TRANSPORT OF DANGEROUS GOODS IN ELECTRIC VEHICLES

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AECI®

good chemistry

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UNITED NATIONS

SUB-COMMITTEE OF EXPERTS ON THE TRANSPORT OF DANGEROUS GOODS

- Meets Twice a year
- Part of Economic and Social Council (ECOSOC)
- Develop the Model Regulations and Manual of Tests Criteria (MTC)
- Part of this is EWG – Only meets once a year
- Not industry based
  - Regulators
  - NGO's
- Consider improvements to the Model Regulations and MTC
- Discussions around impact of new technologies on Transport of Energetic Substances
- At the 64th session in June 2024 Electric Vehicles were tabled for discussion

SUSTAINABLE MINING

- Zero diesel emissions and reduces ventilation and cooling needs
- Healthier work environment and lessens the environmental footprint
- Less particulate matters and diesel fumes in the mines
- Perceived as environmentally friendly

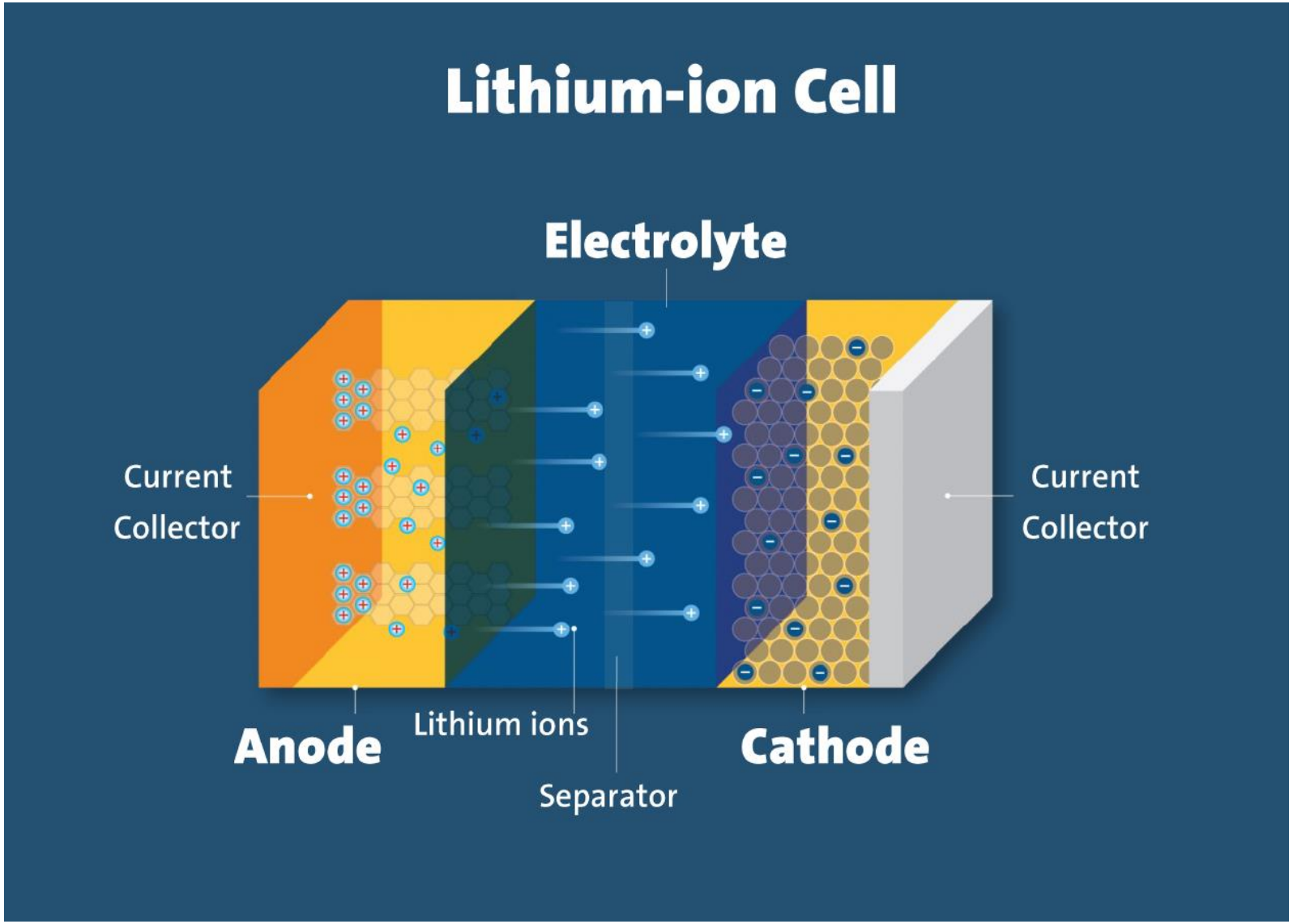
