Boom in Li-ion batteries: safe handling comes first

Li-ion batteries whitepaper

DEKRA



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Lithium-ion (Li-ion) batteries and rechargeable Li-ion batteries are considered to be drivers of growth and a bridging technology for both the energy transition and CO₂-neutral electrification. While there were some 36 factories for the production of battery cells (gigafactories) worldwide in 2018, this number is set to double by 2028 and capacity is expected to increase tenfold to over 2,000 GWh. At the same time, Europe's share of the global production is expected to triple: to approximately 17 percent.

As the demand for batteries for electric vehicles and portable batteries is set to increase rapidly, the Batteries Regulation (BATT2) of the European Union has created a harmonized legal framework which takes the entire life cycle of batteries into account. The BATT2 is valid for all EU member states from 02/18/24 onwards, and replaces the Battery Directive. Its aim is to ensure a safe, closed loop-oriented and sustainable value chain for all batteries. This will result in an increased degree of responsibility at all stages: from the production and recycling through to the disposal and all forms of transport.



Used Li-ion batteries: an economic and safety factor

The protection of used lithium-ion(Li-ion) batteries is becoming a structurally important safety factor in the energy transition. The more recyclable batteries are manufactured and the shorter their usage cycles become, the more important the safe and high-quality recycling of the waste batteries becomes.

The Fraunhofer Institute has forecast that the EU-wide demand for new batteries will amount to approximately 2.5 megatons by 2030. From 2040, this will result in approximately 1,500 kilotons of waste Li-ion batteries and battery components needing to be recycled every year.

The high energy density of used (Li-ion) batteries also means that they pose an acute fire and environmental risk – due, in particular, to improper collection, storage and transport. Their end-to-life chain is often interrupted.

In Germany, for example, some 50 percent of waste electrical and electronic equipment (WEEE) ends up in the household waste by mistake or is disposed of illegally. Even minor mechanical damage can trigger spontaneous combustion or in some cases major fires with serious environmental damage. Recycling facilities as well as city centers, parking garages, sea ferries and aviation are therefore becoming particularly sensitive areas for the storage of Li-ion batteries and WEEE.

Figure: stiftung elektro-altgeräte register foundation, ear.

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1. Collecting and sorting: the start of the chain of responsibility

An almost weekly occurrence of major fires in the recycling chain is increasingly placing the waste management industry under strain. In many cases, cause of such fires are improperly separated lithium-ion batteries or accumulators that have found their way into the mixed waste. The more waste electrical and electronic equipment (WEEE) is generated, the greater the demands on the quality assurance and risk management during the transport and storage of used, refurbished or reused batteries. It is in these areas in particular that the DEKRA experts often discover improper acceptance, storage and forwarding processes during audits.

While batteries have a high level of safety during their production, and the fire risks of batteries for electric vehicles can be classified as low, the main hazards are to be found in the logistics chains, in second use and in forms of use that are not authorized by manufacturers. As soon as high-energy batteries are shipped, installed in external systems or subjected to excessively high voltages or are damaged, a considerable risk of fire arises. In the interests of achieving safe end-to-life management, it is therefore of crucial importance that batter-



ies with different histories and different safety behavior are not mixed.

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Consumers and public collection points:

The chain of responsibility for the environmentally-friendly disposal of Li-ion batteries extends from the consumer, to the collection point and all the way through to the waste disposal company, which is subject to the certification. However, if the upstream return or collection point fails to expertly assess the installation condition of the battery, the systematic separation and high-quality recycling of the Li-ion batteries is not possible.

The non-destructive and breakage-preventing set-up of the collection of WEEE at the collection and transfer points provides the basis for the further steps of the processing (dismantling, recycling), and is an essential prerequisite for the safe and successful distribution of the batteries and storage capacities.

