

# Li-Ion Battery Response Considerations



## Communications



November 2024 CRRT Presentation

# Li-Ion Battery Response Considerations

## Transportation



November 2024 CRRT Presentation



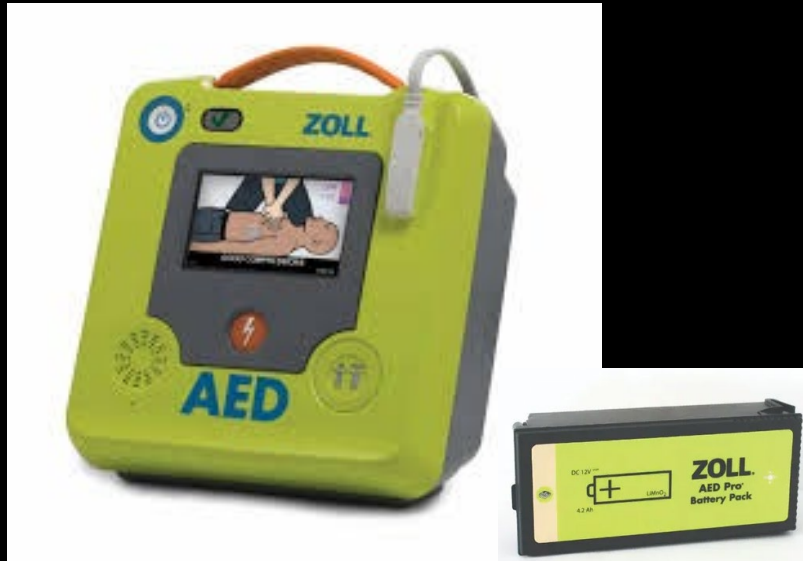
# Li-Ion Battery Response Considerations

## Energy Storage



November 2024 CRRT Presentation

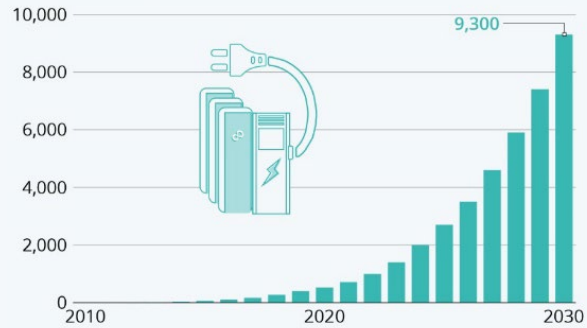
# Li-Ion Battery Response Considerations





## High Demand for Lithium-Ion Batteries

Cumulative lithium-ion battery demand for electric vehicle/energy storage applications (in GW hours)

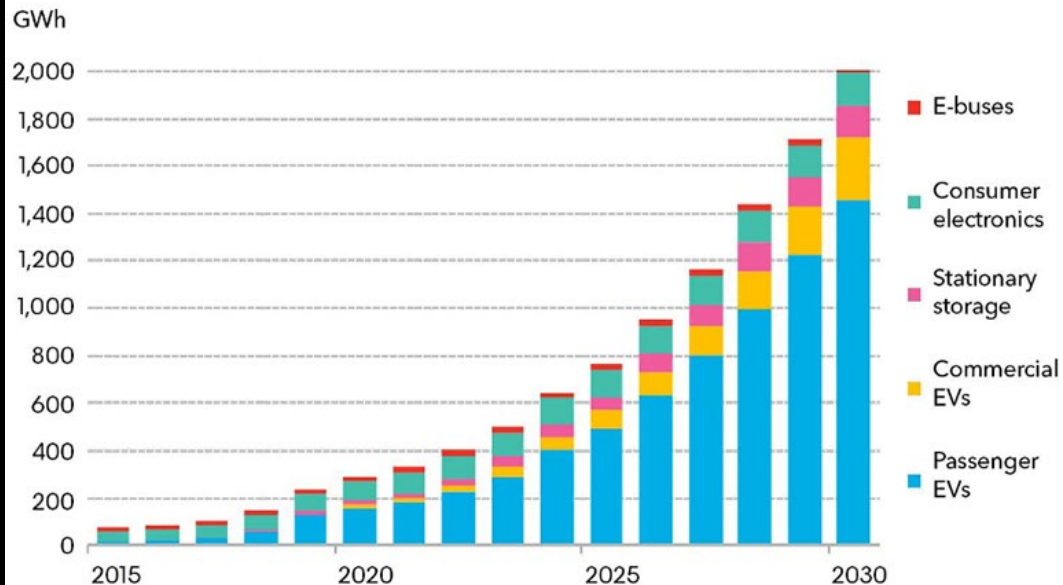


Source: Bloomberg

# 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

## Annual lithium-ion battery demand



2018

> 4 million



> 77 GWH



2028

50 to 200 million

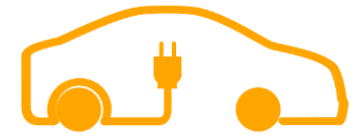


250 to 1100 GWH



2040

up to 900 million



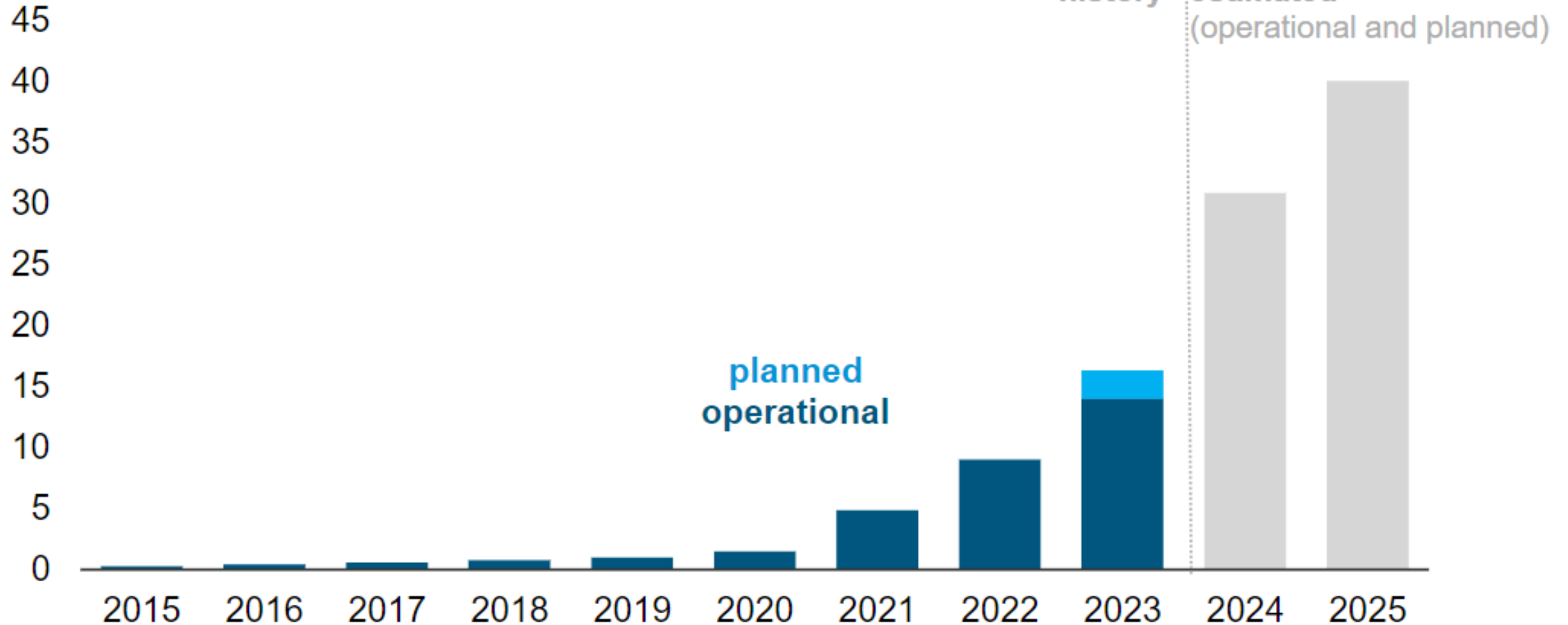
600 to 4000 GWH



# Trends in Li-Ion Batteries

Annual U.S. cumulative installed battery capacity (as of November 2023)

gigawatts



Data source: U.S. Energy Information Administration, [Preliminary Monthly Electric Generator Inventory](#), based on Form EIA-860M



# Trends in Li-Ion Batteries

## Last year, Americans registered more than 3 million electric and plug-in hybrid vehicles

While still a fraction of the more than 200 million gasoline vehicles registered every year, EVs are increasingly commonplace on the road.

