# LIFE CYCLE ASSESSMENT OF END-OF-LIFE VEHICLE PROCESSING

Executive summary

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## Executive summary

In view of the Corporate Sustainability Reporting Directive (CSRD) and as part of its ongoing commitment to accelerating the transition to a circular economy, Febelauto, the organisation responsible for the collection, treatment, and recycling of end-of-life vehicles (ELVs) in Belgium, commissioned this study to quantify the environmental benefits of ELV processing. The assessment focuses on internal combustion engine passenger cars treated at authorised treatment facilities in Belgium and is intended to support a wide range of stakeholders including importers, manufacturers, dismantlers, and policymakers in preparing for future sustainability reporting obligations and in calculating and communicating potentially avoided emissions.

The primary objective of the study is to quantify both the greenhouse gas emissions generated by ELV processing and the avoided emissions and material savings resulting from reuse, recycling, and energy recovery. To achieve this, an attributional life cycle assessment (LCA) with system expansion was conducted to account for the credits associated with avoided burdens. The Environmental Footprint 3.1 method was applied, focusing on the climate change impact category expressed in $CO_2$-equivalent emissions. Modelling was performed using SimaPro v9.6.0.1 and the Ecoinvent v3.9.1 cut-off system model.

Life cycle inventories were developed using activity data provided by Febelauto, including the total mass of components collected during depollution and outputs from shredding processes, as well as their distribution across four treatment routes: reuse, recycling, incineration with energy recovery, and disposal. The dataset reflects operational activities for the year 2023, with the average ELV weight estimated at 1,261.01 kg. This dataset is specifically representative of the Belgian market for internal combustion engine passenger cars. Other vehicle types, such as electric vehicles, light commercial vehicles, or trucks, are outside the scope of this study. Based on this dataset, and supported by complementary literature, the material composition of an average ELV and the mass-based distribution across treatment options were determined.

The environmental impacts of recycling and energy recovery processes were modelled using existing Ecoinvent datasets. Where no suitable datasets were available, state-of-the-art LCA literature and custom inventory models were used to ensure accurate and up-to-date representation. To model avoided burdens, material flows were adjusted using recycling rates (accounting for process losses) and quality factors (reflecting substitution efficiency), in line with the logic of the Circular Footprint Formula from the Product Environmental Footprint method.

The results show that processing one average ELV generates 666.1 kg $CO_2$-eq, but enables the avoidance of 4,063.9 kg $CO_2$-eq through reuse, recycling, and energy recovery. This results in a potential net climate benefit of 3,397.8 kg $CO_2$-eq per vehicle. In parallel, an estimated 1,100.8 kg of primary raw materials are substituted through the generation of secondary materials and the direct reuse of parts, reducing the demand for virgin resource extraction.

Direct reuse of dismantled components, which represents 23% of the ELV’s weight, accounts for 48% of the avoided emissions, demonstrating the strong climate benefit of extending product life by replacing newly manufactured parts. While the recycling of steel generates approximately 340 kg $CO_2$-eq of emissions due to the energy and material inputs required for processing, it still provides the largest material-specific climate benefit. Indeed, recycling steel avoids more than 1,300 kg $CO_2$-eq that would otherwise be generated through primary steel production. Aluminium, although making up only

6% of the vehicle's weight, accounts for 12% of the total avoided emissions, due to the energy intensity of its primary production. Recycled polymers and energy recovered through incineration also contribute smaller, but still meaningful, shares to the overall benefit.

While this study provides a robust and transparent quantification of the environmental benefits associated with ELV processing, several limitations should be acknowledged. Recycling rates and quality factors used in the modelling are based on literature and generic assumptions and may not fully reflect the variability of real-world recycling practices, local conditions, or energy mixes. In the case of reuse, the study assumes a 1:1 substitution between reused and newly manufactured parts, without considering any potential degradation, reduced performance, or shortened lifetime of reused components compared to new parts. This modelling choice may lead to an overestimation of avoided emissions in situations where reused parts have a shorter lifespan. Moreover, avoided emissions are allocated entirely to the ELV processing system, although in practice these benefits arise from the joint efforts of all actors across the value chain.

Avoided emissions should therefore be seen as the result of a collective value chain effort, and not attributed to individual actors alone. Claiming avoided emissions at a single-actor level risks double-counting and misrepresenting the systemic nature of these benefits. In line with CSRD requirements and the RECORD association's methodological guide, avoided emissions should always be reported separately from induced emissions and not deducted from an organisation's carbon footprint. A recommended formulation is that *"participation in the ELV processing chain contributes to a cumulative GHG reduction of X tonnes* $CO_2$*-eq."* Any communication of avoided emissions should also be accompanied by clear disclosure of the functional unit, reference scenario, reference year, modelling assumptions, and study limitations.

This study confirms that ELV processing in Belgium delivers significant climate and resource-saving benefits, reinforcing its role in the national circular economy and supporting Belgium's broader low-carbon transition. By quantifying avoided emissions and material substitution using a robust LCA framework, Febelauto provides a solid basis for transparent, standardised reporting aligned with the latest developments in avoided emissions accounting and CSRD compliance. The results can inform policy development, support industry reporting, and inspire eco-design strategies, while advancing Febelauto's mission to promote sustainable vehicle end-of-life management and circular practices across the mobility sector.