COMMON USES LITHIUM-ION BATTERIES

ELECTRIC VEHICLE INCIDENT

LITHIUM VS LITHIUM-ION

- What is the difference between lithium batteries and lithium ion batteries?
- No metallic lithium
- Lithium metal batteries are generally not rechargeable but have a much higher energy density.

CHEMISTRY OF LITHIUM-ION



TYPES OF LITHIUM-ION BATTERIES

CATHODES

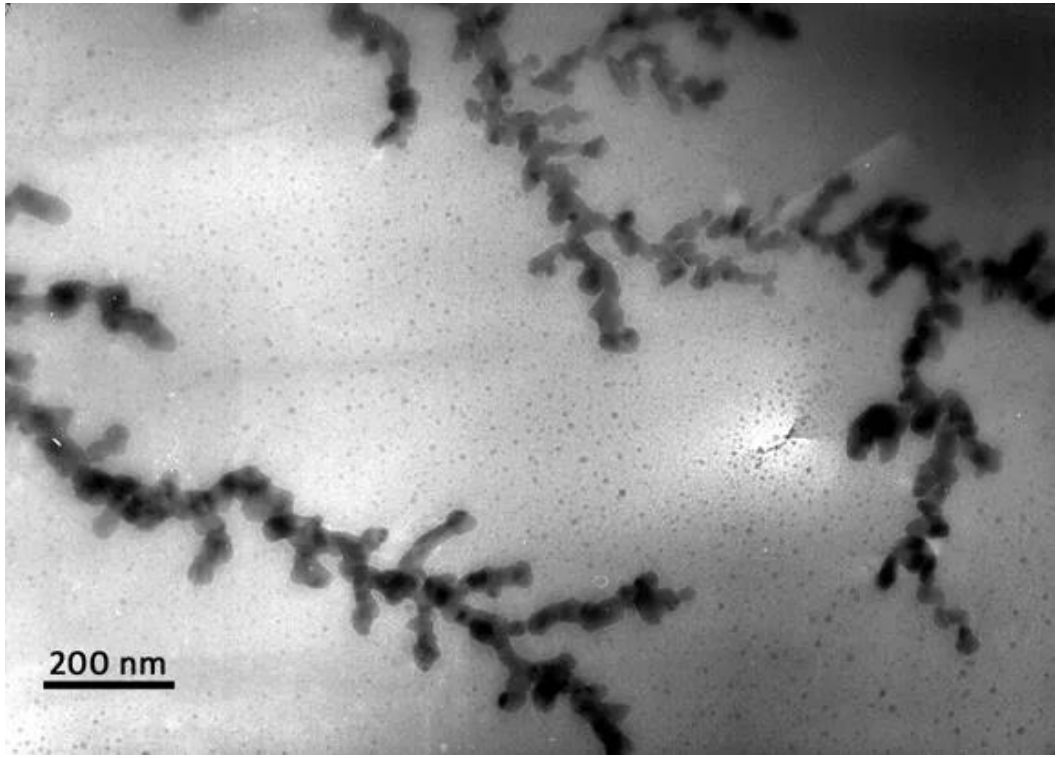
- **Lithium Cobalt Oxide (LCO)**
  - high energy density, consumer electronics like smartphones, digital cameras, and laptops.
- **Lithium Iron Phosphate (LFP)**
  - long lifespan, high power, and good thermal stability
- **Lithium Manganese Oxide (LMO)**
  - balance between power density, energy density, and thermal stability but has shorter lifespan
- **Lithium Nickel Cobalt Aluminium Oxide (NCA) and Lithium Nickel Manganese Cobalt Oxide (NMC)**
  - high energy density, good power density, and lifespan.
  - Commonly used in electric vehicles
  - More prone to thermal runaway

