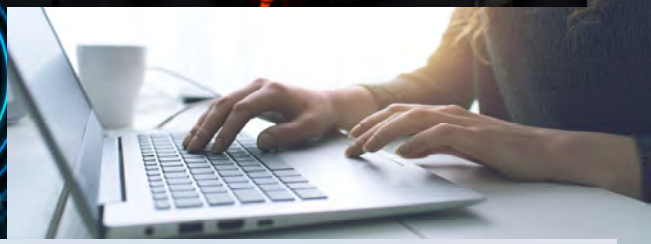
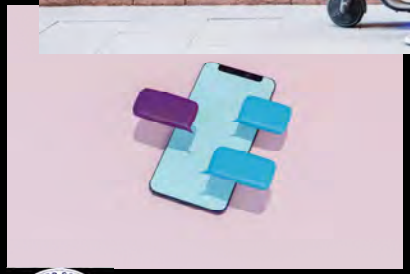
Li-Ion Battery Response Considerations



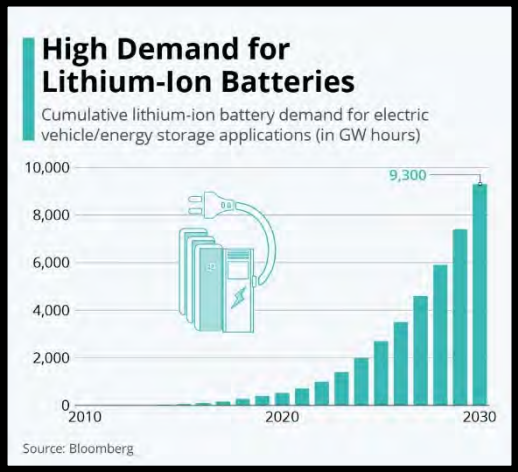




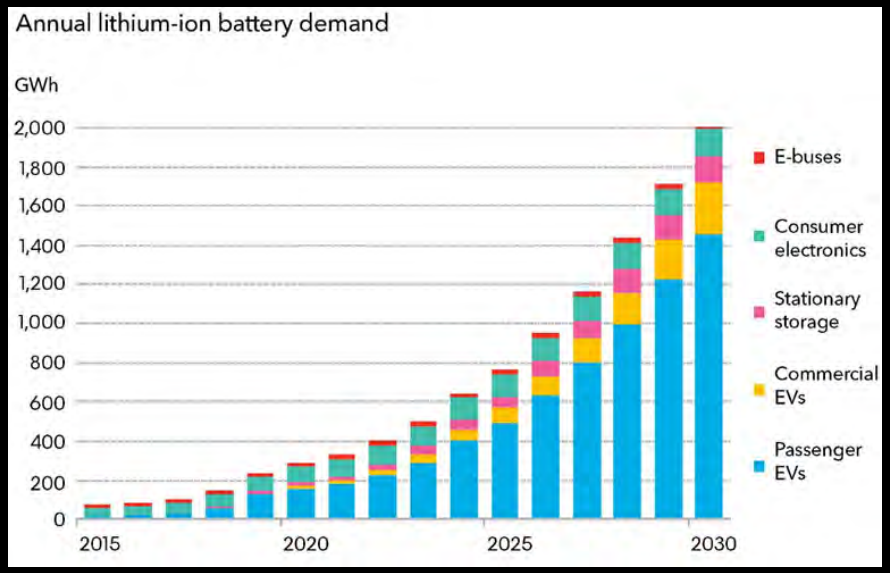


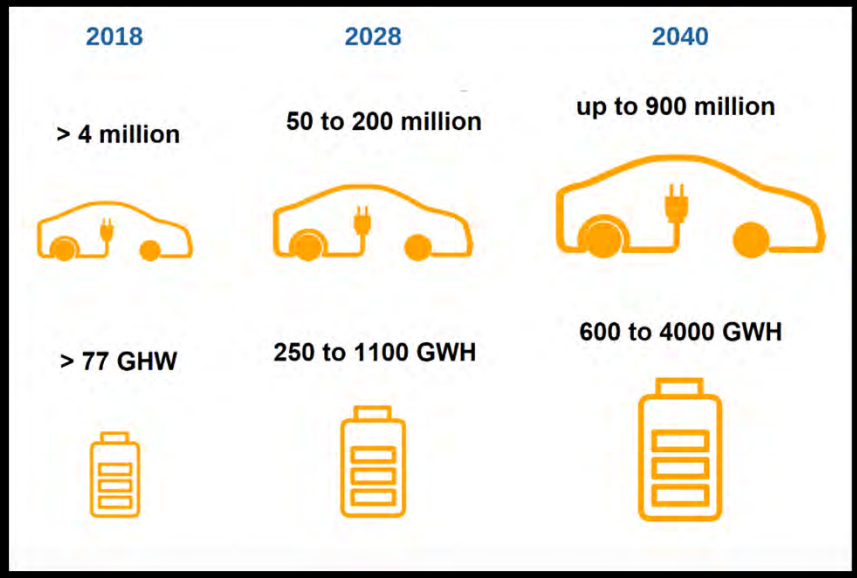
January 2024 Caribbean Regional Response Team Meeting

Trends in Li-Ion Batteries



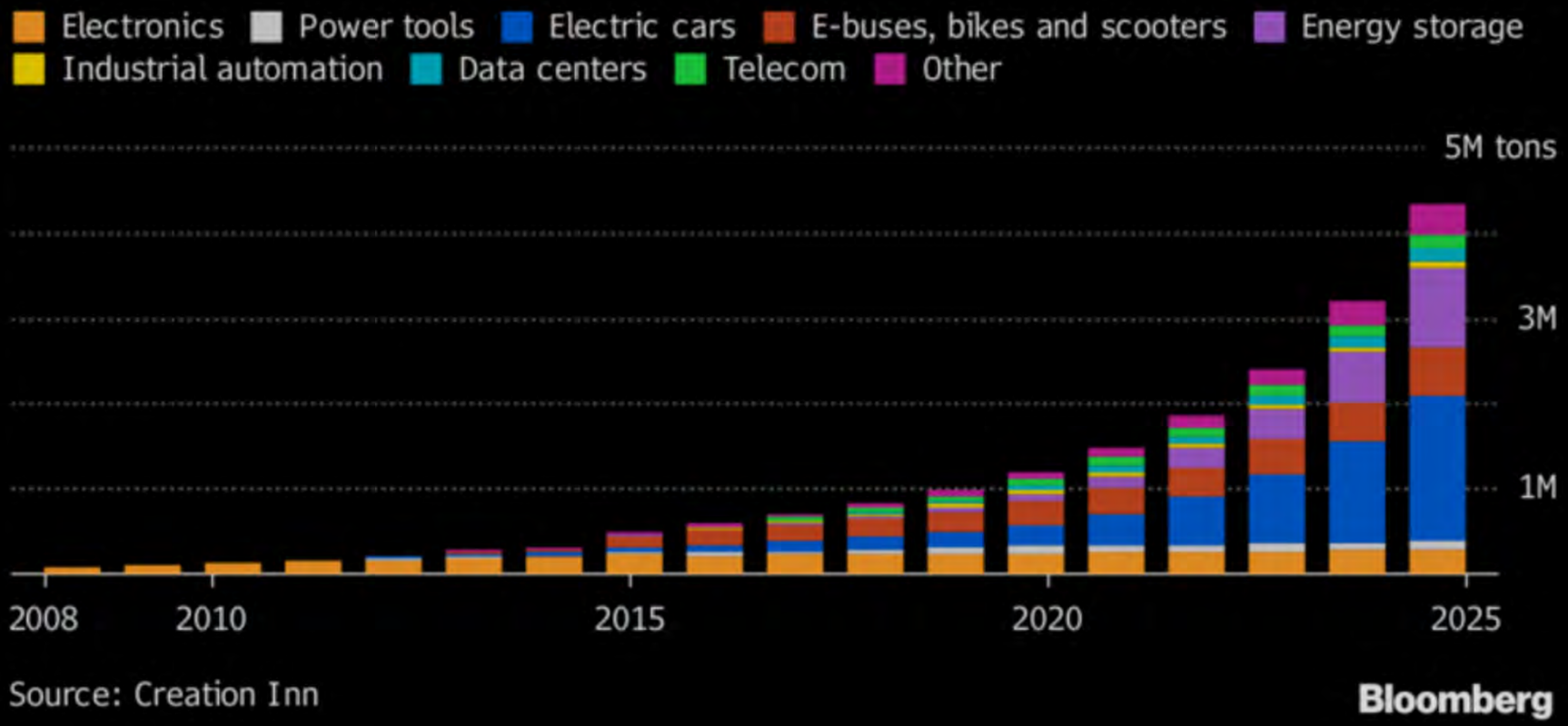
- Demand is increasing
- Energy density of batteries is increasing
  - Thermal runaway severity increases
- Production increasing
- Cost per kilowatt hour decreasing
- Products reaching “end of life” increasing





