Industrial Emergency Council

Emergency Response Training

BUILDING THE PLANE AS WE FLY IT

EL DORADO HILLS

ROB REZENDE

Objectives – What we are here to do

Safety – To increase responder safety with strategy and tactical considerations.

Risk Assessment – To increase situational awareness by sharing current knowledge, research, and “best practice” to improve risk-based decision making.

Company Level Operational Dialogue – To foster in-station discussions on Engine and Truck Company strategy and tactics before the incident occurs.

Objectives – What we are **NOT** here for

Politics – We will not discuss the efficacy of regulation, safety, Lithium-Ion Batteries.

Assessing Merit – We will not discuss the environmental merits of the technology.

ALL the answers – This technology is moving so fast, we are ”building the airplane while we fly it”! Nobody has all the answers, we hope to provide you with enough knowledge to aid you in deciding the safest approach for you and your crews.

Battery Types

Non-rechargeable Batteries (Alkaline)

Stable, no significant energetic releases.
Consistent energy, long-term power, but loses strength over time.
Long shelf life.

Non-rechargeable Batteries (Lithium Metal)

Stable, large energy density.
Can provide strong energy surges even after a period of low discharge
Lithium metal found inside is **extremely water reactive**

Battery Types

Parts of a battery

The answer to "what is inside a battery?" starts with a breakdown of what makes a battery a battery.

Container Steel can that houses the cell's ingredients to form the cathode, a part of the electrochemical reaction.

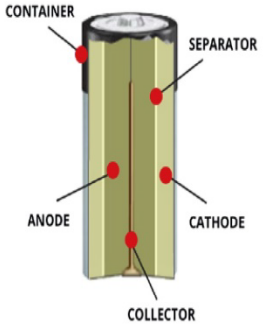
Cathode A combo of manganese dioxide and carbon, cathodes are the electrodes reduced by the electrochemical reaction.

Separator Non-woven, fibrous fabric that separates the electrodes.

Anode Made of powered zinc metal, anodes are electrodes that are oxidized.

Electrolyte Potassium hydroxide solution in water, the electrolyte is the medium for the movement of ions within the cell. It carries the iconic current inside the battery.

Collector Brass pin in the middle of the cell that conducts electricity to the outside circuit.



Alkaline Battery (Inside)

Lithium Metal Battery (Inside)

Inside a lithium metal cell

Battery Types

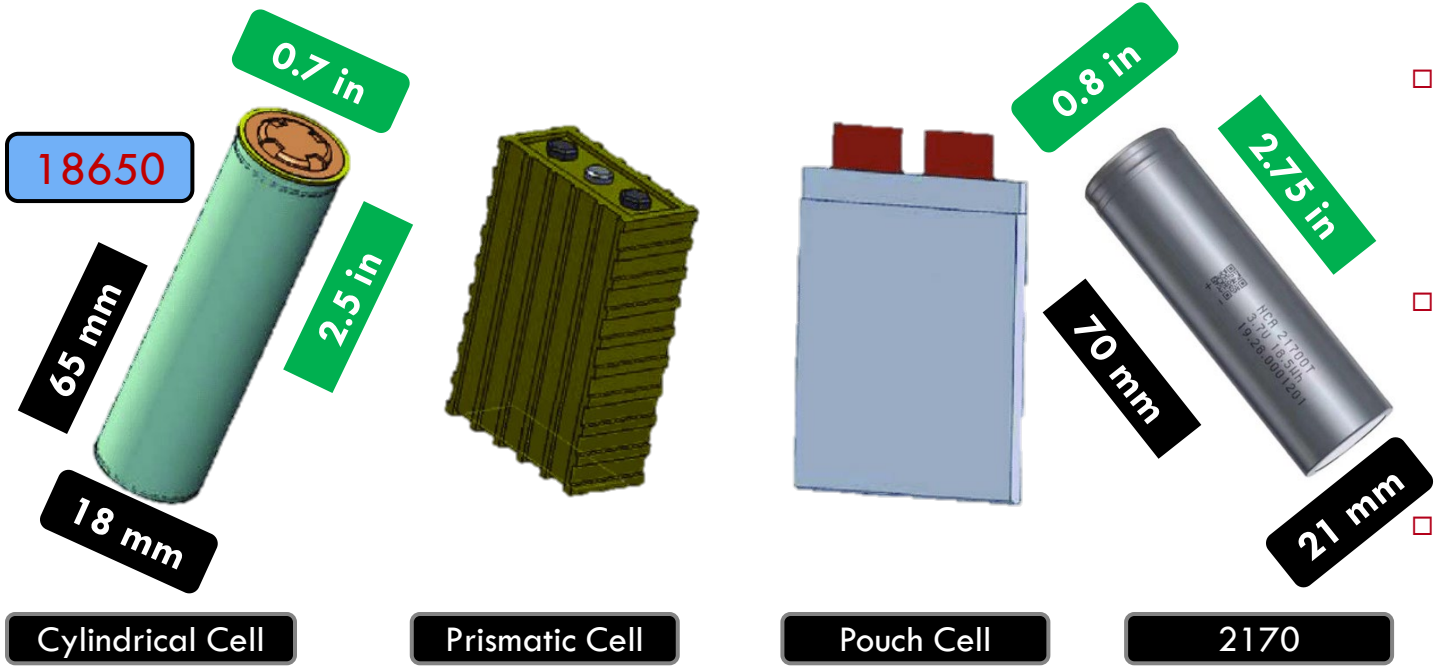
Lead Acid Batteries

Stable, low energy density.
Contains Lead and Sulfuric Acid.
Risk of explosion due to Oxygen and Hydrogen generation during charging

Nickel Cadmium (NiCad)/Nickel Metal Hydride (NiMH) Batteries

Rechargeable and stable
Suffers from ”memory effect”
Can be smothered (METAL-X, Sand, etc.)
Water application can cause hydrogen gas release

Lithium-Ion Battery Types

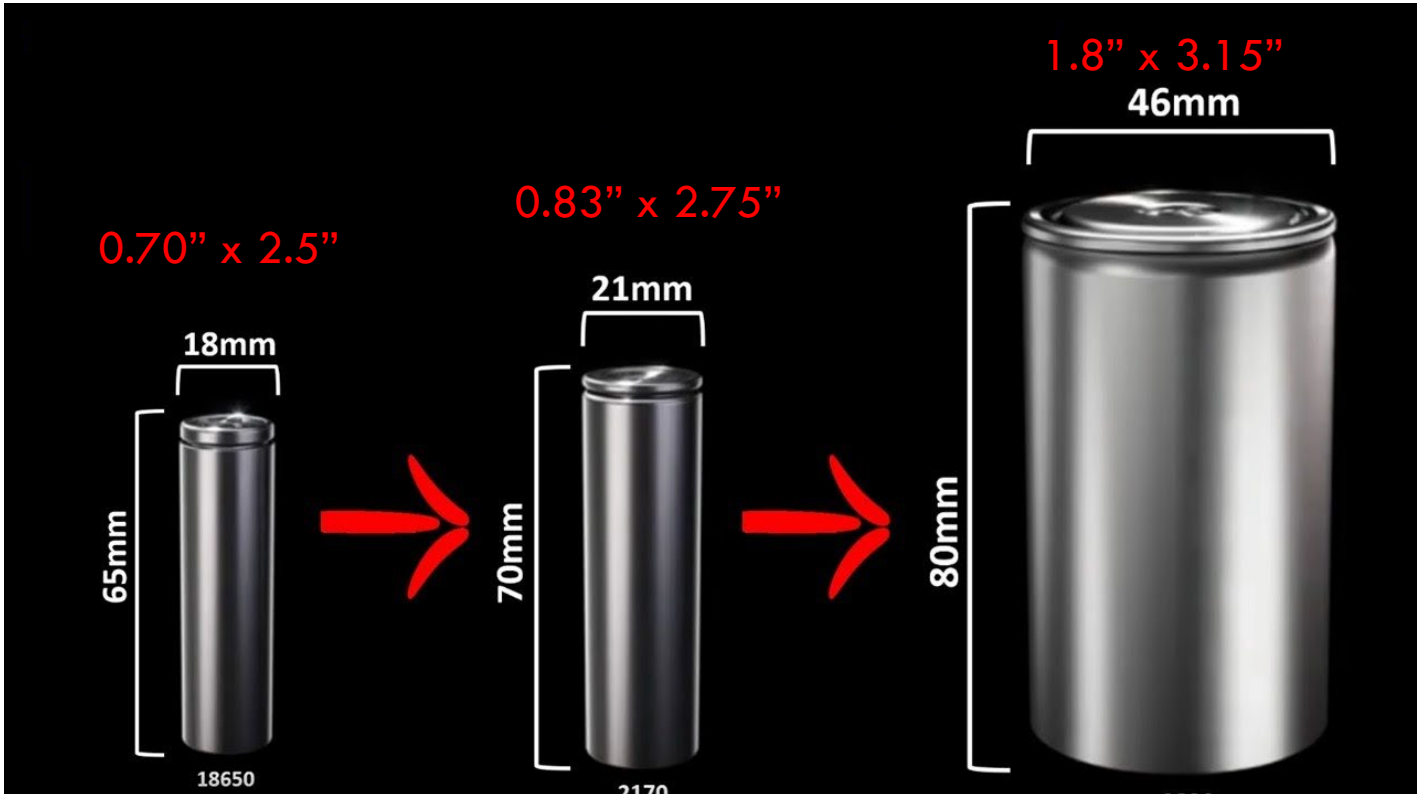


- Cylindrical Cells (18650) are the most common battery in most mobile applications (bikes, scooters, etc.)
- Cylindrical Cells are also used by electric vehicles, where you can find anywhere from 3K-7K individual cells
- Prismatic and Pouch Cells are found in all other electric vehicles

Lithium-Ion Batteries Good memory resistance Very stable High energy density

Toxic, corrosive, flammable, and explosive gas generation during thermal runaway

Evolution of the Cylindrical Cell



- Here is an example of how the cylindrical cell size has evolved over time

How do Lithium-ion batteries work?

