Lithium-ion Batteries

Issues paper

December 2022

Contents

Glossary

Term	Definition
ACCC	Australian Competition and Consumer Commission
ACL	Australian Consumer Law, Schedule 2 of the *Competition and Consumer Act 2010* (Cth)
BMS	A Battery Management System which is dedicated to regulating and/or controlling a battery's cells, including preventing the battery from charging/overcharging
BRANZ	Burns Registry of Australia and New Zealand
CCA	*Competition and Consumer Act 2010* (Cth)
EESS	The Electrical Equipment Safety System, a regulatory framework aimed at increasing consumer safety in household electrical equipment throughout participating jurisdictions in Australia and New Zealand
ELV	Extra low voltage refers to electrical equipment that operates at a voltage below 50V AC RMS or 120V (ripple-free DC)
ERAC	Electrical Regulatory Authorities Council
e-vehicles	Includes electric and hybrid cars, motorcycles and Vespa-style motor scooters
Health Canada	Government department, Health Canada
Household appliances and power tools	Includes cordless vacuums, drills, mowers, leaf blowers and other appliances and tools, including tools used by tradespeople
Li-ion	Lithium-ion, a particular type of battery chemistry that stores (charges) and releases (discharges) energy by a reduction/oxidation reaction that causes electrons to flow from the cathode (positive electrode – metal oxide) to the anode (negative electrode – carbon graphite) through an external wire circuit which powers devices connected to that circuit[1]
Li-ion batteries	Are generally rechargeable batteries that use Li-ions to store energy and are used in consumer products such as personal devices, personal transportation devices, renewable energy storage systems and e-vehicles. For the purposes of this paper, the term 'Li-ion

1 Nitta et al., '*Li-ion battery materials: present and future*', *Materials Today*, 2015, 18(5):252–264, doi: 10.1016/j.mattod.2014.10.040.

	batteries' may be used interchangeably to refer to the batteries themselves or products containing them
OECD	Organisation for Economic Co-operation and Development
Personal devices	Includes consumer products such as mobile phones, tablets, laptops, wireless headphones, e-cigarettes, digital cameras, smart wearables and other personal devices
Personal transportation devices	Includes consumer products such as e-bikes and e-scooters (including those used by delivery drivers and those that can be rented), hoverboards and other rechargeable personal transportation devices but does not include e-vehicles
QISU	Queensland Injury Surveillance Unit
Renewable energy storage systems	Batteries for home renewable energy systems (not grid scale)
State and territory ACL regulators	Consumer Affairs Victoria Attorney General's Department, Consumer and Business Services South Australia Consumer, Building and Occupational Services, Tasmania New South Wales Fair Trading Northern Territory Consumer Affairs Office of Fair Trading Queensland Department of Mines, Industry Regulation and Safety Western Australia, Consumer Protection Access Canberra
State and territory electrical regulators	Energy Safe Victoria Access Canberra Department of Mines, Industry Regulation and Safety Western Australia, Consumer Protection Northern Territory WorkSafe Department of Energy and Mining, Office of the Technical Regulator, South Australia Electrical Safety Office, Office of Industrial Relations, Queensland Electricity Standards and Safety, Department of Justice, Tasmania New South Wales Fair Trading

US CPSC	United States Consumer Product Safety Commission, an international regulator
VISU	Victorian Injury Surveillance Unit

Executive Summary

Scoping product safety issues and identifying potential hazard prevention strategies relating to lithium-ion (**Li-ion**) batteries (**Li-ion batteries**) is a 2022-23 product safety priority for the Australian Competition and Consumer Commission (**ACCC**).[2] Li-ion batteries, which are generally rechargeable batteries, power many popular consumer products, including:

- 'household appliances and tools' – includes cordless vacuums, drills, mowers, leaf blowers and other appliances and tools, including tools used by tradespeople
- 'personal transportation devices' – includes consumer products such as e-bikes and e-scooters (including those used by delivery drivers and those that can be rented), hoverboards and other rechargeable personal transportation devices but does not include e-vehicles
- 'renewable energy storage systems' – batteries for home renewable energy systems (not grid scale)
- 'e-vehicles' – includes electric and hybrid cars, motorcycles and Vespa-style motor scooters
- 'personal devices' – includes consumer products such as mobile phones, tablets, laptops, wireless headphones, e-cigarettes, digital cameras, smart wearables and other personal devices.

The manufacture and supply of Li-ion batteries for use in consumer products has grown significantly since the 1990s. [3] There are many types of Li-ion batteries.

The chemistry of Li-ion batteries makes them more volatile than traditional batteries. The most dangerous outcome associated with Li-on batteries is the potential to rapidly overheat and cause fires that cannot be easily extinguished, leading to property damage, serious injury and/or fatality.

Some key issues causing incidents with Li-ion batteries include:

- charging issues – using incompatible charging equipment or leaving devices on charge where the Li-ion battery does not protect against overcharging
- mechanical issues – damage caused to the casing of the Li-ion battery, including through puncturing, compressing/compacting, including during disposal, or impacting the Li-ion battery
- environment/external issues – exposure to heat or moisture
- quality/manufacturing issues – faults within the Li-ion battery itself and the products that contain the Li-ion battery.

The ACCC is concerned about the increasing number of incidents involving Li-ion batteries, some causing house fires resulting in serious injuries and property damage. While we are not aware of any Australian fatalities directly attributed to Li-ion batteries, we are aware that there are media reports that cite deaths related to Li-ion battery incidents both in Australia and overseas. In Australia, obtaining data relating to incidents and injury with Li-ion batteries is challenging, in part due to the absence of a national injury database. There have been over 200 product safety reports (including recall notifications) to the ACCC in the last 5 years

[2] ACCC, *Product safety priorities 2022-23*, June 2022, accessed 14 November 2022.

[3] Ziegler et al., *'Re-examining rates of lithium-ion battery technology improvement and cost decline'*, Energy & Environmental Science, 23 March 2021.

and a spike in media reports since February 2021, many of which report significant harm caused by Li-ion batteries in Australia and overseas, including serious injuries and significant property damage.

There is no regulatory framework or mandatory safety standard which squarely addresses the risks with Li-ion batteries in Australia. Suppliers of Li-ion batteries in Australia may choose to comply with aspects of relevant voluntary or international standards and regulations.

The ACCC has prepared this Issues Paper to seek views and further information on Li-ion battery safety and the options available to address the safety issue.

