Lithium Ion - risks but few decent solutions. Is this the current response plan ?

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How did we get here?

- Blame the Brits - patent filed in 1976
- Then the Americans and Japanese took it forward using lithium cobalt oxide but these were notably unstable and prone to ignition
- Eventually Sony began producing the first rechargeable lithium ion battery. A year later Toshiba followed. These used a soft carbon anode.
- In 1990s the anode material changed to hard carbon and graphite
- By 2010 global Li-ion production capacity was 20 gigawatt hours (GWh). In 2016 it was 28 GWh. In 2020 767 GWh. In [illegible]bly 850GWh.

Why?

- High energy density, low self discharge, no memory effect, relatively low cost, high and predictable performance.
- Store a lot of energy in a relatively small container.
- Fast recharging – 8 times faster than lead acid.
- Can be recharged to 100% of its capacity compared to 80% for lead acid.
- Weigh 5 times less than lead acid
- Releases gas when it is charged
- Last 3-4 times as long

Consumer friendly

- Battery management built in
- Reliable and long lasting
- Quickly recharged
- No immediate user risk
- Versatile
- Easy to accommodate to suit most power requirements
- Key is high output power for the weight of the battery pack

Everywhere but should they be?

- User perspective
- Less space, significantly more output per kg, no gassing, easy to recharge, durable.
- Continuing to improve efficiency
- BUT

Have we dashed to new tech too quickly?

Graeme Warnell Slides

The Future Appears Electric

In the UK £16.7bn of investment is required to support a mass EV market

The UK will need 507 new public charge points installed every week until 2035

Across the EU this demand is 7000 new charge points per week

VW ramps up investments in electric car transition with €180bn injection

Shell snaps up EV charging operator Volta for $169 million

bp invests £1 billion in UK EV charging infrastructure

UK businesses planning to invest £13.6bn in electric vehicles this year, survey finds

Ford to boost EV parts investment for UK plant by $180 mln

UK Automotive invests £10.8 billion in first 'electric decade'

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The Future Appears Electric

The public can charge on the go almost everywhere unsupervised – it has become a “way of life”

As the EV market share starts to grow rapidly what risks do we need to consider for the electric future?

EV’s do not bring **MORE RISK** but they definitely bring **NEW RISKS**

Today these NEW RISKS are being overlooked

The Transition - Today

With EV charging most of the supporting infrastructure & equipment is relatively new.

Many charging locations have yet to meet the test of time.

The second hand battery market is starting to develop but most EV's are running on their original batteries

Most charging cables are provided by vehicle manufactures or charge pole providers

The Transition – The Future

EV charging poles & battery storage systems are now installed in areas previously outside the recognised “refuelling & storage zones” that we associated with hydrocarbons

- Multistorey car parks
- Mother & child parking bays
- Residential basements
- Car showrooms

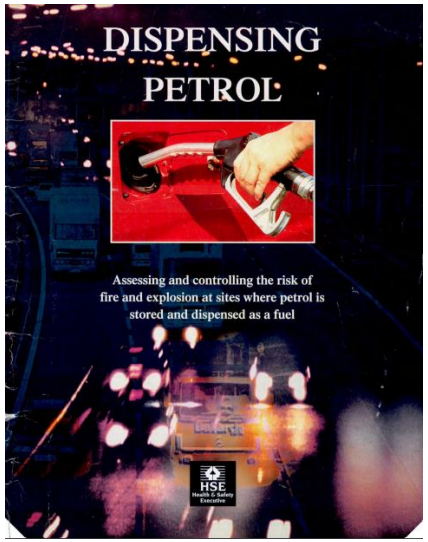
Regulatory Transition

We will retain a hydrocarbon vs electric vehicle fuels mix for at least 20 years

A hydrocarbon dominated market has driven legislation & best practise guidance for over 100 years

We do not have 100 years experience in dealing with EV's.