Voltage in Lithium-Ion Battery Tech

Cell Phones = 3.4 to 4.5V

E-Scooter = 28 to 48V

E-Bike = 48 to 52V

Prius = 200V

Tesla = 350 to 400V

F150 Lightning = 400V

GMC Hummer = 400V

Ford Mach-e = 450V

Trolley = 600V

Tesla Truck = 800V (reported)

Tesla Semi = 1000V (reported)

Exponential Increase – Infrastructure

Federal Infrastructure Investment and Jobs Act (11/15/2021)

- $6 Billion
  - Battery Storage
- $7.5 Billion
  - Rapid charging stations – 500,000 along highways and in communities
- $1 Billion
  - School Buses

School Buses?

Rapid smoke and flame production

BATTERY PRODUCTION

Not all batteries are created equal

The battery industry can be roughly split into three tiers

Tier I

Largest companies of the industry such as Tesla, Panasonic, Samsung and LG Chem.

Tier II

Major battery companies such as BYD, SK Innovation and CATL.

Tier III

Made up of many companies such as GEELY and Farasis, and most of the Chinese producers.

BATTERY PRODUCTION

Not all batteries are created equal

According to Benchmark Minerals' "Lithium-ion Battery Megafactory Assessment"*:

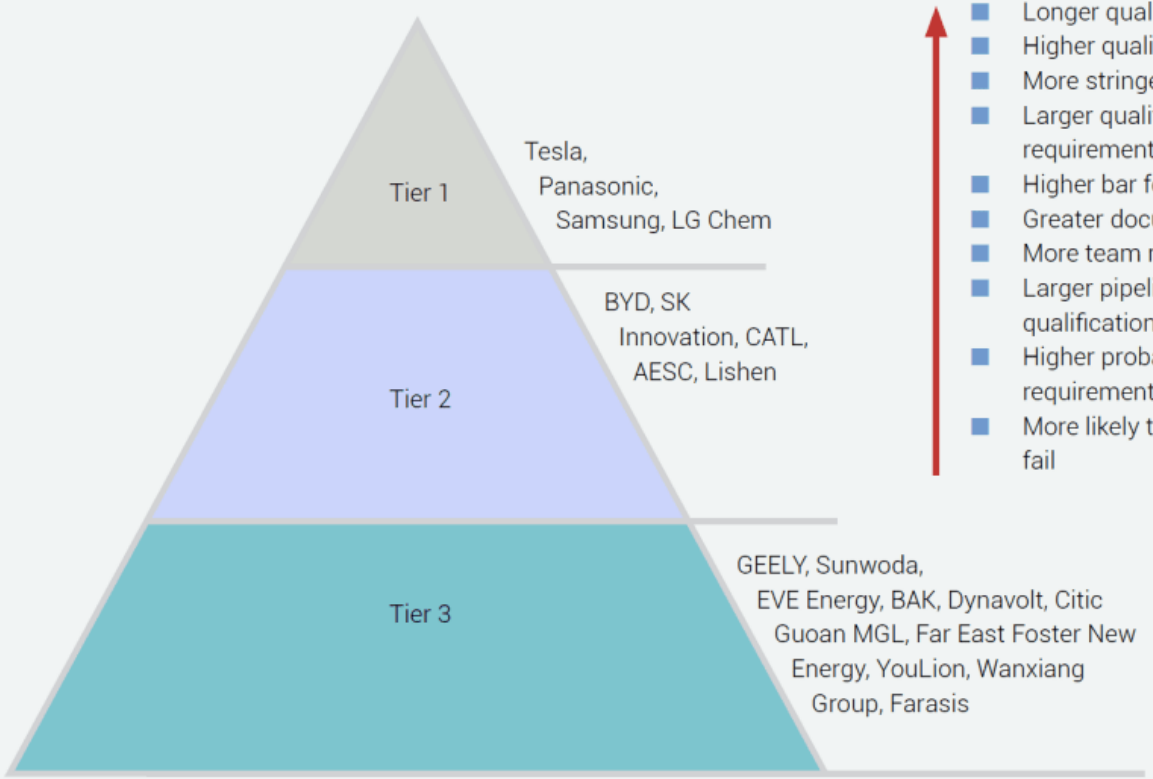
Tier 1	Qualified to supply multi-national electric vehicle (EV) producers outside of China
Tier 2	Qualified to supply Chinese EV market/non EV applications
Tier 3	Unqualified – limited or no track record of cell production

** Benchmark Minerals provides independent prices, data and supply chain intelligence for lithium-ion batteries and rare earth elements*

THE TIERS OF BATTERY PRODUCTION

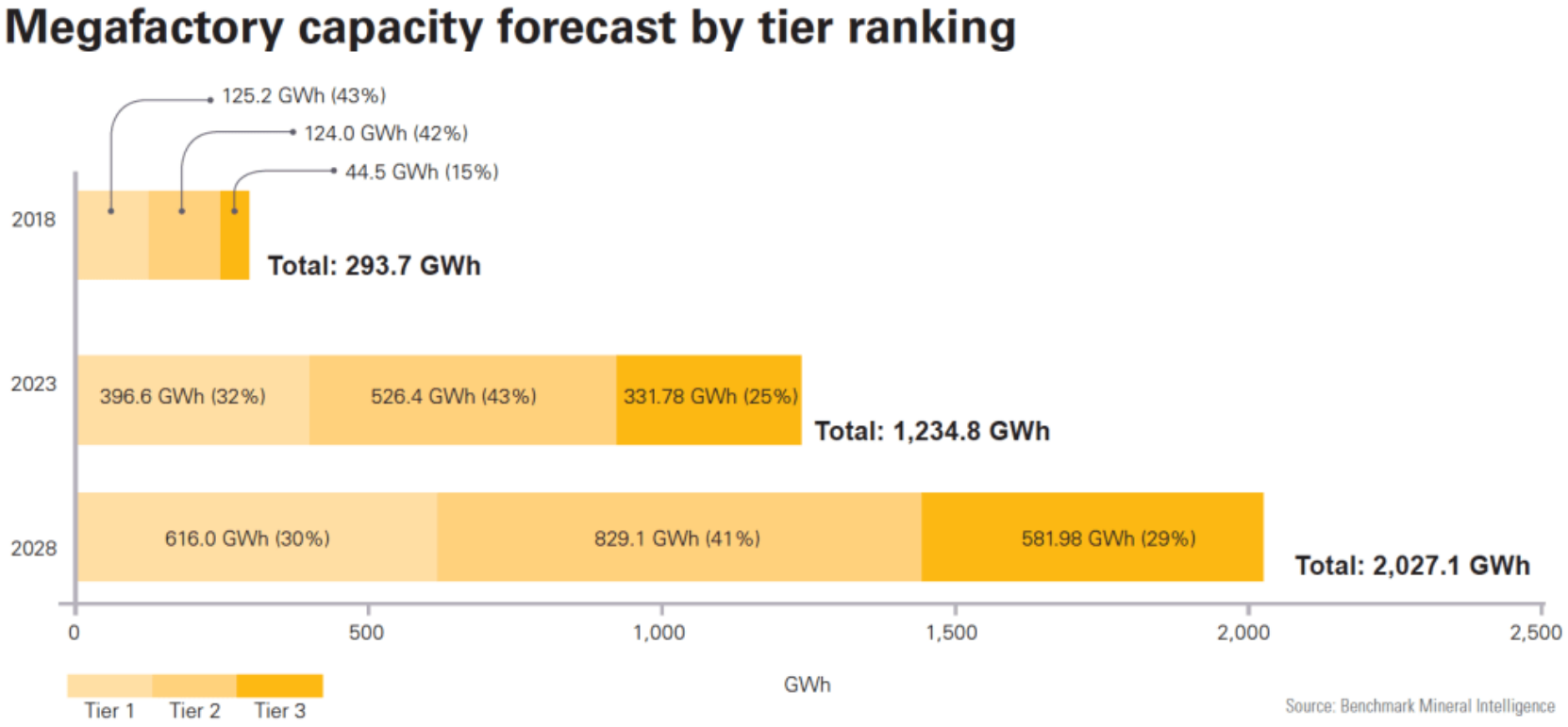
Examples of producers by tier

Battery manufacturers can be split into different tiers, with a few established, large-scale producers in the top-tier, and up and coming producers in the lower tiers

