



Basic Li-Ion Battery Hazards & 2025 SoCal Wildfire Case Study

Presented By:
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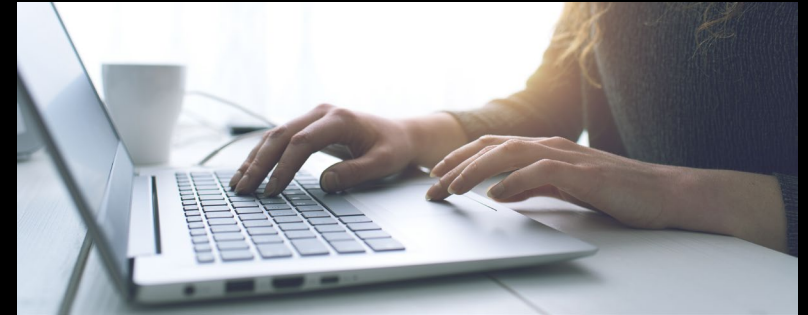


May 2025 – USCG AST Response Workshop





Communications



May 2025 – USCG AST Response Workshop



Transportation



May 2025 – USCG AST Response Workshop



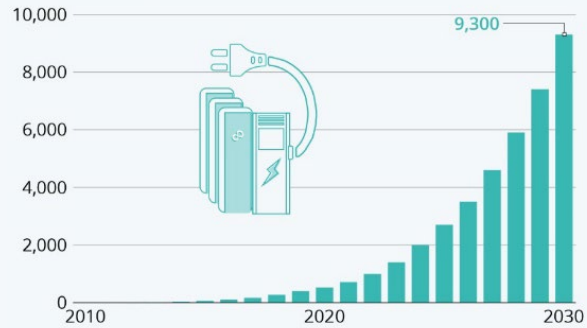
Energy Storage



May 2025 – USCG AST Response Workshop

High Demand for Lithium-Ion Batteries

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

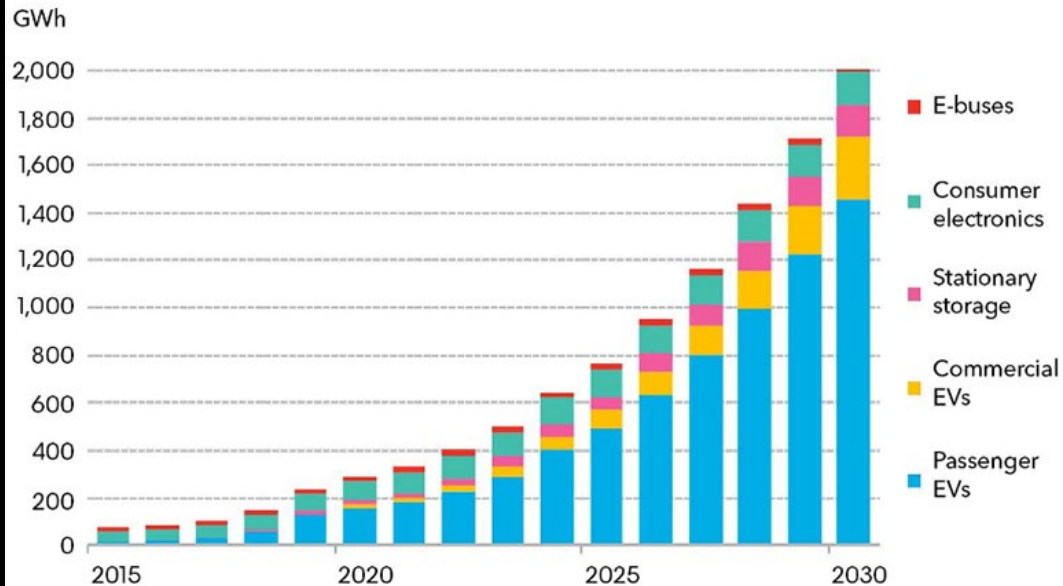


Source: Bloomberg

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

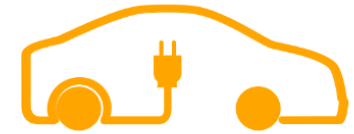


250 to 1100 GWH



2040

up to 900 million

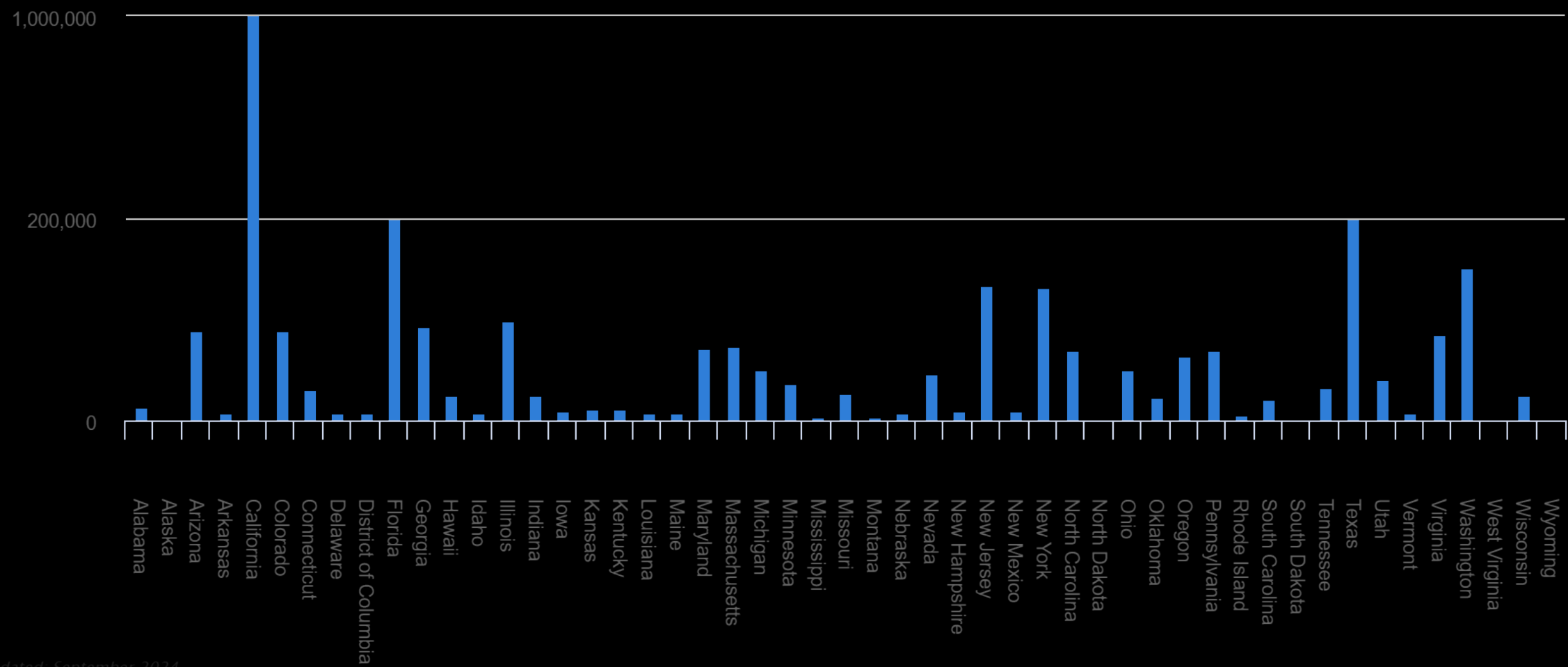


600 to 4000 GWH



Trends in Li-Ion Batteries

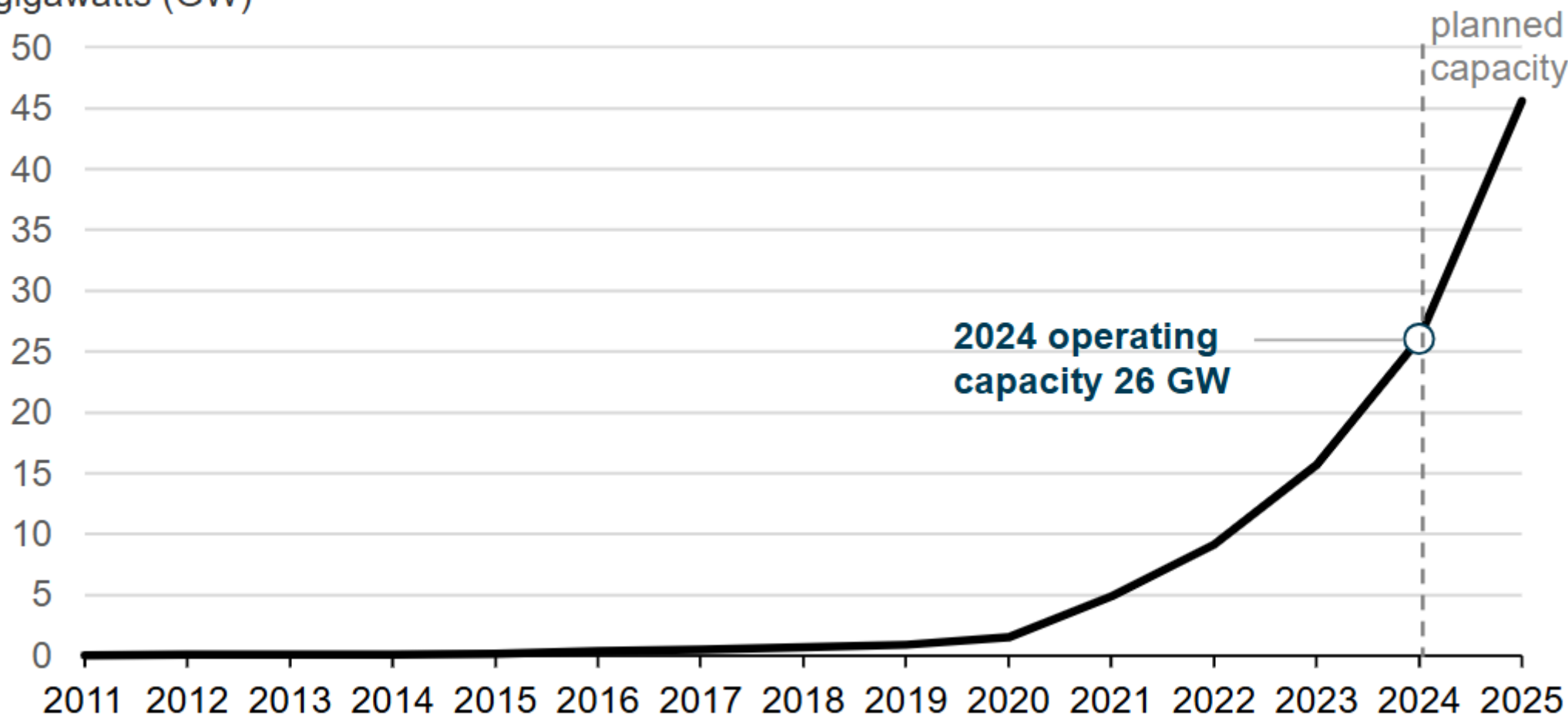
Electric Vehicle Registration – Sept. 2024



