



# Hawai'i Natural Energy Institute Research Highlights

## Grid Integration & Energy Efficiency

### O'ahu Retirement Study

**OBJECTIVE AND SIGNIFICANCE:** O'ahu's fleet of oil-fired generators is aging, becoming increasingly unreliable, and more difficult to maintain. Increased cycling to integrate variable renewable energy and more stringent EPA emissions policies are also decreasing the longevity of these units. In September 2022, HECO retired its largest coal-fired power plant and replaced it with a portfolio of hybrid solar + storage projects. At that time, the HNEI-Telos team conducted analyses showing that solar + storage could reliably replace the coal plant. However, the ability of solar + storage to continue replacing firm capacity – resources that are available irrespective of weather – diminishes at higher levels of retirements. Given that significant amounts of firm capacity will be required to operate a reliable grid (see "[Clean Firm Needs](#)" project summary), HNEI-Telos conducted longer-term analysis to help develop long-term retirement plans for O'ahu.

**KEY RESULTS:** Under current load levels, the Waiau steam oil plant (370 MW) could be retired reliably, but would require 900 MW of solar and storage hybrid resources – double the amount of recent procurements. If load growth materializes as expected – largely from expected EV adoption – the same amount of solar and storage could only retire 150 MW, a small portion of the total plant. As a result, to achieve state-wide decarbonization targets, the utility needs to simultaneously plan for oil plant replacements and the growing capacity needs to support electric vehicles.

While some of the oil units can be replaced by near-term solar and storage additions, the ability to continue replacing fossil-fuel resources exclusively with hybrid solar and battery plants is limited. Other firm resources need to be considered for future planning.

**BACKGROUND:** HECO's oil generation plants are aging and becoming less reliable. On average, they are over 40 years old, with some plants over 60 years old – well beyond their original design life. The Waiau power plant, for example, is the third oldest non-hydro generating station over 20 MW in the United States. These old systems lack the flexibility required to integrate renewable energy sources effectively, leading to increased curtailment and increased likelihood of equipment failures.

Increased age, cycling, and emissions compliance requirements are all eroding generator reliability and availability. This trend, which started in 2015, increased further in from 2020-2022.

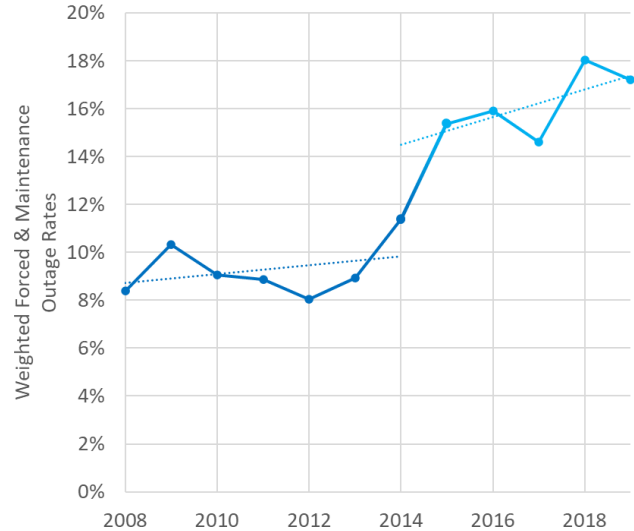


Figure 1. Increasing maintenance and forced outages for HECO's O'ahu thermal fleet.

Some of these plants will need to be retired, but it will take years to plan, receive regulatory approval, permit, interconnect, and construct new facilities. Early and proactive planning, starting now, is essential to maintaining reliability and options in the future.

**PROJECT STATUS/RESULTS:** Solar and storage can effectively reduce the generation from oil plants, allowing them to run less and reduce emissions significantly. However, there are limits to how much capacity can be retired completely, while maintaining a reliable system.

To assess the retirement and replacement options available, HNEI conducted a study for O'ahu that evaluated system reliability across hundreds of unexpected generator outages and over twenty years of weather conditions. The system was evaluated across a range of load growth, solar and storage additions, and additions of new firm capacity. The scenarios evaluated included a combination of the following parameters:

- **Load Growth:** Evaluated Base Load and High Load growth assumptions, representing a current load level and one based on a 2030-2040

load level (with the range representing the pace of electrification).

- **Solar PV and storage adoption:** Various solar and storage levels were evaluated, ranging from solar and storage levels procured in Stage 1 and 2 to an increase of 1100 MW of new projects.
- **Firm Capacity Additions:** The analysis was conducted with and without the proposed 400 MW of firm capacity additions identified in the IGP and Stage 3 Firm Renewable procurement.

Results show that recent procurements for solar and storage present further opportunities for retiring additional oil plants. However, solar and storage resources alone cannot entirely replace all of the oil plants on the system. During extended periods of low wind and solar availability, which can persist for several days, some dispatchable firm capacity is still required to maintain reliability. Moreover, the increasing adoption of electric vehicles contributes to a rise in overall load, which limits the possibilities for retiring oil plants without new dispatchable firm capacity.