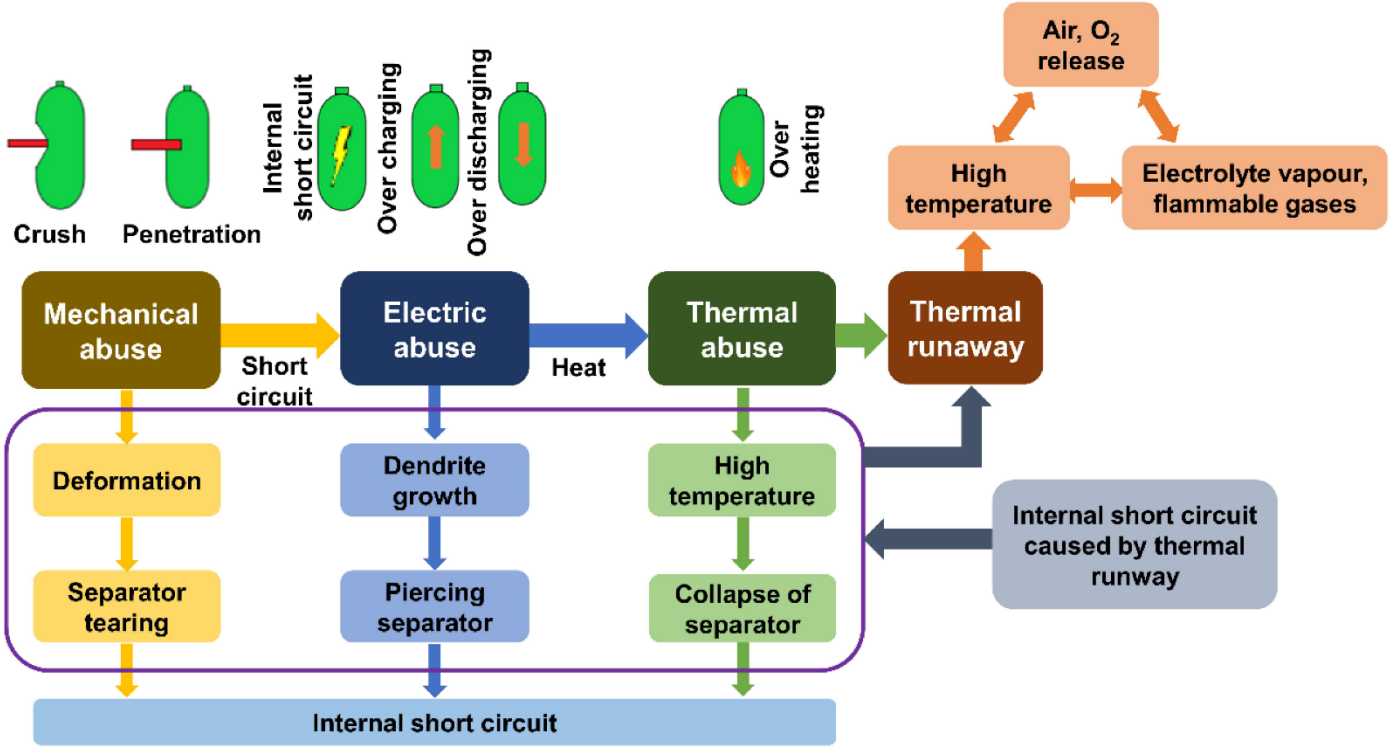


Source: Benchmark Mineral Intelligence

CAPACITY FORECAST BY TIER

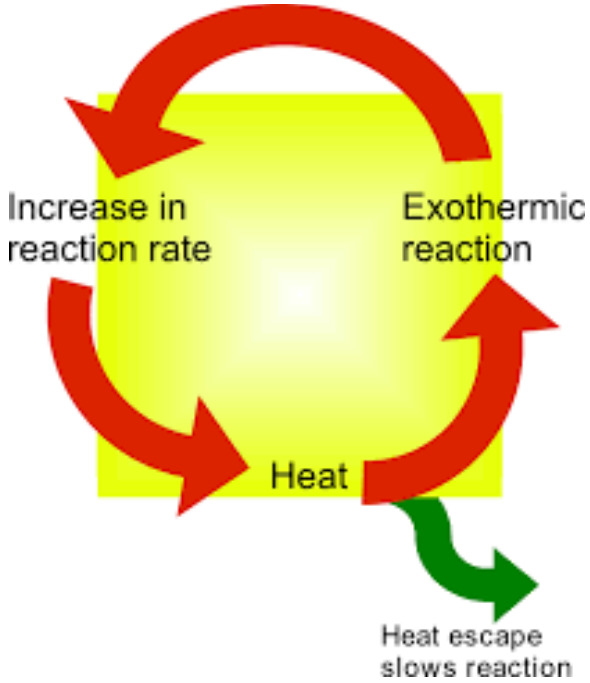


Why do batteries fail?



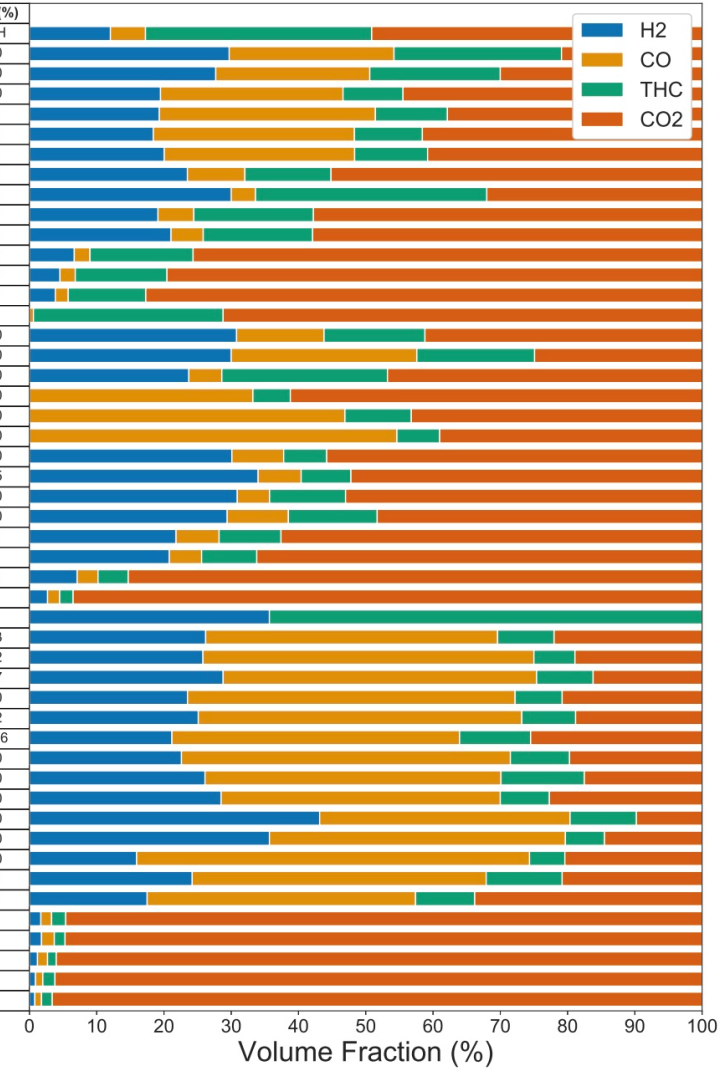
Differences in Lithium-Ion Battery Fires

- Very toxic atmospheres
- Burn temperatures are higher than normal
- Fires can burn without additional Oxygen – can't smother!
- Explosive potential – Hydrogen Gas
- Thermal Runaway reaction
  - Chemical reaction – rapid degradation
  - Does not require external Oxygen
  - Nearly impossible to stop once it starts
  - Could happen in seconds or days
- Re-ignition is common – <u>as much as 30 days or more!</u>



TYPES OF BATTERY CHEMISTRY AND VENT GASES

Literature	Chemistry	SOC (%)
Ohsaki (2005)	LCO	OCH
Somandepalli (2014)	LCO	150
Somandepalli (2014)	LCO	100
FAA Study (2016)	LCO	100
FAA Study (2016)	LCO	90
FAA Study (2016)	LCO	80
FAA Study (2016)	LCO	70
FAA Study (2016)	LCO	60
Somandepalli (2014)	LCO	50
FAA Study (2016)	LCO	50
FAA Study (2016)	LCO	40
FAA Study (2016)	LCO	30
FAA Study (2016)	LCO	20
FAA Study (2016)	LCO	10
Kumai (1999)	LCO	0
Golubkov (2014)	NMC	100
Golubkov (2014)	LCO/NMC	100
Fernandes (2018)	LFP	190
Yuan (2015)	LFP	190
Yuan (2015)	LFP	180
Yuan (2015)	LFP	170
Golubkov (2015)	LFP	130
Golubkov (2015)	LFP	115
Golubkov (2015)	LFP	100
Golubkov (2014)	LFP	100
Golubkov (2015)	LFP	75
Golubkov (2015)	LFP	50
Golubkov (2015)	LFP	25
Golubkov (2015)	LFP	0
Zheng (2016)	LFP	0
Golubkov (2015)	NCA	143
Golubkov (2015)	NCA	132
Golubkov (2015)	NCA	127
Golubkov (2015)	NCA	120
Golubkov (2015)	NCA	112
Golubkov (2015)	NCA	104.6
Golubkov (2015)	NCA	100
Golubkov (2015)	NCA	100
Golubkov (2015)	NCA	100
Lammer (2017)	NCA-32A	100
Lammer (2017)	NCA-35E	100
Lammer (2017)	NCA-MJ1	100
Golubkov (2015)	NCA	75
Golubkov (2015)	NCA	50
Golubkov (2015)	NCA	0
Golubkov (2015)	NCA	0
Golubkov (2015)	NCA	0
Golubkov (2015)	NCA	0
Golubkov (2015)	NCA	0



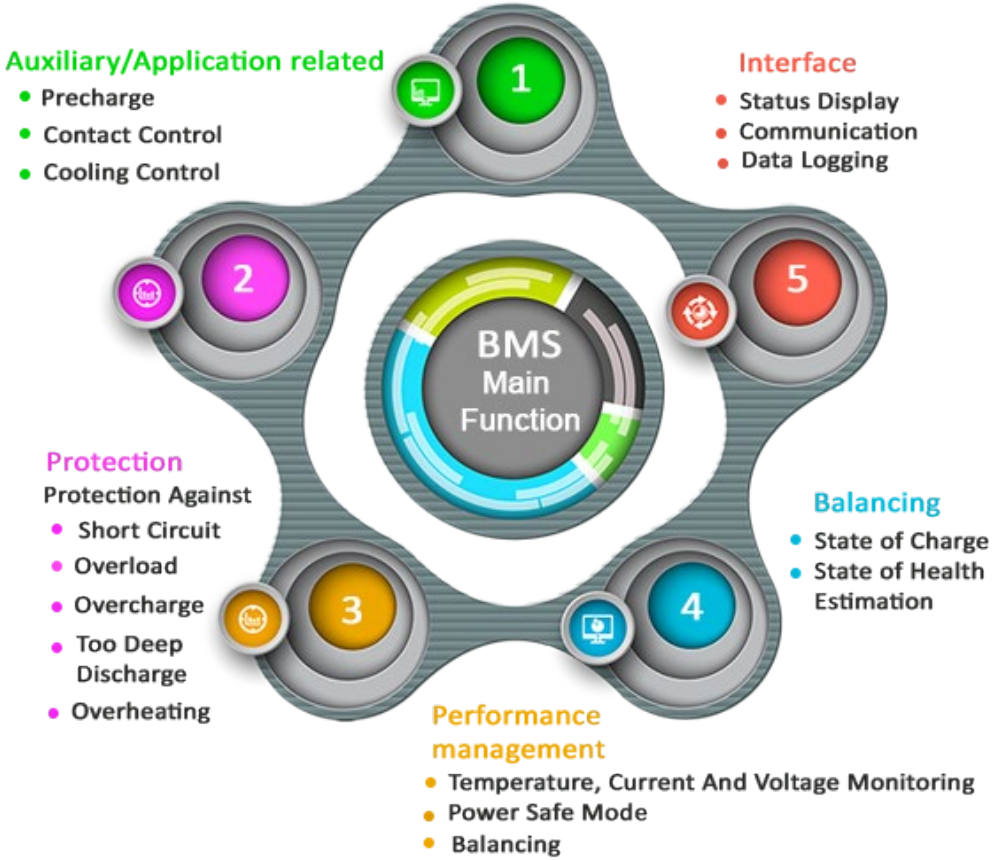
Propagation

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

Preventing Battery Failure

A battery pack built together with a battery management system with an external communication data bus is a smart battery pack.