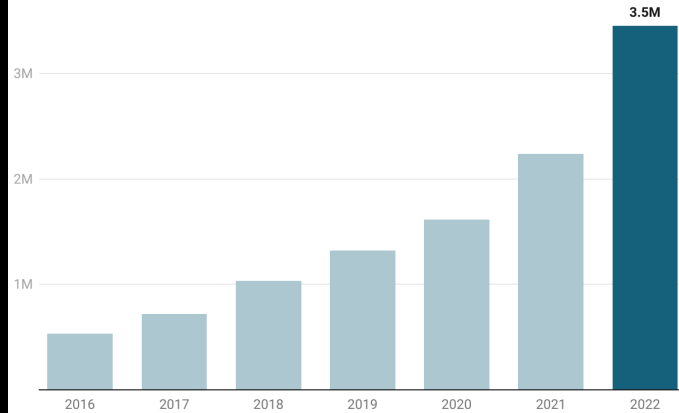
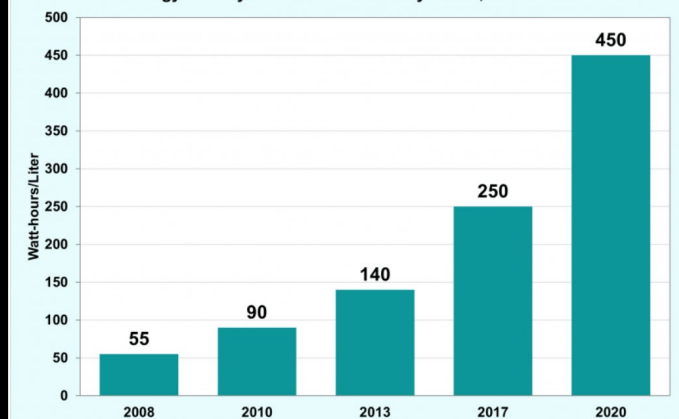


Chart: Scott Pham, CBS News • Source: Alternative Fuels Data Center, US Department of Energy

## A Shifting Risk Profile for Lithium-Ion Batteries

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

## Energy Density of Lithium-ion Battery Packs, 2008-2020



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.



## WARNING - FIRE and EXPLOSION RISK

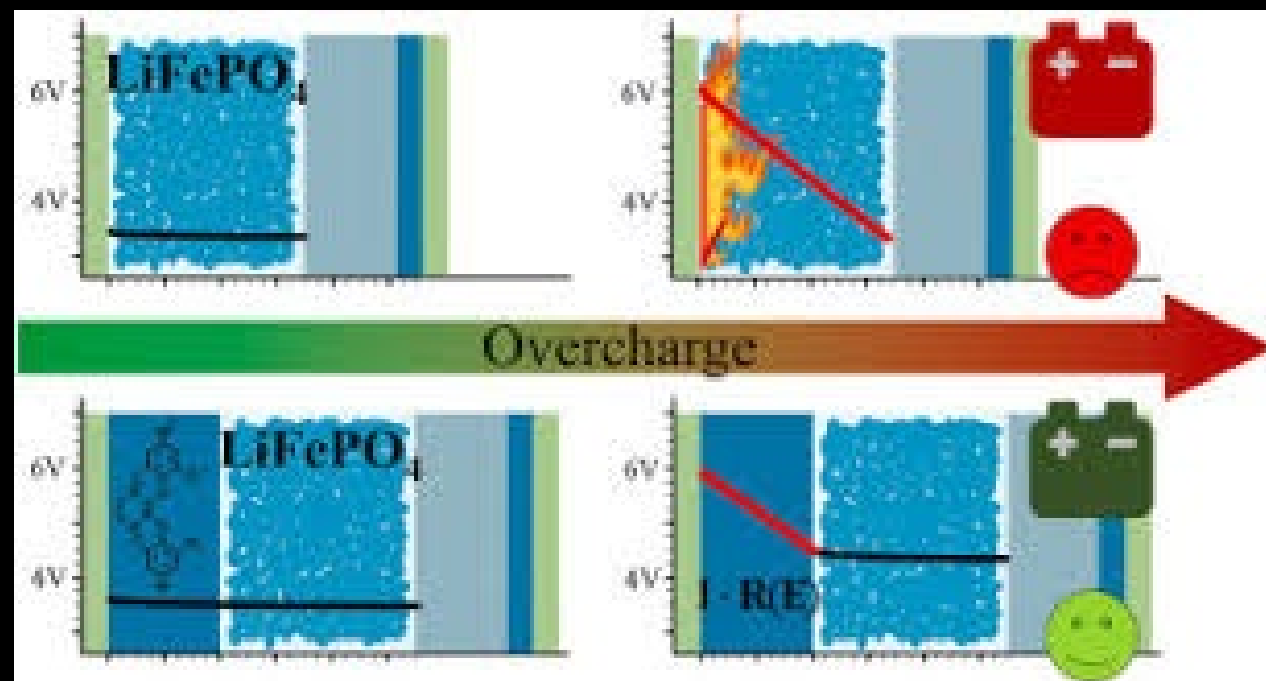
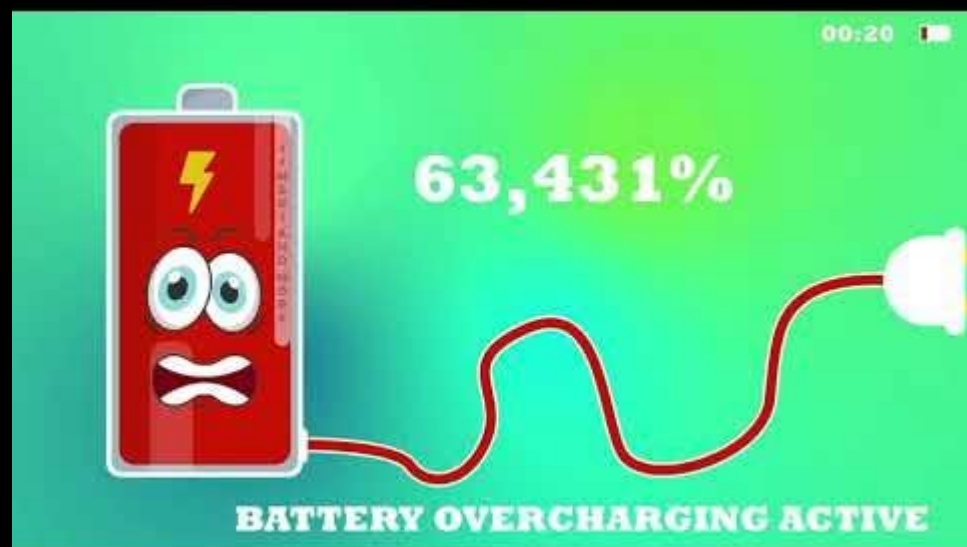
These 18650 batteries sold on Amazon may be dangerous or deadly



