FEASIBILITY STUDY OF AN ALUMINIUM PRODUCT BUSINESS MODEL USING LITHOGRAPHIC ALUMINIUM IN A CLOSED LOOP PROCESS

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ABSTRACT

This paper describes the assessment of the environmental performance of a new cradle to cradle business model using LCA-methodology. An important issue is the trade-off between environmental credits due to the avoidance of the use of primary aluminium, and additional environmental impacts resulting from the extra transport steps needed to collect the aluminium waste, bring it to an aluminium production plant for recycling and re-use into new aluminium coils. The study shows that the additional transport steps have a very limited environmental impact compared to the manufacturing of the product. It is thus environmentally advantageous to recollect aluminium scrap even at larger distances to be able to increase the recycled content of the product.

INTRODUCTION

A consortium between different industrial partners, resp. a producer and a user of aluminium consumables, the aluminium industry and logistic service providers, and VITO was set up to assess the feasibility of closing the loop of scrap aluminium into new products. This research is performed in a MIP (environment innovation project) project that, motivated by both economic and social responsibility triggers, has the objective to study the feasibility of a business model using aluminium in a cradle to cradle process. The feasibility of this business model is evaluated on business level, on technical level and on corporate social responsibility level.

The request for this feasibility study came from one of the core industrial partners, who deems it important to monitor and improve the environmental performance of their aluminium products. To further improve the performance, the effect of closing the aluminium loop is assessed in this research project. An important issue is the trade-off between environmental credits due to the avoidance of the use of primary aluminium, and additional environmental impacts resulting from the extra transport steps needed to collect the aluminium scrap waste, bring it to an aluminium production plant for recycling and re-use into new aluminium coils.

METHODS

The environmental performance of the new business model is assessed using the LCA-methodology according to ISO 14040 and 14044 and keeping in mind the PEF guidelines. The manufacturing of the product, the use of the product by the client, the processing of the waste and all transport steps are included in the functional unit. Data are collected from project partners, customers and scrap dealers. The modelling of the environmental impact of the different transport steps is done with specific transport emission models. Background processes were taken from the Ecoinvent 2.2 database. Environmental profiles are calculated using the ReCiPe v1.07 midpoint (H) impact assessment method and the software package SimaPro 7.3.3.

For recycling of waste various methodological approaches can be followed, of which we selected three for this study (the recycled content approach, the end of life recycling approach and the Product Environmental Footprint Guide approach).

In the recycled content approach, at the beginning of the life cycle both the impacts of the aluminium recycling process (e.g. energy) as well as the credits of the recycling process (saving virgin material) are taken into account for the amount of recycled aluminium that is used in the product. The benefit of the recycled content approach is that it allows to monitor improvements regarding the input of recycled lithographic aluminium in the production process (closing the cycle) and the possibility to benchmark the product with competitors (who apply the recycled content approach).

In the end of life recycling approach, the impacts of recycling of the aluminium and the avoided production of virgin aluminium (by bringing the recycled material on the market, independent from the place where it will be used), are taken into account at the end of the life cycle. At the beginning of the life cycle neither credits nor impacts of the recycling process are taken into account for the amount of recycled materials, since these impacts and credits have already been allocated to the previous life cycle of the material. The advantage of the end of life recycling approach in this case is that it allows including the possibility of using recycled lithographic aluminium consumer scrap as a high quality substitute for virgin aluminium. This approach is logical from the perspective of the aluminium industry sector.

The third approach, considered in the Product Environmental Footprint Guide, is situated in-between the two previously described approaches. It allocates the impacts and credits due to recycling equally between the producer using recycled aluminium and the producer making a product that will be recycled at the end of its life: 50/50 allocation split.

RESULTS AND DISCUSSION

The environmental impact of four scenarios is analysed: business as usual (BAU), alternative alu (AA) scenario and two Cradle to Cradle (C2C 1 and C2C 2) scenarios. In the BAU scenario, no recycled aluminium is used for the product and at the end of the life cycle the plates become available on the regular open scrap market. In the AA scenario, no recycled aluminium is used for the product and at the end of the life cycle a fraction of the plate scrap (eg. 15%) is guided to dedicated scrap partners. The C2C scenario builds on the AA scenario; the fraction of the scrap that is guided to dedicated scrap partners eventually could be recycled into lithographic aluminium by the producer and an aluminium converter, and replace x% of the primary raw aluminium of the product. In C2C 1, a recycled content of 20% is considered. In C2C 2, more aluminium scrap is bought on the market to be able to reach a recycled content of 100%. Like in the AA scenario, it is assumed that at the end of life 15% of the volume of the product goes to dedicated scrap partners.

Environmental burdens of the business as usual scenario, according to the recycled content approach, are largely due to the production of the lithographic aluminium, except for agricultural land occupation (which is caused by the use of pallets to transport the product). The impact of the transport steps is relatively small. The transportation of the product to the customers contributes to up to 8% of the total environmental impact, depending on the category considered. The impact of the use phase is insignificant for almost all environmental impact categories.

