

Preliminary Guidance for Avoided Emissions Accounting in Waste Management and Recycling

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for their expertise in the industry sector and waste management:

PAPREC FRANCE	a French leading industrial company specialized in recycling waste, i.e. to turn waste into Raw Materials From Recycling sold as substitute to Virgin Raw Materials. Through its activities PAPREC contributes to a more efficient use of natural resources and aims at reducing industries and cities' carbon footprint in a sustainable way.
SÉCHÉ ENVIRONNEMENT	a major player in the environment, particularly in all types of waste recycling, thanks to its know-how and specialized equipment. More specifically for its hazardous waste management component, the Group's vocation is to support the international development of its industrial customers by making its predominantly chemical skills available to it.
SUEZ	a leading company in water and waste activities for 150 years, is fully engaged in the resource revolution. The Group supports its municipal and industrial customers as they change from a linear model, which over consumes resources and emits GHG, to a circular model, aiming at recycling and recovering solid waste and wastewater.
VEOLIA group	the global leader in optimized resource management. With over 171,000 employees worldwide, the Group designs and provides water, waste and energy management solutions which contribute to the sustainable development of communities and industries. Through its three complementary business activities, Veolia helps to develop access to resources, preserve available resources, and to replenish them. In 2018, the Veolia group supplied 95 million people with drinking water and 63 million people with wastewater service, produced nearly 56 million megawatt hours of energy and converted 49 million metric tons of waste into new materials and energy. Veolia Environnement (listed on Paris Euronext: VIE) recorded consolidated revenue of €25.91 billion in 2018. www.veolia.com
VEOLIA RESEARCH & INNOVATION (VERI)	Veolia Research structure, which develops technological, contractual, social and managerial innovations in order to offer solutions or services with high added value to industrial, municipal and tertiary customers. It contributes to Veolia growth, improves the performance and productivity of its activities while anticipating future needs; VERI contributes to a large part to this preliminary guidance

for their qualities as experts and their support in the redaction:

EIT Climate-KIC	a European knowledge and innovation community, working to accelerate the transition to a zero-carbon economy. Supported by the European Institute of Innovation and Technology, EIT Climate-KIC identifies and supports innovation that helps society mitigate and adapt to climate change.
THE GOLD STANDARD FOUNDATION (GSF)	set up to ensure that projects reducing carbon emissions under the UN's Clean Development Mechanism also contributed to sustainable development. Its standard Gold Standard for the Global Goals was launched in 2017, to allow climate and development initiatives to quantify, certify, and maximise their impacts toward climate security and sustainable development;
QUANTIS	is specialized in guiding top organizations to define, shape and implement intelligent environmental sustainability solution. Quantis delivers resilient strategies, robust metrics, useful tools, and credible communications to its clients; uses the latest science and makes it actionable;
THE WORLD BUSINESS COUNCIL FOR SUSTAINABLE DEVELOPMENT (WBCSD)	is a global, CEO-led organization of over 200 leading businesses working together to accelerate the transition to a sustainable world. It helps make its member companies more successful and sustainable by focusing on the maximum positive impact for shareholders, the environment and societies. Its member companies come from all business sectors and all major economies, representing a combined revenue of more than US\$8.5 trillion and with 19 million employees.

Acronyms

EPE	Entreprises pour l'Environnement, epe-asso.org
GHG	Greenhouse Gases
GSF	Gold Standard Foundation
ICCA	International Council of Chemical Association
ILCAj	Institute of Life Cycle Assessment, Japan
LCA	Life Cycle Assessment
LCT	Life Cycle Thinking
LFG	Landfill gas
OEF	Organisation Environmental Footprint
PEF	Product Environmental Footprint
PET	Polyethylene terephthalate
PP	Polypropylene
RDF	Refuse Derived Fuels
UN	United Nations
WBCSD	World Business Council for Sustainable Development
WRI	World Research Institute, wri.org
WTE	Waste-to-Energy

1. Introduction

In March 2019, the European Commission adopted a comprehensive report on the implementation of the Circular Economy Action Plan. The report presents the main achievements under the Action Plan and sketches out future challenges to shape our economy and pave the way towards a climate-neutral economy where pressure on natural and freshwater resources as well as ecosystems is minimised.

The waste management and recycling sector is a key actor and enabler in the circular economy ecosystem. The solutions already implemented and to be developed allow GHG savings, either by GHG emissions mitigation (e.g. biogas capture and flaring from landfills) or by GHG avoided emissions by choosing the optimum solution (e.g. material recycling, waste to energy recovery, high GWP gases destruction, organic matter recovery...).

The literature (scientific literature, existing frameworks and guidelines) has been increasingly referring to GHG savings in recent years. However, it appears that there is still **a long way to go to build a robust and shared approach, making it possible to account for the GHG avoided emissions provided by the waste management and recycling sector.** Indeed, the existing sectoral protocols for calculating avoided emissions do not sufficiently focus on waste management and recycling, to make them operational for the sector. Furthermore, the calculation and consolidation of avoided emissions on the global scope of the organizations belonging to the waste management and recycling sector also suffers from this lack of common approach, as mainly produced at product, company or national levels.

Therefore, working to converge on a common approach is essential for steering the progress in the organisation's

commitments to mitigate GHG emissions and organizing dialogue between the waste management and recycling sector and its stakeholders. **The need for common and robust guidance document has thus appeared to the professionals of the sector as a goal to achieve,** despite the diversity of the activities it embraces.

Consensus was reached, in a consortium gathering companies, experts and NGO's, to define key methodological steps to calculate the GHG avoided emissions contribution of the waste management and recycling activities. This work is based on an extensive literature review, expert interviews, as well as several case studies provided by the consortium members.

This preliminary guidance document aims at providing sensible and relevant clarification elements in order to foster these dialogues between the waste management and recycling sector, its municipal and industrial clients, as well as local and national authorities, investors and statutory auditors, and more broadly all stakeholders involved in this issue.

Beyond GHG emissions and avoided emissions reporting, it is an ambitious GHG common reduction commitment and its inclusion in value chains and business models that is essential.

These necessary methodological issues do not have to overshadow a common main objective: the promotion of collaborative initiatives aiming at including all economic

activities in a GHG mitigation trajectory that is compatible with the Paris agreement's ambition and the protection of resources.

The results from this preliminary guidance document should not be used for insetting or offsetting intentions, since it was built **to validate a common approach and to promote the key role of waste management and recycling sector towards a net zero ambition.**

2. Approach

Some guidance or standards for accounting of environmental impacts published recently can help avoided emissions accounting (i.e. the GHG Protocol, ISO 14040 series). However, there is not yet a standard nor a specific guidance document for waste management & recycling activities.

EPE produced respectively in 2013 and 2019 two reports on GHG quantification and avoided emissions accounting, in which Paprec, Séché Environnement, Suez and Veolia participated. The recommendations help understand the challenges and opportunities for waste management and recycling. Nevertheless, additional specific recommendations and requirements are welcome **to ensure that all actors use the principles with the same approach for waste management and recycling activities.**

Consequently, in 2019, a consortium including companies covering a large variety of waste management and recycling activities worldwide, non-profit organization and experts of LCA and GHG accounting, decided to collaborate in a project supported by EIT Climate KIC.

The common objective of the authors was to produce this preliminary guidance document for the construction of a future dedicated methodological framework for waste management and recycling.

Authors of this preliminary guidance document worked in order **to identify challenges and issues and then status on key recommendations for accounting avoided emissions in waste management and recycling activities.**

This work was based on:

- * a thorough literature review;
 - * a strong reliance on experts to exchange on the project and agree on the project's ambition;
 - * exchanges on sector-specific discussions and;
 - * testing the approach through four pilot case studies to ensure that the main specific questions around waste management and recycling were well identified.
-



3. Overview

3.1. Purpose of the preliminary guidance document

Through this document, **the authors have reached consensus in the area of avoided emissions accounting, by defining methodological steps needed to evaluate the contribution of waste management and recycling activities, in a reliable and consistent way.** Then comparing avoided emissions calculations issued from different entities would become possible.

The document does not provide a technically detailed methodology but sets out main challenges and steps to follow for avoided emissions accounting for several applications. It should, therefore, be considered as **the first step of the construction of a future methodological framework to account for avoided emissions in waste management and recycling activities.**

This document is based on a literature review of almost 30 documents expressly developed for avoided emissions or that are applicable for avoided emissions accounting. This state of the art is useful to define and characterize all issues and challenges associated with the concept of avoided emissions, on internationally existing standards and guidance, on LCA & GHG reporting, that are essential concepts to account for avoided emissions.

This document also provides an overview of the methodological challenges and provides first recommendations about waste management and recycling 'avoided emissions' accounting studies. Some sensitive aspects concerning scoping of avoided

emissions and eligible and non-eligible reference solutions in the waste management and recycling sector will be addressed in the outset.

This document addresses off-the-shelf solutions available for the waste management and recycling sector, and that are foreseeably expected in the near future.

Covered activities are related to the following waste management and recycling areas: landfill, incineration, material recycling, organic waste recycling, energy recovery, and the solutions associated with these activities, notably:

- products (e.g. waste, energy, material from recycling);
- processes (e.g. incineration, chemical recycling etc.);
- projects (e.g. new technology of recycling, new policy of waste management, corporate or national action plan etc.);
- company activities (corporate reporting).

In summary, authors proposed through this preliminary guidance document:

- * **to provide a consensual vision of situations when waste management and recycling can claim credit for avoided emissions and when they cannot.**
 - * **to provide first recommendations about a methodological framework to account for avoided emissions in the waste management and recycling sector, depending on the goal of the study.**
-

Nota bene:

- * *This document being a preliminary guidance, it does not aim to answer all the questions, but provide key methodological principles that will be developed further in a future methodological framework. The different phases of the methodology are presented but not detailed in this document.*
- * *Some first consensual requirements are proposed by the authors for specific challenges (e.g. application for corporate reporting finality).*

3.2. Who will use this document

This preliminary guidance document is intended to facilitate the drafting of a future methodological framework, through recommendations, based on current scientific knowledge, companies' positioning and expert consensus on key issues.

This preliminary guidance document is designed:

- * **for experts** from waste management and recycling sectors, academic and organizations that will be contributing to the drafting of the forthcoming methodological framework;
- * **for voluntary users** interested in accounting emissions avoided thanks to solutions from the waste management and recycling sector;
- * **for companies from the waste management and recycling sector and all related parties of the value chain.** Indeed, downstream manufacturers of products issued from recycling materials or companies that generate waste can be interested in applying the recommendations to facilitate decision-making between different recycling solutions or waste treatment processes;
- * **for extended application** by sectoral associations or institutions in order to account for the benefits associated sector-wide decisions.