Waste Not

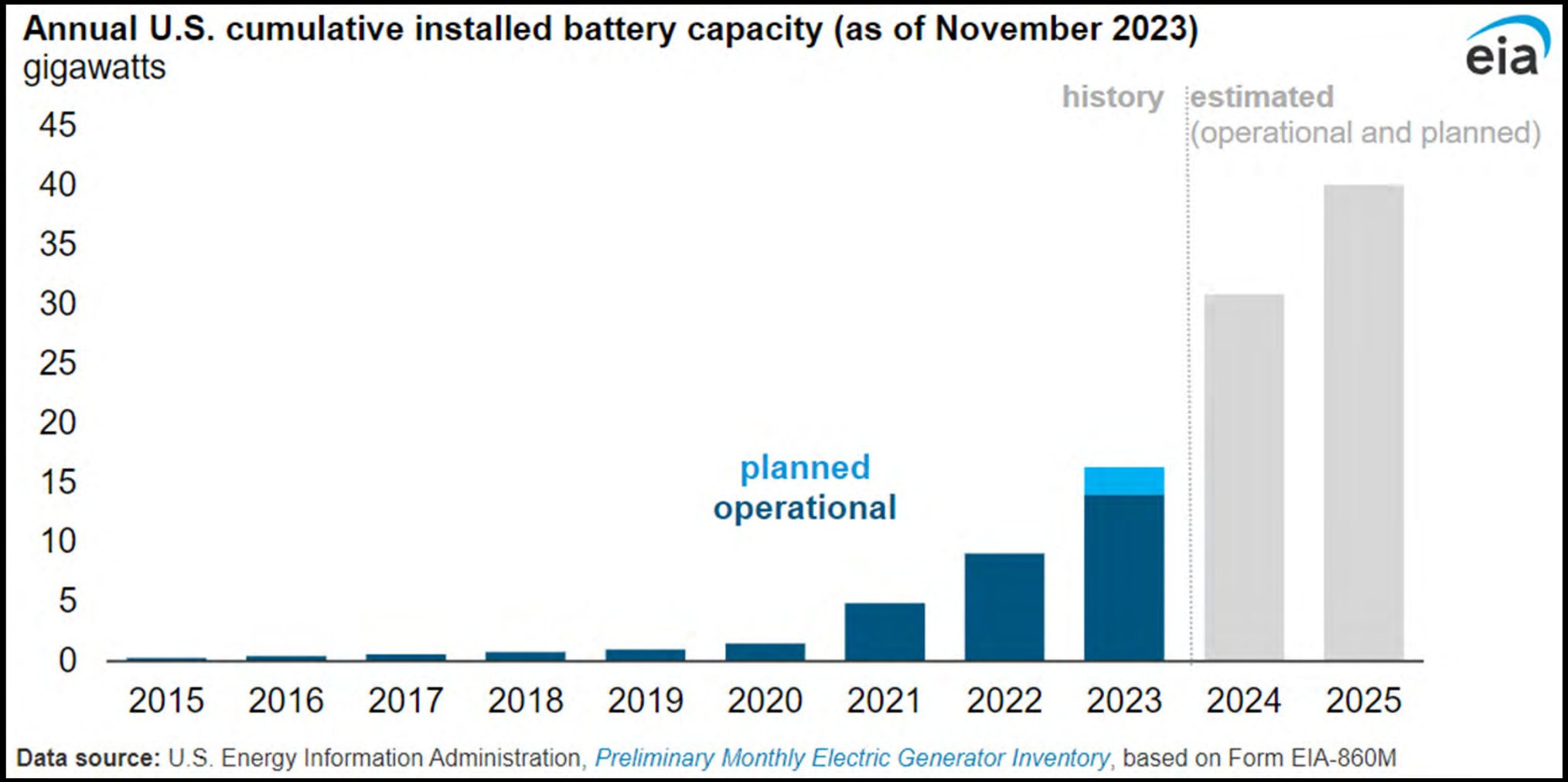
The volume of lithium ion battery cells being sold is set to surge, creating opportunities for recyclers



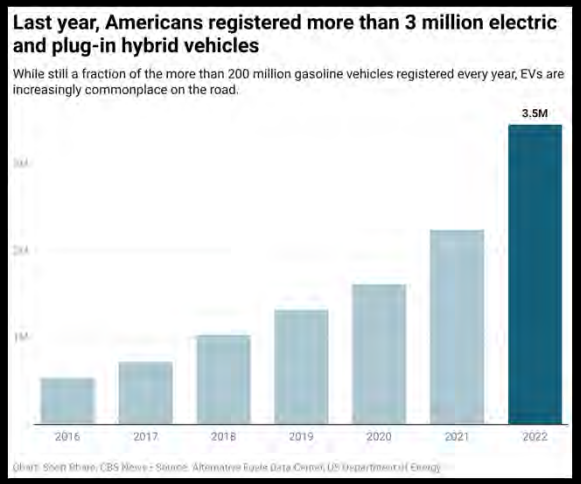
Source: Creation Inn

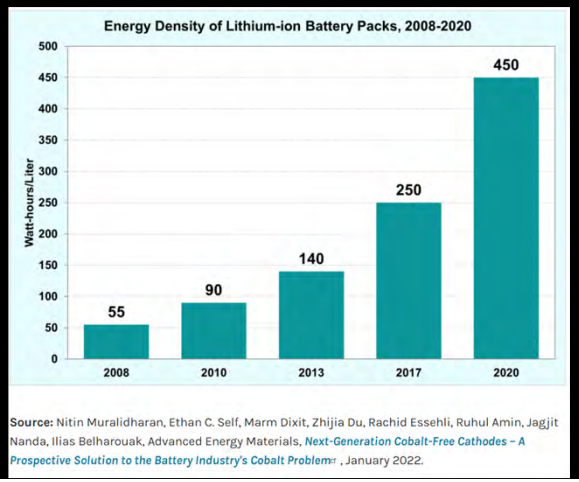
Bloomberg

Trends in Li-Ion Batteries



Trends in Li-Ion Batteries





Source: Nitin Muralidharan, Ethan C. Self, Marm Dixit, Zhijia Du, Rachid Essehli, Ruhul Amin, Jagjit Nanda, Ilias Belharouak, Advanced Energy Materials, *Next-Generation Cobalt-Free Cathodes – A Prospective Solution to the Battery Industry's Cobalt Problem*, January 2022.

A Shifting Risk Profile for Lithium Batteries

- Increased Availability and Involvement
  - California gas-powered lawncare and generator phaseout
  - NY Right to Repair Laws
  - Growth in Recycle/Reuse/Refurbish Market
  - Growth in off-market products
  - Increase in micro-mobility (scooters/e-bikes)