Objective and scope of the Issues Paper

The objective of the Issues Paper is to obtain stakeholder views and information about the safety hazards associated with Li-on batteries and potential options to mitigate the risks.

Your feedback to this Issues Paper, together with further targeted consultation and research, will inform the ACCC's final report, in which the ACCC will develop recommendations to mitigate safety risks associated with Li-ion batteries.

Since commencing this project in June 2022, the ACCC has:

- reviewed internal and publicly available information and data
- undertaken preliminary consultation with key stakeholders
- conducted a consumer survey to understand the awareness of consumers about these hazards and risks
- published online safety information for consumers.

This work has informed what the ACCC considers to be the preliminary key issues with Li-ion batteries which we are now seeking feedback on through this Issues Paper.

This Issues Paper contains:

- a broad overview of Li-ion batteries, including the type used in the market, associated hazards, the market and regulatory landscape and a preliminary discussion on potential risk mitigation strategies
- issues on which we are seeking comment
- information about how to make submissions and key dates for the project.

The scope of this Issues Paper is limited to consumer products. The Issues Paper:

- includes personal devices, household appliances and power tools, personal transportation devices, e-vehicles and renewable energy storage systems
- excludes industrial products and grid scale renewable energy storage batteries
- includes products like power tools used by tradespeople, e-bikes used by delivery riders and rental e-bikes and e-scooters, as these types of products are frequently used by consumers and/or stored in homes.

Have your say

The ACCC invites interested parties to provide information and comment on this Issues Paper.

This Issues Paper includes questions that are designed to elicit feedback and information. Respondents may answer some or all of the questions posed, or can raise a matter not explicitly addressed, where it is relevant to the safety of Li-ion batteries. Consultation questions are listed in the relevant sections of the paper and at pages 5 and 6.

Submissions must be provided on or before **Friday, 3 February 2023**.

How to make a submission

Online (preferred option)	ACCC consultation hub at: **https://consultation.accc.gov.au/** NB: **If you wish to provide additional information via a document, please do so using the consultation hub file upload function. If you would like to upload files that are larger than 25MB, please contact lithiumbatteries@accc.gov.au.**
By email or post	Director Lithium-ion Batteries Project Consumer Product Safety Division Australian Competition & Consumer Commission GPO Box 3131 Canberra ACT 2601 lithiumbatteries@accc.gov.au
Contacts	Sasha Srkulj Director Lithium-ion Batteries Project Consumer Product Safety Division Phone: +61 3 9290 1828 Email: lithiumbatteries@accc.gov.au

All submissions will be treated as public documents and published on the ACCC website, http://www.productsafety.gov.au/, unless otherwise requested. Parties wishing to submit confidential information are requested to:

- clearly identify the information that is the subject of the confidentiality claim – the identified information must be genuinely of a confidential nature and not otherwise publicly available
- provide a non-confidential version of the submission in a form suitable for publication – this public version should identify where confidential information has been redacted.

The ACCC will not disclose the confidential information to third parties, other than advisers or consultants engaged directly by the ACCC, except where permitted or required by law. The general policy of the ACCC on the collection, use and disclosure of information is set out in the ACCC/AER Information Policy (June 2014).

Questions for response

The ACCC is seeking your feedback in response to the questions below and repeated at relevant parts throughout the Issues Paper. The ACCC encourages you to respond to any questions that are relevant to you and to raise any additional issues that you consider relevant to the subject. When providing a response, please provide the reasons for your response and include any supporting documentation. If you are a consumer, you may wish to focus on questions 4 to 8, as these are the questions that are most relevant to consumer experiences.

Types of Li-ion batteries in consumer products

1. Do you consider certain types of Li-ion batteries (see Table 1.1) are more hazardous than others? For example, are certain types of Li-ion batteries more hazardous because of the chemistry make up and/or other factors that impact the hazard (see Table 1.2 for reference)? Please provide an explanation and/or evidence to support your response.

Hazards and risks associated with Li-ion batteries

2. Do you consider the characterisation of the hazards of Li-ion batteries in Table 1.3 accurate and why? Are there other hazards?

3. Is there a stage at which Li-ion batteries are most dangerous? For example, when being manufactured, transported, stored, used/misused, charged or disposed of. Please provide an explanation and/or evidence to support your response.

Li-ion battery incident data

4. Can you provide any information or data (not already provided) on injuries, incidents, fatalities or near-misses involving a Li-ion battery?

Consumer awareness and behaviour

5. Do you consider that consumers are sufficiently educated on Li-ion battery safety hazards? If so, what are the key sources of information for consumers? Do you consider that further consumer education is required, what should the message be and in what form?

6. What actions can consumers take to mitigate the risks presented by Li-ion batteries?

7. As a **consumer** or **retailer**:

    a. Do you assume the manufacturer has conducted safety testing on Li-ion battery products you purchase?

    b. What safety-related factors influence your purchasing decisions?

8. Are there particular Li-ion battery products, brands or manufacturers you have safety concerns about? Please provide an explanation and/or evidence to support your response.

9. What other actions can supply chain participants take to mitigate the risks presented by Li-ion batteries?

10. If you are a **manufacturer** or **seller/distributor** of Li-ion batteries, what education or information, if any, do you provide to your supply chain participants, staff and/or consumers about Li-on battery hazards and risks?

11. If you are a **manufacturer** or **seller/distributor** of Li-ion batteries, what safety and quality assurance processes do you have in place? How and where is safety and quality assurance testing undertaken? Have you encountered any barriers to undertaking this process?

The market

12. What information or data can you provide about who the major players are in the Australian market for Li-ion batteries, including all supply chain participants, and the types of products they supply?
13. Are there alternatives to Li-ion batteries that are in the market or in development that are potentially safer than Li-on batteries? What are they?

Regulatory landscape

14. Do you consider government intervention is required to manage Li-ion battery safety risks? If yes, what form of intervention do you recommend? Please explain your response.

Potential risk mitigation strategies

15. Do you recommend any existing voluntary, industry or international safety standard, or overseas regulatory frameworks or certification methods, as having potential to mitigate the risks discussed in this Issues Paper? To what extent do these already address the risks discussed in this Issues Paper?

16. If you are a **manufacturer** or **seller/distributor** of Li-ion batteries, please provide details about whether the products you, or your supply chain participants, supply meet any relevant voluntary, industry and/or international standard and/or regulations, or other certification or quality assurance processes/requirements.

17. Do you consider that any of the potential risk mitigation strategies identified in this Issues Paper would prevent injuries or fatalities from Li-ion batteries in Australia, either on their own or as part of a combined approach? Why?

