SCORELCA

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ENVIRONMENTAL AVOIDED EMISSIONS AND AVOIDED IMPACTS

EXECUTIVE SUMMARY

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Scientific managers:

- Dieuwertje Schrijvers, Guido Sonnemann
Université de Bordeaux, ISM, 351 cours de la libération,
33405 TALENCE cedex

- Mathilde Fiorletta
Vertech Group, 11 Rue Défly, 06000 Nice

SCORE LCA is an association that has been created to financially support collaborative research on LCA and related topics. It aims to promote and organize cooperation between companies, institutional and scientists in order to support the evolution of LCA methods and its practical implementation at European and international level.

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- ✓ The views and recommendations expressed in this publication are those of the authors and do not necessarily reflect, unless otherwise stated, the views of all members of SCORE LCA.

- ✓ The information and conclusions presented in this document were established on the basis of scientific and technical data and regulatory and normative framework in force at the date of the publication of documents.

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1. Introduction

Since the Kyoto protocol, and with reinforced motivation since the Paris Agreement, citizens, companies, and policymakers are motivated to decrease the greenhouse gas (GHG) emissions – and their environmental impacts in general – of the products that they use and produce. Especially companies have done significant efforts in the development of innovative solutions that have a lower environmental impact, such as the development of renewable energy technologies, low-carbon mobility, or the development of materials that enable to decrease the environmental impacts of conventional technologies.

When an innovative material or technology appears environmentally beneficial, it is of interest to be able to communicate these benefits. This enables manufacturers, consumers, and policymakers to select the materials and products or invest in processes that provide a beneficial contribution to the reduction of environmental impacts – especially the effects on climate change. Therefore, there is an interest in the quantification of the potential contribution of avoided emissions of materials, products and actions. We can define avoided emissions as **the environmental benefits generated by the supply of a solution to the market**, as shown in Figure 2. It can be challenging to calculate the avoided emissions of a solution provided by a company, especially if this solution leads to increased environmental impacts within the company’s perimeter and obtains only environmental benefits in other life cycle stages, such as during distribution, use, or end-of-life treatment of a product. Life Cycle Assessment is a suitable tool to compare two alternative solutions that provide the same functionality, while taking into consideration the whole life cycle of the product. This is illustrated by Figure 2, where a company produces a product (Product A) with better material properties than the previous version of this product. This leads to higher impacts during the production of the product, but the benefits during the use phase are so high that over

the whole product life cycle, the product is environmentally beneficial. Avoided emissions can be achieved by (Entreprises pour l'Environnement, 2018):

- Displacing a product with higher life cycle impacts
- Enabling impact reductions compared to the non-use of the product, taken into account the whole life cycle of the product

These solutions could include:

- The provision of (components of) low-carbon products and services (i.e. the cradle-to-gate impacts are lower than that of an alternative product)
- The provision of (components of) low-carbon products and services with decreased impacts downstream (transport, use, end-of-life)
- Conducting projects that contribute to emission reductions in the value chain (evaluation of actions and their consequences)
- Investments in third-party projects that contribute to emission reductions in the value chains of third-party actors

In conclusion, **the calculation of « avoided emissions » enables to evaluate and communicate the environmental benefits of an action compared to the non-implementation of this action.**

While the avoided emissions evaluated by an LCA are calculated for the whole life cycle of a product, it is possible that the actions of one actor in a product's value chain lead to environmental benefits beyond the boundaries of this value chain. An example would be the production of a co-product or by-product that can be used during the production process of a completely different product, as an alternative for a primary product. This shows us that we can differentiate two types of environmental benefits that could take place beyond the gate-to-gate boundaries of a single actor in a product's value chain:

- Type 1: called « avoided impacts » in this document

The co-production of a multifunctional process could be environmentally beneficial compared to the production of the same products by monofunctional processes. In order to make a joint production process comparable to a process with only one product output, one might consider the alternative production route of the co-produced product as "avoided impacts". Avoided impacts are illustrated in Figure 1.

