Responding to Tomorrow's Fires

Firefighting Tactics for Alternative Energy in Residential Settings

The Scottish Fire and Rescue Service is undergoing significant operational, technological and organisational development to address the rapidly growing risks associated with alternative fuels, including electric vehicles (EVs), lithium-ion batteries, hydrogen systems

Operational Safety Priority

How the Scottish Fire and Rescue Service is evolving to safely resolve and mitigate the impact of emergencies involving alternative fuels.

Case Study: EV Charging

EV charging related fire in underground car parking structures.

Strengthening Collaboration

Working with the Scottish Fire and Rescue Service and partners to foster stronger partnerships.

Emerging Challenges of Alternative Fuels

- Lithium-ion / Battery Storage (BESS)
- EV Charging
- Hydrogen Systems
- Solar Panels

Lithium-ion Within the Home

In 2024, the Scottish Fire and Rescue Service responded to **26 fires** involving rechargeable batteries, up from just 3 in 2018. That's an **867%** increase in six years. As more Scottish families invest in electric vehicles, solar panels and battery storage systems to meet net-zero targets, incidents of these type will continue to rise.

Lithium-ion fires inside a domestic property create a very different and significantly higher risk environment for firefighters than most "normal" room fires

- E-bike and e-scooters stored at home
- Residential battery storage systems (BESS) for solar
- EV charging points in driveways and garages
- Batteries in portable devices (power tools, mobility aids)

What is Thermal Runway

Lithium battery thermal runaway is an uncontrollable, self-heating state where a cell's temperature rises rapidly (often exceeding 1,000°C)

Triggered by damage, overcharging, or high heat, it causes electrolyte decomposition, producing toxic/flammable gases. This creates a chain reaction releasing intense energy, making it difficult to extinguish.

1

A single cell overheads beyond its safe operating temperature

2

Internal chemical reactions accelerate uncontrollably

3

Temperature rises to >1,000°c in seconds

4

The chain reaction spreads to adjacent battery cells.

Critical Hazards to Firefighters

Thermal Runaway:

Once initiated, chain reaction causes rapid heat generation. Fire growth measured in seconds, not minutes. Flashover risk before safe entry/withdrawal

Extreme Heat and Flame Jets:

Venting cells produce directional flame jets with temperatures reaching several thousand degrees. Compromises PPE, SCBA and neighbouring fuel loads very rapidly

Toxic and Flammable gases:

Large volumes of CO, HF and other decomposition products released before or without visible flame. Inhalation hazards and potential for explosion.

Critical Hazards to Firefighters (cont.)

Re-ignition and Stranded Energy:

Cells remain energised long after apparent knockdown. Documented re-ignitions during overhaul and transport, sometimes hours or days later.

Electrical Hazards:

Damaged systems (BESS, inverters, EV charge points) can leave live DC and AC conductors. Shock risk during firefighting and salvage operations.

Extended Water Demand:

Prolonged cooling operations (hours to days) required to prevent re-ignition. Increases crew duration of exposure and environmental risks.


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Developer Considerations:

"Fire safety decisions start at the design phase, not the installation phase"

Integrated Design

Design and location matters most when ensuring fire safety

Detection and Suppresion

Modern alternative fuel systems require active fire protection systems, not passive reliance.

EV Charging

Install charging points at least 10m from combustible walls or 7.5 m from unprotected glazing

Battery Storage (BESS)

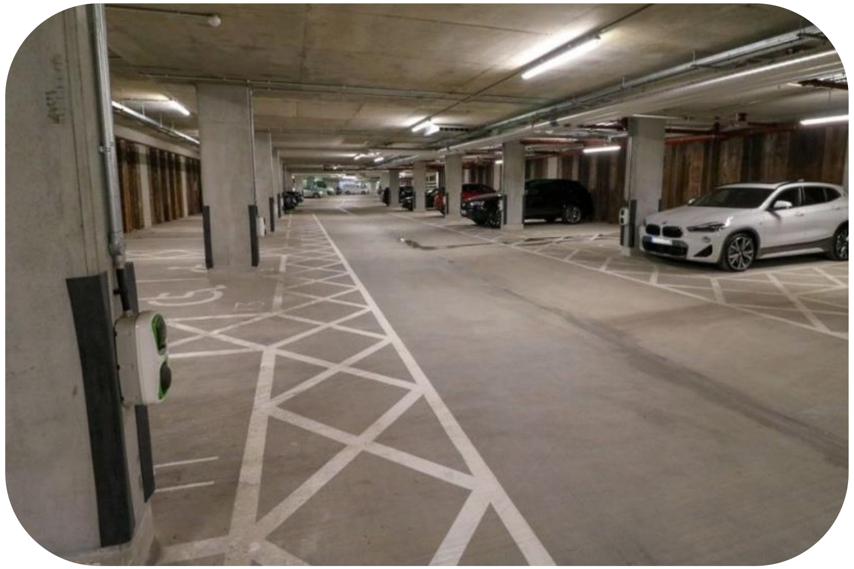
Locate systems outside living areas where possible; if internal, isolate from main areas and escape routes

Hydrogen Systems

Require dedicated, well-ventilated spaces and dedicated detection.

Case Study: EV Charging

Scenario



Location:

Underground car park serving a residential premises of six floors

Setting:

Multiple EVs parked and charging at dedicated ChargePoint's on a covered level with conventional vehicles parked nearby

Case Study: EV Charging

Initial Incident

How incident developed:

Ev connected to a ChargePoint experienced a battery fault during charging, leading to thermal runaway in traction battery

The initial fault produced localised overheating and off gassing, which then developed into a sustained battery fire.

Case Study: EV Charging

Incident Development

Incident development:

As this occurred in a covered car park, hot smoke and toxic gases accumulate under the slab, threatening escape routes and smoke clearance for residents.

Radiant heat proses a risk of fire spread to adjacent vehicles and building elements, especially with vehicles parked in close proximity.

Case Study: EV Charging

Fire and Rescue Response

On arrival, FRS crew face:

Limited visibility and high smoke concentration in the affected level.

Difficulty accessing the seat of the fire quickly due to parked vehicles and structural layout.

Case Study: EV Charging

Lessons Learnt

1. Location and layout of EV ChargePoint's
2. Active fire protection in covered car parks
3. Ventilation and smoke control
4. Electrical design and quality control
5. Risk assessments and liaison with fire service

Strengthening Collaboration

NFCC
National Fire
Chiefs Council

Developers are strongly encouraged to consult with the Scottish Fire and Rescue Service at the earliest stages of planning and design. Early engagement ensures fire safety is embedded in proposals and allows teams to address emerging technology risks, such as hydrogen, EV charging and battery storage from the outset.

Aligning with the latest National Fire Chiefs Council (NFCC) guidance demonstrates best practice and ensures resilient, safe development.