18. What other potential risk mitigation strategies may be effective in reducing the risks posed by Li-ion batteries? Please explain your response.

19. What research is available that is directed to the prevention of injuries or fatalities caused by Li-ion batteries. For example, research into safer design and manufacturing practices. Please provide details of this research.

20. Are there further innovations, including advances in technology, that could either mitigate or exacerbate the hazards associated with Li-ion batteries discussed in this Issues Paper?

1. Background and key issues with Li-ion batteries

1.1. What are Li-ion batteries?

Li-ion batteries are common in products found in Australian homes including a range of personal devices, household appliances and power tools, personal transportation devices, e-vehicles and renewable energy storage systems. The use of Li-ion batteries in consumer products is attractive as they are small in size, have a high energy density and have better power efficiency than other battery types.[4] The manufacturing and supply of Li-ion batteries in consumer products has grown significantly since the 1990s, both domestically and internationally.[5]

While all batteries can be hazardous, the chemistry of Li-ion batteries makes them more volatile than traditional batteries and can present safety risks such as overheating (which can cause injuries such as contact burns) and/or fire. Li-ion batteries contain cells that store (charge) and release (discharge) energy by a reduction/oxidation reaction that causes electrons to flow from the cathode (positive electrode – metal oxide) to the anode (negative electrode – carbon graphite) through an external wire circuit which powers devices connected to that circuit. The opposite reaction occurs during discharge – electrons are released from the anode and travel back to the cathode via the electrolyte solution.[6]

The state of charge of a Li-ion battery refers to the charge level of the battery.[7] This value ranges between 0% and 100%, although Li-ion batteries last longest when operating between 30% and 80% state of charge.[8]

Li-ion batteries are said to function most safely between -20° and +60°C, although the optimal temperature range is between 10° and 30°C across all Li-ion battery types.[9] This range is considered to maximise battery life.[10]

1.2. Types of Li-ion batteries in consumer products

Table 1.1 outlines the ACCC's understanding of the main types of Li-ion batteries based on their cathode chemistry, and the thermal stability of each Li-ion battery type. The thermal stability of a Li-ion battery is measured by the minimum temperature at which it undergoes thermal runaway.

During the ACCC's initial consultation, one international regulator indicated that they regarded lithium iron phosphate batteries as having a relatively low failure rate compared to other types and lithium cobalt oxide batteries amongst the most prone to failure.

4 Clean Energy Institute, *What is a lithium-ion battery and how does it work?*, Clean Energy Institute website, n.d., accessed 13 June 2022.

5 Ziegler et al., 'Re-examining rates of lithium-ion battery technology improvement and cost decline', Energy & Environmental Science, 23 March 2021.

6 Nitta et al., '*Li-ion battery materials: present and future*', *Materials Today*, 2015, 18(5):252–264, doi: 10.1016/j.mattod.2014.10.040.

7 Battery University, *BU-1101: Glossary*, Battery University website, n.d., accessed 13 June 2022.

8 Battery University, *BU-415: How to Charge and When to Charge?*, Battery University website, n.d., accessed 13 June 2022.

9 J Van Zwol, *How does temperature affect your choice of Lithium UPS Battery?*, Data Centre Dynamics website, 12 October 2021, accessed 13 June 2022.

10 J Van Zwol, *How does temperature affect your choice of Lithium UPS Battery?* , Data Centre Dynamics website, 12 October 2021, accessed 13 June 2022.

Our initial understanding is that lithium cobalt oxide is the most common chemistry makeup used for Li-ion batteries in consumer products,[11] and is also among the lowest in thermal stability.

Table 1.1: Types of Li-ion batteries by chemistry in consumer products ranked by highest to lowest thermal stability[12,13]

Type of Li-ion battery (cathode)	Thermal Stability	Consumer products
Lithium sulfur[14]	Very high	• Not widely commercially available
Lithium iron phosphate (LFP)	Very high (270°C)	• Household appliances and power tools • Personal transportation devices • e-vehicles • Renewable energy storage systems
Lithium titanate	Very high	• e-vehicles • Renewable energy storage systems
Lithium manganese oxide (LMO)	High (250°C)	• Household appliances and power tools • Personal devices • e-vehicles
Lithium nickel manganese cobalt oxide (LMC)	Moderate (210°C)	• Household appliances and power tools • Personal transportation devices • e-vehicles • Renewable energy storage systems
LCO aluminium oxide	Low (150°C)	• Household appliances and power tools • e-vehicles
Lithium cobalt oxide (LCO)	Low (150°C)	• Personal devices
Lithium polymer with LFP, LMO, LMC or LCO cathode	Varied	• Personal devices • e-vehicles • Renewable energy storage systems

Table 1.2 below outlines the main types of Li-ion battery cell structures and the types of consumer products they are typically used in, highlighting the advantages and disadvantages of each type of structure in relation to its safety risks.

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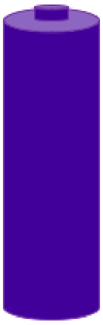
11 Dragonfly Energy, *A Guide To The 6 Main Types Of Lithium Batteries*, Dragonfly Energy website, 27 September 2021, accessed 13 June 2022;

12 Battery University, *BU-216: Summary Table of Lithium-based Batteries*, Battery University website, n.d., accessed 13 June 2022; Battery University, *BU-205: Types of Lithium-ion*, Battery University website, n.d., accessed 13 June 2022; Dragonfly Energy, *A Guide To The 6 Main Types Of Lithium Batteries*, Dragonfly Energy website, 27 September 2021, accessed 13 June 2022; Solar Victoria, *Section 4: Solar battery systems and components*, Solar Victoria website, n.d., accessed 13 June 2022; Battery University, *BU-301a: Types of Battery Cells*, Battery University website, n.d., accessed 13 June 2022; Battery University, *BU-206: Lithium-polymer: Substance or Hype?*, Battery University website, n.d., accessed 13 June 2022.

13 Australian Academy of Science, *Lithium-ion batteries*, Australian Academy of Science website, 15 March 2016, accessed 3 November 2022.

14 The Faraday Institution, *Lithium-Sulfur Batteries: Advantages*, The Faraday Institution website, 21 July 2020, accessed 15 November 2022.