In our race to decarbonise safety & environmental considerations are now lagging behind



ICE – EV Risk Comparison

Risk Comparisons ICE - EV

Hydrocarbon Vehicle Risks

- Explosive vapours
- Highly flammable
- Release of volatile organic compounds
- Asphyxiant
- Pollution of water & soil

Electric Vehicle Risks

- Explosive gasses
- Highly flammable
- Release of volatile organic compounds
- Toxic gasses
- Pollution of water & soil
- Risk of electrocution

Risk Mitigations ICE - EV

Hydrocarbon Risk Mitigation

- Vapour detection
- Wet stock management
- Spill management
- Firefighting equipment
- Oil water separators
- Experience & knowledge
- Best practise & legislation

Electric Vehicle Risks Mitigation

- Battery isolation
- Automatic battery shut off
- Manual emergency stop
- **Electrolyte gas detection**
- **Fire suppression**
- **Fire water containment**
- **Best practise & legislation**

The Future

EV infrastructure will not remain new forever

We know the demand for faster charging puts more strain on the battery

Battery and cable theft is on the increase - an unregulated second hand battery & cable market is inevitable

Accidents and poor road conditions can contribute to long term battery damage = thermal runaway.

Thermal Runaway

What is thermal runaway ?

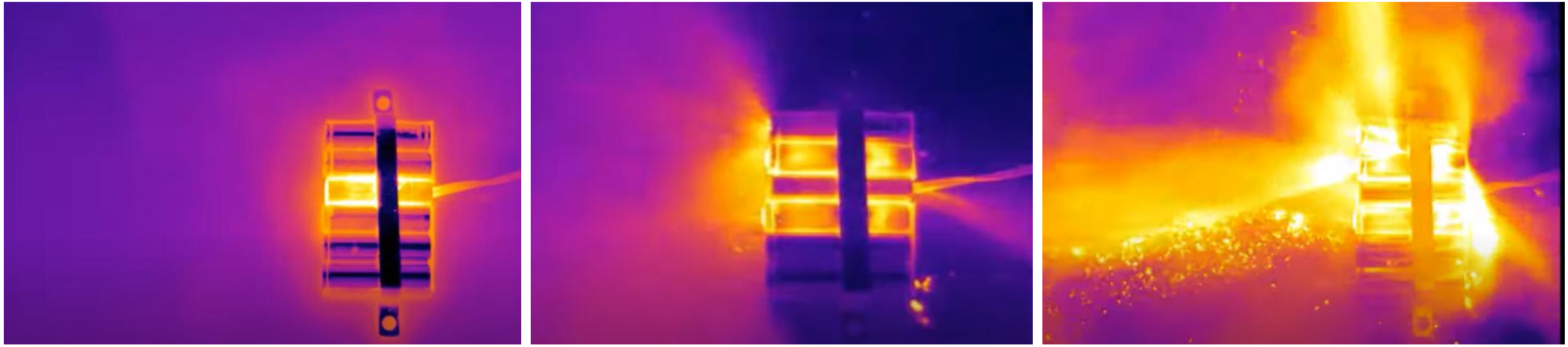
Lithium-ion batteries rapidly convert chemical energy to electrical energy