TYPES OF LITHIUM-ION BATTERIES

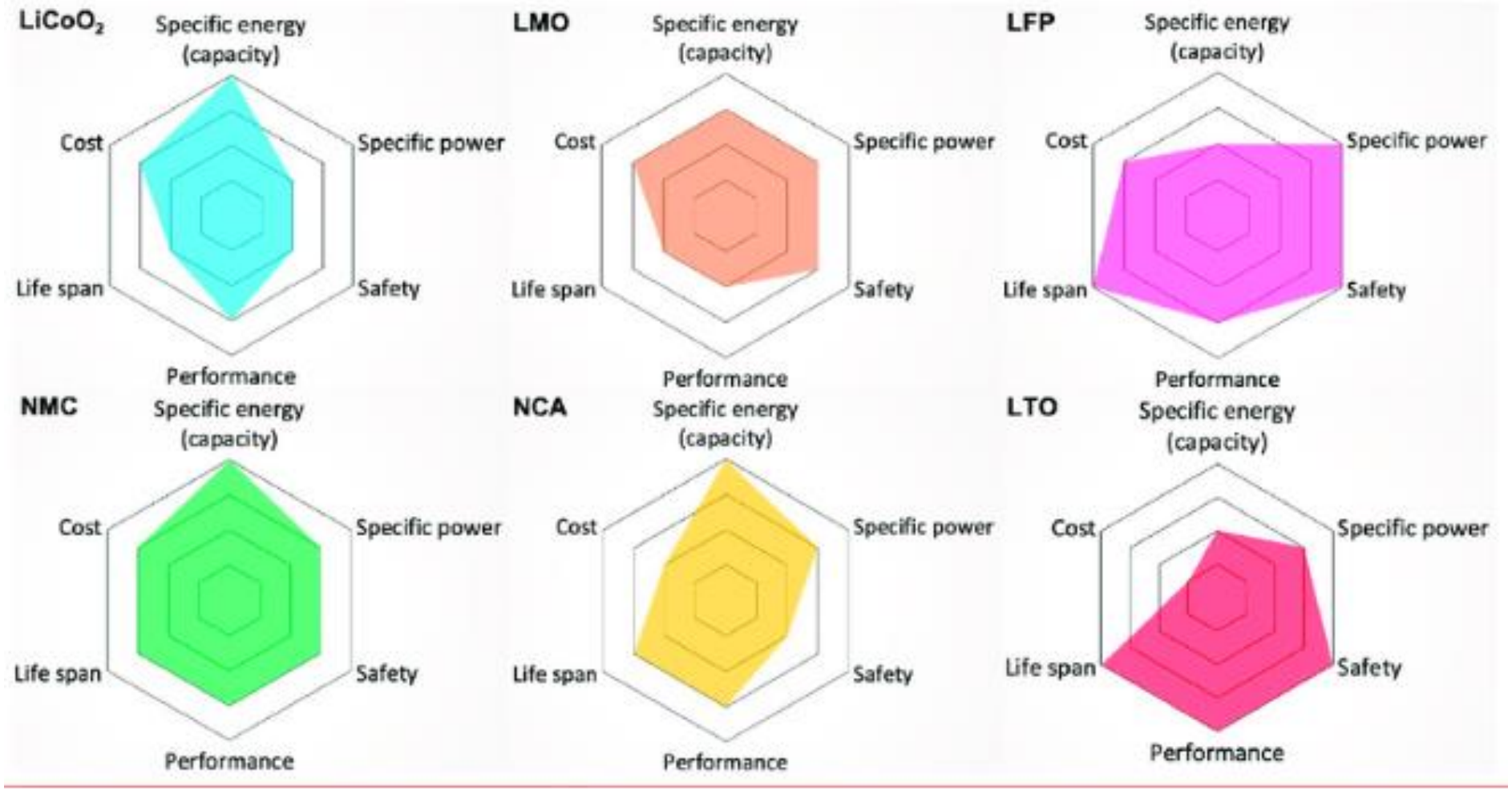
ANODE

- **Lithium Titanate (LTO) (Minority)**
  - Prioritises safety with rapid charging capabilities and an extended lifespan.
- **Graphite (Majority)**
  - Metallic Li deposition on the anode is a possibility
  - Can happen during fast charging