Table 1.2: Types of Li-ion batteries by cell structure in consumer products[15]

Li-ion battery cell structure	Advantages / disadvantages	Consumer products
Cylindrical 	**Advantages** • Easy to manufacture • Good mechanical stability • Withstands high internal pressure • Often spaced apart to aid thermal management and prevent thermal runaway propagation **Disadvantages** • Heavy • Low packaging density	• Household appliances and power tools • Personal devices • Personal transportation devices • e-vehicles (used by brands such as Tesla)[16]
Prismatic 	**Advantages** • Thin design • Optimal use of space **Disadvantages** • High manufacturing costs • Shorter life cycle than cylindrical cell structure	• Personal devices • e-vehicles
Pouch (commonly Li-Polymer) 	**Advantages** • Flexible • Lightweight • Efficient use of space **Disadvantages** • High manufacturing costs • Cell design needs to allow for swelling • Exposure to high heat & humidity can shorten life • Less durable than cylindrical cell structure	• Personal devices • Renewable energy storage systems • e-vehicles

Question

1. Do you consider certain types of Li-ion batteries (see Table 1.1) are more hazardous than others? For example, are certain types of Li-ion batteries more hazardous because of the chemistry make up and/or other factors that impact the hazard (see Table 1.2 for reference)? Please provide an explanation and/or evidence to support your response.

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15 Battery University, *BU-301a: Types of Battery Cells*, Battery University website, n.d., accessed 13 June 2022.

16 Autoevolution, *The Main Types of Li-ion Batteries Explained and What is best for Electric Vehicles*, Autoevolution website, 12 February 2022, accessed 28 June 2022.

1.3. Hazards and risks associated with Li-ion batteries

The chemistry of Li-ion batteries can present safety hazards, including leaking and overheating, leading to risks of fire and explosion. Li-ion batteries have caused fire and explosions in Australia and overseas that have led to property damage and serious injury, including burns.

As part of our initial consultation for this project, we obtained incident and injury data from internal and external sources (see section 1.4). The data indicates that Li-ion batteries caused injuries by leaking, overheating and undergoing thermal runaway.

Thermal runaway is said to be the most damaging and potentially catastrophic hazard associated with Li-ion batteries.[17] Thermal runaway occurs when heat in the Li-ion battery increases faster than it can be dispersed to its surroundings.[18] The high temperature causes the cell materials to decompose in a reaction that creates more heat, causing the materials to decompose at a faster rate. This self-feeding reaction causes the battery to heat up and ignite, releasing toxic flammable gases ('cell venting').[19] The reaction also degrades the cathode and releases oxygen[20], further fuelling the fire and potentially creating an explosion and releasing shrapnel. Where multiple battery cells are included in a product, thermal runaway can propagate from one cell to another.[21, 22]

Li-ion battery fires can be difficult to extinguish because the chemical reactions that fuel these fires are self-sustaining and can burn intensely.[23] While water cannot extinguish these fires, it can cool them down and prevent surrounding areas from igniting.[24]

The severity of a Li-ion battery cell failure is impacted by its total stored energy.[25] Some Li-ion batteries have in-built safety measures, including a battery management system (**BMS**), to help prevent battery damage or failure and to minimise safety hazards.[26]

Additionally, the type of consumer product that contains the Li-ion battery may impact the level of risk. As an example, state electrical regulators commented on the fact that products containing larger capacity Li-ion batteries, such as renewable energy storage systems, can be of higher risk. Another factor is potential consumer misuse, including through connection to the wrong type of charger.

The four broad causes of overheating and thermal runaway are set out in Table 1.3 below.

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17 Chen et al., '*A review of lithium-ion battery safety concerns: The issues, strategies, and testing standards*'.

18 Chen et al., '*A review of lithium-ion battery safety concerns: The issues, strategies, and testing standards*'.

19 B Zollo, *Preventing Li-Ion Thermal Runaway During Battery-Cell Test*, Electronic Design website, 2 November 2020, accessed 14 June 2022.

20 Feng et al, '*Mitigating Thermal Runaway of Lithium-Ion Batteries*'.

21 A video example of scooter with a Lithium-ion battery undergoing thermal runaway can be seen here.

22 Lopez et al., *Experimental Analysis of Thermal Runaway and Propagation in Lithium-Ion Battery Modules*, Journal of The Electrochemical Society, 9 July 2015.

23 Fire and Rescue NSW, *Battery and Charging Safety*, Fire and Rescue NSW Website, 2021, accessed 15 November 2022.

24 Impact Fire Services, *How do you put out a lithium-ion battery fire?*, Impact Fire Website 8 October 2021, accessed 3 November 2022.

25 National Fire Protection Association, *Lithium-ion Batteries Hazards and Use Assessment*, National Fire protection website, n.d., accessed 14 June 2022.

26 Lithium-Ion Battery Test Centre, '*Lithium Ion*', Lithium-Ion Battery Test Centre website, n.d., accessed 13 June 2022.

Table 1.3: Hazards presented by Li-ion batteries [27]

Hazard	Cause Mechanism
Overcharging Overcharging may cause excess Li-ions to form metallic lithium on the anode.[28] Metallic lithium is flammable and may cause short-circuits, leading to increased internal temperature and possibly thermal runaway. [29]	**Incompatible Chargers** Overcharging can occur where an incompatible charging device is used[30], or where the charger otherwise fails to regulate the charge. BMSs may help protect against overcharging from the use of incompatible chargers but may not be able to provide complete protection if the degree of incompatibility is too high. The types of products at highest risk from overcharging are personal devices such as mobile phones, and household appliances and power tools, as these are most likely to be connected to an incompatible charger. A Li-ion battery supplier provided the ACCC with an example where a customer mistakenly plugged in the wrong charger for their motor home's house power system which led to overheating and smoking before the system was turned off, requiring a replacement battery.
	BMS Li-ion batteries with no BMS (or an ineffective one) are said to be more susceptible to overcharging. A Li-ion battery supplier has indicated that a key cause of Li-ion battery fires is failure in the BMS or the charger failing to regulate the charge. The supplier said that in batteries made up of multiple cells, failure of the BMS will cause overcharging of cells that are out of balance putting them at risk of overheating and fire, and that BMS failure is more likely as cells age or where the BMS is of low quality. The supplier noted that newer mobile phones that use single cell batteries are less susceptible to fire following a BMS failure. Further, some state electrical regulators have indicated that modifications to batteries to bypass charge controls can impose a greater risk.
Mechanical Damage to the casing of a Li-ion battery can cause air to enter the Li-ion battery and react with the	**Disposal** Fire and emergency service authorities and industry groups/associations have indicated that the hazard of mechanical damage is particularly concerning during the disposal of Li-ion batteries in general waste because they can go undetected and be easily crushed in waste disposal trucks or facilities, causing

[27] Chen et al., '*A review of lithium-ion battery safety concerns: The issues, strategies, and testing standards*', C.Chanson, '*Li-ion Batteries Safety'* [conference presentation], *Agoria*, 20 June 2013, accessed 13 June 2022, Battery University, *BU-304a: Safety Concerns with Li-ion*, Battery University website, n.d., accessed 13 June 2022, Battery University, *BU-304c: Battery Safety in Public*, Battery University website, n.d., accessed 13 June 2022.

