LCA OF AUTOMOTIVE BATTERIES FOR ELECTRIC VEHICLES - A LITERATURE REVIEW

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Life cycle assessments about batteries in electric vehicles assess the environmental impacts of the battery over the whole lifespan from material extraction for the production to end of life treatments in recycling facilities. To analyze and assess the environmental effects of the production and end of life lifecycle steps of automotive batteries for electric vehicles, 46 publications about life cycle assessment of electric vehicle batteries were reviewed by collecting data in a database to gain qualitative and quantitative results for the environmental effects to identify the main influences on the environmental performance of batteries.

Reliance of LCA studies on secondary data from other LCA studies is high due to limited access to primary data. The data basis is limited for impacts per battery component or per production stage and for further environmental impact categories besides the primary energy consumption and global warming potential of processes.

For the battery production, the review seems to show that the environmental impact of cell manufacturing could have been overestimated due to the assessments of relatively small production scales and high electricity shares in the process, while material emissions, like from mining and especially processing, could have been underestimated due to process-based assumptions with limited primary data and could gain importance for future researches.

Focusing on the global warming potential, current LCA studies show overall no significant differences between material emissions of different battery packs with variations in battery chemistries. But differences in primary energy demand and global warming impact could be more significant than assumed due to an underestimation of material processing and the impact of different production locations. The cathode and overall metal use in the battery pack (especially nickel and cobalt for lithium nickel manganese cobalt oxide cathodes, aluminum and steel) seem to be significant and could be influenced by the share of virgin/recycled material and different material processing locations with variations in process design.

Lifetime of batteries could also influence results but is currently mainly designed according to the vehicle lifetime, which could be a wrong assumption. Furthermore, second life applications for batteries after the usage in electric vehicles (for example storage for photovoltaic systems) are at most shortly described and could influence the environmental impacts significantly when further use of the battery pack is considered to utilize the remaining storage capacities of battery packs.

Data on battery recycling processes was limited as often a lack of data was stated and possible environmental impacts and benefits from recycling were not included. Considering the primary energy consumption and the global warming potential, savings due to recycling outweigh negative environmental impacts of recycling. The implementation of a direct recycling approach should be further investigated, as it could facilitate recycling processes by obtaining whole cathodes with higher market values by using a less energy demanding process. Recycling could also gain further importance, as the material processing impacts and impacts of virgin metal use in the cathode and further parts of the battery pack could be considerably reduced by using recycled metals from old battery packs.

In-depth assessments of further impact categories besides the primary energy consumption and global warming potential per battery component and for different material uses should be carried out to gain more data on how impact categories like toxicity or abiotic resource depletion could influence the environmental performance due to the significance of metal use in battery packs in production assessments. Importance of recycling could grow by assessing further environmental impacts.

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