Life cycle assessment of an all-solid state battery

Background

Most current batteries, including lead-acid and lithium-ion batteries, use liquid electrolytes. All-solid state batteries (ASSBs) instead have a solid electrolyte, as well as solid electrodes. In other words, the whole battery is solid. The idea of such batteries is to make the batteries safer but also to increase the energy density. Currently researched cathode materials are generally lithium-based, but the choice of anode material is more versatile and depends on the electrolyte, which in turn also varies a lot between designs. In general, since ASSBs are still at an early stage of technological development, there is a large variation in designs. While many other battery types, in particular lithium-ion batteries, have been studied extensively regarding their environmental and resource impacts, only a limited number of LCAs of ASSBs exist to date. Regarding natural resource use, one can note that the batteries considered in these studies include several different scarce elements, such as lithium, cobalt and lanthanum.

Project

In this master thesis project, the students will first review which already-conducted LCAs of ASSBs exist by consulting the scientific literature. As a next step, a promising ASSB which has not been studied in previous LCAs will be selected. In particular, ASSBs with a low use of scarce elements will be considered promising. Then, the students will conduct a screening LCA of the selected ASSB. The master thesis will be a contribution to the research project "Life cycle assessment of future battery chemistries – high storage capacity without scarce resources?" funded by the Swedish Energy Agency.

Further reading

- Lastoskie, Christian M; Dai, Qiang. 2015. Comparative Life Cycle Assessment of Laminated and Vacuum Vapor-Deposited Thin Film Solid-State Batteries. Journal of Cleaner Production, 91, 158-169. https://www.sciencedirect.com/science/article/pii/S0959652614012876
- Troy, Stephanie, et al. 2016. Life Cycle Assessment and Resource Analysis of All-Solid-State Batteries. Applied Energy, 169, 757-767. https://www.sciencedirect.com/science/article/abs/pii/S0306261916301982
- Sun, Yang-Kook. 2020. Promising All-Solid-State Batteries for Future Electric Vehicles. ACS Energy Letters, 5, 3221-3223. https://pubs.acs.org/doi/pdf/10.1021/acsenergylett.0c01977
- Toyora's game-changing solid-state battery en route for 2021 debut: https://asia.nikkei.com/Spotlight/Most-read-in-2020/Toyota-s-game-changing-solid-state-battery-en-route-for-2021-debut
- Research project: https://www.chalmers.se/en/projects/Pages/Life-cycle-assessment-of-future-battery-chemistries-Q-high.aspx

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