Moreover, this preliminary guidance document provides challenges and recommendations that could be useful for ongoing work done on standards at ISO level.

3.3. Contents

The foreword of this preliminary guidance document consists of a compilation of **terms and definitions (Chapter 4)**.

Thereafter, the preliminary guidance document is structured into four sections:

Chapter 5: Guiding principles and requirements: what are the principles of and requirements for avoided emissions accounting?

- Guiding principles (accuracy, relevance, completeness, consistency, transparency, data quality);
- Overview of the steps for avoided emissions accounting (assessment process and general methodology).

Chapter 6: Review of existing practices and methodological challenges: what is the current situation?

- Overview of existing guidance;
- Pointing out common points and sources of disagreements;
- Pointing out of the core elements to consider for accounting avoided emissions studies.

Chapter 7: Methodological approach for avoided emissions accounting dedicated to waste management and recycling.

- Definition of avoided emissions in the context of waste management and recycling;
- Conducting a study of avoided emissions accounting (purpose, scope and system boundaries, solution to assess, solution to compare to, accounting approach, duration of the avoidance, scaling-up). Two scales were considered: corporate reporting and product/processes analysis (see 7.2 and 7.3).

Chapter 8: Attribution of benefits along the value chain and communication.

4. Key Terms and Definitions

As different definitions can be proposed for core terms associated to avoided emissions accounting in the literature, authors proposed the following definitions for this preliminary guidance document.

Allocation procedure: way to eliminate extra function when one of the compared solutions is multifunctional, by dividing the process into two or more subprocesses or by system expanding or reductioning. When multifunctionality is solved by system reduction, substitution to a similar or equivalent solution is done, leading to avoided impacts (*section 6.2*).

Assessed solution: the solution that contributes to avoid emissions in comparison with a reference solution: industrial process / operation(s) of particular interest on which one focuses and that aims at producing an output that is substitutable to the output of the reference solution.

Attribution of benefits: qualitative or quantitative sharing of the benefits estimated through the avoided emissions accounting, between all actors of the value chain committed in the implementation of the assessed solution.

Attributional approach: approach used in Life Cycle Assessment (LCA) to allocate potential impacts to a given product/ service/ process without considering the potential rebound effects, and consequences associated with the implementation of the assessed solution. The attributional approach is thus a static approach that takes into account the environmental impacts at a given point in time

Authors: referring to the entities who participated in writing this preliminary guidance document and validated the present document. The founding partners of the project are the VEOLIA Group, Veolia Research & Innovation, Quantis, WBCSD, The Gold Standard Foundation, and EIT Climate KIC. The partners who joined and supported the project are Paprec, Séché Environnement, Suez.

Avoidance period: period of time during which solutions are studied and their GHG emissions compared.

Avoided emissions: the GHG reduced emissions that occur thanks to the assessed waste management and recycling solution, compared to a reference solution.

Consequential approach: Approach used in LCA to assess the environmental consequences on the reference solution associated to the introduction of the assessed solution. The consequential approach is thus a dynamic approach that includes rebound effects outside the defined system.

Emission reduction: considering one solution, the result of actions undertaken to optimise that solution and decrease its GHG emissions compared to the previous avoidance period considered.

Energy recovery: Energy recovery from waste is the conversion of waste materials into useable heat, electricity, or fuel through a variety of processes, including combustion, gasification, pyrolysis, anaerobic digestion, and landfill gas (LFG) recovery. This process is often called waste-to-energy (WTE).

Functional unit: reference unit used in LCA, based on the solutions' quantified performance (equivalence of service provided). The definition of a functional unit should ensure that assessed and reference solutions can be compared.

GHG reductions: difference of direct and indirect GHG emissions calculated on two periods of time of the same length on a stable perimeter. For annual disclosure of a company's GHG emissions, GHG reductions are calculated on a one year period.

GHG savings: general term referring to the reduction of emission or avoided emissions. As GHG savings can include GHG reductions and avoided emissions, this preliminary guidance document will not refer to GHG saving in general.

Recycling: industrial processes / operations that add value to waste and transform it into an input that can be used by industries as a substitute to the inputs produced from primary sources which are initially used.

Reference solution: solution used as a reference, against which the assessed solution is compared, on the basis of the same function provided.

Solution: refers to products, processes or projects associated to waste management and recycling activities.

System boundaries: set of stages of the value chain that are included in the system of comparison.

Waste management value chain: all the operations associated to the waste management and recycling activities.

5. Guiding Principles and Requirements

5.1. Accounting Principles

As mentioned beforehand, the accounting of avoided emissions has often been considered a sensitive topic.

When accounting for avoided emissions, companies should follow some basic principles in order to ensure that the calculation and communication are robust and aligned with stakeholders' expectations.

For this preliminary guidance document,

5 guiding principles

for avoided emission accountancy (inspired by the principles used in corporate carbon reporting) have been identified:

Relevance: The assessed product, service or process is effectively contributing to GHG reduction (avoided emissions are significant and real). Companies should be precautionous when communicating about avoided emissions by ensuring that the assessed solution does not lead to an unintended increase in emissions.

Completeness: Avoided emission accounting should provide a global picture of GHG emissions using a life cycle perspective for both the assessed system and the reference solution. Life cycle stages that would be identical in both scenarios assessed can be however omitted from the calculations.

Consistency: The data, reference solution definition methodology and overall GHG accounting should be consistent between systems assessed by a given company when comparing avoided emissions or when reporting on overall avoided emissions by the company. Any variations should be justified.

Accuracy: Follow recommendations on data quality in order to ensure that reported avoided emissions are as accurate as possible. If uncertainty is considered high (calculations are based on sensitive generic data), assumptions and high uncertainty parameters should be clearly stated. Basic data requirements for any avoided emission calculation are presented in the section 7.3.

Transparency: Any company reporting on avoided emissions should ensure transparency by detailing the methods and data used to calculate avoided emissions. Reporting requirements recommendations are presented in the section 7.4.

5.2. Summary of steps for the calculation of avoided emissions

Once companies have committed to following basic accounting principles presented in section 5.1, the following approach should be used to account for avoided emissions. These steps (Figure 1) are presented in detail in Chapter 7:

Step 1: Goal definition

Companies should clearly define the purpose of any avoided emissions calculation.

Step 2: Choice of LCA approach to be used:

Depending on the goal of the study either Attributional or Consequential LCA can be used to calculate avoided emissions. The choice of methodology should be based on the goal and the ways of the study, and clearly justified in the supporting documentation.

Step 3: Identification of the assessed solutions and definition of system boundaries:

Scoping of solutions leading to avoided emissions and definition of reference solutions considered to carry out the assessment. For both solutions, the relevant system boundaries must be defined by companies.

Step 4: Data collection:

Companies should collect relevant data following data quality recommendations for both the assessed solution and the reference solution. Any assumptions or data gaps should be stated in any supporting documentation.

Step 5: Assessment of avoided emissions: Companies should follow the methodology for the assessment of avoided emissions presented in chapter 7 of this document.

Step 6: Reporting: Companies should report on your avoided emissions according to current recommendations.

5.3. Data requirements

Companies should refer to the Scope 3 Standard and Calculation Guidance (WRI, WBCSD, 2013) for requirements and recommendations on data quality to be used in the approach set out in this preliminary guidance document.

In general terms, **companies should ensure that data used for the calculation are:**

- * **Complete:** Completeness includes the percentage of material and energy flows for which data is available and used out of the total number that relates to a specific activity. In order to consider data as complete, all major flows contributing to environmental impacts should be considered.
- * **Accurate/ Reliable:** Data used for the calculations should be based on dependable sources, data collection processes or databases.
- * **Representative temporally, technologically and geographically:** Data used for calculations should reflect the technology under assessment, its age and the actual geographic location assessed.

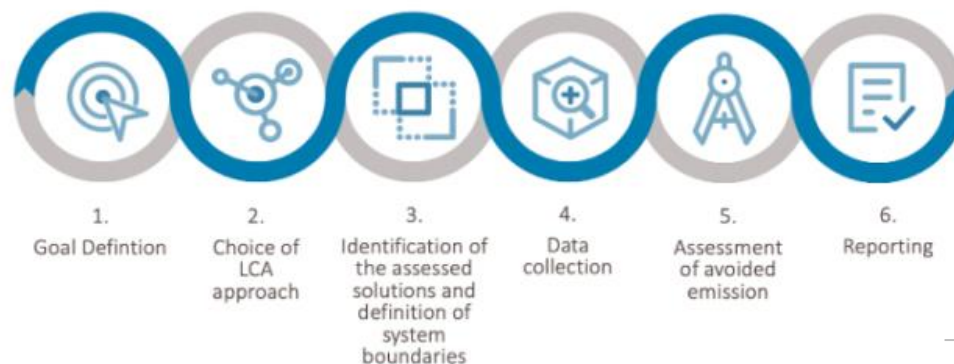


Figure 1.

Summary of steps for the calculation of avoided emissions.

5.4. Corporate reporting requirements

Since external communication on avoided emissions is considered as a sensitive topic, when communicating on avoided emissions from a project, process or product, companies should follow certain principles:

- * **Narrative:** The origin of avoided emissions (i.e. why is the solution considered as a source of avoided emissions?) and a description of the system should be provided.
- * **Environmental impacts:** Companies should also communicate on GHG emissions and other relevant environmental impacts of the said project, product or process on air, water, soil, biodiversity... , whatever the impact (positive or negative).
- * **GHG emissions versus avoided emissions:** When avoided emissions are communicated at the company level, full scope GHG emissions (it is to say direct and indirect emissions as defined in the new ISO 14064 (2019) should also be provided. As per regular reporting standards, avoided emissions should not be added.
- * **Transparency:** All relevant information for the calculation should be provided, including:
 - Reference solution conditions
 - Data collected and used for the calculation (including data quality assessment based on data requirements presented previously).
 - Other assumptions or information that would provide stakeholders relevant information for the understanding of avoided emissions.

For additional recommendations on reporting, companies should refer to ISO 14040 series on Life Cycle Assessment and ISO 14060 series on carbon quantification and reporting, as well as the GHG Protocol Standard.

Nota bene:

It should be noted that data quality, databases used and overall approach might vary between assessments. Comparisons between avoided emissions reported by different stakeholders or by different assessment should not be done unless the comparability of the different assessment has been confirmed.