A comparison of the four scenarios for the recycled content approach is presented in figure 1. For readability reasons, only the human health related categories are shown. Results are similar for ecosystems and resources related environmental impact categories. Per environmental impact category, the scenario with the largest contribution is set at 100%, the contribution of the other scenarios is presented relative to that 100%.

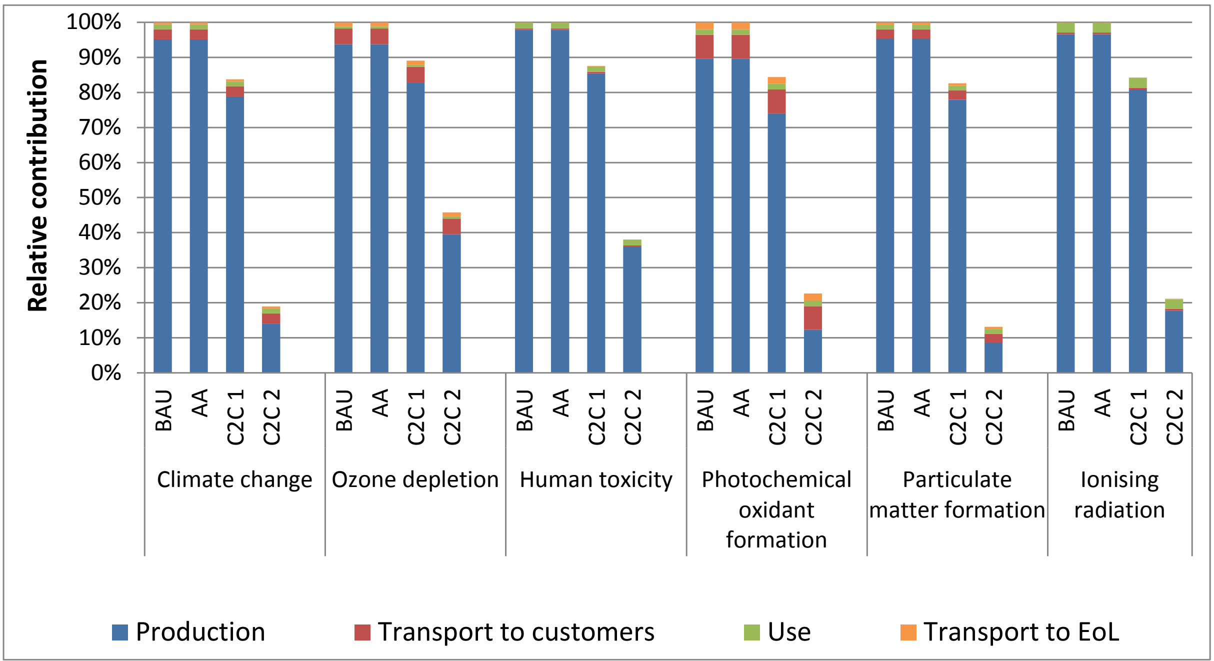

Figure 1: Environmental profile of the product in the 4 scenarios, according to the recycled content approach, for human health related categories.

The difference of the AA scenario and the BAU scenario is negligible (around 0,01%). The C2C 1 scenario has a smaller environmental impact in all impact categories (2 to 18% reduction), as the impact of the production of secondary aluminium is much lower than the impact of primary aluminium production. Since only secondary aluminium is used in the C2C 2 scenario, its impact is the smallest (10 to 88% reduction compared to the AA and BAU scenario).

When the same comparison of the four scenarios is made for the end of life recycling approach, the results for all scenarios are very similar. Indeed, equal credits for recycling are given in all scenarios, as lithographic aluminium consumer scrap will always be reused in other products. The impact of the additional transport needed to recollect the aluminium scrap is still the same as for the recycled content approach, but has become relatively more important as the total impact has decreased. However, the difference of the AA and the BAU scenario is still negligible (around 0,1%).

CONCLUSIONS

This study shows that the additional transport steps needed to collect the aluminium scrap waste and to bring it to an aluminium production plant for recycling and re-use have a very limited environmental impact compared to the manufacturing of the product. It is thus environmentally advantageous to recollect aluminium scrap even at larger distances to be able to increase the recycled content of the product (when using the recycled content approach).

Even when using the end of life recycling approach, recollecting scrap to be used in the product again will not add much to the environmental impact. It has to be noted that guiding the scrap to dedicated scrap partners was only considered for 15% of the volume of the product, when the location of the customer and amount of product used allows for this pathway.

To check whether it results environmentally beneficial for an additional client to enter one of the scenarios other than BAU, an excel tool is developed that allows the producer of the aluminium product to estimate the environmental impacts while adapting the values of recycling and transport parameters.

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