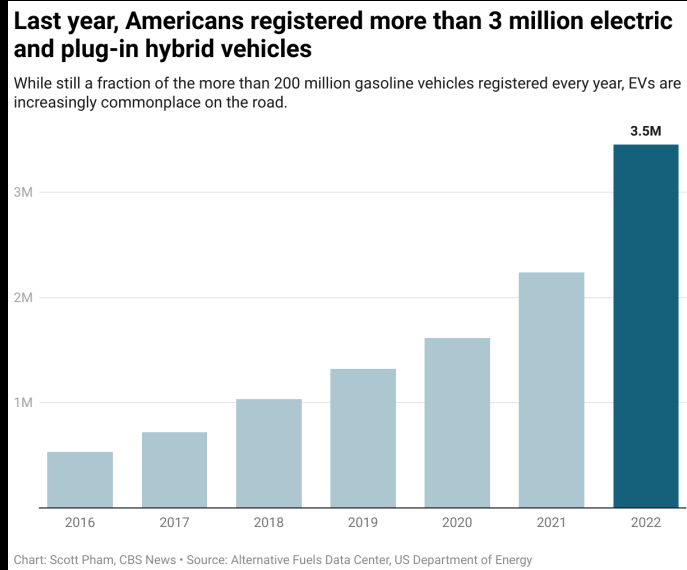
Trends in Li-Ion Batteries

U.S. battery capacity increased 66% in 2024

Cumulative U.S. utility-scale battery power capacity (2011–2025)
gigawatts (GW)

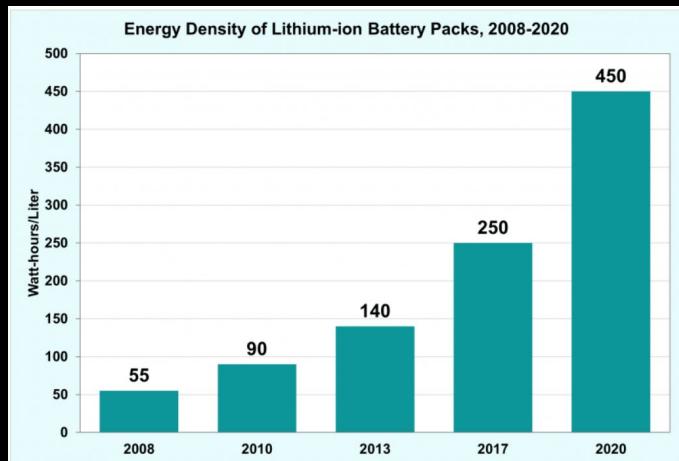


Trends in Li-Ion Batteries



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



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.



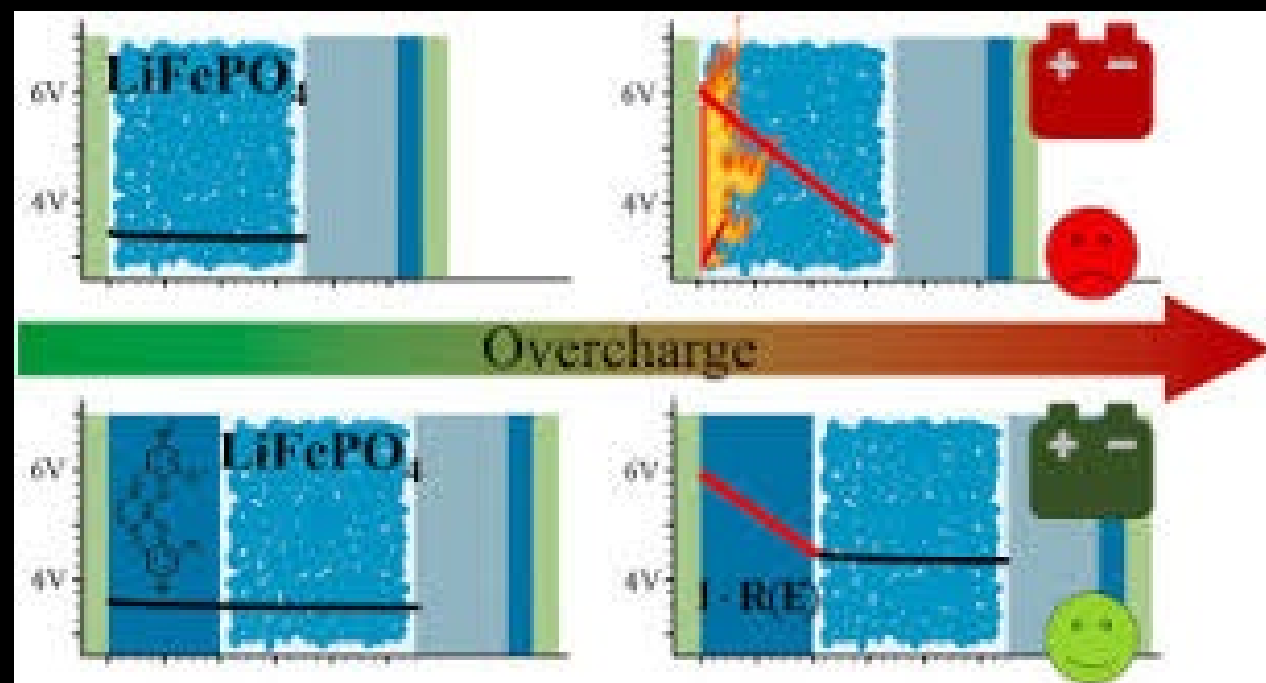
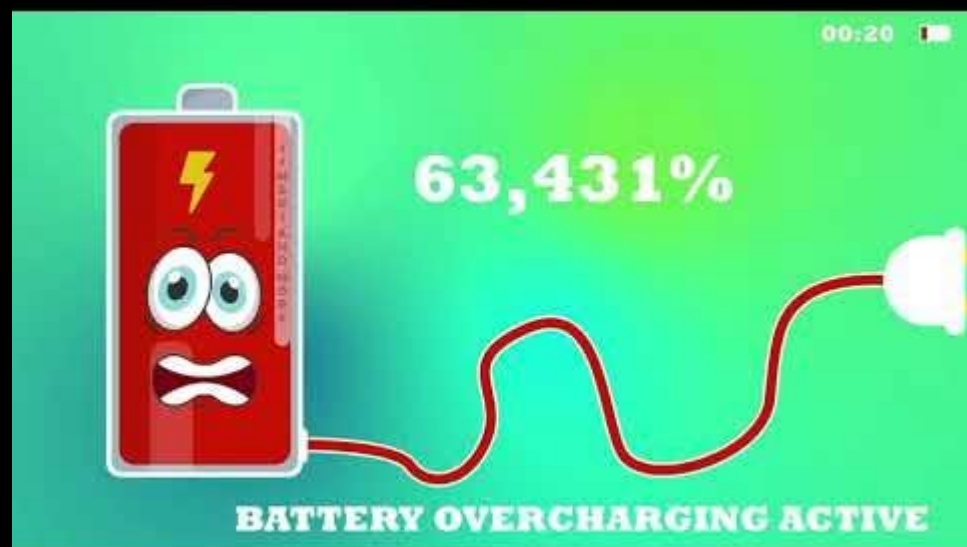
WARNING - FIRE and EXPLOSION RISK

These 18650 batteries sold on Amazon may be dangerous or deadly



Knockoff Battery Dangerous?





Dear New Jerseyites,

It's time to speak out for your right to repair

This year, the people of New Jersey have a chance to guarantee their right to repair their stuff.

S1723 covers everything with a chip—cell phones, laptops, smart watches, refrigerators. It makes sure that you can get all the parts, tools, and documentation you need to fix your stuff (or take it to a repair shop of your choice).

It's yours. You own it. You shouldn't have to beg the manufacturer for permission to fix it when it breaks. Tell your legislator that you want the right to repair.

There are two easy ways to get in touch: call and write. We'll track down your legislator's contact info for you.