## Knockoff Battery Dangerous?









**OKAY  
IN  
TRASH**



**REQUIRES  
SPECIAL  
RECYCLING**





# Types of Lithium Batteries

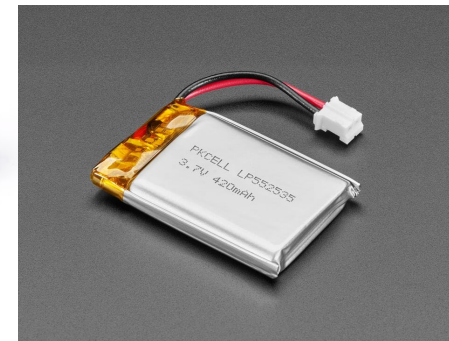
## Lithium Metal

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



## Lithium Ion

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



# Four Primary Presentations of LIB



Energy Storage Systems



Electric Vehicles

Micro-mobility



Personal Electronic Devices





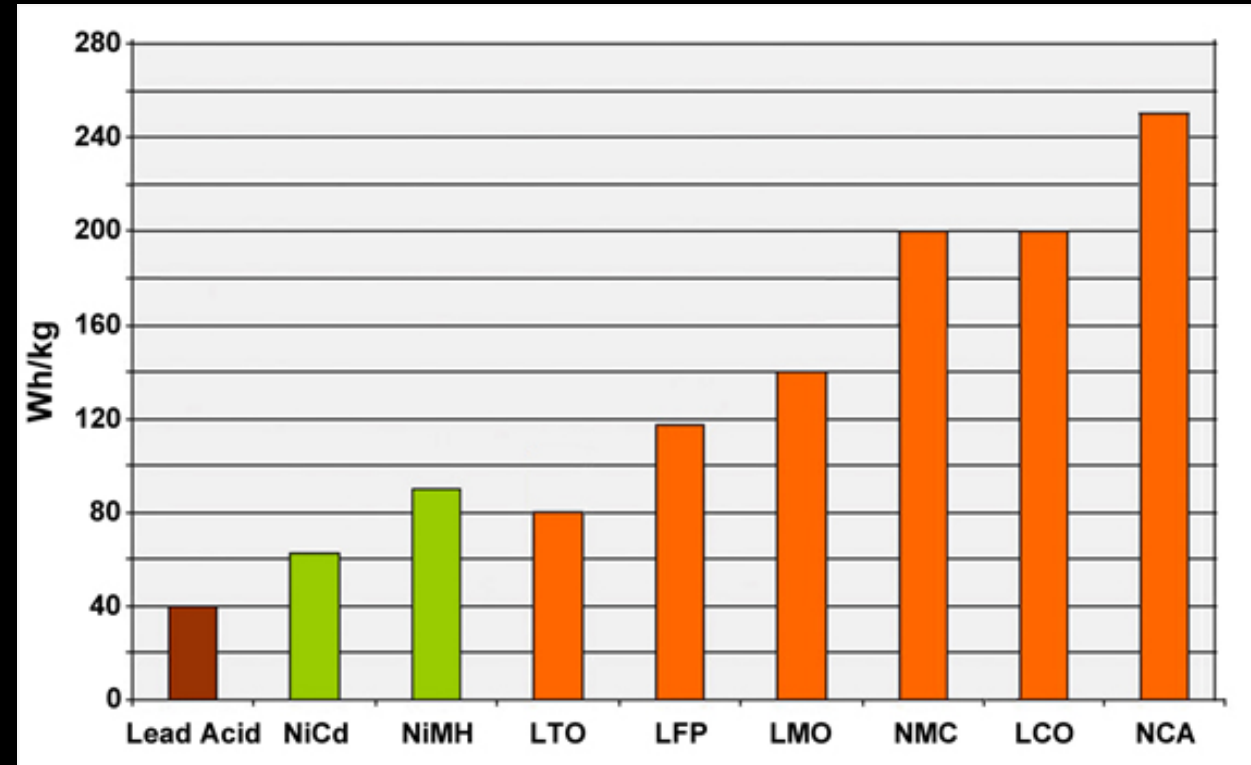
# Types of Li-Ion Batteries

## Styles

- Cylinder
- Pouch
- Prismatic



# Li-Ion Battery Chemistry



## Chemistry

- Lithium Cobalt Oxide( $\text{LiCoO}_2$ ) — LCO
- Lithium Nickel Cobalt Aluminum Oxide ( $\text{LiNiCoAlO}_2$ ) — NCA
- Lithium Nickel Manganese Cobalt Oxide ( $\text{LiNiMnCoO}_2$ ) — NMC
- Lithium Manganese Oxide ( $\text{LiMn}_2\text{O}_4$ ) — LMO
- Lithium Iron Phosphate( $\text{LiFePO}_4$ ) — LFP
- Lithium Titanate ( $\text{Li}_2\text{TiO}_3$ ) — LTO
- Lithium Hexafluorophosphate ( $\text{LiPF}_6$ ) - LHP

# 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 & Abuse
- Imperfections
- Overcharging
- Incompatibility/Modifications
- Damage through impact

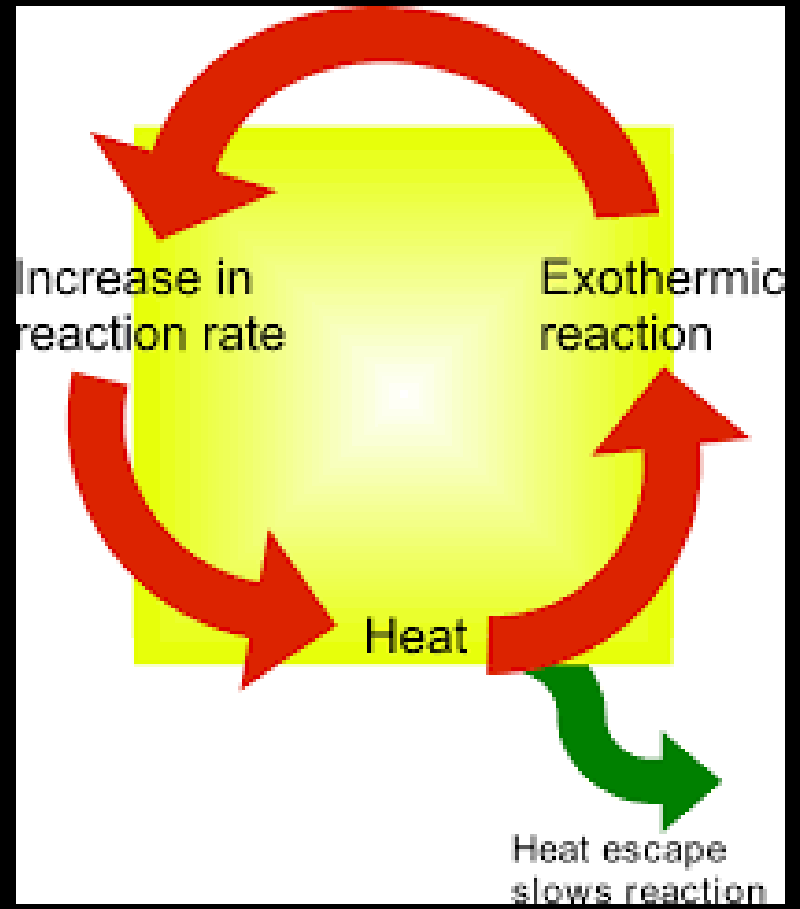


## Are characterized as:

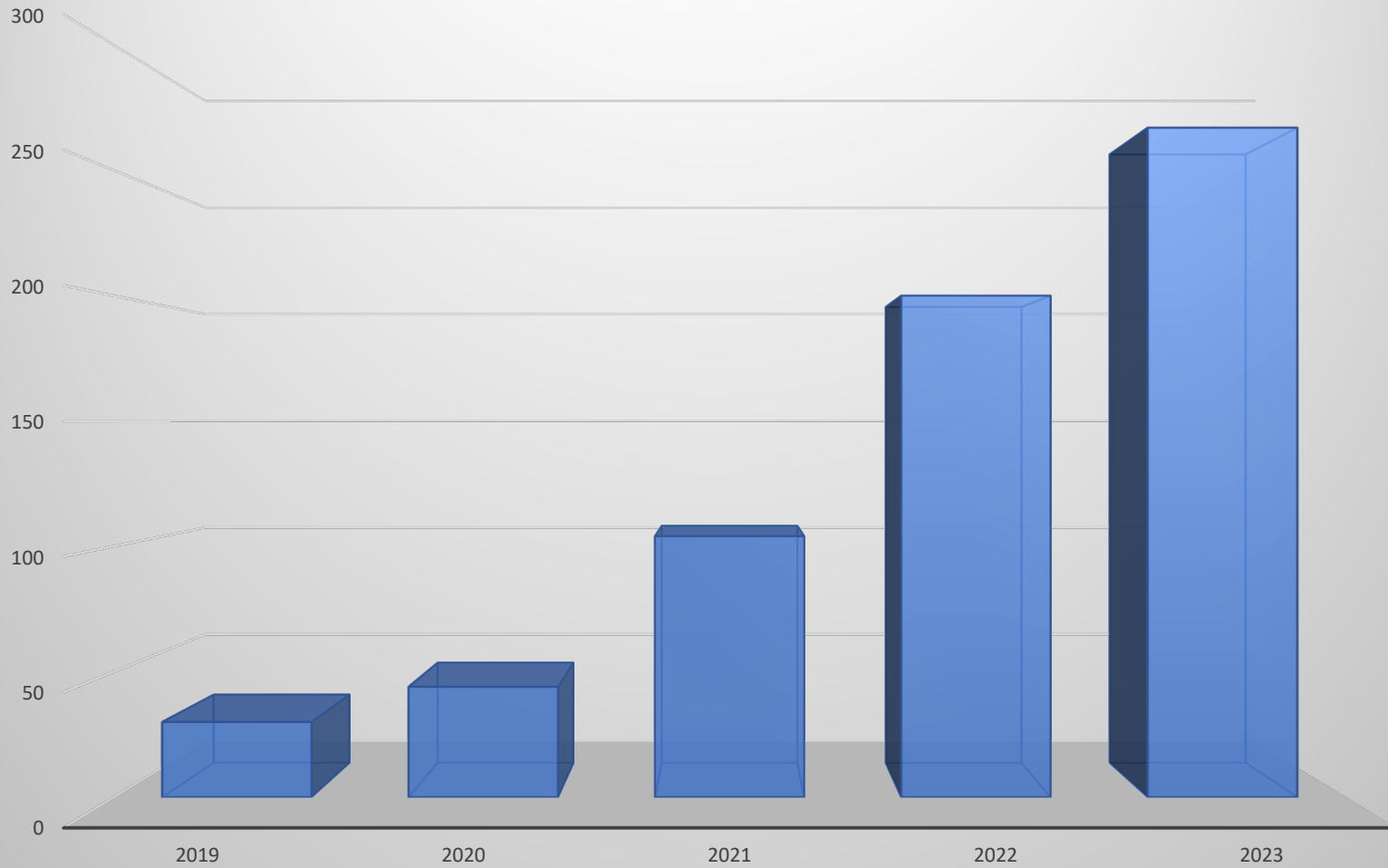
- Unreliable
  - No longer working appropriately
- Unpredictable
  - Overheat
  - Expansion/Swelling
  - Fire
  - Explosion
- Hazardous Waste
  - Disposal concerns
  - Expense

