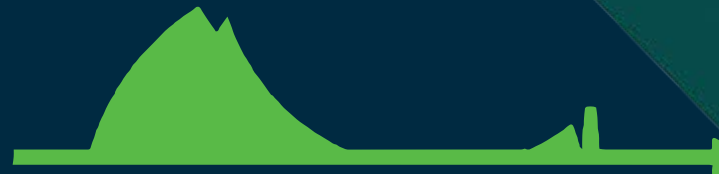


Lithium
Battery
3000mAh

LITHIUM BATTERY SAFETY


BE ALIGNED TARANAKI



THE HAZARD LITHIUM BATTERIES ARE EVERYWHERE

In 2023 40 million Light Electric Vehicles (LEVs) (electric bikes, scooters, skateboards, unicycles & hoverboards) were sold globally.

Li-ion batteries possess the elements needed to self-sustain a fire, making them susceptible to potential explosions. The presence of flammable electrolytes,

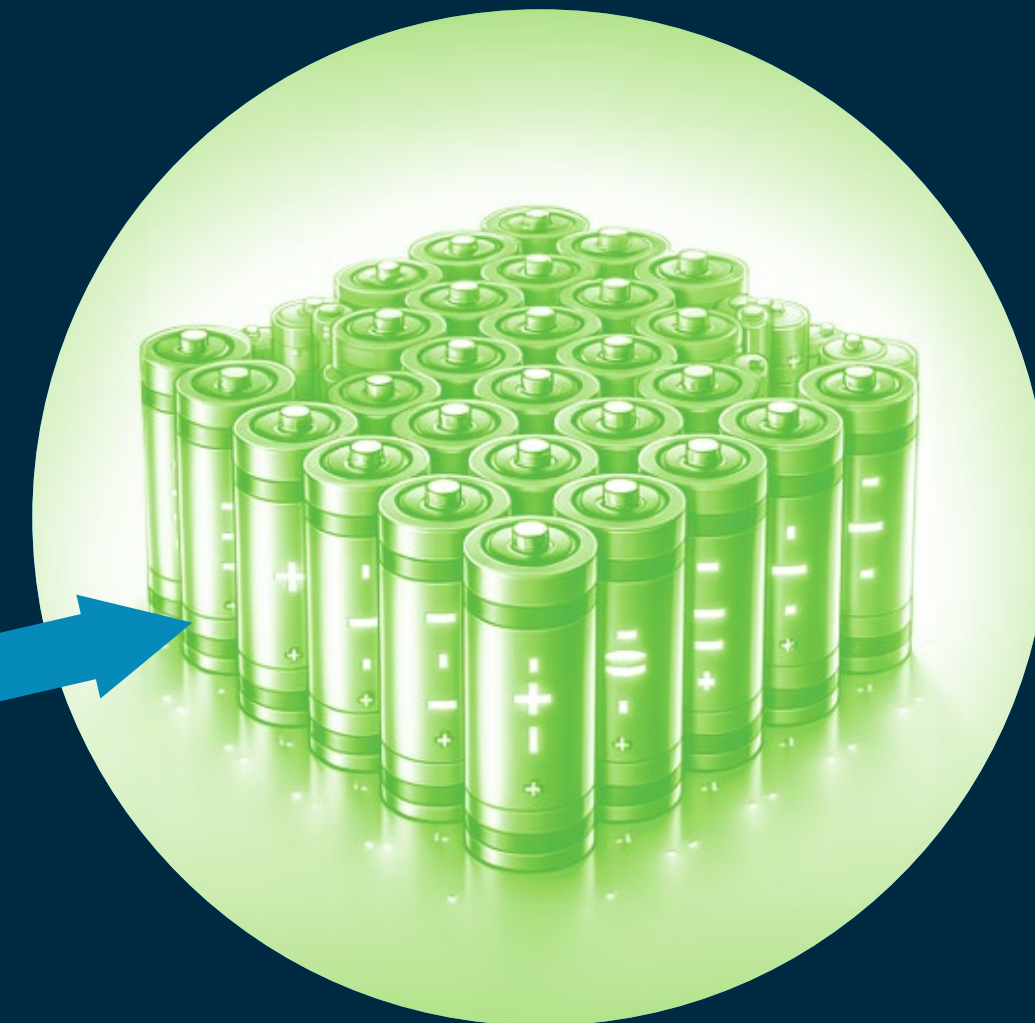
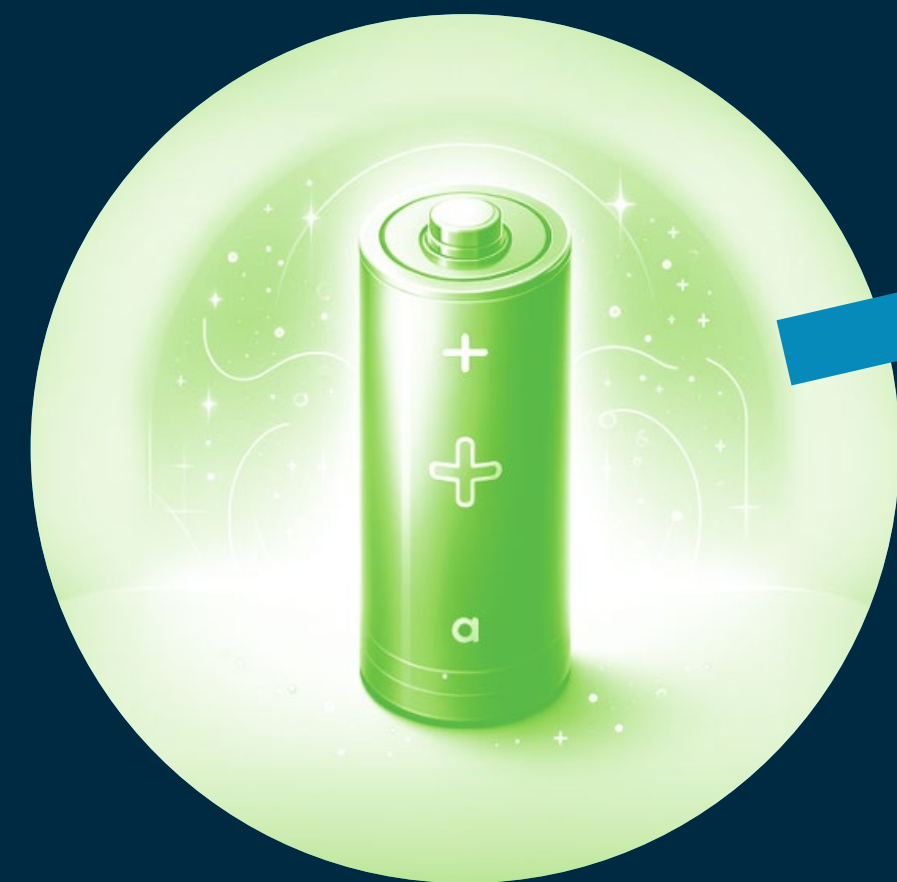
organic solvents, and oxygen in the battery structure poses a risk, especially when exposed to stressors like internal shorts, overcharging, external heat, or fire.