[28] Battery University, *BU-409: Charging Lithium-ion*, Battery University website, 25 October 2021, accessed 3 November 2022.

[29] Science Daily, *Lithium-ion batteries: Phenomenon of 'lithium plating' during the charging process observed*, Science Daily website, 3 September 2014, accessed 14 June 2022.

[30] Battery University, *BU-304b: Making Lithium-ion Safe* Battery University website, n.d., accessed 22 June 2022.

electrolyte solution or break the separator between the two sides of the battery, initiating internal short-circuits.[31] This can cause thermal runaway, overheating and fire.[32] Damage to the Li-ion battery shell casing can be caused by: • puncturing, • compressing / crushing / compacting, or • dropping / impacting.	fires.[33,34] Some fire services internationally consider Li-ion batteries to be responsible for catastrophic fires breaking out in various recycling plants in the US, UK, France, Australia and China.[35] An industry association informed the ACCC that approximately 50% of people are disposing of Li-ion batteries in general waste and that a major waste collector had indicated that it was seeing 15 fires a month resulting from different types of batteries. Battery recycling bins can often be found in shopping centres, libraries, and other community buildings.[36]
	Use Some state and territory electrical regulators consider mechanical damage to Li-ion batteries more likely to arise in certain products based on the typical manner and/or environment in which they are used. For example, the typical use of personal transportation devices can involve exposure to weather and dropping/impacting during use.
Environmental/External Damage to Li-ion batteries due to external conditions.	**Heat** Li-ion batteries may overheat when subjected to high external temperatures, causing leakage of the flammable/corrosive electrolyte solution or thermal runaway and fire.[37]
	Moisture When liquid or airborne moisture ingresses into Li-ion battery powered devices, it may cause electrical shorting, potentially leading to thermal runaway.[38]
	Other fire origins Thermal runaway may be created by fires originating from outside the Li-ion battery. For example, a faulty charger may ignite and spread fire to the Li-ion battery during charging. In these circumstances it may be

31 Chen et al., '*A review of lithium-ion battery safety concerns: The issues, strategies, and testing standards*'.

32 EVreporter, *Lithium-ion battery safety – perils and promises*, EVreporter website, 27 October 2021, accessed 14 June 2022.

33 A video example of a Lithium-ion battery being punctured and undergoing thermal runaway can be seen here.

34 Fire and Rescue NSW, *How can I recycle my used batteries?,* Fire and Rescue NSW website, 2021, accessed 3 November 2022.

35 Media articles about Li-ion batteries causing fires in recycling plants in the US, UK, France, Australia, China.

36 Fire and Rescue NSW, *How can I recycle my used batteries?,* Fire and Rescue NSW website, 2021, accessed 3 November 2022.

37 Chen et al., '*A review of lithium-ion battery safety concerns: The issues, strategies, and testing standards*'.

38 See, e.g., *Flooding exposes 'extreme risk' of new electric cars*, Herald Sun, 17 October 2022, accessed 1 December 2022..

	difficult for fire and emergency services to discern the origin of the fire.[39] This makes it difficult for fire authorities to collect accurate data on the number of fires in which an Li-ion battery is the root cause. During initial consultation, fire authorities and recyclers noted that these external hazards are present during transport, storage and disposal. Where Li-ion batteries are stored, transported or disposed in loads of other batteries and electrical products, contact amongst electrical components can spark fires and fires can spread to, or between, batteries.[40] Battery and e-waste disposal schemes create a concentrated stream of high fire risk waste, which fire authorities have advised can create intense fires that are challenging and dangerous for firefighters. An international regulator advised that it encourages the separation of damaged and undamaged Li-ion batteries into separate disposal streams to reduce the risk of fire.
Quality/Manufacturing Poor design and manufacturing can cause Li-ion batteries to be more susceptible to overheating and thermal runaway.	**Battery Faults** Spontaneous short circuits or internal chemical reactions can occur if there are faults within the battery itself. A state electrical regulator has noted that design and manufacturing rigour is important in mitigating the risk of overheating and fire. A Li-ion battery manufacturer indicated that decisions relating to the type of electrolyte, binder material and flame retardant, and the use of lithium cells and their structure, are factors that differentiate the safety of Li-ion battery products.
	Consumer Product Faults Manufacturing of the surrounding parts of a consumer product may make the Li-ion battery susceptible to the above hazards, for example where: • the battery is not sufficiently enclosed to prevent airborne moisture • the device is not fitted with effective heat sinks • the device is not fitted with an effective BMS, and/or • the battery casing or consumer product architecture is not sufficiently durable for the intended use (for example, electric scooters would require particularly durable casing to prevent crushing or impacting).

39 See, e.g., A Gordon, *New York's E-Bikes Keep Catching Fire, and It's Getting Worse*, VICE, 26 July 2022, accessed 7 November 2022.

40 See, e.g., Battery recycling scheme B-Cycle recommends taping battery terminals during storage and disposal, n.d., accessed 9 November 2022.

Questions

2. Do you consider the characterisation of the hazards of Li-ion batteries in Table 1.3 accurate and why? Are there other hazards?

3. Is there a stage at which Li-ion batteries are most dangerous? For example, when being manufactured, transported, stored, used/misused, charged or disposed of. Please provide an explanation and/or evidence to support your response.

1.4. Li-ion battery incident data

In Australia, data relating to injuries and incidents with Li-ion batteries is difficult to obtain due to a number of factors, including:

- the absence of an Australian national injury database
- injuries and incidents usually cannot be conclusively attributed to a certain product due to difficulties in interpreting the cause of death
- near-miss incidents and fatalities are often not reported to the ACCC.

For these reasons, the ACCC has consulted with key external stakeholders to obtain further data relating to Li-ion batteries. Broadly this collected data demonstrates:

- common injuries involving Li-ion batteries are burns, including chemical burns and electric shocks
- personal devices like mobile phones, tablets and laptops were the most common products in reports received by the ACCC and state and territory Australian Consumer Law (**ACL**) and electrical regulators
- many of the incidents reported either a fire or a near miss, including overheating or swelling of the battery. Products recalled domestically and internationally were almost all recalled due to a risk of fire
- there has been a spike in media reports detailing potential failures associated with Li-ion batteries since February 2021.