**OKAY
IN
TRASH**



**REQUIRES
SPECIAL
RECYCLING**

Types of Lithium Batteries

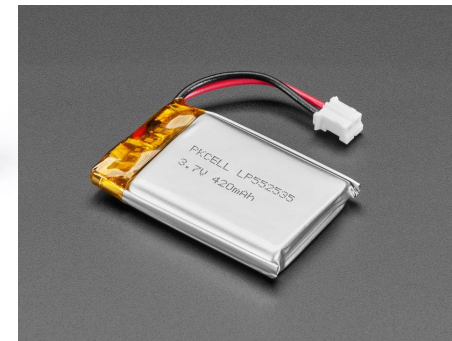
Lithium Metal

- 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



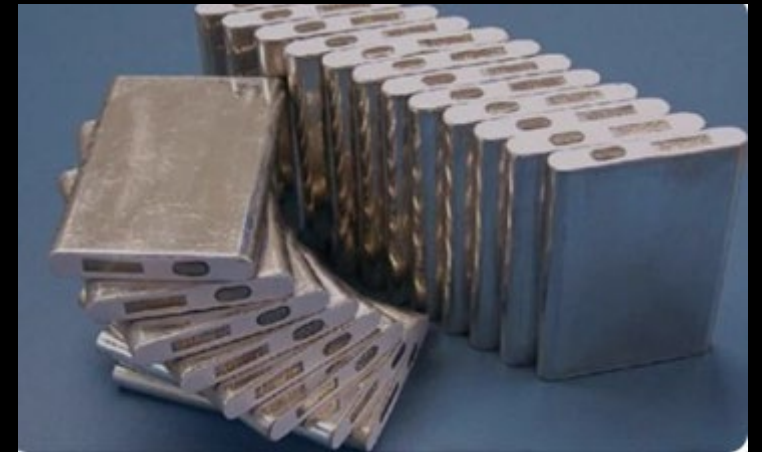
Personal Electronic Devices



Types of Li-Ion Batteries

Styles

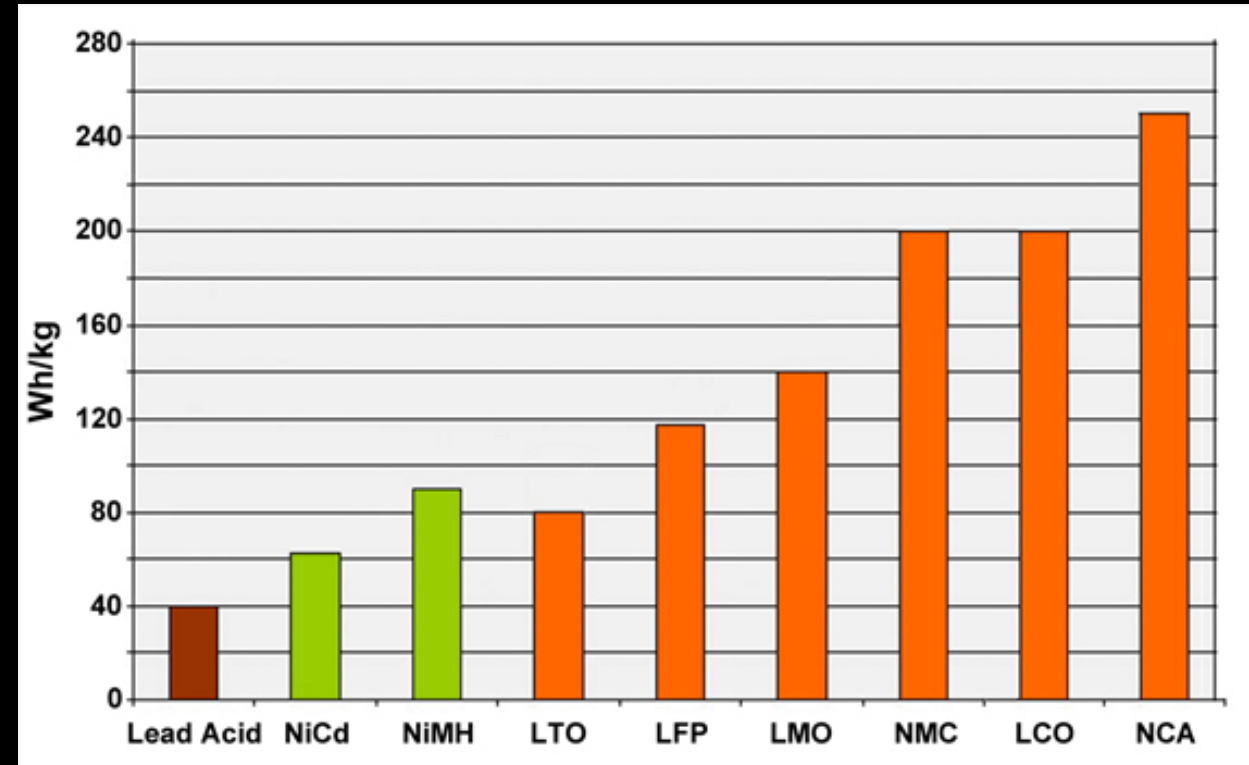
- Cylinder
- Pouch
- Prismatic



Li-Ion Battery Chemistry

Chemistry

- Lithium Cobalt Oxide(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 (Li_2TiO_3) — LTO



Li-Ion Battery Electrolyte

Type

- Liquid
- Solid
- Gel

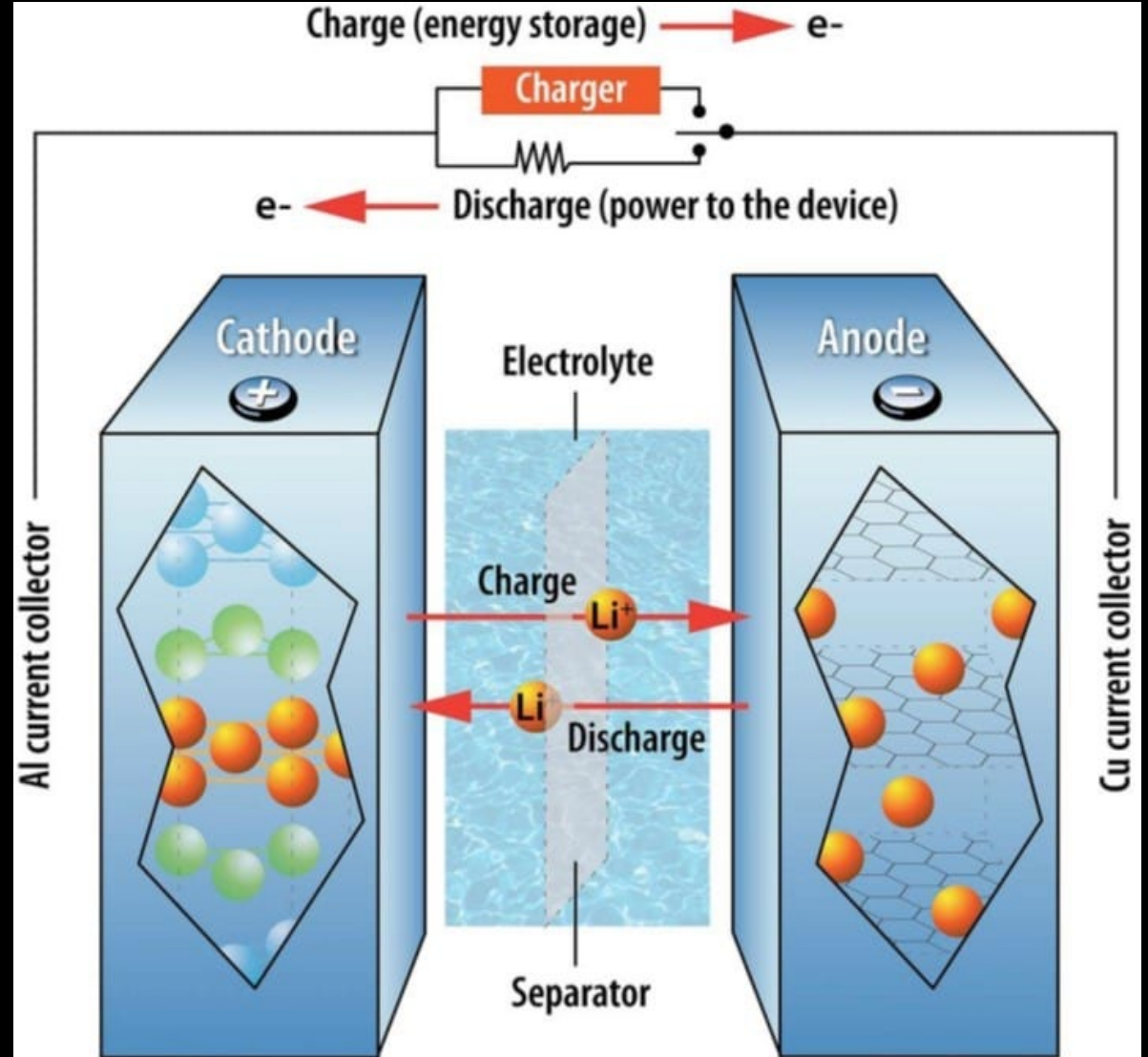
Lithium Salt

- Lithium Hexafluorophosphate (LiPF₆) – LHP

Solvents

- Ethylene carbonate
- Propylene carbonate
- Dimethyl carbonate
- Ethyl methyl carbonate
- Fluoroethylene carbonate
- Methyl acetate
- Methyl propionate

**CONFIDENTIAL
INFORMATION**



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:

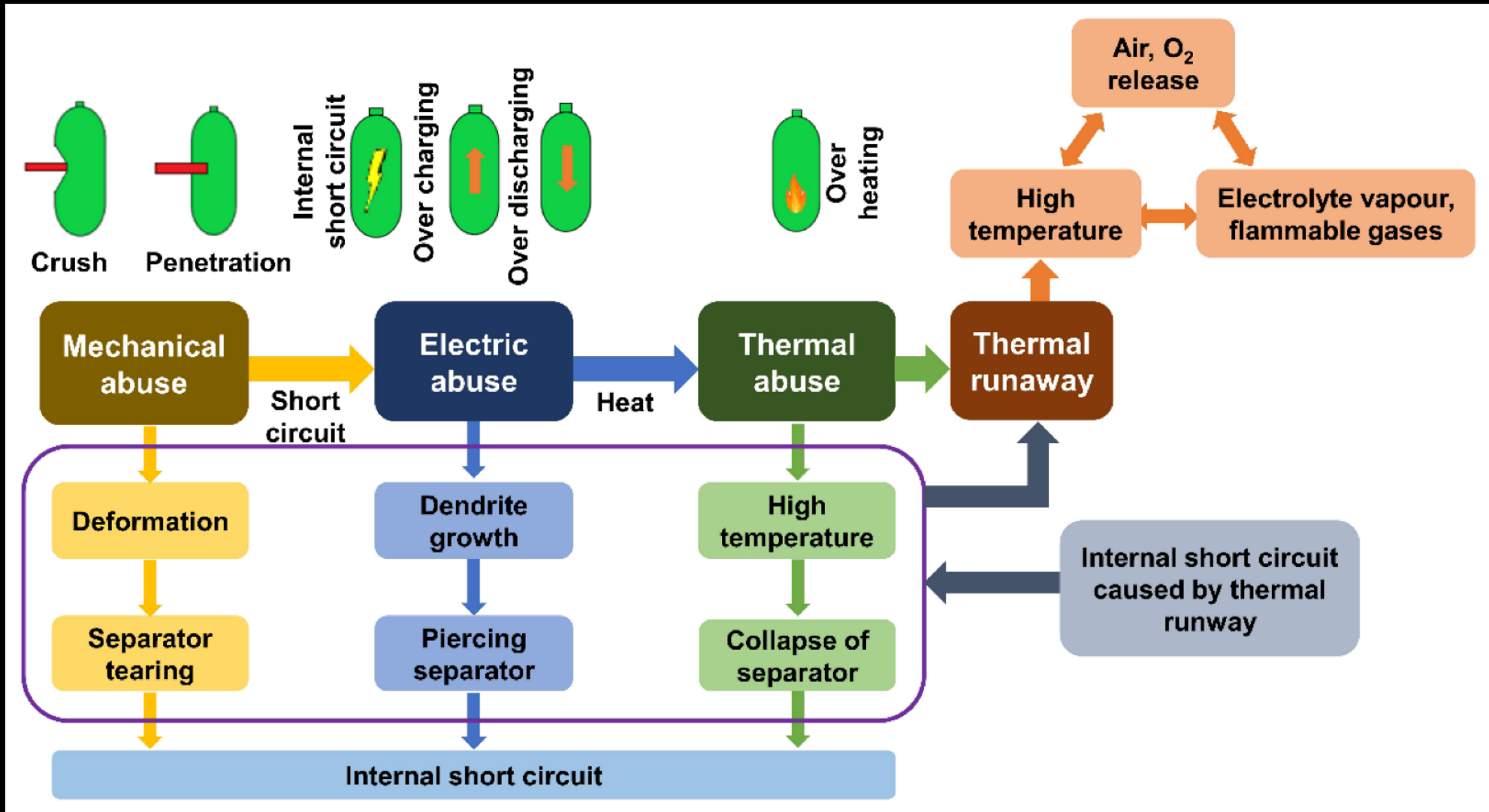
- Misuse & Abuse
- Imperfections
- Overcharging
- Incompatibility/Modifications
- Damage through impact



Are characterized as:

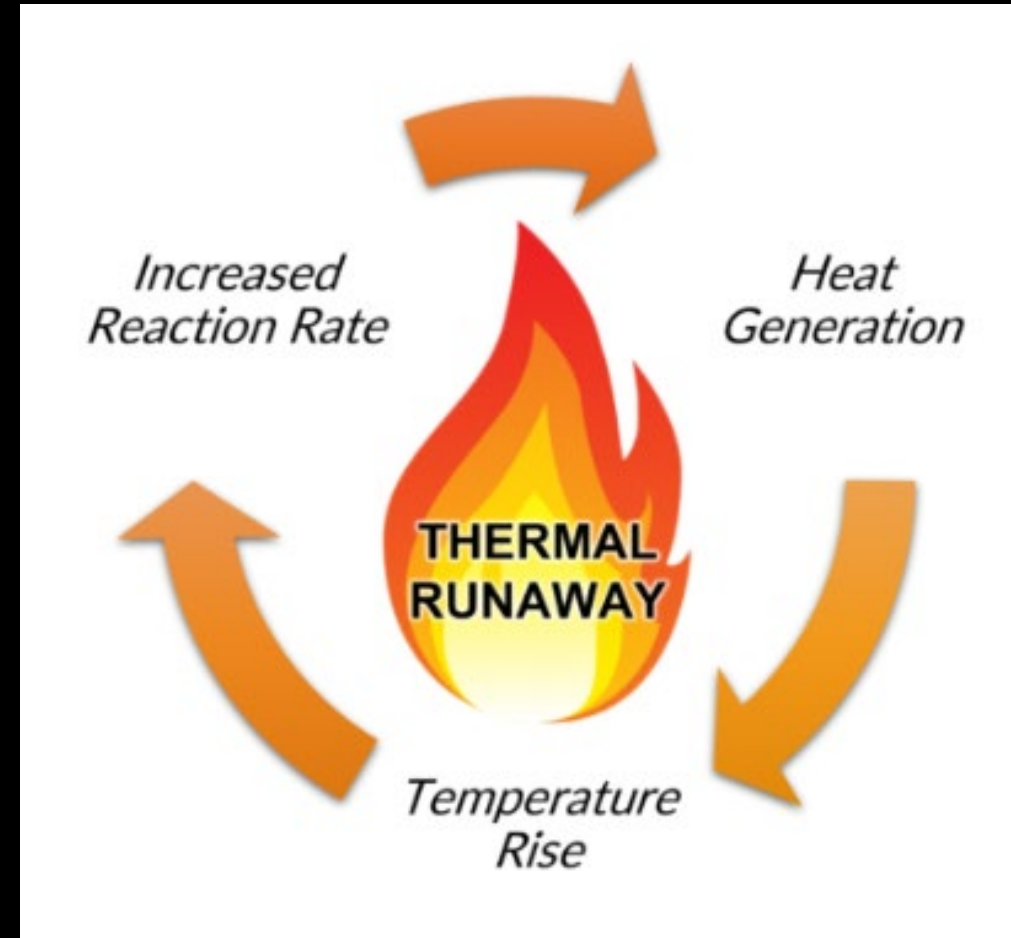
- Unreliable
 - No longer working appropriately
- Unpredictable
 - Overheat
 - Expansion/Swelling
 - Fire
 - Explosion
- Universal & Hazardous Waste
 - Disposal concerns
 - Transport limitations
 - Expense

Why do batteries fail?



Characteristics of Li-Ion Fires

- Very toxic atmospheres – H, HF, HCN, CO, heavy metals
- Burn temperatures are higher than normal - >2,000°F
- 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
 - Rapid event that can propagate to other cells
- Re-ignition is common and cannot be predicted – can happen minutes, hours, days, weeks, months later



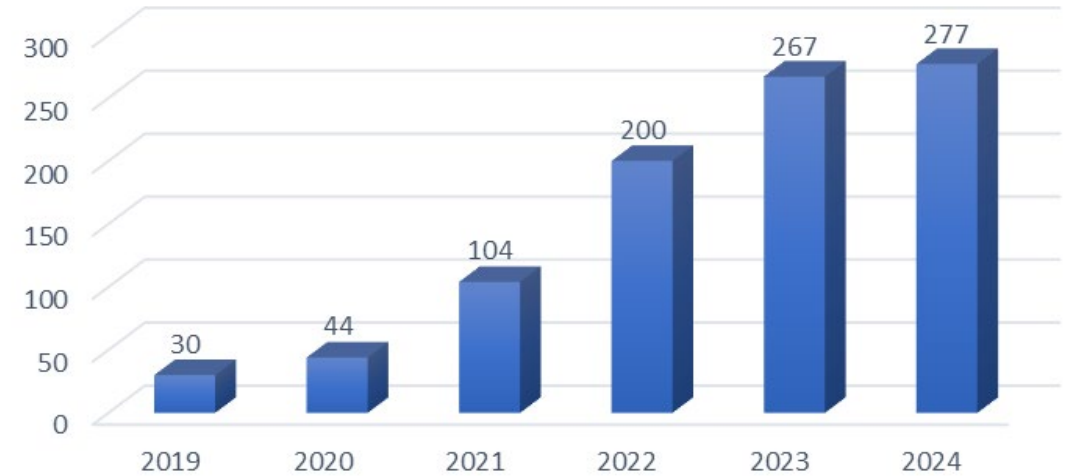
Characteristics of Li-Ion Fires



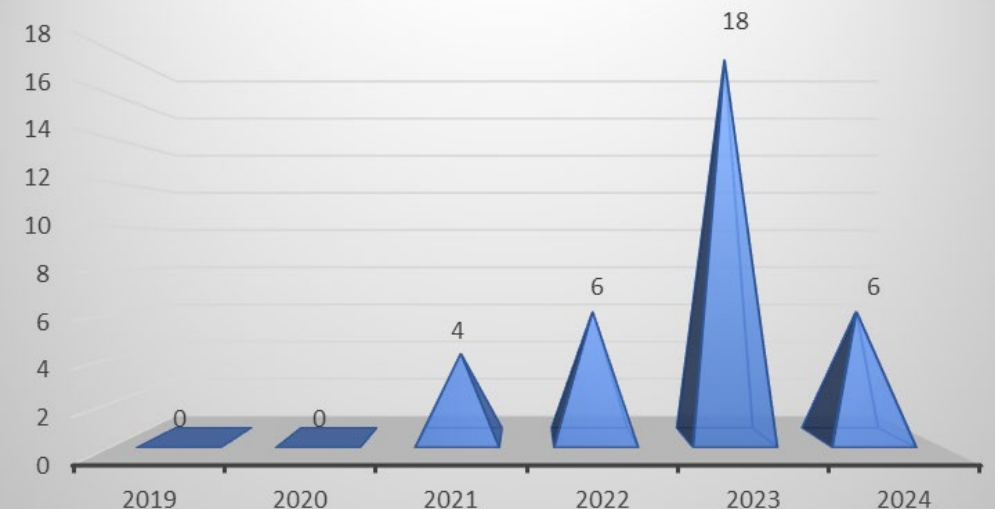
- Signs of trauma
- Gasses emitting
- Increase in temperature
- Pop and hiss
- Projectiles
- Intense fire
- Propagation
- Secondary fires

- Largest number of LIB incidents
- FDNY LIB fires:
 - 44 in 2020
 - 220 in 2022
 - 268 in 2023 (18 killed, 150 injured)
 - 277 in 2024 (6 killed)
- Public exposure concerns
 - Stored and charged inside occupied residences and businesses
 - Stored near entry and exit ways
 - Can ignite with little-to-no warning
 - Rekindle is likely.