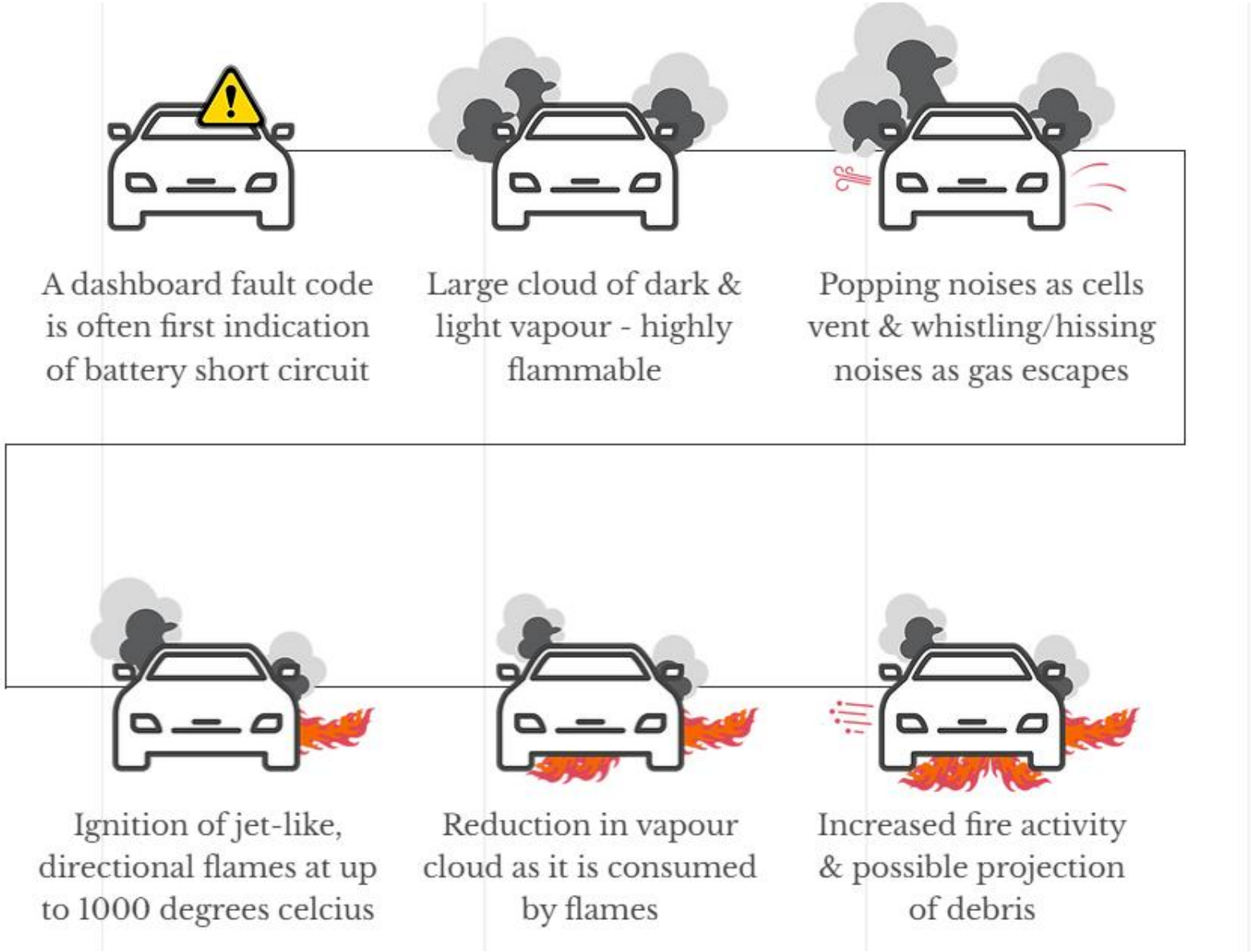
Thermal runaway occurs when the battery cannot dissipate heat faster than it produces it

It can start with a single cell that is either faulty, damaged or overcharged

From one cell it spreads to the next rapidly

What is thermal runaway ?





Thermal runaway always has tell tale signs that can be often seen or heard

When is our preferred charging time ?

If you are charging overnight who will see or hear these warning signs ?

Electric Vehicle Fires


TESLA
TESLA


WU21 BJF

Electric vehicle fires

An EV fire can reach temperatures of up to 2000C, even higher in enclosed spaces

Releases highly explosive electrolyte gasses, toxic fumes & large amounts of soot

It can jet flames outwards 2-3m and can spontaneously reignite

Electric vehicle fires

Bigger vehicles = bigger challenges

Large vehicles such as busses & trucks will have multiple batteries

In HGV's there can be up to 5 batteries

In single decker busses they can be mounted on the roof and in the floor

Electric vehicle fires

Only cooling that battery stops thermal runaway

Thousands of litres of water are needed to cool the battery

If the flames are suppressed without cooling the battery it remains in thermal runaway

The battery pack will revert to emitting both explosive and toxic gasses

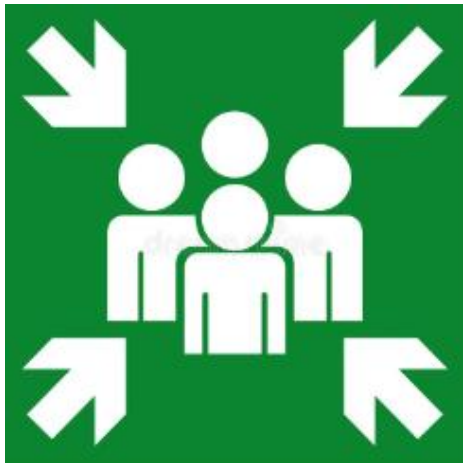
What can we do ?