- Lithium-ion batteries can't be transported at 0 V and should not be kept (transported at the discharged state)

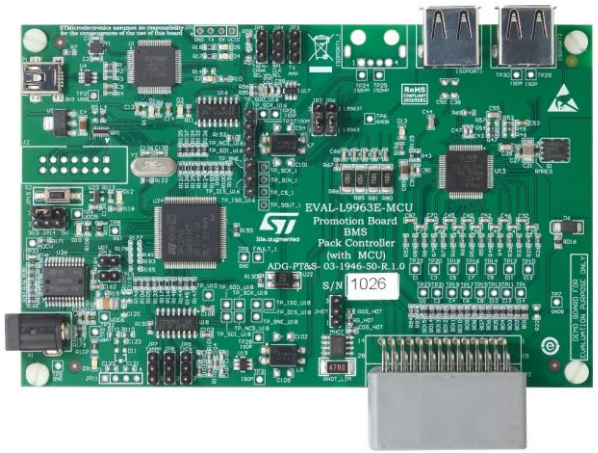


SELECTION OF LITHIUM-ION BATTERIES



BATTERY MANAGEMENT SYSTEM

- **Monitoring**: A BMS monitors the battery's health and operational parameters in real-time, making crucial decisions to ensure smooth operation.
- **Protection**: By preventing overcharging and overdischarging, a BMS plays a vital role in extending the lifespan and safety of lithium-ion batteries.
- **Temperature Management**: It maintains proper temperature levels, crucial for battery efficiency and safety.
- Comprises of a **sophisticated electronic circuit board**, including sensors and a microprocessor, to monitor and control the battery's functions.



National Business Aviation Asso...

The Dangers of Lithium Battery Fires – And What to Do in Flight | NBAA - National...

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The scary business of putting out an EV fire | David Booth | Driving

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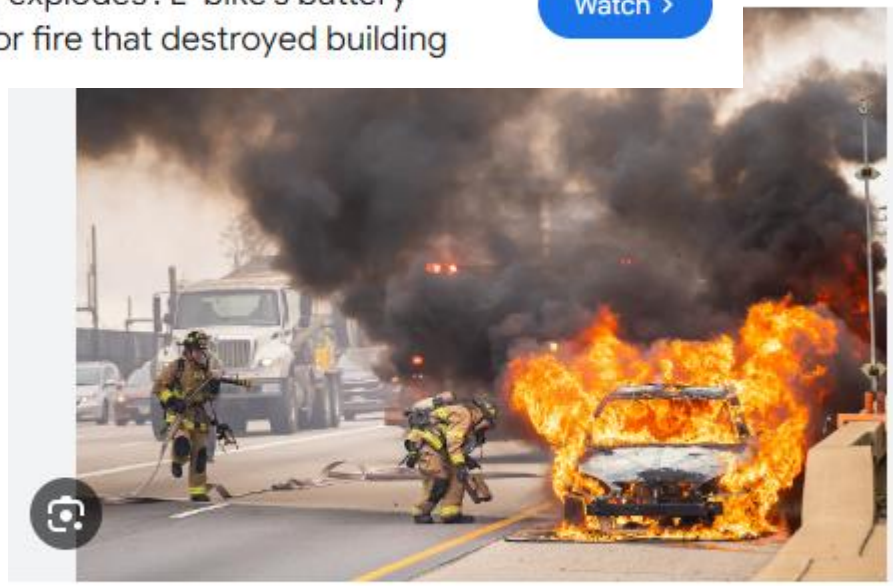
CNN
1:21

'It literally explodes': E-bike's battery blamed for fire that destroyed building