# Characteristics of Li-Ion Fires

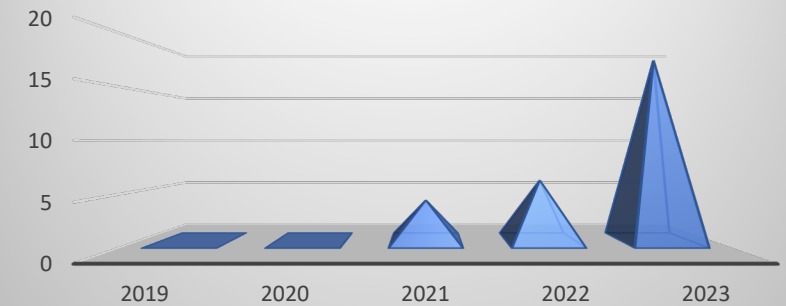
- Very toxic atmospheres – H, HF, HCN, CO
- Burn temperatures are higher than normal
- Battery fires can burn without Oxygen – can't smother!
- Explosive potential – Hydrogen Gas
- Thermal Runaway reaction
  - Chemical reaction – rapid degradation
  - Does not require Oxygen
  - Nearly impossible to 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



**Number of NYC Structure Fires  
Due to Exploding e-bikes**



**NYC Deaths By Lithium-Ion  
Batteries**





# Characteristics of Li-Ion Fires



- Signs of trauma
- Gasses emitting
- Increase in temperature
- Pop and hiss
- Projectiles
- Intense fire
- Propagation
- Secondary fires





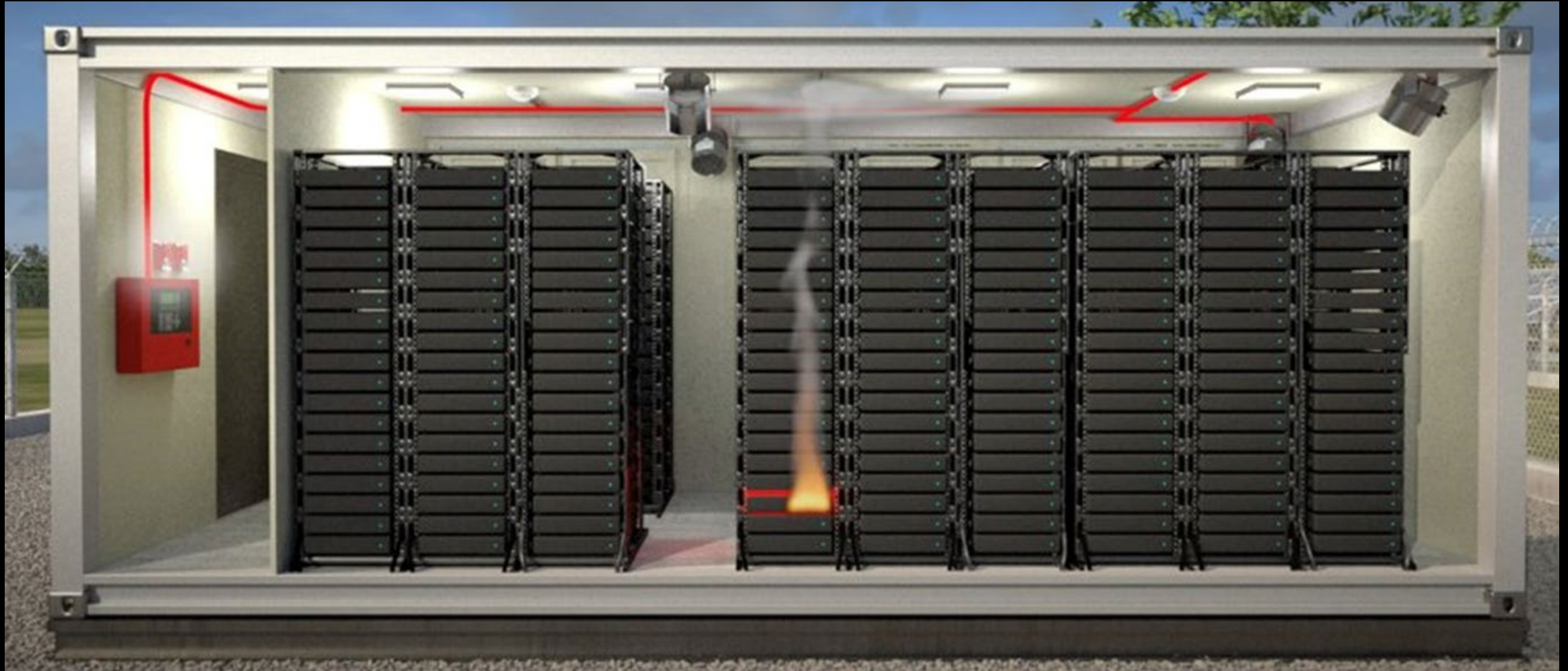








# BESS Incidents









# Flooded Car Incidents

Hurricane Ian – September 2022

Hurricane Idalia – August 2023



**ELECTRIC VEHICLE FIRES CAUSED BY SALTWATER FLOODING**



6:15  
90°

Surveillance

Credit: Pinellas County Government

Nest

# Flooded Car Incidents

Hurricane Helene  
September 2024





# 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






# Battery Recyclers





**ELECTRIC TRUCK SMOLDERING DAYS AFTER CRASH**  
**EYEWITNESS NEWS**

abc 7  
#abc7eyewitness



United States  
Environmental Protection  
Agency

## EPA Completes Time-Critical Cleanup at Warehouse

**Morris Lithium Battery Site**  
Morris, Illinois

October 2022

**For more information**

If you have questions, comments or need more information about the Morris Lithium Battery Fire site cleanup contact these U.S. EPA team members:

*For technical questions*  
**Len Zintak**  
On-Scene Coordinator  
312-886-4246  
zintak.leonard@epa.gov

*For general questions*  
**Muhtsun**

U.S. Environmental Protection Agency has completed a time-critical cleanup at the Morris Lithium Battery site. On June 29, 2021, a significant fire erupted at a building where a large quantity of batteries, including lithium batteries, were stored. Lithium batteries contain a flammable electrolyte that can become pressurized when damaged causing them to rupture and catch fire. Additional items containing potentially hazardous materials including solar panels and waste electronics were also found at the warehouse.

During winter months, EPA conducted periodic site inspections to ensure the perimeter fencing, building fencing, and the targeted batteries inside the building were secured. EPA also conducted perimeter and neighborhood air monitoring during these inspections.