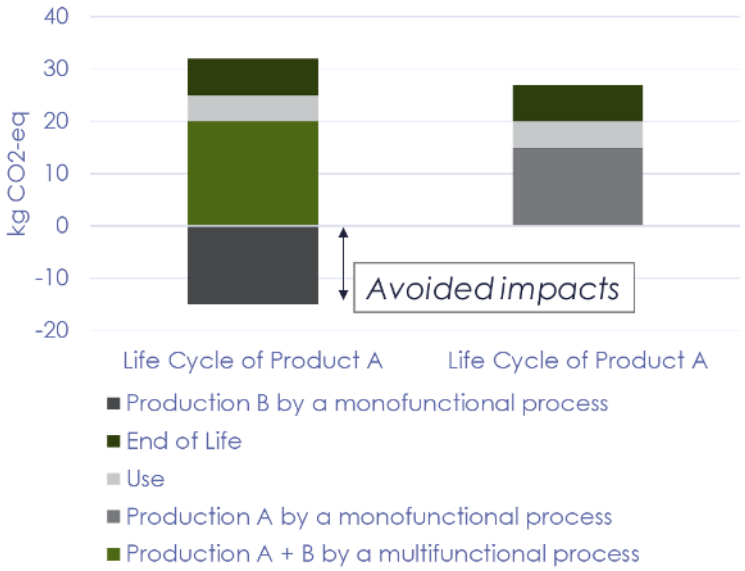

Figure 1 Modeling of Type 1 « avoided impacts » due to the co-production of Product A and Product B. The impacts of the production of Product B via an alternative production route are calculated. These impacts are « avoided » by the production of Products A and B via a multifunctional production process.

- Type 2: called « avoided emissions » in this document.

The action of one actor in a product's value chain could lead to decreased environmental impacts downstream in the product's value chain, for example during decreased impacts during the use phase or the end of life treatment of the product. The difference between the impacts due to this action compared to the environmental impacts of a reference product system could be considered as "avoided emissions", as illustrated in Figure 1.

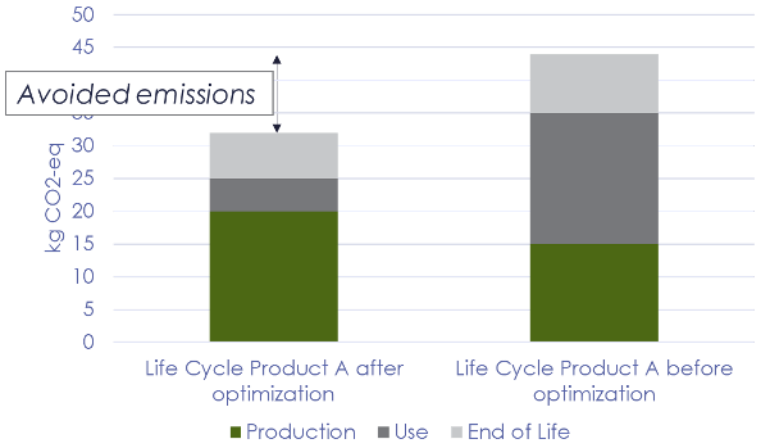

Figure 2 Calculation of the avoided emissions of the optimized product system of Product A

Even though "avoided emissions" in the form of elementary flows in the life cycle inventory phase are also converted into "avoided impacts" in the life cycle impact assessment, the term "avoided impacts" is more commonly used to indicate the environmental impacts that are subtracted from a product system, or substituted, due to the production of a co-product or recycling. The calculation of "avoided impacts" therefore represents an intermediate calculation step in the evaluation of the total environmental impacts or benefits of a product in an LCA. The term "avoided emissions" is used in this document to distinguish between "type 1" and "type 2", as this is currently internationally the most common reference for the **net environmental benefits of a product or service**. However, ongoing work in ISO working groups could result in the adoption of different terminology in the near future.

This project aims to answer the following question: "*How can we quantify, communicate, and interpret the avoided impacts and avoided emissions generated by an actor in the value chain of a product or service?"* To answer this question, the possible approaches to evaluate avoided impacts and avoided emissions are first identified and characterized. For Type 1 as for Type 2, the existing methodological framework is specified by assessing the state of the art (focusing on the methods developed by ADEME, (2016), Entreprises pour l'Environnement (2018), Grönman et al. (2019), ICCA and WBCSD (2017), The Institute of LCA Japan (2015), as well as consequential LCA (Sonnemann and Vigon, 2011; Weidema et al., 2009)). Two case studies (the co-production of metals and the recycling of polypropylene (PP)) have been conducted. These elements are available in the final report of the project. Methodological recommendations for the evaluation of avoided impacts and avoided emissions are provided in Section 2. Because the evaluation of « avoided impacts » is an intermediate calculation step in the calculation of "avoided emissions", Section 2 focuses on the evaluation of "avoided emissions". Recommendations on the communication and interpretation of "avoided emissions" are provided in Section 3.

2. Recommendations to evaluate "avoided emissions"

2.1. Attributional or consequential LCA

- Choose between an attributional or a consequential LCA depending on the intention of the company:
    - Communicate the **share of global impacts that can be associated with a product** → attributional LCA.