6. Review of Existing Practices and Methodological Challenges for Avoided Emissions Accounting in Waste Management and Recycling

6.1. Overview of existing documentation about avoided emissions accounting

The literature review covered a wide spectrum of documentation. 27 documents (FR/EN) were consulted to widely cover the existing knowledge on avoided emissions accounting (see Appendix 2). The analysis consisted in a comparison between the major guidance and documents expressly dedicated or adapted to avoided emissions accounting. The purpose of this work was to synthesize, summarize literature and practices, to identify gaps and highlight emerging patterns.

The research included:

Combinations of the following terms:

Avoided emissions, reduction of emissions, comparative emissions impacts, GHG savings, carbon neutral, climate benefits, offsets, climate change mitigation, climate positive, allocation, net-positive accounting, reduction targets.

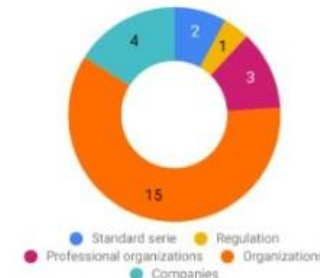
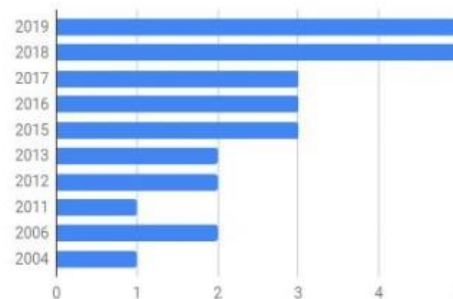


Figure 2.

On the left: number of publications per year between 2004 and 2019

On the right: origin of documents dedicated to or applicable to avoided emissions

Different sources:

- Academic (universities, public institutes, peer-reviewed articles or conference papers),
- Non academic (professional organizations, research organizations, governmental agencies, policy communications),
- Private initiatives from companies and consultants.

Different nature of documents:

- Standards about LCA and GHG footprinting;
- General and sectoral-specific guidelines;
- Workings papers;
- Study reports intended for the communication of the benefits to climate.

The Figure 2 presents the evolution of the literature around the concept of avoided emissions and the origin of the guidance document applicable to avoided emissions accounting.

This observation reveals **an increase in the interest for the topic 'avoided emissions' over the last four years**. The majority of the available guidance document was developed jointly by consortiums of public and private organizations.

Although no dedicated standard is available for avoided emissions accounting, some standards established for life cycle assessment (ISO 14040-44), carbon footprint (ISO 14067), or GHG reporting (ISO 14064, GHG Protocol for products, corporate, corporate value chain, and GHG Protocol Policy and Action Standard) provide requirements that may be applied for avoided emissions accounting. Indeed, almost all the analysed guidance documents refer to one or several of these standards.

Among all the analysed documentation, only few guidance documents were specifically developed for estimating and reporting avoided emissions. The list below presents a panel of the most relevant existing dedicated guidance documents (may be not exhaustive):

- * Addressing the Avoided Emissions Challenge (ICCA and WBCSD, 2013);
- * Avoiding Greenhouse Gas Emissions, the essential role of chemicals. Guidelines : Accounting for and Reporting Greenhouse Gas (GHG) Emissions Avoided along the Value Chain based on Comparative Studies (ICCA and WBCSD, 2019);
- * Guidelines for Assessing the Contribution of Products to Avoid Greenhouse Gas Emissions (Institute of Life Cycle Assessment Japan, 2015);
- * Estimating and reporting the Comparative Emissions Impacts of Products (World Research Institute, 2019);
- * Carbon handprint - An approach to assess the positive climate impacts of products demonstrated via renewable diesel case (Business Finland; Technical Research Centre of Finland, 2019);
- * Framework for Assessing Avoided Emissions (RISE Mission Innovation, 2018);
- * Avoided emissions - Companies assess their climate solutions. Protocol for the quantification of GHG from waste management activities. v5. (EPE, 2013);
- * How to quantify GHG savings resulting from an action designed to reduce GHG emissions- QuantiGES (ADEME, 2016);
- * Avoided environmental emissions and impacts (Score LCA, 2019).

6.2. Analysis of the core terms surrounding avoided emissions

The majority of the existing guidance documents of interest was developed for all sectors, since specific guidelines exist for the chemical sector (ICCA & WBCSD, 2013), or other specific sectors (i.e. waste, transportation in EPE, 2018).

Every guidance documents have a different definition for avoided emissions, but claims to highlight the contribution to the reduction and containment of climate change. So, whatever the document, **avoided emissions are always perceived as positive impacts on climate change (i.e. GHG that are not emitted), thanks to a solution provided by an entity, compared to a reference solution that generates more GHG.** All the existing guidance documents have in common the use of Life Cycle Thinking (LCT) to account for avoided emissions, although not always explicitly written (i.e. QuantiGES).

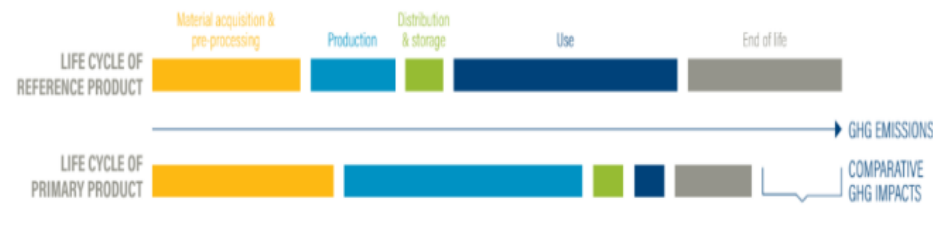


Figure 3.

Representation of the avoided emissions concept, drawn from WRI working paper, 2019

The resulting **avoided emissions correspond to the result of a comparative analysis between two solutions** (see Figure 3), with two main ideas:

- * **The difference of impacts between two current solutions that fulfill the same function** (i.e. ILCA), EPE);
- * **The potential reduction of emissions resulting from the implementation of a solution** (i.e. QuantiGES).

This concept of emissions avoidance has been known for some time by LCA practitioners when comparing two solutions, one being multifunctional. One possibility to manage the comparability of the solutions, one being multifunctional, is the substitution, also termed as avoided impacts.

Avoided impacts calculations are well known by the waste management industry, since waste management and recycling is multifunctional. Consequently, several LCA guides provide recommendations for allocation in case of recycling, and propose the “avoided impacts” approach (see GHG Protocol products, ISO 14067).

This preliminary guidance document intends to clarify and distinguish between avoided emissions and avoided impacts concepts, in the context of waste management and recycling activities, that are fundamentally multifunctional.

6.3. Key issues associated to avoided emissions accounting

The literature review helped to identify the important methodological issues associated with avoided emissions accounting, including the following themes:

1. Choice of the reference solution to compare with the assessed solution
2. Choice of the methodological accounting approach
3. Definition of the system boundaries of the system
4. Sharing of benefits between all actors of the value chain
5. Scaling-up at market level and the consolidation at corporate level
6. Quality of data
7. Communication

In almost all of the documentation, the assessed solution and the reference solution have to be defined, nevertheless the definition is generally quite fuzzy and may lead to several possible uses.

1. Choice of the reference solution to compare to the assessed solution

The assessed and the reference solution can be either a product, a technology, a process, a decision, an action, or a policy, depending on the scale of the solution providing benefits to climate and the aim and the topic of the study. For instance, in QuantiGES, the topic of the study is the accounting of avoided emissions because of the implementation of an action, whereas in ICCA & WBCSD guidance, the compared solutions are some products that fulfill the same function.

The reference solution is always the solution subject to comparison, and corresponds to a scenario that can either **represent the most likely situation in the absence of the assessed solution** (i.e. Carbon handprint, QuantiGES, ILCAj), **or the solution that is going to be replaced** by the assessed solution (i.e. ICCA), **or the product that fulfills the same function** than the assessed solution (i.e. ICCA). These three ideas are often intermingled, and whatever the point of view, the same fundamental questions arise:

- Which market: Average market at one time (i.e. ICCA)? A product with the highest market size or market share (i.e. ILCAj)?
- Which technology: Conventional technologies (i.e. ICCA, carbon handprint)? Best available technologies (i.e. carbon handprint)? Product before innovation is developed (i.e. ILCAj)? Previous version of the technology?
- Which regulatory requirements (i.e. ICCA refuses solutions about to be banned)?
- Which product: final or intermediate? (i.e. ILCAj requires final product focus)
- Is the reference dynamic or static over time: continuation of the current technologies (i.e. GHG Protocol, option 1)? Or a reference solution tends

to adjust over time (GHG Protocol, option 2)? No future changes except discount factor (i.e. ICCA)? Average at one time?

Table 1 provides more details about the challenges to overcome for the definition of the most adapted solutions.

2. Choice of the methodological accounting approach

The Life Cycle Assessment approach can be either attributional or consequential. Only a few references explicitly define the type of LCA methodology to apply, and generally, even if not explicitly written, the guidance document follows an attributional approach, and is based on a static inventory of emissions and 'removals'. Equally scarce guidance documents express the preference for a consequential approach (i.e. QuantiGES, GHG Protocol P&A, WRI, scientific study from Score LCA). The analysis shows that if the solution is a process, and when changes are on a large scale and influence the market, it is rather a 'consequential' point of view, and if the solution is a product, it is more likely an 'attributional' point of view. However, it is not clear and systematic, and **even if the consequential approach is sometimes more adequate, the practice reveals that attributional approaches are predominant.**

3. Definition of the system boundaries of the system

Regarding the scope, the majority of the guidance documents reviewed affirms that the **entire life cycles** should compare final product(s) and the reference solution. However, they also authorize the omission of parts in both life cycles, with specific requirements (for instance, in ICCA & WBCSD and ILCAj guidance, it is possible to omit identical processes).

Regarding the intermediate products, some guidance documents (i.e. ILCAj, WRI) indicate that **for intermediate products used as components in final products, a panel of representative final products should be chosen and integrated in the assessment**. Carbon handprint guidance is more demanding, since it requires to systematically consider the final customer application.

Regarding the potential changes outside the life cycle for both products (assessed and reference), only three guidance documents, with a consequential approach (quantiGES, GHG Protocol P&A, Mission Innovation), require to consider rebound effects on the market and evolution in the reference evolution over time. Carbon handprint excludes explicitly the rebound effects since the majority does not address this issue.

Finally, **avoidance period is often cited as a key issue** because the potential long-time change can modify deeply the reference solution, especially for long-lived products, because policies may change the business environment over the lifetime of the assessed product (WRI, 2019).

