utilized by HNEI throughout 2021-2023 and recently adopted by HECO. It utilizes sequential Monte Carlo probabilistic modeling which incorporate 22 years of chronological solar data, 8 years of chronological wind data, and hundreds of samples of thermal generator outages. This is the same probabilistic methodology used to evaluate the AES coal plant retirement on O'ahu.

Grid simulations were conducted across seven scenarios with assumptions on load, DER integration, and other system details derived from HECO's IGP assumptions for the year 2026. The Reference Point scenario assumed the current grid's resource mix, including KPP and M10-13, without additional retirements or new solar resources. Three additional scenarios were evaluated; 1) with KPP retired, 2) with M10-13 retired, and 3) with both KPP and M10-13 retired. This evaluated retirement levels between 33 MW and 82 MW.
This analysis was similar in nature to the work conducted in 2021 and 2022, but was updated in 2023 to reflect recent cancellations and delays in Stage 1 and Stage 2 replacement resources as well as recent changes to the Maui load forecast.

Each of these scenarios was evaluated without any replacement resources, and across a range of solar + storage replacements from 20 MW to 180 MW, using equal 20 MW tranches of new resources. In addition, the matrix of cases was conducted with and without the 40 MW Waena standalone battery system, which has not yet received Commission approval. A chart of the installed capacity evaluated in the Reference Scenario, the retirement scenarios, and the replacement scenarios is provided in Figure 1.

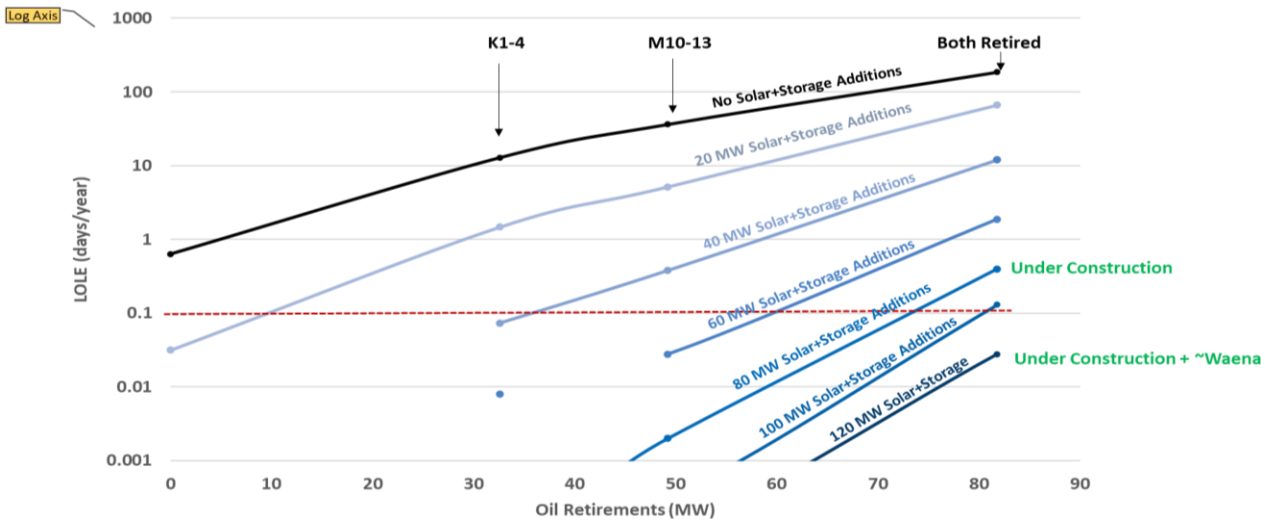

Figure 1. Loss of Load Expectation with oil retirements and solar + storage replacement.

Each case was analyzed across 506 random samples (replications) of chronological dispatch, representing 22 years of weather data (23 solar, 8 wind) and 22 outage profiles per weather year (506 total). The output of the analysis included the number, the magnitude, and the duration of the capacity shortfall events that occur when there are not enough available resources to serve load.

Results of the analysis are provided in Figure 2 with which shows the total amount of capacity retirements (MW) on the x-axis, and the loss of load expectation (LOLE, days per year) on the y-axis (note log axis). Loss of load expectation measures the number of days in the year where the Maui power system would have insufficient resources to meet demand, thus requiring emergency measures or rolling blackouts. Each dot measures the overall system reliability under a given assumption of thermal retirement (K1-4, M10-13) and solar + storage replacement. Contour lines are provided to allow interpolation across a range of retirement and replacement options.

This probabilistic approach – evaluated across a range of both retirement and replacement resource options – clearly shows the relationship between retirement and required replacement resources to allow for easy interpretation as timelines shift.
These results indicate that with the K1-4 retirement in isolation (-33.5 MW), any combination of 40 MW of solar + storage or standalone storage resources brings the system back to its current level of reliability (i.e. a near 1-1 replacement of oil with solar + storage). The retirement of M10-13 in isolation (-50 MW), would require more replacement resources, between 40 and 60 MW – again a near 1-1 replacement. With both oil plants retired (-81.8 MW), between 80 and 100 MW of replacement solar + storage capacity would be required to maintain reliability. This highlights that full deployment of the under-construction hybrid solar + storage resources plus additional resources would be required to meet current system reliability levels.

Another way to visualize the data, shown in the Figure 2, isolates the reliable scenarios for replacement. This visualization makes the gap more apparent between the resources currently under construction and the resources needed to retire both units.

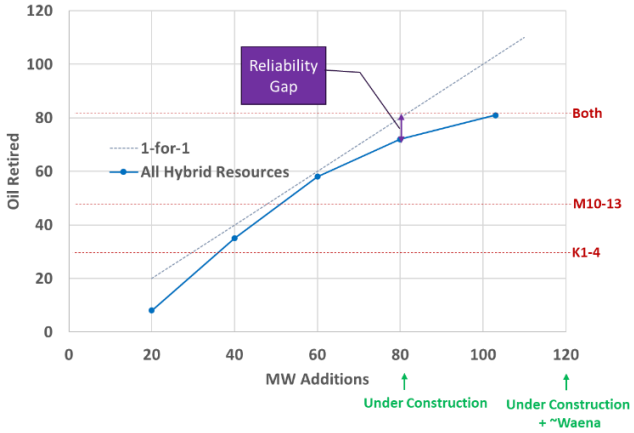

Figure 2. Reliability Frontier for retirement of oil units and additions of new resources.

There are options available to get to a reliable system with both units retired, including simply constructing more hybrid units, which are currently being tendered in HECO's Stage 3 procurement process, building the proposed 40MW Waena BESS (which was selected in the Stage 1 solicitation but does not yet have regulatory approval), adding load shifting or customer-sited resources (such as the Grid Services RFP), or other sources of generation.

In 2022 and early 2023, these results were shared with the PUC, HECO, and the Maui ACET to support ongoing planning in the state and continued monitoring of Stage 1 & 2 replacement schedules. The HNEI-Telos team plans to continue updating and refining the analysis given changes to procurement schedules, changes to load, and other system developments. Results of this work will be presented to key stakeholders when it is relevant to do so.

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