  - Communicate the **direct and indirect consequences of a decision** → consequential LCA.

- Other factors that can influence the choice between an attributional or a consequential LCA:
  - The availability of data
    - With regard to the system to be added to/ subtracted from (in an attributional LCA) or to be substituted by (in a consequential LCA) the multifunctional system under study, the **average technology** is preferred when an attributional LCA is conducted whereas a consequential LCA will focus on the **marginal technology**[1].
  - The foreseen validity of the results
    - The results of an attributional approach are less dependent on the market context of the analysis and could therefore be stable over a longer period of time.
    - The results of a consequential LCA, especially for a multifunctional system, are valid in the short term because they depend on the marginal application identified at a time *t*.
  - Permitted uncertainty of the results
    - An attributional LCA can potentially lead to results that are highly dependent on the assumptions applied and the scenarios estimated as relevant for the company (choice of processes used for system expansion, choice of the reference solution, etc.).
    - The accuracy of the results of the consequential LCA strongly depends on the accuracy of the identification of marginal technologies and users[2].
- Apply the same approach (attributional or consequential) to all products / processes of the company in order to harmonize the communication of results.
- Choose the same calculation method for the analyzed solution and the reference solution.

2.2. Reference solution

- Choose and specify the **reference solution** according to the situation preceding the decision (before the decision is implemented by the company or the individual) in a consequential LCA and following the recommendations of EpE in an attributional LCA, in particular by checking that the solution reference
  - meets the same user needs as the analyzed solution,
  - is a credible alternative to the analyzed solution and available on the market,
  - is shared and recognized by a large number of economic actors in the sector or by actors affected by this solution,
  - is chosen in consultation with the stakeholders of the company.
  - is in accordance with, at least, the regulations in force or entering into force soon, and with the uses foreseen by these regulations in a given territory.
- Determine the boundaries of the reference system by respecting the **functionality** of the analyzed system (for a multifunctional system such as a recycling system, it is not correct to choose only the primary production of the same material as a reference system: an extension

[1] The marginal technology corresponds to the technology subject to respond to an increase or decrease of the demand for one unit of product.

[2] The marginal user is the consumer subject to increase or decrease its use of a product.

of the reference system must be performed in order to make the two systems comparable to each other, see Section 2.3).

2.3. The case of a multifunctional system of analysis (calculation of avoided impacts)

The following recommendations concern "avoided impacts" as initially defined in this project. Indeed, the entire modeling of a multifunctional system is potentially based on the calculation of these avoided impacts and important methodological choices are made at this stage.

If the LCA is attributional and the system is multifunctional (recycling or coproduction):

- Prefer **system expansion** if the LCA can be process-oriented.
    - Add additional functions to the functional unit and extend the system to these functions. If the system corresponding to the average technology is also multifunctional, apply allocation.
    - A **reduction of the system** is not recommended. A subtraction of the monofunctional systems corresponding to the average technology from the multifunctional system gives the same results as an extension of the system, but only for the calculation of the difference (lower or higher) in emissions. System reduction can lead to a misinterpretation of the results by suggesting that the resulting environmental impacts are attributed to a single product instead of the complete process and that the subtracted impacts are avoided.
- Apply **allocation** if the LCA must necessarily be product-oriented.

If the LCA is consequential and the system is multifunctional (recycling or coproduction):

- Identify the marginal user of the co-product or the recycled product, the marginal technology, and indirect effects related to this marginal technology, using market data.
- Model the avoided impacts of the marginal technology via **substitution** by *subtracting* the inventory of the marginal technology and additional indirect effects for an increase in supply and *adding* this inventory for an increase in demand.
- In the case of co-production, pay close attention to the identification of the determining co-product and the dependent co-product(s).

2.4. Scenario of analysis and the reference scenario

- Define the scenario of analysis and the reference scenario, as far as possible:
    - In consultation with stakeholders,
    - By verifying that they are shared and recognized by a large number of economic actors in the sector or by actors affected by these scenarios.
- Construct the scenario of analysis and the reference scenario using the most credible avoidance period possible and considering that changes in regulations, standards or behavior can significantly reduce the avoidance period.
- Compared LCIs must be complete and consistent, with clearly defined and comparable system boundaries between the two scenarios.
- Justify all the calculation assumptions, especially the assumptions related to the identified marginal user and the marginal technology in a consequential LCA.
- Evaluate the sensitivity of the results to these assumptions (eg: energy mix, emission factors, avoidance period ...).
- Choose assumptions that result in lower avoided emissions.

