Constellium Aluminium for automotive body sheet Life Cycle Assessment summary

Introduction

This document aims at describing the results of Constellium internal Life Cycle Assessment (LCA) work on aluminium automotive body sheets, focusing on an aluminium hood for illustration purpose. It also contains a comparison with a steel part.
This study respects ISO14040/44 standard for LCA and the resulting report underwent a critical review by independent third parties (Quantis with a contribution from French CETIM).

The document structure is as follows:

- Scope of the study: description of scope and main assumptions.
- Results: disclosure of results, with a specific focus on climate change (greenhouse gas emissions). Full study was performed on a wider range of indicators.
- Sensitivity analysis: study and discussion of main parameters influencing the results
- Conclusions

Scope of the study

A key issue is the definition of the scope of the study, notably to exclude unsuited comparison or data extrapolation. Comparison should make sure that it addresses the same scope.

This study's scope is a car hood that can be produced either out of aluminium sheets by Constellium Neuf-Brisach site, thus based on this site specific performance and metal sourcing, or from steel, then using public data from literature and standard LCA database (from GaBI LCA software).

The figure hereunder summarizes the system boundaries (i.e. life cycle steps that are included or excluded from the scope) and material flows. Investigated life steps included primary metal elaboration, metal transformation (rolling operations, including scrap recycling), car use phase and end-of-life (including recycling).

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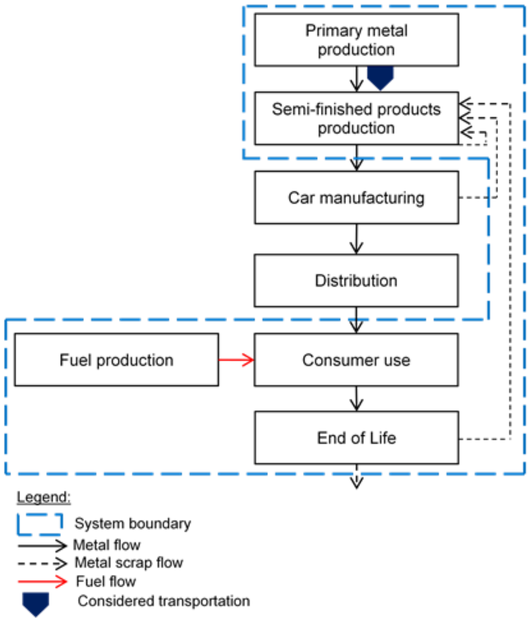

As illustrated on the figure on the left, two life cycle steps are excluded from the scope.

- Car manufacturing, due to missing data
- Product distribution

Other steps were included, from metal production (from bauxite mining to electrolysis) to product use and end of life.
Transportation of slabs and coils are included along with transformation scrap production and recycling in the model.
Due to a lack of data related to steel, scrap production and recycling during the car part manufacturing was not included. Its effect was investigated for aluminium only in the study.

Main assumptions:

- Metal according to Neuf-Brisach 2014 sourcing
- European average car consumption from GaBi software database (diesel, but gasoline case was also investigated, showing changes that were not significant enough to alter the study's conclusions)
- 100% primary metal input, as recycling credits were considered using the avoided impact
    - (= end of life) approach.
- Mass of the aluminium car hood: 7.87 kg, with 40% mass saving over steel hood.
- Effect of 100 kg mass saving on fuel consumption: 0.28 l / 100 km[1]
- Two components design: Skin (6016 alloy) and lining (5182 alloy). The case of a single alloy solution for the whole hood does not bring any significant change to the results. Hence conclusions are valid for both multi-alloys and single alloy solutions.
- Average distance ran by the car: 200,000 km.
- Car end of life: according to European statistics, 84% of cars are being collected and recycled in Europe. The remaining 16% were supposed to experience an extra 50,000 km of use before being landfilled (worst case approach for end of life).
- Recycling rate of steel: 97%[2] for the 84% collected fraction of end-of-life cars
- Recycling rate of aluminium: 91%[2] for the 84% collected fraction of end-of-life cars

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[1] C. Koffler and K. Rohde-Brandenburger, "On the calculation of fuel savings through lightweight design in automotive life cycle assessments," The International Journal of Life Cycle Assessment, vol. 15, no. 1, pp. 128-135, January 2010
[2] Internal calculation based on actual shredding campaigns within French IRT M2P program.