A smart battery pack must be charged by a smart battery charger.

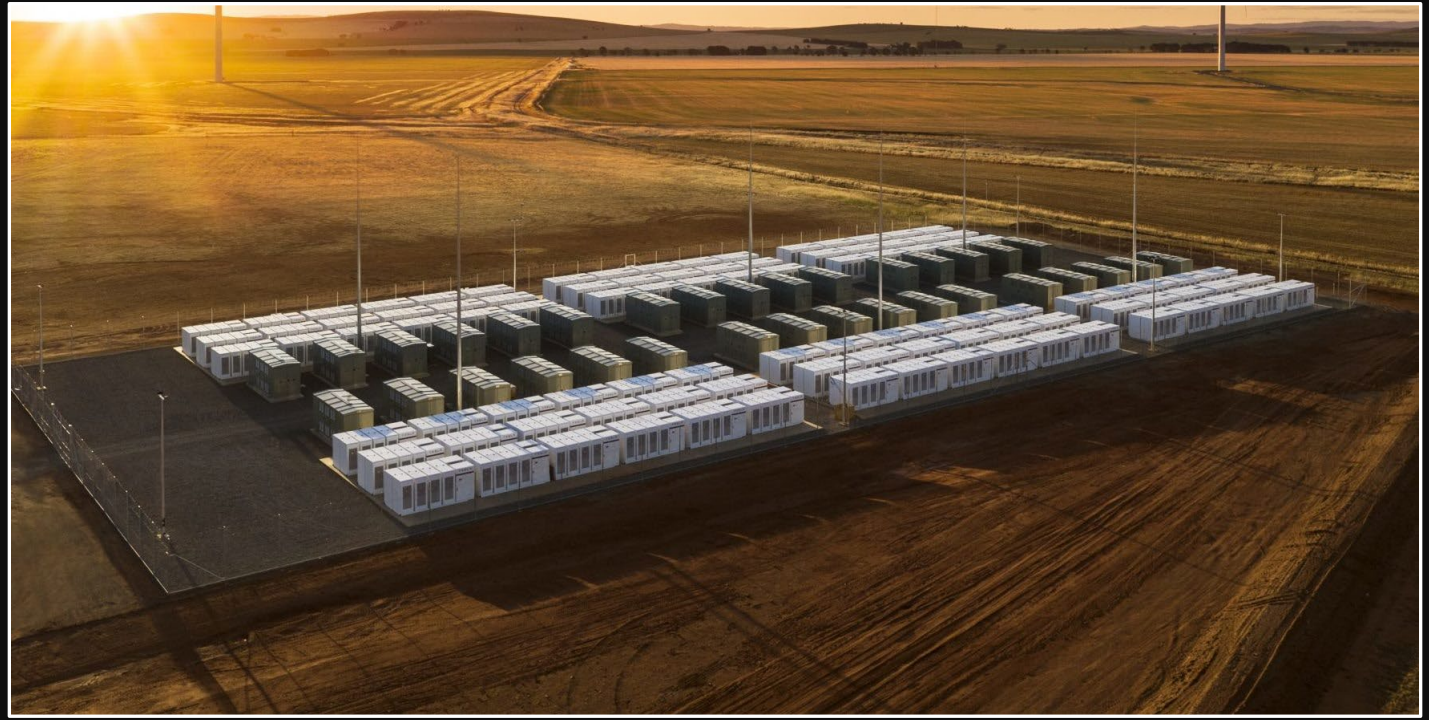


Three Primary Presentations of LIB

Energy Storage Systems

Electric Vehicles

Micro-mobility



Battery Energy Storage System (ESS)

TYPES OF ENERGY STORAGE SYSTEMS

The four most common types of energy storage systems:

(others: Hydro, Hydrogen, thermal, Superconductor, and compressed air)

Lithium-Ion Batteries (LIB)

- Currently the most popular type
- High energy density
- Susceptible to thermal runaway

Lead Acid Batteries

- Used for many years
- Low energy density
- Shorter lifespan than LIB
- Contains acid

Flow Batteries

- Longer lifespan than Lead Acid or LIB
- Electrolyte solution in tanks
- Very low fire risk –non-flammable electrolyte
- Small market share currently

Flywheels

- Kinetic energy
- One of the oldest ESS
- Advancement in technology vastly improved
- Often used as hybrid with LIB
- Can have catastrophic mechanical failure

ESS USES

One or more batteries store energy, which can then be used at a later time.

Assists in load leveling and grid support, helping to balance fluctuations in electricity demand throughout the day and reduce congestion on the grid.

Improves power quality by smoothing out voltage fluctuations that may otherwise disrupt equipment operations.

Electricity stored typically comes from:

- Wind
- Solar
- Grid connection

KEY TAKEAWAYS FROM APS EXPLOSION REP

SEVERAL VALLEY FIREFIGHTERS HURT IN 2019 BLAST

abc 15 ARIZONA

DIFFERENT GENERATIONS

- 2012 First Installations
  - Lower safety standards
  - Walk-in Cabinets
  - Lower ventilation requirements
- NFPA 855
  - Developed in 2016
  - Changed after 2019 Surprise, AZ incident.
- NFPA 68 and 69
  - Deflagration controls
- UL 9540
  - A set of standards for ESS
- UL 9540A
  - Method of evaluating thermal runaway
  - Requirements for Battery Management Systems

COMPONENTS OF A BESS

A battery system. It contains individual battery cells that convert chemical energy into electrical energy. The cells are arranged in modules that, in their turn, form battery packs.

A battery management system (BMS). A BMS ensures the safety of the battery system. It monitors the condition of battery cells, measures their parameters and states, such as state-of-charge (SOC) and state-of-health (SOH), and protects batteries from fires and other hazards.

An inverter or a power conversion system (PCS). This converts direct current (DC) produced by batteries into alternating current (AC) supplied to facilities. Battery energy storage systems have bi-directional inverters that allow for both charging and discharging.

An energy management system (EMS). This is responsible for monitoring and control of the energy flow within a battery storage system. An EMS coordinates the work of a BMS, a PCS, and other components of a BESS. By collecting and analyzing energy data, an EMS can efficiently manage the power resources of the system

TYPES OF LIB CHEMISTRY IN A BESS

- Lithium Cobalt Oxide (LCO)
- Lithium Nickel Cobalt Aluminum Oxide (NCA)
- Lithium Manganese Oxide
- Lithium Iron Phosphate (LFP)
- Lithium Nickel Manganese Cobalt Oxide (NMC)
- Lithium Titanate

SAFETY SYSTEMS

Vary by manufacturer and year built

- Fire control systems
  - Typically at each module to prevent propagation
- Deflagration control systems (NFPA 68 & NFPA 69)
  - i.e. Overpressure burst disks, ventilation engineering, etc.
- Smoke/heat detector
- Gas sensors
  - CO, H2
- Temperature control system
- Cooling
  - Liquid lines directly to each module. Managed by BMS.
- Heating
- Ventilation
- Air conditioning systems
- The safety systems have their own monitoring and control units

SAFETY SYSTEMS – TESLA MP2/MXL

Fire Safety Features
Reported by Fisher Engineering's – Fire Protection Engineering Analysis

Battery Management System

No Integral Fire Detection or Suppression System

Site Controller and Monitoring

- 24/7 remote monitoring
- First Responder Emergency Hotline

Electrical Fault Protection

- Active
- Passive

Explosion Control System

- 22 overpressure vents (not NFPA 68/69 compliant)
- 12 sparkers
  - Installed at a variety of locations and heights
  - Designed to burn flammable gases
- IP66 enclosure
  - Allows natural ventilation to exhaust flammable/explosive gases out

DIFFERENCE BETWEEN MP1 vs MP2

** reported by Fisher Engineering*

Megapack 1

- Cylindrical NMC
- 12,000 cells per module
- 9540A Testing:
  - Cascading thermal runaway of all cells
  - Flames observed outside cabinet
  - Consumed entire cabinet
  - Manual hoselines not required to stop cabinet to cabinet spread

Megapack 2

- Prismatic LFP
- 336 cells per module
- 9540A Testing:
  - 1 cell propagation
  - No evidence of sustained flaming
  - No flames observed outside cabinet
  - Manual hoselines not required to stop cabinet to cabinet spread

BESS Current and Planned for SD County

Enersmart – 55 locations planned in San Diego

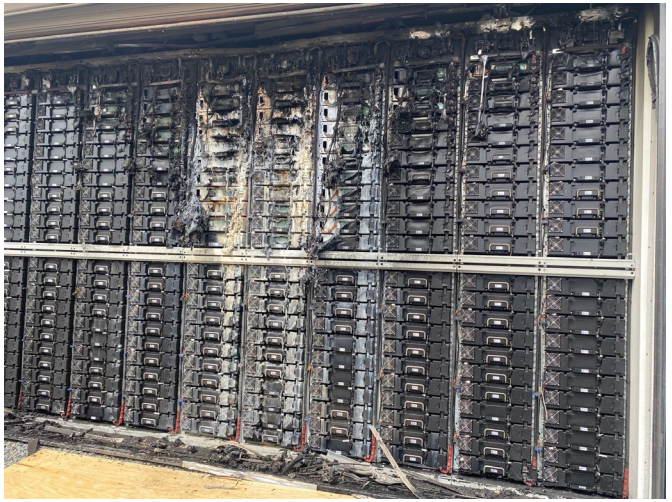
- Chula Vista – 2 systems (6 MW_{AC})
- Murray – 7 systems (21 MW_{AC})
- Mesa Heights – 1 system (3 MW_{AC})
- Imperial Beach – 2 systems (6 MW_{AC})
- Alpine – 2 systems (6 MW_{AC})
- Spring Valley – 12 systems (36 MW_{AC})
- San Diego/Carmel Mtn – 10 systems (30 MW_{AC})
- Border (Otay Mesa) – 6 systems (18 MW_{AC})
- Ramona - 13 systems (39 MW_{AC})