What can we do ?

Call the emergency services immediately.

- Protect yourself
- Protect your staff
- Protect the public
- Protect the environment

Ensure you have a clear emergency procedure and any muster points you have reflect the added risks EV fires bring.



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Protecting People

The number one cause of injury related to fires is smoke inhalation.

A smoke inhalation claim from exposure to toxic fumes causing minor damage to your airways **with no real long-term effect on your ability to breath** will lead to average compensation pay-out amounts of: £4,700 – £11,000.

For longer term damage £11,000 - £48,000

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A warning to the public

Never attempt to tackle an EV fire on your own

You will not have the appropriate equipment

You will not have the correct training

You will not have time

You can die

Beware the e-bike, e-scooter & mobility scooter

Home conversions e-bikes may contain much bigger batteries than expected

They can explode violently and emit enough fumes to render a person unconscious or worse

They are all typically charged at night and indoors

New York 2023 - 6 fatalities in 3 months

Current methods - but not solutions

Current methods but not solutions

Breathing apparatus must be worn

It cannot be deployed accurately in a smoke filled space

It will not stop thermal runaway and It may trap explosive gasses

A used the blanket is covered in toxic debris - is it really reusable ?

Fire blankets

"The blanket does not stand up well to sharp objects or overly rough handling. The installation of the blanket must therefore be done carefully, without hard, jerky movements, so as not to damage the fabric or the loops".

Current methods but not solutions

EV manufacturers DO NOT recommend vehicle submersion

The battery cannot always be isolated

The forklift and container are normally metal

The chances of having this facility on site or nearby are limited

Vehicle Submersion

Current methods but not solutions

The average EV fire requires +10,000 litres of water to suppress it

You would need a lot of fire extinguishers to recreate this

They would all need to be discharged simultaneously

Extinguishers are better suited for Lithium-ion battery power tools, phones, laptops, vapes

Extinguishers


Staff tried to fight the blaze
with extinguishers but
the fire was too strong

Current methods but not solutions

The emergency services may elect for a controlled burn option

For open air bus charging depots this can be a good option

Be sure that the burn area is suitable, a concrete hardstanding being better than asphalt and free from other combustible materials

Controlled Burn

Current methods but not solutions

Industry solutions need to work hand in hand with the fire services

Encapsulation agents promote rapid cooling and use less water this is a step in the right direction

They may be key in helping fill the gap left by old PFOS/ PFAS active firefighting foams