Since completing the active clean-up in April 2022, EPA has consolidated

U.S. ENVIRONMENTAL PROTECTION AGENCY  
POLLUTION/SITUATION REPORT  
Goo Smoke Shop Fire - Removal Polrep  
Initial Removal Polrep

The logo is circular with a red border. Inside the border, the words "UNITED STATES OF AMERICA" are written in a semi-circle at the top and "EMERGENCY RESPONSE" at the bottom. In the center, there is a blue circle with the white "EPA" logo, and below it, the words "EMERGENCY RESPONSE" are written in red.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY  
Region V

Subject: POLREP #1  
Initial  
Goo Smoke Shop Fire  
D512  
Clinton Twp., MI  
Latitude: 42.5531270 Longitude: -82.9266370

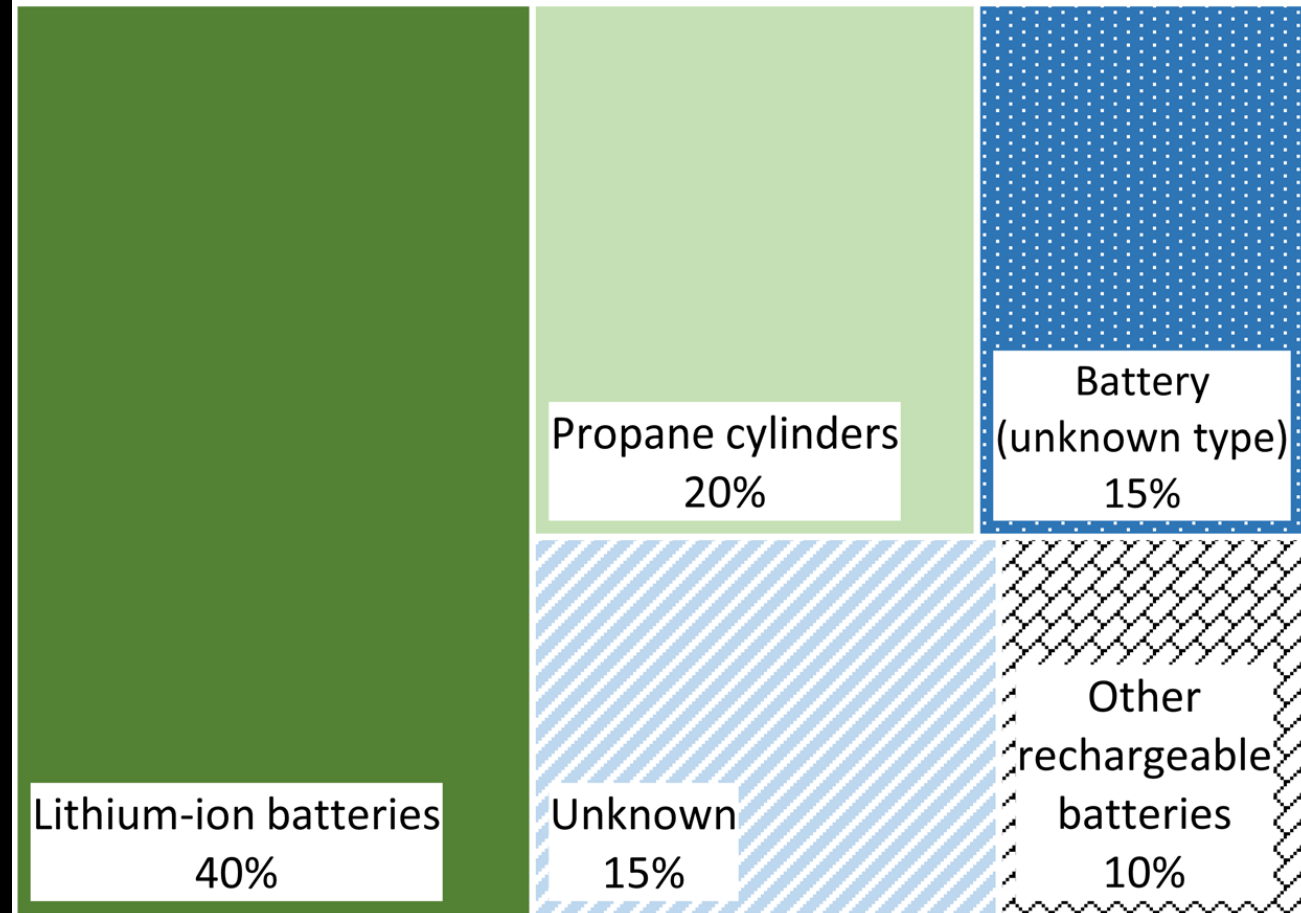


# Transport & Disposal Challenges

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



Sources of Fires at Waste Management Facilities



# 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:

DDR Batteries cannot be transported via aircraft.



# 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



# Electric Vehicles, Batteries, Cobalt, and Rare Earth Metals

October 25, 2017 | 11:59 am



BATTERY PACK FOR BMW i3 ELECTRIC VEHICLE (AT MUNICH TRADE SHOW ELECTRONICA). PHOTO: RUDOLFSIMON CC-BY-2.0 (WIKIMEDIA)

The case for switching to electric vehicles (EVs) is nearly settled. They are cheaper to use, cut emissions, and offer a whisper

quiet ride. One of the last

arguments available to the EV-hater club, which is largely comprised of thinly veiled oil-industry front groups funded by the Koch brothers, focuses on the impacts from the materials used to make an EV's battery pack.

Specifically, the use of lithium, cobalt, nickel, and other metals that are part of an EV lithium-ion battery pack has raised red flags about the poor human rights and worker protection records in the countries where these materials



**Josh Goldman**  
Former Contributor

## Hazardous Waste

CONTACT US

Hazardous Waste Home

Learn the Basics of  
Hazardous Waste

Hazardous Waste  
Management

Generation

Identification

Definition of Solid Waste

Exclusions

Characterization

Delistings

Transportation

Permitting

Land Disposal Restrictions

Requirements for Importers

Requirements for Exporters

Recycling

Cleanups

Regulations for Certain  
Wastes

EPA Hazardous Waste  
Initiatives

SW-846 Test Methods

State Authorization

A to Z Directory of Topics

## Lithium-Ion Battery Recycling

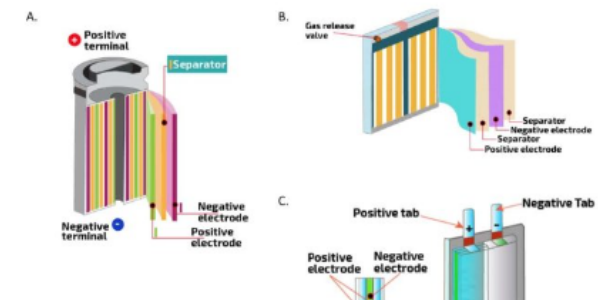
On this page:

- [Background on Lithium Batteries](#)
- [Lithium-Ion Batteries as Waste](#)
- [How Lithium-Ion Batteries are Recycled](#)
- [Lithium-Ion Battery Reuse](#)
- [Additional Resources](#)

### Background on Lithium Batteries

Lithium-ion batteries are a type of commonly used rechargeable batteries that vary in size and design, but work in very similar ways. A battery is made of one or more cells, with each individual cell functioning to produce electricity.

A cell contains an anode layer, a cathode layer, and a separator, all of which are in contact with an electrolyte, which is most often a liquid. These components are stacked or rolled together and placed in an outer packaging— typically either a steel can or an aluminum/polymer pouch material.



### Find a Recycling Location Near You

To find a battery recycling location near you, consult the following resources:

- [Earth911](#) ↗.
- [Call2Recycle](#) ↗.
- [Consumer Technology Association's Greener Gadgets](#) ↗.

