Li-Ion Battery Response Considerations

WELCOME

Presented By:

U.S. EPA Region 2
Weston Solutions START V

December 2024 Erie County Fire Training Academy Presentation

Li-Ion Battery Response Considerations

LOGISTICS

Facility
Restrooms
Emergency Location/Safety Message
Survey

Li-Ion Battery Response Considerations

OBJECTIVES & TOPICS

Basic Understanding & Principles of Li-Ion Batteries
Hazards and Risks
Types of Energy Storage
Different Chemistries
DDR and Misuse
Air Monitoring
Packaging, Disposal, Recycling
Fire Response Tactics

Li-Ion Battery Response Considerations

COURSE OUTLINE

- Li-Ion Battery Awareness
- Waste Profile and Disposal
- Tactical Considerations
  - Micro-mobility
  - Electric Vehicle
  - Larger Scale
- Health and Safety
  - Air Monitoring
  - PPE
- Live Demo

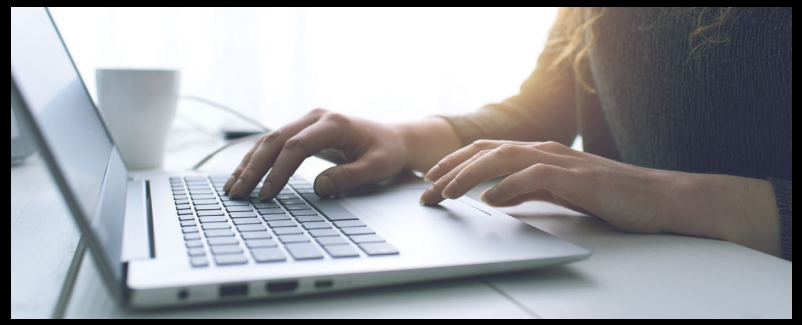
Li-Ion Battery Response Considerations

Module One: Awareness

Uses in the consumer marketplace
Trends in energy storage
Types of Batteries
Chemistries
Hazards and Risks

Li-Ion Battery Response Considerations

Communications



Li-Ion Battery Response Considerations

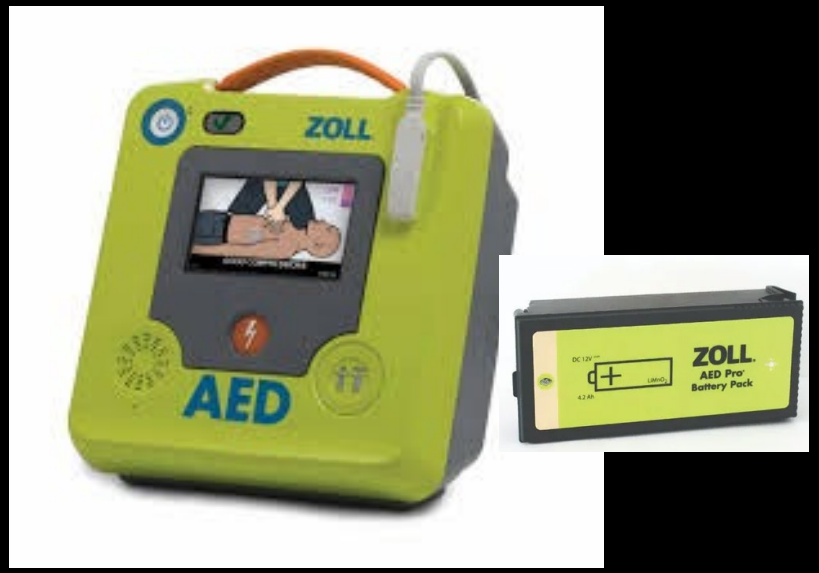
Transportation

Li-Ion Battery Response Considerations

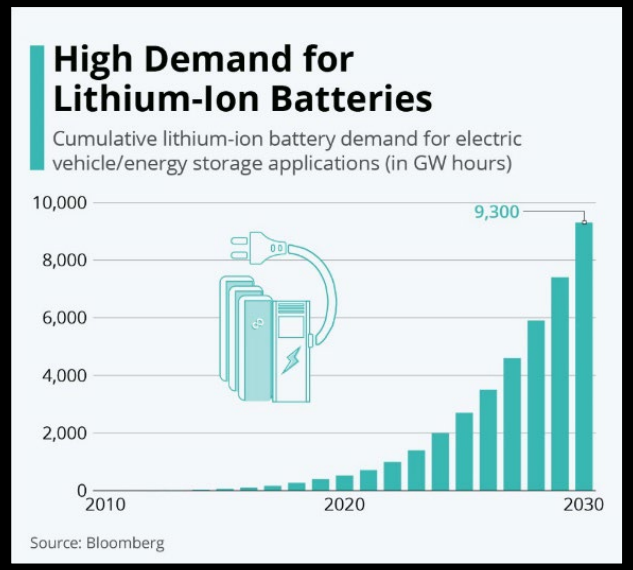
Energy Storage

Li-Ion Battery Response Considerations

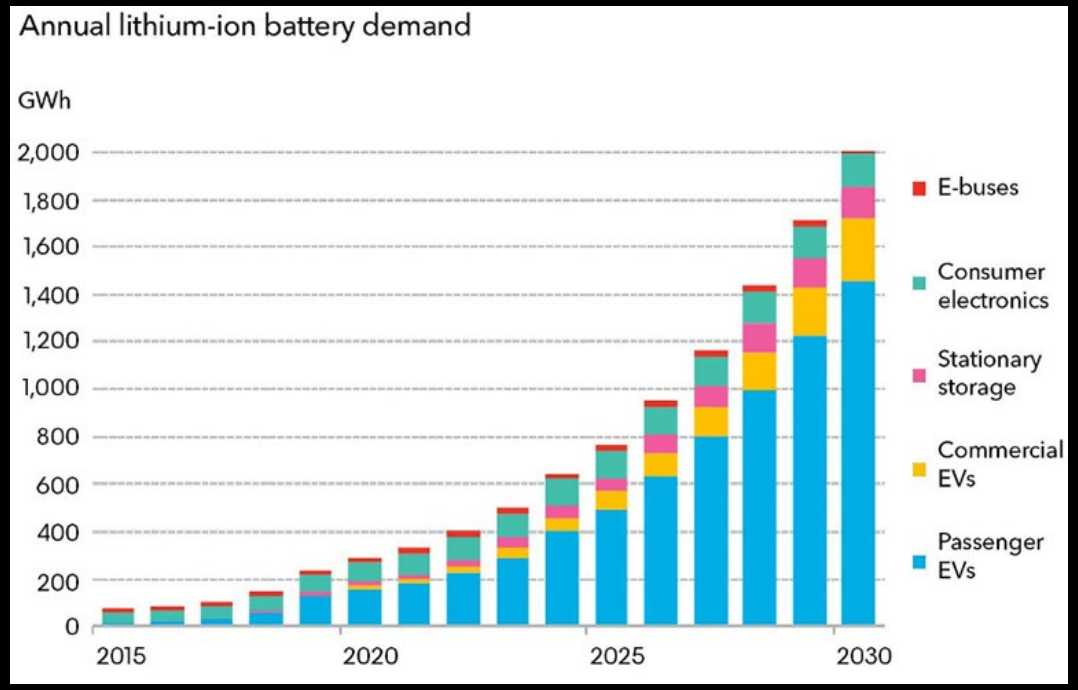
Household/Medical

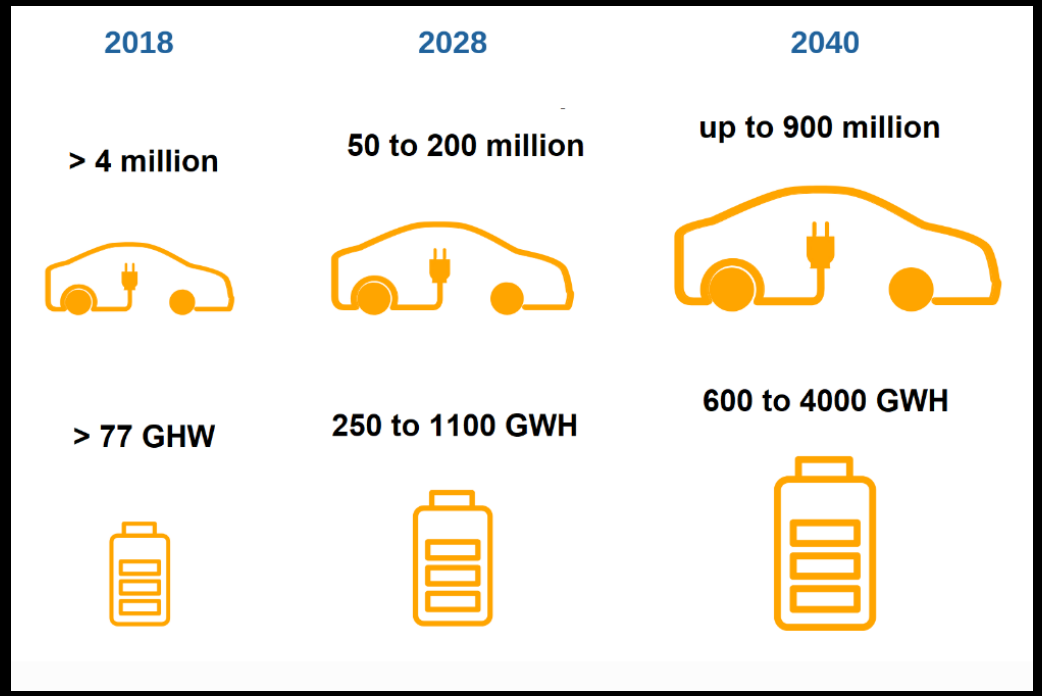


Trends in Li-Ion Batteries

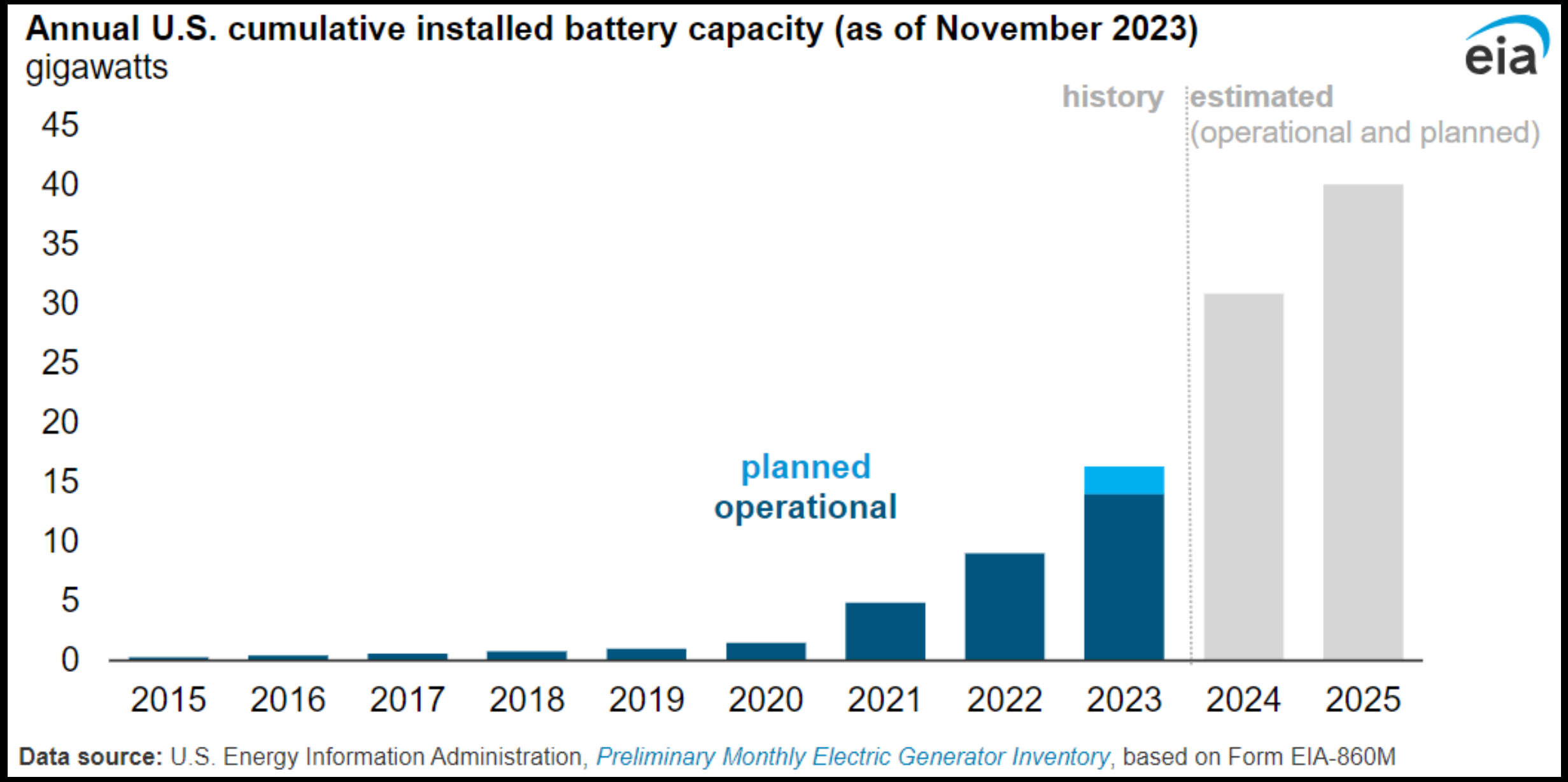


- Demand is increasing
- Energy density of batteries is increasing
  - Thermal runaway severity increases
- Production increasing
- Cost per kilowatt hour decreasing
- Products reaching “end of life” increasing

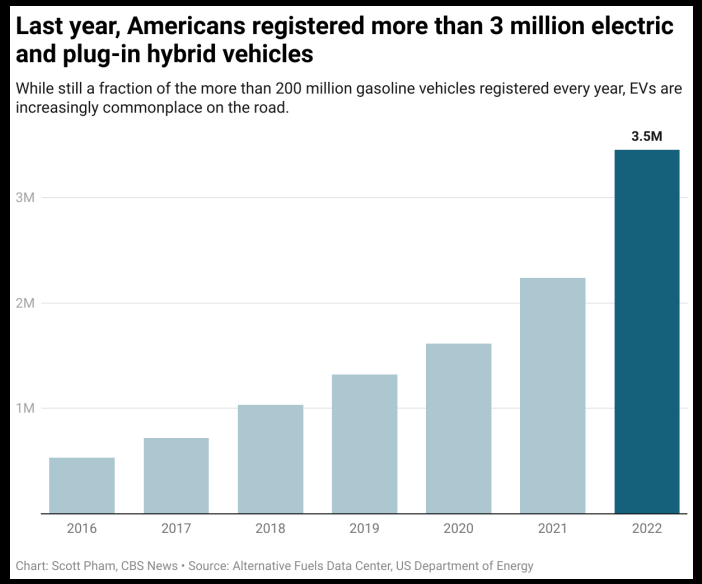


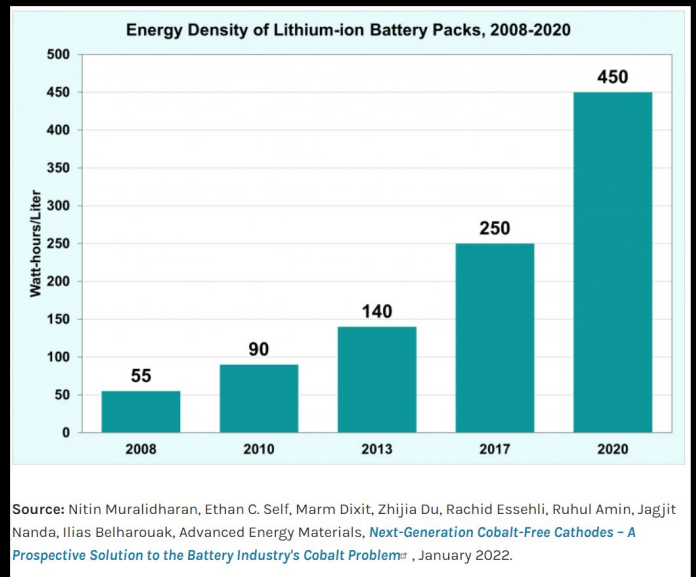


Trends in Li-Ion Batteries



Trends in Li-Ion Batteries





A Shifting Risk Profile for Lithium-Ion Batteries

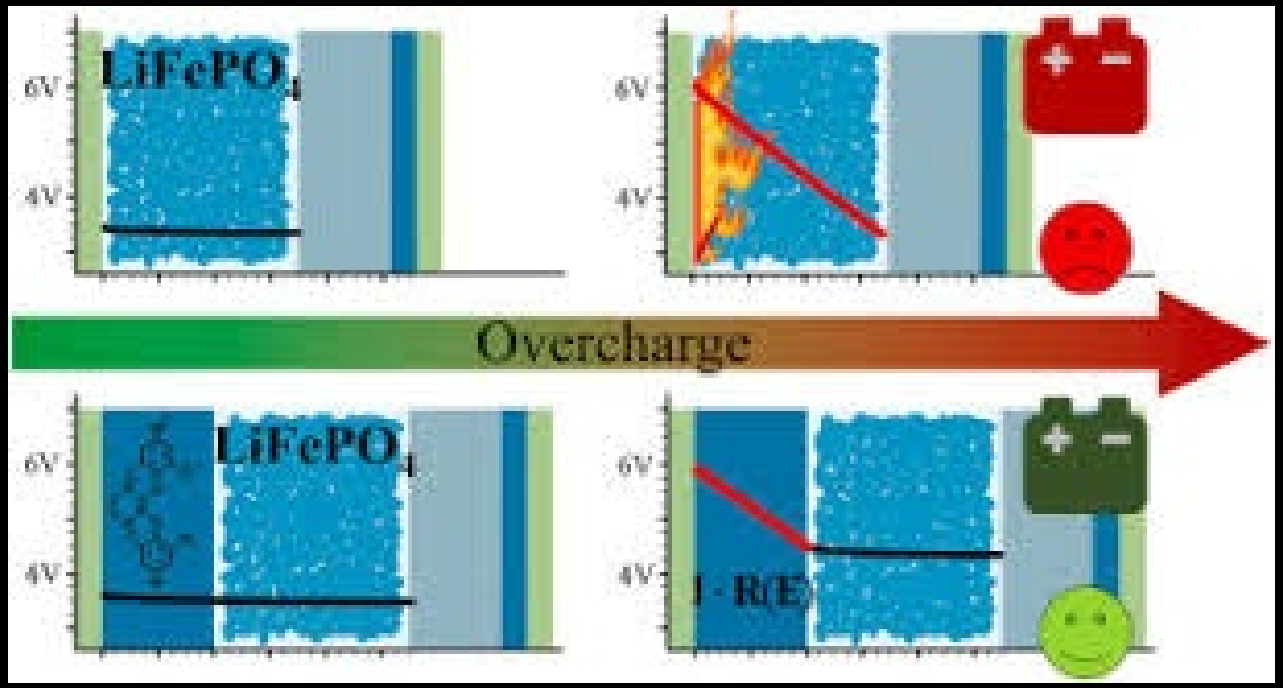
- Increased Availability and Involvement
- California gas-powered lawncare and generator phaseout
- Right to Repair Laws in numerous states
- Growth in Recycle/Reuse/Refurbish Market
- Growth in off-market products
- Increase in micro-mobility (scooters/e-bikes) & energy storage