2.5. Calculation scope

- Do not omit any life cycle stage, except possibly the stages of which it can be reasonably estimated that they have identical emissions between the evaluated scenario and the reference scenario. Justify any omission.

2.6. Contribution of value-chain actors

- In an attributional LCA, calculate the difference in emissions for the entire value chain and avoid the attribution of avoided emissions to a stakeholder in the value chain. The company cannot claim all or part of the emissions without losing consistency and risking double counting.
- In a consequential LCA, the analysis of an individual decision (e.g. the increase in the supply of recycled PP granulates) enables to allocate 100% of the avoided emissions to the concerned actor. If the analyzed decision is a joint decision between two actors, the avoided emissions can be divided among the actors according to the calculated avoided emissions if their decision had been individual.

2.7. Aggregation of the results

Concerning the aggregation of results at the level of a company:

- EpE mentions the possibility of aggregating emissions at the level of an enterprise if it *"communicates in a transparent way its scope and aggregation method by making these accessible in a pedagogical way in relation to the presented numbers"*. This study shows, conversely, that aggregation is **not recommended** if the approach is **attributional**, since the company cannot claim the entire reduced carbon footprint associated with a product, nor can it calculate its contribution without risking double counting.
- Aggregation is **possible** for **consequential** studies under two conditions:
    1. The overall decision of the company should not affect the market parameters (for example, recycling 1 kg of PP might not lead to the same consequences as recycling 1000 tonnes of PP). Only if the important market factors are not affected (i.e. structural changes in the market) with a large functional unit, it is possible to say that the impacts of a small decision can be scaled up to the total consequences of a decision. Otherwise, before aggregating the results across a company, the LCA for each decision must have a functional unit that is consistent with the size of the decision (eg, annual recycling of 100 tonnes of PP).
    2. Aggregated decisions should be additive; hence, they should not influence one another. If this is indeed the case, a company could communicate about the total impact of all the decisions it made during the year in question.

3. Recommendations to communicate and interpret “avoided emissions”

3.1. Requirements for the communication of LCA results of ISO 14044 et ISO 14020

An evaluation of requirements of ISO standards is done to identify which aspects are primordial in the communication of avoided emissions. The requirements of the ISO standards on communication aim for an accurate interpretation of the results. Therefore, parties interested in the results of « avoided emissions » should carefully check if all communication requirements presented in this section are followed, before conclusions are drawn.

ISO 14044

ISO 14044 (ISO, 2006) states requirements that must be followed when LCA results are communicated to a third party, and in particular when the results are intended to be used in comparative assertions. From the attributional and consequential study that were conducted on an example of the recycling of PP, key elements are identified that must be reported in order to provide sufficient information to interpret and communicate the results:

- Goal: **The reason to carry out the LCA study should be formulated in sufficient detail to justify a choice between an attributional and a consequential approach**. An attributional approach aims to identify the impacts that are attributed to a product or a process, while a consequential approach aims to identify what impacts are caused by the additional supply of, demand for, or production of a product.
- Scope:
    - **In an attributional LCA, the functional unit must be formulated in a way that clarifies whether system expansion or allocation is applied**:
        - If system expansion is applied, **the functional unit should include all the functions of the product system**. Here: the production of 1 kg of recycled PP and the end-of-life treatment of 1.17 kg of waste. The LCA goal should be adapted in order to reflect the evaluation of the recycling process rather than the evaluation of the recycled product.
        - If allocation is applied, the functional unit can be formulated as 1 kg of recycled PP.
        - **Applying system expansion while formulating the functional unit as "1 kg of recycled PP" can lead to a misinterpretation of the results, as information on the additional functions that are considered in the analysis is omitted.**
    - **In a consequential LCA, the functional unit must be formulated in a way that clarifies the type of decision that is evaluated**, e.g. the additional supply of a product, the additional demand for a product, or the additional supply of *and* the additional demand for a product.
    - Cut-off criteria can be similar for attributional and consequential LCAs. However, **consequential LCAs can have an additional cut-off criterion that excludes the modelling of consequences that are expected to have limited effect on the overall impact**.
- Life Cycle Inventory Analysis:
    - **A clear documentation of allocation procedures is crucial**, as this is an important difference between attributional and consequential approaches.
    - Sensitivity analyses are relevant in both attributional and consequential LCAs. **For consequential LCAs, specific attention should be put in sensitivity analyses with regard to the identification of consequences**, for example, due to the identification of the marginal supplier or the marginal user.
- Life Cycle Impact Assessment:
    - While avoided emissions are often calculated for Greenhouse Gas Emissions, **ISO 14044 requires a broad consideration of impact categories** if results are used in comparative assertions.
- Life Cycle Interpretation
    - **Sufficient information must be provided to comprehend the limitations of the results and the sensitivity of the results** to relevant modeling parameters.
- Critical review
    - Before the results are communicated to a third party, **the LCA report must be reviewed by an independent panel of reviewers.**