4. Sharing of benefits between all actors in the value chain

About half of the guidance documents recognize that **benefits are obtained collectively within a sector**, but nevertheless point out the fact that actors along the value chain want to claim a part of the benefits. Consequently, the guidance documents are generally quite open but imprecise and variable on how to deal with this issue. For instance, WRI recommends to validate a % with the actors of the value chain, while Mission Innovation proposes four approaches (equal allocation between different actors, financial cost or value attribution, consensus), while the Carbon Handprint attributes the benefit to the organization that provides the assessed solution. Finally, for ICCA and EPE, attribution should not be privileged and is optional while ILCAj requires attribution. EPE and ILCAj introduce attribution depending on the contribution ratio to the technology.

5. Scaling-up at market level and the consolidation at corporate level

Regarding scaling-up, guidance is generally quite poor. When it is done, the recommendation consists in multiplying the avoided emissions by the number of final products in use (i.e. ILCAj, Mission Innovation). WRI specifies that it is necessary to be careful because only market share generates avoided emissions, but not market size, since increasing market size globally increases emissions, even if emissions of the assessed solution are lower than the emissions of the reference solution. **Guidance is also poor regarding the issue of consolidation at company level**, since approximately half of the references does not even mention it (i.e. ICCA & WBCSD, ILCAj, Carbon Handprint). EPE and Mission

Innovation provide warnings about the need to be transparent but do not require a methodology. Only rare guidance documents are specific on this topic: for instance WRI requires to aggregate all products and warns about cherry-picking.

6. Quality of data

Regarding quality of data, **the majority of guidance documents refers to the requirements in ISO 14044 and GHG protocol** (technological, geographical, temporal representativeness, completeness and reliability). Some guidance documents propose additional requirements, such as QuantiGES with the construction of a grading note on quality, or EPE that recommends to validate the data with the value chain partners.

7. Communication

How to report on avoided emissions is generally described in guidance documents, with **recurrent warnings about the need to be understandable and transparent** (i.e. EPE), and occasionally a template with a list of items to be completed (i.e. ICCA & WBCSD, EPE). Some guidance documents also **refer to the ISO 14044 requirements when studies are intended for publication** (i.e. ILCAj, ILCAj, Carbon Handprint). However, few indications are provided on how to represent the avoided emissions. A few notable exceptions are in PEF/OEF documentation, and Score LCA study where they specify that **avoided emissions have to be reported separately in the communication**, and preferably in histograms and not in circular diagram with percentages.

6.4. Specific issues regarding avoided emissions accounting for waste management and recycling activities

Several mechanisms can lead to “avoided emissions”, whose magnitude depends on the perspective adopted and the possible considered functions associated to waste management and recycling. Thus, avoided emissions have relative benefits with regards to the involved mechanisms.

Comparison of the solutions proposed for waste management and recycling

A non-exhaustive list of possible perspectives that can be adopted to account for avoided emissions in waste management and recycling sectors is proposed, and consequently influence strongly the result:

- * **Comparison of solutions from a waste treatment perspective**

for instance: if recycling replaces landfill, what are the avoided emissions thanks to recycling development.

- * **Comparison of solutions from a ‘output from recycling’ perspective**

for instance: comparison between plastic production from recycling and virgin plastic production.

- * **Comparison of solutions from technological process perspective**

for instance: comparison of two competitive new recycling technologies.

Considering the multifunctionality approach in waste management and recycling

Furthermore, waste management and recycling activities are multifunctional, since they allow to eliminate waste but also to produce some material.

Depending on the goal of the study, the multifunctionality can be considered or not to account for avoided emissions. The possible taking into account the multifunctionality of the waste management and recycling activities strongly influence the result of the comparison. One of the most frequent methods to deal with multifunctionality in LCA is the reduction of the system, considering the substitution of the 2nd function by an alternative route.

Thus avoided emissions accounting in the waste management and recycling sector raises additional challenges due to the fact that we can also account for avoided impacts due to the substitution to alternative solution outside the system boundaries. Confusion between avoiding emissions accounting and avoided

impacts can be observed, since both approaches aim to put forward environmental benefits.

The Figure 4 presents an example of the consequence on the calculation of avoided emissions, by considering avoided impact when multifunctionality occurs. In the example, the assessed solution is multifunctional (may be for instance a recycling process), and the reference solution is monofunctional (for instance, virgin production process).

The preliminary guidance document aims to put forward the consequences of the adopted perspective and takes into account (or not) the multifunctionality on the avoided emissions accounting.

These two terms ‘avoided emissions’ and ‘avoided impacts’ should be clarified in case of waste management and recycling activities, and first recommendations should be proposed about the perspective to adopt depending on the goal of the study.

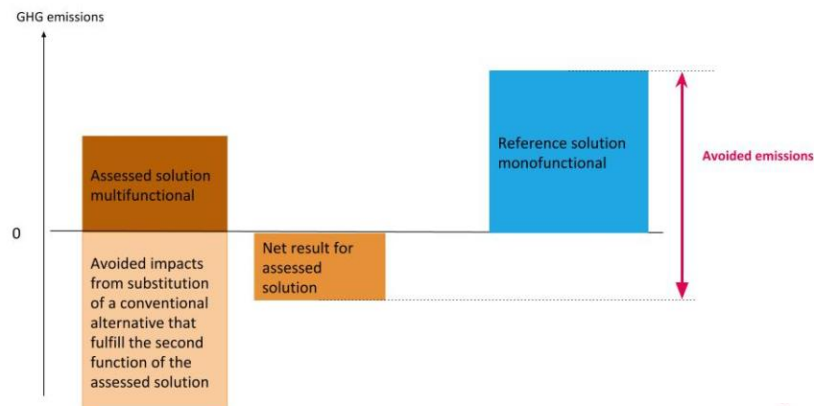


Figure 4.

Representation of the avoided emissions when the assessed solution is multifunctional, integrating the avoided impacts occurring through reduction of the system.

Since the preliminary guidance document especially focuses on the approach to have when the goal is annual corporate reporting, a future methodological framework will provide specific requirements and recommendations for other possible goals, about:

- the most adapted perspective to adopt (corporate or product perspective),
- if the multifunctionality has to be considered or not,
- the most adapted reference solution will be compared against the assessed solution (taking into account the market, the regulation, etc.).

6.5. Analysis of main challenges regarding avoided emissions accounting to address in a future guidance document

The literature review helped to identify several challenges to address when avoided emissions accounting studies are scheduled. Table 1 summarizes the challenges associated with the avoided emissions accounting for waste management and recycling, these are listed through a series of questions to be solved.

For each concern discussed above, a number of choices can be encountered, each decisive for the turn taken by the comparative assessment between the reference solution and the assessed solution. There are no 'good' or 'bad' choices, but each decision has to be made conscious of the objective of the study. Furthermore, for waste management and recycling activities, understanding the underlying functional objectives of the assessed solution is fundamental because the nature and extent of the avoided emissions depend on it. Chapter 7 aims to propose an overview of the general methodology for avoided emissions accounting in case of waste management and recovery activities.



Table 1. Main challenges to address

Topics	Main challenges / questions
Definition of avoided emissions	<ol style="list-style-type: none"> 1. Define avoided emissions and clarify the positioning versus reduction of emissions. 2. List the criteria to fulfill in order to be eligible to claim avoided emissions : <ul style="list-style-type: none"> - system boundaries (specifying which stages of the waste management and recycling activities to take into account in the comparison) - notion of time between the two comparisons (is it the difference at one same moment, now or in the future, is it the difference between two moments) 3. Clarify the positioning of reduction tracking, 4. Define and clarify avoided emissions versus avoided impacts in the case of waste management and recycling activities
Assessed solution	<ol style="list-style-type: none"> 1. Validate the eligible solutions for avoided emissions accounting: product (good or service), process, corporate portfolio, decision (project, action, policy) 2. List the eligible waste management and recycling activities compared to reference scenarios 3. Analyse the function(s) of recycling activities and the consequences on the scenarios to compare including the issue of multifunctionality
Reference solution	<ol style="list-style-type: none"> 1. Validate the eligible solutions that have to be compared with the assessed solutions : <ul style="list-style-type: none"> - in the absence of the assessed solution - or/and that is going to be replaced - or/and that fulfills the same function 2. Validate the most credible situations : <ul style="list-style-type: none"> - A common alternative on an average market - A specific alternative, the highest competitor - Intermediate product, final product - Best available technology, regulatory requirements - A prospective scenario in the future that would represent a future reference 3. Define how to consider the evolution of the reference solution (static? dynamic?)
LCA approach	<ol style="list-style-type: none"> 1. Provide recommendations towards the situation to determine if an attributional or a consequential LCA approach must be chosen, and the associate criteria 2. Provide recommendations on how to consider the multifunctionality of waste management and recycling activities in case of attributional or consequential LCA approach
System boundaries	<ol style="list-style-type: none"> 1. Specify the scenarios eligible for avoided emissions accounting, on the basis of the following criteria : spatial, temporal, stages of the value chain 2. Validate if whether or not, some simplifications are possible by omitting some stages of the life cycle. If so, precise the conditions. 3. Positioning accounting for the rebound and extra boundaries effects, and the evolution of practices and regulations (for long time frame studies for instance)
Attribution on the value chain	<ol style="list-style-type: none"> 1. Specify how waste management and recycling activities should allocate the resulting avoided emissions : consensus with downstream users of products or energy from recycling (ratio of contribution, qualitative considerations) 2. Clarification of the allocation issue when multifunctionality is solved by substitution (with various possible methodologies 100/0, 0/100, 50/50, market etc.), generally between two actors, and the attribution of avoided emissions for several actors on the entire value chain
Data quality	<ul style="list-style-type: none"> - For the assessed solution: recommendations to choose the most relevant data for waste management and recycling activities (site, primary, financial or operational data), including uncertainty and sensibility analysis - For reference solution: recommendations for validating data according to the quality data requirements (see 7.3).
Scaling up & consolidation	<ul style="list-style-type: none"> - Recommendations to validate the consolidation at company level: complete portfolio, control or equity share. - Recommendation to validate the estimation for a global market to sectoral level.
Communication	<ul style="list-style-type: none"> - Recommendations for visually representing the avoided emissions. - Validation about the external communication requirements for avoided emissions (ratio of contribution, contributor on the value chain but no detailed, 100% of avoided emissions etc.)

7. Methodological Approach for Avoided Emissions Accounting Dedicated to Waste Management and Recycling

7.1. Avoided emissions accounting

This chapter provides general approaches and recommendations when embarking on an avoided emissions accounting study. The overall process proposed here covers the full cycle from the study to its final communication.

