Seven things you need to know about lithium-ion battery safety

March 20 2023, by Neil Martin

Credit: AI-generated image (disclaimer)

Lithium-ion batteries are the most widespread portable energy storage solution—but there are growing concerns regarding their safety.

Data collated from state fire departments indicate that more than 450 fires across Australia have been linked to lithium-ion batteries in the past

18 months—and the Australian Competition and Consumer Commission (ACCC) recently put out an issues paper calling for input on how to improve battery safety.

Lithium-ion batteries are used in a wide range of hardware, from electric vehicles and electric scooters to mobile phones and laptops. Residential solar battery systems also utilize the technology, all the way up to grid-scale energy storage systems.

Unfortunately, as even Fire and Rescue NSW acknowledge, not enough is yet known about the probability of lithium-ion battery failure, their mechanisms of failure and potential consequences of failure.

We spoke to UNSW expert, Dr. Matthew Priestley from the Energy Systems Research Group in the School of Electrical Engineering and Telecommunications, to discover what the safety concerns are regarding lithium-ion batteries.

"What we are worried about at the moment is the fact there is very little regulation regarding lithium-ion batteries and the safety aspect associated with that," Dr. Priestley says.

"We want and need this energy storage technology to be safe because they are vital in the uptake of renewable energy and it's important that the public and industry do not perceive it to be dangerous.

"But at the moment, most people do not have an adequate understanding about the risks associated with these batteries, or enough respect for them. That goes for the consumer in their home, but perhaps even more importantly for professionals using lithium-ion batteries on a bigger scale in their workplace.

"I don't think there is enough education regarding proper use, and

storage, and recycling or disposal of lithium-ion batteries and that is the key moving forward."

Dr. Priestley is the lead academic on a project which will develop a short course aiming to educate tradespeople, the public, and other key stakeholders of the risks associated with high energy battery systems.

And here he helps explain the key issues, and potential solutions, regarding lithium-ion battery safety.

What devices are being powered by lithium-ion batteries?

Lithium-ion batteries are extremely common in virtually all Australian homes. Mobile phones, laptops and smart wearables are all powered with lithium-ion batteries, as are newer e-mobility products such as e-bikes and e-scooters.

Power tools can also run on lithium-ion batteries, and they are commonplace in various trade industries, as well as camping and gardening equipment.

Electric vehicles, such as Teslas, use lithium-ion batteries—as does that same company's Powerwall system which stores energy collected from roof-top solar panels or the grid.

On a much bigger scale, the largest lithium-ion battery in Australia was activated in 2021 at the Moorabool Terminal Station just outside Geelong. Known as the Victorian Big Battery, the 300-megawatt battery can store enough energy to power more than a million homes for 30 minutes.

What are the problems with lithium-ion batteries?

All types of batteries can be hazardous and can pose a safety risk. The difference with lithium-ion batteries available on the market today is that they typically contain a liquid electrolyte solution with lithium salts dissolved into a solvent, like ethylene carbonate, to create lithium ions.

It is the presence of these lithium ions that yield superior battery performance, allowing the battery to store a large amount of energy in a relatively small area, which is why these batteries are so useful and common.

However, the liquid electrolyte containing these lithium ions is highly volatile and flammable, which creates a serious risk of fire or explosion, particularly when exposed to high temperature.

In addition to this, the way a lithium-ion battery produces power also generates heat as a by-product.

In an uncontrolled failure of the battery, all that energy and heat increases the hazard risks in terms of fuelling a potential fire. The heat from lithium-ion battery failures can reach up to 400 degrees Celsius in just a matter of seconds, with peak fire temperatures being higher than this.

Unfortunately, lithium-ion battery fires are also not easily contained and are self-sustaining which is why they are considered more volatile than other battery types.

What causes lithium-ion batteries to fail?

Overheating is one of the main causes of lithium-ion battery failures,

although physical damage to the battery can also lead to problems.

Excessive heat—for example from using a faulty charger and overcharging the battery, or due to a short circuit—can damage the battery cell internally and cause it to fail.

The major issue with lithium-ion batteries overheating is a phenomenon known as thermal runaway.

In this process, the excessive heat promotes the chemical reaction that makes the battery work, thus creating even more heat and ever more chemical reactions in a disastrous spiral.

Physical damage to lithium-ion battery cells can allow the electrolyte inside to leak, which is another potential hazard risk.

Why are lithium-ion battery failures so dangerous?

The thermal runaway phenomenon means lithium-ion battery fires are extremely hard to put out.

Water-based fire extinguishers will cool down the battery to help prevent the spread of the fire but will not extinguish the fire on the battery until its energy is dissipated.

Special lithium-ion gel extinguishers do exist but are not yet widely available for all lithium-ion battery applications. And even when a lithium-ion battery fire appears to have been extinguished, it can reignite hours—or sometimes even days—later.

Lithium-ion batteries can also release highly toxic gases when they fail, and excessive heat can also cause them to explode.

How can people mitigate the problems with lithium-ion batteries?

Correct usage and storage of lithium-ion batteries is extremely important.

Batteries should not be exposed to high external temperatures, for example from being left in direct sunlight for long periods of time.

Overcharging is another fundamental issue as this can create excessive heat inside the battery cell.

Therefore, it is important to always use a reputable brand-name charger, rather than a cheap generic version that may be available online.

Good quality chargers, designed specifically for the battery you are using, control the amount of charge going into the cell and will cut off when it is fully charged to ensure the system does not over-heat.

Be very wary if a lithium-ion battery sustains any physical damage, such as being dropped or pierced by an object, as this can lead to leakage and potential problems.

In industrial settings, safe battery storage can be crucial so that in the event of unwanted failure, the resulting fire can be more easily contained and controlled and does not spread—which can quickly cause catastrophic consequences.

It is not advisable to purchase lithium-ion batteries second-hand, or online from unknown and potentially unregulated vendors.

Why don't we just use other forms of batteries?

Other rechargeable battery types do exist and are widely used—such as nickel-cadmium and even lead-acid which date back to the 19th century.

However, lithium-ion batteries are more useful and therefore much more popular as they combine fast charging, long charge holding and high power density, for more battery life in a smaller package.

It is likely that future research will produce a different type of battery with the same properties and fewer hazards than existing lithium-ion technology—such as solid-state electrolyte batteries which are currently very expensive to produce.

What needs to be done to make lithium-ion batteries safer?

Lithium-ion battery packs do feature a battery management system (BMS) which is designed to protect the battery cells and prevent failures from occurring.

The BMS tracks data including temperature, cell voltage, cell current, and cell charge to help ensure that each part of the battery is working correctly and safely. Cooling provisions can also be linked to a BMS to reduce the battery pack temperature if it is getting too hot.

However, it is vital that any battery management system is monitored to make sure it is working correctly, as failure of the BMS can indirectly lead to failure of the lithium-ion batteries themselves. Also, many smaller lithium-ion applications do not possess a BMS as it is not cost-effective to do so.

Additional education and training, especially for tradespeople, can also help to increase knowledge and understanding regarding the dangers of

lithium-ion batteries and help to minimize risks and eliminate danger as much as possible.

Additional research and development will also address some fundamental questions regarding lithium-ion battery safety, although this can be costly and time-consuming.

Provided by University of New South Wales