Lithium batteries – what's the problem?

With few restrictions in the Building Code limiting the use of lithium-ion batteries for energy storage systems or charging electric vehicles, the question is are they safe? BRANZ looked at incidents reported over 10 years to find out.

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LITHIUM-ION BATTERIES (LIBs), ubiquitous in consumer products since they were first commercialised in the early 1990s, are used in items such as cellphones, laptops, power tools and much more.

Several fire incidents

Their light weight and high power density have seen them adopted in applications that were previously not practical, such as solar energy storage systems (ESSs) and electric vehicles (EVs).

Because of international reports of LIBs catching fire and exploding and an increase in LIB-related fires in New Zealand, the Fire Research and Investigation Unit at Fire and Emergency New Zealand (FENZ) questioned the fire hazard they posed.

It contracted BRANZ to undertake a literature review, which identified the possible fire risks associated with the proliferation of LIBs in New Zealand. The review covered a broad range of issues, and this article highlights those most relevant to the building industry.

Reported incidents analysed

BRANZ research analysed LIB-related incidents reported to Energy Safety New Zealand (ESNZ), the electrical and gas regulator within WorkSafe New Zealand, between January 2009 and April 2019. This data was analysed to look at the general trend (Figure 1) but also identified several recurring themes.

A key finding was that many of the LIBs were on charge at the time of the incident.

Power tools feature

LIB-powered power tools feature as a reasonably large group in the ESNZ dataset, with 28 incidents reported. The seven incidents involving head torches were grouped together with cordless power tools, which are high-drain devices.

The LIBs heat up as they are discharged during use before being put straight on fast charge. This heats the LIB further, which can cause it to overheat.

Anecdotally, it is known that power tool batteries can be left on charge for extended periods. For example, they might be put on charge at the end of a workday and left overnight.

Five incidents have been recorded where either the battery overheated during or shortly after charging. Three incidents involving the same brand of power tools were recorded in the year to April 2019.

Energy storage systems

ESSs such as Tesla's Powerwall are being installed in many commercial and residential properties together with photovoltaic cells in response to demands for renewable energy, reduced power bills and less dependence on grid power.

There have been several incidents around the world involving ESSs. One of the most notable was in April 2019 at the Arizona Public Services McMicken facility in Sunrise, where eight first responders were injured when a heavy steel entry door was blown off its hinges by an explosion inside the building.

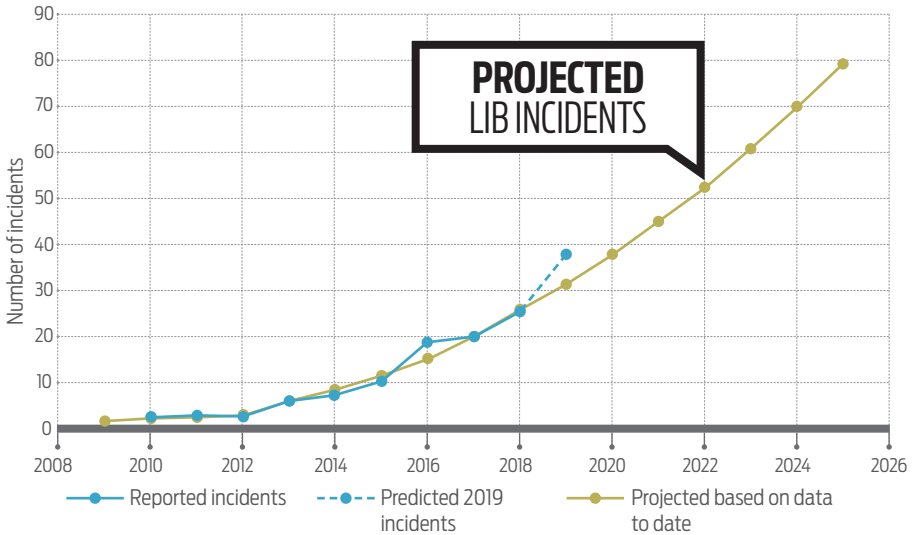

Figure 1: LIB-related incidents in New Zealand.

EV charging

Most high-profile incidents involving electric vehicles have involved a collision before the car caught fire. However, these are not considered a significant risk for buildings.

Other situations where EV fires occurred included while the vehicle was:

- in use
- on charge
- parked and not in use or on charge.

In January 2016, a vehicle in Norway caught fire while being charged, although the fire is thought to have originated at a short-circuit in a junction box, not the vehicle battery.

In August 2016, a vehicle spontaneously caught fire during a test drive in Biarritz in France. The driver and passengers were able to safely exit the vehicle after a dashboard warning.

More recently, in April 2019, a vehicle in a parking garage in Shanghai caught fire for no apparent reason, with the fire spreading to five other vehicles before it was extinguished.

Few Building Code requirements

There are currently very limited provisions in the New Zealand Building Code to restrict ESS or EV-charging installations.

Building Code clause C2 *Prevention of fire occurring* aims to ensure appliances that are hot in normal use do not cause ignition of surrounding materials by restricting the maximum surface temperature. This is not intended to cover fault conditions.

Under normal (non-fault) conditions, LIBs pose arguably lower risk than heating appliances.

Building Code clause G9 *Electricity* has a clear objective in G9.1(a) to ensure that 'the electrical installation has safeguards against outbreak of fire and personal injury'. The performance requirement G9.3.1(e) requires that 'the electrical installation shall incorporate a system to: ... Protect building elements from risk of ignition, impairment of their physical or mechanical properties, or function, due to temperature increases resulting from heat transfer or electric arc'.

Discussions with building consent officers indicate that there would be no building consent requirements for the installation of an ESS or EV-charging station. The only requirement is from an electrical safety perspective. The installation must be installed by a qualified electrician in accordance with AS/NZS 3000:2018 *Electrical installations (known as the Australian/New Zealand Wiring Rules)*.

Possibility of toxic byproducts

The study also identified the possibility for relatively high levels of hydrofluoric acid and phosphoric acid being produced as byproducts of the combustion of LIBs.

It was recommended that further work be undertaken to assess the risk of exposure to firefighters, investigators, insurance assessors, tradespeople and the building occupiers.

BRANZ looking closer at risk to buildings

The study described in this article was funded by the FENZ Tactical Research Fund. Current BRANZ research is further investigating the building fire risks associated with LIBs.

For more The full FENZ research report *Lithium batteries – what's the problem?* can be found at www.fireandemergency.nz.

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