ISO 14020

ISO 14020 (ISO, 2002) summarizes principles to adhere to for the communication of environmental declarations. First of all, the declarations must be based on scientific methodologies that enables the reproduction of the results – e.g. following ISO 14044. Furthermore, interested parties must be provided with access to the procedure, methodology, and any other details that supports the environmental declarations. Specific considerations for attributional and consequential results are identified with regard

to the interpretation of “avoided emissions” and the context for which they are evaluated, which much be clearly communicated. It must be clarified that **the impacts that are calculated by an attributional LCA are not necessarily the impacts that will take place due to an additional demand for (or supply of) the product**. For the communication of the avoided emissions that are calculated by a **consequential LCA, it must be specified in which market context these avoided emissions are evaluated** – as this largely influences the results.

3.2. Suggested vocabulary

Based on the requirements of ISO 14044 and ISO 14020, suggestions are provided for unambiguous terminologies, which limit potential misinterpretations of the results (Table 1). To clarify the different results that are calculated via an attributional or a consequential approach, different terminologies should be used between the "avoided emissions" calculated in an attributional and the "avoided emissions" calculated in a consequential LCA. The concept of **avoidance** is coherent only for consequential impacts, as not only avoided (and increased) emissions within, but also emissions outside the product’s value chain are considered. Hence, shifting of burdens between product systems is taken into account. For this reason, the term **" avoided global emissions"** could be used for consequential LCAs. Conversely, when the analysis is attributional, the used term could be **"a lower carbon or environmental footprint of a product/process".** Here, we refer to the word « footprint », because the impacts calculated with an attributional LCA only refer to impacts that take place within a product’s value chain. If the attributional LCA is based on an extension of the system (such as "the treatment of X kg of waste and the production of X kg of a recycled product"), this would correspond to a "process footprint" rather than a "product footprint" since the analysis could show that the recycling process has a lower carbon footprint than alternative waste treatment and primary production processes. We suggest the wording « lower », because the reference scenario is not necessarily the scenario that will be displaced by the scenario of analysis – the reference scenario could operate simply as a benchmark.

Finally, the "avoided impacts" as defined in this study and calculated via the attributional approach correspond to a **reduction of the system** while the "avoided impacts" calculated via the consequential approach are linked to a **substitution**. For a harmonization of practices, it is thus advisable to keep these terms according to the applied approach. It is also recommended not to use the term "avoided impacts" when the approach is attributional. Indeed, some impacts have been **subtracted** from the analyzed product system but are not necessarily "avoided".

The vocabulary that is suggested in this report implies that the results calculated via the guidance of Entreprises pour l’Environnement should not be referred to as “avoided emissions” – even following the definition for avoided emissions of EpE[3], but instead as "a lower carbon or environmental footprint of a product/process", due to the fact that the guidance of EpE is in line with an attributional approach.

Table 1 Suggested vocabulary for the communication of avoided impacts and avoided emissions

Attributional	Consequential
Impacts **attributed** to a product/process	Impacts **caused** by a decision
Lower carbon or environmental footprint of a product/process	**Avoided global emissions**
System **reduction**	**Substitution**
Subtracted impacts	**Avoided** impacts

[3] Avoided emissions are environmental benefits generated by the implementation of a solution on the market. Avoided emissions are calculated for a single solution in a given application. The more the solution is implemented, the more emissions are avoided (Entreprises pour l’Environnement, 2018).

3.3. Recommended graphics

In order to complement the vocabulary suggestions, graphical representations of the emissions calculated in an attributional and a consequential LCA are provided in Figure 3 and Figure 4, respectively, which underlines the scope of the communication of avoided emissions and lower footprints. In attributional terms, global CO_2 emissions are represented by a blue sphere. The emissions attributed to the reference solution are represented by a large square in the blue sphere. The emissions attributed to the solution of analysis are represented by a smaller square in the same blue sphere. The lower (attributional) footprint associated with the solution of analysis is represented by a green arrow. The influence of the lower footprint on the quantity of global CO_2 emissions (the size of the blue sphere) is not known because it is not subject to analysis in an attributional LCA. In a consequential LCA, global CO_2 emissions before the implementation of a decision are represented by a transparent sphere and the resulting global CO_2 emissions after the implementation of the decision are represented by a blue sphere. The globally avoided CO_2 emissions are identified by a green arrow. It must be noted that the display of the avoided global emissions and the lower carbon footprint are not necessarily represented at the same scale and should not be directly compared.