Three Primary Presentations of LIB

Energy Storage Systems

Electric Vehicles

Micro-mobility

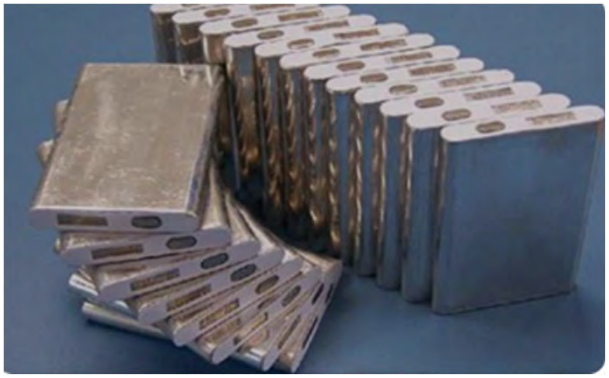
Types of Li-Ion Batteries

<u>Styles</u>

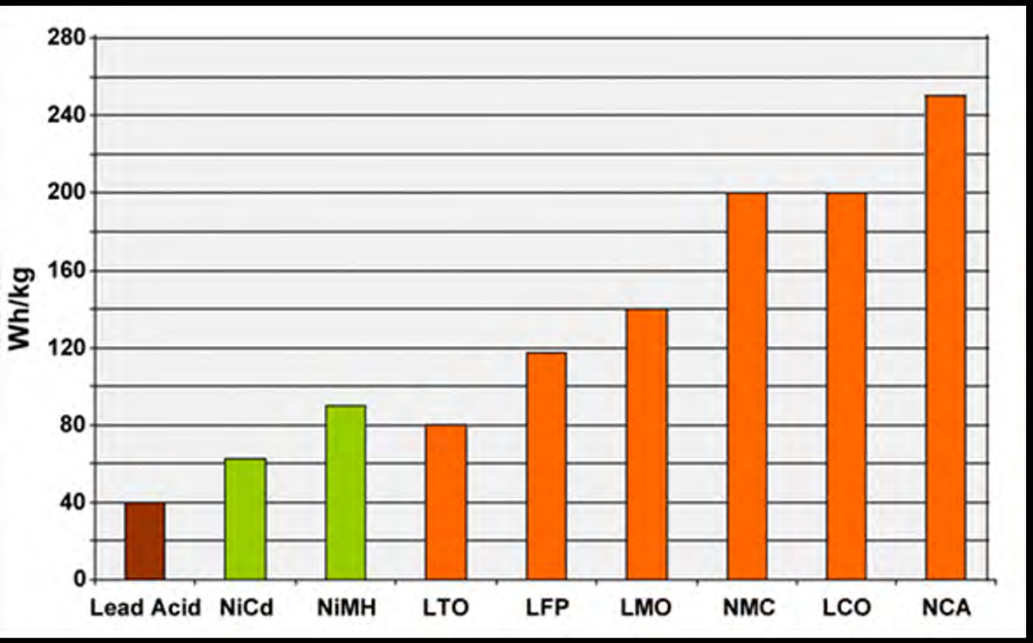
- Cylinder

- Pouch

- Prismatic



Li-Ion Battery Chemistry



Chemistry

- Lithium Cobalt Oxide($LiCoO_2$) — LCO
- Lithium Nickel Cobalt Aluminum Oxide ($LiNiCoAlO_2$) — NCA
- Lithium Nickel Manganese Cobalt Oxide ($LiNiMnCoO_2$) — NMC
- Lithium Manganese Oxide ($LiMn_2O_4$) — LMO
- Lithium Iron Phosphate($LiFePO_4$) — LFP
- Lithium Titanate (Li2TiO3) — LTO

Types of Lithium Batteries

Lithium Metal

- Metallic lithium or alloy
- Tend to be single use and not rechargable
- Typical Configurations:
  - Cell or button
  - Cylindrical
  - Rectangular
- Found in:
  - Watches, digital cameras, flashlights, toys

Lithium Ion

- Lithium compound
- Tend to be rechargable
- Typical Configurations:
  - Cylindrical
  - Pouch
  - Prismatic/Rectangular
- Found in:
  - Laptops, power tools, e-bikes, vehicles, ESS

Dangers of Li-Ion Batteries: Terms to Know

"End-of-life" means batteries meeting their end of service life. They will be scrapped/shredded into precious metals or "Black Mass" or incinerated or landfilled.

Alternatively, "second life" for lithium batteries refers to their repurposing or refurbishing. These are not eligible for the recycling exceptions in the HMR.

"DDR" means damaged, defective, or recalled. These are batteries that are a greater risk and have greater regulatory restrictions. Common in recycling and disposal streams, and commonly found to be the cause of incidents.

"Thermal runaway" means the fire event that occurs in lithium batteries. It is uncontrollable, self-heating, and has a reignition risk that can last weeks.

"Propagation" means fire initiating from one battery causing other batteries in close proximity to go into thermal runaway, resulting in additional fires at the same time.

Dangers of Li-Ion Batteries: DDR

Can be caused by:

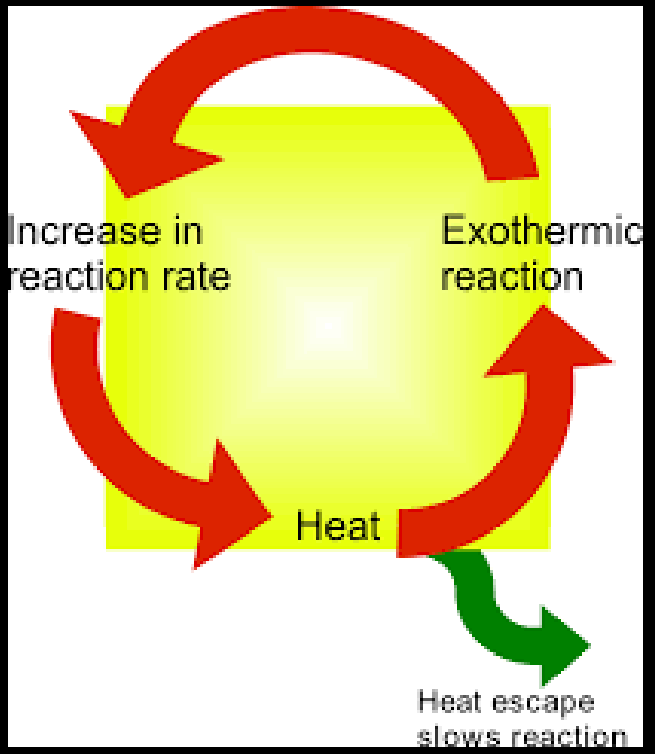
- Misuse
- Imperfections
- Overcharging
- Incompatibility
- Damage through impact

Are characterized as:

- Unreliable
  - No longer working appropriately
- Unpredictable
  - Overheat
  - Expansion/Swelling
  - Fire
  - Explosion
- Hazardous Waste
  - Disposal concerns
  - Expense

Characteristics of Li-Ion Fires

- Very toxic atmospheres
- Burn temperatures are higher than normal
- Battery fires can burn without Oxygen – can't smother!
- Explosive potential – Hydrogen Gas
- Thermal Runaway reaction
  - Chemical reaction – rapid degradation
  - Does not require Oxygen
  - Nearly impossible to stop once it starts
  - Could happen in seconds or days
- Re-ignition is common and cannot be predicted – can happen minutes, hours, days, weeks, months later



