

Environmental Impact Assessment of the Rebuilt Parts Manufacturing Process

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Reducing environmental burdens is essential for achieving a sustainable society. Rebuilt parts recovered from end-of-life vehicles are remanufactured by replacing worn components with new ones and re-inspected to a standard equivalent to new parts. This study targets 13 components—3 engine parts, 3 starters, 4 alternators, 3 compressors—from typical passenger vehicles, and aims to quantify the environmental load of the rebuilt-part manufacturing process.

Life Cycle Assessment (LCA) quantitatively evaluates environmental impacts across the full product life cycle. In this study, LIME2, developed by AIST to reflect Japanese environmental conditions, was used as the impact assessment method. LIME2 performs evaluation in three stages: characterization (assessing impacts across 15 categories including climate change and resource consumption), damage assessment (quantifying potential damage to four safeguard subjects: human health, biodiversity, social assets, and primary production), and integration (weighting and converting these into a single willingness-to-pay indicator). This enables evaluation beyond climate change and allows results to be compared on a consistent basis.

The rebuilt-part manufacturing process was divided into three stages: disassembly, transportation, and rebuilding. In disassembly, recyclable parts are removed from the end-of-life vehicle, the body is sorted by material, and pressed into scrap. The total integrated single indicator for the entire disassembly stage was 35.4 JPY.

Environmental loads from transportation between the disassembly and rebuilding facilities were calculated based on core weight, assuming a transport distance of 78.33 km using 10-t and 4-t trucks. The integrated single indicators for the 13 components ranged from 0.44 to 0.72 JPY for starters, 1.05 to 1.22 JPY for alternators, 0.73 to 1.01 JPY for compressors, and 9.62 to 17.62 JPY for engines.

Remanufacturing impacts were calculated for all component types. Kei car 1 showed an integrated indicator more than twice that of Kei car 2 due to its higher replacement rate. Combining all three stages, the remanufacturing stage dominated: 94.9%–99.0% for starters, 95.5%–98.5% for alternators, 98.5%–99.1% for compressors, and 95.6%–96.9% for engines (Fig. 3). Adding disassembly and transportation impacts did not substantially alter these results.

This study evaluated the environmental impacts of the rebuilt-part manufacturing process using LIME2, incorporating disassembly and transportation stages previously excluded from such analyses. The remanufacturing stage accounted for 94.9%–99.1% of total impacts across all 13 components; calculating only the remanufacturing stage covers more than 90% of the total for every component. Future work will compare these results with new-part manufacturing to quantify the environmental benefit of using rebuilt parts.

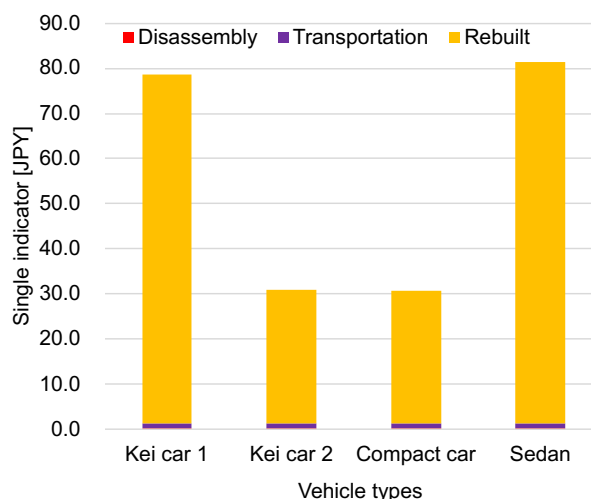


Fig.1 Single indicator of the entire alternator remanufacturing