THE RUNAWAY EXOTHERMIC REACTION - METAL FIRE

To understand how a Li-ion battery can catch fire or explode, it is necessary to understand how the battery is built.

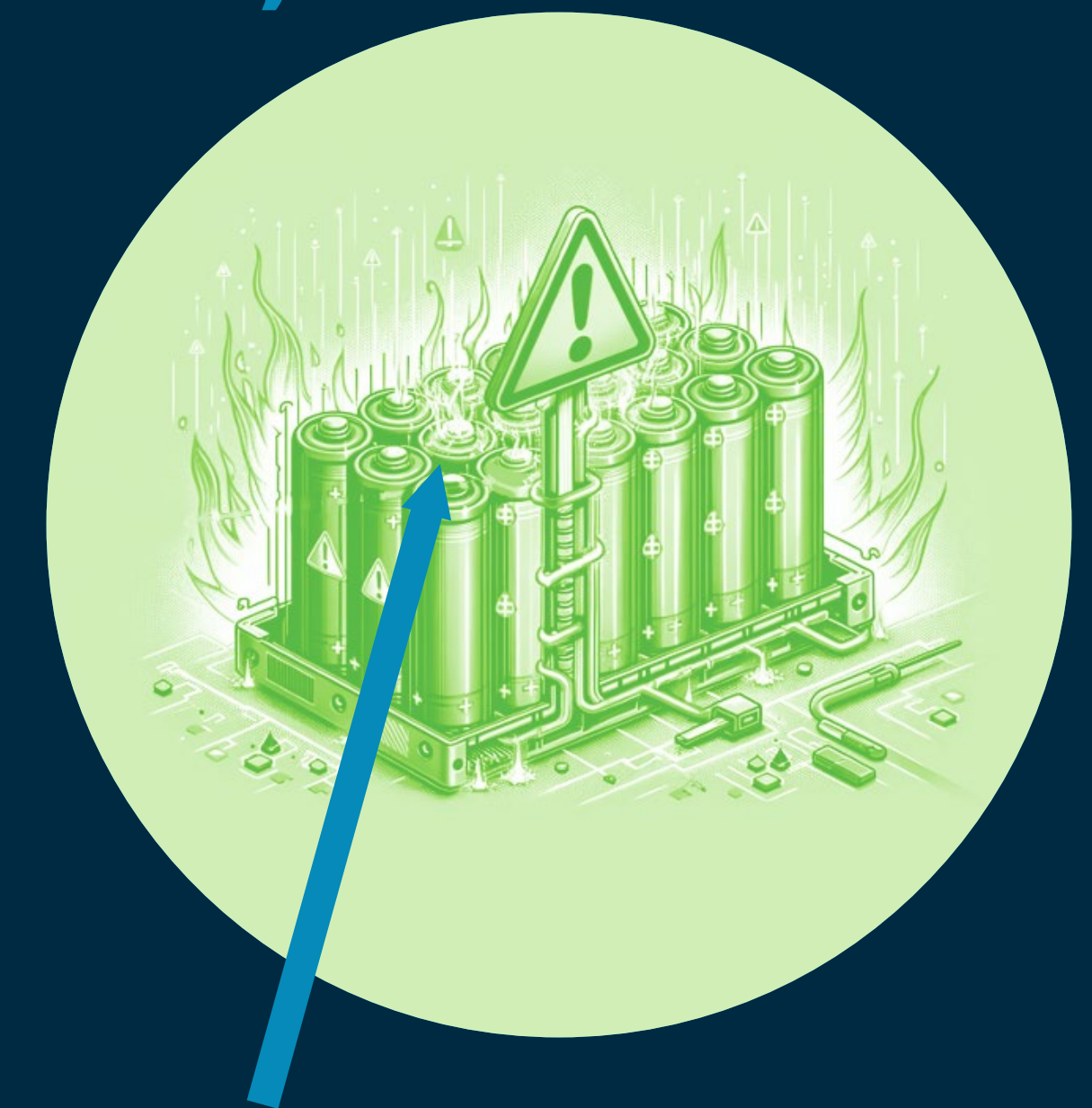
1. Multiple battery cells create a module.



Cylindrical lithium-ion battery cell under normal operation

2. When a battery short circuits the cell heats up.

If a cell is abused, e.g. by heating, crushing or penetration or overcharge, chemical reactions replace the normal electrochemical reactions: the former generate heat and toxic and flammable gasses. The heat speeds up exothermic reactions producing more heat and gases.



Cell affected by short circuit

There are safety measures within some batteries (not all) such as pressure burst discs, shutdown separators, and one-shot fuses.

