



# 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 waste over the next 30 years and beyond. In recent years, Hawai'i has seen large growth in the use of solar photovoltaic (PV) panels. This is expected to continue with new systems, both rooftop and utility scale, combined with battery energy storage systems. Due to this, it is crucial for the state to manage these waste streams in a manner that is both safe and environmentally sound. The objective of this work is twofold: 1) to quantify this waste stream and best practices for their cost-effective recycle and 2) to conduct a comprehensive technical assessment to determine best practices for disposal, recycling, or secondary use of clean energy products produced in the State.

**BACKGROUND:** The 2021 Hawai'i State Legislature passed House Bill 1333 which required that the Hawai'i Natural Energy Institute, in consultation with the Hawai'i State Department of Health, conduct a thorough study on best practices for disposal and recycling of discarded clean energy products in Hawai'i. Specific deliverables addressed were: 1) the amount of PV and solar water heater panels in the State that will need to be disposed of or recycled; 2) other types of clean energy materials expected to be discarded in the State including glass, frames, wiring, inverters, and batteries; 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.

**PROJECT STATUS/RESULTS:** This project, commenced in September 2021, remains ongoing. Findings to date include: 1) identifying material composition of PV panels, inverters, cabling, and mounting equipment as a function of installed power (kg/kW); 2) quantifying the cumulative PV installed by island for residential, commercial, and utility scale since 2005; 3) calculating the projected loading rate of aging PV materials as far out as 2045; 4) determining the preliminary estimates of installed battery capacity at residential, commercial, and utility scale; 5) evaluating estimates of material composition of PV battery as a function of installed power

(kg/kW); 6) conducting a comprehensive assessment of waste treatment options, costs, and risks; and 7) conducting a comprehensive assessment of fee options and recommendations. Specifically:

1. As of 2021, it is estimated that 3.86 million modules have been installed on O'ahu, 720,000 in Maui County, 580,000 in Hawai'i County, and 480,000 on Kaua'i. A total of 225,000 tons of PV related clean energy materials have been installed in Hawai'i through 2021. For context, the total amount of municipal solid waste and commercial/demolition waste generated in the State during 2021 was 2,570,478 tons. The total amount of these PV related clean energy materials installed to date totals 8.8% of all municipal solid waste and commercial/demolition waste generated across the entire State in 2021.
2. The cost of disposing PV panels and Li-ion batteries will require one or more revenue-generating schemes to be established; potentially including waste generator responsibility, extended producer responsibility, state assisted recycle, and state encouraged recycle. The recommendation is to establish a process that covers the full price of their off-island disposal.
3. The possibility of enhanced restrictions or banning of ocean shipping of end-of-life Li-ion batteries was identified as an existential threat to Hawai'i's disposal of these products.
4. To address this threat, the need to deactivate Li-ion batteries or even fully recycle Li-ion batteries on island was identified in order to ensure long term access to ocean transport.

These and other results have been detailed in HNEI's report "[Recommendations on Waste Management of Clean Energy Products in Hawai'i](#)," which was previously submitted to the legislature. Although not mandated, this work was continued in 2022 to add depth to policy recommendations for the disposal and recycling of clean energy materials in Hawai'i and a [supplemental report](#) was produced and is available on HNEI's website.

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