Exploding e-bike batteries were responsible for 190 fires in 2022

Structural fires caused by lithium-ion batteries each month

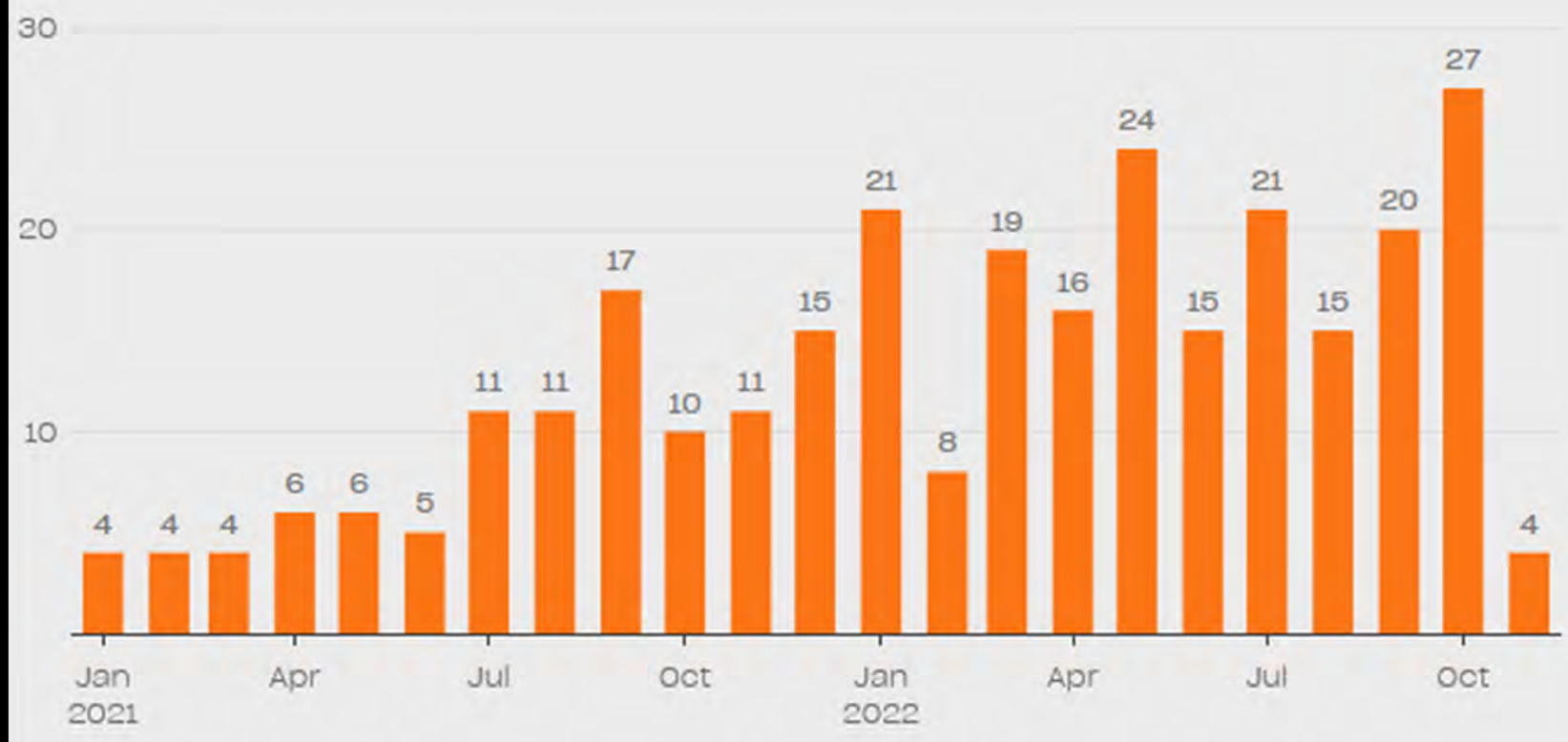


Chart: Suhail Bhat / THE CITY · Source: New York City Fire Department

THE CITY


Newsflare

BESS Incidents

Shipping Incidents
S-Trust Crude Tanker

Shipping Incidents
M/V Genius Star XI

Flooded Car Incidents

Hurricane Ian – September 2022

Hurricane Idalia – August 2023

Battery Accumulators

- May have large numbers of batteries (thousands to millions)
- Batteries may be ancillary to the business, or may be the business
- No limitations to location or staging

Battery Accumulator Identification

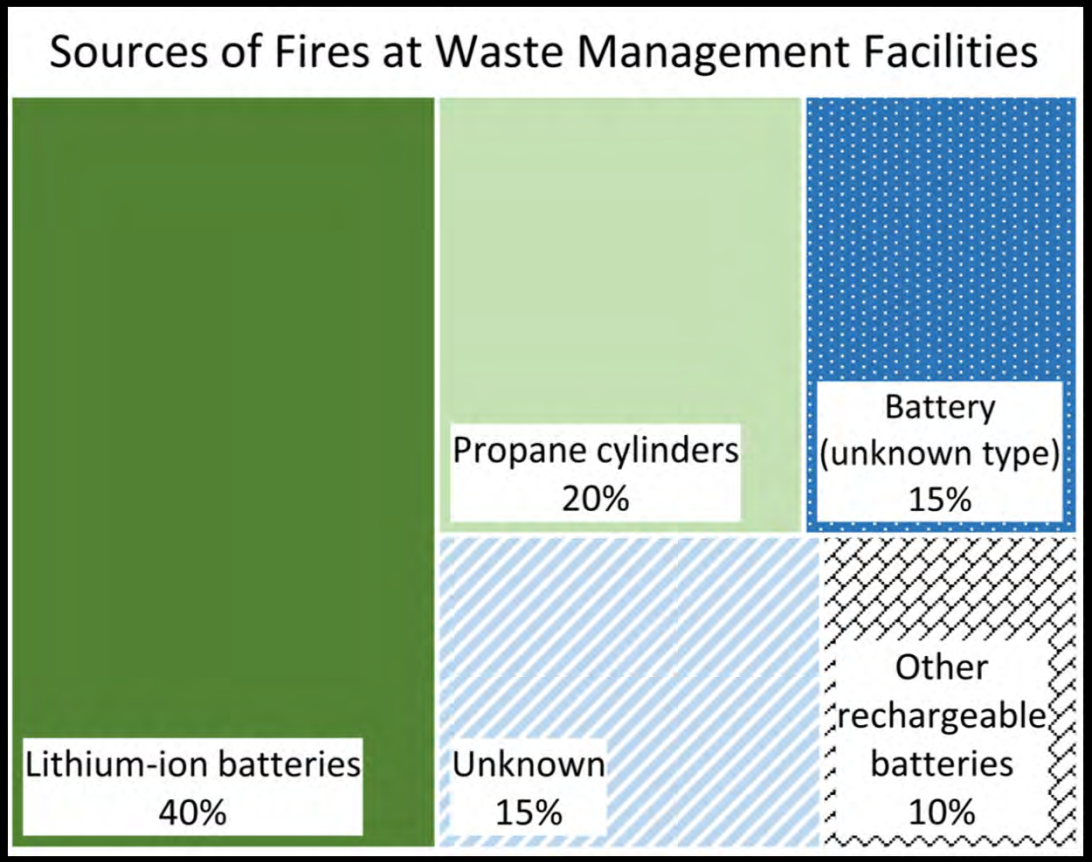
- Currently not necessarily required to report
- May contain many various battery types and chemistries
- Fires may be difficult to extinguish due to large amounts of plastic

Batteries may be involved in the incident OR they may be the cause of the incident

All Incidents

Transport & Disposal Challenges

- Trash trucks/recycling facilities
- 60% of trash truck load fires



Transport & Disposal Challenges

Shipping – DOT Restrictions for DDR Batteries

(f) ***Damaged, defective, or recalled cells or batteries.*** Lithium cells or batteries that have been damaged or identified by the manufacturer as being defective for safety reasons, that have the potential of producing a dangerous evolution of heat, fire, or short circuit (*e.g.*, those being returned to the manufacturer for safety reasons) may be transported by highway, rail or vessel only, and must be packaged as follows:

(1) Each cell or battery must be placed in individual, non-metallic inner packaging that completely encloses the cell or battery;

(2) The inner packaging must be surrounded by cushioning material that is non-combustible, electrically non-conductive, and absorbent; and

(3) Each inner packaging must be individually placed in one of the following packagings meeting the applicable requirements of part 178, subparts L, M, P, and Q of this subchapter at the Packing Group I level:

Transport & Disposal Challenges

DOT Special Permits

- Allows for handling material outside of the Hazardous Materials Regulations, provided a level of security can be met
- Takes time
- Can be issued to response company, manufacturer, project site

Case Study:
Maui Wildfire Response

2023 Maui Wildfire
Li-ion Batteries

Maui Wildfires: Li-ion Battery Operations – The Team

Stephen Ball: USEPA Region 10 On-Scene Coordinator

Keith Glenn: USEPA Region 2 On-Scene Coordinator

Greg Jenkins: Maui Fire Hazmat Captain (ret.), Matson, USEPA Contractor

Chris Myers: USEPA Region 9 On-Scene Coordinator

Eric Nuchims: USEPA Region 9 On-Scene Coordinator

Chris Reiner: USEPA Region 9 On-Scene Coordinator

Rob Rezende: San Diego City FD Hazmat Battalion Chief

Bryan Vasser: USEPA Region 4 On-Scene Coordinator

Leon Wirschem: San Diego County DEHQ – Hazmat Division/Emergency Response

USEPA START and ERRS Contract Support

State and Local Resources

FEMA MATO: Address Li-ion Batteries

Primary Sources:

- Battery Energy Storge Systems (BESS)
- Electric Vehicles (Cars, go-carts, golf carts, etc)

Secondary Sources:

- Limited mobility devices (bikes, scooters)
- Power tools
- Computers

Initial Challenges

- Li-ion batteries are unpredictable
- Concerns over safety of personnel and public
- Not a lot of guidance on how to handle them once impacted by fire
- Shipping via DDR is cost prohibitive and limited by shipping co.
- Shipping Co. do not like DDRs
- Little on-island resources for managing DDR/waste
- Processing in the field was only option
- How to take DDR Batteries to “Not Batteries”
- Disposal (Recycling)
- Few national experts

Reconnaissance - BESS

Intel Obtained from:

- Tesla Database
- HEPCO
- Owner Self-Assessment
- Ground Truth – EPA Teams

Different Brand = Different Battery Chemistry

Reconnaissance of “Powerwalls” (Residential BESS)

Removal/Recovery of “Powerwalls” (Residential BESS)

Step 1: Force Removal

Step 2: Move

Removal/Recovery of “Powerwalls” (Residential BESS)

Step 3:”Lau Lau” Wrap

Tyvek &
Fire Blanket

Step 4:Buffalo Convoy /
Relocate to Staging

Reconnaissance - EVs

- Maui County Data
- Motor Vehicles Data
- National Insurance Crime Bureau
- Owner Self-Assessment & Re-entry Forms
- Hotline, Commercials, PSAs
- Ground Truth – EPA Teams

No resources on-island for investigating battery health

Reconnaissance - Community Outreach
EVs

Maui Wildfire Recovery

Safely Removing Electric and Hybrid Vehicle Batteries

October 31, 2023

Maui gives so much to the world. As guests we are honored to give our support back.