WARNING - FIRE and EXPLOSION RISK
These 18650 batteries sold on Amazon may be dangerous or deadly


DEWALT
20V XR 5AH LITHIUM ION
DEWALT
VS
DEFAKE
ebay
20V XR 4AH LITHIUM ION


Knockoff Battery Dangerous?
M18 REDLITHIUM
HIGH OUTPUT XC6.
18V LITHIUM ION
6.0Ah
$90
$22


00:20
63,431%
BATTERY OVERCHARGING ACTIVE

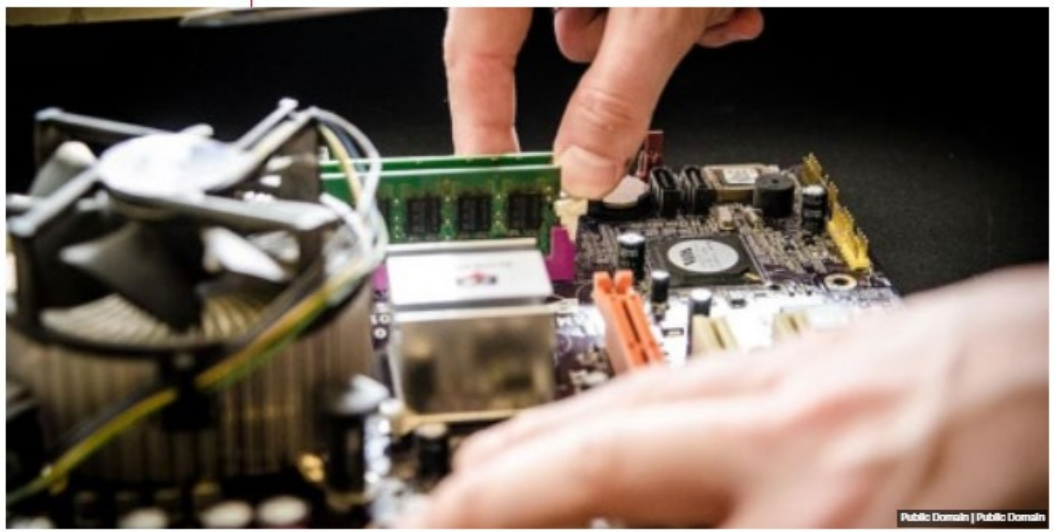

6V
4V
LiFePO4
6V
4V
Overcharge
6V
4V
LiFePO4
6V
4V
I - R(E)

RIGHT TO REPAIR

DECEMBER 22, 2023

New York's Right to Repair law is going into effect. Here's what will change

New York passed the first ever consumer electronics Right to Repair in 2022, which goes into full force on Dec. 28, 2023.



Public Domain | Public Domain

Nathan Proctor
Senior Director, Campaign for the Right to Repair, PIRG

On Dec. 28, 2022, New York's Right to Repair bill was signed into law, and now, one year later, its requirements come into effect.

Here's what that law means for consumers and repair shops in New York and around the country.

What products are covered by the New York Right to Repair law?

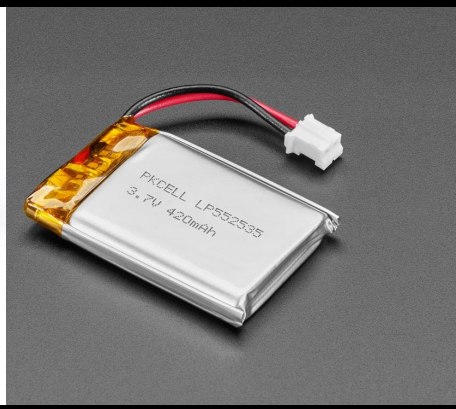
Types of Lithium Batteries

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



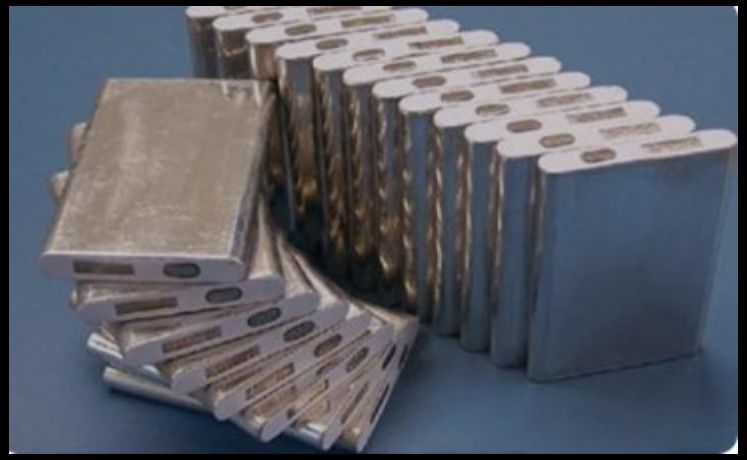
Four Primary Presentations of LIB

- Energy Storage Systems
- Electric Vehicles
- Micro-mobility
- Personal Electronic Devices

Types of Li-Ion Batteries

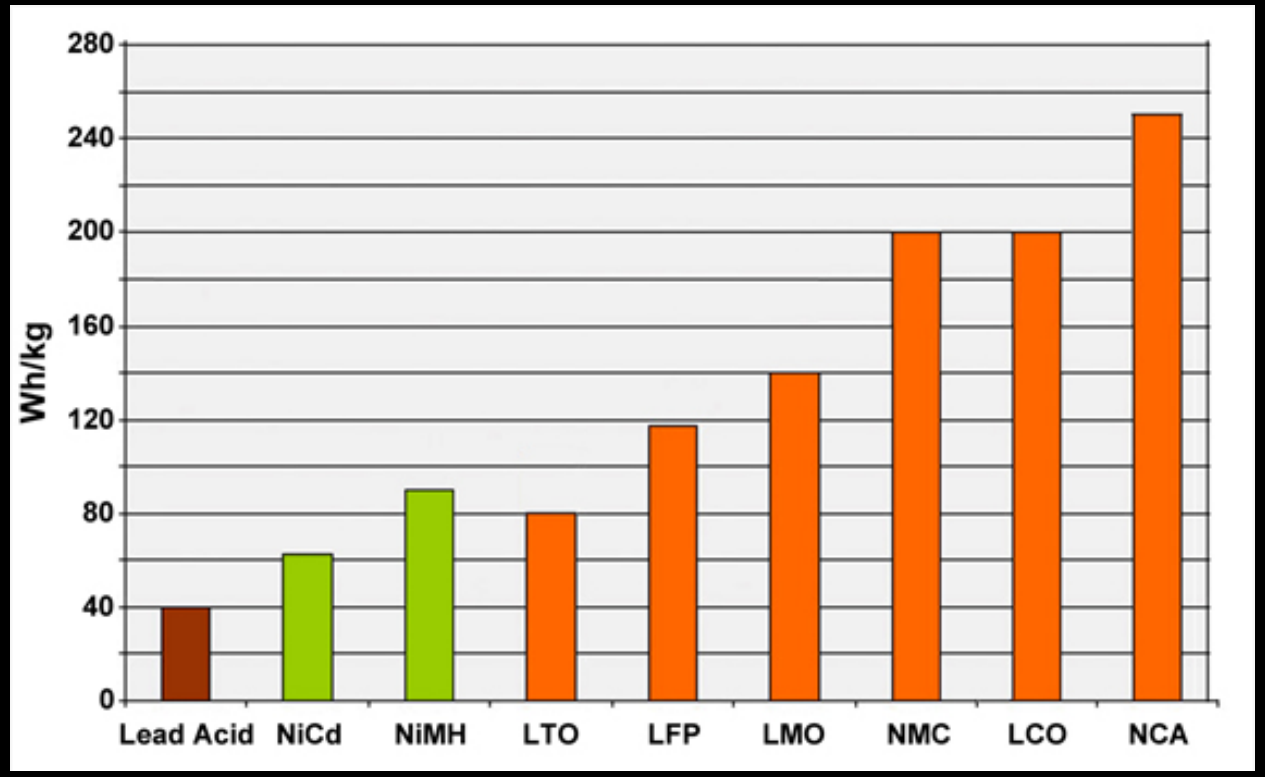
Styles

- Cylinder
- Pouch
- Prismatic



How do Lithium-ion batteries work?

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
- Lithium Hexaflurophosphate (LiPF6) - 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.

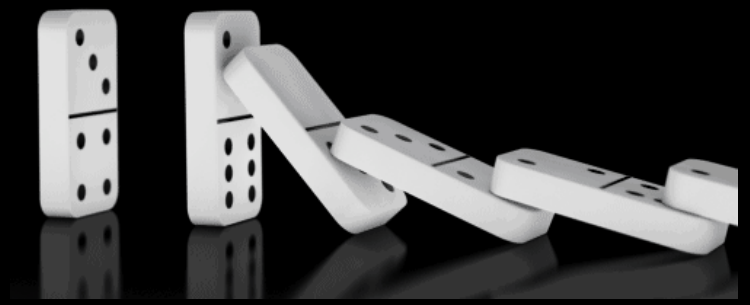
“DDR” means damaged, defective, or recalled. These are batteries that are a greater risk and have greater regulatory restrictions. Common in recycling and disposal streams, and commonly found to be the cause of incidents.

“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.

Propagation

- Propagation
  - Domino effect
  - Thermal Runaway heat from one battery-cell is likely to trigger Thermal Runaway in neighboring battery-cells
- Limiting propagation is primary goal
  - Cooling neighboring cells may prevent propagation
  - Removing exposed cells (i.e., removing other e-bikes, loose cells, etc.)



Dangers of Li-Ion Batteries: DDR

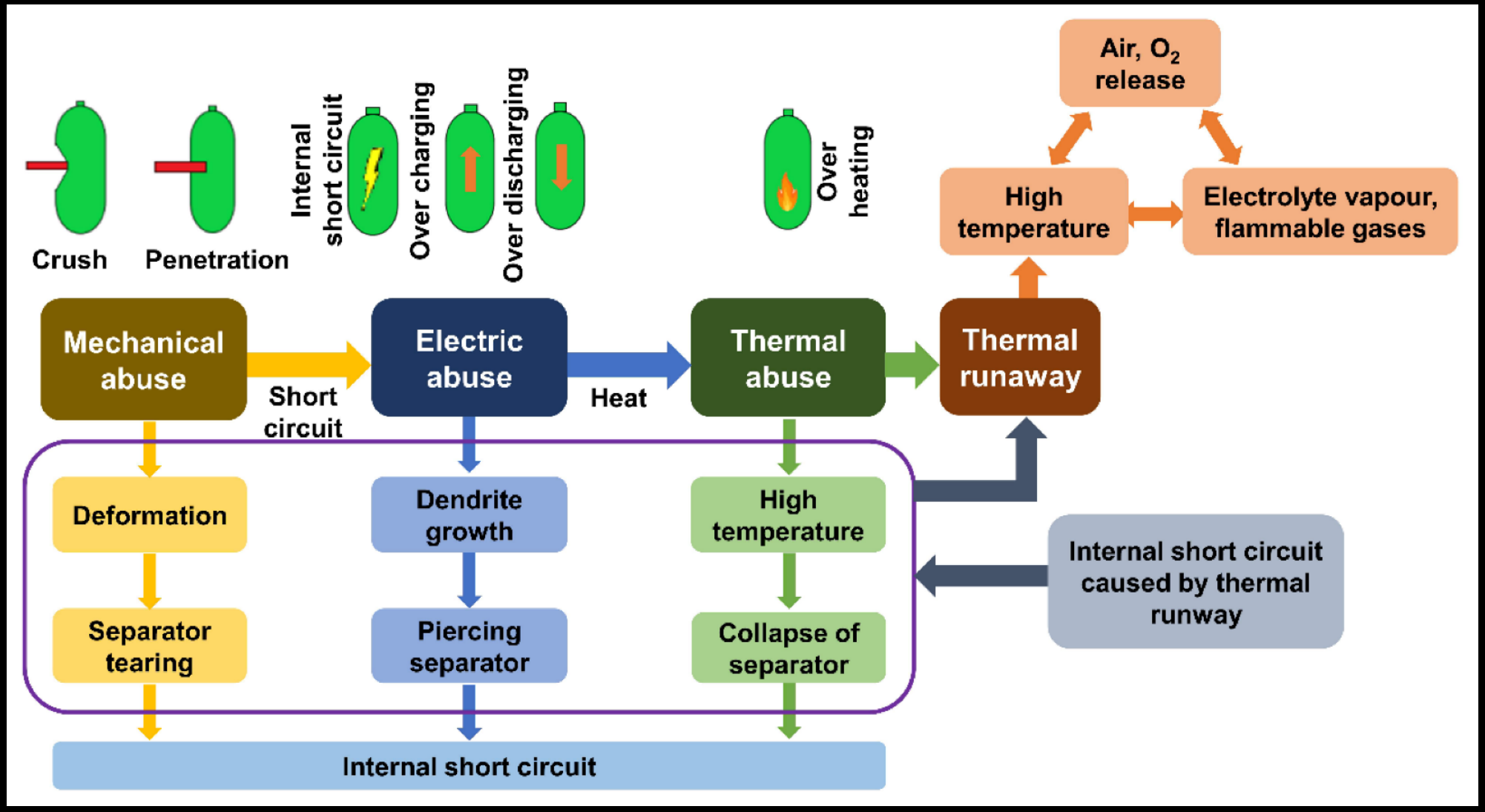
Can be caused by:

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

Are characterized as:

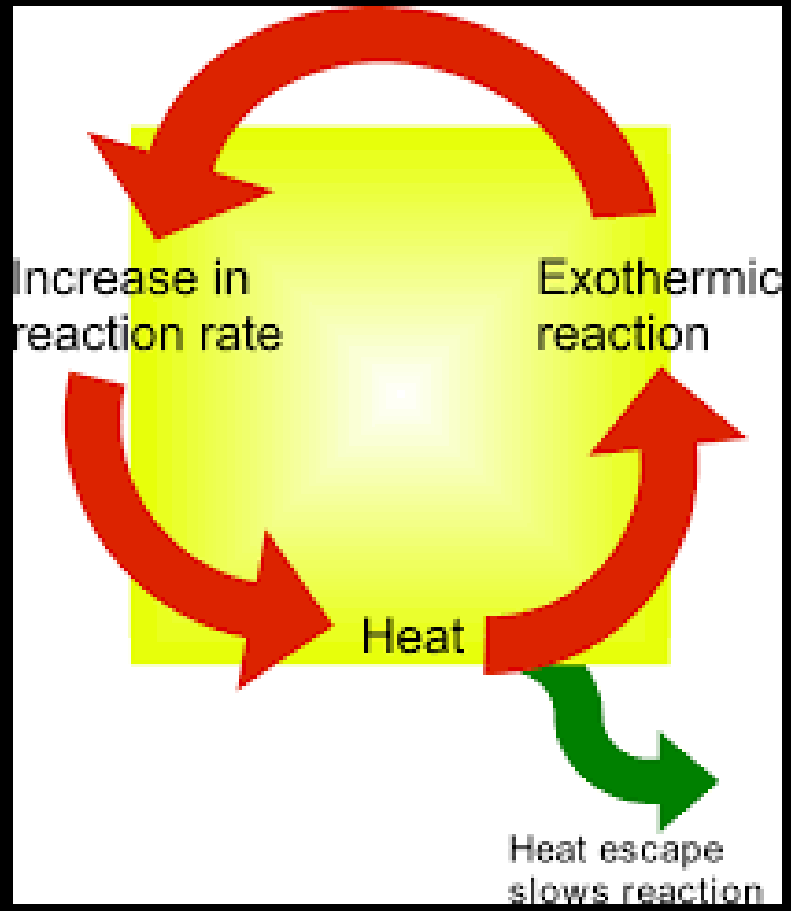
- Unreliable
  - No longer working appropriately
- Unpredictable
  - Overheat
  - Expansion/Swelling
  - Fire
  - Explosion
- Hazardous Waste
  - Disposal concerns
  - Expense

Why do batteries fail?