First, some recommendations based on the issues exposed above in chapter 6 shall be addressed. This preliminary guidance document shall not attempt or cover the entire list of the challenges raised above (see Table 1), as they will be dealt with in the methodological framework.

7.1.1. General approach

LCA approach

The methodology is based on the principles of life cycle assessment, described in ISO 14040-44 standards. LCA methodology allows the comparison between two scenarios along the life cycle of two alternative solutions that fulfill the same function.

The life cycle of the waste management and recycling sector includes the stages from waste collection, preparation, treatment and recycling processes.

LCA is a multicriteria methodology that reviews information on impacts for several environmental categories (resource depletion, ecosystems quality etc.). This preliminary guidance document (and the future methodological framework) focus on impacts on climate change, hereafter named as 'avoided emissions'. Because

of this narrow scope, authors invite users to pay attention to potential trade-offs between environmental consequences.

Definition of avoided emissions applied in waste management and recycling

Avoided emissions are the GHG reduced emissions that occur as a result of the assessed waste management and recycling solution, compared to a reference solution.

In this preliminary specific guidance document dedicated to the waste management and recycling sector, avoided emissions correspond to GHG savings when implementing waste or recycling solutions (section 5.1), depending on the topic. When compared, both the assessed and reference solution have the same nature and are studied through the construction of two scenarios that fulfill the same function.

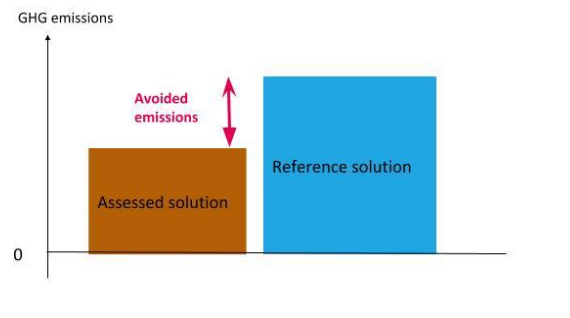


Figure 5.

Schematic representation of avoided emissions

Whatever the mechanisms involved, **avoided emissions correspond to the calculated sum of the cumulative changes in emissions between the assessed solution and the reference solution, along the entire value chain** (including the potential stages with increased emissions).

This can be summarized by the following formula:

$$\begin{array}{c} \text{Avoided emissions} \\ = \\ \text{Emissions in reference solution} \\ - \\ \text{Emissions in assessed solution} \end{array}$$

Avoided emissions occur only when the total difference is positive (Avoided emissions > 0). If the result is < 0, the assessed solution does not save GHG emissions, and avoided emissions cannot be claimed. The assessed solution is, in the latter case, the source of additional GHG emissions and efforts to reduce its impacts should be made.

It should be noted that, in the case of corporate annual accounting, if the result from the comparison between two annual GHG corporate emissions (for example N compared to N-1) on scope 1, 2, 3, results in a decrease in overall emissions, it should not be considered as "avoided emissions", but as a reduction of emissions.

7.1.2. Overview of the recommended steps

Step 1: Goal definition

This preliminary guidance document is proposed as a support for users of avoided emissions accounting, whatever their objectives for the study. Nevertheless, the choice of the methodology and the resulting avoided emissions calculation depends on the objective that has been set. Consequently, the goal must be clearly identified through a set of questions and goals.

Why and for whom do I want to account for avoided emissions?

- * **Claiming the benefits of the outputs from recycling on the marketplace?**
 - for investors?
 - for corporate communication?
 - for the general public?
- * **Benchmarking and piloting the environmental performance of a new low-carbon technology?**
 - for investors?
 - for call for tenders?
 - for researchers or business developers?
- * **Measuring the benefits associated to the scaling-up of the recycling?**
 - for policymakers?
 - for the general public?

Correlated to the list of questions, here is a non-exhaustive list of goals or application fields that can be associated to waste management and recycling 'avoided emissions accounting studies':

Goal 1: Annual reporting of avoided emissions of a portfolio at corporate level

Goal 2: Quantification of the benefits generated by products or processes from the waste management and recycling sector (in case of call for tenders, research and innovation etc.)

Goal 3: Quantification of the benefits generated by projects

Goal 4: Quantification of the sectoral contribution to the GHG reduction ambition

In this preliminary guidance document, methodology and recommendations focus on the **Goal 1**.

Nevertheless, the methodological framework will provide specific recommendations for the other goals and associated mechanisms leading to avoided emissions.

Whatever the identified goal of the study, the application of the results between a) communication about current situation and b) decision-making for future potential situation has to be defined.

The goal and application of the study are key factors that have to be taken into account in priority to determine the best suited Life Cycle Approach.

However, other factors may also influence the choice or the approach, as described in Step 2.

Step 2: Choice of the LCA approach

The attributional approach helps to identify and 'attribute' the share of the overall impact to the assessed solution, in a specific market size (segment or component thereof). By contrast, the consequential approach consists in looking ahead to the consequences of a project on the market share. Therefore:

- * **Attributional approaches** suit well when the aim is **to compare the environmental performance of two solutions that are present on the market at a specific moment**, currently or in the future. Essentially, the attributional approach is a suitable tool to assess the performance of technologies, products, processes, at micro scales.
- * **Consequential approaches** are more suitable **to estimate the net impact of a GHG emission reduction that results from the implementation of a project**. They can then be considered as a policy tool. The reference solution is the situation before the implementation of the project, and the assessed solution is the situation after the project's implementation.

The choice between these two approaches has to be made depending on the objective of the study (see Step 1), but also depending on:

- **data availability:** consequential LCA are lacking in data, and need more time and expertise to be implemented;
- **the scale:** at site level, and even up to corporate level, the scale changes are marginal, and in these situations, consequential and attributional approaches can be applicable.

- **the time period between the assessed solution and reference solution:** either fixed (now, in the future), either as a dynamic approach (evolution of the reference during the considered period).

Thus, even though the consequential approach seems to be more suited to the concept of ‘avoided emissions’ and may recommend the replacement of the reference solution by the assessed solution, the attributional approach may be easier to implement and can be used to account for avoided emissions, either for products, processes or projects (**Goals 2 & 3**).

Unless changes caused by the solution are supposed to be broad, or the solution is an innovation that leads to changes in the market, **the attributional approach is preferred for avoided emissions accounting for the waste management and recycling sector**. It does imply, however, that the core market is not affected by the assessed solution. Consequently, for **Goal 3**, the consequential approach may be more appropriate, since implementation of a sectorial policy is able to deeply modify all the market.

Specifically for annual corporate reporting communication (Goal 1), the attributional approach is the only possible method, in order to be compliant with the approach adopted in scope 1, 2, 3 of the GHG protocol corporate accounting.

Step 3: Identification of the assessed solutions and definition of system boundaries

As defined in ISO 14040-44 standards, both solutions shall afford the same benefits for the user, i.e. the same function(s). The validation of the finality of the study, and the LCA approach will help in defining the function(s) considered for the solutions, and the associated system boundaries.

When comparing, from a ‘process perspective’ in waste management and recycling, the **function on which the comparison is based is the weight (in tons) of processed waste by the two alternative solutions (i.e. waste treatment)**, for instance between landfill and recycling. In this case, the additional function associated with the processing of waste is the production of material.

When comparing from a ‘product perspective’, usually the considered **function is the transformation** through manufacturing **of tons of material (i.e. material production)** by the two alternative solutions, for instance:

- between virgin production of material and production of material from recycling;
- between production of material from two recycling technologies.

In this case, the additional function associated to the production of material is the processing of waste (i.e. waste treatment).

Whichever the perspective used, the **additional function is out of the scope of the comparison**, and the associated emissions and potential benefits consequently occur beyond the boundaries of the systems being compared.

Thus, when these kinds of benefits occur because one of the solutions is multifunctional, they lead to ‘avoided impacts’ (see Figure 4). As such, they may be considered in the ‘avoided emissions accounting’ studies but should not be confused with this last concept.

The methodology and associated recommendations however need to be adjusted depending on the objective/goal (see step 1).

Goal 1: Annual reporting of avoided emissions of a portfolio at corporate level

In the waste management and recycling sector, corporate inventories contain data on direct and indirect GHG emissions from sources located within a company’s internal operations and value chain, according to the GHG protocol corporate accounting and reporting standard (WRI, WBCSD, 2004). Companies assessing avoided emissions shall not claim the entirety of avoided emissions that may occur as a consequence of a solution they might be providing or contributing to. And for this reason, companies want to dispose of methodologies allowing them to claim these benefits, especially when the production of these outputs lead to additional emissions in the scope of the company, that is why they use comparative assessments to claim their benefits.

Thus, when the objective is the communication of the annual Corporate accounting inventories, avoided emissions are associated with the benefits that occur outside the scope of the company. In this case, the contribution from waste management and recycling was factored-in by taking into account the only function considered as production of material. The intrinsic outputs from waste management and recycling are considered as such, independently of the fact that they are the result of a multifunctional process which allows to treat waste. The subject of comparison, therefore only focuses on the material production aspect.

This approach is recommended since all other changes in activities (e.g. putting flaring into place at landfills, changing waste management technologies, etc.) will lead to changes in emissions which are accounted for either directly or indirectly. The purpose of assessing avoided emissions is therefore to account for additional benefits.

Depending on the recovery (energy or material recycling) outlet that is considered, the methodology to adopt for avoided emissions accounting is different.

Possibility 1 – Energy recovery

In this case, avoided emissions correspond to the emissions of the substituted energy for the quantity of kWh that is sold on the energy market (average mix of alternative energy).

It corresponds to the 'Avoided impacts' in the Figure 4. In this case, we just focus on the potential avoidance of impacts associated with the substitution, and conclude that they correspond to avoided emissions. We neglect the secondary function of waste treatment (that is covered in the blue block in Figure 4).

Figure 6 represents this possibility with additional graphic representation in Figure 7 to illustrate the relative

Possibility 2 – Material recycling

Avoided emissions are the difference between the emissions from the production of the output from a reference virgin solution, and the emissions (at a constant user benefit and output) but from the use of recycling (or energy from waste recovery).

It corresponds to the 'Net result for assessed solution' in the Figure 4. In this case we just focus on the difference between the assessed solution and the avoided impacts for one of the two functions of the assessed solution, and we ignore the secondary function of waste treatment (that is studied in blue block in Figure 4).

Figure 7 represents this possibility with a representation different from Figure 4. It helps illustrate the positioning between reduction of emissions and avoided emissions for annual corporate reporting.