Watch ›



Are EV Battery Fires a Safety Concern for Electric Vehicles? | GI

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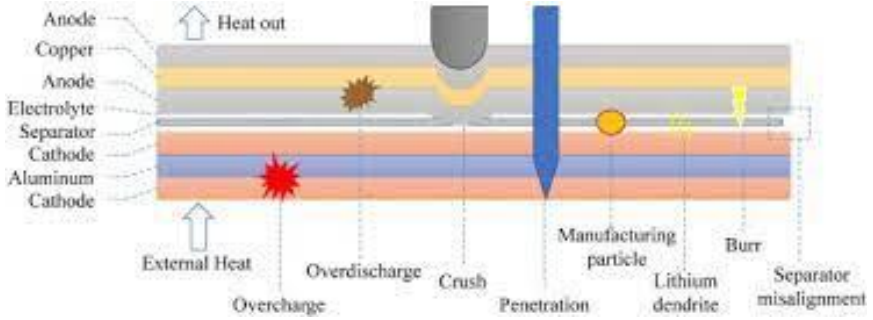
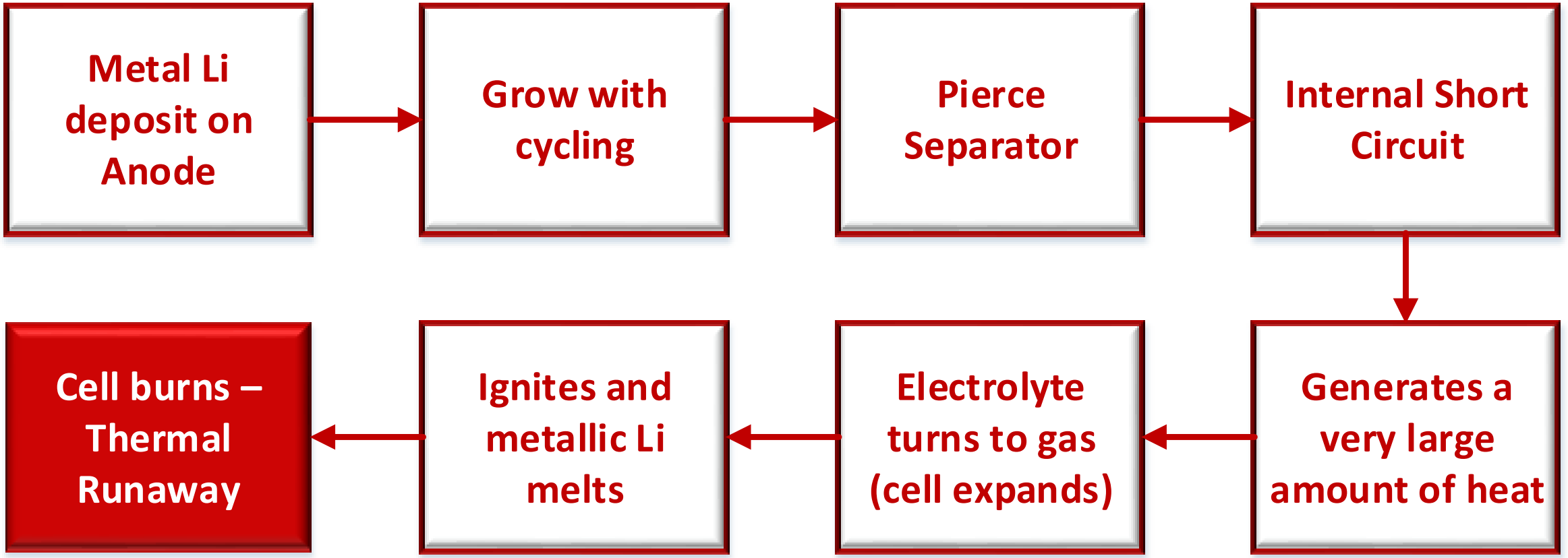
WHY DO THINGS GO WRONG?

