ICCA-WBCSD Avoided Emissions Guidance Case Study

c-LCA – Carbon Life Cycle Assessment of tinplate and polypropylene (PP) containers for chocolate drink powder, Braskem

1. Purpose of study

The purpose of the study is to assess the avoided GHG emissions from the use of PP-based containers instead of a tinplate container for chocolate drink powder.

The study was commissioned by Braskem, world leader in the area of synthesized resins with renewable raw material, and executed by ACV Brasil, a consulting company whose mission is to stimulate the integration of management tools, preferably based on the life cycle subject, in companies' actions.

2. Level in the value chain

The study focuses on the use of PP and green PP (which uses ethanol as its main raw material) resins for a chocolate drink powder rigid container. The study is based on the product level: the container itself; the primary goal is to show the contribution of this chemical industry packaging solution to reducing GHG emissions.

3. Solutions to compare

The PP and the green PP-based[1] rigid containers are compared to the tinplate one. They all deliver an equivalent benefit to the user: pack and preserve chocolate drink powder. Table 1 describes the composition of the containers.

Having in mind the product level chosen, the market for this kind of packaging (for 400g of product) is dominated by the tinplate alternative, with 240.67 million units produced in 2010 (47.5%), followed by the analyzed PP-based alternative, with 86.95 million units produced in 2010 (17.2%) [DataMark 2012]. Others represent 35.3% [DataMark 2012] and are not considered because, as flexible packaging, they do not fit in the rigid category under investigation.

Table 1 - Description of composition of the compared packaging solutions

PP and Green PP-based containers	Tinplate container
PP body: 26.31 g	Tinplate body: 63.26 g
PP lid: 7.27 g	LDPE lid: 7.25 g
Aluminum seal: 1.22 g	Aluminum seal: 0.85 g
Paper label: 2.41 g	Paper label: 2.78 g

4. Functional unit

4.1 Functional unit of the final product

Pack and preserve, with a rigid material, 400 g of chocolate drink powder during one year. This amount requires 1 rigid container to satisfy the functional unit.

4.2 Quality requirements

[1] Polypropylene from ethanol's (Green-PP) production has not started yet; design data were used for this analysis.

All alternatives considered in this study fulfill the same function and meet the minimum requirements concerning the mechanical, safety and food preservation properties, established and controlled by the National Health Surveillance Agency [ANVISA 1999]. It is supposed the options do not have differentiations regarding technical quality characteristics such as stability and durability.

Also, the additional service provided by the alternatives is considered to be the same, since one could use both packages to store different items after consuming their whole content. As for trade-offs referring to other environmental categories, the early conclusions show that PP-based alternatives are potentially the best options when compared to the tinplate package. This is not true for Land Use and Aquatic Eutrophication, for which green PP has a higher impact, and for Total Primary Energy and Non-Renewable Energy categories, in which the differences between results do not allow us to make a conclusion. Despite the fact that the study aims to verify the impacts on climate change, a complementary analysis of the contributions in other impact categories will be discussed.

Land Use Change (LUC), both direct (d-LUC) and indirect (i-LUC), has become an issue - especially regarding bio-based materials. Braskem conducted an extensive and rigorous d-LUC and i-LUC study for I'm Green™ Polyethylene, which also uses sugarcane ethanol as feedstock. This study shows that d-LUC further increases CO_2 removal, as in most cases sugarcane crops expanded into degraded pasture lands. In doing so, sugarcane crops actually increased the above and below ground carbon stocks. When considering i-LUC, the study shows that it might have a significant impact on GWP_{100} profile, but it can be mostly minimized by careful supply selection. Braskem has a Code of Conduct for Ethanol Suppliers and over 90% of purchased ethanol has been done under this Code.[2] Conservatively, the theoretical study did not include LUC in the green PP life cycle.

4.3 Service life

The service life of the package is set by the expiry date of the product packed, which is one year, considering the product was not opened.

4.4 Time and Geography

All data are representative of the Brazilian market in the year 2010, because of the greater abundance and representativeness of data found for the current market.

5. Calculation methodology

The methodology used for calculating the avoided carbon equivalent emissions is based on the "Guidelines by the Chemical Industry for Quantitative Comparison of Solutions to avoid Greenhouse Gas Emissions ", prepared by the ICCA and WBCSD [ICCA & WBCSD 2013].