Under current load levels, the Waiiau steam oil plant (370 MW) could be retired reliably, but would require 900 MW of solar and storage hybrid resources – double the amount of recent procurements. If load growth materializes as expected – largely from expected EV adoption – the same amount of solar and storage could only retire 150 MW, a small portion of the total plant. As a result, to achieve state-wide decarbonization targets, the utility needs to simultaneously plan for oil plant replacements and the growing capacity needs to support electric vehicles.

Beyond the Waiiau plant, there are little to no options available to retiring additional capacity (i.e. the Kahe steam oil plant), unless some other firm capacity is added to the system. Adding 400 MW of new firm capacity to the system, for example, would allow for the retirement of up to 700 MW of oil capacity depending on the amount of solar and storage added, even with continued load growth.

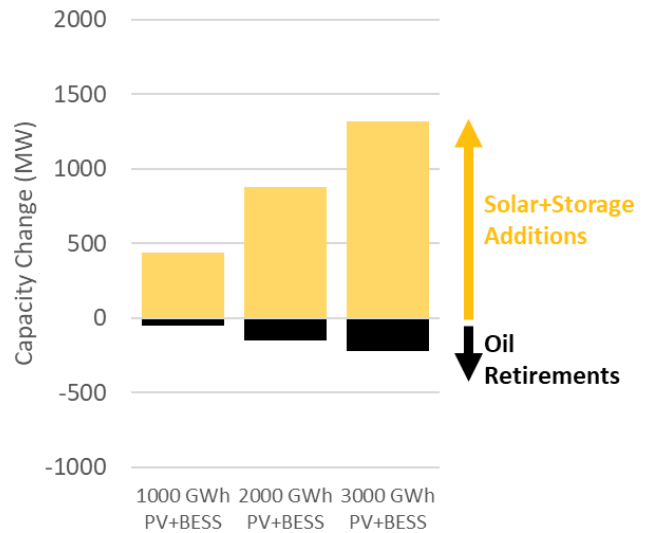


Figure 2. Solar + storage additions required and oil retirements feasible while maintaining 0.1 days/year LOLE reliability levels.

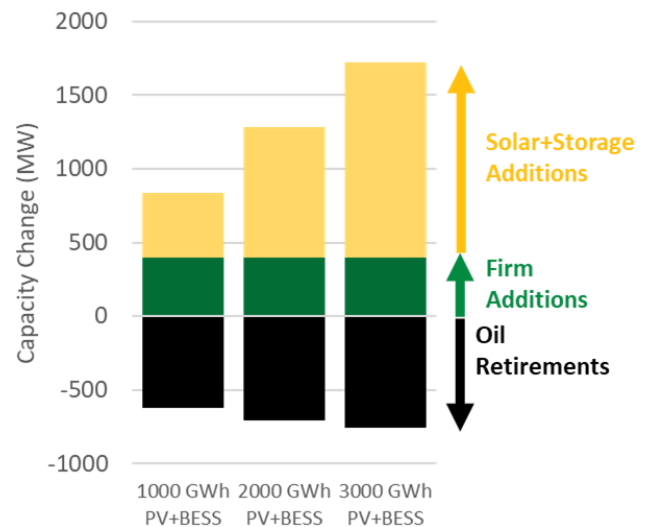


Figure 3. Solar + storage and firm renewable additions required and oil retirements feasible while maintaining 0.1 days/year LOLE reliability levels.

By creating a portfolio of solar, storage, and new clean firm capacity, much of the legacy steam oil fleet on O‘ahu can be retired. Given the continued need for firm capacity, the age of HECO’s generation fleet, and ambitious state policy related to electric vehicle adoption and other electrification efforts, prudent retirement planning is warranted. Monitoring load growth trajectories, specifically related to EV adoption is needed. In addition, any planning for new firm capacity additions should start now, as new

plants will take several years for design, permitting, procurement, and interconnection. In the meantime, HECO has an opportunity to retire a few priority units while working to bring additional supply resources online.

Table 1. Solar + storage additions required to maintain reliability at various levels of oil-generator retirements.

Cumulative Retirements	Solar + Storage Additions Needed		
	Base Load	High Load	High Load + 400 MW Firm
Waiau 3-4 (100 MW)	100 MW	600 MW	0 MW
Waiau 5-6 (200 MW)	300 MW	1000 MW	0 MW
Waiau 7-8 (370 MW)	900 MW	N/A	0 MW
Kahe 1-2 (550 MW)	N/A	N/A	300 MW
Kahe 3-4 (700 MW)	N/A	N/A	440 MW

*Funding Source:* Energy Systems Development Special Fund; Office of Naval Research

*Contact:* Richard Rocheleau, [rochelea@hawaii.edu](mailto:rochelea@hawaii.edu)

*Last Updated:* November 2023