New take-back obligations increase the pressure on critical processes:

In accordance with the German Electrical and Electronic Equipment Act (ElektroG), German consumers have been able to hand in their waste electrical equipment free of charge at many food retailers that also sell electrical and electronic equipment since July 2022. With the significantly expanded collection network and the higher collection rates, the pressure on the critical processes is increasing, i.e. the sorting of electronic waste according to equipment groups and battery types, as well as the storage of the subsequent material fractions in suitable containers. Staff training and awareness-raising regarding the hazards are essential to ensure the proper separation of battery-operated appliances and high-energy Li-ion batteries.

The waste officers at DEKRA have observed that WEEE containing batteries are rarely handed in at discount retailers. Most retailers, however, are not able to remove the batteries (too much time pressure, lack of tools...). They are usually transported to central warehouses by certified waste disposal companies in appropriate transport containers.



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2. The EU Batteries Regulation: new standards for the battery life cycle

The EU Batteries Regulation (BATT2) is valid for all EU member states from 02/18/24 onwards and replaces the Battery Directive. The regulation is a cornerstone of the European Green Deal and is a legal instrument that concerns the entire life cycle of a battery.

Its focus is on all types of batteries (apart from for military use, aerospace, nuclear technology) that economic actors place on the market or put into operation. It results in extensive due diligence obligations concerning the management of waste portable batteries that contain lithium and their subsequent use during their life cycle.

The Batteries Regulation aims to improve the quality of the activities of all the stakeholders involved in the life cycle of batteries, especially those directly involved in the handling and recycling of waste batteries. The requirements have therefore increased; concerning the quality assurance systems, the risk management of the environmental hazards and the transport to the intermediate processing stages.

The safe separation of waste batteries

The Regulation makes it clear that collected waste batteries may not be thrown away or used for the production of energy. To achieve a high rate of material recycling, it is necessary for the separate collection of waste batteries to be expanded as far as possible, and it must be ensured that all the batteries to be collected can be recycled using suitable processes – including in the preliminary stages. The basis for the recycling is the professional separation and storage of waste batteries that are both undamaged and available for the further recycling without the risk of hazardous reactions.

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New categories of battery

With the Batteries Regulation, the previous subdivision of battery types into portable batteries, vehicle batteries and industrial batteries has been expanded to include:

- **Equipment and all-purpose batteries**, up to 5 kg in weight when encapsulated, and intended for devices in the private or household environment (cellular phones, tablets, toys, garden and kitchen appliances, cordless power tools, etc.)
- **Starter batteries** for starter motors, ignition systems, lighting and for backup purposes in transport vehicles or machines
- **LV batteries** as a new category of batteries that power light means of transport, such as e-bikes and e-scooters
- **Electric vehicle batteries** for powering electric vehicles (formerly industrial batteries)
- Industrial batteries for powering vehicles in rail transport, shipping, aviation or for mobile machines and industrial operations. This includes batteries for communication infrastructure, agricultural operations, the generation and distribution of electrical energy such as stationary storage, as well as all batteries over 5 kg that do not otherwise belong to any of the categories.



3. Best practice for the storage of waste batteries

The handling during the transport and storage needs to keep pace with the increasing number of recycling stages and the longer battery life cycles. The Batteries Regulation therefore aims to improve the environmental performance of batteries and the activities of all the stakeholders involved in the life cycle of batteries (manufacturers, distributors, end users) – especially at the stages that are directly involved in the treatment and recycling of waste batteries.