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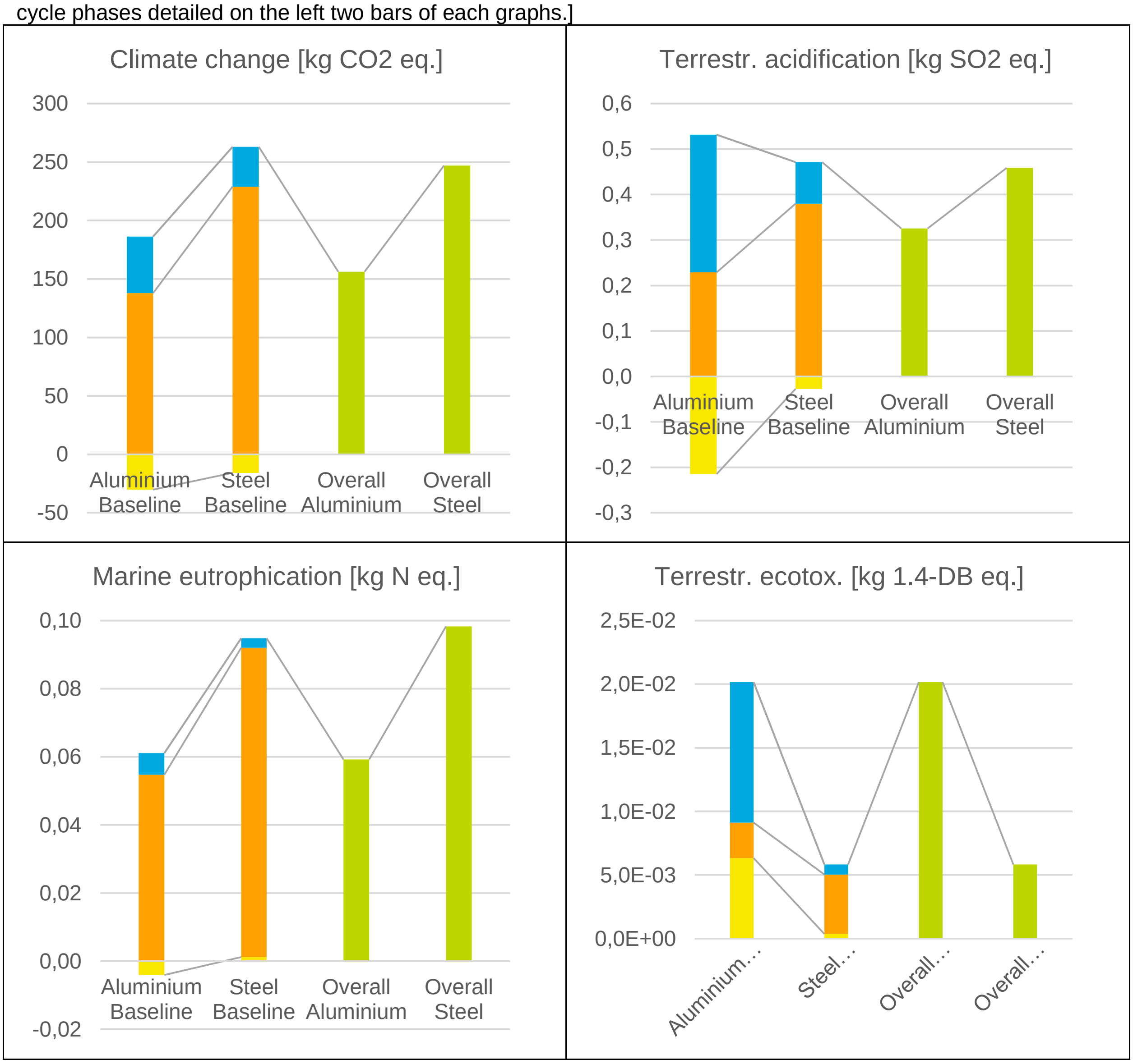
Results

This section will briefly describe LCA calculation results.

Figures below compare steel and aluminium hoods and detailed contribution of main life cycle steps for four indicators: climate change (= greenhouse gas emissions), terrestrial acidification, marine eutrophication and terrestrial ecotoxicity.

Contribution of different life cycle phases are provided according to the corresponding color codes:
[Green “Overall” bars display summarizes added contributions from all life cycle phases detailed on the left two bars of each graphs.]

