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Graz, 12 November 2024

Call for a Master's thesis - Circularity assessment of the Lithium-Ion Battery End-of-Life

Background. With the expected increase of Li-ion batteries (LIBs) especially in the field of mobility, research and policy makers are interested in developing recycling strategies that decrease mining activities and raw material shortage as well as solving End-of-Life (EoL) problems.

Collection rates for LIBs are low, and recycling is technologically challenging and costly. Today, almost no lithium is recovered in the EU because it is deemed not cost-effective compared with primary supplies and recycling is geared towards recovering cobalt, nickel and copper, which is considered more economically valuable. Recycling efficiencies are estimated at about 95% for cobalt and nickel, and 80% for copper, depending on the specific process. The Horizon Europe project FREE4LIB (<https://www.freeforlib.eu/>) is developing several recycling processes with the goal of improving the life cycle and circularity performance of LIBs.

Despite the clear and ambitious recycling targets of the European Commission there is no consensus on how to achieve them. Numerous scientific publications and a new ISO standard (ISO 59020:2024 Circular economy — Measuring and assessing circularity performance) propose different circularity indicators, but there is still not much literature and information on the application of circularity assessment to specific products and the methodical decisions needed for it (e.g., prioritization of indicators to make the most sense for the assessment in the context of LIB EoL).

Objectives. The objectives of this Master Thesis are to shed light on the different circularity assessment indicators, to do a prioritization based on different criteria specific for LIB EoL scenarios and to calculate and interpret the circularity improvements through the newly developed recycling processes. For achieving this goals the following steps are recommended:

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1. Systematic review of the (scientific) literature, including the ISO standard on circularity assessment with the focus on the following aspects:
 - a. Listing of existing indicators
 - b. Description of what parameters and data are needed to calculate these indicators
2. Definition of objective criteria (demands) for the selection, categorization and prioritization of the indicators (potential categories: macro – micro – inflow – outflow – energy – water - economic) for the assessment of LIB EoL scenarios
3. Application of the selected indicators for LIB EoL circularity assessment
 - a. Definition of meaningful system boundaries
 - b. Collection of (project) data and calculation of the indicator(s)
 - c. Interpretation of the results

Focus of the interpretation could be how much each recycling process developed (within FREE4LIB) contributes to the overall circularity of LIBs and the EU recycling targets ([EUR-Lex - 52020DC0098 - EN - EUR-Lex](#)). Optional further tasks include a discussion on how a digital battery passport (DBP) can support the circularity assessment of LIB EoL, e.g., especially regarding data availability.

Methods. The systematic literature review should be done according to the PRISMA guidelines. For the ranking and grouping of the indicators, methods like morphological box or multicriteria decision making methods such as analytical hierarchy process can be used.

Requirements

- Enrolled in the ESS, Circular Economy, Sustainable development etc.
- English skills (due to the international project focus)
- Willingness to get in touch with project partners from the FREE4LIB project and to gather information (support by supervisor)
- High motivation to be involved in an international project
- Planned finalisation of the thesis by May 2025 (negotiable)

Further information. The thesis will be supervised by professor Dr. Rupert Baumgartner (ESS) and co-supervised by project employee Julius Ott MSc. The research should be conducted in English language. If you are interested in the topic, please get in contact by email: Julius.ott@uni-graz.at until **30th of November 2024**

Graz, 10th of November 2024

References

FEASIBLE RECOVERY OF CRITICAL RAW MATERIALS THROUGH A NEW CIRCULAR ECOSYSTEM FOR A LI-ION BATTERY CROSS-VALUE CHAIN IN EUROPE | FREE4LIB Project | Fact Sheet | HORIZON | CORDIS | European Commission (europa.eu) (February 2023)

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