- **Overcharging**: Faulty chargers or battery management systems can lead to overcharging, initiating thermal runaway.
- **Thermal Runaway Risk**: Increased heat from overcharging can trigger a thermal runaway event
- **Physical Damage**: Punctures or crushes can create short circuits within the battery, rapidly increasing temperature and possibly triggering thermal runaway
- **External Short Circuits**: Connecting the battery's positive and negative terminals with a metal object or conductive liquid can cause a large current flow, overheating the battery and leading to thermal runaway
- **Internal Short Circuit**: Occurs when two electrode materials inside the cell are internally connected, leading to high localised currents.

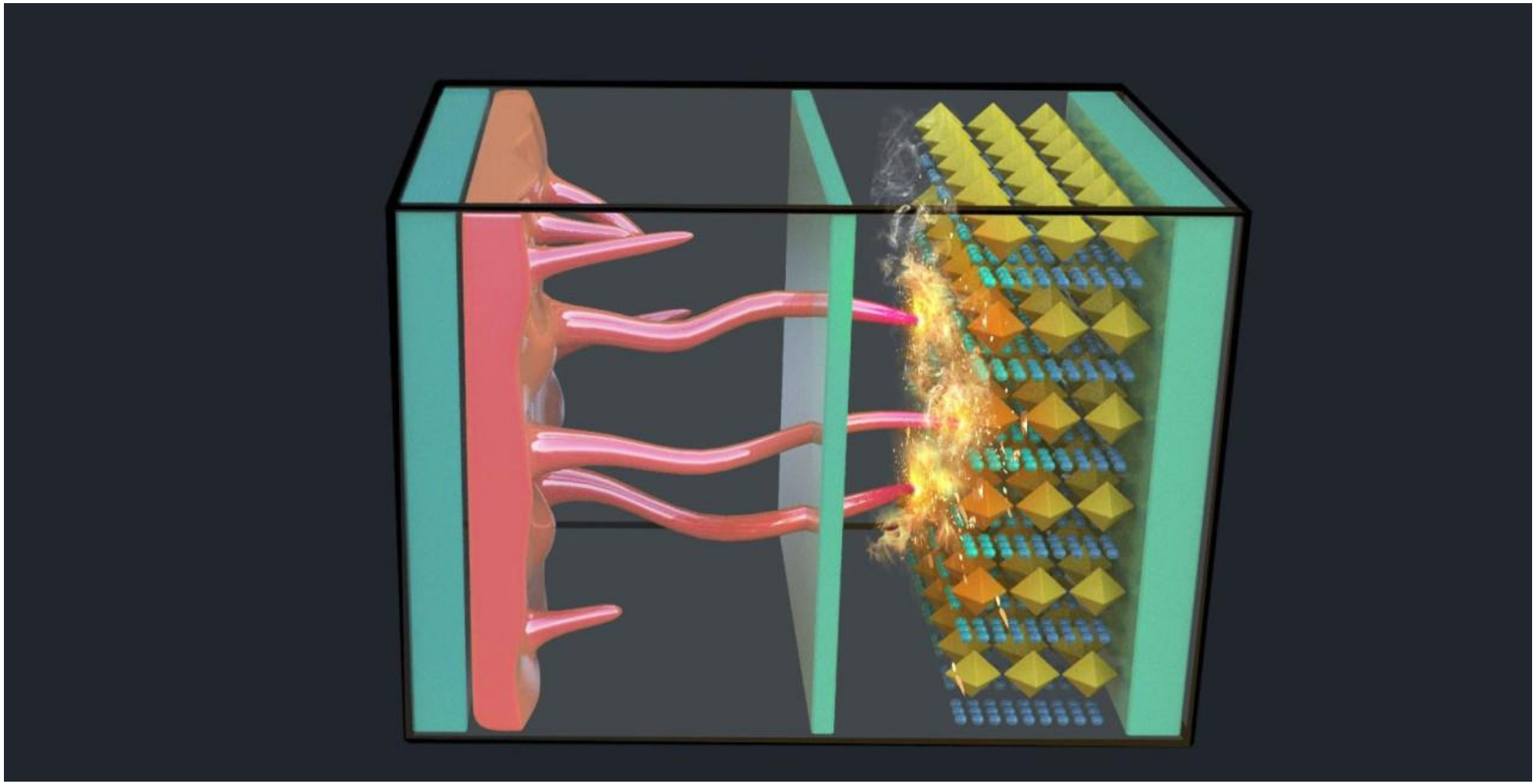


WHY DO THINGS GO WRONG?