THE RUNAWAY EXOTHERMIC REACTION *CONTINUED*

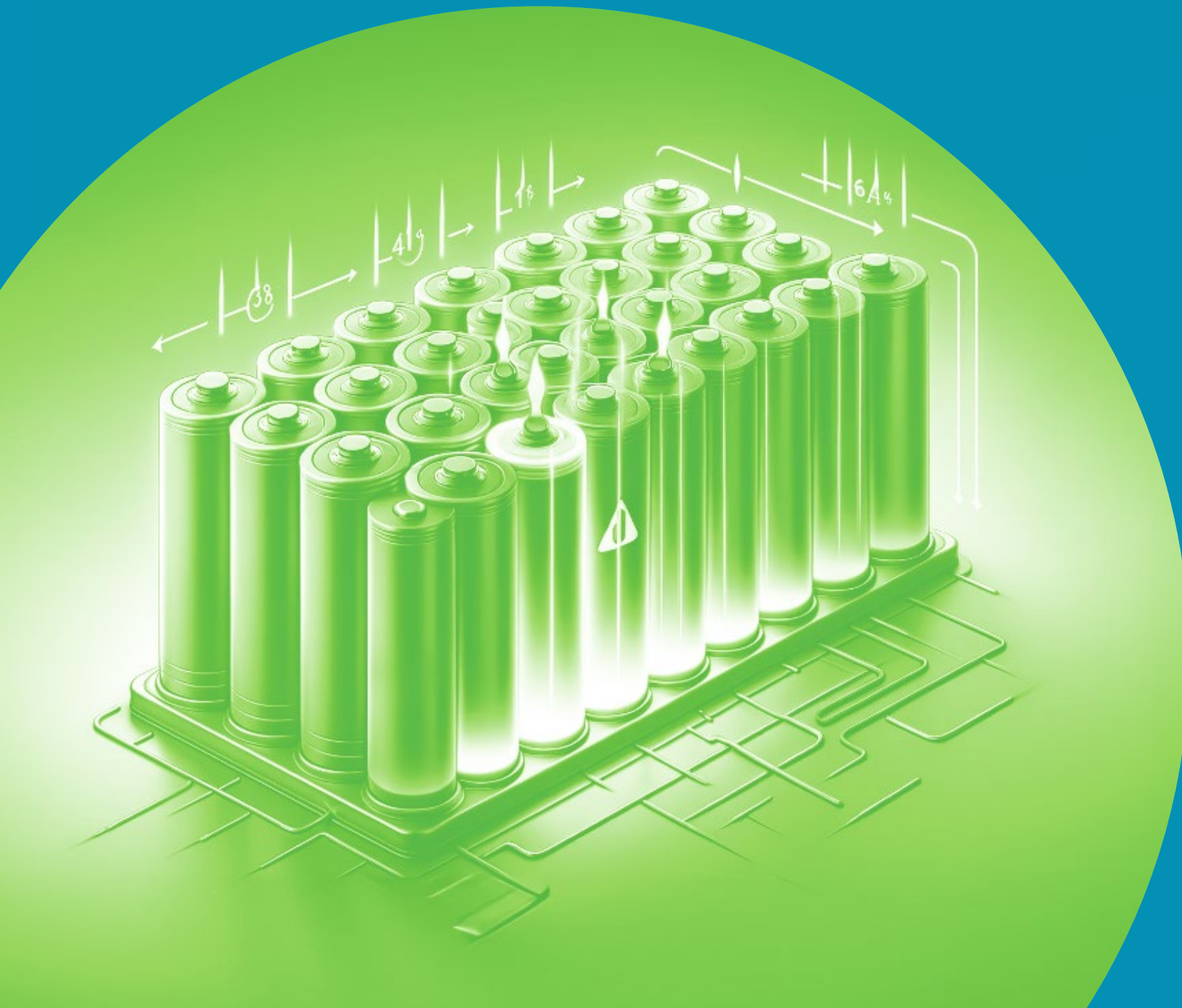
3. Heating starts to affect other cells

Cell heating will continue until the temperature rise exceeds the heat that can be dissipated to the cell's surroundings. This released heat will start to affect other nearby battery cells.

4. The cell goes into thermal runaway

When the generation of heat becomes self-sustaining - the heat releases energy, & the energy in turn releases more heat - the cell is experiencing thermal runaway. When thermal runaway occurs, the cell is undergoing an unstable chemical reaction that is hard to bring under control.

At some point, the separator structure collapses and the electrodes touch, causing an internal short circuit and masses of heat, catapulting the cell to ever higher temperature. Eventually, the gases are vented, either via blast caps on cylindrical and prismatic cells or when pouch cells burst. Initially, heavy metal dust particles from the cathode will present as a dark cloud, which is followed by a white vapour cloud as the gases take with them fine droplets of the solvent.



THE RUNAWAY EXOTHERMIC REACTION *CONTINUED*

5. In some cases, cell ignition will occur

As oxygen mixes with the vapour cloud & heat continues to build, the battery cell may ignite, causing surrounding cells to do the same. Ignition will occur anywhere between seconds and minutes of the white vapour cloud showing



6. Vapour cloud explosion is a risk

In the right circumstances, the white vapour cloud of toxic flammable gases will deflagrate (explode) without warning. If it occurs, vapour cloud explosion is a high risk to emergency responders.



ASSOCIATED HEALTH HAZARDS

- ▶ Leaking batteries - the electrolyte in lithium batteries contains corrosive salt; if it reacts with water or humidity, it can generate hydrofluoric acid and irritate the eyes, nose, and throat or cause chemical burns.
- ▶ In the event of overheating, lithium-ion batteries can become hazardous. They may release flammable electrolytes and toxic gases like hydrogen, methane, carbon monoxide, phosphorus pentafluoride (PF5), phosphoryl fluoride (POF3), and hydrofluoric acid.
- ▶ These substances increase the risk of explosions and pose serious health threats, including suffocation.
- ▶ One critical warning sign of these dangers white 'smoke' coming from a battery, indicating the release of these hazardous gases and vapors. It's vital to avoid inhaling this smoke, as it's both toxic and flammable.



