SPICE
METHODOLOGICAL GUIDELINES

SPICE, co-founded by L'ORÉAL & Quantis

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Project information	
Topic	SPICE is an initiative that brings together organizations in the cosmetics industry to work towards a common goal: **to shape the future of sustainable packaging**. SPICE will develop business-oriented methodologies and data to support resilient decisions along the entire packaging value chain.
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SPICE Members	CORPORATE • Aptar • Avon • Chanel • Clarins • Coty • Estée Lauder • Heinz Glas • Hermès Parfums • L'Occitane • L'Oréal • LVMH • Schwan Cosmetics • Shiseido • Sisley ASSOCIATED • CITEO • Cosmetic Valley • Elipso • FEBEA • PCPC
SPICE Co-founders	• L'Oréal • Quantis

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1. Introduction

1.1. Context

SPICE is an initiative that brings together organizations in the cosmetics industry to work towards a common goal: **to shape the future of sustainable packaging**. SPICE will develop business-oriented methodologies and data to support resilient decisions along the entire packaging value chain.

1.2. Purpose of the document

The projected final version of this document aims to provide methodological guidelines for carrying out a quantified environmental assessment of packaging in the cosmetics industry.

This document presents the first version of the methodological guidelines, which covers the topics discussed during the following meetings:

- SPICE Committee #1 held on May 15th, 2018,
- SPICE Committee #2, held on October 15th, 2018, and
- SPICE Committee #3, held on January 15th, 2019.

1.3. Acronyms

- CFF: Circular Footprint Formula
- FU: Functional Unit
- GHG: Greenhouse Gas
- IPCC: Intergovernmental Panel on Climate Change
- LCA: Life Cycle Assessment
- LCI: Life Cycle Inventory
- LCIA: Life Cycle Impact Assessment
- PC: Packaging component
- PCR: Post-Consumer Recycled
- PEF/OEF: Product Environmental Footprint/Organization Environmental Footprint
- ROR: Rate of Restitution

2. Methodological guidelines

2.1. Functional Unit

2.1.1. Topic definition

Life Cycle Assessment relies on a "functional unit" (FU) to compare different, yet interchangeable, products that can be used as substitutions for one another in fulfilling a certain function for the user or consumer. The FU describes this function in quantitative terms and serves as a reference point for the comparison, ensuring that the products being compared do indeed fulfil the same function. It is therefore critical that this parameter is clearly defined and measurable. This section aims to define a common functional unit for cosmetics packaging.

FOCUS BOX – Example of a Functional Unit

- **What is the function of a light bulb?**

"To provide light at a certain intensity and for a certain amount of time"

- **What functional unit can we be used to compare two types of light bulbs?**

"To provide 500 to 900 lumens for 10,000 hours"

- **Using this functional unit, how do we compare these two light bulb types?**

In this example, fulfilling 1 FU will require either 10 incandescent light bulbs or 1 fluorescent light bulb.

X10

Incandescent light bulb
60 W – 1,000h

X1

Fluorescent light bulb
13 W – 10,000h

2.1.2. Functions and FU for the cosmetics industry

SPICE focuses on packaging for the cosmetics industry, but does not consider packaging content.

Packaging solutions fulfil different functions:

- to contain and protect the formula
- to enable the delivery and application of the optimal amount of formula to the consumer
- to maximize effectiveness of the formula
- to maximize the complete dispensing of the formula
- to allow for its shipping and transportation
- to communicate about the product
- to promote brand values
- to display legal information

Based on these functions, the functional unit of cosmetics packaging should be:

To contain, protect, and deliver 1mL[1] of formula to the consumer while:

- **facilitating optimal amount delivery,**
- **maximizing effective application of the formula,**
- **maximizing the complete dispensing of the formula,**
- **promoting brand values,**
- **communicating about the product,**
- **displaying legal information,**
- **allowing for its shipping and transportation.**

[1] This functional unit can also be applied to dry products, after proper conversion from mass (e.g. grams) to volume (mL), if necessary.