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

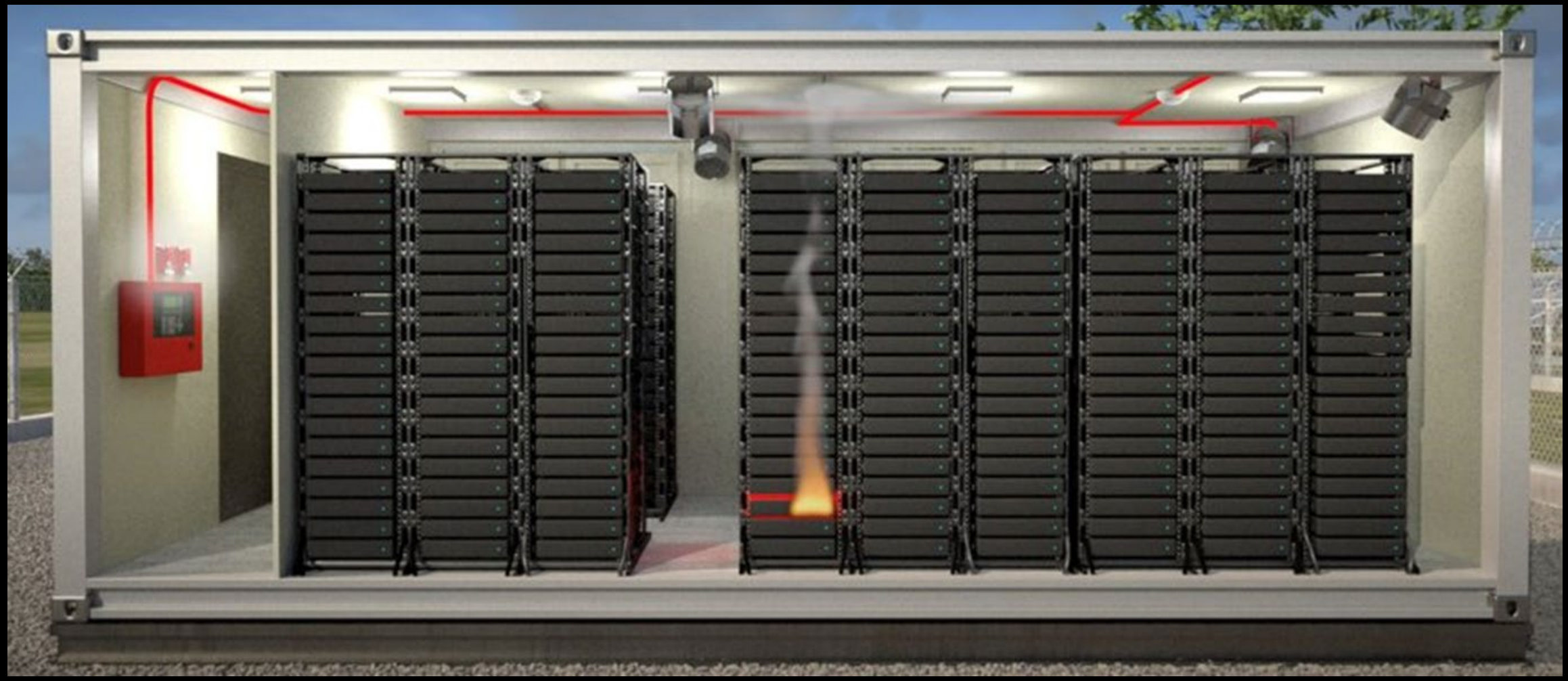


Characteristics of Li-Ion Fires

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


Newsflare

BESS Incidents



Flooded Car Incidents

Hurricane Ian – September 2022

Hurricane Idalia – August 2023

Flooded Car Incidents

Hurricane Helene

September 2024

Shipping Incidents
S-Trust Crude Tanker

Shipping Incidents
M/V Genius Star XI

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

All Incidents

Li-Ion Battery Response Considerations

Module Two: Waste Profile & Disposal

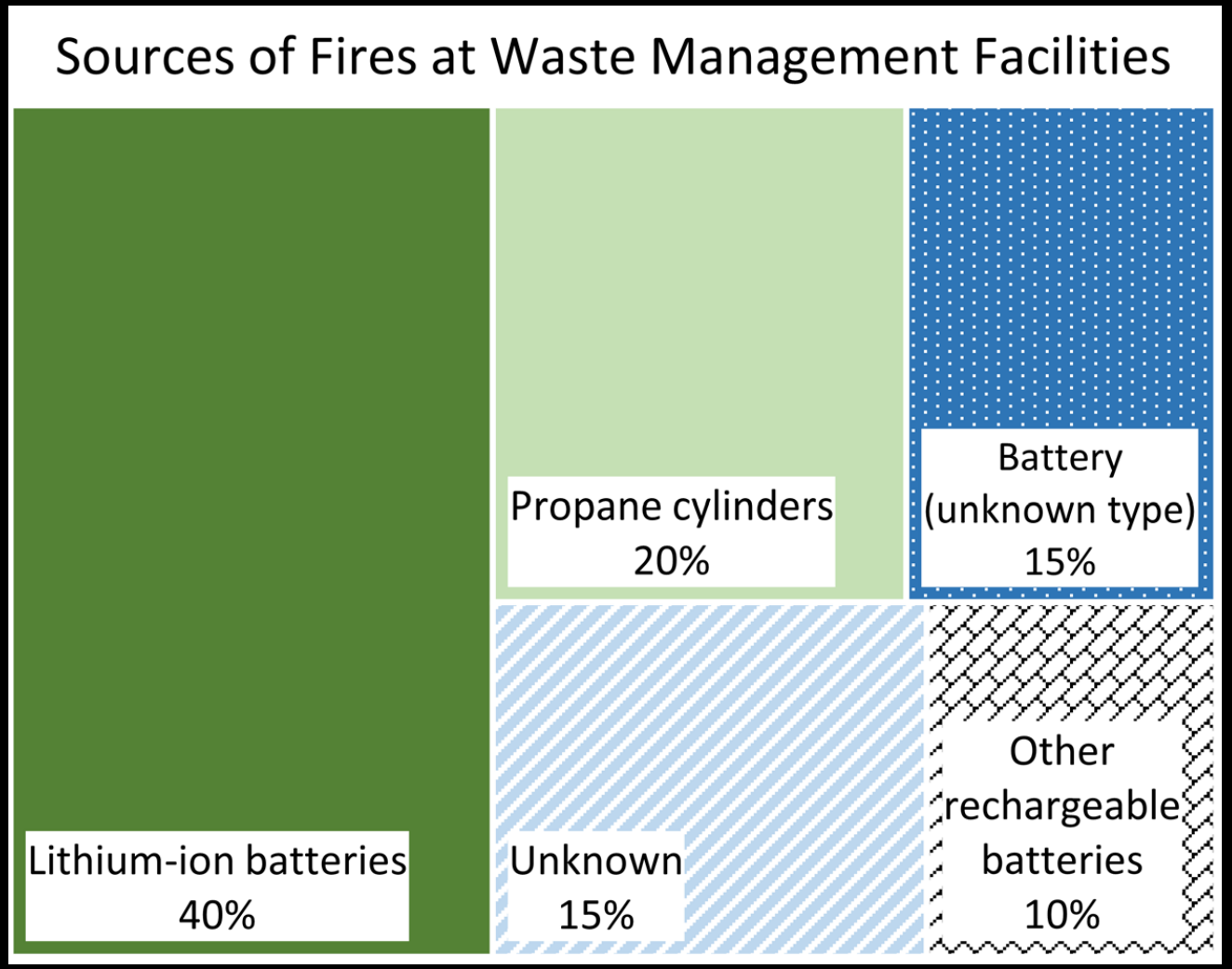
Hazardous waste regulations
Challenges
DDR packaging options
Transportation of materials
Disposal and Recycling


+ AA
RECHARGEABLE
OKAY
IN
TRASH
REQUIRES
SPECIAL
RECYCLING


1249
REPURLIC
208-345 1265

Consumer Disposal

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



Union of Concerned Scientists

The EQUATION

SIGN UP EN ESPAÑOL DONATE MENU

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: RUDOLFSIHON CC-BY-2.0 (WIKIMEDIA)

Josh Goldman
Former Contributor

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

EPA United States Environmental Protection Agency

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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

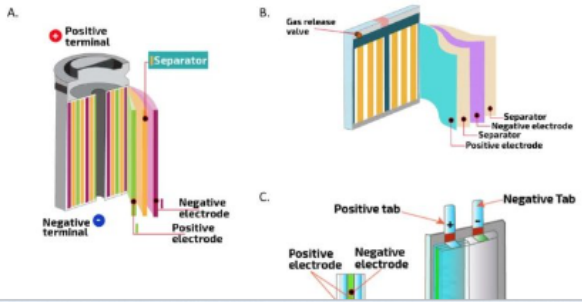
Lithium-Ion Battery Recycling

On this page:

Background on Lithium Batteries

Lithium-ion batteries 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.

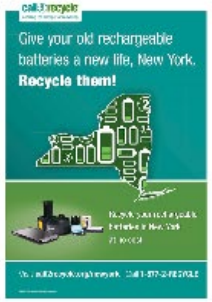
Consumer Recycling

AVOID THE SPARK™

Be battery safety smart.

Be battery safety smart and learn how to protect people and property. MORE

Resources



New York Recycling Poster

Download

Box Terminal Protection Guide

Download

Bulk Shipping Safety Guidelines

Download

Find a Drop-off Location

Enter Postal Code

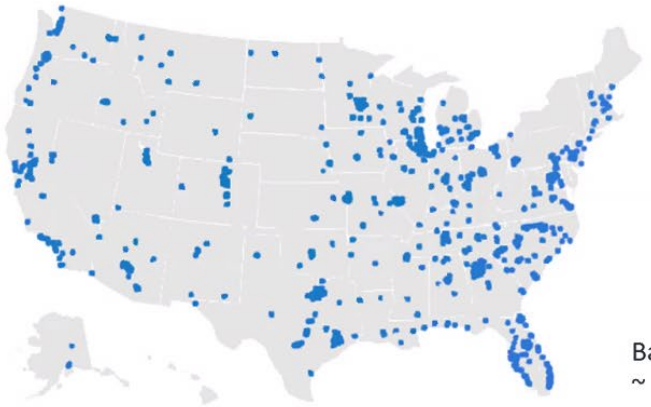
- Who supports the program?
- How to become a collection partner
- What types of batteries can be recycled?
- How are the batteries recycled?

Contact Us

Customer Service: Phone: 1-877-723-1297 Email Us

Consumer Recycling

Consumer Electronics Battery Recycling, Reprocessing, and Battery Collection - Retailer Programs



Projects begin Fall/Winter 2024/25

More than 1,000 collection points across the US

Battery collection potential for
~ 20 M batteries/Year
~ 6 M + lbs. / Year

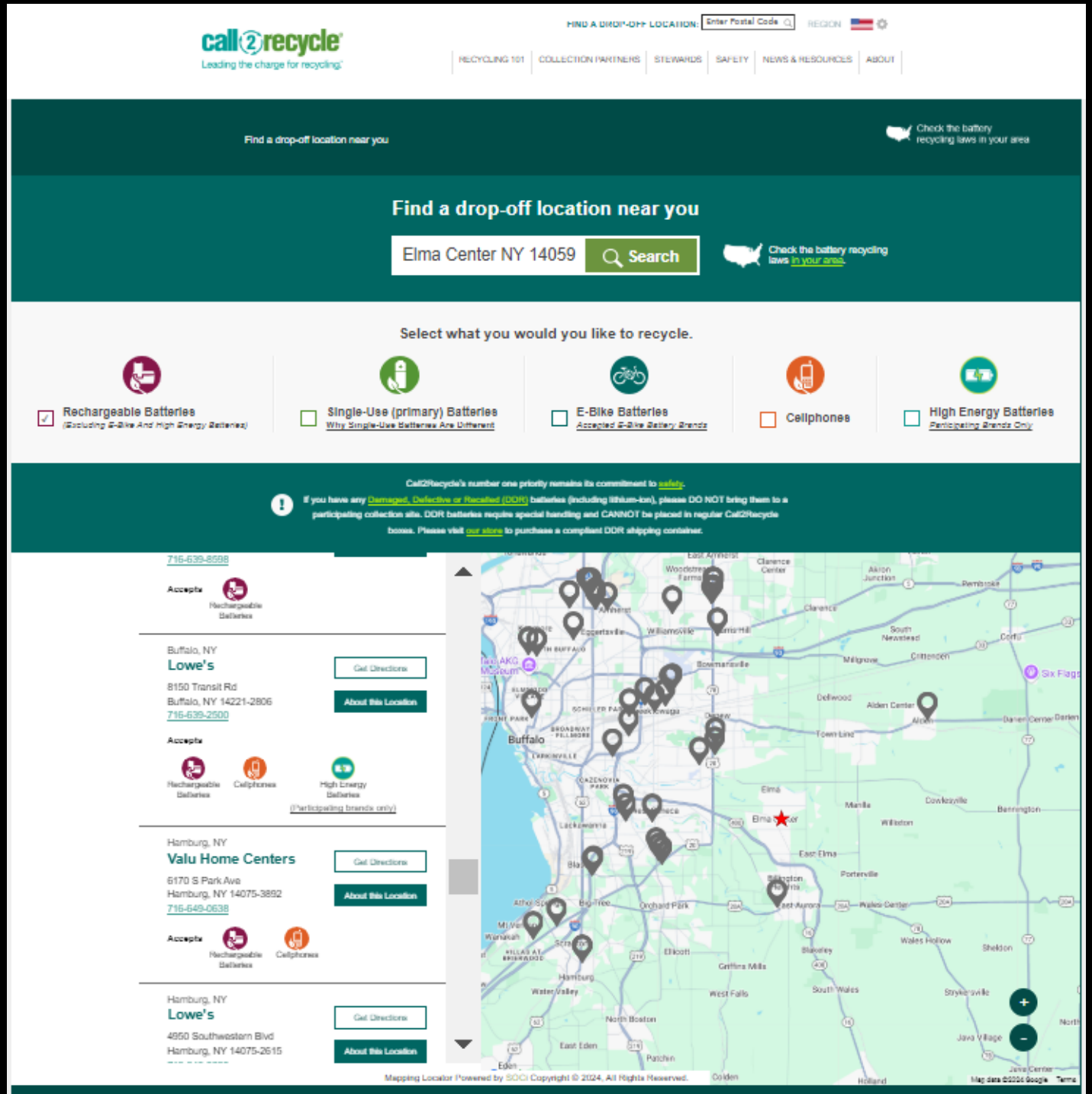
Over $30M overall investment

BatteriesPlus

Staples

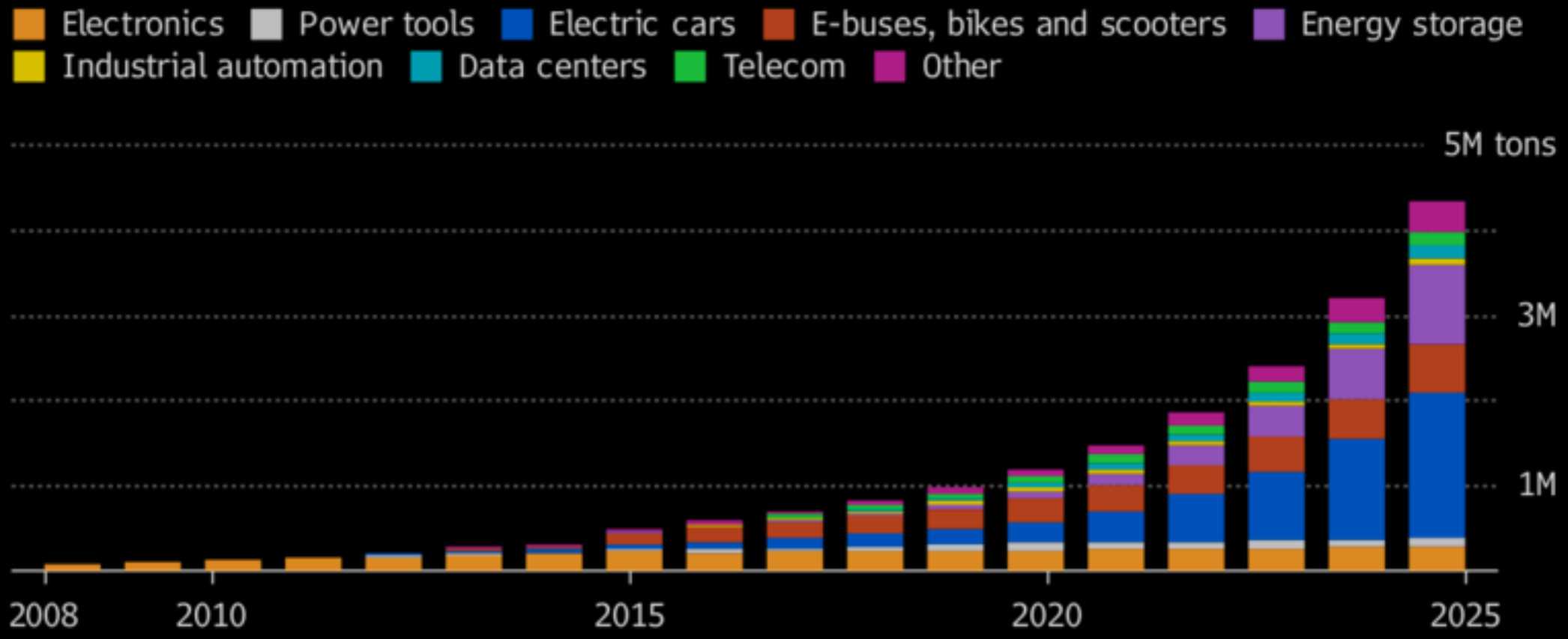
No cost to consumers, predicted to increase battery recycling by 100% over pilot programs

Consumer Recycling



Waste Not

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



Source: Creation Inn

Bloomberg

DDR Battery Disposal

- Who will collect, containerize, store batteries?
- Who will be responsible for getting rid of them?
- How do you address these?