PREVENTION OF LITHIUM FIRES

- ▶ Disconnect devices when fully charged. Avoiding overcharging.
- ▶ Ensure devices and batteries are not subjected to physical abuse.
- ▶ Keep any damaged batteries away from those that have not been damaged. Reduce the risk – store batteries in smaller amounts and separate.
- ▶ After a 'bottoming out' incident such as striking a kerb or rock with the underside of an EV vehicle (most batteries are on the underside of vehicles) have an expert rcheck the battery for damage. Be very cautious of any electric vehicle that has been involved in a collision, submerged in water, has an unusual odor, a bulging, heated, or leaking lithium-ion battery pack.
- ▶ For smaller devices, such as vapes, phones, and laptops, do not charge these under a pillow, on the bed or couch.
- ▶ Never store or leave batteries or devices in areas where they can be exposed to heat or moisture. Keep devices away from direct sunlight.
- ▶ Store lithium-ion power tools away from house / sleeping areas, if possible, inside a garden shed or garage is ideal.



METAL FIRES THINGS TO KNOW

Metal fires, particularly those involving lithium, are challenging to extinguish because they are both a source of ignition and a fuel.

Once a battery pack catches fire it can be difficult to put out and it may need to be left to burn out on its own in a safe and controlled manner. However, if a battery overheats and begins to smoke, water can be used to cool the battery down and stop the spread of fire – however, there are recommendations NOT to use water to extinguish the fire: The water can have a pH of 11+, it may need to be neutralized before

being disposed of. Batteries can be neutralized with a solution of 20% NaCl.

Let emergency services know that it's a suspected lithium battery fire.

The fire will produce irritating, toxic or corrosive gases

The fire may re-ignite after it is extinguished (international experience has found this could be several days later)

Containers may explode when heated

Electric vehicles and internal combustion engines (ICE) burn at a similar heat, refuting the common misconception that EVs burn hotter than ICE Vehicles (NFPA testing (August 2023)).

All vehicle fires produce projectiles, however, the venting of gases from lithium-ion battery cells may cause more debris to fly than ICE vehicles.

EMERGENCY RESPONSE ACTIONS TO TAKE

Small fire

- ▶ Use dry chemical, soda ash, lime, or sand to extinguish.
- ▶ If safe to do so, move undamaged containers from fire area.

