Hawaiʻi Natural Energy Institute Research Highlights

Energy Policy & Analysis

Grid Reliability with AES Retirement

OBJECTIVE AND SIGNIFICANCE: The AES Hawaiʻi coal plant, the largest power plant on Oʻahu, is scheduled to retire in 2022. This retirement will decrease the amount of dispatchable fossil capacity available to the utility by more than 10%. The objective of this ongoing study is to evaluate the ability of proposed solar + storage resources to provide the required energy needed while also maintaining grid reliability with the pending AES coal plant retirement. The results of this analysis have been briefed to the Hawaiʻi Public Utility Commission (PUC), the utility, and other stakeholders. Ongoing work is presented as part of the Governor's "Powering Past Coal" task force. The results of this work are expected to have important implications for power system planning and policy for Oʻahu.

KEY RESULTS: Stochastic analysis, using the tools developed by the HNEI-Telos Energy team and reported last year, are being used to assess capacity reliability risks associated with the AES retirement, updates for utility plans, and possible impacts due to delays in project schedules. Analysis shows that deployment of the Stage 1 solar + storage systems along with a small fraction of the Stage 2 projects would maintain or even improve risk relative to current operations, but that timing of resource additions is critical. Stand-alone storage, demand response (DR) and behind-the-meter solar with storage (DER) similarly reduces risk.

As a result of delays in Stage 1 deployments, HECO has proposed to restructure their planned outage schedules for the critical months of September - November 2022. The HNEI-Telos Energy analysis shows this to be an effective means to mitigate risk although some amount of additional resources (~40 MW) would still be required to achieve the same capacity reliability as found in current operations. Based on the latest (November 2021) projections for Stage 1 deployments, utility plans for rescheduled maintenance, and the PUC's emergency DR program, current plans appear adequate to transition through the retirement of the coal plant. However, with ever-changing delivery schedules due to both local issues, such as interconnection requirement studies, permitting, and global shipping delays, this work is ongoing and will continue until sufficient resources are deployed to ensure capacity needs are met.

BACKGROUND: As the Hawaiʻi grid transitions to renewables including higher percentages of variable renewable energy, these new resources are required to provide not only energy, but also to provide capacity and other grid services currently provided by fossil generation. Current utility plans call for combining solar with battery storage resources allowing solar energy to be shifted from the middle of the day, when there is surplus renewable generation, to other times of the day including the evening peak-load hours that occur after the sun has set. The inclusion of storage into these systems offers the opportunity for them to provide grid services, one of which is capacity – or the ability to provide energy when it is required for reliability. The first test of this strategy revolves around the pending retirement of the AES coal plant in September 2022.

The AES coal plant is an independent power producer with a long-term Power Purchase Agreement (PPA) with Hawaiian Electric Company (HECO) that expires in 2022. SB 2629 enacted in 2020 bans coal-fired generation in Hawaiʻi after 2022, ensuring the AES retirement. The objective of this ongoing study, requested by the PUC, is to evaluate the ability of the planned Stage 1 and Stage 2 utility scale solar + storage plants to provide the capacity resources needed to ensure reliable grid operations once the AES coal plant is retired.

The Stage 1 solar + storage projects were originally proposed to be completed in 2022, prior to or concurrent with the AES retirement. However, as of November 2021, several of these projects are encountering delays, pushing their delivery dates to beyond the legislatively mandated AES coal facility retirement.

Beyond the Stage 1 projects, an additional 274 MW of solar with 1,223 MWh of battery storage plus a 185 MW, 565 MWh stand-alone battery energy storage project to be located in Kapolei was awarded in the Stage 2 RFP. While the Stage 2 projects would provide significant capacity, they are not expected to be online until the end of 2022 or later.

Novel "Stochastic Modeling" methodologies, developed by HNEI and Telos Energy and summarized in HNEI's 2020 report to the legislature, that accurately account for the chronological operations of storage, solar variability, and generator outages are being utilized to determine if the proposed solar + storage systems can maintain reliability when AES is retired. These models are being used to identify key timelines as well as to assess the viability of other mitigating measures such as DER and the proposed rescheduling of HECO generator maintenance.

PROJECT STATUS/RESULTS: The stochastic methodology previously described is being used to evaluate the reliability the O‘ahu grid, following the AES coal plant retirement assuming different buildouts of utility-scale solar + storage resources. Each case is analyzed across 1,008 random draws (replications) of chronological dispatch, representing 21 years of solar data and 48 unique outage profiles for each year of solar data. The output of each analysis includes the number (probability), the magnitude, and the duration of capacity shortfall events that might occur when there are not enough available resources to serve load. This methodology was repeated across eight cases, one of which represents the current system (Base Case), one with AES retired without any replacement capacity, and the six additional cases with AES retirements and incremental additions of solar + storage resources up one representing the full buildout of recently awarded Stage 1 and Stage 2 projects (426 MWac of solar with 1,833 MWh of battery storage).