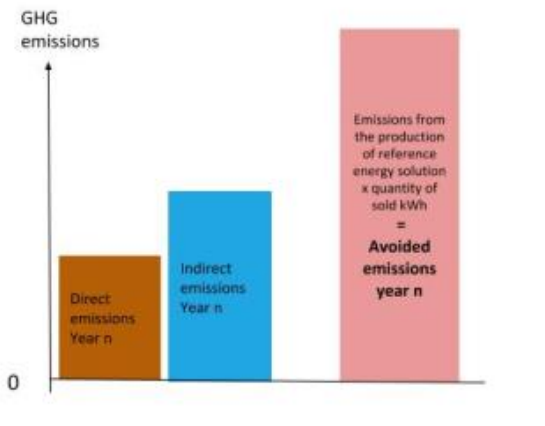


Figure 6.

Representation of the possibility 1 of avoided emissions for reporting application in case of energy recovery

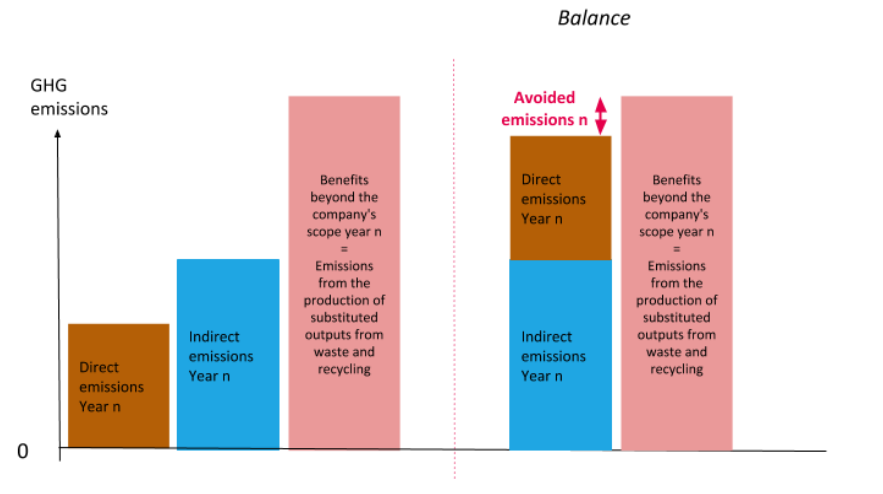


Figure 7.

Representation of the possibility 2 of avoided emissions for reporting application, in case of material recycling

Other Goals: Products / processes differentiation or projects implementation, at different possible scales of time & space

The future framework will represent further the proposed approach. Globally, when object of the claims concern the GHG performance of products or processes, the avoided emissions correspond to the difference of the total life-cycle emissions (across all scopes) between a company's process or product and an alternative that provides the same function. In this case, the avoided impacts associated with the multifunctionality of the system can be either accounted or not, depending on the perspective of the waste management and recycling solution.

The **reference solution** can be:

- **An average of the products in the market in the year of assessment.** For example for material substitution, the classical mode of production of the material from virgin resources
 - **A regulatory requirement,** for example, if the regulation imposes to minimally flare the CH₄ from landfill, it has to be considered as the reference solution
 - **A future condition: when the assessed solution is expected as a long-term replacement,** when the reference will have evolved. For example, when the regulation will impose à % of recycled plastic in packaging
 - **Other: a specific competitive solution, a best available technology** etc.
-

In conclusion, whichever the goal, the reference scenario has to integrate the minimum regulatory standard. If the avoidance period is long or at a specific moment in the future, **the evolution of the regulation or conventional alternatives have to be taken into account.** Whatever the approach, it will need verification so that the assessed solution replaces the reference solution, thus the market share increases for the assessed solution, and emissions of GHG are reduced thanks to the use of the assessed solution.

Since avoided emissions occur throughout the whole value chain, **all life stages of the solutions should be addressed in the comparison.** However, if compared solutions have some identical stages, it is possible to exclude them (for instance, same transport mode and distance between two stages).

Step 4: Data collection

Justification towards all assumptions and all emission factors should be documented. A robust collection of relevant data (see 7.3) needs to be done for both the assessed solution and the reference solution. All assumptions or data gaps should be stated in all supporting documentation.

Step 5: Assessment of avoided emissions

Each stage of the life cycle for both retained solutions requires collecting primary data. The emission factors for each considered GHG needs to be validated. The calculations of the emissions of both solutions have to be conducted, followed by their comparison in order to assess the avoided emissions.

Step 6: Reporting

Reporting the avoided emissions results should be done following the recommended guidelines (see 7.4 for corporate reporting). In the event of potential trade-offs, these should be investigated and communicated.

7.2. Recommendations for corporate reporting

Table 2. Main challenges / questions and Authors recommendations for corporate reporting (goal 1).

Topics	Main challenges / questions	Authors recommendations for corporate reporting
Definition of avoided emissions	1. Define avoided emissions and clarify the positioning versus reduction of emissions.	Avoided emissions disclosed in annual corporate reporting for waste management and recycling sector are emissions savings in CO ₂ eq out of the direct and indirect emissions scope (scope 1+2+3) resulting from the activity of the company on its operational perimeter.
	2. List the criteria to fulfill in order to be eligible to claim avoided emissions.	<ul style="list-style-type: none"> - System boundaries: scenario comparison based on the activity: selling recycled material produced by the company or energy recovery provider. - Notion of time between the two comparisons: difference of GHG emissions from the company activity and from the reference solution on a year of reporting basis.
	3. Clarify the positioning of reduction tracking.	In case of corporate reporting, GHG emissions reductions are the result of the comparison of direct and indirect GHG emissions between year n-1 and n (the result can also be an increase).
	4. Define and clarify avoided emissions versus avoided impacts in the case of waste management and recycling activities.	<p><i>Energy recovery</i>: in case of reporting avoided emissions from energy recovery, avoided CO₂eq emissions = avoided GHG impacts (see 7.1.2 Step 3, Figure 6). Eg:</p> <ul style="list-style-type: none"> - biogas is compared to gas usage. - electricity from biogas or incineration is compared to the energy mix for electricity production. - heat from biogas or incineration is compared to the energy mix for heat production. <p>NB1: Flaring biogas from landfill is counted as a reduction of scope 1 and not eligible for avoided emissions accounting. NB2: Onsite consumption of energy recovery accounting: The majority of partners in the consortium recommend to not include self-consumption of electricity in calculation of avoided emissions. A complete study based on other case studies should be provided in the future guidance document to confirm this positioning.</p> <p><i>Recycled material</i>: avoided CO₂eq emissions are the result of the comparison between two solutions on the year n. (see 7.1.2 Step 3, Figure 7). Eg.: Waste management and recycling sector's activities are both to sort material for recycling or direct use, and to integrate the recycling phase. Those two activities are eligible for avoided emissions accounting, comparing the production of recycled material to the production of raw material.</p>
Assessed solution	1. Validate the eligible solutions for avoided emissions accounting.	Positive output from materials recycling and energy recovery from waste treatment on operational perimeter of the company
	2. List the eligible waste management and recycling activities compared to reference scenarios addressed in this guidance document.	<ul style="list-style-type: none"> - biogas valorisation on landfills - waste to energy recovery - materials recycling - high GWP gases destruction - organic matter recovery

Topics	Main challenges / questions	Authors recommendations for corporate reporting
Assessed solution	3. Analyse the function(s) of recycling activities and the consequences on the scenarios to compare including the issue of multifunctionality.	The function of recycled material or energy recovery is the only function taken into account (without the waste treatment one).
Reference solution	1. Validate the eligible solutions that have to be compared with the assessed solutions	Authors have been using consolidated emission factors "avoided CO2 emission factor" already embedding the comparison between the two solutions. The recommendation is to substitute this consolidated emission factor by the emissions factor of the raw material production and the emission factor of the recycled material production to be more transparent on the hypothesis of the calculations.
	2. Validate the most credible situations	The production of harmonised emission factors adapted to the latest technologies of the sector is recommended.
	3. Define how to consider the evolution of the reference solution (static? dynamic?)	Not applicable as the solutions are compared on a one year basis.
LCA approach	1. Provide recommendations towards the situation to determine if an attributional or consequential LCA approach must be chosen, and the associate criteria	Attributional
	2. Provide recommendations on how to consider the multifunctionality of waste management and recycling activities in case of attributional or consequential LCA approach	Multifunctionality is not considered, only the substitution to alternative solutions
System boundaries	1. Precision of the scenarios eligible for avoided emissions accounting, on the basis of the following criteria: spatial, temporal, stages of the value chain.	Beyond the scope of the company's GHG emissions' inventory meaning emissions from the substitution of energy or materials of other industries.
	2. Validate if whether or not, some simplifications are possible by omitting some stages of the life cycle. If so, precise the conditions.	In case of energy recovery, the avoided emissions are equal to the GHG emissions for energy production with the local energy mix.
	3. Positioning about the taking into account the rebound and extra boundaries effects, and the evolution of practices and regulations (for long time frame studies for instance).	Not applicable for corporate reporting
Attribution on the value chain	1. Precision about how waste management and recycling activities should allocate the avoided emissions calculated: consensus with downstream users of products or energy from recycling, ratio of contribution, qualitative.	In the case of corporate reporting companies disclose avoided emissions which correspond to savings for their clients without allocation, in order to enable to measure the contribution to the circular economy of the sector.
	2. Clarification of the allocation issue when multifunctionality is solved by substitution.	Not applicable for corporate reporting.

Topics	Main challenges / questions	Authors recommendations for corporate reporting
Data quality	<ul style="list-style-type: none"> - For assessed solution: - For reference 	It is recommended to disclose GHG avoided emissions as required by ISO 14060: in the case of corporate reporting, it may be solved by disclosing intervals.
Scaling up & consolidation	Recommendations to validate the consolidation at company level:	Use the GHG Protocol definition for perimeter. Recommendation : operational perimeter
	Recommendation to validate the estimation for a global market to sectoral level.	<i>Not specified in this document.</i>
Communication	Recommendations about the visual representation of the avoided emissions.	GHG emissions and avoided emissions are to be disclosed in separate tables and graphs, so that it is clear that they are not offsetting direct and indirect emissions.
	Validation about the external communication requirements about avoided emissions (ratio of contribution, contributor on the value chain but no detailed, 100% of avoided emissions etc.)	Transparency requirements on the methodology



7.3. Key issues and challenges for products or processes analysis

Products or processes studies can be achieved in different contexts with several goals, such as differentiation of

current products on the market, call for tenders, technology innovation, or sectoral analysis etc.

