



Hawai'i Natural Energy Institute Research Highlights

Energy Policy & Analysis

Disposal and Recycling of Clean Energy Products in Hawai'i

OBJECTIVE AND SIGNIFICANCE: Hawai'i's pursuit to become fully renewable by 2045 will produce substantial streams of clean energy product waste over the next 30 years and beyond. In recent years, Hawai'i has seen a large uptake in the use of solar photovoltaic (PV) panels and storage lithium-ion batteries (LIB). Due to the risk of explosion and flammability of these batteries at end-of-life (EOL) and the increasing risk of decreased access to ocean shipping, it is crucial for the state to develop a process to manage these waste streams in a manner that is both safe and environmentally sound.

The primary objectives of this work are to: 1) quantify this waste stream; 2) review best practices for disposal, recycling, or secondary use of clean energy products produced; 3) evaluate potential stewardship structures; and 4) recommend structures for laws that could be enacted to implement each stewardship program.

BACKGROUND: The 2021 Hawai'i State Legislature passed House Bill 1333 requiring HNEI, in consultation with the Hawai'i State Department of Health, to conduct a thorough study on best practices for disposal and recycling of discarded clean energy products in Hawai'i. The legislation directed that this study address: 1) the amount of PV and solar water heater panels that will need to be disposed of or recycled; 2) other types of clean energy materials expected to be discarded; 3) the type and chemical composition of those clean energy materials; 4) best practices for collection, disposal, and recycling of those clean energy materials; 5) whether a fee should be charged for disposal or recycling of those clean energy materials; and 6) any other issues the Hawai'i State Energy Office and Department of Health consider appropriate. This initial report was submitted to the legislature in December 2022.

Additional follow on studies have continued to add depth to recommendations for the disposal and recycling of clean energy materials in Hawai'i. One of the more significant conclusions was that the state should develop an independent stewardship structure/framework that includes a public option for processing EOL LIBs.

PROJECT STATUS/RESULTS: This project's research findings include: 1) determining the material

composition of equipment; 2) quantifying the cumulative PV and battery storage installed since 2005; 3) quantifying the projected disposal loading rate of aging materials to 2045; 4) assessment of waste treatment options; 5) assessment of fee options with recommendations; 6) assessment of developing LIB deactivation and/or preprocessing facilities; and 7) identifying the structure and requirements of potential stewardship frameworks to meet Hawai'i's unique needs.

As noted in our [initial report](#), we found that:

- PV systems are composed of both recyclable materials and trace amounts of precious and toxic metals, while LIBs include trace amounts of metals and minerals, recyclable metals, graphite carbon, plastics, and electrolyte;
- Recycling of these materials require complex pathways including strict storage and shipping requirements;
- It was estimated that, as of 2021, up to 225,000 tons of PV-related clean energy materials was deployed in the state, equivalent to approximately 8.8% of the total municipal solid and commercial and demolition waste generated in a single year (2021);
- Based on a 15-20 year lifespan for PV and 10-15 year lifespan for batteries, the quantity of waste is expected to increase during the latter half of this decade; and
- Covering the cost of off-island disposal for PV panels and LIBs is likely to require one or more revenue-generating schemes.

HNEI's [supplemental report](#) expanded on initial efforts, adding insights gained from participation in national recycling working groups and interviews with key mainland stakeholders. It highlighted the high costs associated with disposal of LIBs in Hawai'i due to shipping risks.

The possibility of enhanced restrictions or outright banning of ocean shipping of EOL LIBs is identified as an existential threat to Hawai'i's disposal of LIBs. This report also identified and reviewed several revenue-generating disposal and recycling schemes including waste generator or producer responsibility, state encouraged/assisted recycle, and/or visible fees. It was concluded that no single strategy could be used

in Hawai‘i, but rather a stewardship program that could pursue many in parallel would be needed.

A [follow on study](#) assessed the state of EOL PV panel and LIB waste streams and highlighted the high costs associated with disposal of LIBs in the state. A lack of any tracking mechanisms caused the working group to estimate accumulation amounts of these products by evaluating import and export data. Unlike certain states on the mainland, Hawai‘i does not have land-based access to states where processing of EOL PV panels and LIBs are permitted. This requires operators to initially transport these EOL products via ocean transport. The need to deactivate and/or pre-process LIBs on-island was identified as needed to ensure long term access to ocean transport.

In 2025, this project was expanded to include a [comprehensive study](#) on “waste” EOL lithium batteries that: 1) discusses the overall logistic pathway; 2) discusses insurance requirements of each treatment pathway; 3) presents three frameworks of stewardship structures that manage and fund collection, transport, storage, sorting, treatment, and shipment; and 4) identifies the requirements and pros and cons of shipping batteries “as is” or performing a deactivation treatment prior to shipment. This report was submitted to the Hawai‘i State Energy Office in support of their recycling working group.

Of the three stewardship structures presented, the one the authors considered the most practical and effective is a state sanctioned non-government aligned professional responsibility organization that can/will oversee a broad portfolio of public/private efforts to manage the capture and processing/pretreatment of used “waste” EOL LIBs. The working group also recommended a framework that not only oversees/manages the collection, on-island transport, temporary storage, sorting, and deactivation of used “waste” EOL lithium batteries, but is also empowered in law to raise the funds that will be necessary to support the capture and disposal of over 95% of all used “waste” EOL lithium batteries produced in Hawai‘i.

A request for proposals (RFP) was posted to engage an independent entity to provide a comprehensive analysis of the requirements for each stewardship structure considered, as well as provide mock bills

that could be used to empower them in law. The selection process is expected to conclude in December 2025 with a contract executed in January 2026 with an expected completion date of August 2026.

Of the three methods reviewed to pretreat the used “waste” EOL lithium batteries for marine transport, the most practical for Hawai‘i was felt to be a state-supported wet shredding operation that is easily accessible to the public. The working group also strongly noted that additional privately run treatment/shipping pathways should also be encouraged and supported by the stewardship structure as long as they meet standards acceptable to the stewardship.

This work has led to the publication of the four reports linked below, with another forthcoming, estimated for a Spring 2026 release.

1. [Recommendations on Waste Management of Clean Energy Products in Hawai‘i](#), December 2022
2. [Policy Recommendations on Waste Management of Clean Energy Products in Hawai‘i](#), December 2023
3. [Waste Management of EOL PV Panels and LIBs in Hawai‘i](#), December 2024
4. [Options for Lithium Battery Disposal in Hawai‘i: Requirements and Analysis](#), December 2025

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Contact: Michael Cooney, mcooney@hawaii.edu

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