The Federal Emergency Management Agency tasked EPA to remove lithium-ion batteries from electric and hybrid vehicles affected by the Maui wildfires. **The process includes:**

locating, recovering, de-energizing, transporting, & disposing of batteries.

The batteries should be considered extremely dangerous, even if they look intact. **Disturbing lithium-ion batteries can cause:**

- electric shock
- uncontrollable overheating
- release of toxic and/or explosive gasses
- fire

DO NOT:

- attempt to start, repair, charge, or sit in electric and hybrid vehicles
- remove vehicle batteries

If you have an electric or hybrid vehicle in the burn zone, please call the EPA hotline at: 808-539-0555 or the County of Maui's Abandoned Vehicle and Metals Office at: 808-270-6102.

To watch a video of EPA's electric and hybrid vehicle battery removal process, use this QR code.

808-539-0555 R9Wildfiresinfo@epa.gov epa.gov/maui-wildfires

YouTube Search

Electric and Hybrid Vehicle Battery Handling Informational

UNITED STATES EPA REGION IX EMERGENCY RESPONSE ENVIRONMENTAL PROTECTION AGENCY

0:00 / 1:10

Electric and Hybrid Vehicle Battery Deconstruction on Maui

EPA Regions 697 subscribers Subscribe 4 Share

246 views 8 days ago

MAUINOW Sections Maui News Wildfires & Recovery Business

EPA processing hundreds of thousands of lithium-ion batteries from Maui fires for recycling in Nevada

By Cammy Clark

November 15, 2023 · 10:00 AM EST

** Updated November 15, 2023 · 11:57 AM*

117 Shares

Listen to this Article 5 minutes

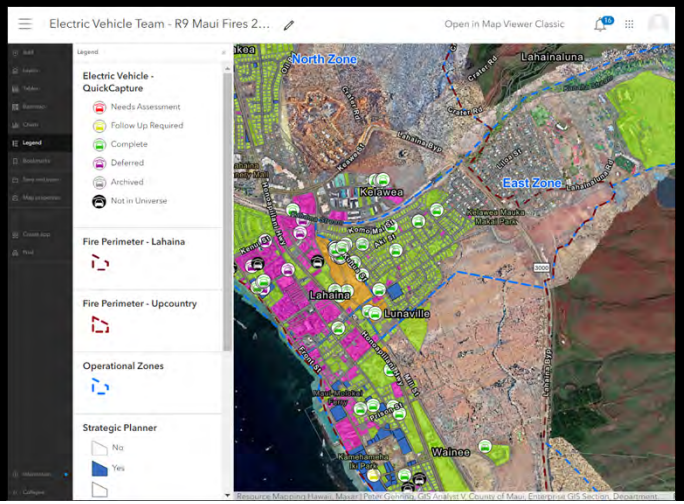
A A A

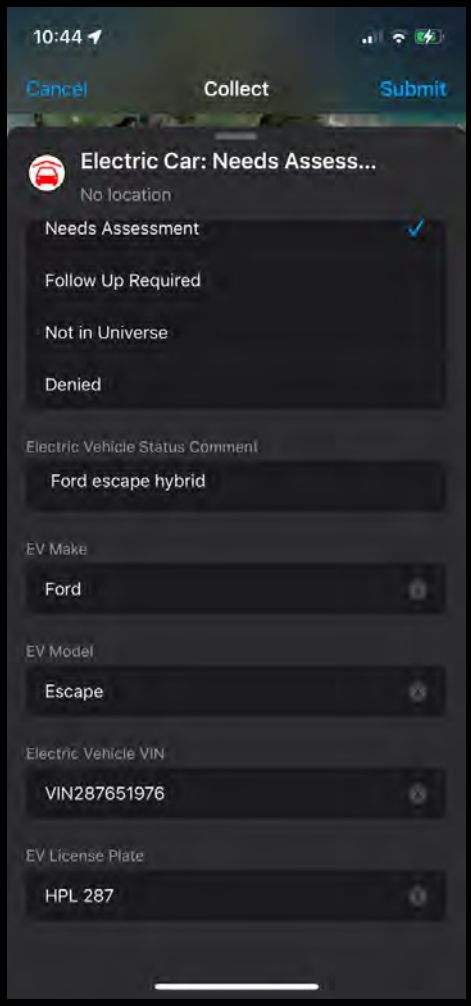
Workers at an EPA temporary processing site in Olowalu use a drumroller to crush lithium-ion batteries from the Lahaina burn site before they are shipped to the mainland for recycling of rare metals and disposal of what's left. PC: Cammy Clark

Reconnaissance - EVs

Data Management

- Assessment Info
- Point Collection in App
- Vehicle Research
- Battery Condition/Type





Battery Recovery/Removal - EVs

To gain an understanding of battery type, important to know:

- Make
- Model
- Year
- Option

This was a luxury if available.

Battery Recovery/Removal - EVs

Different Make = Different Battery

Different Model = Different Battery

Different Year = Different Battery

Different Option = Different Battery

National Fire Protection Association

Emergency Response Guides\Tech Ref

Battery Recovery/Removal – EVs (Tesla)

Step 1: Cut Roof/Access Points

Step 2: Flip Vehicle

Battery Recovery/Removal – EVs (Tesla)

Step 3: Remove Fasteners & Central Strip

Battery Recovery/Removal – EVs (Tesla)

Battery Recovery/Removal – EVs (Tesla)

Step 4: Cell Harvest

Battery Recovery/Removal – EVs (Toyota Prius)

Battery Recovery/Removal – EVs (Nissan Leaf)

Battery Recovery/Removal – EVs (Subaru)

Battery Recovery/Removal – EVs (BMW i3)

Battery Recovery/Removal – EVs (Difficulty w/ Insurance/Auction)

Battery Recovery/Removal – EVs (Difficulty w/ Insurance/Auction)

Health and Safety - EVs

Electrician

Temperature Checks

Air Monitoring

Health and Safety - Electrical Hazards-Voltage Checks

Electric Vehicle

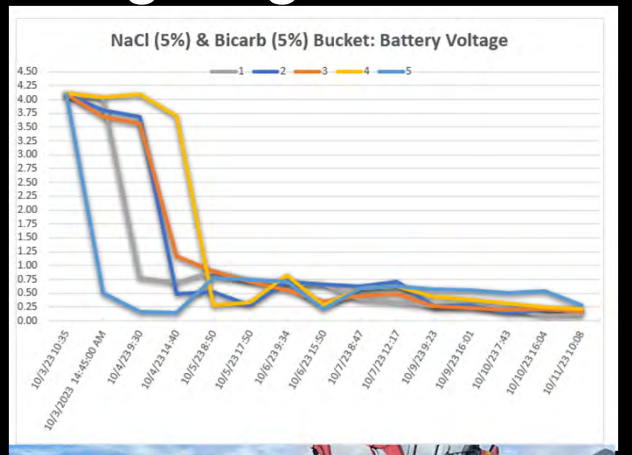
Residential Battery Energy Storage System

Health and Safety - Dust, Toxic Vapors, and Fire Hazards

Water/Pump and Hose Line in Place, PPE On

Battery Transport (BESS & EV)

Battery Processing – De-Energizing



Battery Processing – De-Energizing

Battery Processing – Crushing

Battery Processing – Crushing

What is it?
Battery? HazMat? Scrap Metal?