- Overall
- Metal production
- Use
- End of life



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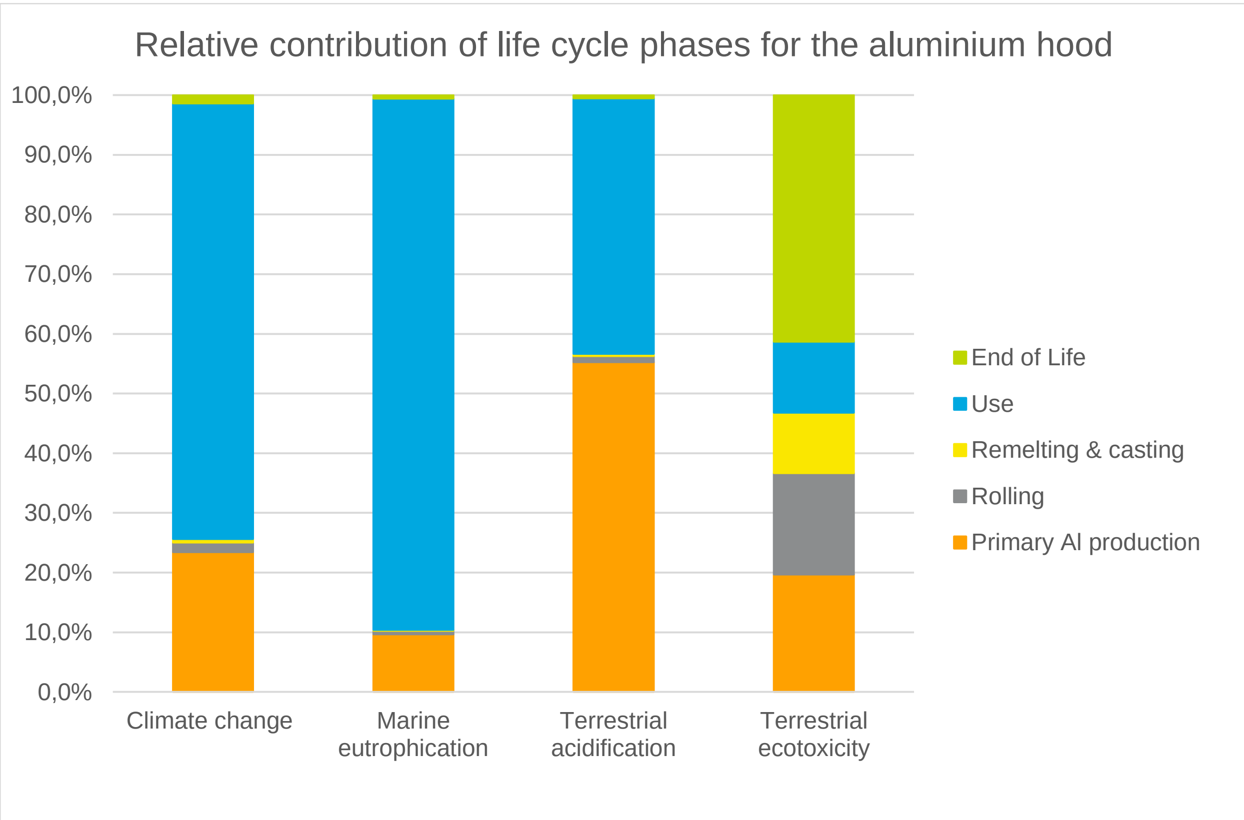
For Climate Change and Marine Eutrophication, the main contribution comes from product use phase (mostly from associated fuel consumption). The overall impact of the aluminium hood is also lower than for steel hood.

Metal production comes second, mostly due to primary metal production. End of life contribution yields a net reduction of the overall impact. The negative value (= credit) is justified by the reuse of recycled aluminium in another product, thus replacing the use of primary metal for a much lower environmental impact.

For terrestrial acidification, the metal elaboration is the main contributor, with slightly higher importance than the use phase. The overall impact is still lower for the aluminium hood than for its steel equivalent.

The terrestrial ecotoxicity indicator shows a different picture, with a dominating contribution of metal elaboration and end of life (recycling). The outcome is that the steel hood then shows a lower environmental impact than the aluminium one regarding this indicator.

A more detailed analysis of the different life cycle phases was performed for the aluminium hood (see figure below).



Similar results were not available at this level of detail for steel parts, as only aggregated (from mining to rolling) data are available for steel production.

Analysis of the effect of the main parameters on the results

This section allows for interpretation and discussion of the results.

Due to its lower weight, the aluminium hood exhibits lower emissions during its use phase. Consequently, for indicators where the vehicle use phase is an important contributor to the environmental performance, the overall result of Aluminium hood exhibits a significantly lower impact than the steel one. This is notably the case for climate change, terrestrial acidification and marine eutrophication.