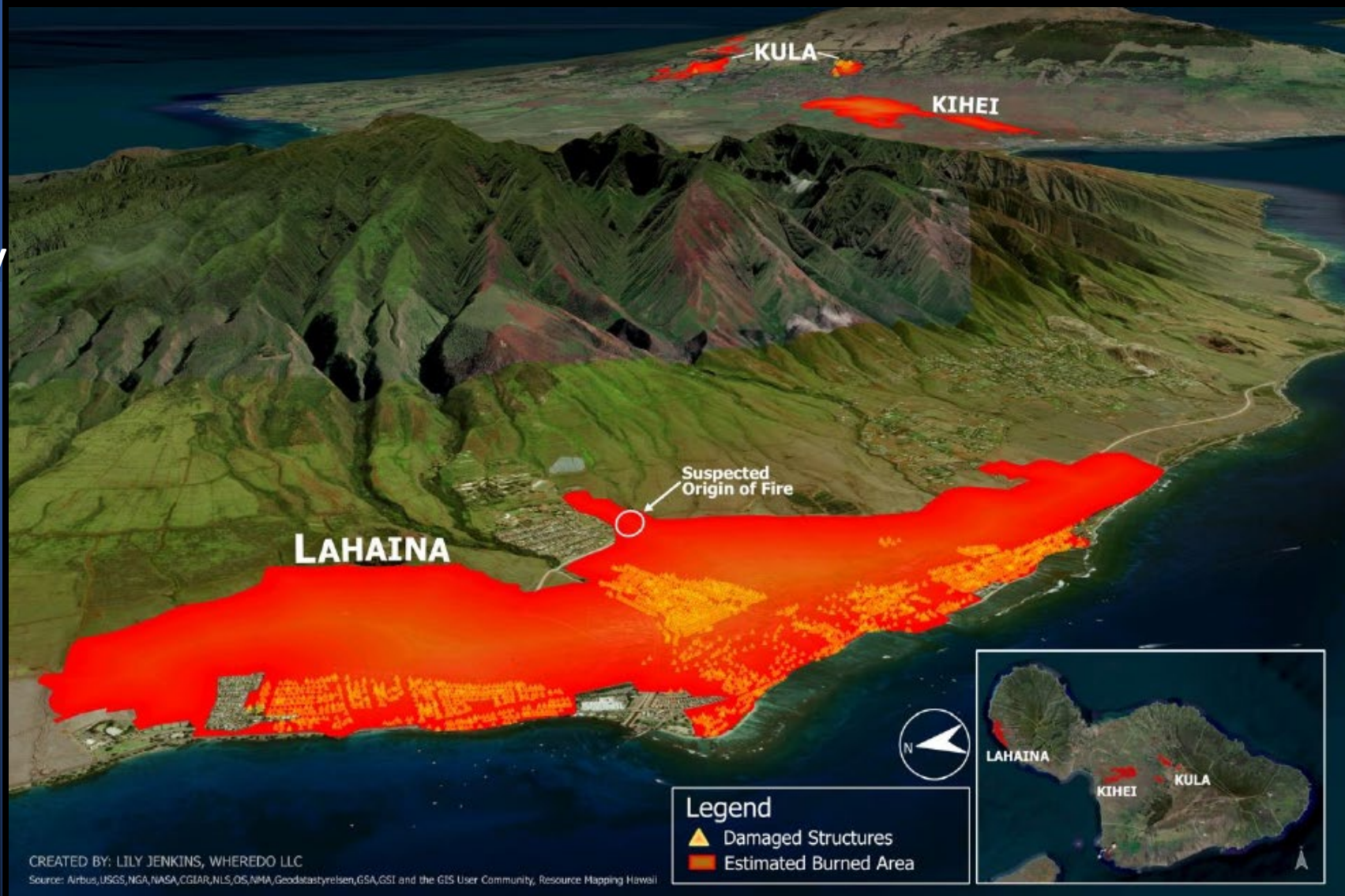
**Disclaimer:** These sites are listed for informational purposes only. U.S. EPA does not endorse any of these entities or their services.





# Lithium-Ion Battery Case Study:

## Maui Wildfire Response

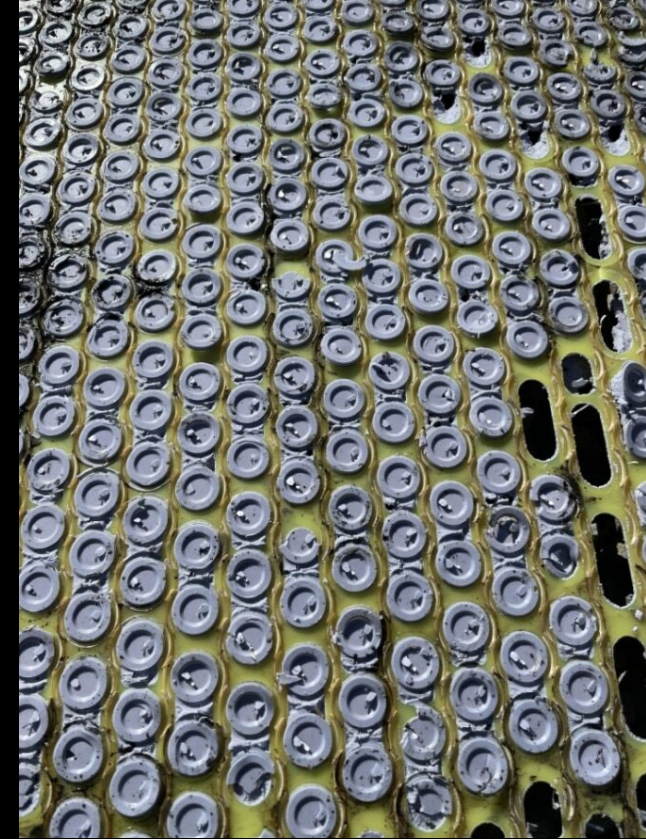


October 2024 ERT Presentation





# 2023 Maui Wildfire Li-ion Batteries



*Disclaimer:* The actions carried out by the EPA, contractors, and support staff were based on the knowledge and information available at the time. At the time of the Maui Wildfire Response, the behavior of lithium-ion batteries was not well understood. Future responses may involve different actions depending on lessons learned, updated data, or new regulations.





## 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 Storage 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.



Search

## Electric and Hybrid Vehicle Battery Handling Informational



## Electric and Hybrid Vehicle Battery Deconstruction on Maui



EPA Regions  
697 subscribers

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4   Share

246 views · 8 days ago

## 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



Listen to this Article  
5 minutes



Workers at an EPA temporary processing site in Olowalu use a drum roller 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

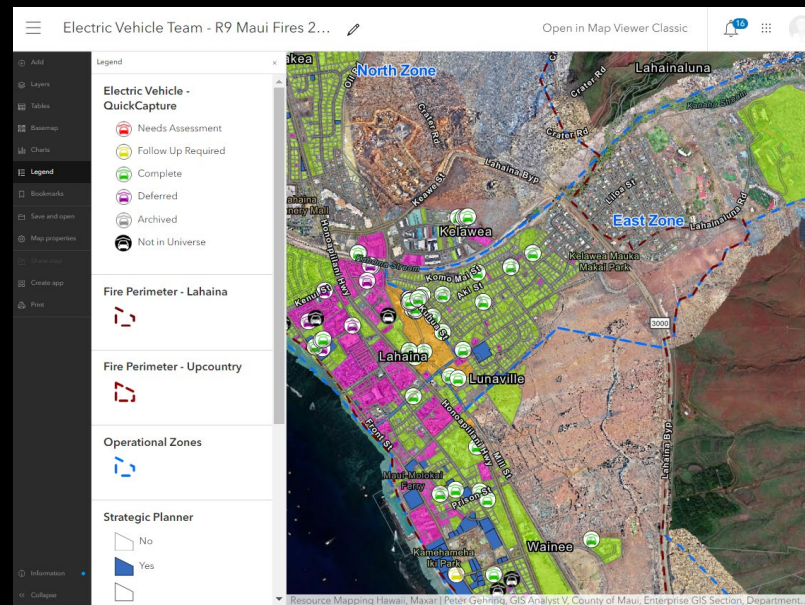




# Reconnaissance - EVs

## Data Management

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



10:44

Cancel Collect Submit

Electric Car: Needs Assess...