BESS TACTICAL CONSIDERATIONS IF BATTERIES ARE INVOLVED

- Defensive Operations!
- Life safety
  - PPE
  - Rescue
  - Evacuate / Shelter-in-Place
- Property Conservation
  - Allow system safety devices to operate as designed
  - Monitor alarm panel and manually activate any safety devices if appropriate

BESS FIRE – VALLEY CENTER, CA

BESS FIRE – VALLEY CENTER, CA

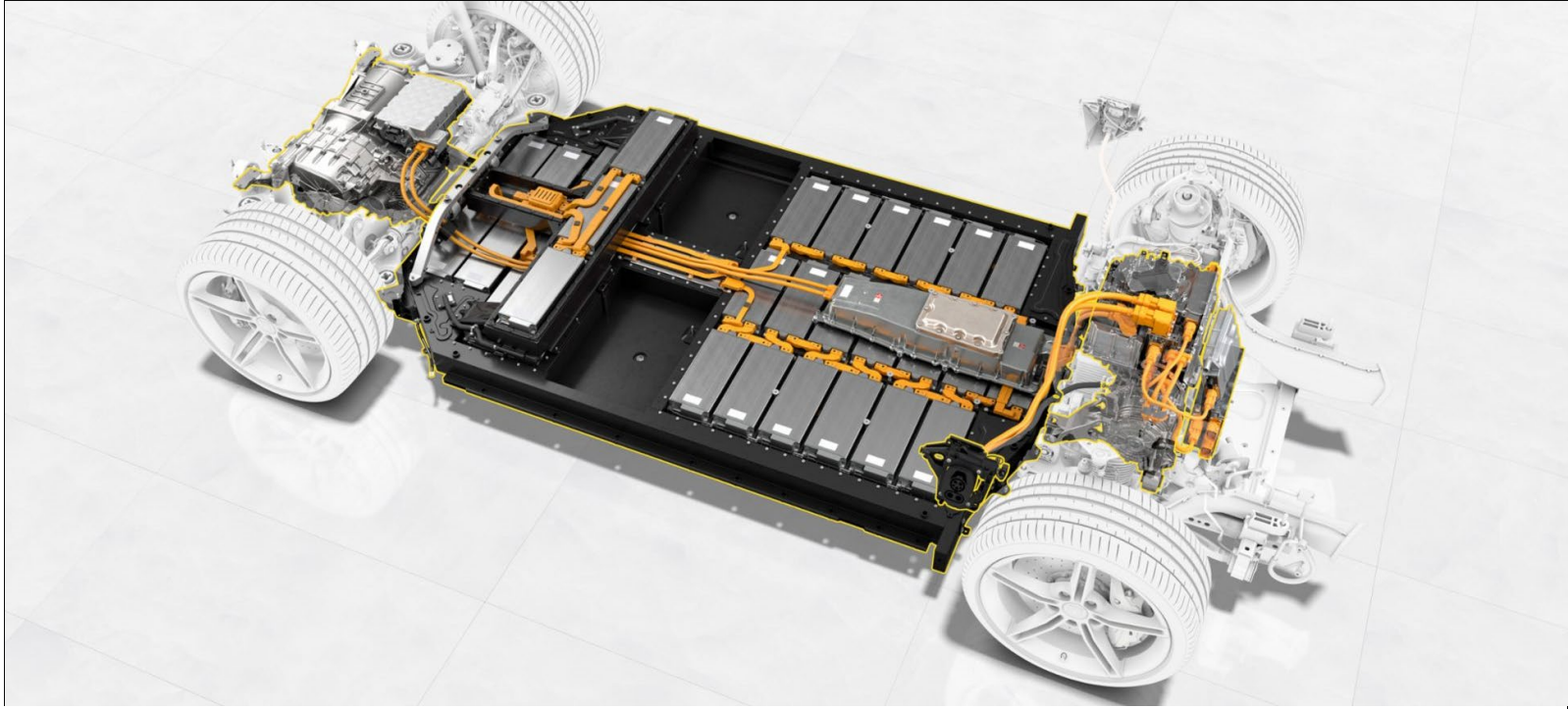


BESS TACTICAL CONSIDERATIONS IF BATTERIES ARE INVOLVED

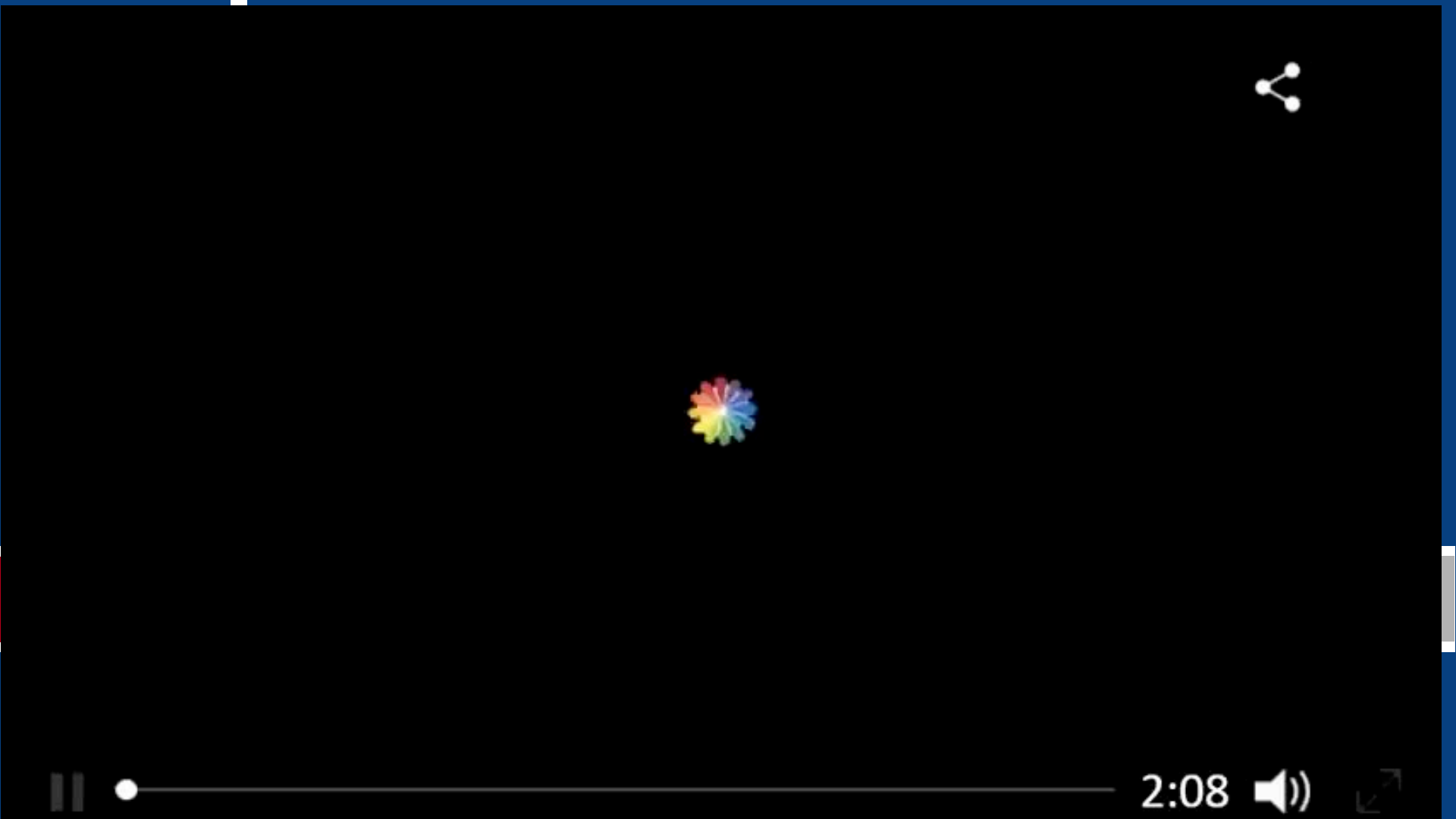
- Prevent propagation
  - Water application ONLY if exposure protection is required
  - Water curtains and unstaffed lines
  - Apply from a distance and upwind if possible
    - Protect exposed battery containers
    - Extinguish and protect other infrastructural exposures
  - Electrical hazard has not been demonstrated in testing at battery fires
    - Use 30-degree fog for water curtains
    - Do not apply water to burning container
- Protect other exposures
  - Neighboring structures
  - Vegetation

BESS TACTICAL CONSIDERATIONS IF BATTERIES ARE INVOLVED

- Incident Stabilization
  - Let it burn!
    - May take multiple operational periods
- Environmental Protection
  - Minimize/contain/redirect runoff if possible
- Resources (some considerations)
  - BESS Personnel / Technicians
  - EPA
  - Hazmat
  - Gas/Electric



Battery Electric Vehicles (BEV)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Exponential Increase – Battery Electric Vehicles (BEV)