Number of NYC Structure Fires
Due to Lithium-Ion Batteries



NYC Deaths By Lithium-Ion Batteries





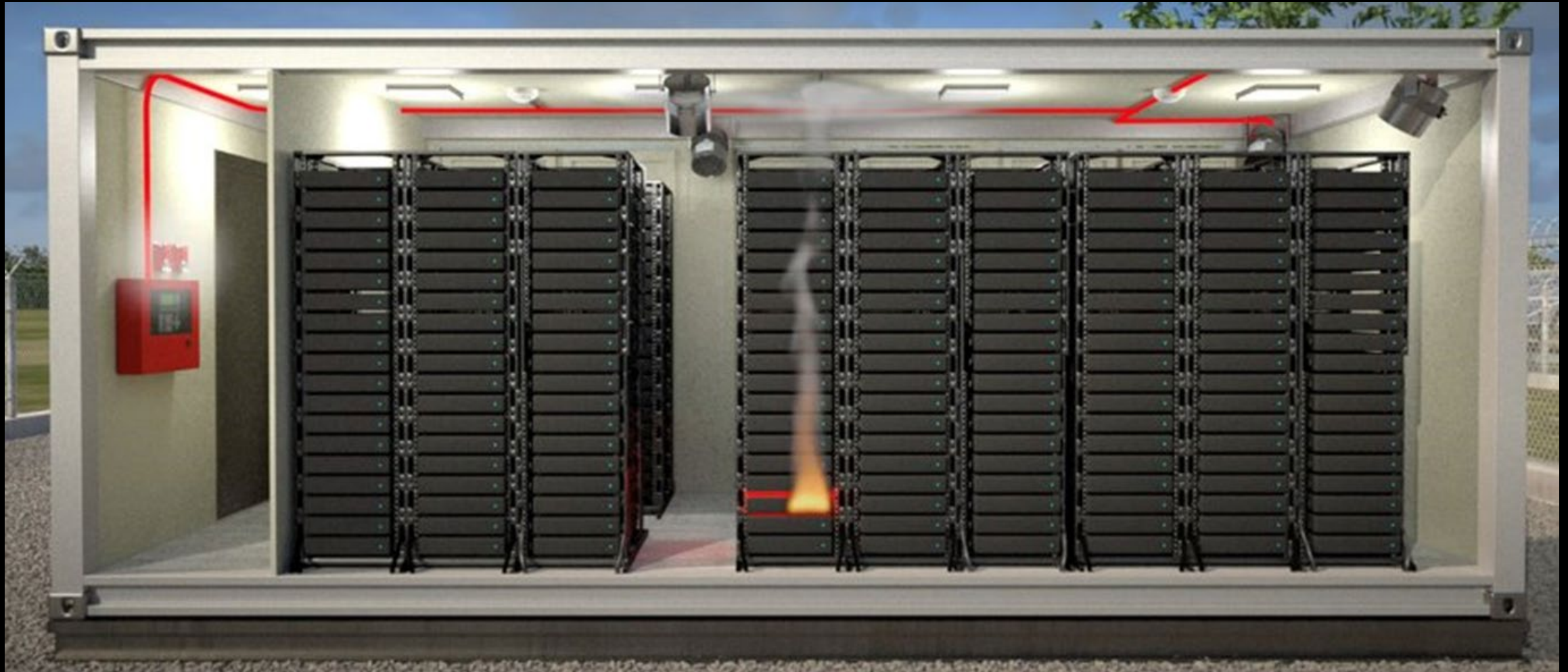








BESS Incidents





Flooded Car Incidents

Hurricane Ian – September 2022

Hurricane Idalia – August 2023



ELECTRIC VEHICLE FIRES CAUSED BY SALTWATER FLOODING



6:15
90°

Searchwater

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 Recyclers

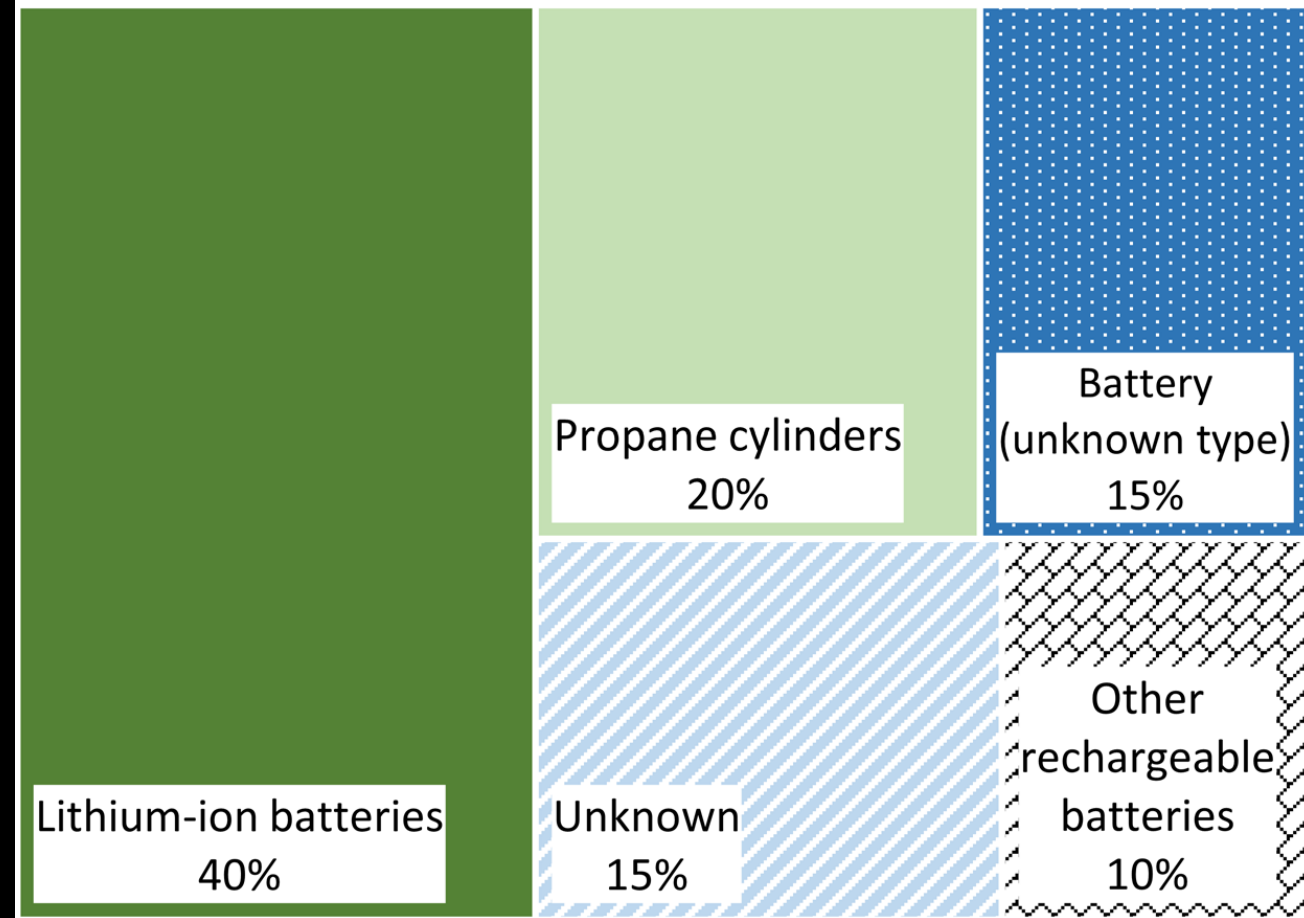


Transport & Disposal Challenges

- 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

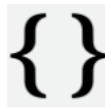


BATTERY PACK FOR BMW i3 ELECTRIC VEHICLE (AT MUNICH TRADE SHOW ELECTRONICA). PHOTO: RUDOLFSIMON CC-BY-2.0 (WIKIMEDIA)

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

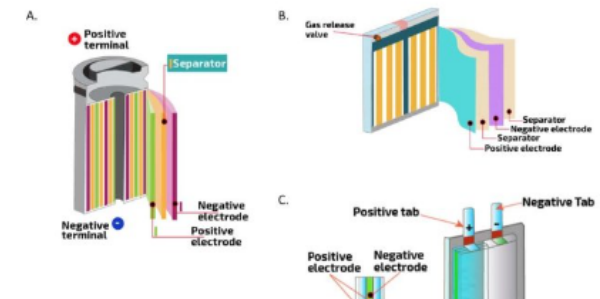
On this page:

- [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:

2025 SoCal Wildfires



May 2025 – USCG AST Response Workshop



EPA Mission Stafford Act Response

Palisades Fire

Pacific Palisades

973

Structures Damaged
Residential,
Commercial and
Other

6,837

Structures Destroyed
Residential,
Commercial and
Other

12

Confirmed
Civilian Fatalities

3

Confirmed
Civilian Injuries

1

Confirmed
Firefighter Injuries

1,074

Structures Damaged
Residential, Commercial and
Other

9,414

Structures Destroyed
Residential, Commercial and
Other

17

Confirmed Civilian
Fatalities

9

Confirmed Firefighter
Injuries

Altadena

Eaton Fire

- On January 7, 2025, a fire started in the Pacific Palisades region of Los Angeles.
- Fires quickly spread across multiple areas of the city. More than 57,000 acres of land were devastated (89 square miles).
- Over 200,000 people were evacuated.
- More than 18,000 structures were damaged or destroyed.



Battery Operations Roadmap

- Battery Identification
- Data Management
- Field Operations
 - Electric Vehicles
 - Energy Storage Systems
 - Other Arrays
- Battery Processing
- Battery Termination
- Disposal





Reconnaissance

Los Angeles Wildfires

Lithium-ion batteries burned by wildfires

The U.S. Environmental Protection Agency (EPA) has been assigned by the Federal Emergency Management Agency (FEMA) to remove lithium-ion batteries affected by the Los Angeles County wildfires.



This includes battery:

- recovery
- safe transportation
- processing (de-energizing)
- safe disposal



Use extreme caution when returning to your property



Your home may have damaged or destroyed lithium-ion batteries, lithium-ion battery energy storage systems, and electric and hybrid vehicles.

- ✓ **The batteries should be considered extremely dangerous**, even if they look intact.
- ✓ **Lithium-ion batteries can spontaneously re-ignite, explode, and emit toxic gases and particulates even after the fire is out.**

Household Items with Lithium-Ion Batteries:



Other examples:

- | | | |
|----------------------------|-------------------------------|------------------|
| • Electric/hybrid vehicles | • Home alarms | • Scooters |
| • Electric bikes | • Power banks or stations | • Drones |
| • Hoverboards | • Game controllers | • Tablets |
| • Wheelchairs | • Home energy storage systems | • Power tools |
| • Digital cameras | • Personal mobility device | • Vaping devices |

If you hear a popping, hissing noise, or see smoke or fire:

1. Do not attempt to extinguish or smother the battery.
2. Leave the area immediately.
3. Move upwind at least 330 ft (the length of a football field) and **call 911**.