By February 18th, 2025, the EU Commission will issue a delegated act to ensure that the handling of waste batteries complies with the regulation. As a result, economic stakeholders will be required to structure their quality assurance systems in such a way that, for instance, the following due diligence obligations in accordance with Annex XII Part A are complied with during storage:

Storage at locations with impermeable surfaces and a suitable weatherproof cover or in suitable containers

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- Waste batteries must be stored in all facilities in such a way that they are not mixed with waste composed of conductive or flammable materials
- Precautionary and safety measures protecting stored waste batteries against:
 - → Excessive heat, such as high temperatures, fire or direct sunlight
 - → Water, precipitation and flooding
 - → Crushing or damage
- Storage of lithium batteries in their usual installation position, never upside down.
- Storage in well-ventilated areas and covered with high-voltage rubber insulation
- Storage facilities for waste lithium batteries are to be provided with warning signs



4. Best practice for the transport of waste batteries

The extended producer responsibility set out in the Batteries Regulation encompasses all stakeholders that place batteries on the market – including batteries that have been prepared for reuse, re-purposed or refurbished.

▶ To determine the requirements for the transport and handling of waste batteries containing lithium, the criteria for the certification of specialist waste disposal companies and for audits in accordance with the German Electrical and Electronic Equipment Act (ElektroG) and German Batteries Act (BattG) have proven themselves in practice.

The requirements for transport are described in LAGA (German Federal/State Working Group on Waste) implementation guideline M31A (chapter 6) for the ElektroG. This guideline contains specifications and information concerning the relevant special regulations on how waste electrical equipment (containing undamaged or damaged Li-ion batteries) should be transported for intermediate processing, disposal or recycling.



1. Transport of WEEE with lithium batteries to intermediate processing sites

- resistant outer packaging, or
- unpackaged transport (such as lattice boxes), provided that the cells and batteries contained therein are equally protected by the device, or
- securing of the cells or batteries to prevent their excessive movement
- Transport unit \leq 333 kg lithium batteries and cells

2. Transport of WEEE with undamaged lithium batteries for disposal/recycling

- see 1 and
- short-circuiting protection and prevention of hazardous generation of heat
- class 9 hazardous goods transport, other requirements of the ADR are to be complied with
- transport document, fire extinguishing equipment
- depending on the total quantity of hazardous goods trans-



ported, additional instructions, driver training and protective equipment where necessary

3. Transport of WEEE with damaged lithium batteries for disposal/recycling

- type-approved hazardous goods packaging (containers, crates, canisters, etc.)
- non-flammable and non-conductive padding material
- individual packaging in inner and outer packaging with non-combustible and non-conductive thermal insulation materials (e.g. dry sand)
- short-circuiting protection
- ventilation equipment
- measures to provide protection against vibration and shock
- absorbent inert material in the case of leaks
- transport document, fire extinguishing equipment
- depending on the total quantity of hazardous goods transported, additional instructions, driver training and protective equipment where necessary

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Source: Notification of the German Federal/State Working Group on Waste (LAGA) 31 A, Implementation of the Electrical and Electronic Equipment Act

5. Standards for safe closed loops for batteries

The quality assurance concerning the battery life cycle is subject to a wide-ranging regulatory framework. The key requirements are defined by the German Circular Economy Act, the EU Batteries Regulation, LAGA implementation guideline M31A to the ElektroG and the

Hazardous Goods Transport Ordinance.

Waste Framework Directive (WFD)

The Directive strengthens the promotion of the circular economy and confirms the "polluter pays principle," whereby the costs of waste management are borne by the original waste producer. Separate collection obligations for waste for recovery/recycling purposes and bans on mixing.

German Batteries Act (BattG)

The law is primarily aimed at manufacturers, distributors, end consumers and public waste management companies, such as municipal recycling centers. As part of their product responsibility, manufacturers and retailers are required to ensure proper disposal with high collection rates. Retailers are obliged to take back waste batteries and rechargeable batteries free of charge. Local authorities are also required to accept waste batteries from electrical equipment free of charge.

EU Batteries Regulation (BATT2)

The new EU Batteries Regulation replaces the Battery Directive 2006/66/EC of 09/06/2006, and came into force on August 17th, 2023. It has been valid for all EU member states since February 18th, 2024. The new requirements include the categorization of battery types, conformity obligations, extended producer responsibility, regulations on the management of waste batteries, the climate protection requirements and disclosures of the CO₂-footprint.

