Fraunhofer BATTERIEN

Fraunhofer Battery Alliance

End-of-life and battery recycling

Establishment of an automated recovery of functional materials from battery cells (© Fraunhofer ISC, K. Selsam)

The 26 member institutes of the Fraunhofer Battery Alliance develop technical and conceptual solutions along the entire value chain of electrochemical energy storage systems up to the application level on behalf of customers or in publicly funded projects together with industry. Our expertise and many years of experience range from materials development to system integration of mobile and stationary storage systems.

Competences and field of work

Batteries are a key factor for the implementation of the energy transition. To ensure a sustainable approach, a holistic view of battery technologies is necessary. In this context, the limited use of critical raw materials, a design which is suitable for dismantling and recycling, second-life models, and intelligent, resource-saving, and efficient recycling are crucial. Processes can be optimized through digitized preparation of accompanying information for track and trace concepts. Circular economy measures help to significantly reduce the CO_2 footprint of batteries.

The member institutes have many years of experience in the evaluation of battery and process technologies along the entire value chain from raw material extraction to the battery and recycling. Current lithium-ion batteries as well as future lithium-sulfur batteries and redox-flow batteries are considered, as well as emerging technologies such as solid-state batteries. Already during the development of new battery technologies and the optimization of existing systems, the amount of critical raw materials as well as a recycling-friendly design of the cells and modules are taken into account. Life cycle analysis (LCA) focuses on the areas of cell production (cradle-to-gate), second-use (cradle-to-cradle) and recycling (cradle-to-grave), which are supported by appropriate software and data bases. In the context of second-use concepts for aged lithium-ion batteries, one focus of the institutes is on the industrial reconditioning of modules. For this purpose, methods of rapid characterization are applied and classified second-life batteries are equipped with electrical and optical sensor safety systems in order to achieve reliable and long-term operation in the non-linear aging phase.

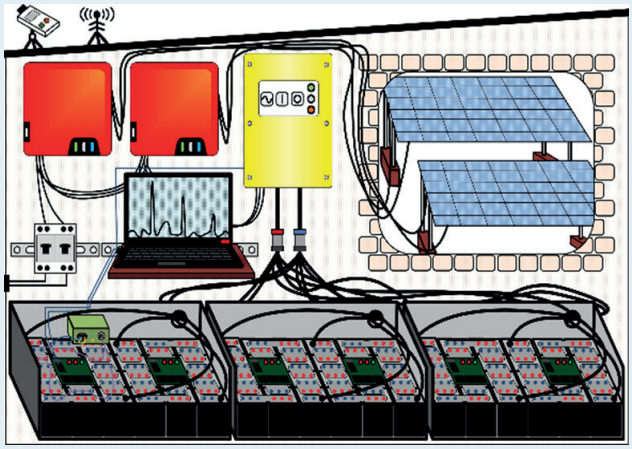
The activities in battery recycling range from mechanical pretreatment and preparation to material recycling (hydrometallurgical and electrochemical processes) to the recovery of functional materials from the black mass and electrolytes as well as regeneration of active materials and the investigation of the reusability of recycled active materials. The focus is on resource-saving, efficient and innovative process management, which can also be transferred to the recycling of future technologies such as solid-state batteries. Recycling is accompanied by comprehensive analysis of the materials, characterization methods and process monitoring. In addition, processes for the automatic disassembly and reassembly of battery systems and their subcomponents are also being considered. Furthermore to the design of respective factory and logistics systems, this includes in particular the development of automated testing, disassembly and reassembly functionalities and their linking to flexible process chains.

Our offer

- Evaluation of battery and process technologies along the entire battery value chain
- Preparation of life cycle assessments (LCA)
- Determination of the remaining useful life of batteries (RUL forecasts)
- Demonstration of reconditioning processes of lithium-ion batteries under market conditions
- Development of cell design suitable for recycling (customer-specific)
- Transfer of the process steps disassembly, recycling, characterization, safety equipment and reassembly under market economy parameters in companies

Pilot plants and equipment

For the dismantling and recycling of batteries, the member institutes have access to a wide range of equipment in various laboratories and pilot plants with the corresponding safety infrastructure. This enables the dismantling of battery systems from the module to the cell with subsequent recycling. Materials can be prepared and classified using shredders and centrifuges. Various systems (autoclave, extraction), reactors (precipitation, leaching) and processes (mainly electrochemical) are used to fractionate, dissolve, concentrate and treat the materials, thus recovering valuable components and metals. The metals are determined qualitatively and quantitatively by means of comprehensive in-process analysis.



Schematic diagram of a prototype island grid system with lithium-ion battery cells pre-aged in transport mode as energy storage (© Fraunhofer HHI)

Please feel free to contact us – with many years of experience and expertise, we will collaborate with you to develop customized solutions tailored to your needs.

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