% of EVs Global Auto Sales

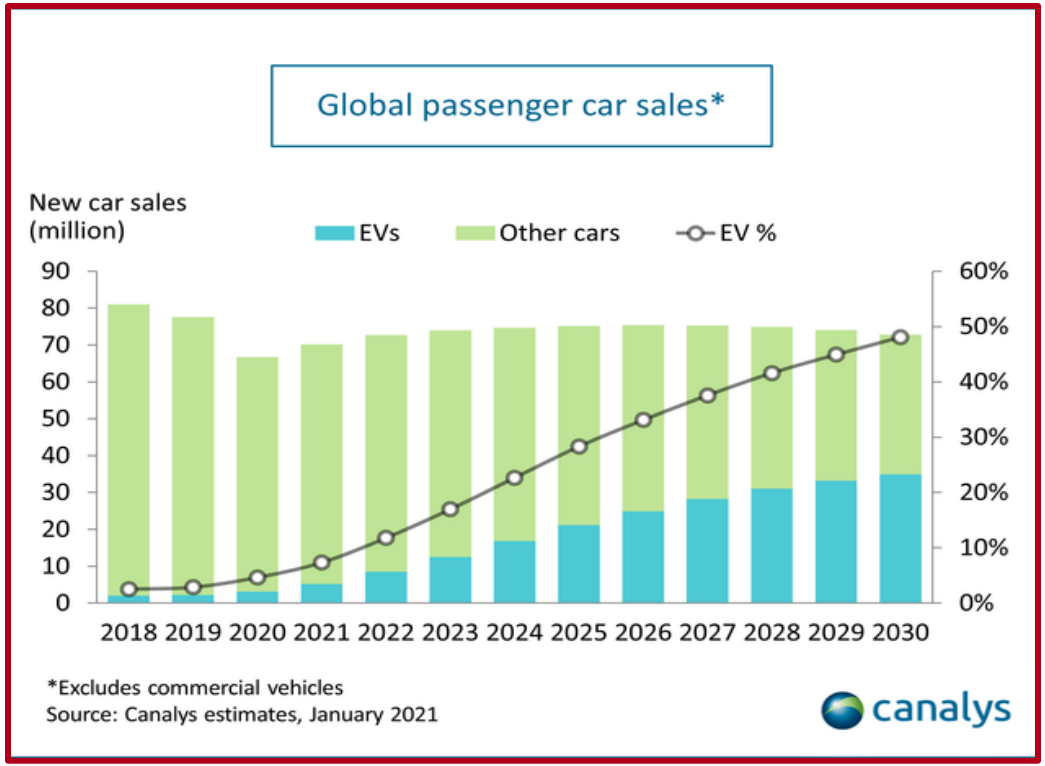
4.7% - 2020

15% - 2025

48% - 2035

California forecasted to be much higher.

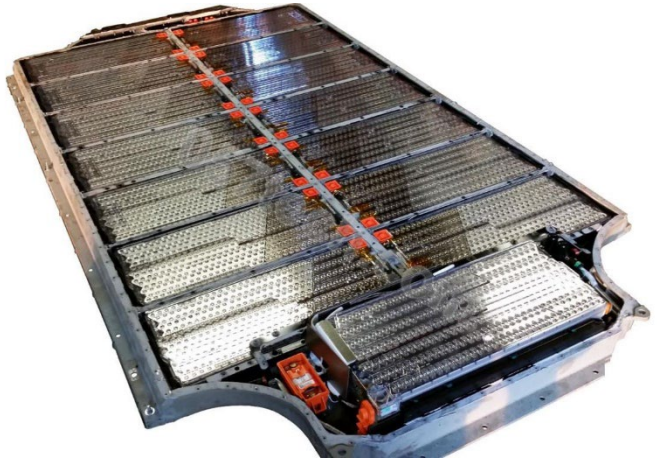
By 2035 100% of all vehicle sales in CA must be battery or hydrogen powered



How quickly do they ignite?

Battery Electric Vehicles (BEV) – Battery Packs

GM Battery Pack
Pouch Cells



Tesla Battery Pack
Cylindrical Cells

BEV Damage

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

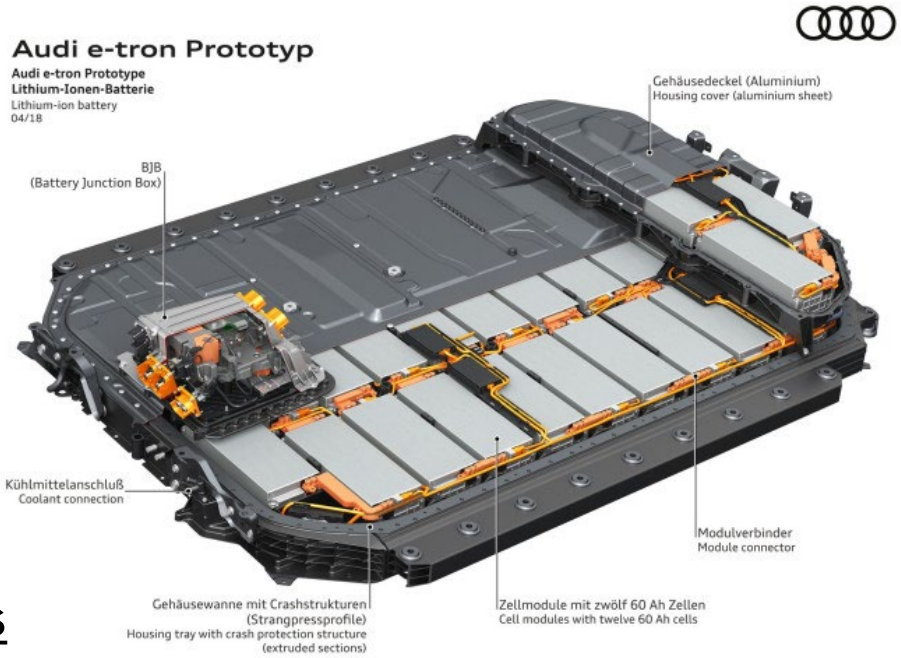
Tesla – Cylindrical Cell Batteries

18650 cell generation

LOTS OF WATER

BEV – 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 days or weeks later!</u>**



3 Keys to Success

BEV Identification

Let it Burn

<u>PROTECT EXPOSURES!</u>

(if possible)

Secure a Water Supply

BEV 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 (about 60%) 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

BEV 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 for 60 minutes.

BEV 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
- 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

BEV Fire Tactical Considerations – FSRI Testing

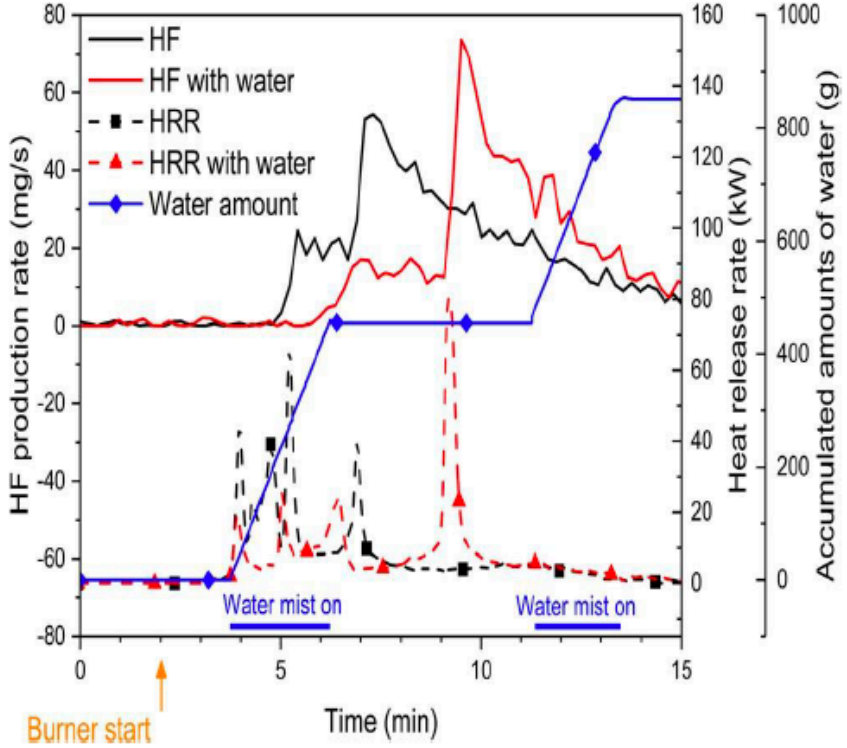
- FSRI estimated the amount of gas released from a residential BESS and what would happen if it caught a source of ignition.

BEV Fire – Inside


KN-48

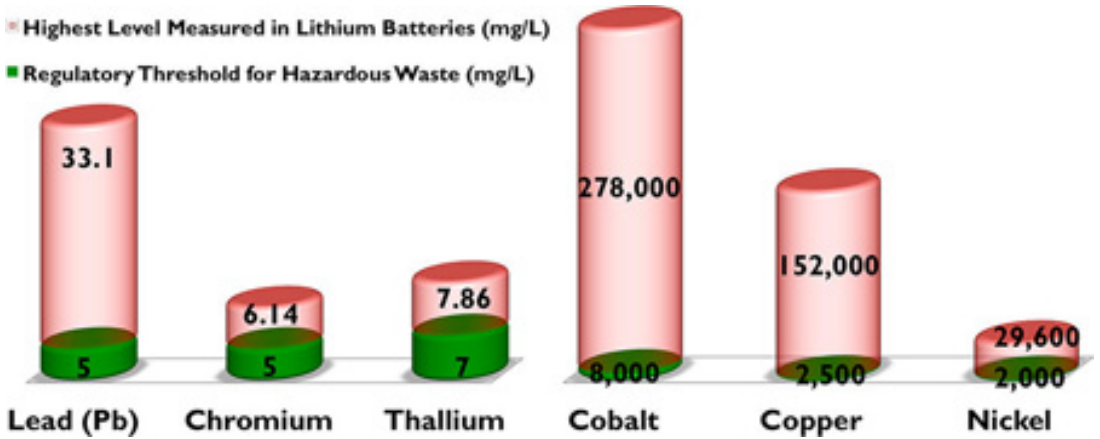
FIREFIGHTER EXPOSURE

- Significant amounts of HF, between 20 and 200 mg/Wh of nominal battery energy capacity, were detected from the burning Li-ion batteries. (2-20kg for an electric vehicle – IDLH 0.025g/m3).
- The measured HF levels, verified using two independent measurement methods, indicate that HF can pose a serious toxic threat, especially for large Li-ion batteries and in confined environments.



FIREFIGHTER EXPOSURE

- Toxic
  - HCl
  - HCN
  - SO2
  - HBr
  - HF
  - CO
  - CO2
- Heavy Metals
  - Cobalt
  - Strontium
  - Metal
  - Lead



Parking Garage or Refueling Station?

PASSENGER EV LIB FIRE INCIDENTS

Global, as of 30th JUNE 2023

EV HV battery fires are very rare...here's what we've been able to track & verify. Data is not exhaustive.

Why EV FireSafe?

Transport emissions account for:

25%

of global greenhouse gas emissions, which has led to the rapid electrification of vehicles

EV battery fire incidents have led to concerns about emergency responder safety when attending

EV lithium ion battery fires

To enhance emergency responder safety, we researched plug-in (BEV & PHEV) passenger electric vehicle battery fires from

2010 - 2023

breaking down our findings here & at evfiresafe.com

How many EV battery fires?