DDR Battery Disposal

- Highly unstable material
- May be hazardous waste, universal waste, or unregulated
- DDR batteries may not be accepted at consumer recycling points
- DDRs may not be accepted at hazardous waste collection sites
- Regulations are burdensome, expensive and ineffective to address all safety concerns

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; submit for approval
- Can be issued to response company, manufacturer, project site

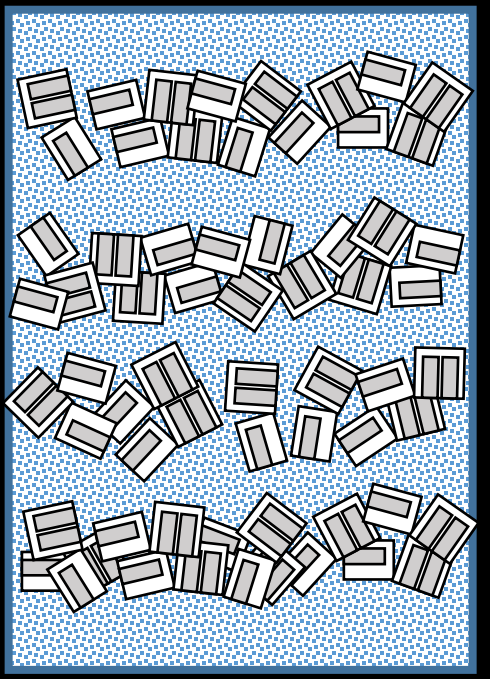
DOT SP-16532 – held by cleanup company, not site specific

- Special Permit to package multiple “small” lithium ion batteries
  - Up to 400 lbs in a standard 55-gallon drum



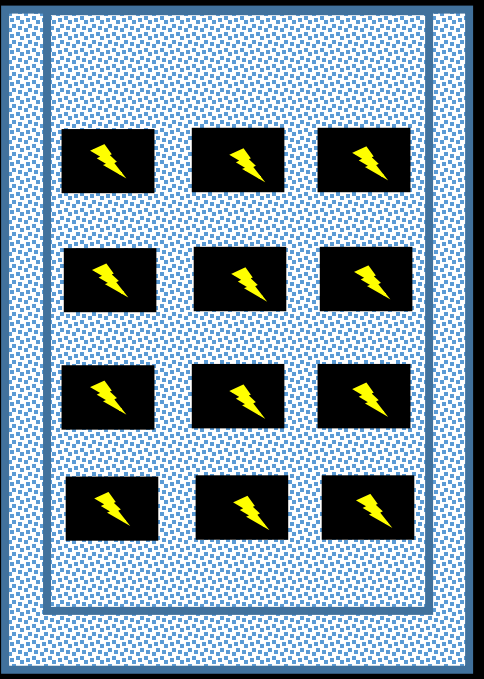




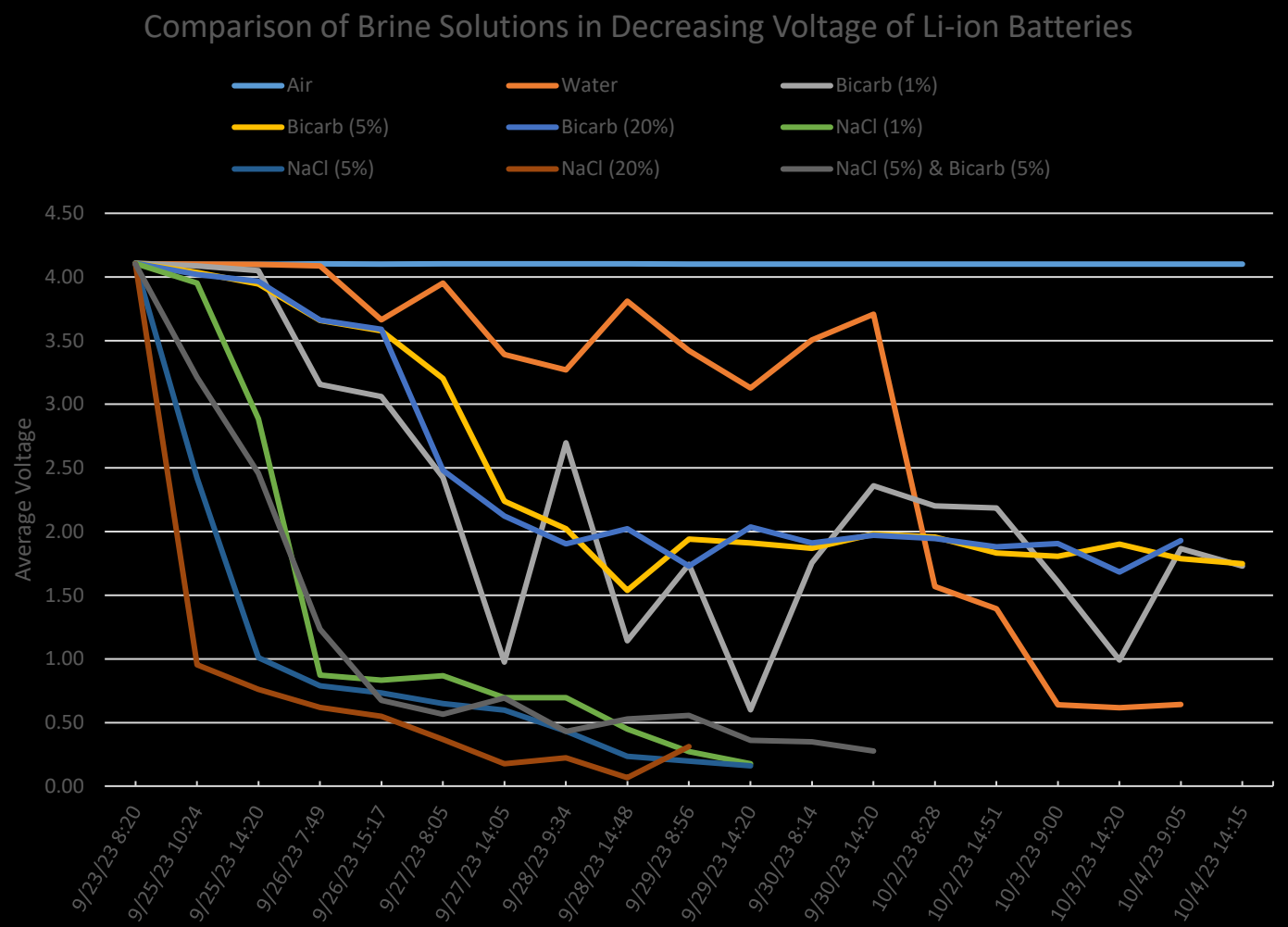



DOT SP-21329 – held by EPA R4, site specific

- Special Permit to package multiple “large” lithium-ion batteries (>300Wh, 14 lbs)
  - Up to 180 lbs in a Call2Recycle drum ($800 per drum)



Battery De-Energizing



- Discharge battery for safety
- Create a salt solution of 5% NaCl
- Allow to soak for 3 days
- Lower voltage
- Release of gases

Runoff/Brine Solution

- TCLP results for RCRA metals have been non-detect for disposal
- Studies show other metals may be present in high concentrations

Brine solution and runoff water are likely to be non-hazardous but should be disposed of at a POTW if possible.

Table 13
Comparison of contamination of sprinkling and storage water with limit and background levels.

Contaminant/ Parameter	Unit	Sprinkling water	Storage water	Process water	Drinking water limit values [1]	Industrial effluent limit value [2]
pH value	-	8.2	12.3	8	6.8 - 8.2	6.5 - 9.0
Chloride	mg/l	2	22	3	250	n.s.
Sulphate		34	98	2	250	n.s.
Nitrate		2	< 1	< 1	40	n.s.
Phosphate		<1	< 1	< 1	1	n.s.
Fluoride		8	330	< 1	1.5	n.s.
PAH [c]	µg/l	0.001 [a] 0.36 [b]	0.02 [a] 0.02 [b]	0.001 [a] < 0.001 [b]	0.1	n.s.
Benzo[a]pyrene		< 0.001 [a] 0.07 [b]	0.004 [a] 0.01 [b]	< 0.001 [a] < 0.001 [b]	0.01	n.s.
Nickel		36000 [a] 48400 [b]	55000 [a] 181000 [b]	< 700	20	2000
Cobalt		36000 [a] 46000 [b]	50000 [a] 181000 [b]	< 400	n.s. (≤ 70)	500
Manganese		36000 [a] 44000 [b]	53000 [a] 199000 [b]	< 1300	50	n.s.
Lithium		7000 [a] 2200 [b]	1460000 [a] 31000 [b]	< 1300	n.s. (≤ 40)	n.s.

Battery De-Energizing

Disposal

- End-Point Recycling Facilities over the best option for disposal
  - Discharge battery (3 days in brine)
  - Grind battery to 0.5” or less pieces
  - Extract metals
  - Dispose of remaining mash

Li-Ion Battery Response Considerations

Module Three: Tactical Considerations

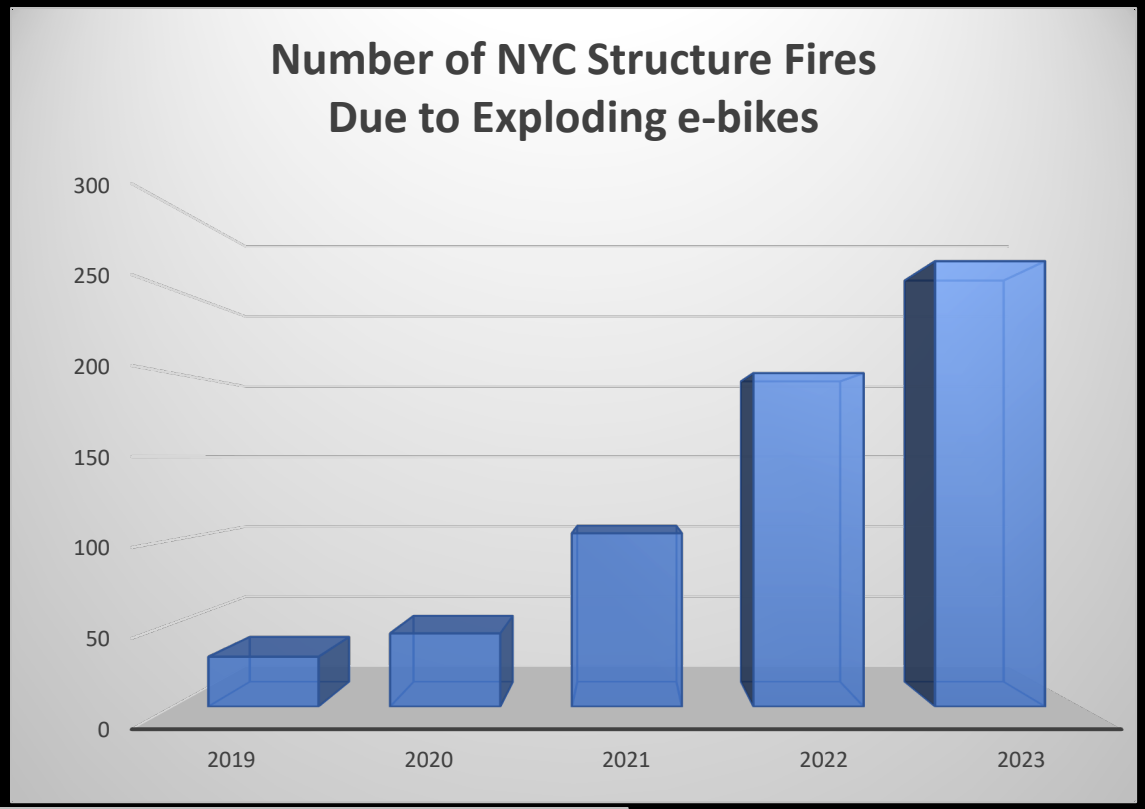
Micro-Mobility
Electric Vehicles
Energy Storage Systems
Accumulators/Recyclers
Stafford Act

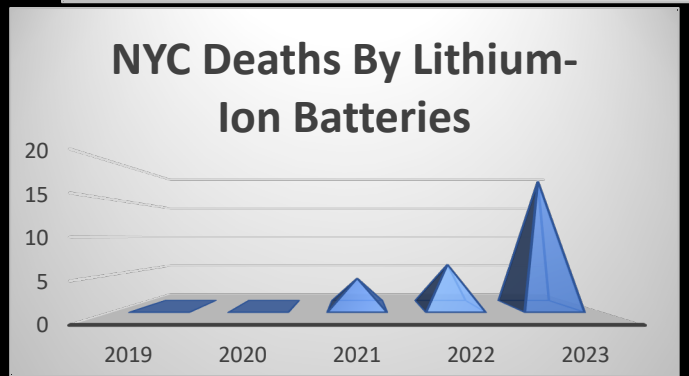
Micro-Mobility Devices

E-BIKES, SCOOTERS, HOVER BOARDS, ETC.

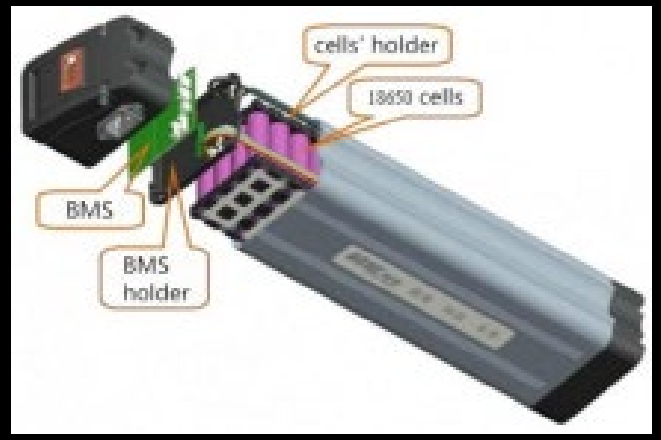
Micro-Mobility Devices

- Largest number of LIB incidents
- FDNY LIB fires:
  - 44 in 2020
  - 220 in 2022
  - 268 in 2023 (18 killed, 150 injured)
  - Now leading cause of fire and deaths in NY City, 2024.
- Public exposure concerns
  - Stored and charged inside occupied residences and businesses
  - Stored near entry and exit ways
  - Can ignite with little-to-no warning
  - **<u>Rekindle is likely.</u>**





Micro-Mobility Devices



(i) Electric Unicycle

(ii) Egret (kick electric scooter)

(iii) Electric Scooter

(iv) Three-wheeler Electric Scooter

(v) Electric Mobility Cart

(vi) Electric Bike (bicycle)

(vii) Hoverboard

(viii) Segway

(ix) Electric Caster Board

Intentional
E-Scooter
Overcharge:
Living Room

Overcharge Time:
01:39:27

Living Room

This experiment was designed to intentionally drive a lithium-ion battery into failure to examine the potential hazards of storing and charging e-mobility devices, which have been known to catch on fire and cause explosions.