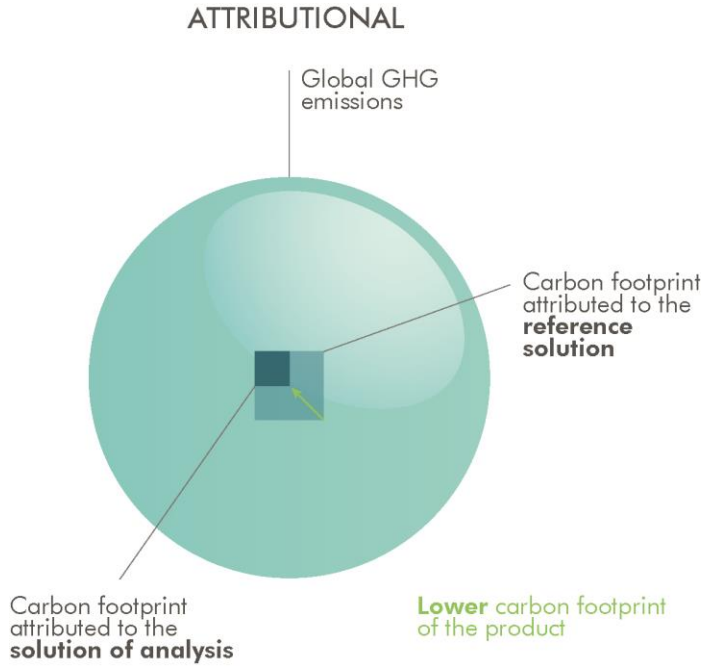

Figure 3 – Representation of GHG emissions of an analyzed scenario compared to the reference scenario resulting in a « lower carbon footprint » as evaluated via an attributional LCA.

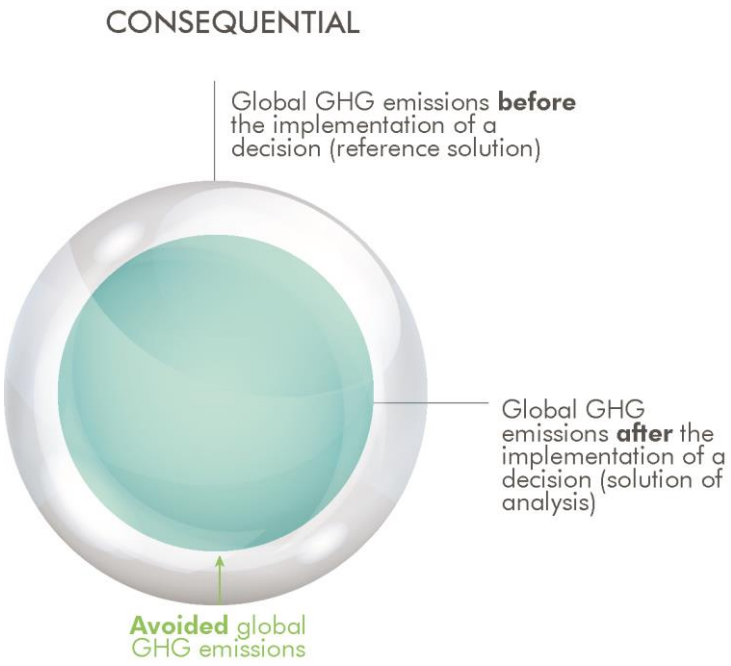

Figure 4 – Representation of GHG emissions of an analyzed scenario compared to the reference scenario resulting in « avoided global emissions » as evaluated via a consequential LCA.

Finally, a possibility of presenting the aggregated avoided emissions (calculated by a consequential LCA) of a company over a year is shown in Figure 5.

