

SUMMARY - POSITION PAPER ON SAFETY

Lithium-ion batteries are still anticipated by our society as being dangerous, as reported accidents are sometimes spectacular and their treatment by media raise curiosity and concern about their safety in the public's opinion. However, substantial R&I efforts at different levels have been undertaken to understand, detect, identify, and mitigate possible hazards (emission gas, heat, fire, projections...). Those progresses are associated with the successful development of dedicated standards (ISO, IEC, CEN-CENELEC, etc...) and regulations (UNECE R100, UN model regulation for the transport of dangerous goods, etc). As a result, **today's battery systems have reached a good level of safety.**

A new proposal for regulation on batteries at European level has been published and will further strengthen requirements for safety testing (annex 5)¹.

The investment on further resources in R&I actions and standardization for battery safety is paramount to ensure confidence and the widespread adoption of e-mobility and electrochemical energy storage in our society. Battery research results in ever new battery technologies, and increasing variety of use-cases. All these advances and use -case evolutions (large stationary storage, heavy duty applications, ...) need to be foreseen and aligned with safety requirements, protocols or normative framework. This will provide safe, cost efficient and quick solutions to the battery market, thus increasing EU competitiveness.

Safety needs to be seen from the **whole battery chain perspective**. The improvement of safety at any specific level of the value chain, for example at materials level, should be beneficial for all other levels. It does not stop at intended use and must be considered in a much larger scope along the whole value chain, and include:



- Materials handling, components processing, cells, modules and system manufacturing/assembly, installation of battery systems.
- Use, maintenance, repair and second life of the product in its application environment.
- Dismantling, handling, transport, storage and recycling of waste, damaged and defective batteries.

The **creation and adaptation of existing standards** to encompass the whole battery value chain is of great importance. At materials level, for example, the development of a safety assessment methodology is needed. At manufacturing level, methodologies to improve the safety management would be very beneficial, considering, for example, material nano-particle manipulation, upscaling processes and the development of safe designs. The **adaptation of the already developed standards and strategies for the battery management systems (BMS, BTMS)** needs to be continuously updated. Existing standards and management strategies should be kept updated in view of the development of new technologies and offer early detection and mitigation measures for each of them. Their development has to be supported by continuous research. Guidelines for the use of suitable extinguishing media are necessary and should be based on the results of experimental testing and models. In addition, in order to avoid that safety testing becomes the bottleneck of the industry, continuous work on test protocols is needed. This should result in the most appropriate tests and decrease their duration and complexity.

¹ https://ec.europa.eu/environment/topics/waste-and-recycling/batteries-and-accumulators_en



Further improvements of battery safety, in particular those impacting the intrinsic safety of the electrochemical components, can decrease the effort, cost and risk ² related to other measures currently required to ensure battery safety.

New advances in battery technology such as solid-state batteries or batteries with aqueous based solutions, replacing flammable electrolyte or other volatile components can result in a major improvement of safety and have a significant impact on the cost of battery systems. Sensor technologies which provide direct feedback to battery management systems can enhance safety. Self-healing technologies can also serve to avoid dangerous degradation events. Novel advancements should result in fewer components, less cost and less overall risk.

Automatization of the processes and robotics might play a key role in several parts of the battery value chain such as manufacturing, handling, transport, recycling and storage of waste and damaged or defective batteries. For example, the development of safe automatized procedures can be used to safely produce batteries, avoiding any kind of human interaction. In addition, processes to disassemble packs and modules, to identify elements suitable for 2nd life or to separate cells that have potential defects can also be automatized. The development of automatized processes for disassembly will broaden **the re-use of second life cells** in stationary applications. By implementing those procedures, the necessity for personnel near possible dangerous situations will be decreased.

Sustainability is the main goal of the presented approach. **Second life** applications and the extension of life of used batteries are one of the green solutions now being tackled. In this field, there is a need to develop the adequate diagnosis tools to select the reusable batteries and to manage the new associated risks. Methods for State of Safety (SoS) cell diagnosis are missing to date.

The development of safe and sustainable batteries in Europe includes many technical challenges. Beyond technical countermeasures, the **education of professionals** working at the different levels of the circular battery value chain is necessary to properly handle batteries, being able to recognize and avoid dangerous situations. This also applies to end users and emergency personnel (fire brigade ...). ³

² *nb: any safety device or measure is linked to a risk of not being effective, e.g. failure of electronic protection, intended or unintended violation of safety procedures, malfunction of safety barriers.*

³ For more information, a more detailed overview of the Safety white paper can be found at the Batteries Europe Website https://ec.europa.eu/energy/topics/technology-and-innovation/batteries-europe/news-articles-and-publications_en.