How Many GPMs?

- Lithium-Ion batteries do not require Oxygen to burn.
- Smothering also does not work
- Inerting with clean agent may inhibit class A fire but not battery fire, where flaming combustion is suppressed, explosive and toxic gases build-up and don’t burn off; Surprise, AZ.
- Cooling to prevent cell propagation may be successful if water can be placed into battery pack
  - **DO NOT** force open the battery pack

Micro Mobility Concerns

Micro Mobility Concerns

Micro Mobility Concerns

"Farming"

Micro Mobility Concerns

Rapid failure

Overhaul

Toxic atmosphere

Rekindle

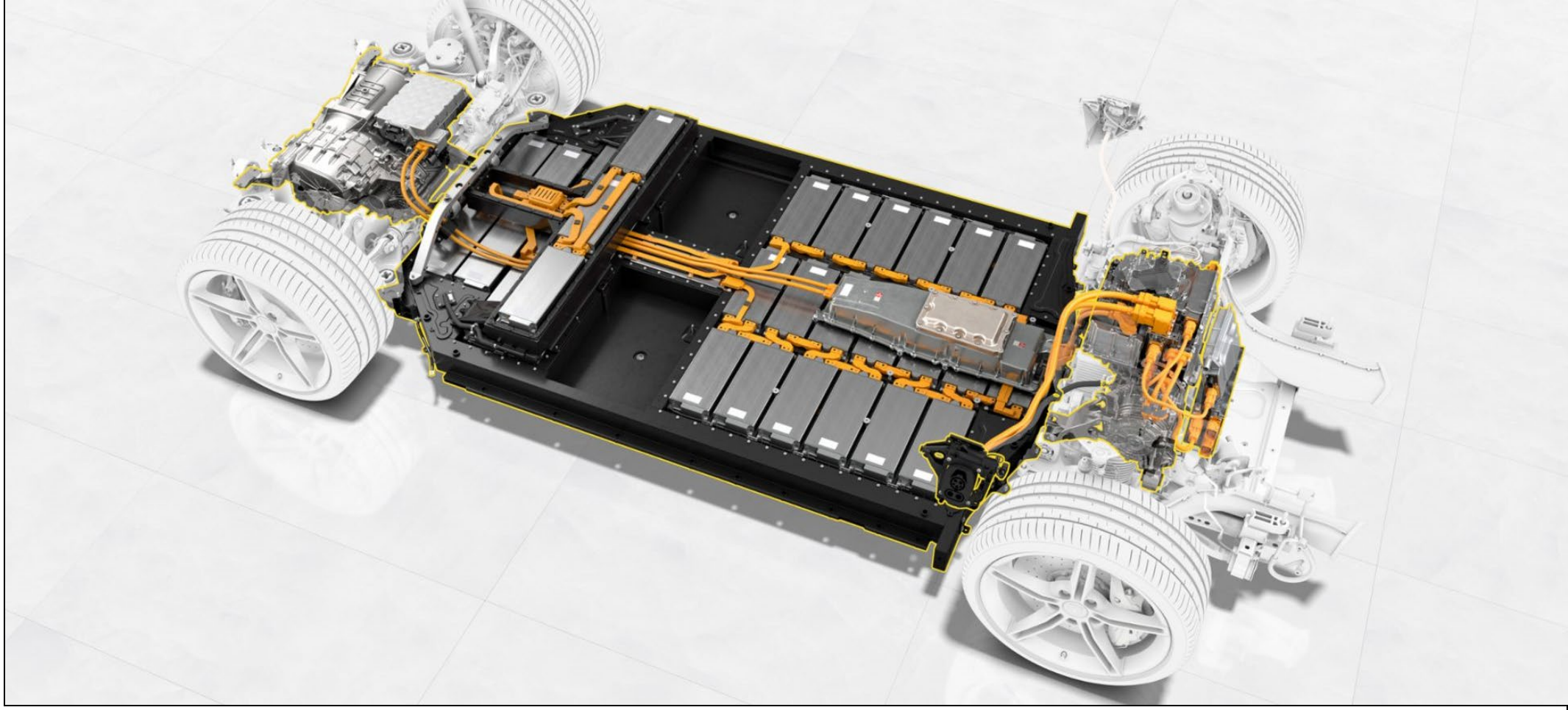
Explosive

Micro Mobility Tactical Considerations

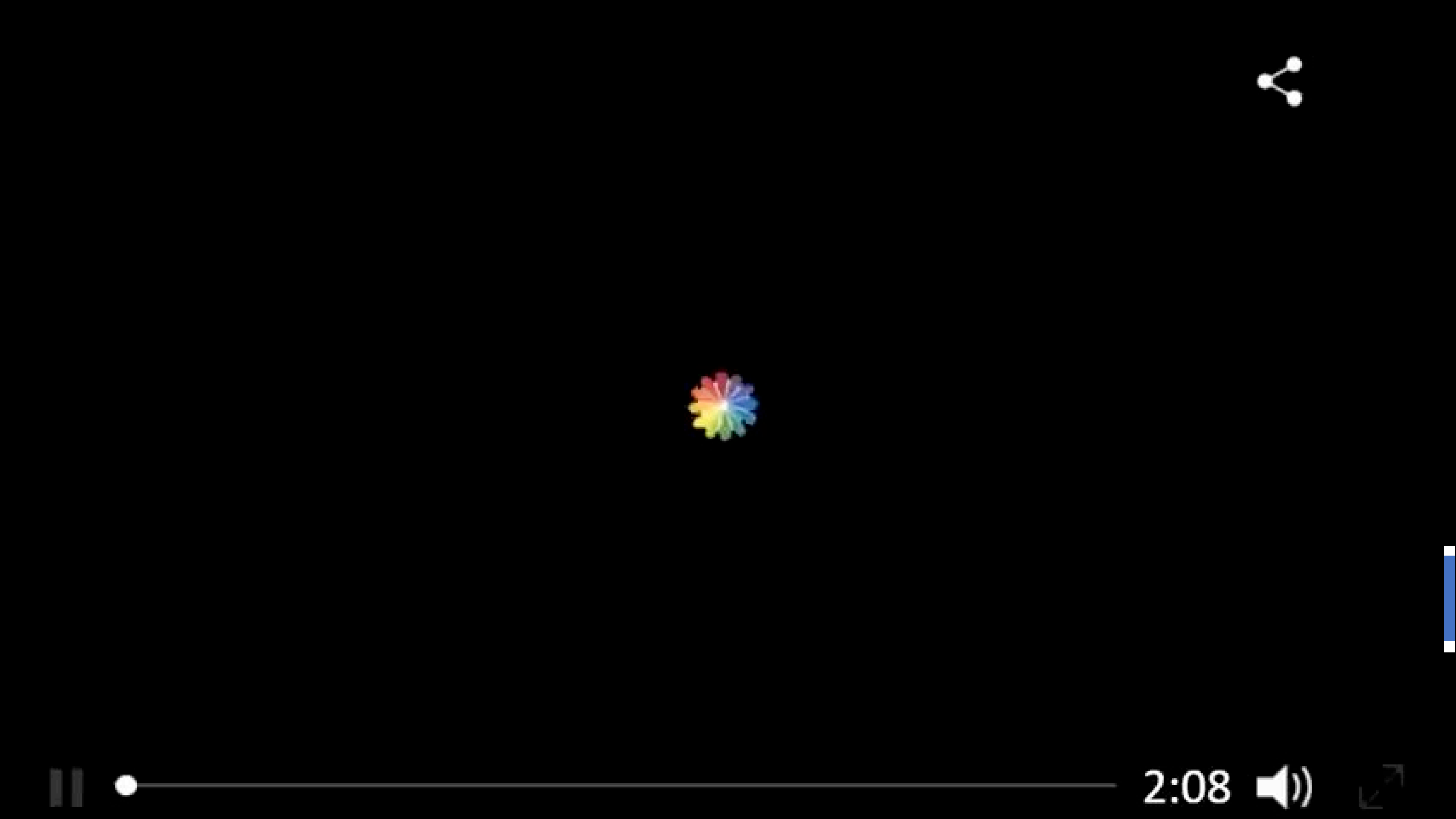
- Life safety
  - PPE/SCBA
  - Rescue
  - Evacuate area
- Incident Stabilization
  - If outdoors
    - Allow micro mobility to burn to completion
    - Prevent propagation to other devices/battery packs
  - If indoors
    - Attack residential fire like normal
    - **During fire attack, uninvolved micro mobility device may ignite behind you!!**

Micro Mobility Tactical Considerations

- Move all lithium-ion battery cells and devices to a safe location, away from firefighting operations, **PRIOR to overhaul**
  - Use shovel with wooden handle
  - Outside is preferred
  - Consider bathroom, bathtub, sink, or metal bucket and fill with water if outdoor not an option
- Wear SCBA during overhaul
- Advise Investigators of possible LIB presence
- Request HIRT to assist with battery stabilization, mitigation, overpacking, and disposal
- Provide protection line during overpacking procedures



Electric Vehicles (EV)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Exponential Increase: Electric Vehicles (EV)

% of EVs Global Auto Sales

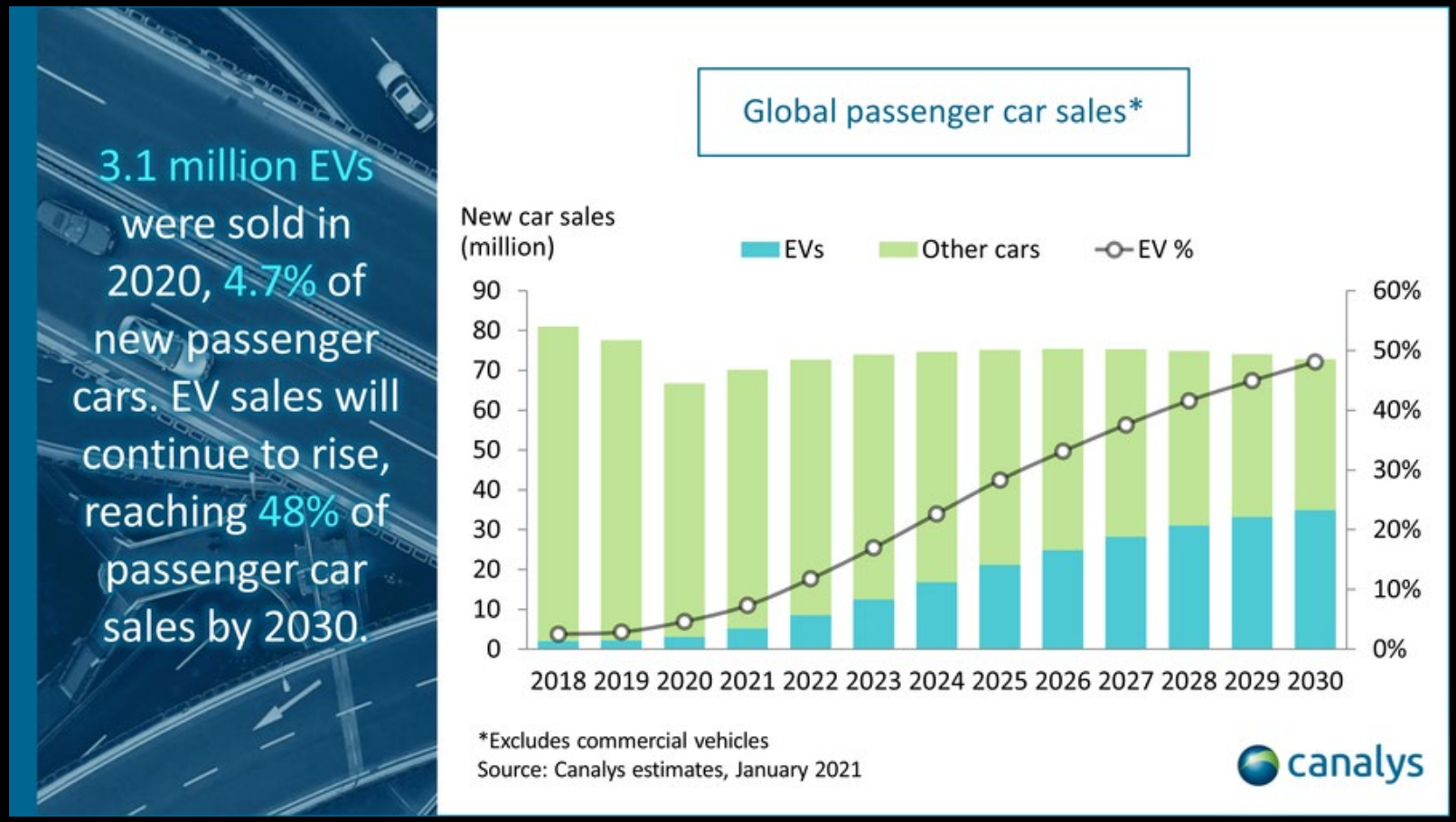
4.7% - 2020

15% - 2025

48% - 2035

California forecasted to be much higher.

By 2035 100% of all vehicle sales in CA must be battery or hydrogen powered



Battery Recovery/Removal - EVs

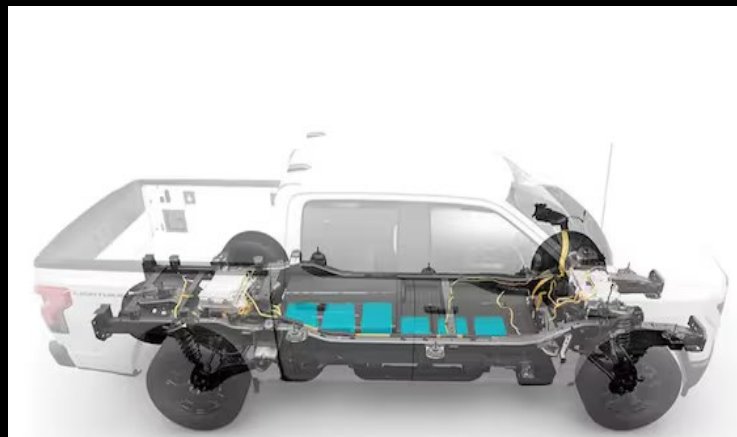
To gain an understanding of battery type, important to know:

- Make
- Model
- Year
- Option

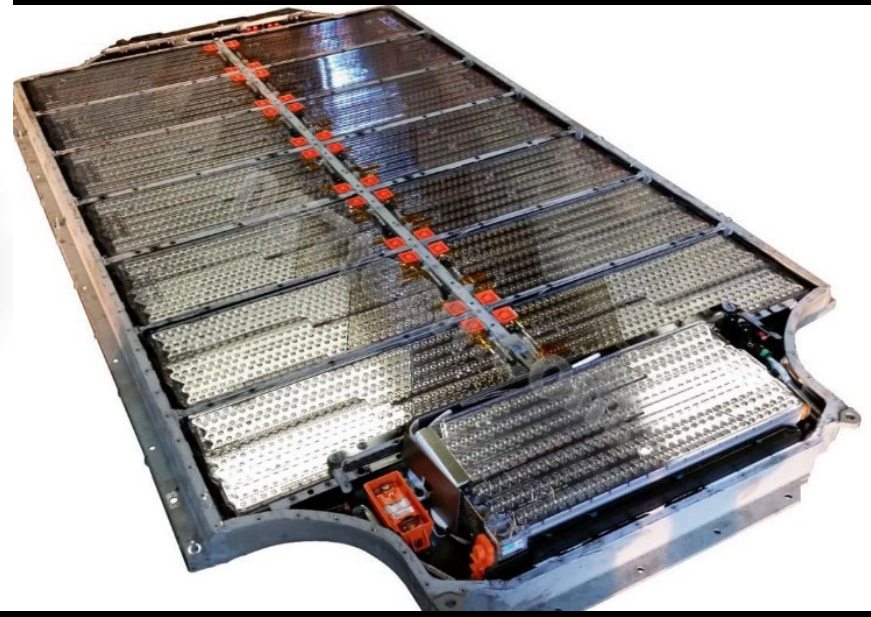
This is a luxury if available.