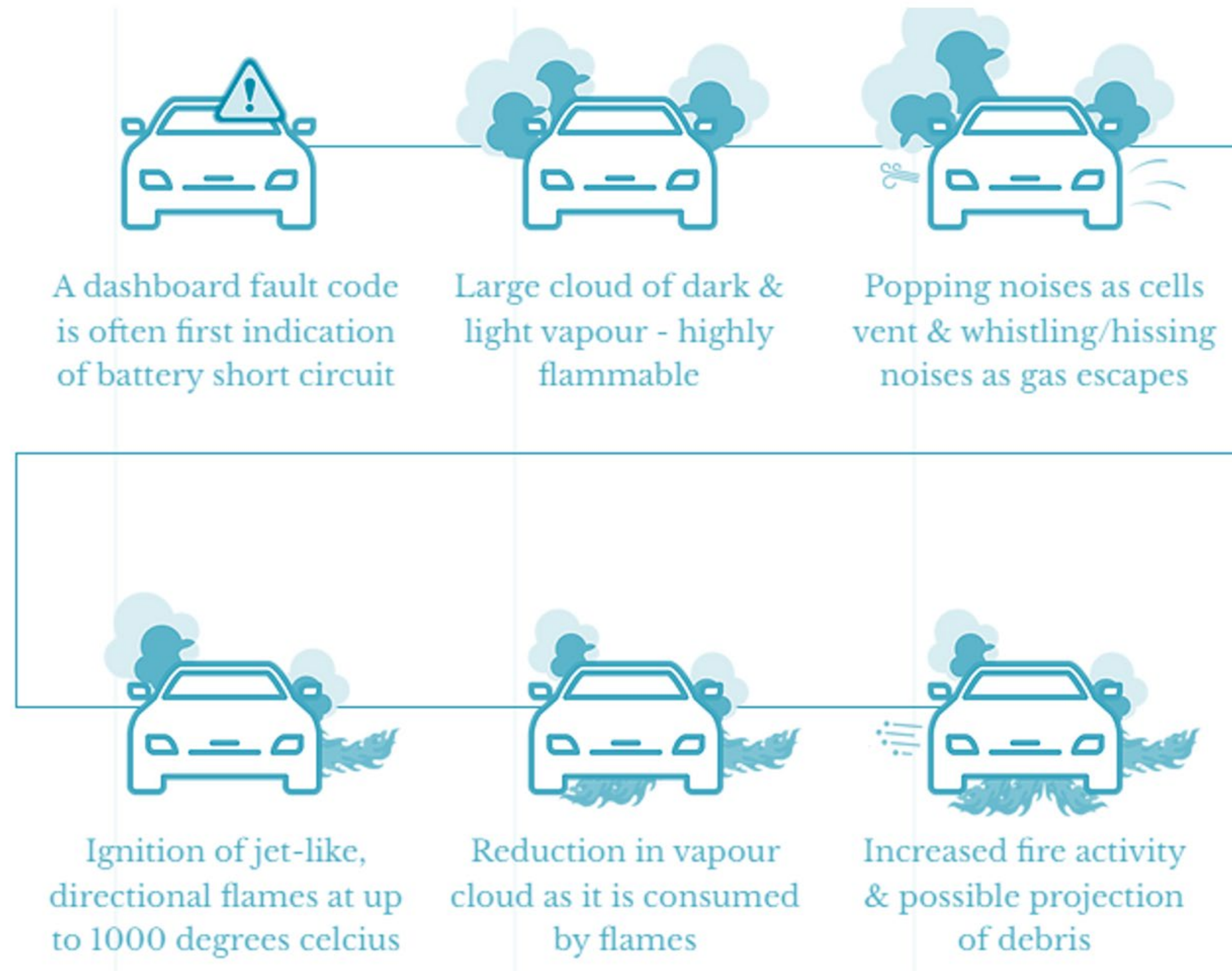
Large fire

- ▶ Use DRY sand, graphite powder or Lith-X class 'D' metal fire extinguisher.
- ▶ Withdraw immediately in case of rising sound from venting safety devices or discoloration of the tank.
- ▶ Wear SCBA and chemical splash suit, structural firefighters' uniform may provide limited protection.
- ▶ If an electric vehicle is on fire water is the most effective way to extinguish an EV battery fire. Lots of water to cool the battery and suppress flames is required; at least 4000 liters should be established. The battery, located along the floor pan, means the vehicle may need to be jacked up to apply water.



BATTERY FIRE BEHAVIOR

(Electric Vehicle)



Video credit: Diesel Centre

An electric Nissan Shuiku on charge at a DC unit ignited, destroying four other vehicles.

HOW AND WHERE TO DISPOSE LITHIUM BATTERIES

Proper disposal of lithium batteries is essential.

In 2023 a fire at the Hāwera Transfer Station was linked to a disposed lithium battery, while a battery is believed to have caused a blaze at New Plymouth's material recovery facility on Colson Road.

The simple rule is that no battery should go in into a recycling or landfill bin.

- ▶ Before attempting any additional material recovery, be sure all batteries have been removed and are being kept separate. If the batteries cannot be easily separated, seek the services of a specialist to remove them, and ensure that the location where the specialized processing takes place has the necessary permits.
- ▶ When it comes to broken batteries, use the UN-approved barrel technique, and make sure to wrap any batteries that leak or swell up tightly in plastic.
- ▶ Prevent short circuits by insulating battery terminals and wires.
- ▶ If using barrels or cartons, pack the batteries according to UN regulations. Layer them with dry sand (for lithium-ion).
- ▶ Discarded lithium batteries should be kept indoors (within a fire-proof building) since they pose a fire hazard due to the possibility of short-circuiting.

MORE RESOURCES

**Guidelines for the Safe handling,
Transportation, Collection and
Storage of Large Used Batteries
(2021) - The Battery
Industry Group (BIG)**



➔ <https://big.org.nz/wp-content/uploads/2021/06/B.I.G.-Safety-Guidelines-FINAL.pdf>

Worksafe



➔ <https://www.worksafe.govt.nz/topic-and-industry/energy-safety/safe-use-of-lithium-ion-batteries-and-battery-products/>

NZI Insurance



➔ <https://www.nzi.co.nz/content/dam/insurance-brands-nz/nzi/nz/en/documents/nzi/risk-solutions/nzi-risk-solutions-lithium-batteries-management-guide-nz7320-1-1022.pdf>

Storage cabinets



➔ <https://www.hazero.co.nz/collections/lithium-ion-batteries>

