County:	Maui	**Solid Waste Issue:**	Lithium-ion Batteries Rechargeable Lithium-Ion (Li-ion) batteries including consumer, automotive and home power storage uses.
Population (2020 Census):	165,000		
Last Update to SWMP:	Li-ion Batteries are part of the Junk Vehicle Disposal Program, E-Waste Program, and Household Hazardous Waste Programs. County 2024 draft ISWMP Table 12-1 Summary of Plan Recommendations, Implementation Responsibility, Priority and Estimated Cost HHW3) "Consider implementation of lithium battery and solar panel collection as recycling opportunities become available" to be administered by the County of Maui, medium priority, estimated cost of $600,000 per year.		
Waste Characterization Data:	A 2019 Waste Characterization Study showed that 0.1%, or 224 tons of the waste stream consisted of batteries, a portion of which were Li-ion.		
Waste Diversion Data:	There is no waste diversion data on Li-ion batteries recycling available.		
County Ordinances:	The County of Maui does not have any ordinances regarding the management of waste Li-ion batteries. Li-ion batteries are subject to state regulations (HAR 11-273.1; see State fact sheet for additional information).		

Overview:

In 2021, the County of Maui funded a research project for lithium battery recycling and disposal. Since conducting the feasibility study, the County Recycling section has been developing a Li-on Battery Recycling Program. The program is expected to be piloted in fiscal year 2024 and, depending on the piloted outcome, become an official County program in fiscal year 2025.

There are County-contracted facilities permitted by the hazardous waste program to collect Li-ion batteries for recycling (see "Permitted Collectors and Recyclers/Processors" section).

Historical data

The International Energy Agency predicts an 800 percent increase in the number of EVs over the next decade, each car packed with thousands of cells. The dirty secret of the EV revolution is that it created an e-waste time bomb—and cracking Li-ion recycling is the only way to defuse it.

1. As of FY 2020, Maui County has 1467 registered EVs. As of FY 2019, Maui County had 1132 registered EVs As of FY 2018, Maui County had 992 registered EVs. That equals approximately a **25% increase** in EV's registered from 2019 to 2020.
2. As of 2015, of the 20 EV models available in the US, 13 are available in Hawai'i; Nissan Leaf (BEV), Chevrolet Volt (PHEV/ EREV), Mitsubishi i-MiEV (BEV), Tesla Model S, (BEV), Toyota Plug-in Prius (PHEV), Ford Focus Electric (PHEV), Ford C-Max Energi (PHEV), Ford Fusion Energi (PHEV), Porsche Panamera S E-Hybrid (PHEV), Cadillac ELR, (PHEV/EREV), BMW i3 (BEV), BMW i3 REX (PHEV/EREV), and BMW i8 (PHEV).

Current disposal options for Maui County and other areas of the State

A. Current and forecasted data

- Current Disposal Advise for Small Lithium Batteries.
- As an alternative, an individual can take it to your municipal household hazardous waste (HHW) recycling center.
- Currently, most people take the small batteries to Home Depot or Lowes and put them in a cardboard box to be dealt with by an independent contractor by the name of Stericycle. ECycling Maui leaves the batteries in electronic devices and sends them to R2 Certified Recycler URT when possible for disposal.

B. Large Lithium Cell Disposal

- Where recycling facilities are unavailable or the recovered materials are uneconomic, batteries are disposed as waste. The management of disposed Li-ion batteries is governed by EPA Universal Waste rules that require waste handlers to separate hazardous materials for disposal under federal laws but allow the disposal of the remaining non-hazardous waste to comply with state and local requirements.
- Proper collection, identifying battery chemistries, and fully de-energizing batteries are as important to a disposal site as to the recycling processes discussed above. Once rendered inert from fire risk (mechanically or chemically), non-hazardous materials not recovered for reuse or recycling can be disposed of through municipal waste streams. While some lithium chemistries are considered non-hazardous, many batteries have toxic constituents that require treatment as hazardous materials. The potential toxicity of Li-ion battery materials varies widely by chemistry; for example, where nickel, cobalt, or lead are present in battery chemistries in significant quantities, precautions must be taken at disposal or incineration sites in line with the hazards of those individual materials.

C. Small Lithium Cell Disposal

- Small Li-ion batteries found in consumer electronics have proliferated in recent years, leading to state efforts to deter improper disposal and encourage recycling. However, even in states such as New York that have implemented rules against disposal, consumer batteries have improperly entered municipal waste streams. Although the experience of small consumer goods batteries is not a reliable predictor of the fate of large-scale Li-ion batteries, federal requirements promulgated decades ago did not contemplate the disposal of significant quantities of large Li-ion batteries, and no clear prospects for action at the federal level to strengthen the rules governing recycling or disposal have emerged. In response, some state and regional policies are emerging, such as California legislature creating an Advisory Group to consider approaches to effectively prohibit landfilling Li-ion EV batteries and incentivize reuse and recycling. The ESS industry will also be working with regulators to ensure that waste managers utilize safe disposal practices for Li-ion batteries.

The future revolves around other next generation recycling ecofriendly processes including Bioleaching (the extraction of metals from their ores through the use of living organisms. This is much cleaner than the traditional heap leaching using cyanide. Bioleaching is one of several applications within biohydrometallurgy and several methods are used to recover copper, zinc, lead, arsenic, antimony, nickel, molybdenum, gold, silver, and cobalt for mining copper today.

A Chinese university made a cobalt leaching bacteria. In the future, we could see large leech pond facility running a bio leaching process that's incredibly green and incredibly efficient at handling all the island's e-waste of all types. Electronics and batteries are having low-cost high-quality output materials from this bio-leeching process.