- **Do not** touch fire-damaged products with lithium-ion batteries – they can ignite.
- **Do not** start, move, tow, or charge a fire-damaged electric/hybrid vehicles (EV, PHEV, HEV). These will be assessed by EPA hazardous material professionals.
- **Do not** use or start a fire-damaged residential energy storage or house battery. These will be assessed by EPA hazardous material professionals.
- **Do not** enter enclosed spaces with lithium-ion battery products.
 - Gasses and vapors from damaged lithium-ion batteries can build up in enclosed spaces (such as a garage, shed, basement, or closet) and may produce an explosive environment.

- **DO** call our hotline if you encounter a lithium-ion battery while re-entering your property and/or are unsure if a lithium-ion battery was damaged.



epa.gov/california-wildfires

For questions about this work or if you have an electric or hybrid vehicle and/or a battery energy storage system in the burn zone, call the EPA hotline at:

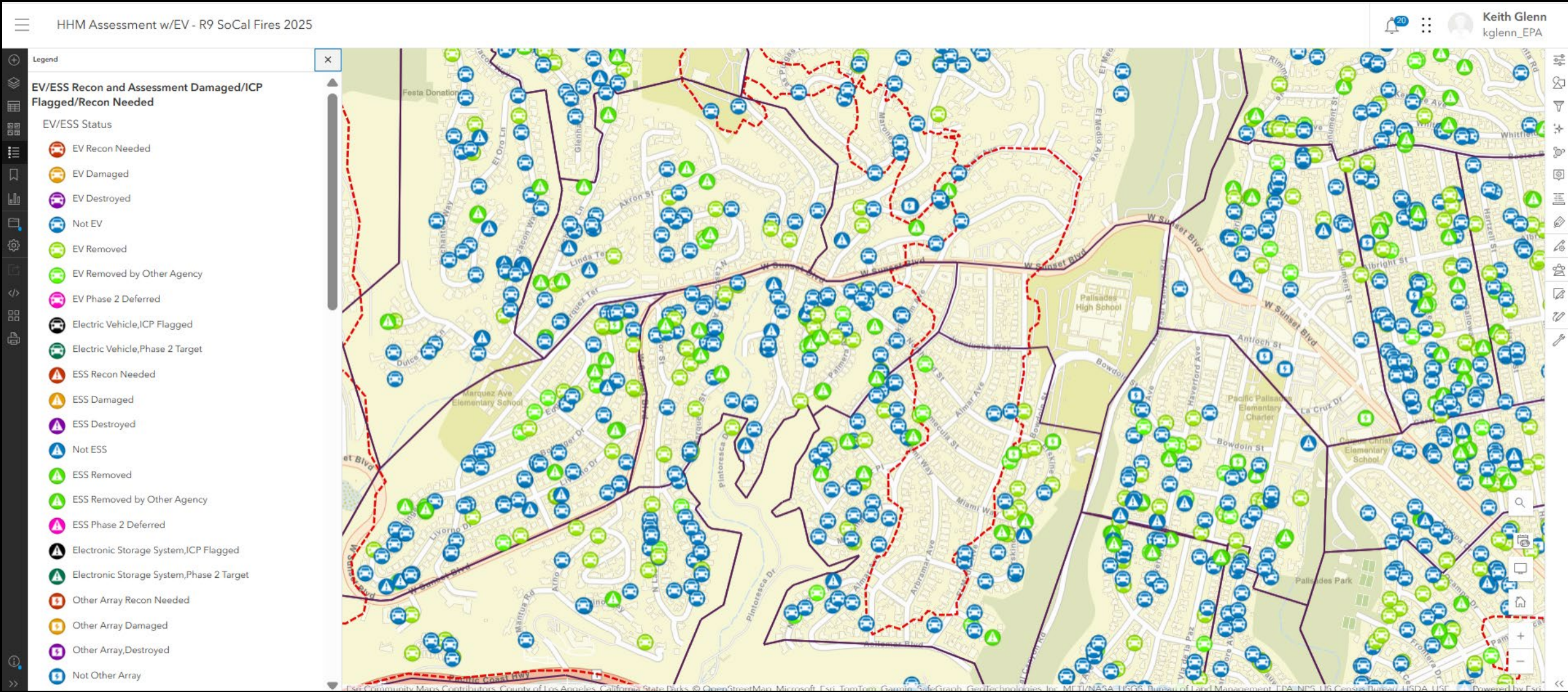
1-833-R9-USEPA
(1-833-798-7372)

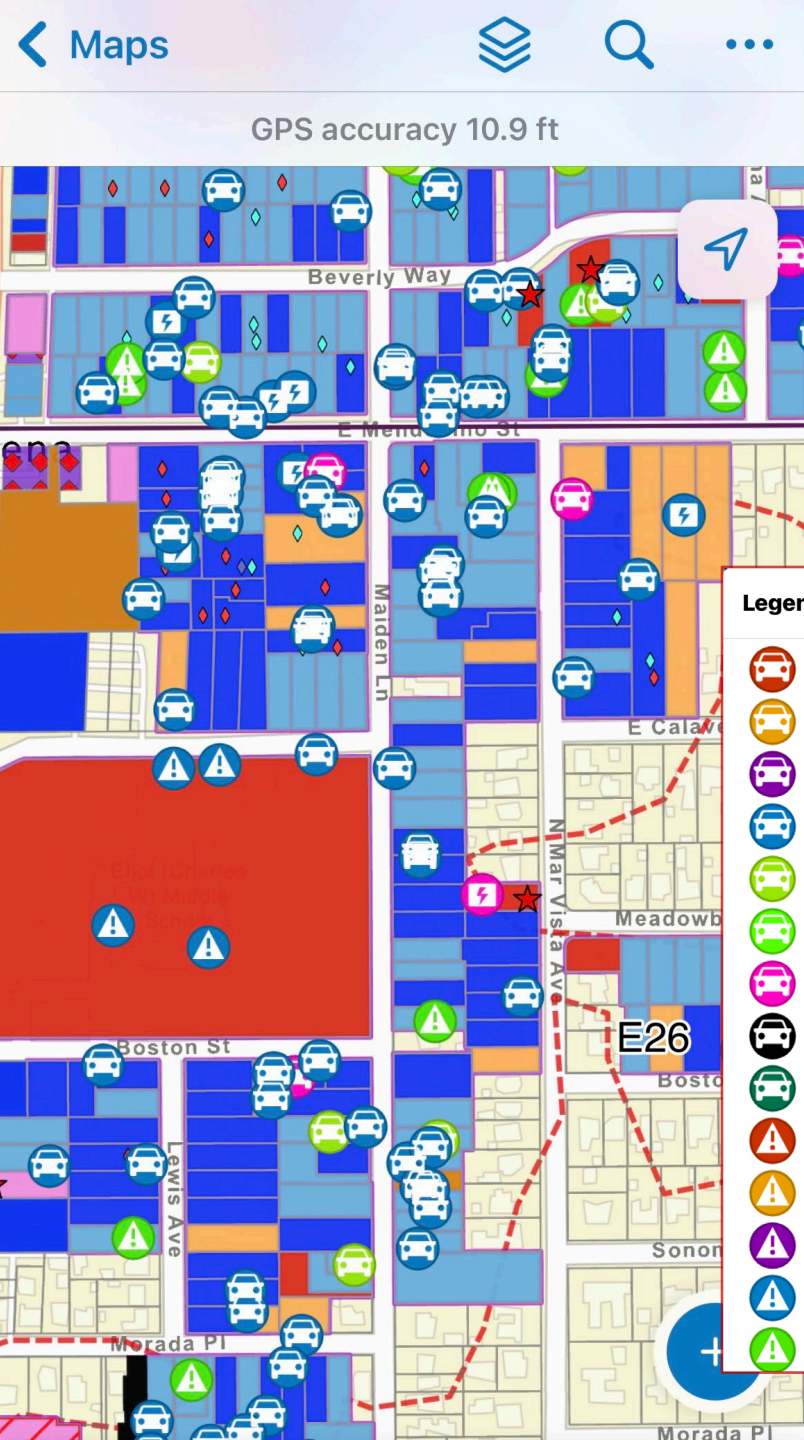
Preliminary ID

- SARCOPS (Search and Rescue)
- CUPA Teams (Certified Unified Program Agency) – LACoFD
- Recon Teams

Other Identification Routes

- HHM Referrals
- Local Permits
- EPA Hotline
- Information Requests/SCE – Tesla, Enphase
- Phase II/Army Corps





Data Management

- All vehicles identified and loaded into mapping system
- EV/Non-EV
- Make/model/year when identifiable
- Photos
- Safety concerns
- Other notes from recon teams

| Legend | |
|--------|----------------------------------|
| | EV Recon Needed |
| | EV Damaged |
| | EV Destroyed |
| | Not EV |
| | EV Removed |
| | EV Removed by Other Agency |
| | EV Phase 2 Deferred |
| | Electric Vehicle, ICP Flagged |
| | Electric Vehicle, Phase 2 Target |
| | ESS Recon Needed |
| | ESS Damaged |
| | ESS Destroyed |
| | Not ESS |
| | ESS Removed |

Battery Recovery Teams

Teams

- EPA OSC
- Technical Contractor (Air monitoring/Data management)
- Equipment Operator
- 5-6 Hazmat Technicians
- Electrician
- (opt.) LACoFD H&S Officer

Equipment

- Mini-excavator
- Water buffalo
- Extrication tools
- Hand tools

H&S

- FR Tyvek, Respirator with combination acid-gas cart., Steel toe/steel shank boots, hard hat, safety glasses
- 75'/330' evac radii