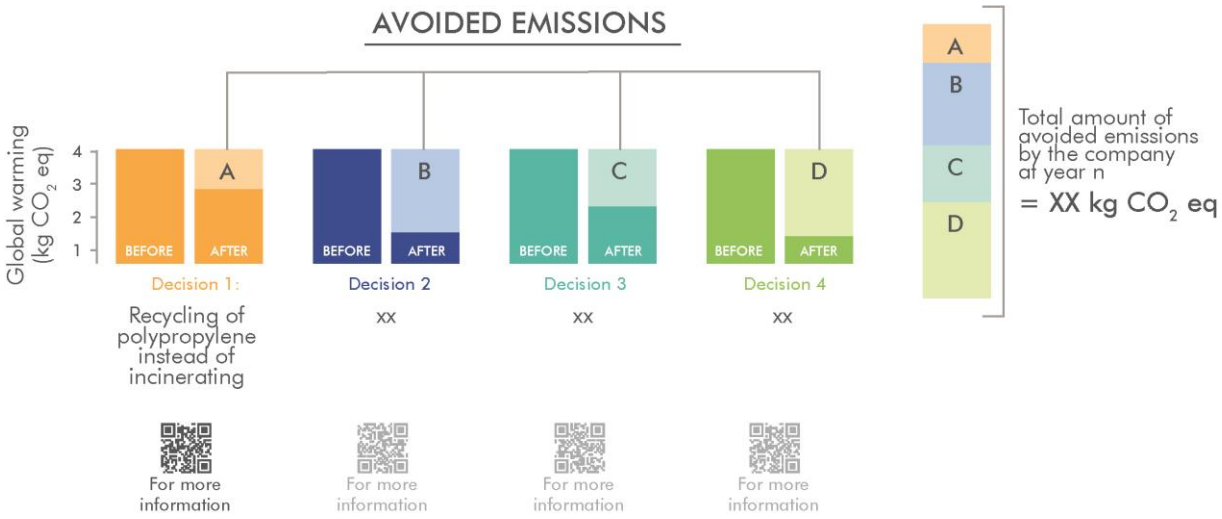

Figure 5 - Aggregation of the impacts of a company over a year (sum of avoided emissions by each decision) calculated as by a consequential LCA. Possibility to access study details through QR codes.

3.4. Minimum communication requirements

Many communication media are available to the company to share its avoided emissions / lower footprints. However, the choice of the information to be communicated must take into account the objective, the scope and the targeted audience in order to define and adapt as best as possible the communication strategy and the graphic style to be used. The strategies to adopt according to the target audience are more precisely detailed in the report. **Regardless the intended audience, all the information on which the calculation of avoided emissions is based must be made available in a dedicated document.**

To support transparency and clarity, certain information must necessarily accompany the communicated avoided emissions / lower footprints (Figure 6):

- Attributional or consequential approach,

- Functional unit,
- Scenario of analysis and reference scenario,

IN CASE OF A CONSEQUENTIAL LCA:

- Marginal technology and marginal user of recycled/co-produced products,
- Other **relevant assumptions,**

IN CASE OF AN ATTRIBUTIONAL LCA:

- Relevant assumptions,
- **Warning:** A lower carbon footprint of a product/process does not guarantee that CO_2 emissions are avoided because of the potential indirect effects on the carbon footprint of other products and processes.