No location

Needs Assessment ☒

Follow Up Required ☐

Not in Universe ☐

Denied ☐

Electric Vehicle Status Comment

Ford escape hybrid

EV Make

Ford

EV Model

Escape

Electric Vehicle VIN

VIN287651976

EV License Plate

HPL 287



## 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)











## 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



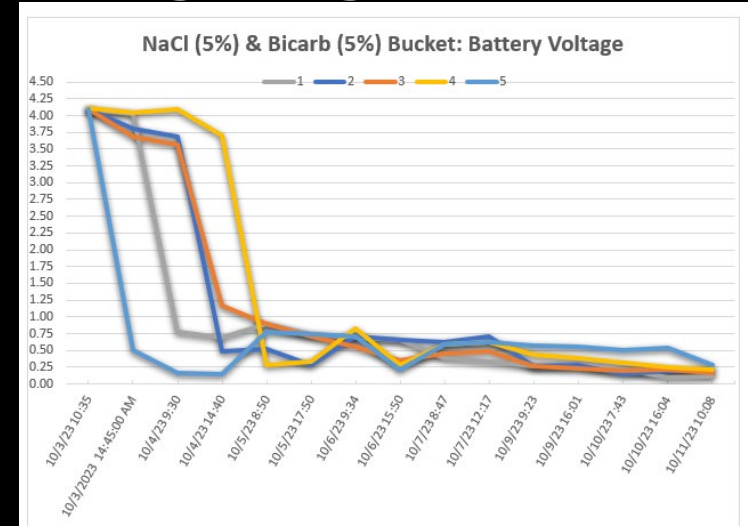


## Battery Transport (BESS & EV)





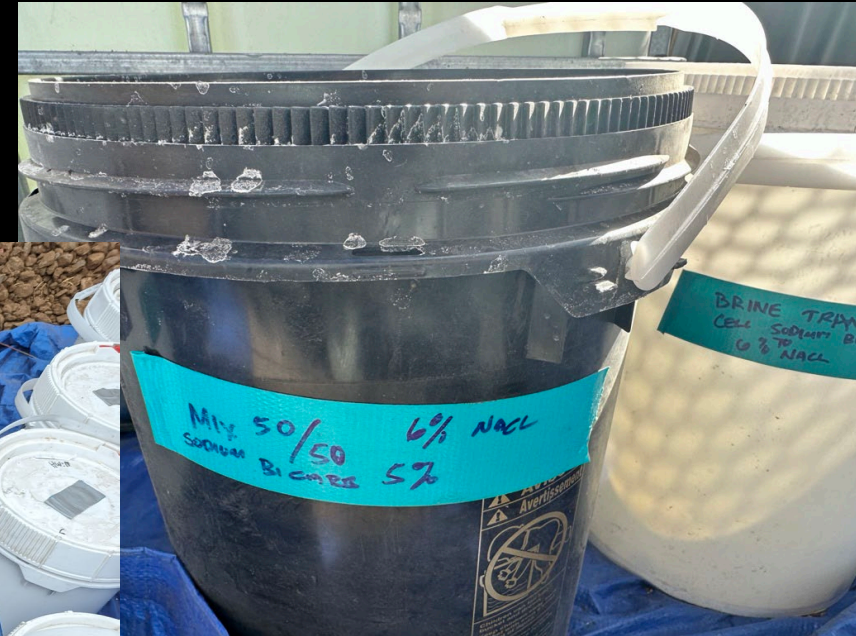
# Battery Processing – De-Energizing







## 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











**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 hybrid 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 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 insulated, 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<sub>3</sub>)
- 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



## Maui Wildfire Recovery

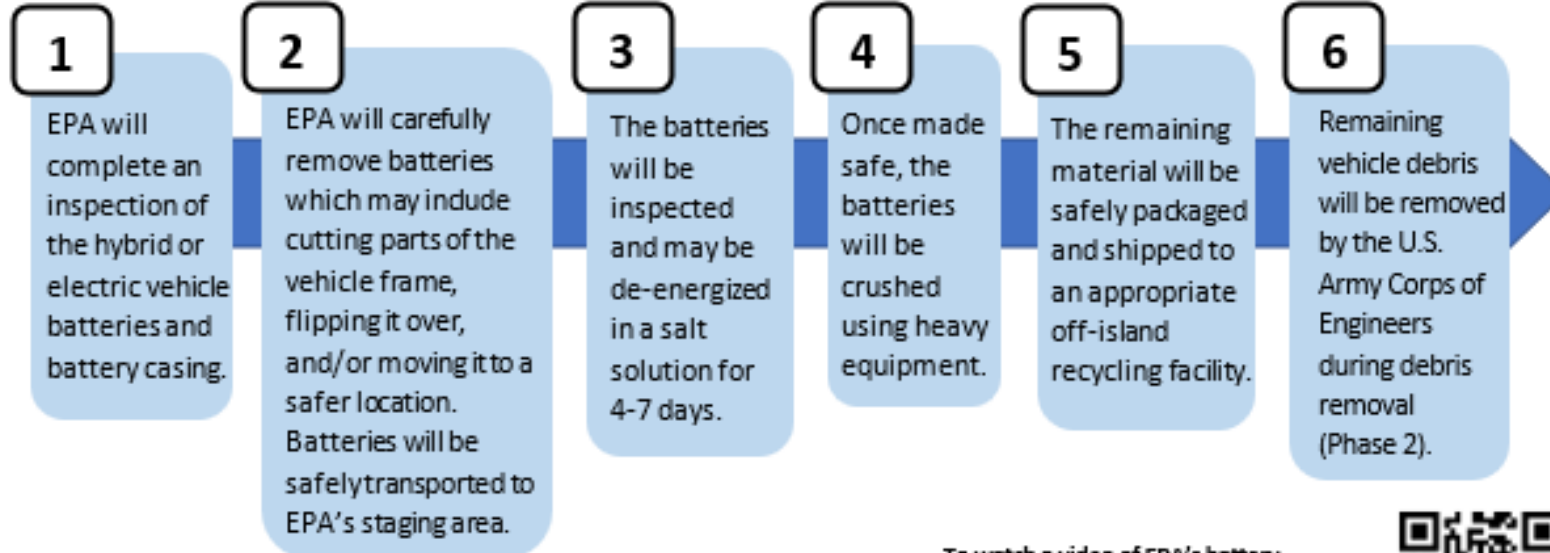
### Steps to Safely Removing Electric and Hybrid Vehicle Batteries

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](tel:808-539-0555) or the County of Maui Abandoned Vehicle and Metals Office at: [808-270-6102](tel:808-270-6102).



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



808-539-0555



[R9Wildfiresinfo@epa.gov](mailto:R9Wildfiresinfo@epa.gov)



[epa.gov/maui-wildfires](https://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	N/A
Stored Energy (Electricity) / Fire and Explosion	1. Electric/Power supply lines	1. Ensure all electrical power has been shut off/disconnected from the power wall:  a. Licensed/certified electrician to verify power status.					
	2. Power walls (Tesla and other brands or homemade versions)	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. Lithium batteries	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: <ul style="list-style-type: none"><li>Partially burned, Partially insulated, intact, but suspected insulated 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.</li><li>Wrap powerwall in fireblankets (e.g., Bridgehill).</li><li>If any reaction occurs during handling, immediately drop the power wall and vacate the area to a safety place.</li><li>Place in transport vehicle and secure in place using straps or other equipment.</li><li>Ensure fire extinguisher and pressurized water sprayers are available during transport.</li></ul>						
	5. Transport power wall to secure staging area for further processing: <ul style="list-style-type: none"><li>Coordinate with local fire department prior to transport.</li><li>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.</li></ul>						

		• 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
COVID-19 Exposure	Unknown	Follow COVID-19 protocols					

Chemical & Radiological Hazards							
Hazard	Source	Control Measures	Exposure Potential				
			H	M	L	Unk	N
Hydrogen Fluoride	By-product of fires involving lithium batteries	1. Partially burned, Partially insulated, intact, but suspected insulated 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 insulated, intact, but suspected insulated 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 #8: EV Battery Removal and Transport

JHA		
JHA #: 008	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/Jaws 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	Red	Yellow	Green	Unk	N/A

		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 safe 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 Ram 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 Ram worn by perimeter personnel. MultiRae monitoring by screening team. P100 respirators on EV battery removal crew					
Flammable and Combustible gases	Batteries	Well ventilated area. P100 respirators and proper eye protection (i.e., goggles). If ventilation concerns, switch to SCBA.					
Acid gases	Batteries	P100 respirators, acid-proof gloves					
Lead acid	Batteries	Tyvek suits, 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).					