Battery Recovery - EV



Battery Recovery - EV



Battery Recovery - EV



Battery Recovery - EV



Battery Recovery - ESS

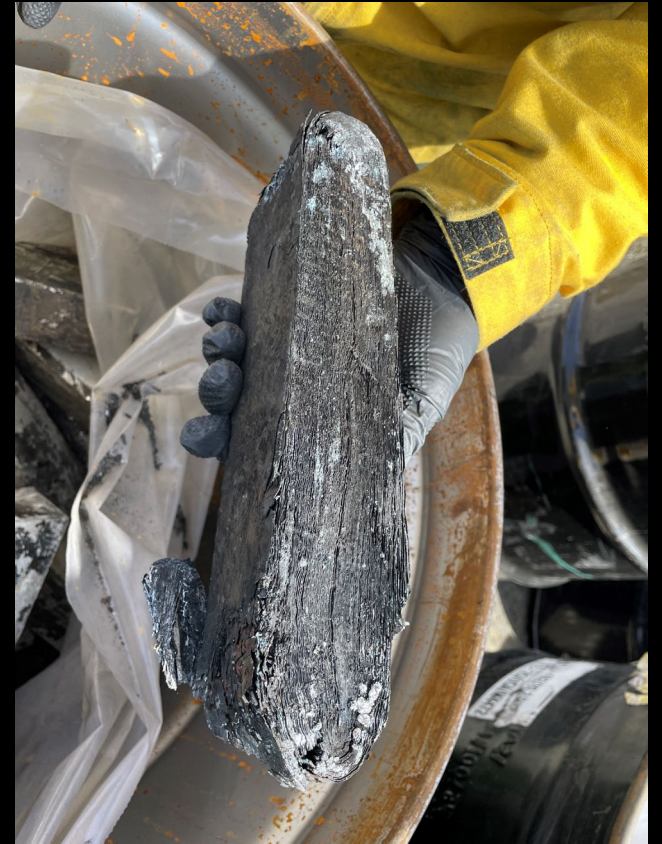


Battery Recovery - ESS



Battery Recovery - ESS







Battery Recovery – Partially & Undamaged

Primary Hazards:

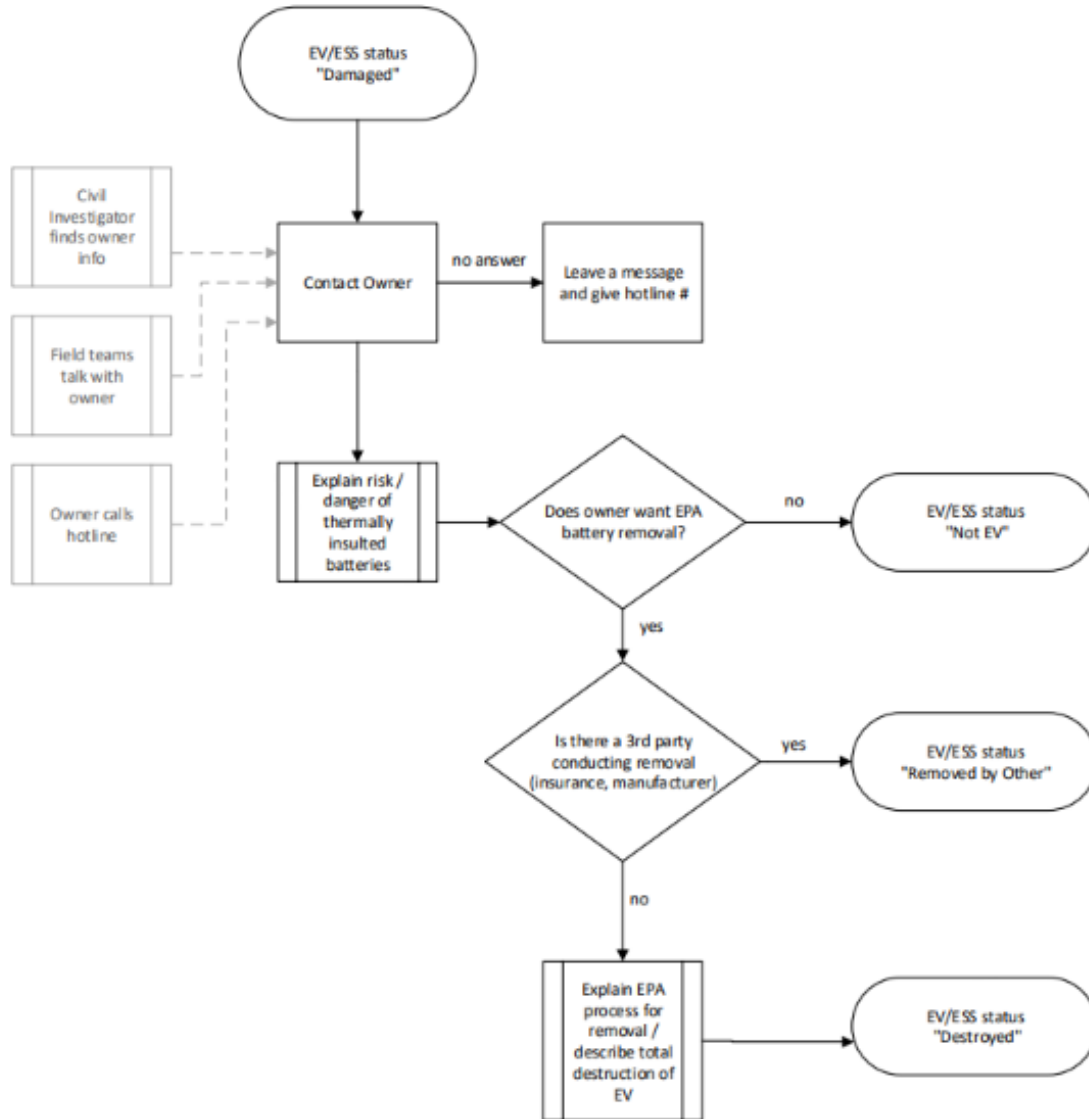
Thermal Runaway
Offgassing

60°C (140°F) – Temperature exposure level where we begin to see thermal impact to batteries

EPA developed an adjudication process to work with residents and determine who would be handling units that were only slightly damaged in the fire (EPA, DOT, insurance, other)



Battery Recovery – Partially & Undamaged Adjudication Process



Use of Civil Investigators

Work with local authorities

Contact Owner

Explain hazards

Make a determination

Data Management input / Documentation

Battery Recovery – Partially & Undamaged



Battery Recovery – Partially & Undamaged



Electric Vehicle Response Resources



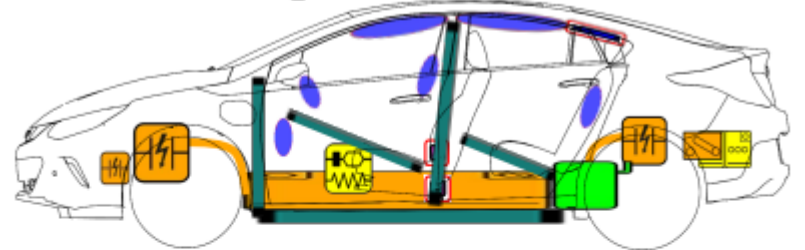
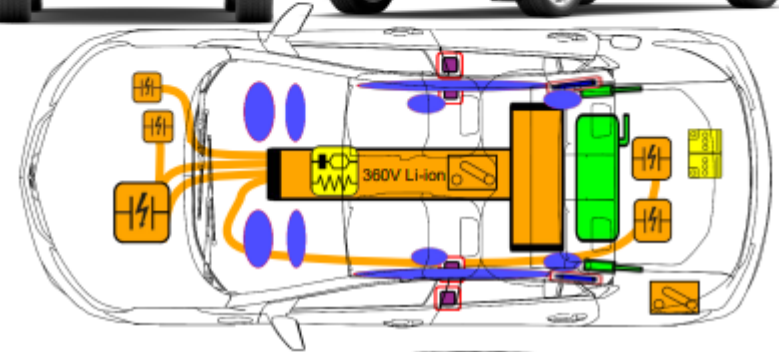
The screenshot shows the NFPA website's "EMERGENCY RESPONSE GUIDES" page. At the top is the NFPA logo and a search bar. Below the logo is a navigation menu with links: "About NFPA", "For Professionals", "Education and Research", "News and Articles", "Membership", and "Events". A large banner image of an electric vehicle charging cable is overlaid with the text "EMERGENCY RESPONSE GUIDES". Below the banner, a paragraph states: "NFPA actively maintains a collection of Emergency Response Guides from alternative fuel vehicle manufacturers. These guides are free to download." A "REFINE BY" sidebar on the left lists vehicle manufacturers with checkboxes: Acura (1), Alfa Romeo Tonale (1), Audi (1), Autocar (1), Automobili Pininfarina (1), Azure Dynamics (1), Battle Motors (1), and Bentley (1). A "+ Show more" link is at the bottom of the list. The main content area shows "Results 1-12 of 79" and a "Sort by: Title Ascending" dropdown. Below this, three vehicle logos are displayed: Acura, Alfa Romeo Tonale, and Audi. Each logo is accompanied by the text "TOPICS: EMERGENCY RESPONSE" and the specific guide title: "Acura Emergency Response", "Alfa Romeo Tonale", and "Audi Emergency Response".

The screenshot shows the "EV Rescue" mobile app interface. At the top, the status bar shows "TELUS Wi-Fi", "10:20 AM", and "100%". The app header is green with the text "EV Rescue" and "[VIN]". Below the header is a section titled "Choose an Option" with four green buttons: "Passenger Cars Pickup Trucks Sport Utility Vehicles (SUV)", "Delivery Vans Trucks Buses Equipment", "Charging Stations Energy Storage Solar Panels", and "Electric Vehicle Incident Data Collection Form". At the bottom is a navigation bar with icons for "EV Rescue", "Notifications", "Share App", and "More".