They are ideal for multi class fires – hybrid vehicles

Encapsulation Agents

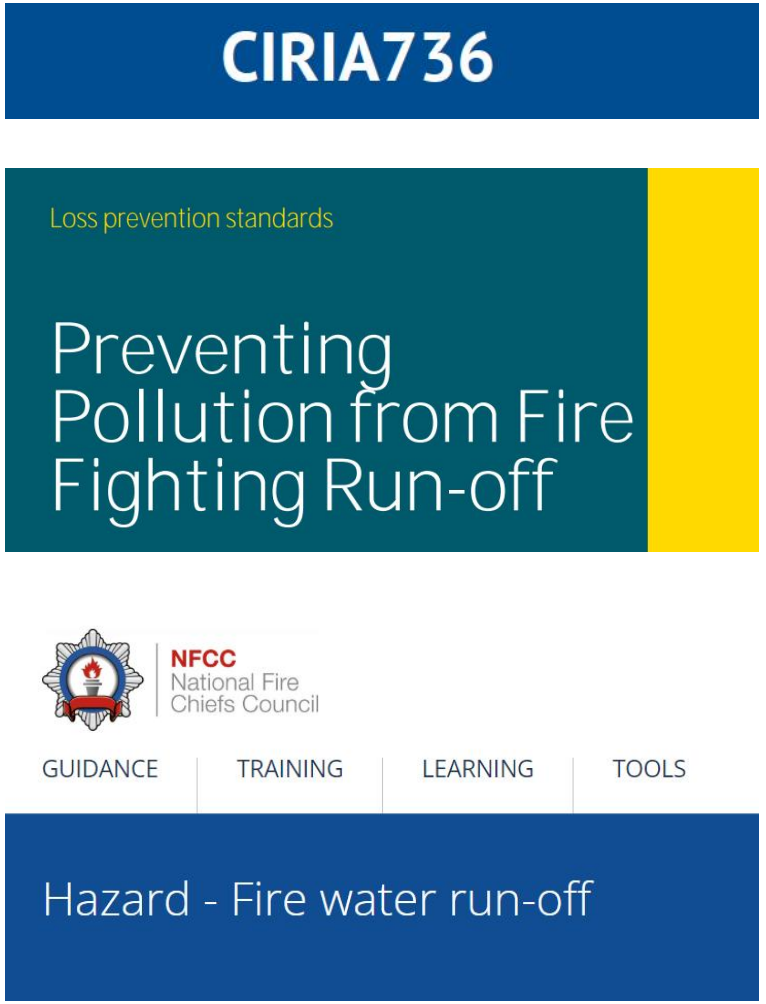
Fire water pollution prevention

Fire Water Pollution

It is **not the responsibility** of the emergency services to protect the environment from fire water pollution

Statutory regulations and best practise guidance regarding fire water pollution prevention is well documented

There is no legal defence for fire water pollution



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Fire Water Pollution

In a battery fire simulation the chemical contamination of the extinguishing water exceeded the threshold values for industrial wastewater by a factor of x70 – 100

“Under no circumstances should this water enter the sewage system or natural environment”

In the event of an EV fire where does contaminated fire water typically go ?

Fire Water Pollution

Pollution prevention valves can be installed on most facilities

With minor modifications firewater can be retained above or below ground

These systems can be manually operated or automatically activated

However they are not mandated

After the fire

After an EV fire

The EV will need safely disposing of or removing from site & made safe

To avoid reignition ensure a proper recovery vehicle is used

For damaged EV's on flatbed recovery vehicles be very careful when strapping them to avoid electrocution

After an EV fire

In basement, multi storey car parks and enclosed space fires it is important to remember everything will be contaminated

Cleaning operations will generate contaminated water, dust and waste

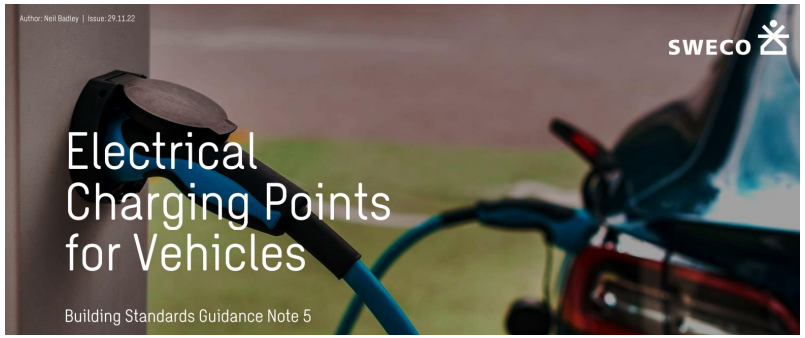
The Future

The future

Better awareness, education, training, guidance and legislation are needed at the design stage for EV charging locations and battery storage systems

There is some guidance available but it is a long way from being best practice

Today we are installing EV charging as if it were risk free



RSA

Risk Control Guide

ELECTRIC VEHICLE CHARGING AND ENCLOSED CAR PARKS

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The future

Electric vehicles do not bring **MORE** risks but they do bring **NEW** risks.

However, the way these risks manifest themselves are not new.

- Fire & Explosion
- Public Safety
- Pollution

We designed out these risks and developed legislation & best practise guidance for hydrocarbons - why are we not doing this for electric vehicles ?