This analysis was conducted with and without the proposed adjusted maintenance schedules to understand the reliability benefits of HECO’s proposal to limit planned generator maintenance during the peak reliability risk window from September 2022 through the end of the year.

The matrices in Figure 1 below summarize the number of hours of unserved energy for two representative cases, the Base Case, and a case assuming the AES retirement and full build out of the Stage 1 projects. For each case, the numbers shown in the matrix represent the hours of unserved energy from a subset of the 1008 random draws of solar and unit outages are shown. As the matrices indicate, many draws do not have any capacity shortfall events. On average, the number of hours with outages increases by 82% when AES is retired and only replaced with Stage 1 resources.

For each case, the outage rates of all 1008 random draws are summarized into a single metric, the average loss of load expectation (LOLE) value. Additional metrics such as loss of load hours (LOLH), which summarizes the average number of hours per year; and expected unserved energy (EUE), which provides an average amount of unserved energy (MWh) per year are also obtained in this analysis. Figure 2 on the following page shows the average LOLE for each of the eight cases. LOLE (y-axis) is plotted against increasing solar + storage

Outage Draws (columns) / Solar Years (rows)

Solar Year	1	2	3	4	5	6	7	8	9	10	11	12
1998	0	0	5	0	0	0	0	0	0	2	0	3
1999	0	0	6	0	0	0	0	0	2	0	18	0
2000	0	0	0	2	0	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	2	0	0	0	1
2003	0	2	3	0	0	3	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	1	0	0	0	0	0
2006	0	0	0	0	0	0	2	0	0	0	0	0
2007	0	0	0	0	0	0	0	0	0	0	0	0
2008	0	0	0	0	0	0	0	0	0	0	0	0
2009	0	0	0	0	0	0	0	0	4	0	0	0
2010	0	0	0	0	0	0	0	0	0	0	0	0
2011	3	0	0	0	0	0	0	0	1	0	0	0
2012	0	0	0	0	0	0	0	0	0	0	0	0
2013	0	0	1	0	0	2	2	0	0	0	0	11
2014	0	0	1	0	0	0	0	3	0	0	0	0
2015	0	0	0	0	0	0	3	0	0	0	1	0
2016	0	0	0	0	0	0	3	0	0	0	0	3
2017	0	0	0	0	0	0	0	0	0	0	0	0
2018	0	0	0	0	0	0	0	1	0	0	0	0

Base Case

Solar Year	1	2	3	4	5	6	7	8	9	10	11	12
1998	0	0	10	3	0	0	2	0	3	6	0	0
1999	2	0	9	0	3	0	0	0	0	0	3	0
2000	0	0	0	0	0	0	0	2	0	0	6	0
2001	0	0	0	2	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	6	0	0	0	0
2003	0	0	1	0	0	0	0	0	0	0	0	1
2004	0	2	0	0	0	1	0	0	0	0	0	0
2005	0	0	0	4	0	0	0	1	0	0	0	0
2006	0	0	0	0	0	0	0	0	0	0	3	0
2007	0	3	0	0	0	2	0	0	0	0	0	0
2008	3	0	0	0	0	0	0	5	0	0	0	0
2009	0	0	2	0	1	0	0	1	0	0	3	0
2010	0	0	0	0	0	0	0	0	0	0	0	0
2011	11	0	2	0	0	0	0	0	1	0	3	0
2012	0	3	0	0	0	0	0	0	0	0	0	0
2013	2	0	3	3	0	2	0	0	0	0	0	7
2014	0	0	10	0	0	0	0	0	0	0	0	0
2015	1	0	0	0	3	0	8	0	0	0	0	0
2016	0	1	0	2	0	0	0	0	1	0	0	0
2017	0	0	0	0	0	0	1	1	0	0	0	0
2018	0	10	0	0	0	0	0	0	0	0	0	1

AES Retired + Stage 1

Figure 1. Example of Loss of Load Hours by Solar Years and Outage Draw.

adoption (x-axis). Low values represent lower risk of capacity shortfall. The dashed red line at the bottom of the chart represents the Reference Point, the calculated LOLE of the current system before the AES retirement and without additional solar + storage. The black line represents system reliability after the AES retirement with increasing amounts of solar + storage, including deferred maintenance, and the dashed line shows what the reliability level would be without deferred maintenance.

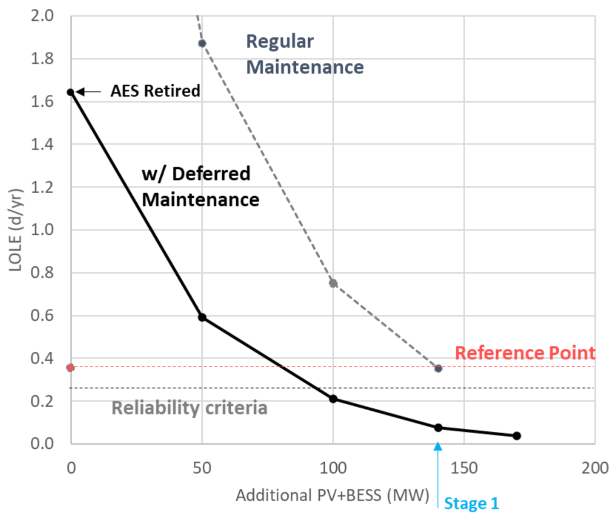

Figure 2. Loss of Load Expectation with Increasing PV+BESS.