Electric Vehicles (EV) – Battery Packs

GM Battery Pack
Pouch Cells



Ford Lighting Battery Pack
Pouch Cells



Tesla Battery Pack
Cylindrical Cells

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)

Battery Recovery/Removal – EVs (Toyota Prius)

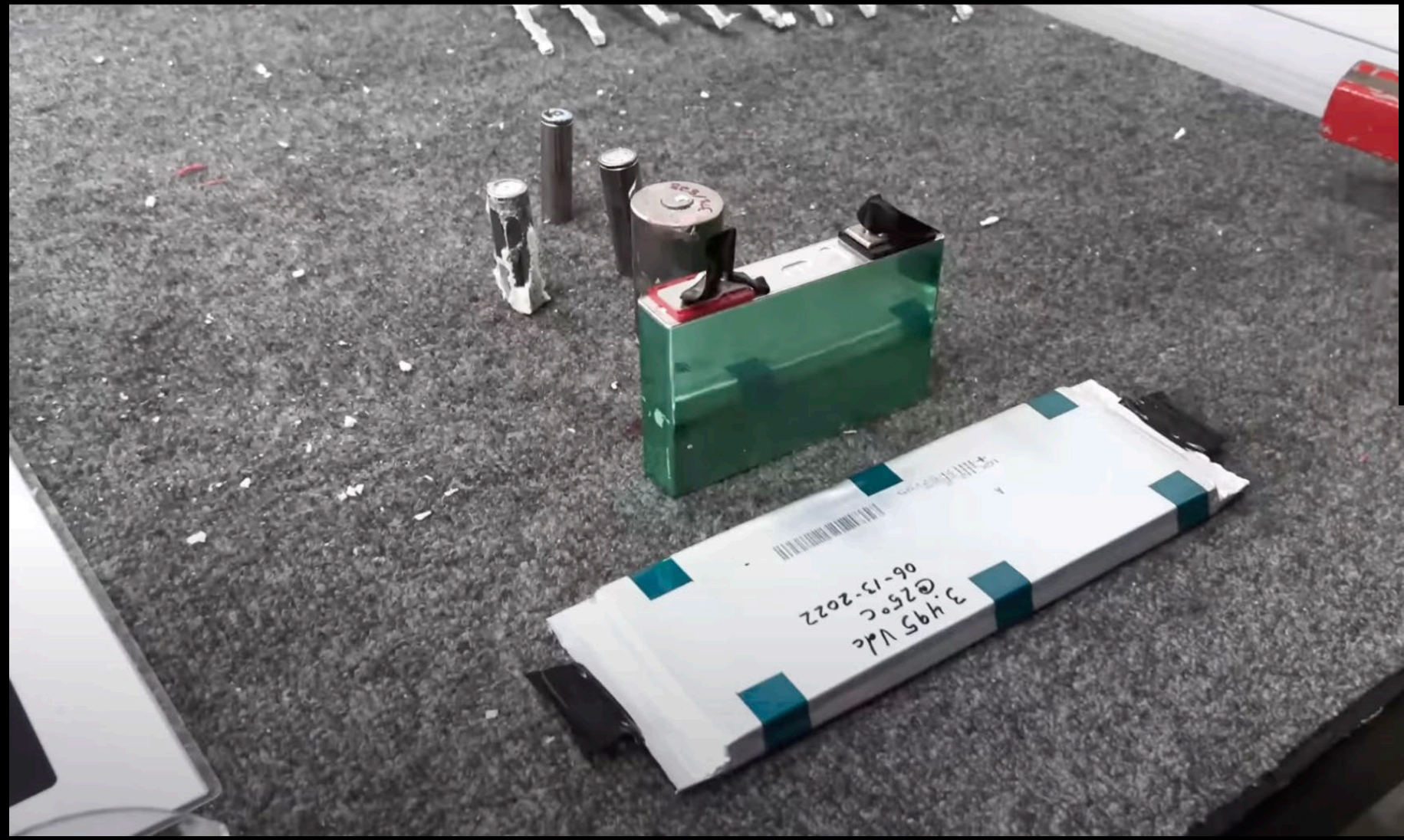
Battery Recovery/Removal – EVs (Nissan Leaf)

Battery Recovery/Removal – EVs (Subaru)

Battery Recovery/Removal – EVs (BMW i3)

Battery Recovery/Removal – EVs

Electric Vehicles (EV) – Battery Packs



EV Damage

- Lithium-Ion Batteries primarily located in underside of vehicle
- Identification of battery involvement is key:
  - White smoke
  - Battery cell projectiles
  - Hissing/popping sounds

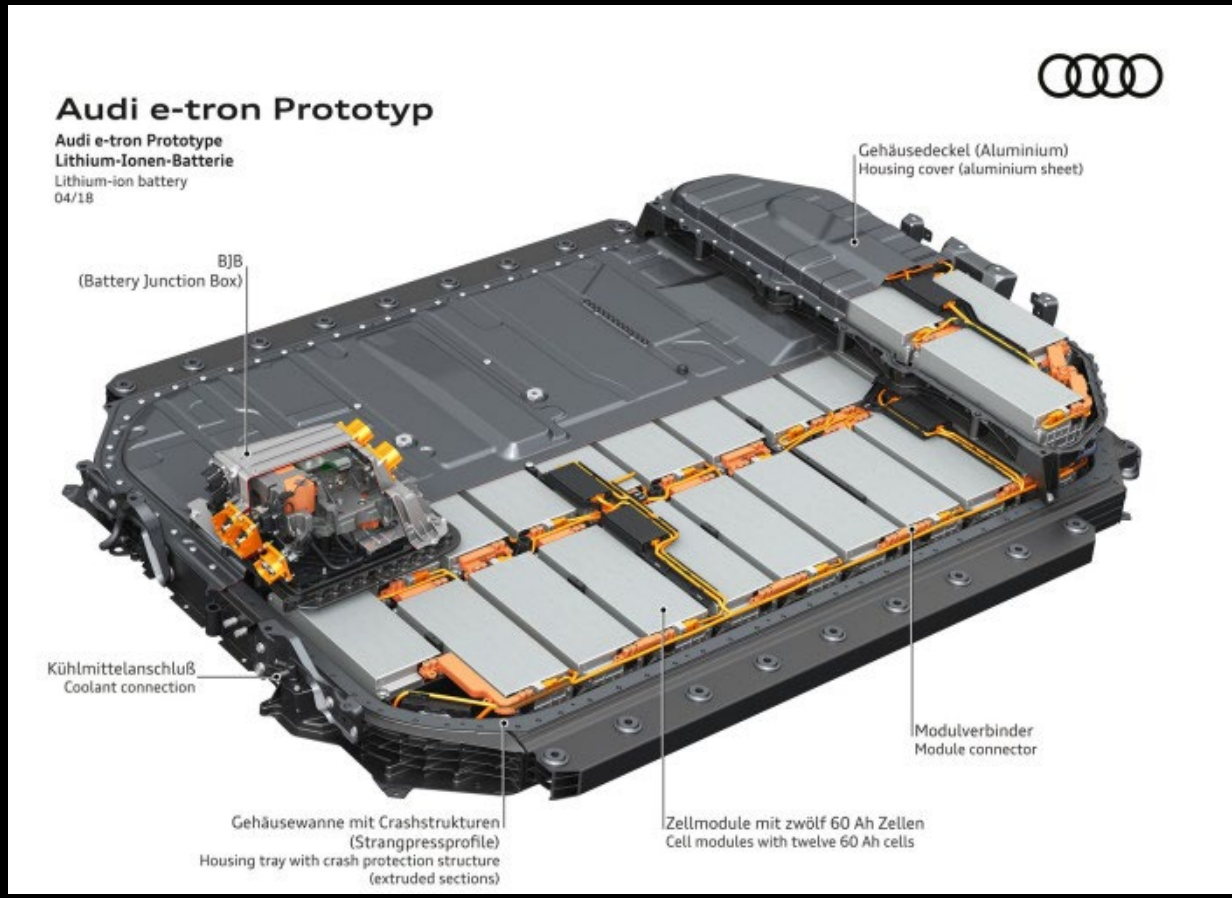
Tesla – Cylindrical Cell Batteries

18650 cell generation

LOTS OF WATER

EV – Offensive Operations

- Water is considered best cooling agent
  - If offensive operation engaged:
    - Water should be applied under the vehicle and up at the batteries.
    - For pouch cell vehicles (i.e., GM), there may be access points near the wheel wells
    - Water application into access points to battery compartment can prevent propagation (manufacturer specific)
- **<u>Rekindle can occur minutes, hours, days, weeks, months, years, later!</u>**



3 Keys to Success

EV Identification

PROTECT EXPOSURES!

(If possible)

Water

EV Fire Tactical Considerations

- Life safety
  - PPE
  - Rescue / Check for victims
  - Chock wheels
  - Evacuate / Shelter-in-Place
- Incident Stabilization
  - **Attack the fire like a normal vehicle fire.** Foam is NOT recommended
    - Most EV fires do not involve the batteries
  - After confirming it is an EV and batteries are involved, if possible, allow the batteries to burn and evacuate the area 330’ in all directions and protect exposures.
  - Stay out of smoke, toxic.
  - Consider PPV fans to move smoke away from victims and responders.

EV Fire Tactical Considerations

- If extinguishment/cooling is required:
  - Secure a water supply
  - Consider tilting the vehicle to gain access to the underside of the vehicle
    - This will require training prior to placing into operations
    - Lifting points must be referenced
  - Consider directing spray into side vents of battery pack
  - Use a thermal imager to check for continued heating
  - Never cut, crush, puncture, or open a high voltage battery to extinguish it
  - If the cells are visible due to damage, you can direct a hose stream directly on the cell
  - Observe the battery and watch for evidence of thermal runaway

EV Fire Tactical Considerations

- Other considerations
  - Refer to the Emergency Response Guide (ERG) for the specific make and model of the vehicle for guidance on securing power to the lithium-ion battery. www.NFPA.org
    - Some battery cooling mechanisms are powered by the 12-volt system
  - Once the lithium-ion battery has been cooled, stand-by at least 45 minutes and continue monitoring the lithium-ion battery using the thermal imager and observe for any other signs of thermal runaway

EV Fire Tactical Considerations

- Tow Company
  - Make sure it's towed on a flatbed.
    - Regenerative braking sends power to batteries. This may cause a fire with rotational force on wheels
  - Store 50 ft away from all exposures

EV ERG – NFPA link

Example ERG

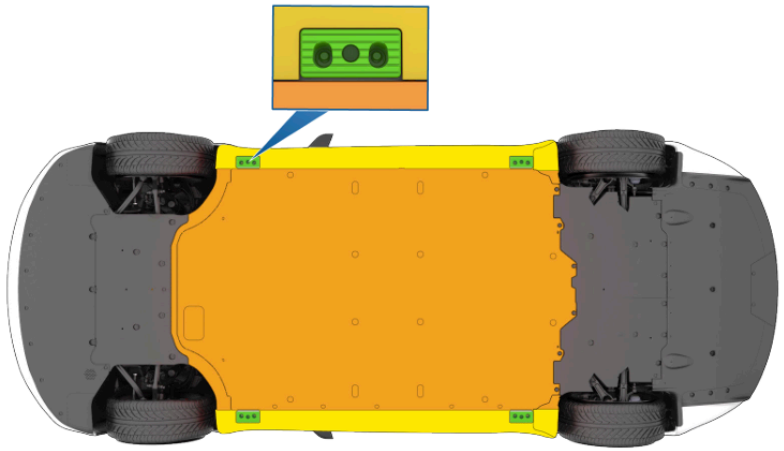
STABILIZATION / LIFTING POINTS

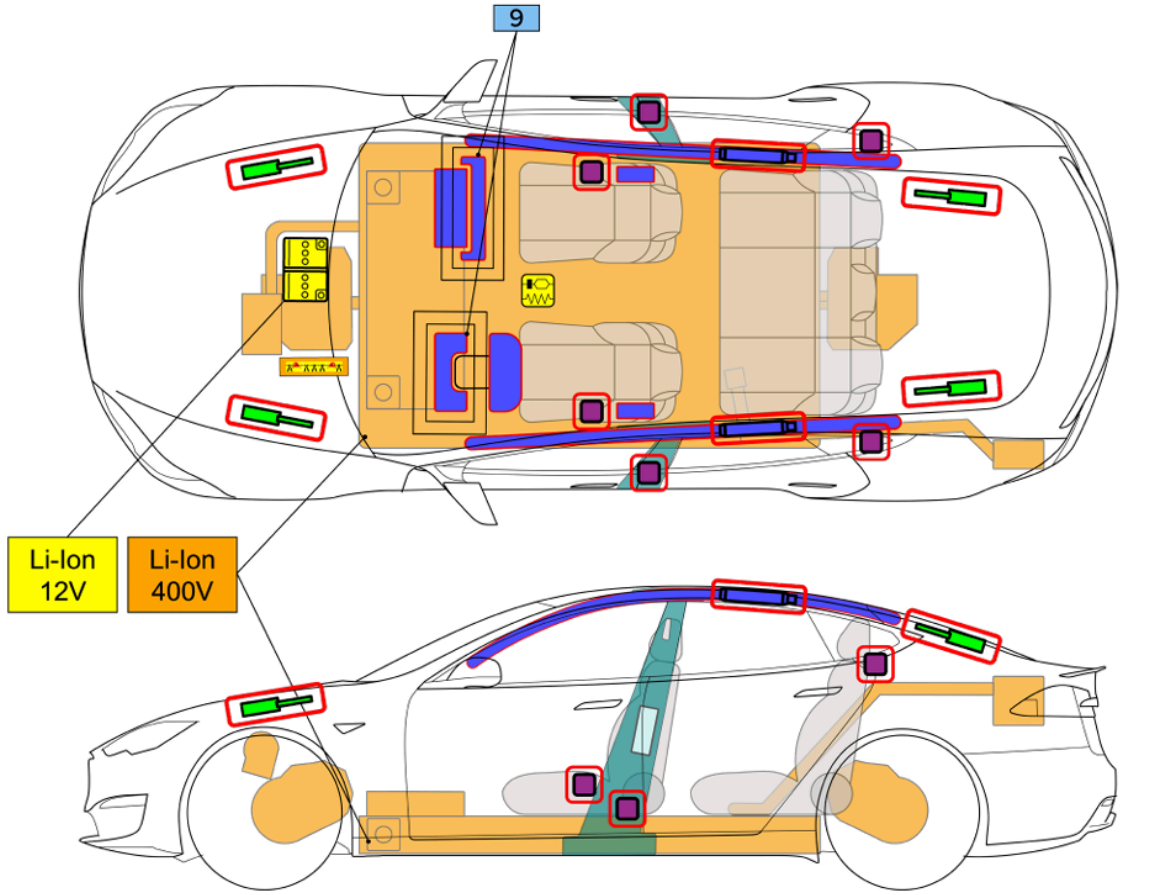
The high voltage battery is located under the floor pan. A large section of the undercarriage houses the high voltage battery. When lifting or stabilizing Model S, only use the designated lift areas, as shown in green.

WARNING Be careful to not damage the battery pack while stabilizing / lifting the vehicle.

WARNING The vehicle should be lifted or manipulated only if first responders are trained and equipped at the technician level per the applicable country's national fire training requirements and are familiar with the vehicle's lifting points. Use caution to ensure you never come into contact with the high voltage battery or other high voltage components while lifting or manipulating the vehicle.

WARNING DO NOT USE THE HIGH VOLTAGE BATTERY TO LIFT OR STABILIZE MODEL S.





