

Evaluation of a Remanufacturing for Lithium Ion Batteries from Electric Cars

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Abstract : Electric cars with their fast innovation cycles and their disruptive character offer a high degree of freedom regarding innovative design for remanufacturing. Remanufacturing increases not only the resource but also the economic efficiency by a prolonged product life time. The reduced power train wear of electric cars combined with high manufacturing costs for batteries allow new business models and even second life applications. Modular and intermountable designed battery packs enable the replacement of defective or outdated battery cells, allow additional cost savings and a prolongation of life time. This paper discusses opportunities for future remanufacturing value chains of electric cars and their battery components and how to address their potentials with elaborate designs. Based on a brief overview of implemented remanufacturing structures in different industries, opportunities of transferability are evaluated. In addition to an analysis of current and upcoming challenges, promising perspectives for a sustainable electric car circular economy enabled by design for remanufacturing are deduced. Two mathematical models describe the feasibility of pursuing a circular economy of lithium ion batteries and evaluate remanufacturing in terms of sustainability and economic efficiency. Taking into consideration not only labor and material cost but also capital costs for equipment and factory facilities to support the remanufacturing process, cost benefit analysis prognosticate that a remanufacturing battery can be produced more cost-efficiently. The ecological benefits were calculated on a broad database from different research projects which focus on the recycling, the second use and the assembly of lithium ion batteries. The results of this calculations show a significant improvement by remanufacturing in all relevant factors especially in the consumption of resources and greenhouse warming potential. Exemplarily suitable design guidelines for future remanufacturing lithium ion batteries, which consider modularity, interfaces and disassembly, are used to illustrate the findings. For one guideline, potential cost improvements were calculated and upcoming challenges are pointed out.

Keywords : circular economy, electric mobility, lithium ion batteries, remanufacturing

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