Fatalities

The ACCC is not aware of any fatalities directly attributed to Li-ion batteries, however notes that some media outlets have reported on fatalities in Australia[41] and internationally[42] that appear to be linked to Li-ion batteries.

[41] See, e.g., Brisbane Times online, Father-to-be dead, pregnant partner burned in e-scooter battery caravan fire, 22 March 2022, accessed 22 November 2022.

[42] See, e.g. The Guardian, *E-bike batteries have caused 200 fires in New York: 'Everyone's scared'*, 15 November 2022, accessed 23 November 2022.

Injuries and incidents in Australia

ACCC reports

Between 1 April 2017 and 31 October 2022, the ACCC received 30 mandatory reports from suppliers[43] and 160 reports from consumers relating to Li-ion batteries, with approximately 25% involving an injury.

Table 1.4 sets out the product categories that made up the reports received by the ACCC (mandatory and consumer reports).

Table 1.4: Incident reports to the ACCC by product type

Product Category	Product type	% of reports
Personal devices	Mobile phones and tablets	19%
	Computers and accessories	18%
	Smart wearable devices	6%
	Adaptors, chargers, and batteries (e.g. portable phone power banks, battery packs)	7%
Renewable energy storage systems	Energy saving technology	7%
Other product categories	Various products including power tool batteries, loudspeakers, and cordless vacuum cleaners	43%
	Total	**100%**

State and territory ACL regulator reports

Between 1 January 2017 and 19 August 2022, state and territory ACL regulators received 95 reports relating to Li-ion batteries. A summary of these reports broken down by product type is shown below:

Table 1.5: Incident reports to state and territory ACL regulators by product type

Product category	Product Type	Number of reports	% of reports
Personal devices	Laptops and tablets	25	26%
	Mobile phones	12	13%
	Wifi modems	4	4%
	Batteries and chargers	8	8%
	Smart wearable devices	4	4%
Renewable energy storage systems	Residential and solar batteries	11	12%
Personal transportation devices	E-mobility devices	9	9%
	Motor vehicle accessories	6	6%

43 Section 131 of the ACL requires suppliers of consumer goods to report deaths, serious injuries or illnesses associated with consumer goods to the ACCC within 2 days of becoming aware of the incident.

Household appliances and power tools	Power tools	6	6%
Other	Other product categories	10	11%
	Total	95	100%[44]

State and territory electrical regulators reports

Between April 2017 and August 2022, the state and territory electrical regulators received more than 200 reports relating to Li-ion batteries. These agencies are responsible for technical and safety electrical regulation in Australia and collect data on safety incidents involving Li-ion batteries. Most of the reported incidents resulted in property damage.

Emergency Department presentation data

There is currently no single source of injury data for emergency department (**ED**) presentations in Australia. As such, nationwide injury estimates have been extrapolated from the information that is available.

The Queensland Injury Surveillance Unit (**QISU**) and Victorian Injury Surveillance Unit (**VISU**) provided relevant product-related ED injury presentation data from participating hospitals to the ACCC.[45,46]

QISU and VISU both report on injury surveillance data collected by participating EDs. In Victoria, all EDs with an overnight facility are mandated to collect level 1 injury surveillance data. In Queensland, participation is voluntary and only a selection of hospitals participate, collecting level 2 injury surveillance data. Level 2 data may capture more product information than level 1 depending on the product type.[47]

Due to the voluntary nature of QISU data collection data completion (ascertainment) at QISU sites varies over time. For this reason, VISU data may be more useful for trend analysis. Depending on the product being investigated, limited QISU trend analysis can be performed using data collected at paediatric hospitals which have been long-term participants in data collection.

Because of the way the systems are set up, QISU data systems collect more injury text narrative relative to VISU and this can affect case identification, depending on the product being investigated.

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44 Individual percentages for product categories do not sum to 100% due to rounding.

45 The VISU data is provided from July 2016 to June 2021 while QISU data is provided from July 2017 to June 2022. The data provided by VISU and QISU does not capture all hospitals with an emergency department. Population demographics and the type of participating hospitals may influence the data captured. For example, children's hospitals may capture more incidents in the younger age groups and hospitals with 24-hour emergency departments may capture more overall incidents than those without.

46 QISU collects injury data from ED at participating hospitals across Queensland. The data is estimated to represent roughly 20% to 25% of all ED injury presentations in the state depending on the age group and injury type studied. The QISU database contains injury data collected from Jan 1999-present (currently 23 years). Not all hospitals have collected for the full 23 year period. Data is collected in the following Hospital and Health Service areas: Darling Downs HHS, Cairns and Hinterland HHS, Central QLD HHS, Children's Health QLD HHS, Mackay HHS, Metro North HSS, Metro South HHS, North West HHS, Townsville HHS and Wide Bay HSS.

QISU data is collected at the point of triage; when the triage nurse ticks yes to an injury this triggers an injury module to open for completion by the triage nurses (64% average completion rate). The injury module fields are not mandatory, allowing the triage nurses to skip part of or all the injury fields depending on clinical flow priorities. Consequently, the data may have missing codes in the injury data fields. QISU coders can supplement coded fields based on information in the injury description field (triage text in EDIS and the Injury Surveillance field in FirstNet).

Each record is validated and coded in accordance with the National Data Standards – Injury Surveillance (NDS-IS) (National Injury Surveillance Unit 1998). This process lags several months behind data intake. In some situations, machine validation can be used to include more recent data.

47 For more information on NDSIS data collection refer to https://www.cdc.gov/nchs/data/ice/ice95v2/c04.pdf

QISU data shows 35 ED presentations for the period 1 July 2017 and 30 June 2022. Within the 35 cases:

- 30 were identified as Li-ion battery related injuries and 5 were identified as potential Li-ion battery related injuries based on the products involved in the injury
- the most common products involved were powerpacks or energy storage
- more than half of the incidents involved burns, with the upper limbs being the most commonly affected body part. Individuals between the ages of 25-44 were the most common age range affected.

VISU data shows 18 ED presentations for injuries involving or potentially involving Li-ion batteries for the period July 2016 to June 2021. More than 70% of the presentations involved burns, with the wrist and hand being the most common body part affected.