Data used in the study came from the client (PP and green PP productions), from literature and from Ecoinvent database version 2.2, with adaptations of the electricity (considering the most recent data on the split among different energy sources and the use of charcoal replacing part of the hard coal), the transport (considering the road transport technology in the fleet and the diesel type used) and

[2] A more detailed discussion of this issue and the d-LUC and i-LUC study can be found in the complete LCA study available on the ICCA website.

the disposal scenarios (considering the absence of leachate and gases collection for treatment in dumps and a partial collection in controlled landfills).

The end of life base scenario is built accordingly [ABRELPE 2011], for which the average shares of waste disposal in Brazil are 58.1% of waste going to sanitary landfill, 24.2% to controlled landfill and 17.7% to disposal to dump. All these three different types of waste treatment for non-recycled materials were considered and modeled in this study.

Boundary setting

The study includes activities from cradle to grave. The filling process was excluded from the system because it was assumed to produce identical effects in the calculation of the c-LCA of the alternative solutions. The aluminum seal and the paper label were not considered either, due to their low and approximately similar weight, although they should be included in further evaluations.

Methods/formulas used

Through data gathering, CO_2-eq. emitted in the steps of extraction, manufacturing, distribution, consumption and disposal of the final product is quantified for the compared packages. Unit-based avoided emissions are then obtained as the difference between the cradle-to-grave emissions from the chemical solutions (green PP and PP-based containers) and the solution being compared (tinplate container). Scenario-based avoided emissions are obtained as the difference between the 2010 scenario – according to market data from [DataMark 2012] - and a future scenario where the market is supposed to be overtaken by the PP and green PP-based solutions.

Modeling and calculations were made using SimaPro® software version 7.3.3. The impact method used was IPCC 2007 GWP, with characterization factors for a timeframe of 100 years [IPCC 2007].

Key parameters

For activities in the value chain, the following parameters which drive the generation of GHG emissions are considered:

- The origin and processing of raw materials and materials;
- The recycling rates of the components of the packaging solutions, assumed as 10.8% for PP [Plastivida 2010], 50% for tinplate [ABEAÇO, 2012] and 13.2 % for LDPE [Plastivida 2010];
- The downgrade factor [3]used in plastic recycling processes, assumed as 0.5;

[3] Plastics cannot usually be recycled indefinitely, as some functional properties of the plastic are lost every time it is mechanically recycled. The downgrade factor accounts for this loss.