INTERNAL SHORT CIRCUIT



DENDRITE GROWTH



PREVENTION

- Purchasing products from reputable manufacturers
- Proper usage, storage, and charging practices can significantly reduce the risk of thermal runaway
- Using the **correct charger** minimises the risk of overcharging
- Inappropriate charging activities have led to overheating
- A well-designed **battery management system** safeguards against overcharging and deep discharging
- Some batteries are equipped with **safety vents**. These release the built-up gases when internal pressure increases, reducing the risk of a potential explosion
  - › released gases can be harmful to the environment and your health, especially indoors.




INFRASTRUCTURE

- Battery chargers, rapid chargers, and battery exchange stations
- EV charging infrastructure to support growing demand
- Grid constraints
- Infrastructure in the first world:
  - In the EU there are more than 330,000 public charging points, but 69% are concentrated in the Netherlands, Germany, and France, and only about 10% are fast charging stations
  - In the UK, there are more than 32,000 public charging points with 1,800 ultra-rapid chargers, distributed relatively evenly across the country except for a high concentration in London
  - In the US, there are more than 47,000 charging locations in the US, with about 6,000 ultra-fast charging stations. Current charger installations tend to be clustered in higher income and population-dense areas

ADR

- Agreement concerning the International Carriage of Dangerous Goods by Road
- Part of the United Nations Economic Commission for Europe (UNECE)
  - Takes information from GHS and UN model regulations
- Was only for EU countries
- Has since become an internationally applicable
- Department of Transport in South Africa is considering adoption

UNITED NATIONS - EWG

CONCERNS

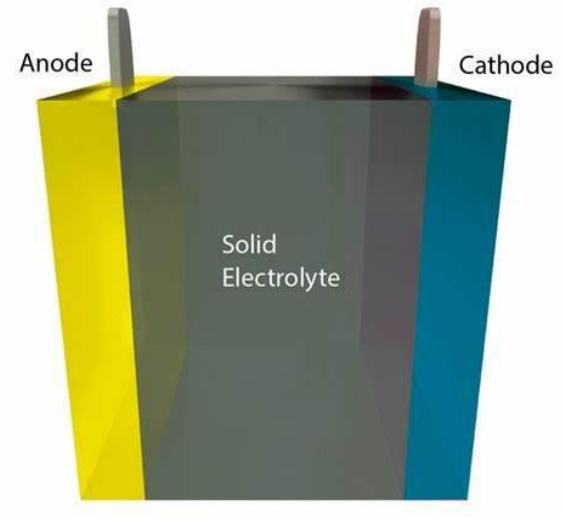
- Informal discussions:
  - Electric vehicles
  - Hydrogen peroxide
- One of the members is part of working party at the ADR
- Special focus on the use of EV's to transport dangerous goods
- Currently, according to the ADR, the carriage of the following may not be transported using EV's:
  - Explosives
  - Flammable substances
  - Self-reactive substances
  - Oxidisers
  - Organic peroxides