The influence of recycling rate and average mass saving on climate change impact were investigated in the case of the Neuf-Brisach primary metal sourcing in 2014, and in the case of an European average sourcing[3]:
Graphs below display the combination of mass saving and aluminium part recycling rate for which aluminium performs better (green area) or worse (orange area) than steel. The black boundary corresponds to an equal performance of both materials regarding this indicator.

Note: the sensitivity analysis has been performed by making the aluminium part recycling rate fluctuating while keeping the steel's one constant.

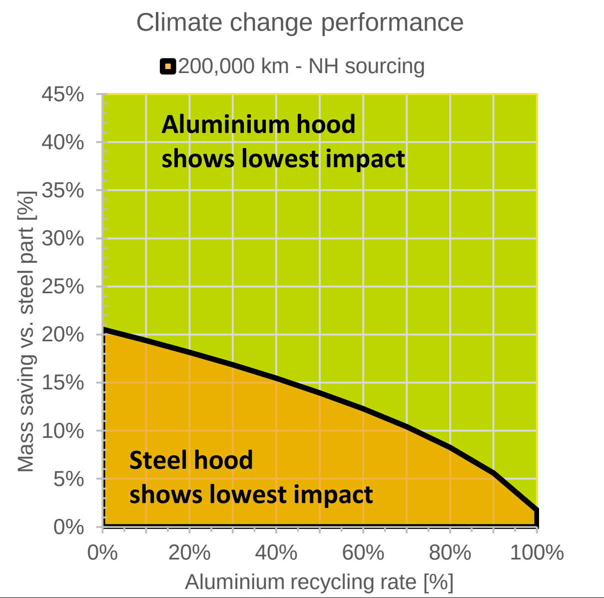


Fig. A: Primary metal sourcing for Neuf-Brisach in 2014

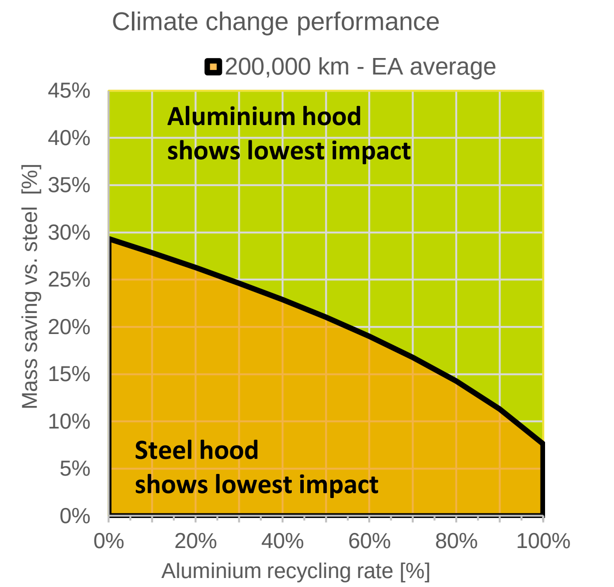


Fig. B: European average primary metal sourcing

[3] Average impact for « aluminium used in Europe », from EAA environmental profile report 2013.

The main conclusion is that in the worst case (no recycling at all for aluminium, while steel is still 97% recycled), the aluminium part still shows lower impact than steel as long as the associated mass saving is above:

- 30% for primary metal sourcing based on European average
- 20% when considering Neuf-Brisach specific primary sourcing in 2014, due to its specific low GHG emissions, compared to the European average.

With more realistic assumptions (recycling rate around 90%), the aluminium hood performs better for any mass saving ratio above 11% (EA average) or 6% (Neuf-Brisach sourcing). These results do not rely on car-hood specific data. For this reason, they remain applicable for any automotive rolled part manufactured out of Constellium Neuf-Brisach sheets.

Other parameters were also investigated, that showed no significant change on the results and conclusions. This is notably the case of motor size, gasoline / diesel, 150 000 or 200 000 km lifetime, recycling or landfilling of end-of-life cars not collected in Europe, recycling process (data based on either Constellium Neuf-Brisach or EA European average), steel production process (blast furnace or electric arc furnace).

Conclusion

The aluminium hood environmental performance assessed by LCA shows that its impacts are lower by up to 40% compared to a steel hood through several indicators, notably climate change.

The main contributions come from the use phase and the metal elaboration. The aluminum hood shows better performance in the use phase thanks to its lower weight.

Recycling is and mass saving compared to the steel part are key.

Metal sourcing mainly influences the importance of the gap between aluminium and steel but does not alter the conclusions.

Critical review report of the full LCA study is available on demand at the following e-mail address: sustainability@constellium.com