Electrical and Electronic Equipment Act (ElektroG -> WEEE Directive)

This law implements Directive 2012/19/EC on waste electrical and electronic equipment (the WEEE Directive). Its aim is to prevent or reduce the harmful impact of waste electrical and electronic equipment (WEEE) and its processing. Since July 2022, food retailers have also been obliged to take back electrical equipment if they sell such equipment several times a year.

Hazardous Goods Transport Ordinance for lithium-ion batteries.

Regulations that have to be fulfilled in road/rail, sea and air freight: ADR, RID, IMDG, IATA DGR, PI, SP.

Circular Economy Act (KrWG)

The amended law came into force in Germany on 10/28/2020 and serves to implement the Waste Framework Directive of the European Union. The focus is on greater product responsibility on the part of manufacturers and retailers as well as specified requirements regarding critical raw materials, harmful substances and precautions against the illegal disposal of waste (littering).



UN 38.3 Test modules

Before lithium cells/batteries can be transported, they have to be tested. Transport conditions such as pressure, temperature, crushing, impact, etc. are simulated. (UN Manual of Tests and Criteria). Part III, section 38.3 describes eight test modules.

Ordinance on requirements for the treatment of waste electrical and electronic equipment

Before lithium cells/batteries can be transported, they have to be tested. Transport conditions such as pressure, temperature, crushing, impact, etc. are simulated. (UN Manual of Tests and Criteria). Part III, section 38.3 describes eight test modules.

WEEE Directive 2012/19/EU (Waste Electrical and Electronic Equipment)

This Directive defines the minimum requirements for the treatment of waste electrical and electronic equipment in the European Union with the aim of preventing or reducing waste from electrical and electronic equipment through reuse. (ElektroG)





6. DEKRA supports

The electrification and development of batteries is increasingly dependent on safe closed loops in the disposal and recycling chain. In the time of the sustainable transformation, the systematic monitoring of risky processes is also becoming more important than ever before – and with it, the management and updating of all the necessary regulations and documentation. For this reason, a risk management system is required which is able to take dynamic market conditions and risk situations into account on an ongoing basis.

Companies should use their management systems to review and strengthen the resilience in the supply chain and company processes, including in terms of battery-related risk situations. Suitable structures here are, for example, those based on international standards such as EN ISO 9001 et seq. (quality management), ISO 14001 et seq. (environmental management) and the Ordinance on Specialist Waste Management Companies (EfbV).

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Certified quality management according to ISO 9001

The standard is compatible with other ISO standards due to its high level structure. Synergies arise in the context of the organization, leadership, planning, support, operation, evaluation of performance and improvement. The risk-based approach is essential for being able to identify opportunities and potential threats, derive suitable measures and to review these on an ongoing basis. The certification ensures that strategic corporate goals (for the development of new market potential in the life cycle management of batteries, for instance) are effectively supported by quality management and business processes.

Certified environmental management in accordance with ISO 14001

This standard enables a fundamental improvement in environmental performance, to minimize the impact of the disposal on the environment, for example. All environmental impacts are taken into account: The use of raw materials, waste minimization, CO₂ emissions, the impact on ecosystems, investment decisions, etc. The focus is on defining environmental goals and measures that are suitable for implementing and reviewing the formulated environmental policy at the company and product levels. Certified companies benefit from the more efficient use of raw materials, new KPIs for managing the environmental performance and an improved level of risk prevention.



Certified waste management company With a certification in accordance with the German Ordinance on Specialist Waste Management Companies (EfbV), companies or specific subdivisions can document their environmentally friendly processing of waste, including waste electrical and electronic equipment. Companies can also identify where the operational risks and environmental hazards are in their own waste management. Both the EfbV certification (including the ElektroG and BattG) and certification in accordance with the ElektroG assess the requirements regarding the transport, storage and handling of Liion batteries (waste batteries).

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