Waste Determination and Transportation

- Assess state of battery cell condition and charge
  - Increase state of charge is related to risk and reactivity
  - Brine solution can significantly reduce the state of charge.
  - Based upon battery assessment, as necessary brine/de-energize battery cells (5% Sodium Chloride, 5% Sodium Bicarb)

- Crush/destroy/de-construct
  - No longer meets the definition of a battery per EPA or a lithium-ion battery per DOT/PHMSA

Waste Determination and Transportation

- Material still observed to generated very limited toxic and flammable gases (Electrolysis, hydrolysis, oxidation, and/or decomposition)
- Material moved in packaging that provides:
  - Ventilation
  - Particulate Control
  - Water Intrusion Control
- Packaging transported in open top containers

Waste Determination and Transportation

Battery Packaging

Battery Packaging

Maui Wildfires 2023
Damaged Lithium-Ion Battery Management Guide for Electric Vehicles
Version: November 2, 2023

1. OBJECTIVE

The handling of damaged lithium-ion batteries inherently presents significant hazards to response personnel. This Guide has been established as a set of general guidelines for the proper handling of lithium-ion batteries to protect all response personnel. The purpose of this procedure is to outline the minimum requirements for safe handling, transportation, and the disposal process considerations for fire damaged lithium-ion batteries through a process of hazard identification and exposure control practices resulting in risk mitigation (Hazard x Exposure = Risk).This Guide is geared towards the following categories of lithium-ion batteries: Battery Energy Storage Systems (BESS), electric and hybrid vehicles (EVs), micromobility devices (e-bikes and scooters), and small batteries (vaping devices, computers, cell phones, etc.)

2. HAZARDS

Thermally insulted, burned or partially damaged lithium-ion batteries are susceptible to thermal runaway. This chemical reaction produces self-sustaining high temperatures that can result in the release of toxic and flammable/explosive vapors with the potential for fire (Figure 1). In addition to combustion products, the vapor produced during thermal runaway and fire can include the following hazardous and toxic and flammable/explosive vapors.:

- Hydrogen (30%-50%)
- Carbon monoxide (CO)
- Hydrogen fluoride (HF)
- Hydrogen chloride (HCl)
- Hydrogen cyanide (HCN)
- Phosphoryl fluoride (POF_3)
- Organic solvent droplets
- Ethane, methane, and other hydrocarbons

Figure 1: Diagram depicting a cascading thermal runaway event.

Burned or damaged batteries are unpredictable and cannot be considered fully discharged or free of hazards. Reignition from propagation or thermal insult to other cells within a battery is common and can occur 30 to 90 days from an initial thermal runaway event. During transportation, extreme temperatures and mechanical damage (such as puncturing or jostling) can trigger additional thermal runaway events. Batteries, groups of cells, or individual cells that have suffered significant fire damage may be present as a mass of melted or consumed material that must be evaluated by the Electric Vehicle Task Force to determine if the article has the remaining potential to be a functional cell or battery. When in doubt, the fire damaged article(s) in question must be rendered safe by the Electric Vehicle Task Force (eliminate the hazard) to effectively manage any risks associated with any necessary future steps, such as: local ground movement/transportation, disposal or remediation, and long-distance shipping by ground or vessel, etc.

SOPs - EVs

SUPERFUND TECHNICAL ASSESSMENT RESPONSE TEAM
STANDARD OPERATING PROCEDURE FOR RECONNAISSANCE OF ELECTRIC VEHICLES
2023 MAUI WILDFIRE RESPONSE
DRAFT OCTOBER 27, 2023

1. OBJECTIVE

This Standard Operating Procedure (SOP) describes the process to determine the presence and location of hybrid and electric vehicles (EVs) impacted by fire. Identification of EVs in a burn zone is necessary to ensure the proper handling and recycling/disposal of lithium ion and nickel-metal hydride battery packs. The objective is to identify and log all hydrid and EVs within the burn zone. This includes vehicles with partial or no visible impacts by fire since temperatures as low as 150 degrees fahrenheit can compromise the batteries. The purpose of the battery reconnaissance (recon) is to:

1) Understand the scope of the EV project and collect specific data in the site database which can then be queried for information;
2) Assist the battery recovery process;
3) Inform EPA's discussions of the disposition of EVs with interested third parties such as owners, insurance companies, local police and city officials, local auto recovery companies;
4) Plan battery processing activities; and
5) Plan disposal of EV batteries.

The Battery Recon Team will be followed by the Battery Removal Team which will be responsible for assessing the condition of the vehicle and the battery, if the battery should be removed, or if the owner of the vehicle or insurance company should be contacted (e.g., if the vehicle appears not to be impacted). The Battery Recon Team will typically be made up of 2-3 START personnel with oversight by an Federal On-Scene Coordinator.

2. SUMMARY OF METHOD

Recon is done by a team of trained hazmat responders familiar with vehicle manufacturers, models, and mechanical and battery technology. Teams will survey burned areas looking for vehicles with either hybrid or all electric drivetrains. Once a vehicle is positively identified with hybrid or EV technology, it is marked physically with paint or grease pencil, with a blue colored lightning bolt (typically paint can be used on burned vehicles and the grease pencil on non-burned vehicles on the windshield or glass) and digitally entered into electronic field collection and mapping software (QuickCapture via Field Maps). Additional methodology can be found in the Maui Wildfires 2023 Damaged Lithium-Ion Battery Management Guide for Electric Vehicles.

Maui Wildfire Recovery

Steps to Safely Removing Electric and Hybrid Vehicle Batteries

October 31, 2023

Maui gives so much to the world. As guests we are honored to give our support back.

The Environmental Protection Agency (EPA) and the County of Maui are locating hybrid and electric vehicles in the burn zone. If you own a hybrid or electric vehicle, please call EPA's hotline at: 808-539-0555 or the County of Maui Abandoned Vehicle and Metals Office at: 808-270-6102.

1. EPA will complete an inspection of the hybrid or electric vehicle batteries and battery casing.
2. EPA will carefully remove batteries which may indude cutting parts of the vehicle frame, flipping it over, and/or moving it to a safer location. Batteries will be safelytransported to EPA's staging area.
3. The batteries will be inspected and may be de-energized in a salt solution for 4-7 days.
4. Once made safe, the batteries will be crushed using heavy equipment.
5. The remaining material will be safely packaged and shipped to an appropriate off-island recycling facility.
6. Remaining vehicle debris will be removed by the U.S. Army Corps of Engineers during debris removal (Phase 2).

To watch a video of EPA's battery removal process, scan this QR code:

808-539-0555

R9Wildfiresinfo@epa.gov

epa.gov/maui-wildfires

JHA – Battery Energy Storage Systems

2023 Maui Wildfires

U.S. Environmental Protection Agency, Region 9

Emergency Response Section

JOB HAZARD ANALYSIS #7: Power Walls / Lithium Batteries

JHA		
JHA #: 007	**Name of Task:** Power Walls / Lithium Batteries	**Location:** 2023 Maui Wildfires
Task Description: Managing power walls and lithium batteries		**Task Duration:** Daily

Physical Hazards

Hazard	Source	Control Measures	Exposure Potential H	M	L	Unk	NA
Stored Energy (Electricity) / Fire and Explosion	1. Electric/Power supply lines 2. Power walls (Tesla and other brands or homemade versions) 3. Lithium batteries	1. Ensure all electrical power has been shut off/disconnected from the power wall: a. Licensed/certified electrician to verify power status. 2. Ensure no backfeeding to the power wall (i.e., solar panels or any other device that could potentially be feeding energy to or drawing energy from power wall). 3. Isolate the energy storage system (i.e., power wall) after verification that all energy to the system has been shut off or disconnected. 4. Prepare power wall for transportation: • Partially burned, Partially insulted, intact, but suspected insulted power walls: - Use SCBA for respiratory protection along with Flame-Resistant (FR) clothing. Completely charred or Completely charred and bulged power walls: – Use organic vapor/acid gas filters along with Flame-Resistant (FR) clothing. • Wrap powerwall in fireblankets (e.g., Bridgehill). • If any reaction occurs during handling, immediately drop the power wall and vacate the area to a safey place. • Place in transport vehicle and secure in place using straps or other equipment. • Ensure fire extinguisher and pressurized water sprayers are available during transport. 5. Transport power wall to secure staging area for further processing.: • Coordinate with local fire department prior to transport. • If reaction occurs during transport, park vehicle immediately in a location with minimal fire risk (to the extent possible); call fire department (dial 911) immediately for assistance.					
		• Maintain fire readiness (fire extinguishers and pressurized water sprayers to cool container during transport in the event of reaction/fire situation).					
Chemical Exposure	By-product of fires involving lithium batteries	See Chemical Hazards section below					

Biological Hazards

Hazard	Source	Control Measures	Exposure Potential H	M	L	Unk	NA
COVID-19 Exposure	Unknown	Follow COVID-19 protocols					

Chemical & Radiological Hazards

Hazard	Source	Control Measures	Exposure Potential H	M	L	Unk	NA
Hydrogen Fluoride	By-product of fires involving lithium batteries	1. Partially burned, Partially insulted, intact, but suspected insulted power walls: - SCBA required for respiratory protection while handling power walls. – Completely charred or Completely charred and bulged power walls: organic gas/acid gas filters required for respiratory protection. 2. FR clothing required for potential fires. 3. In the event a reaction occurs during handling, immediately drop the power wall and vacate the area to safety. 4. Notify the fire department (dial 911).					