	Airbag		Stored gas inflator		Seatbelt preten-sioner		SRS Control Unit		Pedestrian protection active system
	Automatic rollover protection system		Gas strut/ pre-loaded spring		High strength zone		Zone requiring special attention		
	Battery low volt-age		Ultra ca-pacitor, low voltage		Fuel tank		Gas tank		Safety valve
	High voltage battery pack		High volt-age power cable/com-ponent		High voltage discon-nect		Fuse box disabling high voltage system		Ultra capaci-tor, high voltage
	Cable cut								

EV Fire Tactical Considerations – Inside (underground/garage)

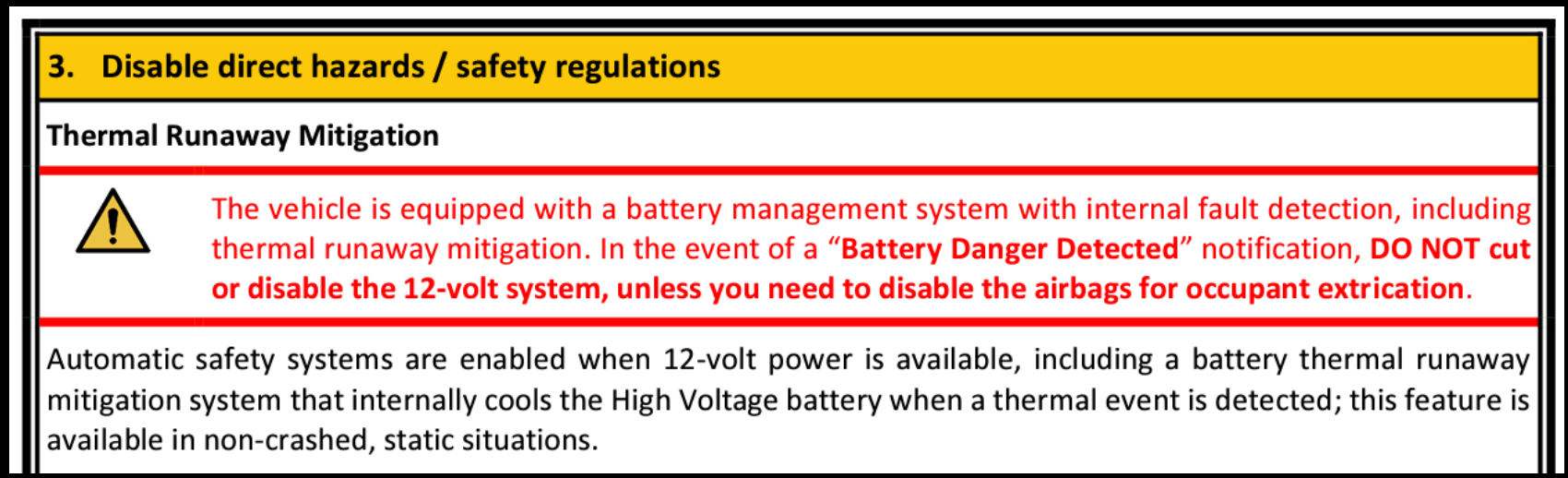
FSRI Demo on BESS Release Inside Garage

BEV Fire Tactical Considerations – Inside (underground/garage/warehouse)

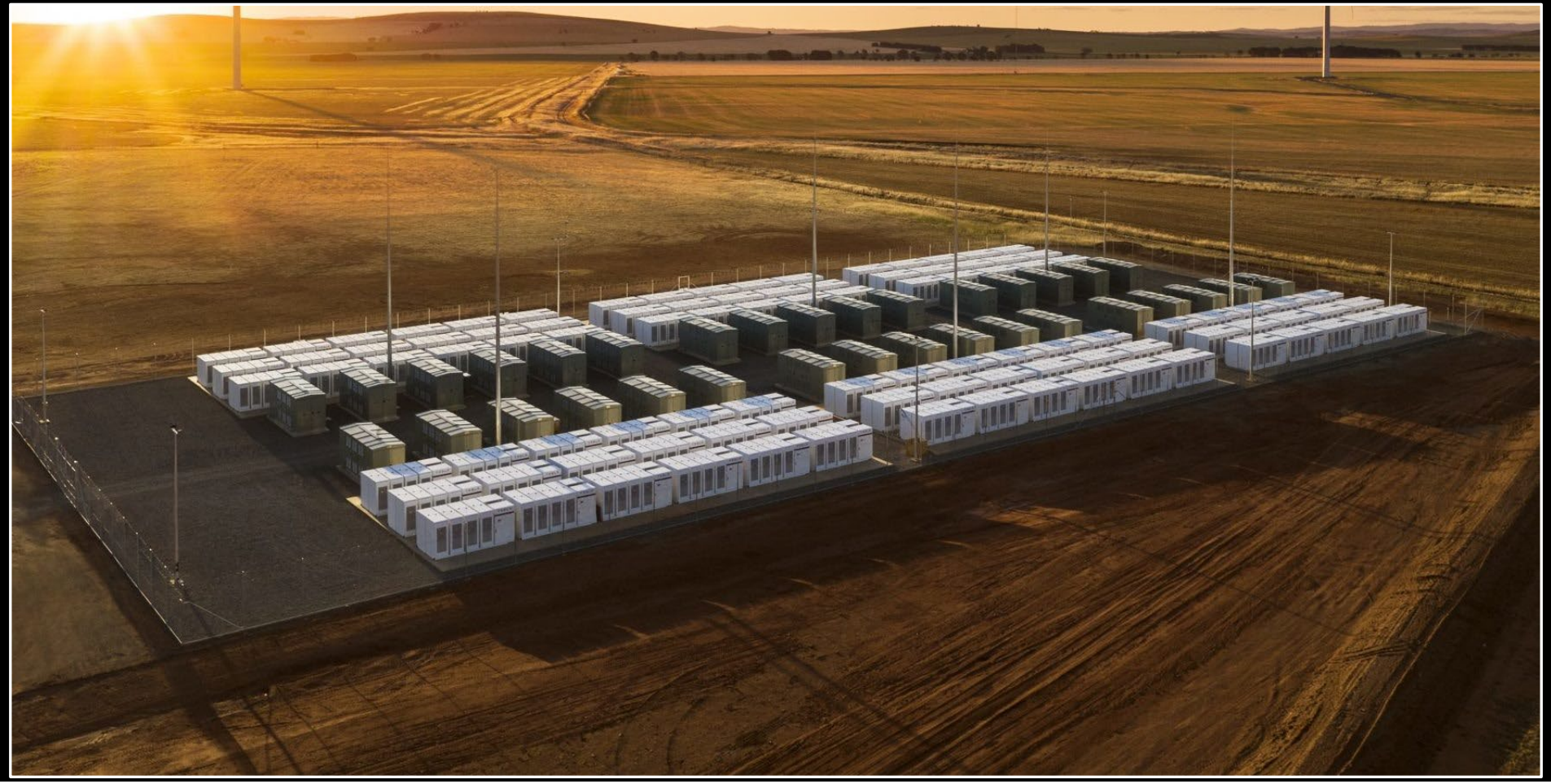
- Considerations: Garage
  - Approach from a 45° angle to avoid possible door explosion/over pressurization; deflagration-detonation phenomena.
  - f no active fire, be concerned with possible explosive atmosphere
- Warehouse
  - Careful cutting into rollup doors without knowing what's inside
- Underground Parking
  - Toxic atmosphere hazard
  - Explosive atmosphere less likely due to
  - Allowing vehicle to burn is an option, with significant consequences to the structure
    - EV fires do not release more heat energy than internal combustion engine (ICE) fires
  - Identification of EV will be difficult, if not impossible. Follow your department SOP for underground vehicle fires
  - Perform thorough PPE and personal decontamination procedures

EV Vehicle Extrication

- Charged and STAFFED hoseline!
  - Fog pattern for hydraulic ventilation
    - Does not require full GPM
    - GPM Flow x degree of fog pattern = CFM
- "RIC" Team with SCBA?
  - Consider a standby team to take over operations on SCBA



3. Disable direct hazards / safety regulations
Thermal Runaway Mitigation
The vehicle is equipped with a battery management system with internal fault detection, including thermal runaway mitigation. In the event of a "**Battery Danger Detected**" notification, **DO NOT cut or disable the 12-volt system, unless you need to disable the airbags for occupant extrication**.
Automatic safety systems are enabled when 12-volt power is available, including a battery thermal runaway mitigation system that internally cools the High Voltage battery when a thermal event is detected; this feature is available in non-crashed, static situations.



Battery Energy Storage System (BESS)

KEY TAKEAWAYS FROM APS EXPLOSION REP

SEVERAL VALLEY FIREFIGHTERS HURT IN 2019 BLAST

abc 15 ARIZONA

Battery Energy Storage System (BESS)

- Large Systems
- Multiple racks of batteries
- Surprise, AZ – 2019
- Regulations
  - NFPA 855
    - Safety measures
  - UL 9540 & 9540A
    - Testing of system

BESS Failure Tactical Considerations

- Signs of possible BESS Failure
  - Suspicious odor emanating from the BESS
  - Smoke
    - Battery thermal runaway fires are preceded by smoke
- If fire, smoke, or suspicious odor is observed, consider:
  - If possible, shut off the unit/system.
  - Evacuate the area of all non-emergency personnel.
  - Do not approach the unit and attempt to gain access.
    - Some BESS safety mechanisms are designed to maintain doors shut, and other have automatic ventilation doors.
  - Contact site emergency contact and/or manufacturer.

BESS Tactical Considerations
If Batteries Are Involved

- If a fire is confirmed:
  - Non-Intervention or Defensive Operations
  - Establish water supply.

- #1-Life safety
  - Stay out of smoke!
  - PPE
    - Structural Firefighting Gear and SCBA.
  - Rescue
  - Evacuate / Shelter-in-Place
    - Use as much "ground truth" as possible.

BESS Tactical Considerations
If Batteries Are Involved

- #2-Incident Stabilization
  - Let it burn!
    - Applying water to the burning unit will only delay the event.
    - May take multiple operational periods.
    - During periods of module propagation, there may be no sign of fire, but the event can still be active and flare up can still occur.
  - Environmental Protection
    - Minimize/contain/redirect runoff if possible
    - Use lowest GPM needed

BESS Tactical Considerations
If Batteries Are Involved

- #3-Property Conservation
  - Allow system safety devices to operate as designed.
  - Monitor alarm panel and manually activate any safety devices if appropriate.
  - Prevent propagation.
    - Water curtains and unstaffed lines
    - Apply from a distance and upwind if possible.
      - Protect exposed packs
      - Extinguish and protect other infrastructural exposures
      - Use 30-degree fog for water curtains to absorb heat and knock down toxic plume
  - Protect other exposures.
    - Neighboring structures
    - Vegetation
  - Recovery
    - Allow batteries to cool (this process may take 12-48 hours or longer).
    - Use on-site resources and manufacturer for decommissioning and recovery plans.

BESS Tactical Considerations
If Batteries Are Involved

- Resources to consider
  - BESS Personnel
  - EPA, Environmental Health, Hazmat
  - Gas/Electric

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

Site Safety

Lakes Parkway Fire Response

- Fire Department responded to facility, twice, three days apart and requested EPA assistance

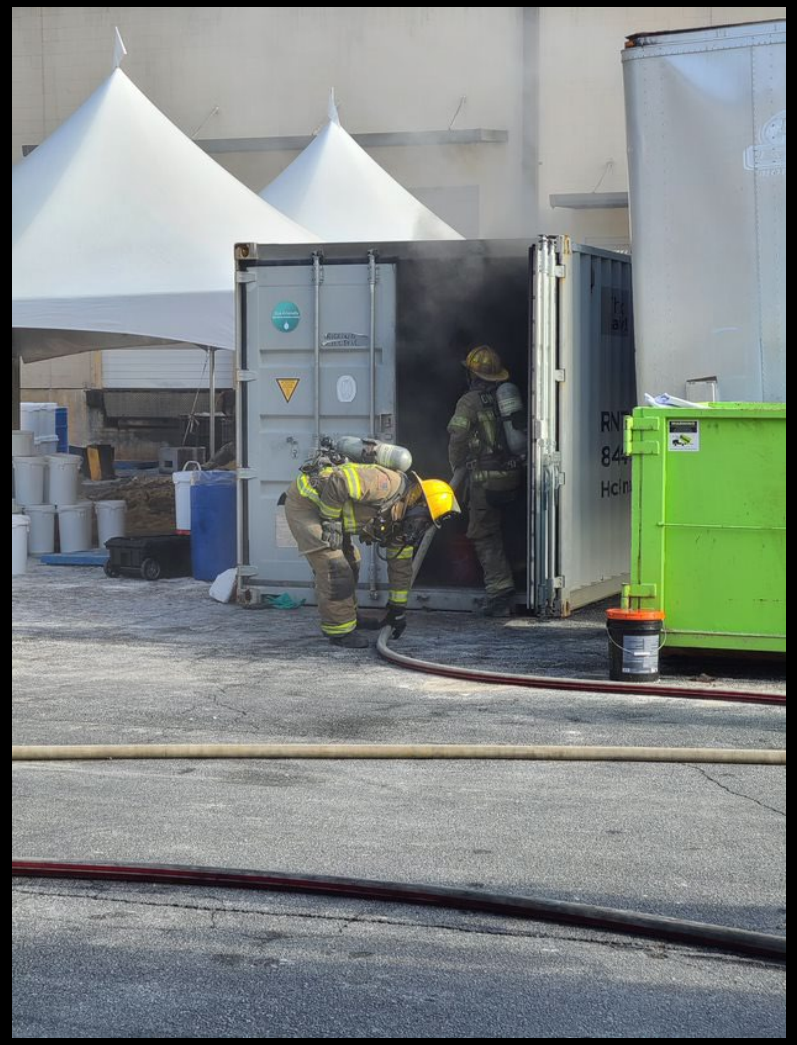
Damaged Batteries are Unpredictable


UN3480

First Fire of the Day – recently packaged bucket

Technically not a Fire?

Second Fire of the Day – bucket packaged 5 days ago




20
GWINNETT
JACKSON

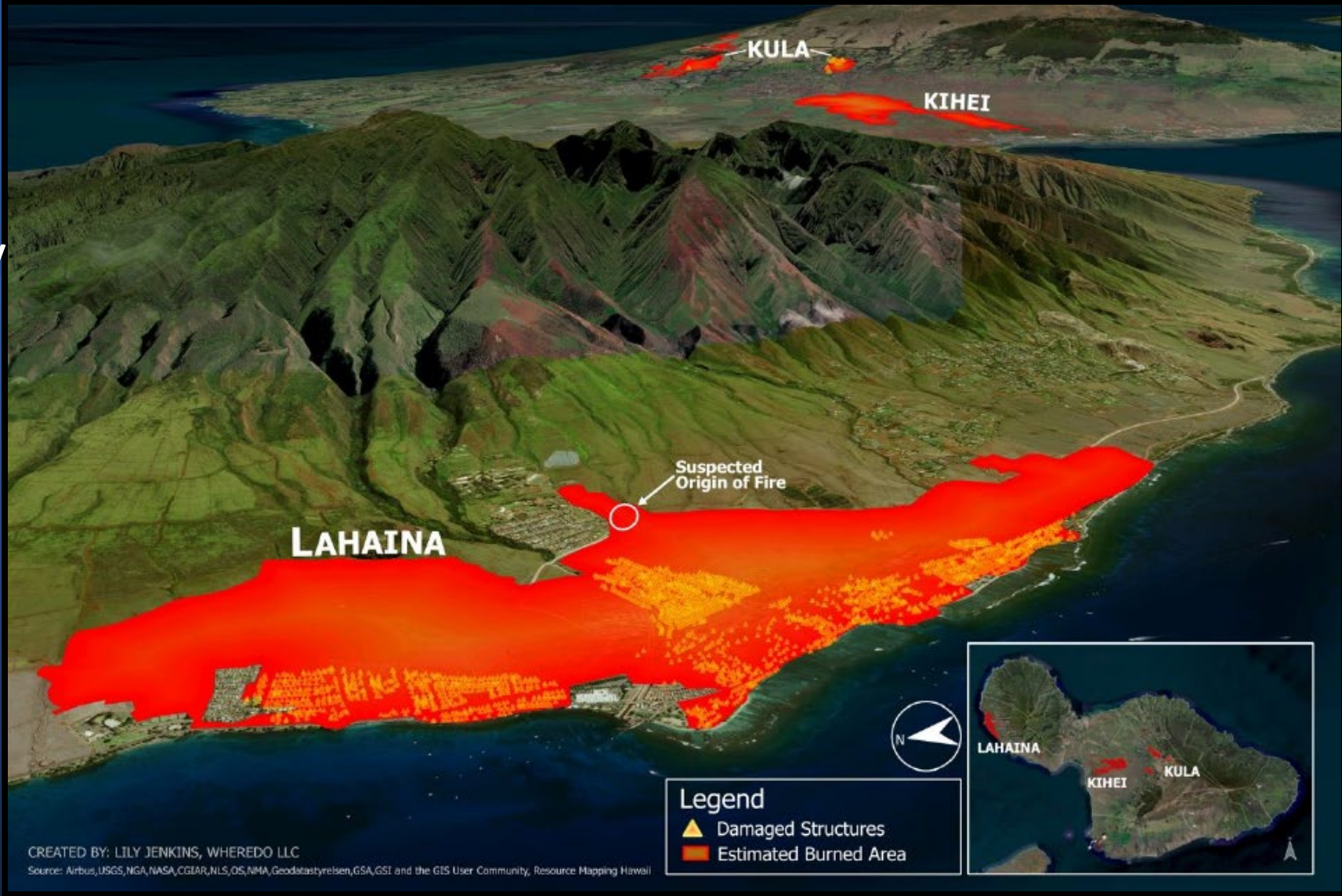
Aftermath

- Approximately 20 buckets were damaged during the second fire
- The bucket that caught fire had been packaged approximately 5 days ago and not been touched/moved for 4 days

Battery Recyclers

Lithium-Ion Battery Case Study:

Maui Wildfire Response



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 - 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

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

Health and Safety - EVs

Electrician

Temperature Checks

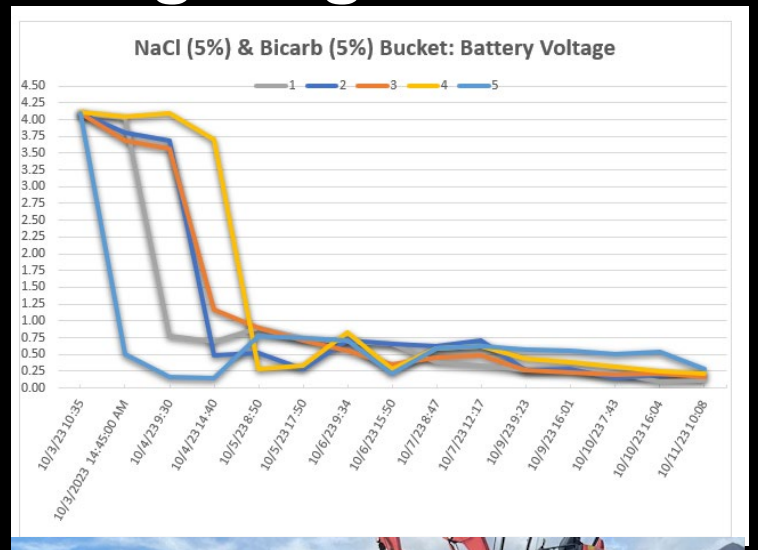
Air Monitoring

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

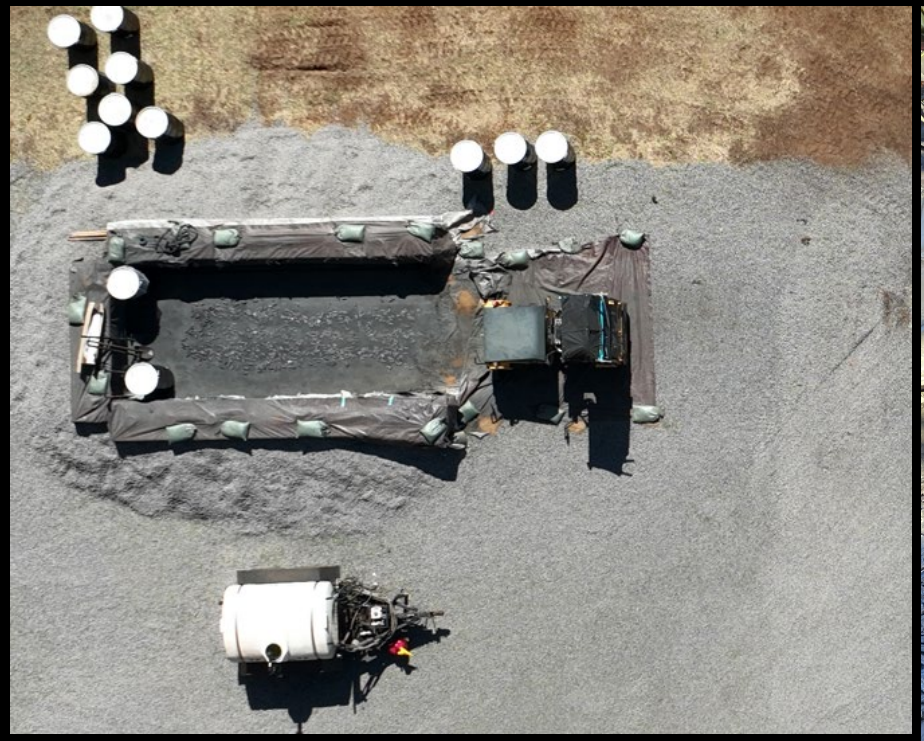
Water/Pump and Hose Line in Place, PPE On

Battery Transport (BESS & EV)

Battery Processing – De-Energizing



Battery Processing – 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 & JHAs

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.