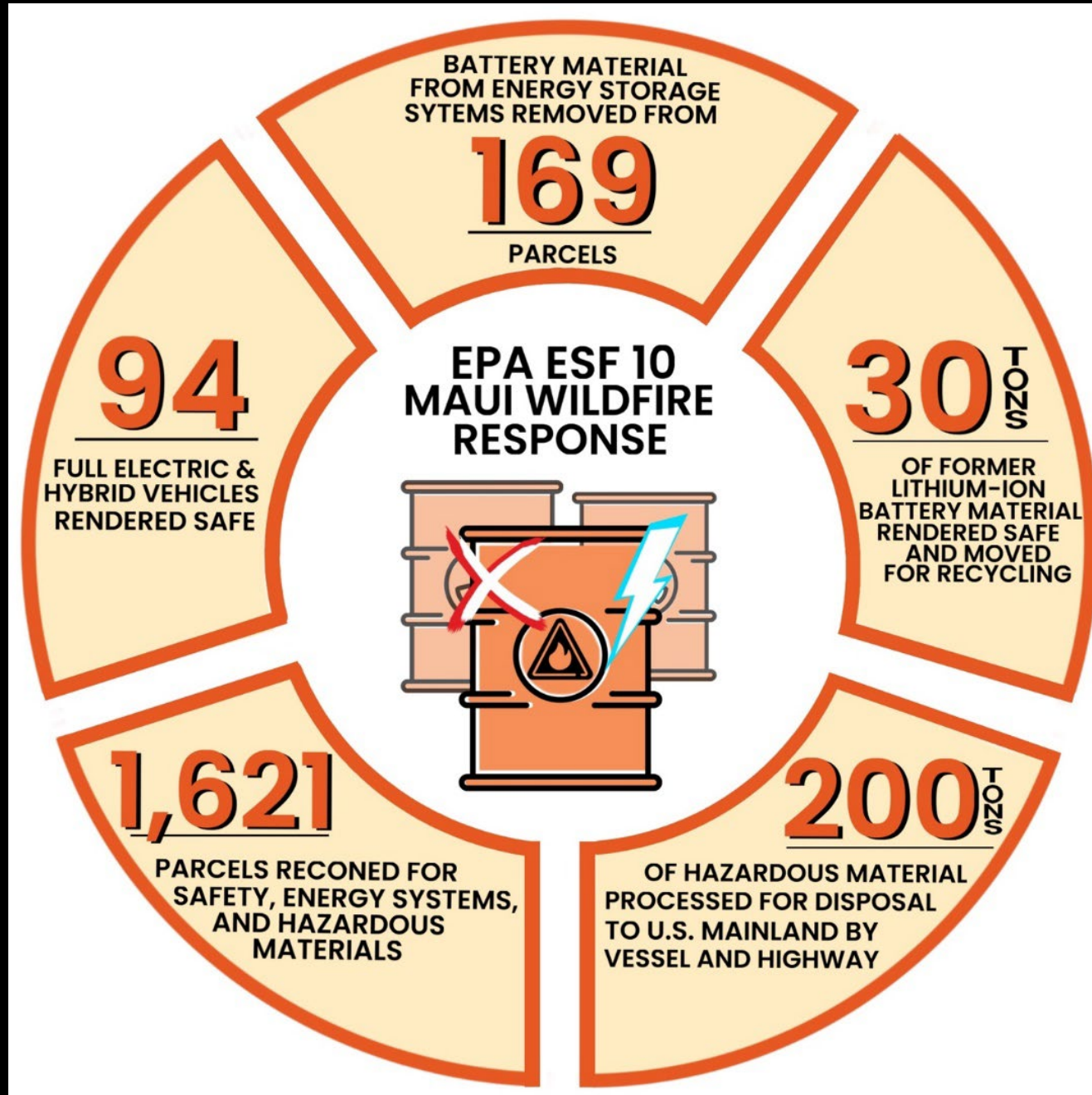
PPE				
Level A	Level B	Level C	Level D Mod	Level D
	Active thermal event or poorly ventilated area. (SCBA for respiratory protection combined with FR clothing)	Completely charred or completely charred and bulged EV battery: (Organic gas/acid gas filters required for respiratory protection combined with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

Other	
None	

### NOTES:

From draft SOP on EV Reconnaissance – 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

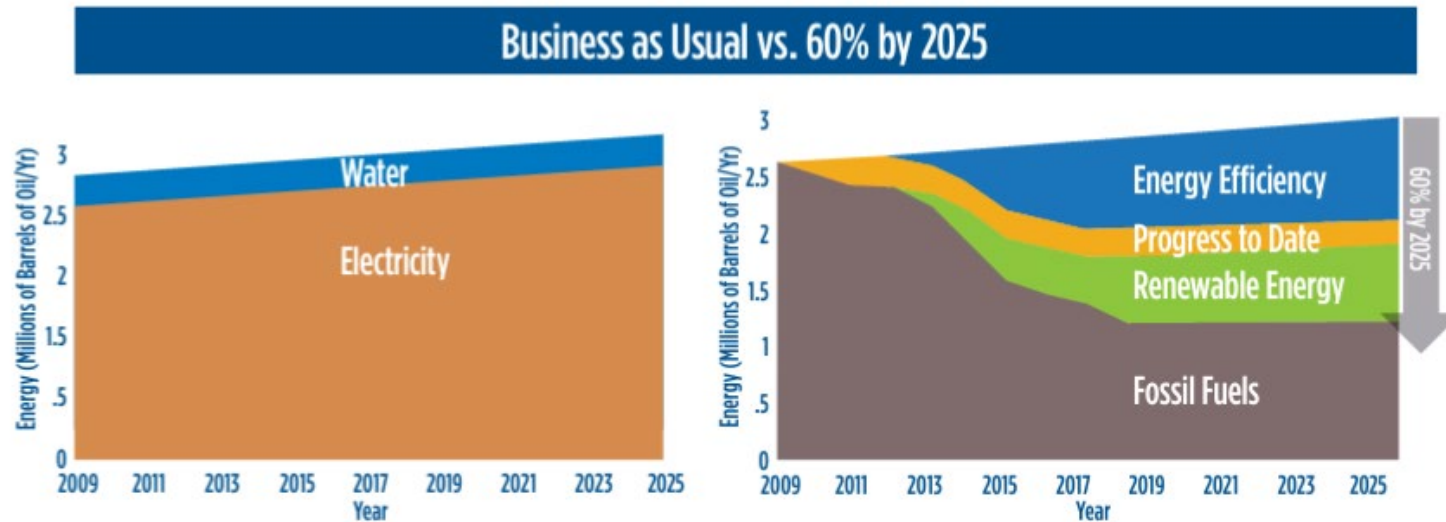
Meet 100% of the electrical needs with renewable energy by 2050



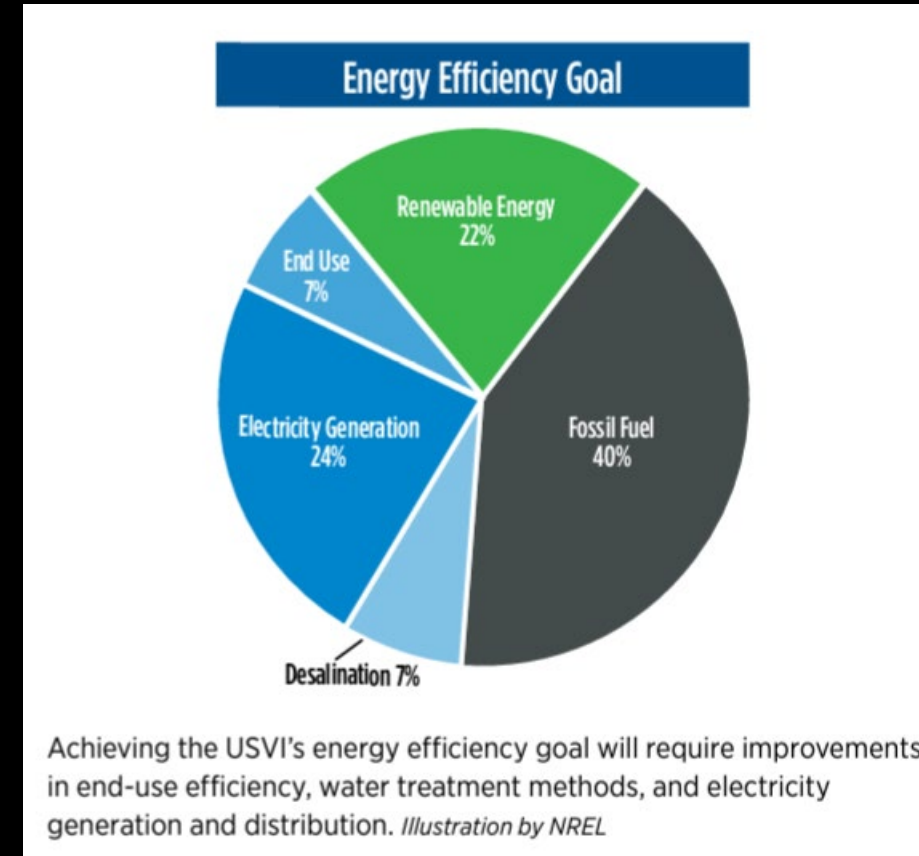


# U.S. Virgin Islands

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





# Increased Use of Micro-mobility Devices and EVs





# Increased Use of Solar and ESS



# Gaining Ground

## Research/Understanding

- Knowledge through trial
- Education from experts
- Outreach from manufacturers
- Multi-Agency sharing and partnerships
- Rule making & alterations
- EPA National LIBTF





# Questions?



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November 2024 CRRT Meeting