Since 2010, the EV FireSafe research team found:

393 verified* EV traction battery fires globally

+ 74 investigating - online rumour, tip off, clickbait

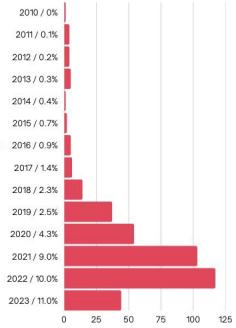
+ 21 unverified - from a reliable source, waiting on further info

'...more than 10 million electric cars were sold worldwide in 2022 and...sales are expected to grow by another 35% this year (2023) to reach 14 million.

International Energy Agency, April 2023

When did they occur?

By year & EV global market share:

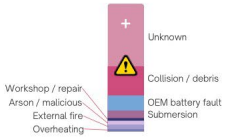


**Not exhaustive. From more than one online source, interviews, first hand accounts, videos, images, academic & fire agency reports & online training*

EV HV battery fires are very rare, but present new risks & challenges for emergency responders. From these verified incidents, we found:

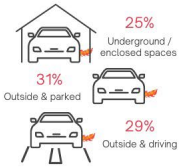
Cause

Battery cell abuse, leading to thermal runaway & ignition or explosion, caused by:



Location*

*16% unknown



25% Underground / enclosed spaces

31% Outside & parked

29% Outside & driving

Ignition vs explosion

95% Ignition
Jet like, directional flames

5% Vapour cloud explosion
Violent deflagration

Vapour cloud explosion

Of total vapour cloud explosion incidents:

70% Underground / enclosed space

30% Open air

Charging

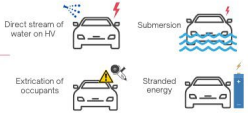
Of total EV battery fire incidents:

18% EV connected to energised charging

2% EV disconnected from energised charging within 60 minutes of incident

Electrocution

We found NO reports or evidence of electrocution or near miss of emergency responders from:



But electrocution is still a risk!

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

- Considerations: Garage
  - Approach from an angle to avoid possible door explosion/over pressurization
  - If 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 available space
  - 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

Example ERGs

Example ERG

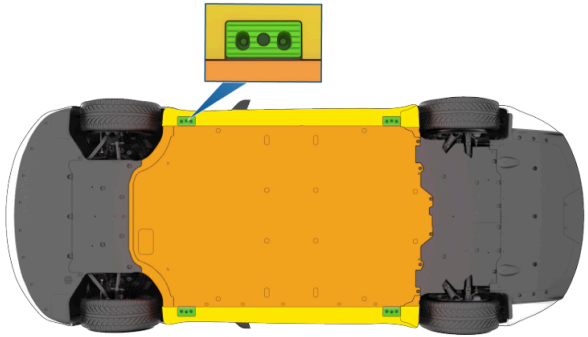
STABILIZATION / LIFTING POINTS

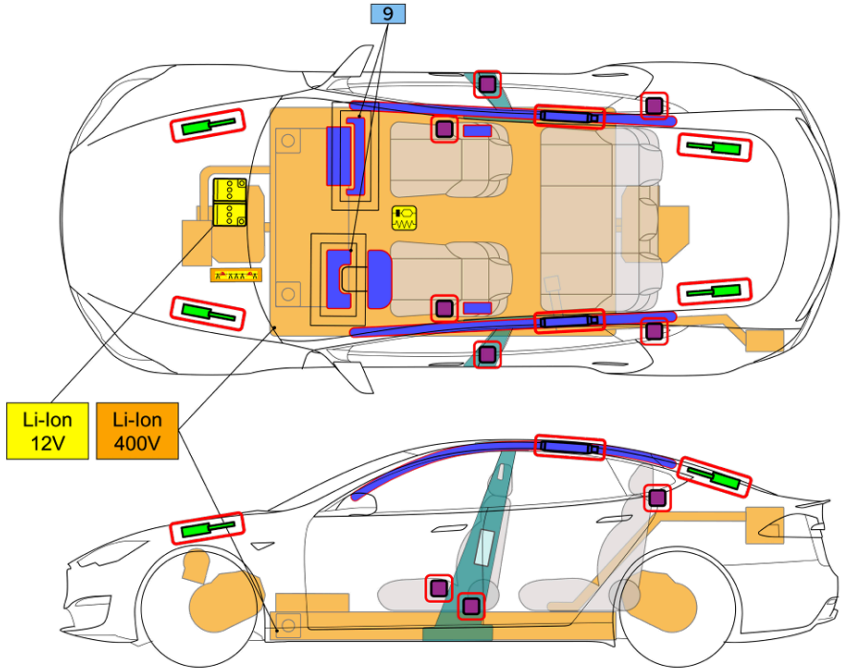
The high voltage battery is located under the floor pan. A large section of the undercarriage houses the high voltage battery. When lifting or stabilizing Model S, only use the designated lift areas, as shown in green.

> ⚠ **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.

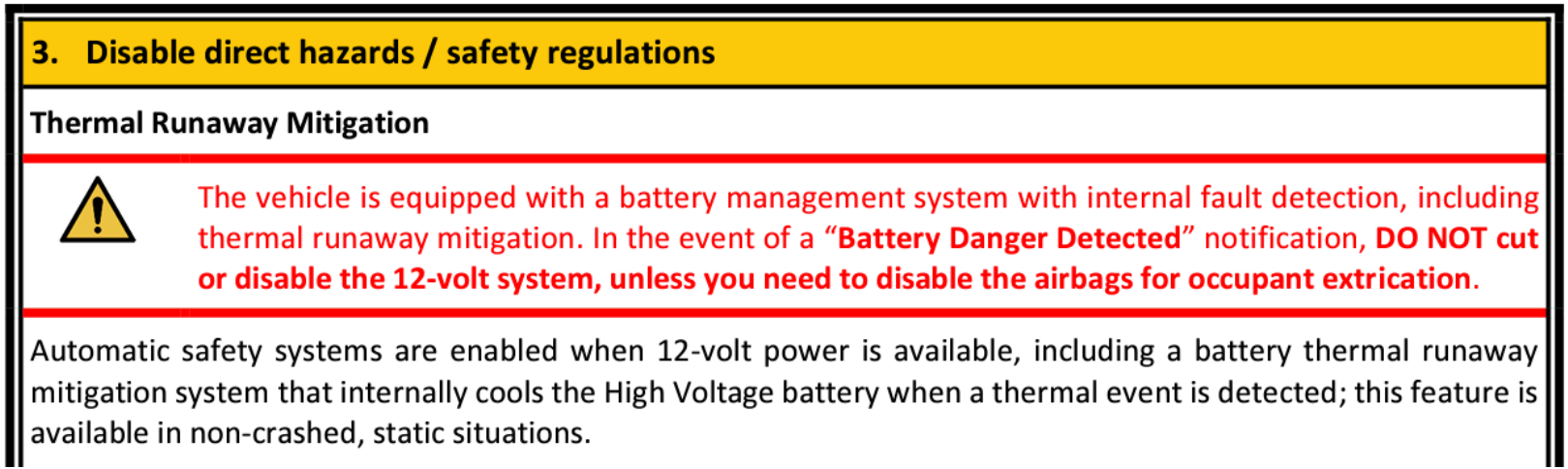




	Airbag		Stored gas inflator		Seatbelt preten-sioner		SRS Control Unit		Pedestrian protection active system
	Automatic rollover protection system		Gas strut/ pre-loaded spring		High strength zone		Zone requiring special attention		
	Battery low volt-age		Ultra ca-pacitor, low voltage		Fuel tank		Gas tank		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								

BEV Vehicle Extrication

- Charged and STAFFED hoseline!
  - Fog pattern for hydraulic ventilation
    - Does not require full GPM
- "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.

Other Battery Electric Vehicles

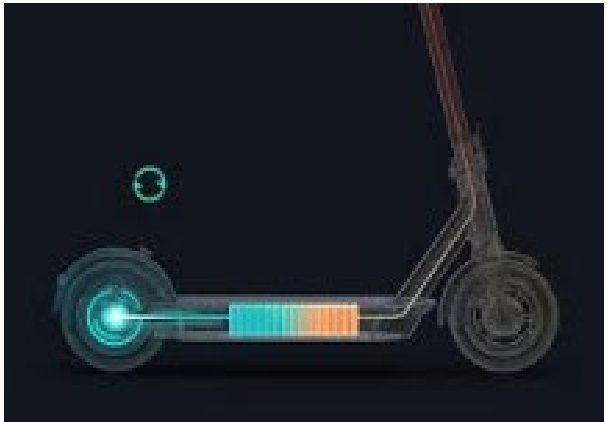
Micro-Mobility Devices

E-BIKES, SCOOTERS, HOVER BOARDS, ETC.

Micro-Mobility Devices

- Largest number of LIB incidents
- FDNY LIB fires:
  - 44 in 2020
  - 220 in 2022
- 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

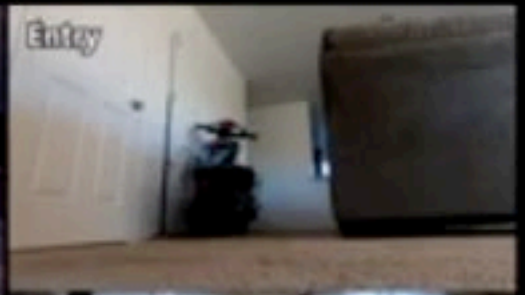
(viii) Segway

(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.

Pause

vimeo

Inside View

Structure Fire Involving Micro Mobility – SDFD E19

Pay special attention to the status of the windows upon arrival!

How Many GPMs?

- Lithium-Ion batteries do not require Oxygen to burn.
- Smothering also does not work
- Cooling to prevent cell propagation may be successful if water can be placed into battery pack
  - **DO NOT** force open the battery pack

Can you have more GPMs than this?