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 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 sparyers 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
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 #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 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 safey 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 sparyers 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					
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 ventillated 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.)		

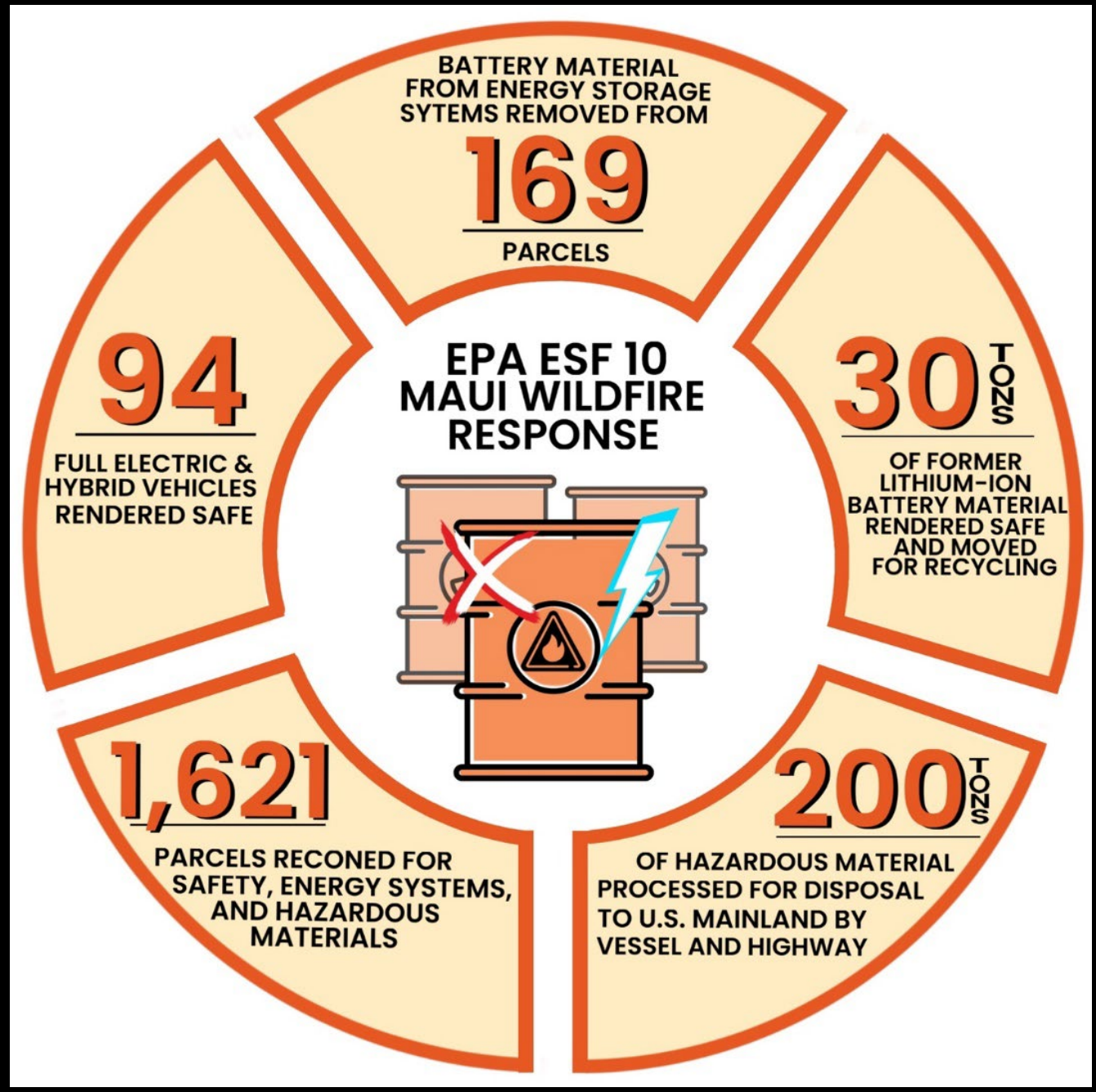
Other

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.


BATTERY MATERIAL FROM ENERGY STORAGE SYTEMS REMOVED FROM
169
PARCELS
94
FULL ELECTRIC & HYBRID VEHICLES RENDERED SAFE
EPA ESF 10 MAUI WILDFIRE RESPONSE
30 TONS
OF FORMER LITHIUM-ION BATTERY MATERIAL RENDERED SAFE AND MOVED FOR RECYCLING
1,621
PARCELS RECONED FOR SAFETY, ENERGY SYSTEMS, AND HAZARDOUS MATERIALS
200 TONS
OF HAZARDOUS MATERIAL PROCESSED FOR DISPOSAL TO U.S. MAINLAND BY VESSEL AND HIGHWAY


CITY of SAN DIEGO
SpecOps
HAZ
MAT
1889
FIRE-RESCUE

Li-Ion Battery Response Considerations

Module 4: Health and Safety

Air Monitoring
What chemicals to look for
Equipment Considerations
Personal Protection

Air Monitoring

EPA DRAFT Air Monitoring Guidance
Target Compounds for Lithium-Ion Battery Fires

- Carbon Monoxide
- Carbon Dioxide
- Hydrofluoric Acid (Hydrogen Fluoride)
- Sulfur Dioxide
- Hydrogen
- Hydrochloric Acid(Hydrogen Chloride)
- Various Hydrocarbons (methane, ethylene, propylene, etc)
- Formaldehyde
- Manganese
- Copper
- Nickel
- Cobalt
- Carbon Black
- Lithium
- Iron
- Lead
- Phosphorous Pentoxide

Air Monitoring – RAE Sensors

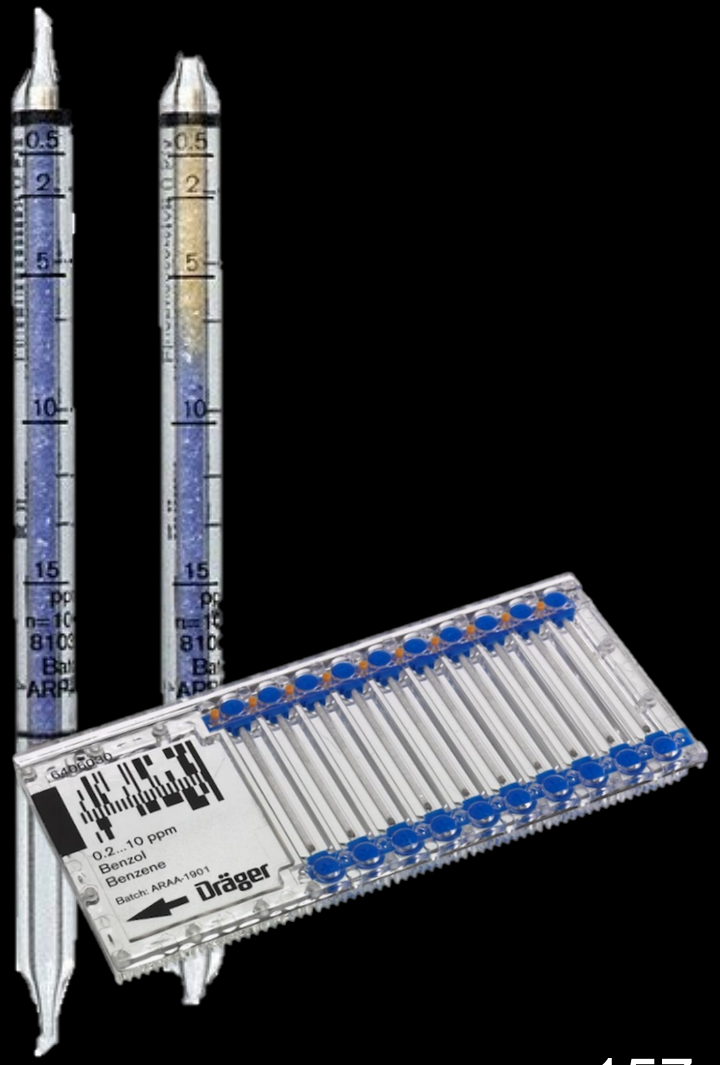
Target Compound	Ionization Potential	RAE Sensor	Detection Range
Carbon Monoxide	14.01 eV	CO	0-500 ppm
Hydrofluoric Acid (Hydrogen Fluoride) AreaRAE Only	15.98 eV	HF	0.5-10 ppm
Sulfur Dioxide	12.3 eV	SO2	0-20 ppm
Hydrogen	15.43 eV	LEL H2	0-100% (0-30% O2) 0-1000 ppm
Hydrochloric Acid (Hydrogen Chloride) AreaRAE Only	12.74 eV	HCl	0-15 ppm

Air Monitoring – SPM Flex

Target Compound	SPM Flex Tape	Detection Range
Hydrofluoric Acid (Hydrogen Fluoride)	Mineral Acid	0.4-20 ppm
Sulfur Dioxide	Sulphur Dioxide	0.01-2.5 ppm
Hydrochloric Acid (Hydrogen Chloride)	Mineral Acid	0.2-20 ppm

Air Monitoring – Dräger Tube

Target Compound	Tube Available	CMS Chip Available	Detection Range
Carbon Monoxide	✓	✓	5- 150 ppm, 100-700 ppm
Carbon Dioxide	✓	✓	1-20% Vol.
Hydrofluoric Acid (Hydrogen Fluoride)	✓		0.5-15 ppm, 10-90 ppm
Sulfur Dioxide	✓	✓	≥0.1-3 ppm
Hydrogen	✓		0.2-2%, 0.5-3%
Hydrochloric Acid (Hydrogen Chloride)	✓	✓	0.2-3 ppm, 5-50 ppm



Air Monitoring – DustTrak (Particulates)

- Measurement range: 0.001 to 150 mg/m^3
- Operating temperature range: 32 to 122 ºF
- Method of particle detection: 90º light scattering
- Flow Rate: 3 L/min
- Simultaneously measures different particle diameters by algorithm (PM_{10}, PM_4, $PM_{2.5}$, PM_1 and Total Particulates)

PPE Considerations-Emergency

- Turnout Gear & SCBA
- Keep protection level during overhaul process
- Decon of turnout gear being evaluated

PPE Considerations-Decon TEEX Study

- Texas A&M Engineering Extension Service led study
- 3 tests of 50 NMC batteries in thermal runaway exposing emissions to various materials found in the fire fighting industry
- 6 swatches with bunker gear including outer shell, moisture barrier and thermal liner.
- 6 swatches cab apparatus material and SCBA shoulder straps
- SVOC penetrated to vapor barrier. Water cleaning 21% -91% efficiency. CO2 showed many compounds undetected.
- Penetration of metals to vapor barrier was very low

PPE Considerations-Decon TEEX Study Results

- 75 SVOC identified during testing
- Bunker Gear
  - SVOC penetrated to vapor barrier.
  - Water cleaning 21% -91% efficiency.
  - CO2 cleaning showed many compounds undetected.
  - Penetration of metals to vapor barrier was very low. Thermal liner-ND. CO2 cleaning removed over 99% metal contamination. Iron, lead, magnesium most difficult to remove. Copper, cobalt, manganese and nickel remained.
- SCBA Straps
  - Contained highest amount of contamination
- TEEX report: https://teex.org/ev-ess-current-practices/

PPE Considerations-Removal

- Modified Level D PPE – FR Coveralls, Thermal Work Gloves, Nitrile Gloves, Eye and Face Protection (safety glasses, splash goggles, face shield, based on specific tasks), Safety Boots
- Modified Level C PPE – FR Coveralls, Thermal Work Gloves, Nitrile Gloves, Full-face Air Purifying Respirator (APR) with appropriate cartridges; typically, the multiple purpose P100, Organic Vapor and Acid Gas cartridges, Safety Boots
- Modified Level B PPE – FR Coveralls, Thermal Work Gloves, Nitrile Gloves, Self-Contained Breathing Apparatus (SCBA) or Supplied Air Respiratory (SAR), Safety Boots

Li-Ion Battery Response Considerations

Module 5: Additional Considerations

Opportunities for Concern

- 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
- Education
- Challenges at local response level

Potential EPA & Partner Agency Involvement

Education

- Trainings
- Outreach

Large Disasters/Stafford Act

- Floods
- Fires
- Terrorism to network

Sites

- Battery recycler
- Independent modifier/entrepreneur
- Repair shop
- BESS network
- Vap shop
- Transportation sector
- Battery farmer
- Accumulator

NY Lithium-Ion Laws

- Legislation S.154F/A.4938-D prohibits the sale of lithium-ion batteries used in micro-mobility devices, bicycles with electric assist or mopeds unless such batteries are manufactured in accordance with certain standards and specifications.
- Legislation S.154F/A.4938-D provides a civil penalty and authorizes district attorneys, county attorneys, and corporation counsel to have concurrent authority to seek the relief.
- Legislation S.8743/A.9338 directs the Department of State, in consultation with the Division of Homeland Security and Emergency Services and the New York State Energy Research and Development Authority, to develop and maintain safety resources, information, and protocols in regard to fire hazard prevention relating to, but not limited to, lithium-ion batteries, second-use lithium-ion batteries, bicycles with electric assist as defined in section one hundred two-c of the vehicle and traffic law, mopeds, and micro-mobility devices.
- Legislation S.8742/A.9337 requires the State Fire Administrator within the Office of Fire Prevention and Control of the Department of Homeland Security and Emergency Services to provide training materials for first responders regarding emergency response to incidents involving lithium-ion batteries.
- Legislation S.7503-B/A.01910-B requires retailers of micro-mobility devices, bicycles with electric assist and mopeds powered with lithium-ion batteries, and lithium-ion batteries intended for use in such devices or bicycles to provide customers with an operating manual.
- Legislation S.9419/A.7628-A requires police and judicial officers investigating an accident with an e-bike or e-scooter that results in death or injury to make a report to the Department of Motor Vehicles, consistent with current requirements for motor vehicles and motorcycles. Also requires police to investigate such incidents when they are made aware of them.
- Legislation S.7703-B/A.8450-B requires mopeds to be registered by dealers at the point of sale, if they are to be used in the State.
- Legislation S.7760-A/A.8102-A requires micro-mobility devices, mopeds, and bicycles with electric assist to have a red tag attached to the charging cord which states to unplug when not in use.
- BESS Proposed Updated Laws(2024): Emergency Response Plans, pre-incident planning and coordination with local first responders. Larger facilities will be required to have monitoring and alarms

Gaining Ground

Research/Understanding

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

Li-Ion Battery Response Considerations

Conclusion / Final Thoughts

Questions?

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Survey


Lithium-Ion Battery Response Considerations EPA Region 2 - How did we do?