Chevrolet Volt
5 Door Hatchback
2016

First Responder
Rescue Sheet



| | | | | | | | | | |
|--|---------------------------|--|----------------------------|--|-------------------------|--|------------------|--|-------------------------------|
| | Air Bag | | Stored Gas Inflator | | Seat Belt Pretensioner | | SRS Control Unit | | |
| | | | Gas Strut/Preloaded Spring | | High Strength Zone | | | | |
| | Battery Low Voltage | | | | Fuel Tank | | | | |
| | High Voltage Battery Pack | | High Voltage Power Cable | | High Voltage Disconnect | | | | Ultra Capacitor, High Voltage |



Battery Recovery – Partially & Undamaged



Battery Recovery – Partially & Undamaged



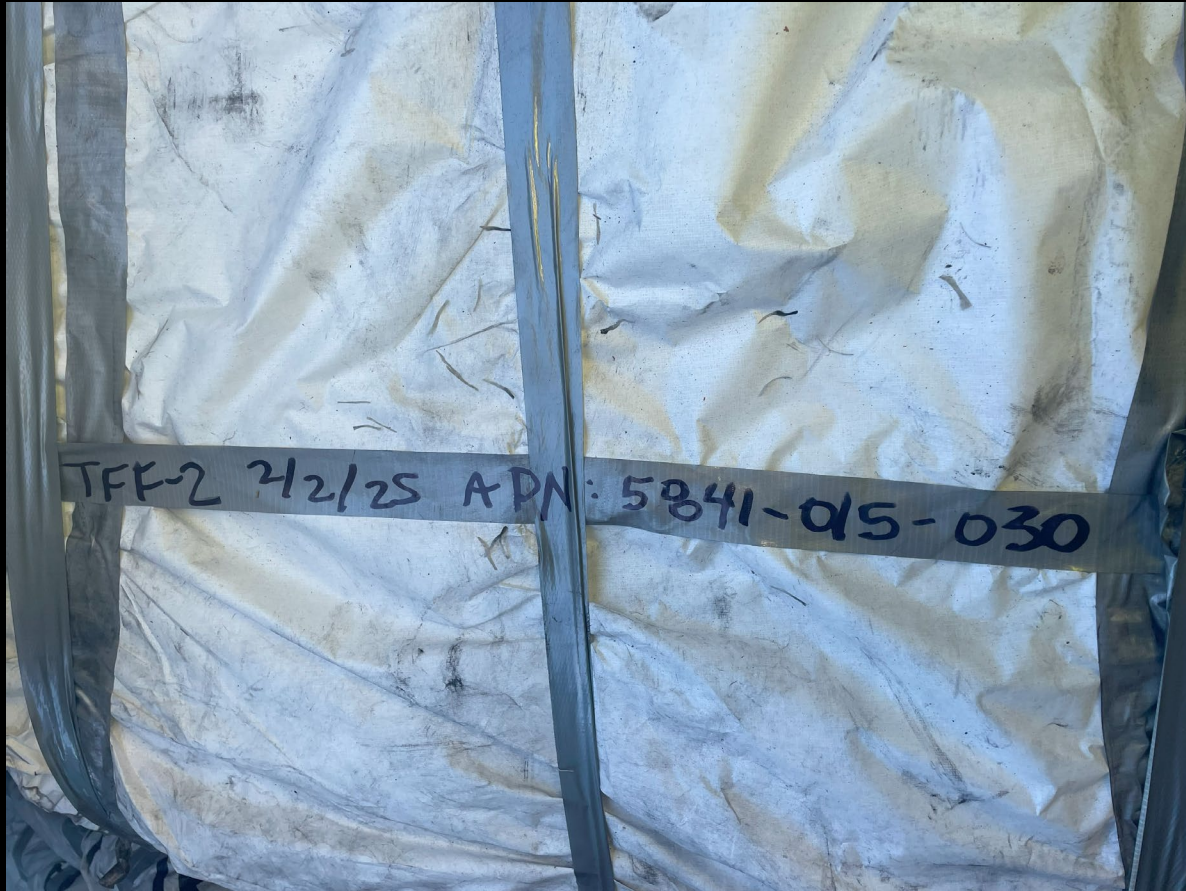
Battery Recovery – Partially & Undamaged



Battery Recovery – Partially & Undamaged

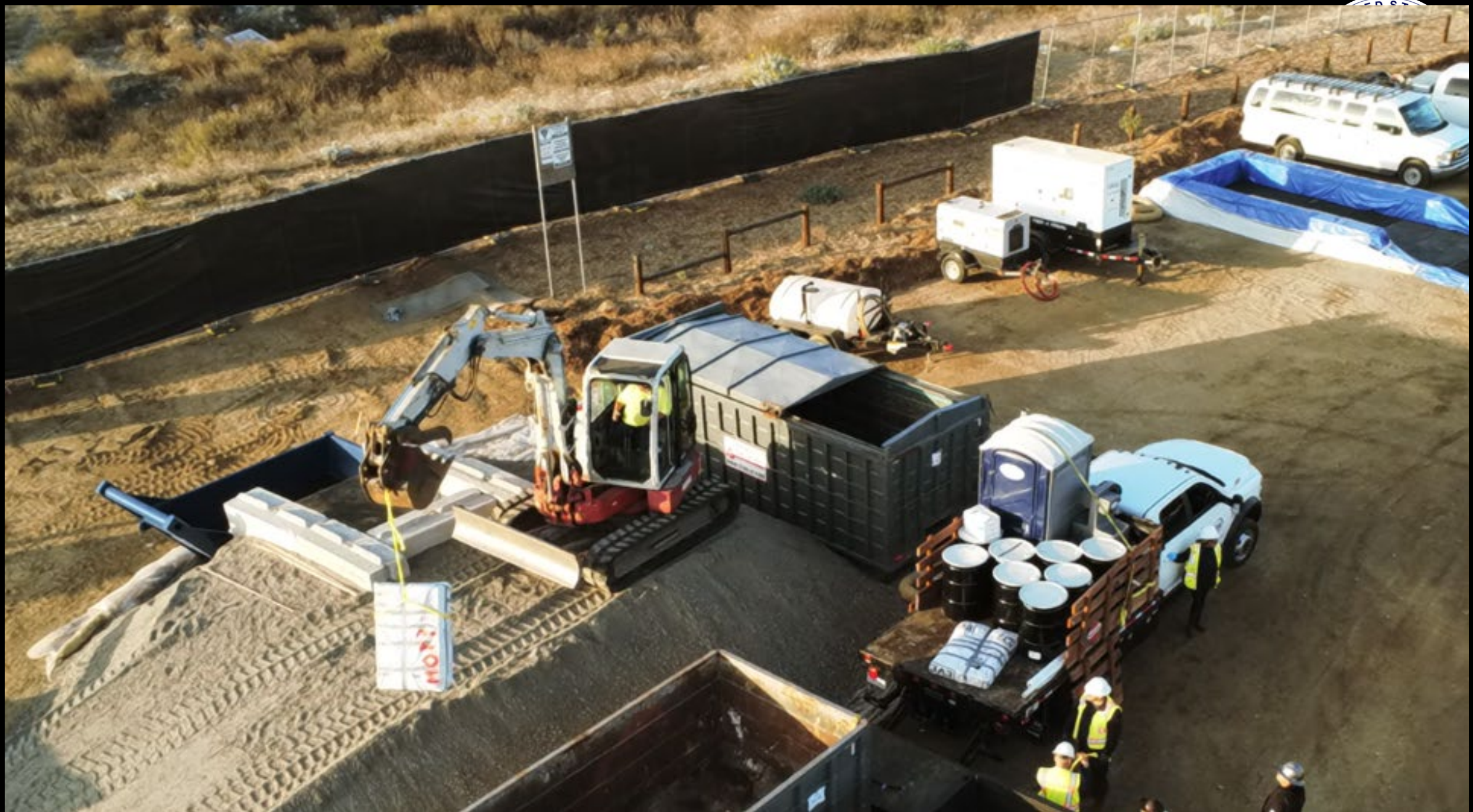


Battery Transport



Staging







Battery Processing

Types of Batteries

NiMH

Lithium Ion

Cylindrical

Prismatic

Pouch

Processing

Brine Bath – Baking Soda and NaCl

Vibratory Roller

Shredder/Excavator





Battery Processing - Brining



Battery Processing – Smash Pad



Battery Processing – Smash Pad



Battery Processing - Crushing



Battery Processing - Shredding



Battery Processing - Shredding





Final Product



Disposal





Disposal



Processed battery material is no longer considered Hazardous Waste

In Maui – sent via vented cubic yard boxes to a recycling facility

In CA – First attempt at bulk disposal using roll-offs.

- Air monitoring investigation determined that ventilation was necessary for transportation due to H₂ accumulation/LEL.
- Disposal through Clean Harbors to a facility in Utah.



Air Monitoring

Biggest concerns are H₂ gas, HF, and metals. Respirators mandatory during battery processing operations.

- AreaRae
- Dustrak
- SPM Flex (HF – Mineral Acid)
- SPM Flex (HCN)

**H₂ is cross-sensitive with CO, so standard suite of sensors were used and adjusted

Heavy metals – Personnel monitoring.





Statistics

SoCal vs. Maui Battery Processing

Increased quantity of recon/recovery teams & staging areas
Larger staging/processing – frac tanks, equipment, smash pad
More processing capacity
Smaller footprint per staging area
Use of shredders
Better understanding of batteries; lessons learned from Maui
Willingness to expand beyond our knowledge and try new methods



Maui Wildfires

~1,200 properties
~400 targets
~98 vehicles & 150 ESS locations
30 tons (est) batteries processed
90-day timeframe
~3 teams recon/recovery/processing

SoCal Wildfires

~18,000 properties
>5,000 ESS & EV targets
~645 vehicles & 420 ESS locations
500 tons (est)
28-day timeframe
~25 teams recon/recovery/processing

Challenges

- Expedited timeline
- Obtaining personnel and resources
- Training personnel in batteries
- Not in my back yard (NIMBY)
- Topography
- Volume of material
- Separate geographical locations
- Natural disasters (landslides)

CALIFORNIA
Heavy mudslides and flooding shut down PCH, sweep vehicle and firefighter into ocean





Resources

response.epa.gov/R2LIBResources

response.epa.gov/R4LithiumIonBatteryOutreach

Future OSC LIB Guidance Document



Acquisition Directorate
Research & Development Center

Lithium Battery Fire Hazards in the Maritime Environment

Distribution Statement A: Approved for public release; distribution is unlimited.

April 2025



**Homeland
Security**



Questions?



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