BRANZ data

Between 1 January 2017 and 31 December 2021, the Burns Registry of Australia and New Zealand (**BRANZ**) recorded the following:

- 21 admissions for burns involved or related to Li-ion batteries
- the most common products involved were e-cigarettes and mobile phones, with the lower limbs and hands being the most common injury sites.[48]

Overseas regulators

For the period between 1 January 2017 and 31 October 2022:

- the US National Electronic Injury Surveillance System, which provides injury data from a sample of hospitals in the United States, reported 202 injuries relating to Li-ion batteries. The most common injury type in this data related to burns, which accounted for 46%of all reports
- the United States Consumer Product Safety Commission, an international regulator (**US CPSC**) Clearinghouse, which provides incident data involving consumer products from various data sources, reported 216 product safety incidents relating to Li-ion batteries. 25% of these reports resulted in an injury to the consumer
- the UK Office of Product Safety and Standards data reported 11 safety reports for products containing Li-ion batteries. These reports related to various products including electric mowers (2 reports), hair dryers (2 reports) and e-mobility devices (2 reports). Of these 11 reports, 5 resulted in consumer recalls.

Additionally:

- from 2010 to 2022, the European Commission issued 53 dangerous product alerts relating to Li-ion batteries
- from 1 January 2017 to 31 July 2022, Health Canada received 1,439 reports related to products containing a Li-ion battery. Not all reports concerned an injury or adverse event. Of these reports, 77% involved fires, explosions or other thermal events such as smoke, overheating and combustion.

Australian recalls

The ACCC publishes supplier-initiated recalls on the Product Safety Australia website. Notably:

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[48] Records could list more than one injury site.

- 22 supplier-initiated recalls of products containing Li-ion batteries have been notified between 1 April 2017 and 31 October 2022
- 20 of the recalls reference a risk of fire due to overheating or short-circuiting
- the most recalled products were laptop batteries (3 recalls) and loudspeakers (3 recalls).

Overseas recalls

The Organisation for Economic Co-operation and Development (**OECD**) Global Recalls Portal reported 128 recalls of products containing Li-ion batteries among OECD members between 1 January 2017 to 31 October 2022. The most common categories were electrical supplies (47 reports), self-balancing scooters (13 reports) and computing (7 reports).

Information provided by the US CPSC showed that there were 32 recalls of products containing Li-ion batteries in the United States between fiscal years 2017 and 2020. All these products were recalled due to fire hazards, with 8 of the recalls relating to laptops.

Media reports

The ACCC has identified over 1,400 domestic and international Li-ion battery media reports between 2017 and 2022 as part of its routine media monitoring. The number of media reports detailing potential failures associated with Li-ion batteries has increased since 2017, with a significant spike in reports since February 2021. Many of these reports indicated significant harm from the use of Li-ion batteries, including serious injuries and death due to fire and explosion, as well as economic loss.

Questions

4. Can you provide any information or data (not already provided) on injuries, incidents, fatalities or near-misses involving a Li-ion battery?

1.5. Consumer awareness and behaviour

Given the growing presence of Li-ion batteries in the market, the ACCC sought feedback on consumer awareness and behaviours via an online consumer survey.

The survey received more than 4,500 responses. Key take-outs from survey responses are as follows:

- 85% of respondents indicated that they were aware of which products in their home contained Li-ion batteries
- 79% of respondents indicated that they were aware of hazards associated with the devices
- 87% of respondents indicated that they charged devices unattended, 55% did not read instruction manuals, and 54% used aftermarket chargers. These practices are contrary to safety advice delivered by a range of bodies, including fire authorities and state and territory electrical regulators
- 39% of respondents indicated that they did not know how to correctly dispose of products containing Li-ion batteries. Improper disposal of Li-ion batteries is of particular concern as it can cause and/or exacerbate fires in waste disposal trucks and facilities.

Questions

5. Do you consider that consumers are sufficiently educated on Li-ion battery safety hazards? If so, what are the key sources of information for consumers? Do you consider that further consumer education is required, what should the message be and in what form?

6. What actions can consumers take to mitigate the risks presented by Li-ion batteries?

7. As a **consumer** or **retailer**:

   a. Do you assume the manufacturer has conducted safety testing on Li-ion battery products you purchase?

   b. What safety-related factors influence your purchasing decisions?

8. Are there particular Li-ion battery products, brands or manufacturers you have safety concerns about? Please provide an explanation and/or evidence to support your response.

9. What other actions can supply chain participants take to mitigate the risks presented by Li-ion batteries?

10. If you are a **manufacturer** or **seller/distributor** of Li-ion batteries, what education or information, if any, do you provide to your supply chain participants, staff and/or consumers about Li-on battery hazards and risks?

11. If you are a **manufacturer** or **seller/distributor** of Li-ion batteries, what safety and quality assurance processes do you have in place? How and where is safety and quality assurance testing undertaken? Have you encountered any barriers to undertaking this process?

2. The market

2.1. Market size and penetration are increasing

The Li-ion battery market has grown considerably in both manufacturing and consumer demand since the early 1990's. In 2020, the global Li-ion battery market was estimated at US$40.5 billion and is expected to grow to US$92 billion by 2026.[49]

The proportion of Australians who own at least one Li-ion battery product is high and increasing, with the proportion who use a smartphone expected to increase from 81% in 2017 to 87% in 2026.[50] The consumption of energy from Li-ion batteries is increasing rapidly. In the ten years to 2017, Li-ion battery energy consumption more than tripled, with consumer products being the major contributors.[51]

The major global manufacturers are located in China, Japan and Korea. Products containing Li-ion batteries are sold by many Australian retailers. There are a small number of Australian manufacturers.

2.2. Substitution, new technologies and design and manufacturing choices

Substitution may not be possible in some popular product categories

In some product categories, particularly personal devices like mobile phones, most or all products in the category are Li-ion battery powered. Therefore, in those categories consumers have limited ability to substitute for a product that uses a different, and potentially safer, battery technology.

Safer Li-ion batteries may be possible but slow to emerge

Recent media reports covering the development of emerging alternatives to Li-ion batteries have included discussion of the following technologies: graphene aluminium, sodium-ion, nickel-hydride, nickel-hydrogen, Vanadium, iron-air and iron flow. [52] However, some reports indicate that no technologies are likely to replace Li-ion batteries in the near future, and that Li-ion batteries are likely to become more energy dense and cheaper, but not necessarily safer.[53]

Some manufacturers may be trading off safety against costs

During initial consultation about Li-ion battery safety issues, a Li-ion battery supplier indicated that the design and manufacturing quality of certain aspects of Li-ion batteries can impact their safety, and that some manufacturers of Li-ion batteries may be trading off safety against costs.