PPE

Level A	Level B	Level C	Level D Mod	Level D
	Partially burned, Partially insulted, intact, but suspected insulted power walls: (SCBA for respiratory protection combined with FR clothing)	Completely charred or Completely charred and bulged power walls: (Organic gas/acid gas filters required for respiratory protection combined with FR clothing.)		

Other

None

JHA – EV Battery Removal & Transport

2023 Maui Wildfires

U.S. Environmental Protection Agency, Region 9

Emergency Response Section

JOB HAZARD ANALYSIS #3: EV Battery Removal and Transport

JHA		
JHA #: 003	**Name of Task:** EV Batteries	**Location:** 2023 Maui Wildfires
Task Description: Managing EV batteries		**Task Duration:** Daily

Physical Hazards – EV Battery Removal

Hazard	Source	Control Measures	Exposure Potential H	M	L	Unk	N/A
Overhead Hazards	Burned out structure debris	Situational awareness. Hard hat					
Trip Hazards	Burned out structure debris	Situational awareness, test footing prior to stepping on unknown area					
Electrocution	Energized power lines. Charged EV battery.	Assume all electric lines and appliances are energized. Evaluate EV battery prior to handling.					
Traffic	Vehicles traveling in work areas	Situational Awareness. High visibility vests					
Fall Hazard	Open septic field or tree root burnout	Situational Awareness. Mark deep fall hazards with caution tape and orange spray paint					
Falling Trees	Burned out trees	Situational Awareness. Observe Arborist markings trees. Avoid hazardous tree fall zones. Cease work with wind speeds of 20mph.					
Puncture Risk	Sharp objects in debris	Situational Awareness. Leather work gloves.					
Heavy Equipment	Crush zones during vehicle rotation	Situational Awareness. Spotter usage.					
Pinch Points	Cutting metal/lawn of life	Situational Awareness. Use leather work gloves.					
Heat Stress	Working in protective suits	Follow Work/Rest schedules. Stay Hydrated					
Lifting Injuries	Lift heavy batteries and equipment.	Use propped lifting techniques. Use two man lift for heavy objects Do not carry heavy objects far distances					

Physical Hazards – EV Batteries

Hazard	Source	Control Measures	Exposure Potential H	M	L	Unk	N/A
Stored Energy (Electricity) / Fire and Explosion	1. Electric/Power supply lines 2. EV high-voltage and low-voltage batteries	1. Ensure all electrical power has been shut off/disconnected from EV vehicle: a. Licensed/certified electrician to verify power status. 2. Ensure no backfeeding to the EV vehicle (i.e., solar panels or any other device that could potentially be feeding energy to or drawing energy from EV vehicle). 3. Isolate the energy storage system (i.e., EV battery) after verification that all energy to the vehicle has been shut off or disconnected. 4. Remove EV battery from vehicle using methods identified in the SOP; methods may include rotating vehicle (on side or completely flipped over) using heavy equipment, cutting metal using "Jaws of Life", removing bolts or other metal fasteners (see physical hazards above). 5. Prepare EV battery for transportation: • Active thermal event or poorly ventilated area - SCBA required for respiratory protection along with Flame-Resistant (FR) clothing OR Standard EV battery removal - organic gas/acid gas filters required for respiratory protection along with Flame-Resistant (FR) clothing. • Wrap EV battery in fireblankets (e.g., Bridgehill) or place loose material in drum with bung off. • If any reaction occurs during handling, immediately drop the EV battery and vacate the area to a safety place (upwind). • Place in transport vehicle and secure in place using straps or other equipment. • Ensure fire extinguisher and pressurized water sprayers are available during transport. 6. Transport EV battery to secure staging area for further processing: • Notify local fire department if thermal or other event occurs that requires a response. • If reaction occurs during transport, park vehicle immediately in a location with minimal fire risk (to the extent possible); call fire department (dial 911) immediately for assistance. • Maintain fire readiness (fire extinguishers and pressurized water sprayers to cool container during transport in the event of reaction/fire situation).					
Chemical Exposure	By-product of fires involving lithium batteries	See Chemical Hazards section below					

Biological Hazards

Hazard	Source	Control Measures	Exposure Potential H	M	L	Unk	N/A
COVID-19 Exposure	Unknown	Follow COVID-19 protocols					

Chemical & Radiological Hazards

Hazard	Source	Control Measures:	Exposure Potential H	M	L	Unk	N/A
Alkaline Ash and Battery	Remnants of burned out	Personal Data Rats worn by perimeter personnel. MultiRae monitoring by screening team. P100 respirators on EV					
Materials	Structures and battery materials	battery removal crew					
Asbestos	Remnants of burned out structures	Personal Data Rats worn by perimeter personnel. MultiRae monitoring by screening team. P100 respirators on EV battery removal crew					
Flamable and Combustable gases	Batteries	Well ventilated area. P100 respirators and proper eye protection (i.e., goggles). If ventilation concerns, switch to SCBA.					
Acid gases	Batteries	P-100 respirators, acid-proof gloves					
Lead acid	Batteries	Tyvek suites, acid-proof gloves					
Hydrogen Fluoride	By-product of fires involving lithium batteries	1. Active thermal event or poorly ventilated area - SCBA required for respiratory protection OR Standard EV battery removal - organic gas/acid gas filters required for respiratory protection. 2. FR clothing required for potential fires. 3. In the event a reaction occurs during handling, immediately drop the EV battery and vacate the area to safety. 4. Notify the fire department (dial 911).					

PPE

Level A	Level B	Level C	Level D Mod	Level D
	Active thermal event or poorly ventilated area. (SCBA for respiratory protection combined with FR clothing)	Completely charred or completely charred and bulged EV battery. (Organic gas/acid gas filters required for respiratory protection combined with FR clothing.)		