While the figure clearly shows the unacceptable reliability with the AES retirement without additional solar + storage, much of that loss of reliability occurs in early months following the AES retirement and is recovered with the installation of just the Stage 1 solar + storage. This highlights the importance of project timing. The annual assessment shown in Figure 2 does not address the specific month-by-month timing of capacity additions and potential delays.

To further analyze the timing risk of replacement resources, the annual results shown in Figure 2 were evaluated on a monthly basis. HNEI developed a monthly screening tool to assess system reliability that could be adjusted with changes to commercial online dates and project delays. An example of this analysis is provided in Figure 3, but given the dynamic nature of project commissioning and delays, this analysis is routinely updated. The results show elevated risk throughout September and diminishing to zero as long as the standalone Kapolei storage project, or other solar + storage projects come online as planned.

The monthly assessment also showed that while ~40 MW of additions and deferred maintenance would bring the system back to current reliability levels, an additional 60 MW would be required by the next summer to bring the *annual* reliability for the September 2022 - August 2023 period back to the reference point if maintenance schedules return to normal.

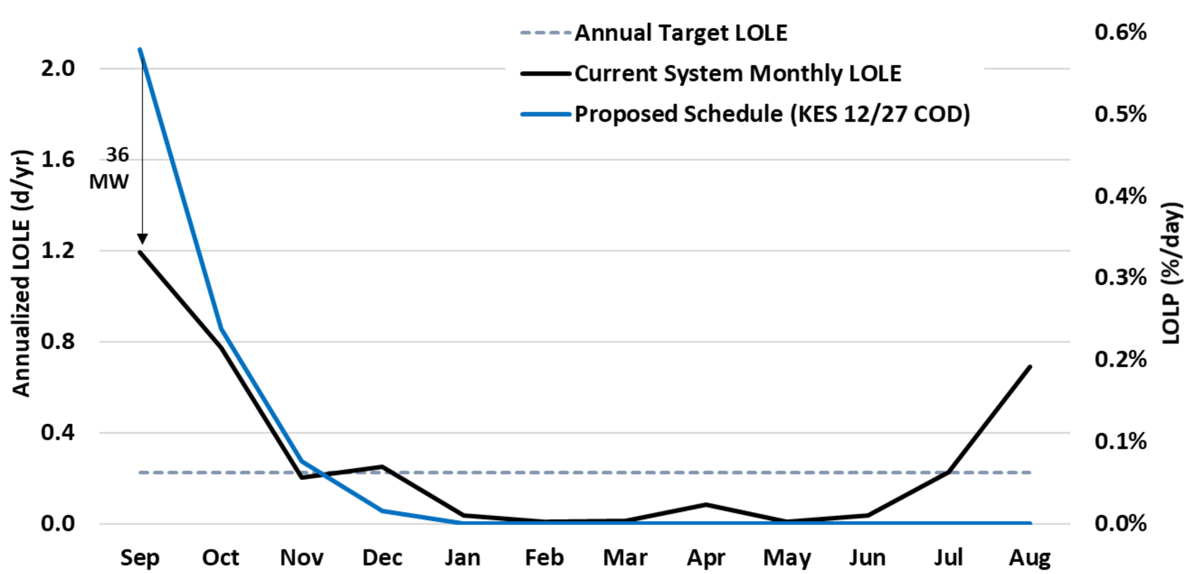

Figure 3. Monthly Annualized LOLE with Proposed Commercial Online Dates

The screening tool was provided to the governor's Power Past Coal task force to allow users to change commercial online dates of projects to screen for periods of increased reliability risk.

Information on outage size, frequency, and duration has been shared with the HPUC and DER parties to help design an emergency demand response program. Results showed that 70% of all resource adequacy events could be covered by a 60 MW, 2-hour resource available during evening hours and that number increased to 85% of all events with 100 MW of resources. Using this information, the HPUC developed a 50 MW emergency DR program requested aggregated battery energy storage systems for reliability.

In summary, with the addition of as little as 10% of the Stage 2 solar + storage projects - or the addition of the standalone Kapolei battery storage project - capacity shortfalls are eliminated altogether.

Recently announced delays of Stage 1 and Stage 2 projects indicate buildout of Stage 1 by the time AES is retired may be substantially under 100MW. HNEI participates in the Governor's Powering Past Coal Task Force and continues to monitor ongoing changes in deployment schedules.

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Contact: Richard Rocheleau, rochelea@hawaii.edu

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