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49 Tycorun Energy, *The history, present situation, and future of global lithium battery market*.

50 Statista, *Smartphone penetration rate as share of the population in Australia in 2017*, Statista website, n.d, accessed 24 October 2010.

51 Austrade, *The lithium-ion battery value chain – New economy opportunities for Australia*, December 2018, p7.

52 See, e.g., ABC News, *Brisbane battery company using UQ technology offers solution to storing solar energy to power homes*, 7 November 2022, accessed 9 November 2022; PV Magazine, *Saturday read: Promising alternatives to lithium-ion*, 6 November 2021, accessed 9 November 2022.

53 Naval Surface Warfare Center, Carderock Division, Report on Emerging Energy Storage Technologies, October 2020, p.56, accessed 24 October 2022.

Questions

12. What information or data can you provide about who the major players are in the Australian market for Li-ion batteries, including all supply chain participants, and the types of products they supply?

13. Are there alternatives to Li-ion batteries that are in the market or in development that are potentially safer than Li-on batteries? What are they?

3. Regulatory landscape

In Australia, the state and territory governments are primarily responsible for regulating the safety of electrical consumer products. However, the laws underpinning the existing regulatory framework differ among the jurisdictions, for example in terms of compulsory recall powers and the voltage thresholds that determine the scope of products covered, including extra-low voltage (**ELV**) products. Most Li-ion battery products are also not covered by the Electrical Equipment Safety System (**EESS**). This creates concerning regulatory gaps.

The inconsistency of the existing regulatory framework is a longstanding concern that was highlighted in the Productivity Commission's 2017 report on enforcement and administration arrangements underpinning the ACL. Among the report's recommendations for improving the framework, the Productivity Commission recommended standardisation of the state and territory laws underpinning electrical goods safety.[54]

Currently, where there are regulatory gaps, the ACL is expected to be able to be relied upon insofar as consumer products are supplied but not specifically regulated by other specialist regulators. The ACL, among other things, allows the Commonwealth Minister to make mandatory safety and information standards, and declare permanent bans on consumer goods. However, the government's Statement of Expectations requires the ACCC to avoid duplication of responsibilities of specialist regulators. Specialist regulators house specialist expertise (in this case, relating to electrical products and electrical safety), have networks of established working relationships with industry, and may have ancillary responsibilities relating to certification and oversight.

The existing framework therefore poses several challenges for consumers, government agencies and industry, particularly where electrical consumer products are supplied across multiple jurisdictions. Currently, consumers may find it difficult to identify whether the goods they wish to purchase are safe. Government agencies face significant complexity when dealing with product safety recalls as the lack of uniform compulsory recall powers across the jurisdictions place a greater reliance on the ACCC to intervene in a specialist product safety regime, when it is not charged, funded and does not have the expertise, to do so. Similarly, businesses must understand and comply with different state and territory laws for the products they supply.

Questions

14. Do you consider government intervention is required to manage Li-ion battery safety risks? If yes, what form of intervention do you recommend? Please explain your response.

[54] Australian Government Productivity Commission, *Consumer Law Enforcement and Administration*, March 2017.

4. Potential risk mitigation strategies

While the Issues Paper is focussed on seeking stakeholders' preliminary views on key issues, the ACCC is starting to explore some potential approaches to reducing the risks associated with Li-ion batteries.

4.1. Regulation

Modified or newly created voluntary, industry and international standards, certification regimes, and/or industry codes or other industry-led frameworks could form a basis for how Li-ion batteries are regulated. These could cover design and manufacturing practices and quality, product testing and certification, and cooperation with state and territory electrical regulators. In discussions with state and territory electrical regulators, the following voluntary, industry and/or international standards were identified as relevant, in part, to Li-ion batteries:

- AS/NZS 60335 series: Household and similar electrical appliances
- IEC 63056:2020: Secondary cells and batteries containing alkaline or other non-acid electrolytes - Safety requirements for secondary lithium cells and batteries for use in electrical energy storage systems
- IEC 62133-2:2017+AMD1:2021: Secondary cells and batteries containing alkaline or other non-acid electrolytes - Safety requirements for portable sealed secondary cells, and for batteries made from them, for use in portable applications - Part 2: Lithium systems
- IEC TS 62933-5-1:2017: Electrical energy storage (EES) systems - Part 5-1: Safety considerations for grid-integrated EES systems - General specification
- AS/NZS 5139-2019 Electrical installations - Safety of battery systems for use with power conversion equipment.

4.2. Industry-led initiatives

Possible options include an industry code or other industry-led framework to address Li-ion battery safety, covering design and manufacturing practices and quality, product testing and certification, and cooperation with state and territory electrical regulators.

4.3. Awareness raising initiatives

Activities may include:

- broader consumer education and awareness by key stakeholders to reduce levels of misuse
- point of sale information
- enhancing general knowledge about battery disposal programs available for Li-ion batteries given the spate of fires associated with general waste disposal and compaction.

Questions

15. Do you recommend any existing voluntary, industry or international safety standard, or overseas regulatory frameworks or certification methods, as having potential to mitigate the risks discussed in this Issues Paper? To what extent do these already address the risks discussed in this Issues Paper?

16. If you are a **manufacturer** or **seller/distributor** of Li-ion batteries, please provide details about whether the products you, or your supply chain participants, supply meet any relevant voluntary, industry and/or international standard and/or regulations, or other certification or quality assurance processes/requirements.

17. Do you consider that any of the potential risk mitigation strategies identified in this Issues Paper would prevent injuries or fatalities from Li-ion batteries in Australia, either on their own or as part of a combined approach? Why?

18. What other potential risk mitigation strategies may be effective in reducing the risks posed by Li-ion batteries? Please explain your response.

19. What research is available that is directed to the prevention of injuries or fatalities caused by Li-ion batteries. For example, research into safer design and manufacturing practices. Please provide details of this research.

20. Are there further innovations, including advances in technology, that could either mitigate or exacerbate the hazards associated with Li-ion batteries discussed in this Issues Paper?

5. Next steps

The ACCC encourages you to make submissions to the questions set out in the Issues Paper and raise any additional issues that you consider relevant. This will further assist the ACCC in developing a more comprehensive understanding of the hazards of Li-ion batteries and the development of recommendations to mitigate those risks. Submissions are due on or before **Friday, 3 February 2023.**