Four case studies were done (see Appendix 1) to highlight challenges for each methodological issue. However, the list of associated challenges is not exhaustive and cannot cover all situations that could be addressed in this chapter in terms of products/processes. Following this statement,

it is not relevant to propose recommendations in this preliminary guidance document (as proposed for the corporate reporting, see 7.2). Precise recommendations related to avoided emissions accounting will be done, case by case, in a future methodological framework.

Table 3. Main challenges for products or processes (goal 2).

Topics	Main challenges	Identified challenges for products or processes towards case studies (see Appendix 1)
Definition of avoided emissions	<ol style="list-style-type: none"> 1. Define avoided emissions and clarify the positioning versus reduction of emissions and negative emissions. <i>While the difference has been established for corporate reporting, it is not as clear for products or processes.</i> 2. List the criteria to fulfill in order to be eligible to claim avoided emissions. 3. Clarify the positioning of reduction tracking. 4. Define and clarify avoided emissions versus avoided impacts in the case of waste management and recycling activities. 	<p><i>Challenge identified through the case study about polypropylene recycling:</i></p> <ul style="list-style-type: none"> - Avoided emissions depend on the finality of the study: product or waste perspective, and the potential taking into account the multifunctionality.
Assessed solution	<ol style="list-style-type: none"> 1. Validate the eligible solutions for avoided emissions accounting. 2. List the eligible waste management and recycling activities compared to reference scenarios addressed in this guidance document. 3. Analyse the function(s) of recycling activities and the consequences on the scenarios to compare including the issue of multifunctionality. 	<p><i>Challenge identified through the case study about polypropylene recycling:</i></p> <ul style="list-style-type: none"> - How to take into account the variability in terms of composition of waste streams inputs - How to consider the variability in terms of regulation in the different countries involved in the upstream inputs - How to define the most adapted assessed solution : treatment of waste through recycling, production of plastic through recycling <p><i>Challenge identified through the case study of a Waste treatment complex composed of a reclaimed landfill with methane capture and energy production and an Energy from Waste plant withco-generation:</i></p> <ol style="list-style-type: none"> 1. Avoidance period: <ul style="list-style-type: none"> - Evolution of the wasteflow: assumptions have to be made on the amount and the characterization of waste recovered through landfilling and through EfW facility. - Evolution of carbon content of local energy mix has also to be considered 2. Scope: Considering the whole scope of the project may makes the reduced and avoided emissions estimation difficult according to current standardized methodologies

Topics	Main challenges / questions	Identified challenges for products or processes towards case studies (see Appendix 1)
Reference solution	<ol style="list-style-type: none"> 1. Validate the eligible solutions that have to be compared with the assessed solutions 2. Validate the most credible situations 3. Define how to consider the evolution of the reference solution (static? dynamic?) 	<p><i>Challenge identified through the case study about polypropylene recycling:</i></p> <ul style="list-style-type: none"> - How to take into account the potential variability in terms of quality of polypropylene from recycling ? - How to define the most adapted reference solution : another conventional waste treatment process, another mode of production of plastic - Whatever the reference solution → how to define the best reference? (average of existing market, average in a future market, best available technology, (future) regulatory requirements ? <p><i>Challenge identified through the case study of a Waste treatment complex composed of a reclaimed landfill with methane capture and energy production and an Energy from Waste plant with co-generation:</i></p> <p>Reference baseline:</p> <ul style="list-style-type: none"> - Current waste treatment infrastructure, - OR minimum compliant new infrastructure implementation according to local current regulation, - OR minimum compliant new infrastructure implementation according to evolution of local regulation during the whole operation period.
LCA approach	<ol style="list-style-type: none"> 1. Provide recommendations towards the situation to determine if an attributional or consequential LCA approach must be chosen, and the associate criteria 2. Provide recommendations about the way to consider the multifunctionality of waste management and recycling activities in case of attributional or consequential LCA approach 	<p><i>Challenge identified through the case study about polypropylene recycling:</i></p> <ul style="list-style-type: none"> - LCA approach should be adapted depending on the scale of the study, time of avoidance, size of the market, and scaling-up of the process.
System boundaries	<ol style="list-style-type: none"> 1. Precision of the scenarios eligible for avoided emissions accounting, on the basis of the following criteria: spatial, temporal, stages of the value chain. 2. Validate if whether or not, some simplifications are possible by omitting some stages of the life cycle. If so, precise the conditions. 3. Positioning about the taking into account the rebound and extra boundaries effects, and the evolution of practices and regulations (for long time frame studies for instance). 	<p><i>Challenge identified through the case study about polypropylene recycling:</i></p> <ul style="list-style-type: none"> - How to take into account the variability in terms of the number of places and actors that intervene in the functional unit delivery.

Topics	Main challenges / questions	Identified challenges for products or processes towards case studies (see Appendix 1)
Attribution on the value chain	<p>1. Precision about how waste management and recycling activities should allocate the avoided emissions calculated: consensus with downstream users of products or energy from recycling, ratio of contribution, qualitative.</p> <p>2. Clarification of the allocation issue when multifunctionality is solved by substitution.</p>	<p><i>Challenge identified through the case study about polypropylene recycling:</i></p> <ul style="list-style-type: none"> - How to take into account the variability in terms of the number of places and actors that intervene in the functional unit delivery <p><i>Challenge identified through a case study of a Waste treatment complex composed of a reclaimed landfill with methane capture and energy production and an Energy from Waste plant with co-generation:</i></p> <ul style="list-style-type: none"> - Attribution of climate benefits between the different actors of the value chain: Asset owner, operator, local energy suppliers
Data quality	<ul style="list-style-type: none"> - For assessed solution: - For reference 	<p><i>Not specified in this document.</i></p>
Scaling up & consolidation	<p>Recommendations to validate the consolidation at company level:</p> <p>Recommendation to validate the estimation for a global market to sectoral level.</p>	<p><i>Not specified in this document.</i></p>
Communication	<p>Recommendations about the visual representation of the avoided emissions.</p> <p>Validation about the obligation to communicate about negative impacts also, or not at company level</p> <p>Validation about the external communication requirements about avoided emissions (ratio of contribution, contributor on the value chain but no detailed, 100% of the avoided emissions etc.)</p>	<p><i>Not specified in this document.</i></p>



8. Attribution of benefits along value chain and communication

8.1. Attribution of avoided emissions between stakeholders in a value chain

One of the major barriers in avoided emission communication is the allocation of these among different stakeholders in the value chain. In most cases, avoided emissions are a consequence of a collaboration between different stakeholders and cannot in essence be allocated to a single entity.

For example, Plastic Packaging Recycling is possible thanks to the collection, treatment and recycling by waste management companies and their providers. However, without the willingness of packaging producers, brand owners and the final consumer, recycling would not occur. It is therefore relevant to discuss the allocation of avoided emissions between all stakeholders in the value chain.

Different approaches for allocation of avoided emissions exist based on different criteria (contribution to the value chain, added value to the process under study, consensus between stakeholders...). Nevertheless, these approaches are often considered either arbitrary (e.g. defining the contribution of a party to avoided emissions is not based on a physical or economic reality) or complex to put in place (e.g. it is difficult to build consensus with all members of a given value chain).

Moreover, the authors of this preliminary guidance document believe that the assessment of avoided emissions should be done in order to identify the environmental interest of a given solution and not to create environmental credits

for specific stakeholders of the value chain. An inappropriate allocation of avoided emissions might in fact, create confusion and could cloud the overall potential benefits of a given solution. Because of this complexity, it has been decided that this preliminary guidance document will not provide any recommendations on the approach to be used for allocation of benefits. However, a common approach to avoided emissions attribution could be developed in a future methodological framework if considered necessary by stakeholders.

The preliminary guidance document is aiming at giving a robust assessment of the environmental impact of waste management and recycling as far as GHG mitigation is concerned. The question of allocation doesn't allow to get the big picture of the comparison of beneficial solutions for the common good and not only for specific actors of the value chain.

8.2. Communicating on avoided emissions

Based on the aforementioned issues, the following communication principles have been defined in the current preliminary guidance document:

- * Companies assessing avoided emissions shall not claim the entirety of avoided emissions that may occur as a consequence of a solution they might be providing or contributing to.
- * If companies communicate on the overall avoided emissions (without allocation between parties), they should clearly state that these avoided emissions cannot be attributed entirely to the company by using sentences, such as:
 - *As part of the value chain, company's X solution contributes to avoiding Y amount of emissions;*
 - *Solution Z helps avoid Y amount of emissions in the value chain.*
- * If companies decide to communicate on a share of avoided emissions and claim it as theirs, then the allocation approach used and the reasoning behind it should be clearly stated (based on recognized methodology by the sector or experts), in the communication.

Appendix 1: Case Studies

Specifically, through their own case studies, authors want to:

- Illustrate the influence of the decision for each key issue associated with avoided emissions calculation;
- Analyse the consequences of methodological choices (combination of decisions for each item);
- Identify the adapted methodological framework for the waste management and recycling sector;
- Determine the challenges to address in the further step of the project for the construction of a common and consensual guidance document for waste management and recycling sector.

All information proposed by authors, through those case studies were been used and aggregated in chapter 7 to highlight methodological steps and recommendations to account avoided emissions at Corporate levels (section 7.2) and for products or processes analysis (section 7.3).