Micro Mobility Concerns

Micro Mobility Concerns

Micro Mobility Concerns

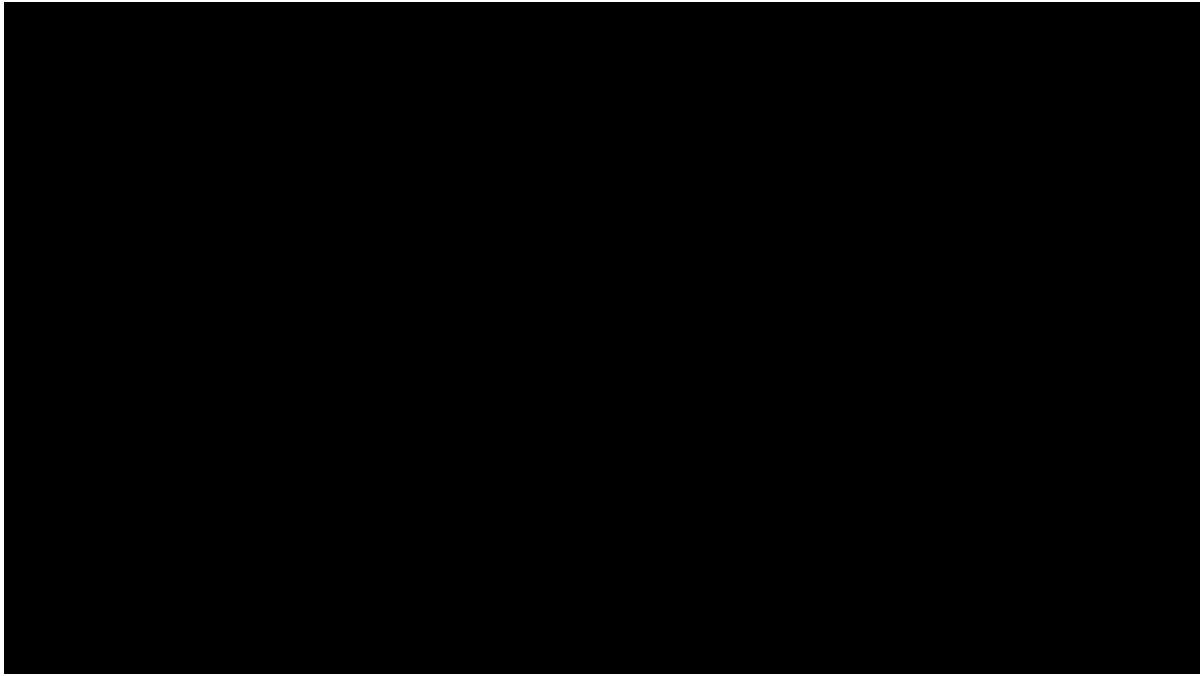
- Large volume of smoke production

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

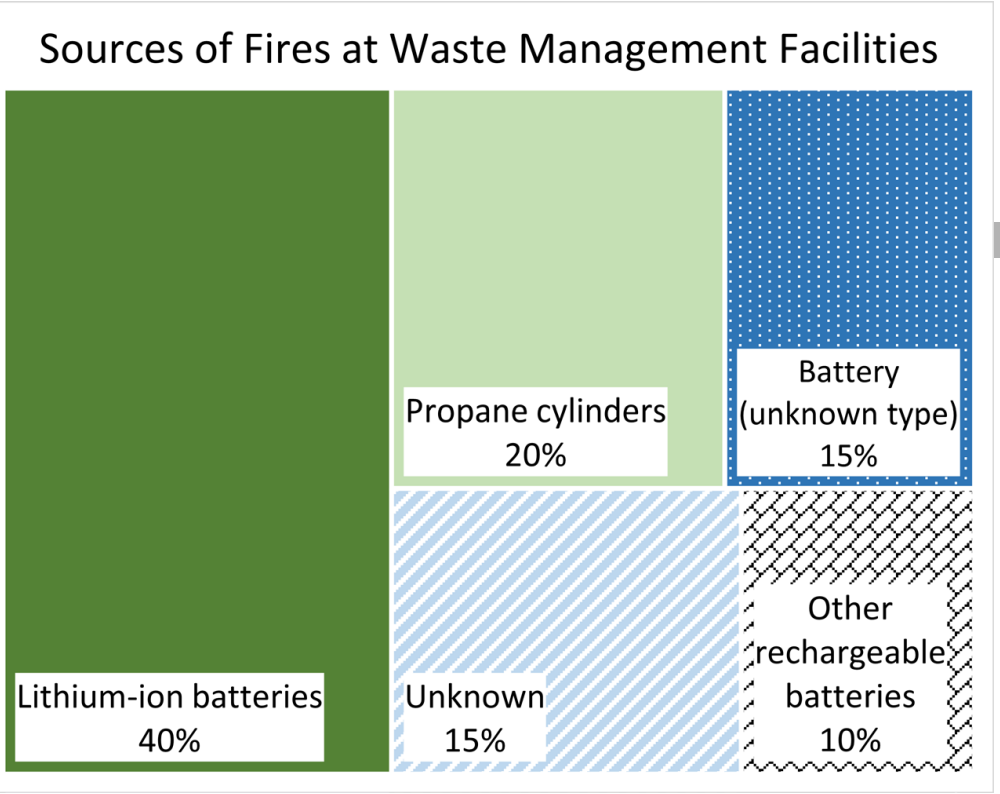
- Move all lithium-ion battery cells and devices to a safe location, away from firefighting operations, **PRIOR to overhaul**
  - Use shovel with wooden handle
  - Outside is preferred
  - Consider bathroom, bathtub, sink, or metal bucket and fill with water if outdoor not an option
  - Wear SCBA during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

Where Do We See Them?

They are everywhere! Increasing fire behavior.

Disposal Challenge

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



Li-ion Battery Fire Recycling Facilities

- Lakes Parkway, GA

Site Safety

Lakes Parkway Fire Response

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

Damaged Batteries are Unpredictable

Other Hazards?

September 12, 2019

- Conception Dive Boat
- 34 dead
- Photography Lithium-Ion batteries “involved”

November 9, 2022

VIP Pedicabs

Bronx Supermarket

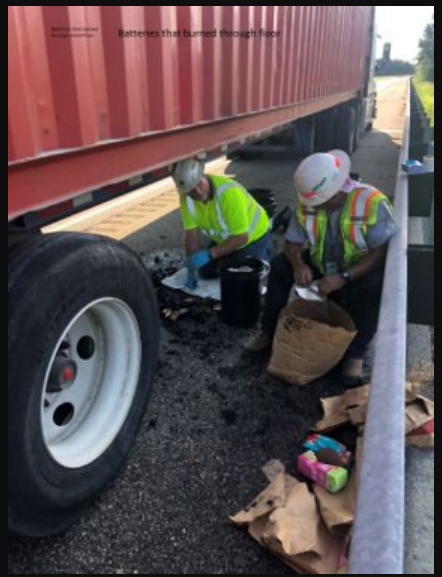
TRANSPORT AND DISPOSAL

Houston TX – April 23, 2017

Shipping container exploded while in transportation by rail.

There was no warning or indication that lithium batteries were involved.

Suffolk, VA – August 19, 2021



Port – L.A. Long Beach – March 4, 2022

Birmingham, AL– March 31, 2023

Shipping Hazards

Netherlands - 2023

North Atlantic - 2022

Other?

- Wildfire starts?

Tag: drone causes fire

Drone crash starts fire in Oregon

Bill Gabbert July 11, 2018 Uncategorized drone, drone causes fire, Oregon 10 Comments

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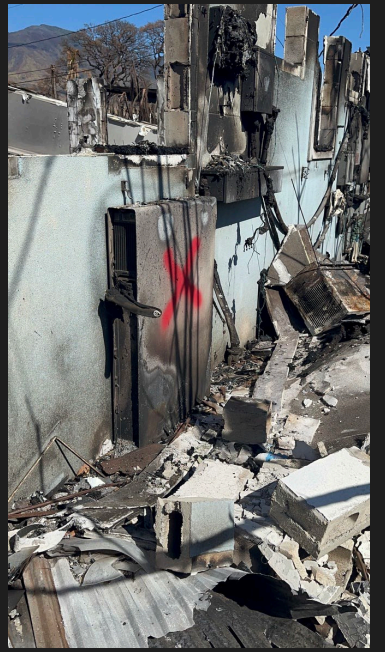

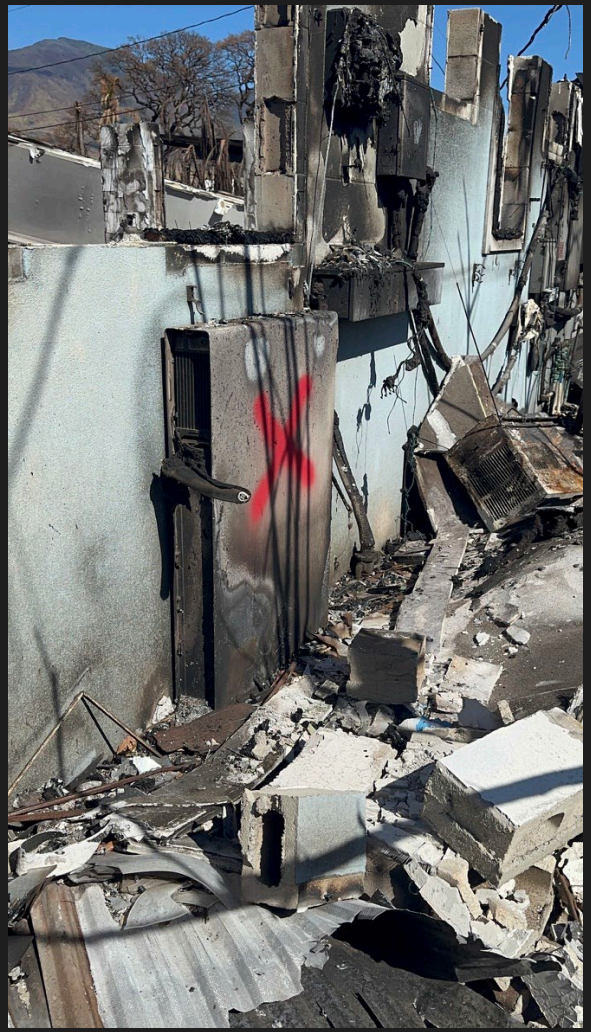


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THANK YOU!

Questions?