

FRAUNHOFER TWIN TRANSITION SERIES – IMPULSE

»Green beginnings for End-of-Life Batteries: The potential of reuse, repair and recycling«

In a nutshell:

- Batteries are the enabling technology for the sustainable transformation.
- New sustainability requirements change the entire life cycle (design, production, use, and End-of-Life phase) of batteries.
- Life-cycle assessments help to determine the environmental impact, but a common European approach is missing.
- Recycling offers new possibilities for a circular economy, research supports the development of sustainable End-of-Life pathways.
- Political support is needed to deploy market-ready solutions.

Storing energy in batteries for later use is a physical concept essential for many technological applications. Batteries are a key enabling technology for a smart and connected mobility sector, an affordable and secure energy system, and a sustainable industrial production. With the ongoing green transformation, the demand for safe, high-performing, affordable batteries increases, whilst new criteria on longevity of batteries or sustainable sourcing of materials become vital in the design and production of batteries.

»Lithium-ion batteries are an important building block of the energy transition.

We need to reduce the use resources and costs of these batteries.«

Mareike Partsch, Fraunhofer IKTS

In this edition of our Fraunhofer Twin Transition Series, researchers from the [Fraunhofer Battery Alliance](#) (represented by [Fraunhofer Research Institution for Battery Cell Production FFB](#), [Fraunhofer Institute for Structural Durability and System Reliability LBF](#) and the [Fraunhofer Institute for Ceramic Technologies and Systems IKTS](#)) presented the challenges and potentials of a concerted approach to new battery technologies. The event outlined state of the art research and technologies and emphasized the need for political support to drive the transition.

Jens Tübke underscored the need for a holistic approach to batteries, which Fraunhofer-Institutes deliver on with diverse competencies crucial for the whole value chain: from the material and cell level to battery systems and their integration in different applications. Further up the value chain, the Fraunhofer Battery Alliance focuses on the evaluation and testing of batteries, including the simulation of different use cases. The research does not stop at the end-of-life (EOL) of batteries, as the Institutes work towards a circular economy, developing new recycling options with accompanying life cycle assessments (LCA).

»For the first time a regulation tries to regulate the whole value chain of a technology.«

Malte Gallée, MEP

The European Parliament, the Council for the EU and the European Commission are currently negotiating the new Battery Regulation in the context of the Circular Economy Action Plan of the European Green Deal. As one of the shadow rapporteurs and patron of our webinar, Malte Gallée highlighted the broad thematic range of the battery regulation. It covers the entire production

process, starting with a required due diligence for the sourcing of raw materials, increased transparency through a battery passport and publication of the carbon footprint as well as facilitated repair or replacement options for customers.

Diving into the nitty gritty of two approaches to support this European endeavor, our experts Thilo Bein and Mareike Partsch outlined the potential of LCAs and the recycling of EOLs.

Transparency along the life cycle: LCAs as tool

To support the transition to a sustainable battery value chain, new ways of measuring the environmental impact are necessary. Since the environmental impact of different recycling processes varies, transparent measurability is required to determine the right pathway for EOLs. Life-cycle assessments (LCAs) provide a solution to this problem. As part of the consortium of the Horizon Europe funded project TranSensus LCA, Fraunhofer LBF and [Fraunhofer Institute for Surface Engineering and Thin Films IST](#) aim to conceptualize and demonstrate a single, European-wide real-data LCA approach for zero-emission road transport, thereby paving the way towards a harmonized standard for LCA.

Choosing the right EOL: To recycle or not to recycle

Recycling is the last step in a circular economy. Batteries should only be recycled when other options such as repurposing, remanufacturing, repair or reuse are no longer economically feasible. Mareike Partsch presented the different steps for batteries at their end of life and highlighted that recycling processes are already well developed, and the quality of recovered materials is adequate with the potential of utilizing up to 40% of recycled materials in the battery production by 2050. However, we have no coherent recycling chains yet and challenges remain, like unresolved safety hazards in the collection process or a change of components and materials in batteries. Current researcher projects address these issues. The [Fraunhofer Institute for Silicate Research ISC](#) works in the Horizon 2020 project [RecyLib](#) on the selective separation of black mass and the regeneration of aged cathode materials to establish sustainable, low-energy and highly efficient manufacturing and recycling chains for lithium-ion batteries.

The future is circular: Support for research

The Battery Regulation needs to draw on the full potential of battery recycling as a crucial part of a high-quality and quantitatively sufficiently available material basis for the replacement of raw materials in battery production. Additionally, the legal framework needs to provide for the retention of material flows within Europe. Time is of the essence and cutting-edge innovations will enable the transformation towards sustainable batteries and manufacturing processes to support the long-term goal of a European standard for a sustainable battery ecosystem.