- The end of life allocation

Figure 1 - Flow-diagrams of the tinplate container system

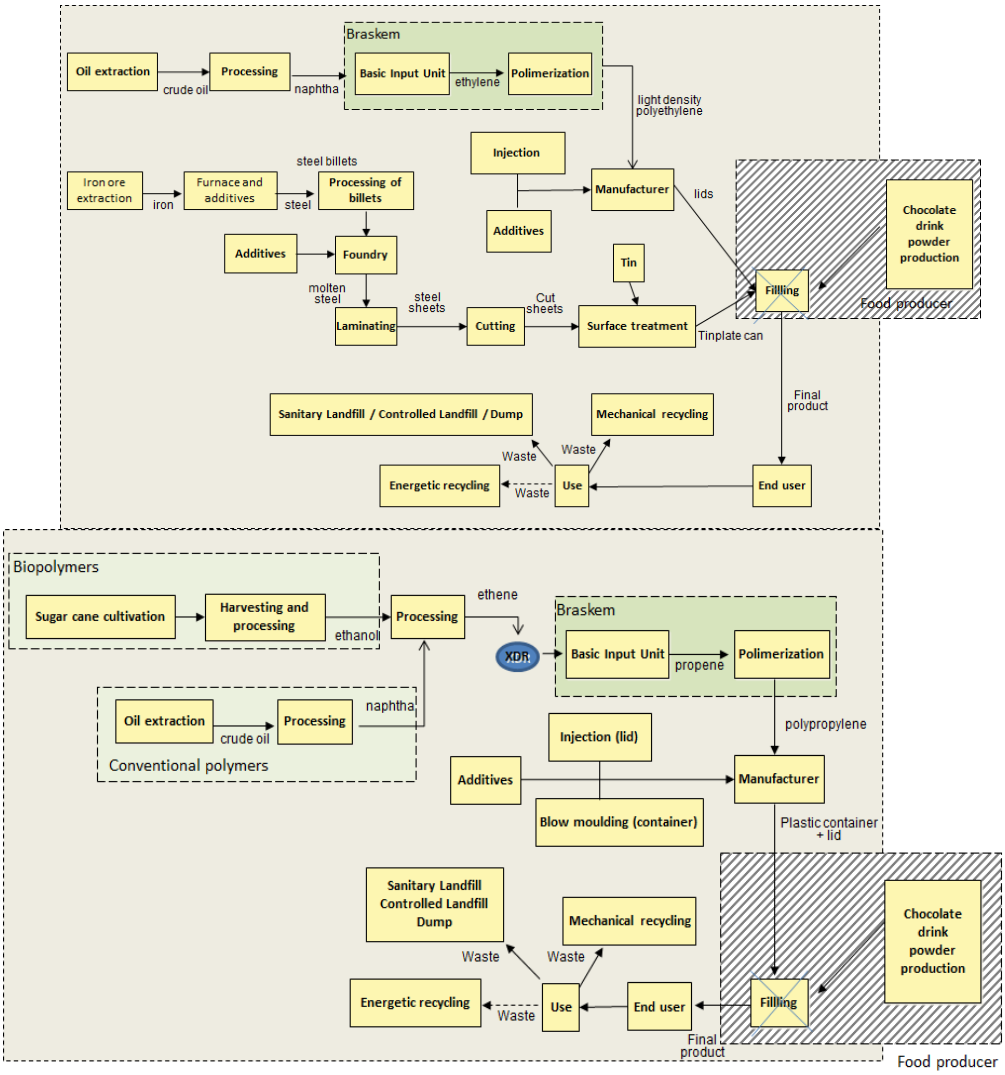

Figure 2 - Flow-diagrams of the Polypropylene-based container system

Allocation

Allocation in the study was made using the 50:50 method, in which benefits and loads of material recycling and disposal are shared equally between the lifecycle originating the materials to be recycled/disposed and the lifecycle using the recycled materials or the energy obtained from incineration. This rule is commonly accepted as a "fair" split between two coupled systems.

6. Results

a. Full cradle-to-grave emissions of the compared solutions:

The detailed results are shown in Table 2. Raw material refers to the PP, the LDPE and the steel, and not to the oil or the iron ore. Distribution refers to the transport of PP, LDPE and tinplate to delivery to the consumer.

Table 2 - Study results: GHG emissions of the compared solutions

Emissions per phase (kg CO_2 eq.)	PP-based container	Green PP-based container	Tinplate container
Raw material	0.086682	-0.06053	0.139917
Manufacturing / processing	0.01891	0.01891	0.092561
Distribution	0.002402	0.002402	0.003489
End of life / disposal	0.002409	0.002409	-0.02816
Total emissions	0.110403	-0.03681	0.207807
Avoided emissions	**0.097408**	**0.244624**	

b. Avoided emissions

i. Unit-based

Figure 33 shows the difference between the cradle-to-grave emissions from the chemical solutions (green PP and PP-based containers) and the solution to compare (tinplate container).

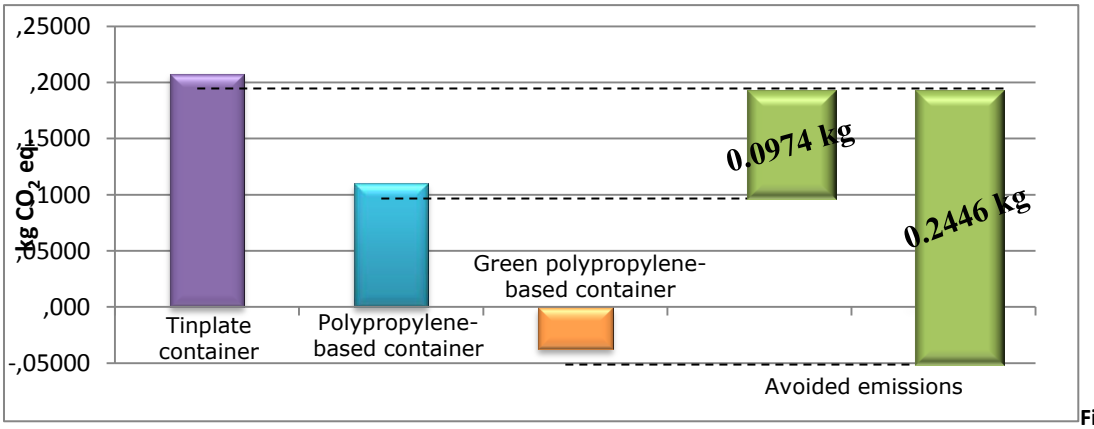

Figure 3 - Avoided emissions (difference between the cradle-to-grave emissions from the chemical solutions and the solution to compare) in kg CO_2 eq.