County Programs & Funding:	• Junk Vehicle Disposal Assistance Program (includes electric and/or hybrid car batteries)[1] • Recycling Grants Program (estimated funds for FY 2024 are $100,000 for the Green Grants Program and $500,000 for the Recycling Grants Program)[2] • A Large and Lithium Battery Diversion Research/Feasibility was conducted in 2021. • A Large and Li-ion Battery Diversion/ Recycling Program is currently in development. • Annual Household Hazardous Waste event accepts small Li-ion batteries • County's E-Waste program will recycle electronics with batteries
Estimated Annual Material Type Generation:	**Estimated Number of Registered Vehicles for Maui (2022)[3]:** • Total Passenger and Freight Vehicles: 176,446 o Total Electric Vehicles: 2,671 **Estimated Number of EV Li-ion Batteries to be Managed Yearly**: Predicted to steadily increase from an estimated total of 92 EV Li-ion batteries a year in 2022 to approximately 5,386 EV Li-ion batteries a year by 2039. **Estimated Number of Commercial Businesses and Residential Households with Photovoltaic (PV) System in Maui (2021)[4]:** 15,390 (92% residential, or approximately 14,160 homes) **Estimated Number of Homes with Li-ion Battery Storage Systems (2021)[5]:** 2,412 **Estimated Number of Home Li-ion Battery Storage Systems to be Managed Yearly[5]:** Predicted to reach approximately 646 by 2039
Permitted Collectors and Recyclers/Processors:	Small lithium batteries can be taken to the annual household hazardous waste events on Maui, Molokai, and Lanai. Small tool batteries can be recycled at Home Depot and Lowes through Stericycle. Electronics containing lithium batteries that are received at the County's E-Waste program are kept in electronics and shipped to URT for recycling. Hammerhead Metals processes vehicles that contain batteries.
News Articles:	*Maui Now*: "Hawaiian Airlines to Implement "Smart Bags" Restrictions" The airline will not accept smart bags containing non-removable Li-ion batteries as checked or carry-on luggage beginning Jan. 15, 2018.
State Solid Waste Stream Issue Statement:	Li-ion batteries from consumer electronics, PV systems, and electric and hybrid vehicles comprise a small but increasing proportion of the state's total solid waste stream. Li-ion batteries contain varying chemistries which require different recycling processes. Furthermore, the chemistry of Li-ion batteries is expected to continue evolving, which could further complicate the recycling process. Li-ion batteries pose potentially adverse public health and environmental impacts if disposed improperly, due to their flammability and toxic chemicals in their composition. Li-ion batteries can contain toxic materials such as compounds from lithium, nickel, and arsenic as well as carcinogenic materials from nickel, arsenic, and occasionally cobalt, copper, and polypropylene. Improper disposal of Li-ion batteries may lead to these chemicals leaching into the soil to contaminate both surface and groundwater, negatively impacting human health. They may also combust, causing fires in collection trucks, processing facilities, and at the landfill. Presently, the Li-ion battery recycling industry is underdeveloped.

County Solid Waste Stream Issue Statement and Potential Solutions:
(County to provide issue statement and potential solutions regarding the management of this material category.)

Issue Statement – Li-ion vehicle batteries are growing exponentially in Maui County. Issues with Li-ion batteries are environmental impacts as well as being difficult to recycle. Manufacturing them leaves a massive carbon footprint. Li-ion batteries emit up to 74% more CO2 than conventional cars. Once they reach end of life, only 5% of Li-ion batteries are recycled in the United States. The rest are dismantled to varying degrees and sent to smelting furnaces. Recycling is problematic because there is a risk of the Li-ion battery short circuiting while shipping, causing fires and/or explosions. Damaged or improperly handled batteries cause hazards to drivers transporting them as well as individuals in their vicinity, which is why they must meet all Hazardous Materials Regulations (HMR) requirements while being transported by air, rail, water or highway. In addition, anyone involved with manufacturing, dismantling, packaging, preparing, or shipping of Li-ion batteries must undergo comprehensive DOT safety training. Recycling is the least sustainable measure in the circular economy and should be the last step when the batteries could no longer be utilized. Hence, retired Li-ion electric vehicle batteries should be considered for remanufacturing or repurposing for a second-life before recycling. The decision to recycle or repurpose is dependent on the chemistry of the battery. Whether retired Li-ion electric vehicle batteries have a second-life or not, all of those Li-ion batteries will need to be recycled in the end anyway. Recycling provides a robust solution to raw material supply-chain challenges and price fluctuations. By recovering critical raw materials from Li-ion batteries, manufacturers can shield themselves from supply disruptions and generate additional revenue streams. Recycling options are either Pyrometallurgy, which is a smelting process, Hydrometallurgical recycling processes, which uses a leachate technique, or Direct Cathode Recycling, which keeps most of the cells intact making it easier for re-manufacture.

Potential Solutions – Possible solutions/options for Maui County is to administer a service contract to either reuse or repurpose Li-ion batteries when possible. If repurposing is not possible, then go through a chemical process or deactivate the cells, dismantle, and ship off island to a Li-ion battery recycling facility; all within the strict guidelines of permits and training.

[1] Junk Vehicle Disposal Assistance Program (mauicounty.gov)
[2] Maui County soliciting applications for Green Grants Program (spectrumlocalnews.com)
[3] Energy_Trend.pdf (hawaii.gov)
[4] Hawaiian Electric sees brisk pace of solar installations (hawaiianelectric.com)
[5] 2023 HNEI Act92 Final Report Clean Energy Products Waste Management (hawaii.edu)