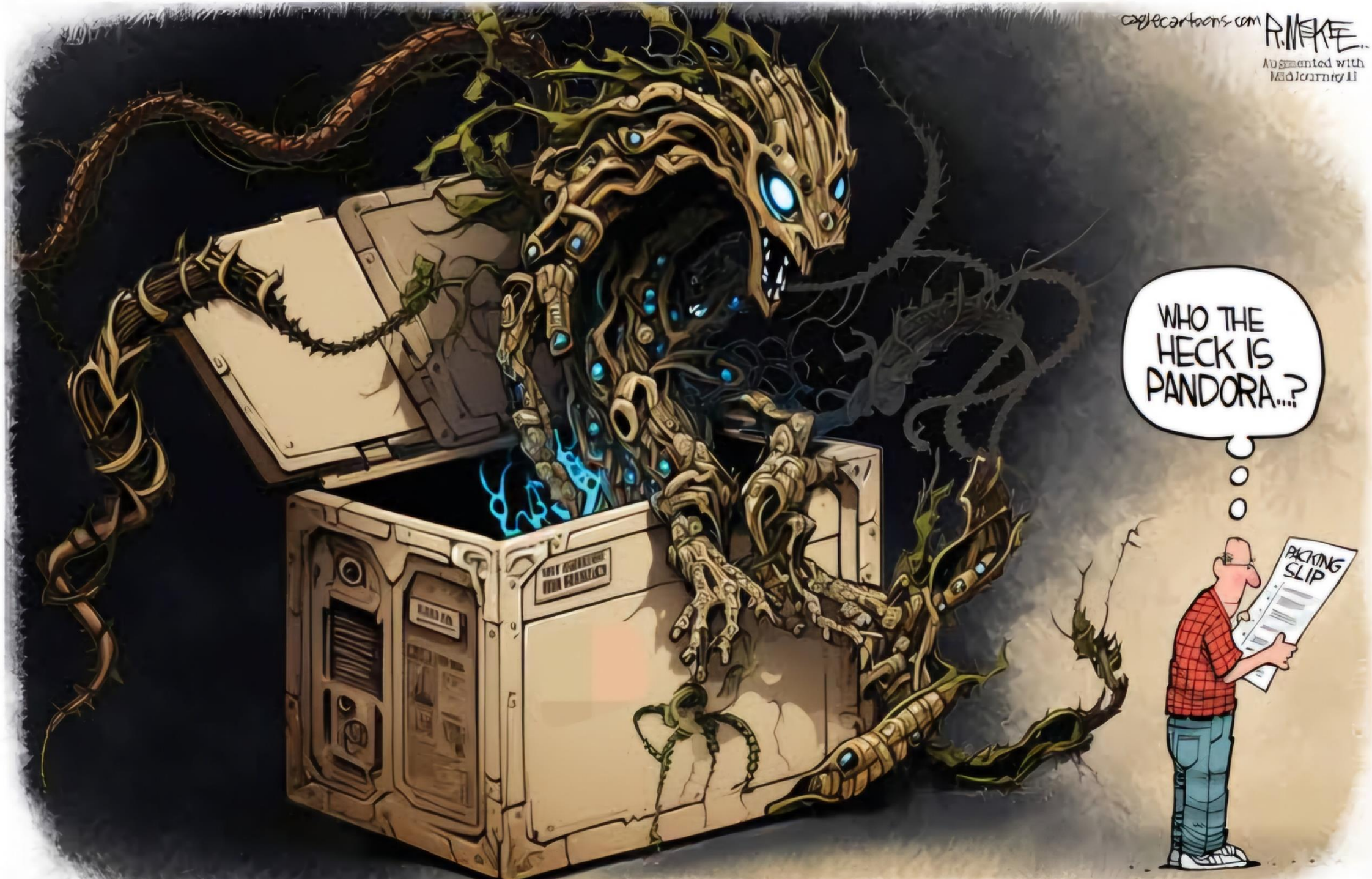
EWG CONCERNS

Diesel Vehicles	Electric Vehicles
Current UN Test Regime is for hydrocarbon fires	Test regime would need to be developed
Approximately 1000 – 2000L of fuel on board (typically burn for 30 minutes)	Can burn for 8+ hours, depending on size of battery arrangement
Typical tanker fire involving AN or ANE's are tyre fires and do not involve the diesel on board	How would a tyre fire affect batteries?
CO, CO_2, NO_x	CO, CO_2, NO_x, SO_2, HCN, HF, PF_5, POF_3
Fire can be extinguished using appropriate media (CO_2/Foam)	Currently no method to extinguish a Lithium ion battery fire
Typical fire 800^{o}C	Typical fire 500^{o}C

THE FUTURE

- Sodium-ion batteries
  - Similar principle to lithium-ion batteries
  - Less likely to have metallic deposition
  - Can be transported at the discharged or 0 V state and still
  - Cannot tell these apart from lithium ion
  - Increased cycling capability
- Solid state batteries
  - These are still lithium-ion batteries*
  - **Inherently safe**
  - Can be super energy dense if the right chemistry used

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