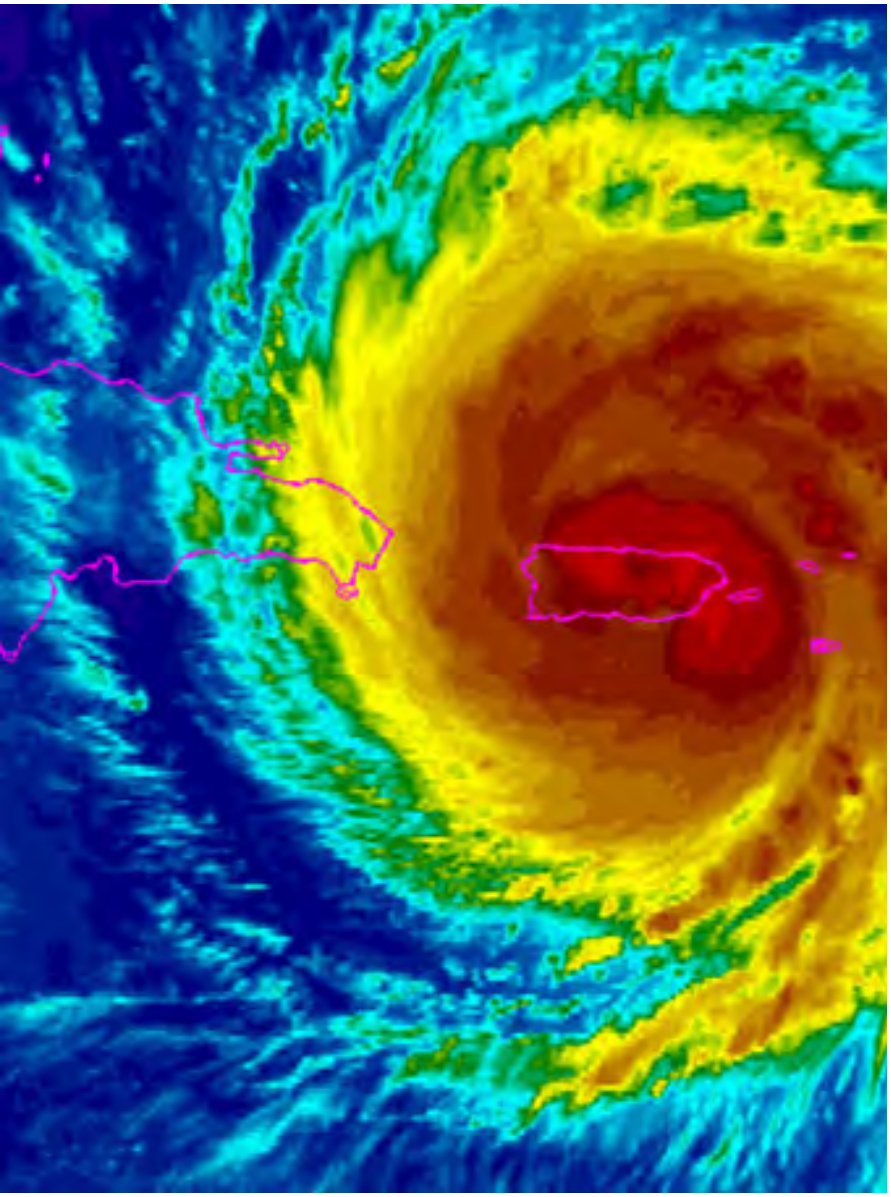
Other

None

NOTES:

From draft SOP on EV Reconnisance – Hazards and required PPE are listed as:
Many hazards exist when performing reconnaissance of burned vehicles. Some of these hazards include sharp edges, broken glass, puncture hazards, structurally unsafe walls, beams, and roofs, high voltage hazards, toxic dust, compromised trees, heat/cold stress, and many more. The recommended PPE for this task is: long sleeve pants and shirts, hardhat, safety toe boots with steel shank, cut resistant gloves, eye protection, high visibility vests, and a dust mask or respirator. Higher level PPE such as Tyvek and boot covers is recommended when conditions require entry into ash footprints.

From draft SOP on EV Battery Removal – Hazards and required PPE are listed as: Numerous chemical and physical hazards are present during vehicle battery recovery. Chemical hazards include acid gases and occasional lead-acid. Physical hazards are heavy lifting of responder tools, sharp metal, fire, heat, ash and dehydration. The PPE level utilized is Level C with half face respirator utilizing acid gas/P100 dual cartridge, flame retardant clothing (FRC), cut resistant gloves, hard hat and safety glasses. Tyvek suits are only utilized during lead acid battery removal.



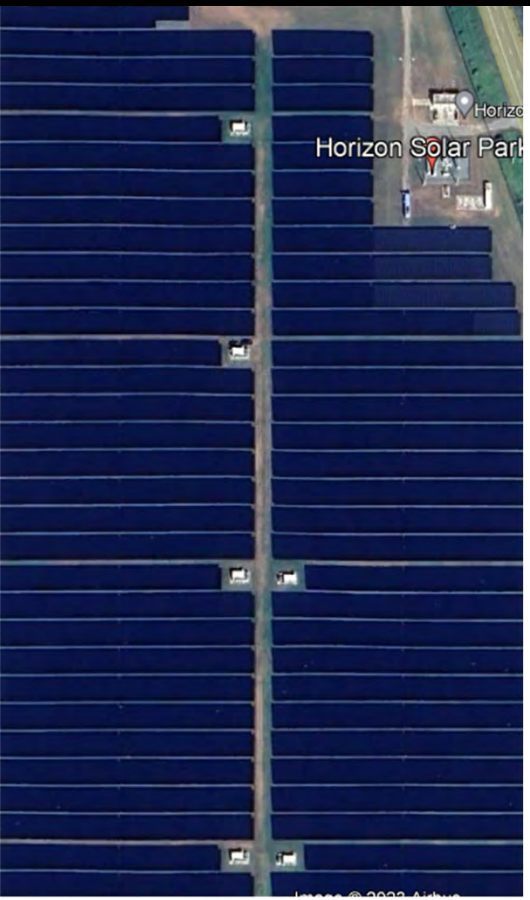
Concerns in Caribbean

- Energy and political initiatives
- Increase in micro-mobility devices
- Increase in EVs
- Use of energy storage systems
- Battery farming
- Weather pattern changes
- Points of disposal/recycling
- Shipping challenges
- Education
- Challenges at local response level

Puerto Rico: PR100

Meet 100% of the electrical needs with renewable energy by 2050

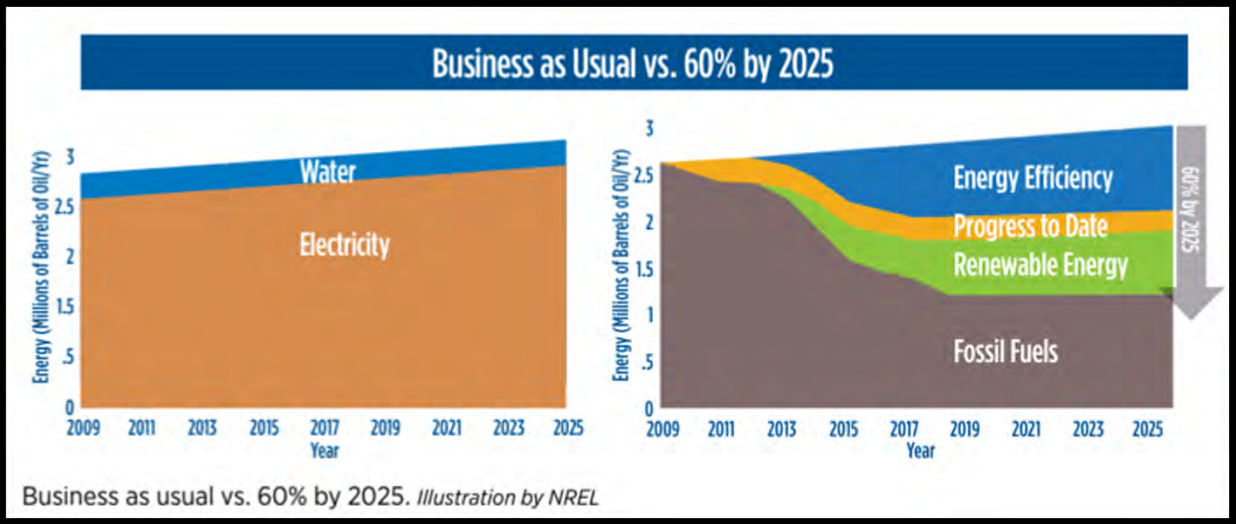
Puerto Rico



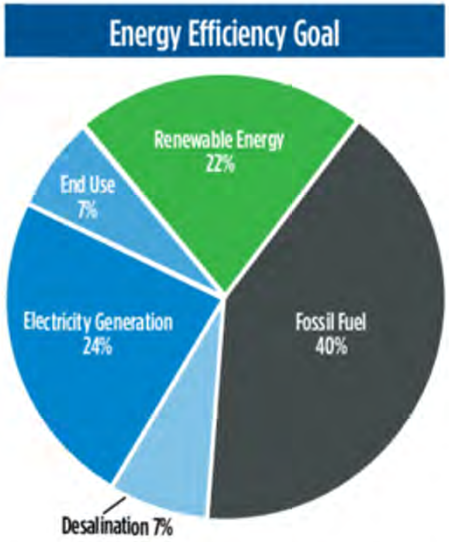
Punta Lima Wind Farm - Wind farm
58J4+R72
Naguabo 00718
Puerto Rico

U.S. Virgin Islands

goal of reducing fossil fuel–based energy consumption by 60% from business as usual by 2025



Business as usual vs. 60% by 2025. *Illustration by NREL*



Achieving the USVI's energy efficiency goal will require improvements in end-use efficiency, water treatment methods, and electricity generation and distribution. *Illustration by NREL*

U.S. Virgin Islands

Increased Use of Micro-mobility Devices and EVs

E·BIKES
SAN JUAN

Increased Use of Solar and ESS

Questions?

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