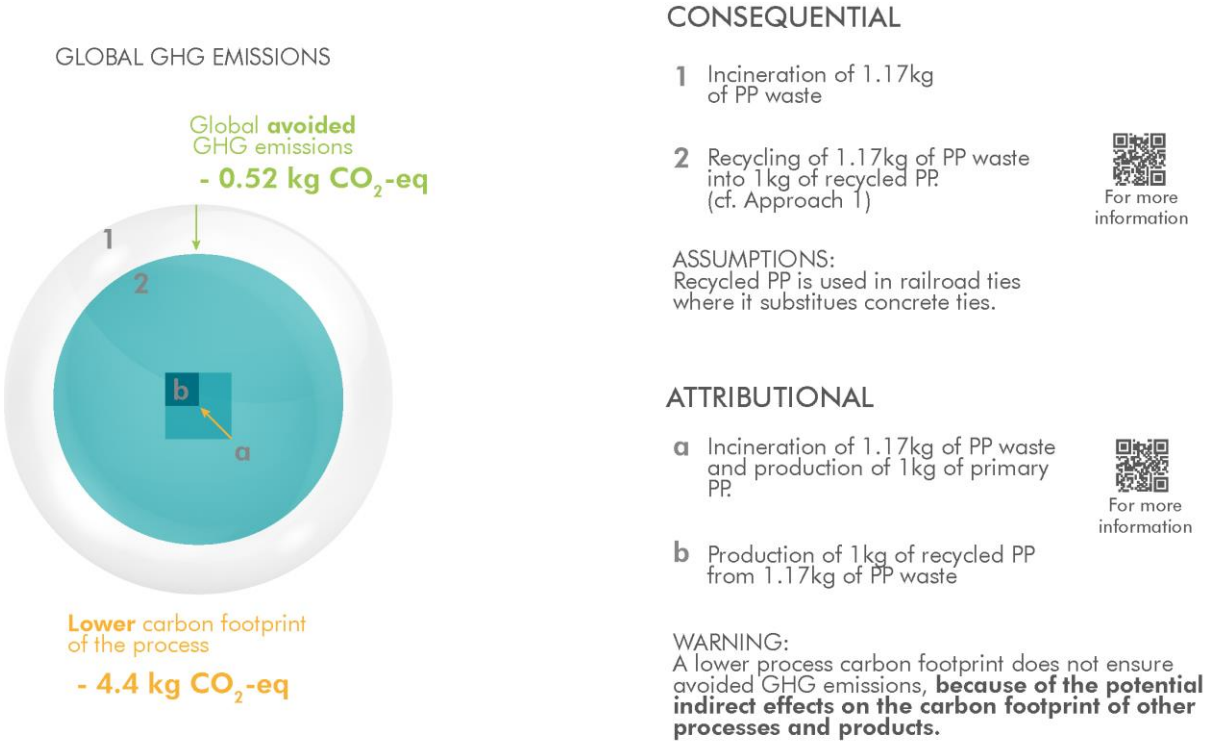

Figure 6 - Graphical representation of the results of the case study on PP recycling according to the applied approach (attributional or consequential) and highlighting the essential information to be communicated.

SUPPORTING MATERIALS

According to the requirements for environmental reporting (ISO 14O20), it is mandatory to provide access to the underlying reports explaining the assumptions on which the results are based as well as the calculation details. Thus, the details of the calculations of avoided emissions / lower footprints are not necessarily communicated with the results but must be available in a comprehensive report. As corporate LCA reports are often intended to serve the eco-design of a product or to measure the progress of internal KPIs, some of the included data is bound to remain confidential (Brilhuis-Meijer, 2014). However, an extract of the report highlighting the non-confidential results of the study can be made available to readers through a digital **flipbook** (Figure 7) available on the company's website.

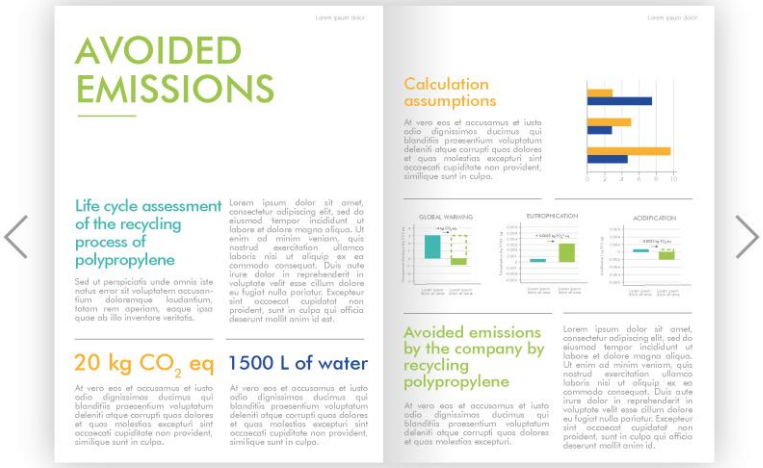

Figure 7 - Example of an online flipbook (accessible through a QR code) to provide details to the reader about the LCA and the study assumptions.

4. Conclusions

This report answers the question "*How can we quantify, communicate, and interpret the avoided impacts and avoided emissions generated by an actor in the value chain of a product or service?"*

By means of the evaluation of the state of the art on methods to evaluate "avoided emissions" and "avoided impacts" and the demonstration of these methods on case studies, important factors are identified that influence the evaluation of avoided emissions:

- The relevance of the application of a life cycle approach based on ISO 14044
- The need to select an attributional or consequential perspective
- The role of the calculation of "avoided impacts" in attributional (discouraged) and consequential (required) LCA
- The sensitivity of the results to certain hypotheses:
    - The reference scenario
    - Selection of data sources
    - Identification of marginal technologies/users (in consequential LCA)
- The potential to allocate avoided emissions among value-chain actors and to aggregate avoided emissions on a company level

Current guidelines provide a freedom of choice regarding these factors, leading to a wide range of potentially valid results, resulting in a potential double counting of environmental benefits, lack of comparability of results, and a lack of confidence of stakeholders to rely on, or communicate, the results.

This report provides guidance in the evaluation of avoided emissions that contributes to reliable, acceptable, and consistent results. In order to enable a transparent and unambiguous communication of avoided emissions, the following recommendations are done:

- Suggested vocabulary to adopt
- Recommended graphics
- Minimum communication requirements

This work has the potential to contribute to the further development and harmonization of guidance documents for the evaluation and communication of "avoided emissions". The availability of robust guidance is primordial for the evaluation of investment and innovation opportunities of companies for the development of low-carbon and environmentally friendly products and services.

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