ii. Scenario-based

In contrast to the above unit based evaluation and now considering the already mentioned market shares for the year 2010 (47.5% of tinplate containers and 17.2% of PP-based containers), Figure 4 and Figure 5 show the avoided emissions of the hypothetical market scenario overtaken by the PP-based solution and the green PP-based solution for 2010 [DataMark 2012].

The avoided emissions related to a hypothetical market scenario overtaken by the PP and the green PP-based solution represent 23.44 ktonCo_2e and 71.67 ktonCO_2e, respectively.

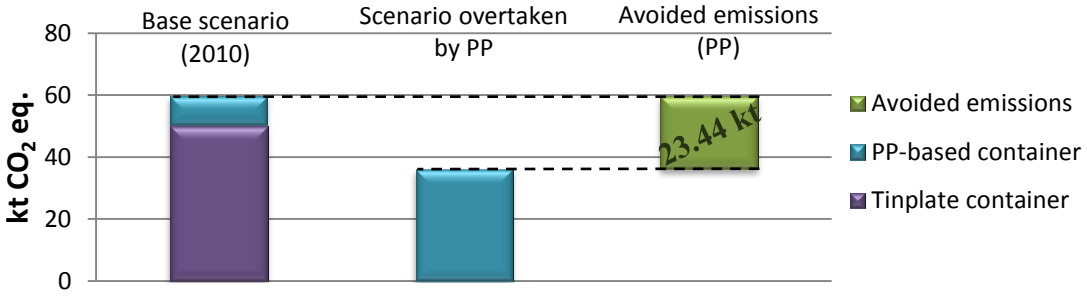

Figure 4 - Avoided emissions (difference between the cradle-to-grave emissions from the production scenario in 2010 and a future market scenario overtaken by the PP solution) in t CO_2 eq.

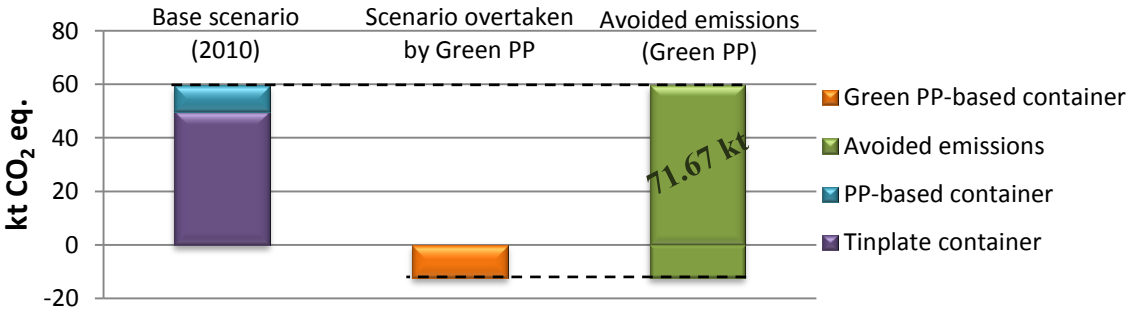

Figure 5 - Avoided emissions (difference between the cradle-to-grave emissions from the production scenario in 2010 and a future market scenario overtaken by the Green PP solution) in t CO_2 eq.

7. Significance of contribution and attribution aspects

The resins produced by the client play a vital role in the value chain and a **fundamental** contribution to the final solution, as the product is the key component that enables the GHG emission reducing effect of the solution. Nevertheless, avoided emissions calculated at the final solution level are attributed to the complete value chain, and not only to the chemical company.

8. Study Limitations and future recommendations

Data coming from the Ecoinvent database, despite some adjustments to the Brazilian circumstances, have limited quality and can be improved in future assessments. Furthermore, for processes to which a direct correspondence with the database was not found, similar processes were used, such as for the processing of tinplate containers from rolled steel. Here also, more accurate data can be added in future studies.

In addition, the calculation methodology used in this study allows evaluating only one impact category, i.e. climate change due to GHG emissions. Therefore, a joint evaluation with assessments considering other impact categories is highly recommended.

9. References

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