Analysis of avoided GHG emissions generated by the recycling of polypropylene (PP) at site level



Description of the PP recycling life cycle

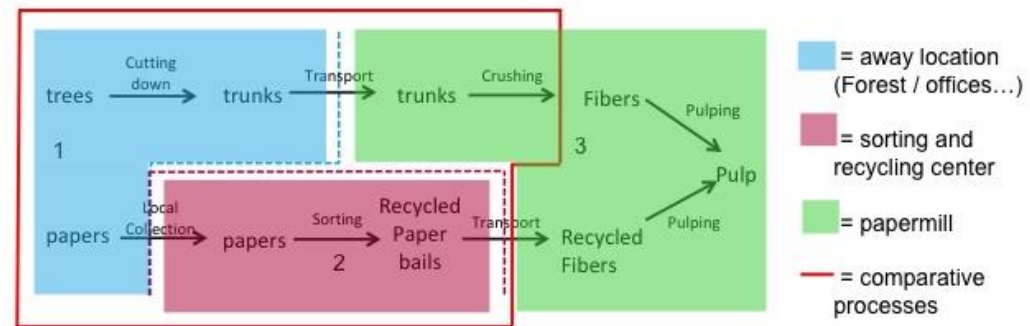


<p>Compared solutions</p>	<p>Assessed solution: production of recycled polypropylene. Reference solution depends on the purpose of the study. Purpose: At site level, purpose is product or process differentiation. Characteristics of the case study: plastic waste input composition is varied, and comes from different places, the process is split into several sites and several actors for the different stages (not all managed by Veolia). Output from the site are pellets for open-loop recycling (automobile components, leisure, construction, household equipment)</p>
<p>Main challenges</p>	<p>Challenge 1: How to take into account variability in terms of regulation requirements, the presence of numerous places and actors, and variable composition of waste input. In 1/ the system boundaries 2/ the construction of the functional unit 3/ the attribution of the benefits. Challenge 2: How to manage the intermediate and final end use level and the number of cycles in the functional unit. Challenge 3: Is the assessed solution monofunctional (i.e. production of PP compounds), or multifunctional (production of PP and treatment of waste?). Is the reference solution an alternative recycling pathway? A virgin production pathway? May the reference solution be another PP waste management? Whatever the retained reference solution → how to define the best reference? (average of existing market, average in a future market, best available technology, (future) regulatory requirements / how to manage the multifunctionality and scope at site level when life cycle is split into several places and several actors? Challenge 4: the purpose is product or process differentiation, but how to account for benefits? Provide recommendations to select the most adapted LCA approach (attributional or consequential), depending on factors such as the scale of the study, time of avoidance, size of the market, and scaling-up of the process? Challenge 5: How to aggregate site level avoided emissions in a global corporate accounting? Is it possible or not?</p>
<p>Author conclusion</p>	<p>The case study put forward key challenges to address when the purpose is product or process differentiation. The case study allows to put forward the huge consequences on the results about the choice of reference solution and the consideration of the potential multifunctionality of waste treatment or not. It also revealed the complexity of consolidation and attribution of benefits because the value chain is split into several actors and places, even within the same stage.</p>

Paper and Cardboard recycling: how to assess the environmental benefit in terms of carbon footprint?

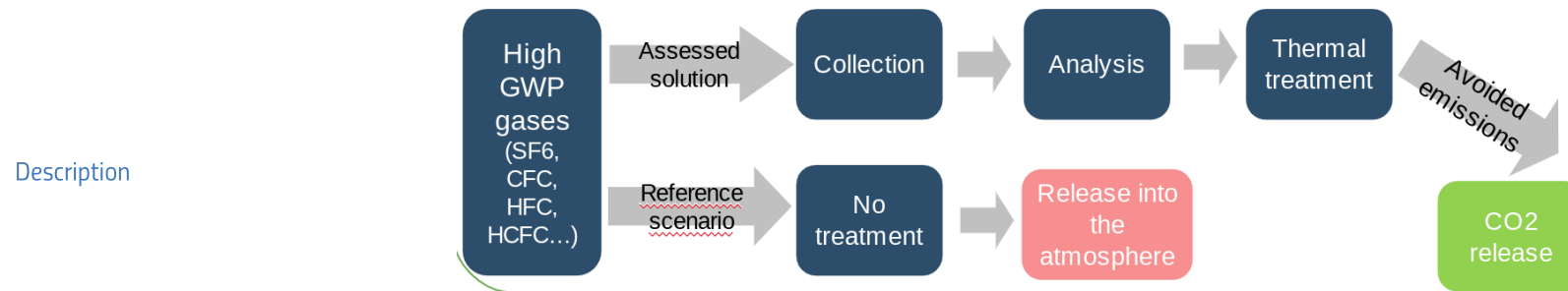


Description of the paper and cardboard recycling life cycle



Compared solutions	Recycling paper and cardboard allow avoided emissions as less energy is used to cut down trees or to crush the fibers from trees... But the technology of papermill can also change the balance: depending on the country energy mix for instance, or if the paper mill produces heat by cogeneration technology for instance.
Main challenges	The main challenges are to identify the paper mills standards of production and technology. This may vary a lot from one country to another, even from one plant to another. Also, the carbon contained in fibers is biogenic, i.e. not fossil... Is it legitimate to talk about avoided emissions then? At the same time some projects of GHG compensation aim at planting trees...
Partner conclusion	Regarding paper and cardboard recycling, the environmental benefit is not so obvious when it comes to GHG avoided emissions. The environmental benefit lies in the carbon storage that is maximized thanks to paper and cardboard recycling as it allows a fiber to be recycled up to 8 times, hence allowing trees to grow and forest to be managed responsibly, enhancing its carbon storage facility. Not recycling paper and cardboard would on contrary lead to an increase of GHG emissions from biogenic carbon.

Greenhouse gases emissions avoided by the thermal treatment of gases of high global warming potential (GWP)

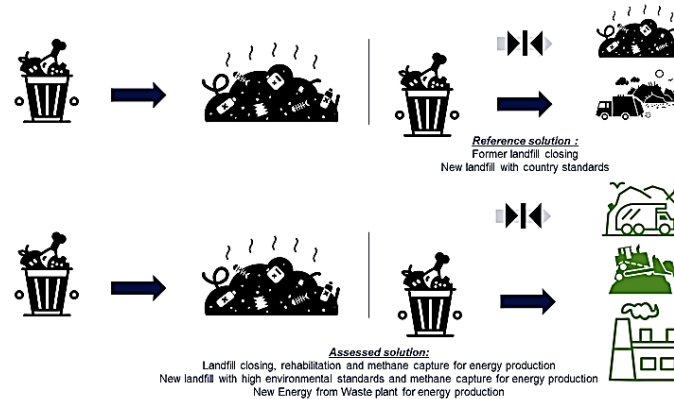


Compared solutions	The base case currently used is the absence of safe and environmentally sound treatment solution for those gases, considering that they are released in the atmosphere (an example would be that the gases are contained into bottles, stored without a treatment solution. The gas may then gradually leak from the bottle. This scenario is the one most likely to occur in the absence of the assessed solution.
Main challenges	<p>Challenge 1: Try to define the appropriate reference scenario, based on existing statistics between the different outfalls for those gases (recovery, elimination, leak...), or based on the scenario most likely to occur.</p> <p>Challenge 2: Possible evolutions in regard to new regulations, or regarding other countries practices. In fact, an evolution in the regulation could be anticipated, in order to influence a type of treatment (e.g. taxes...). That may change the reference scenario and the avoided emissions accounting.</p> <p>Challenge 3: Allocation of the benefits of avoided emissions among the value chain.</p> <p>Challenge 4: The communication issue on the avoided emission designation, in that case, because it is not recognized as such it in every country.</p>
Partner conclusion	This case study shows the importance of treating those gases of high GWP to fight against climate change. Therefore, it highlights the difficulties and the stakes to consider before building a strong reference scenario and to communicate on the matter.

Waste treatment complex composed of a reclaimed landfill with methane capture and energy production and an Energy from Waste plant with cogeneration



Description



Compared solutions

Assessed solution:

- Reduces emissions for the same waste treatment function compared to the reference solution, and avoids energy production emissions by developing renewable energy for electricity production and collective heating as a substitute to fuel and natural gas
- Occurs cobenefits, as short-term eradication of environmental and public health damages.

Main challenges

1. Reference baseline: Current waste treatment infrastructure, OR minimum compliant new infrastructure implementation according to local current regulation, OR minimum compliant new infrastructure implementation according to evolution of local regulation during the whole operation period.
2. Scope: Considering the whole scope of the project may makes the reduced and avoided emissions estimation difficult according to current standardized methodologies.
3. Period of avoidance: Evolution of the wasteflow: assumptions have to be made on the amount and the characterization of waste recovered through landfilling and through EfW facility. Evolution of carbon content of local energy mix has also to be considered.
4. Attribution of climate benefits between the different actors of the value chain: Asset owner, operator, local energy suppliers.

Author conclusion

The case study highlights the case of a multifunctional solution: sustainable waste management and energy from waste recovery. Following an LCA approach, the main contribution to avoided emissions in the value chain of these two functions are located inside the scope of the project. Attribution of climate benefits should be stakeholder inclusive, but also based on a consensus and simple to implement.

Appendix 2: Bibliography

- ADEME, 2016. How to quantify GHG savings resulting from an action designed to reduce GHG emissions- QuantiGES.
- Business Finland; Technical Research Centre of Finland, 2019. Carbon handprint - An approach to assess the positive climate impacts of products demonstrated via renewable diesel case.
- EPE, 2013. Protocol for the quantification of GHG from waste management activities. v5.
- EPE, 2018. Avoided emissions - Companies assess their climate solutions.
- ICCA, WBCSD, 2013. Addressing the Avoided Emissions Challenge
- ICCA, WBCSD, 2019. Avoiding Greenhouse Gas Emissions, the essential role of chemicals. Guidelines : Accounting for and Reporting Greenhouse Gas (GHG) Emissions Avoided along the Value Chain based on Comparative Studies.
- Institute of Life Cycle Assessment Japan, 2015, Guidelines for Assessing the Contribution of Products to Avoided Greenhouse Gas Emissions.
- ISO 14040 (2006, Amdt 2019): General introduction and procedures on how to do a LCA : principles and framework.
- ISO 14044 (2006; Amdt 2017, Amdt 2019): Life Cycle Assessment - Requirements and Guidelines.
- ISO 14064: GHG quantification and reporting. Part 1: Organizations (2018); Part 2 : Products (2019); Part 3 : checking and verification (2019).
- ISO 14067 (2018): Greenhouse gases - Carbon footprint of products, requirements and guidelines for quantification and communication.
- ISO 14069 (2013): Quantification and reporting of greenhouse gas emissions for organizations; Guidance for the application of ISO14064-1.
- RISE Mission Innovation, 2018. Framework for Assessing Avoided Emissions.
- Score LCA, 2019. Etude N° 2018-03 - "Impacts environnementaux & émissions environnementales évitées".
- World Research Institute, 2019. Estimating and reporting the Comparative Emissions Impacts of Products.
- WRI, WBCSD, 2004. GHG Protocol Corporate Value Chain Accounting and Reporting Standard.
- WRI, WBCSD, 2011. GHG Protocol - Product Life Cycle Accounting and Reporting Standard.
- WRI, WBCSD, 2013. GHG Protocol - Policy and Action Standard : An accounting and reporting standard for estimating the greenhouse gas effects of policies and actions.
- WRI, 2019. Working paper. Estimating and reporting the Comparative Emissions Impacts of Products A neutral framework for estimating and disclosing positive and negative GHG impacts of products.