2.2. Scope of environmental footprint

2.2.1. Topic definition

The scope of an environmental footprint represents all the life cycle stages required to fulfil the functional unit, throughout the whole value chain. This section aims to define a common scope for cosmetics packaging, i.e. which stages should be included in the environmental footprint of cosmetics packaging.

2.2.2. Methodological requirements

The scope of the environmental footprint should cover primary, secondary and tertiary packaging. Figure 1 presents the life cycle stages that should be included in the environmental footprint of cosmetics packaging.

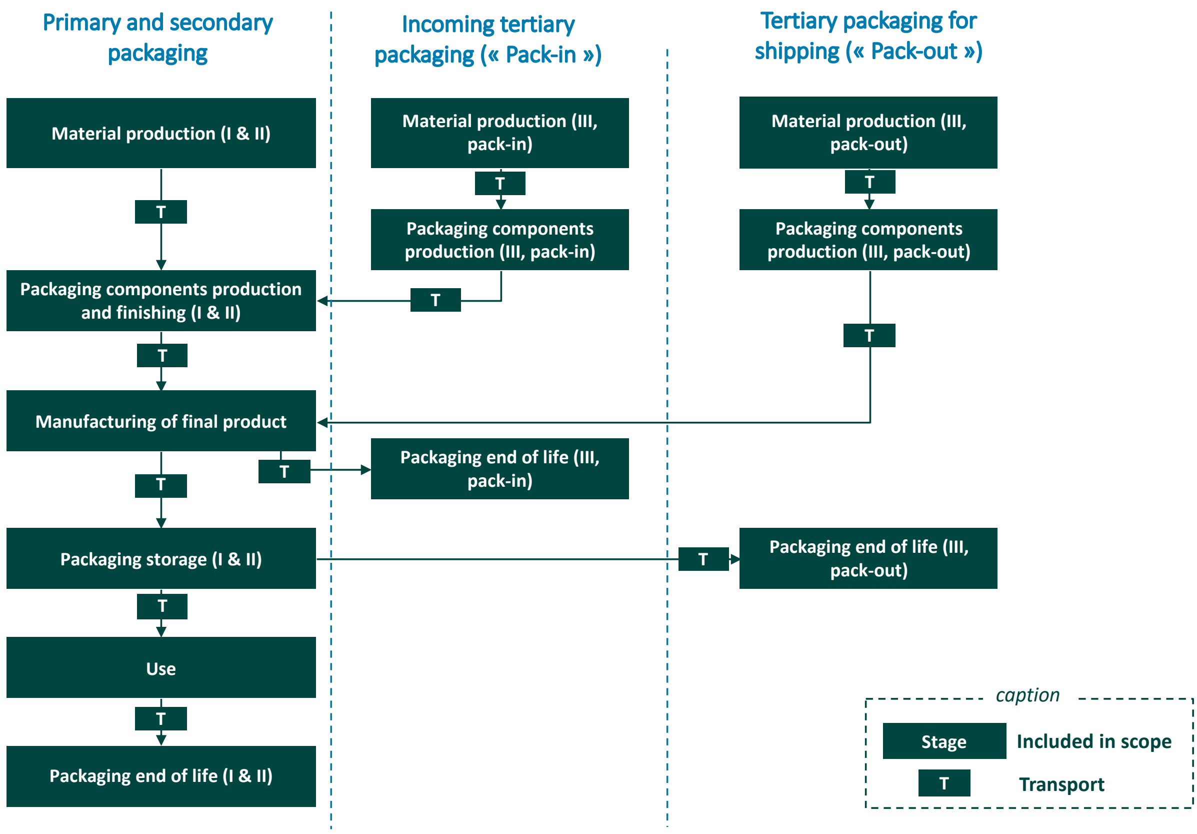


Figure 1 – Scope of environmental footprint of packaging (overview)

Table 1 provides a description of the life-cycle stages

Table 1 - Scope of environmental footprint of packaging

Life Cycle Stages	Included activities
Material production	Resource extraction, agricultural production or recycled material
	Production and end-of-life of tertiary packaging of incoming components ("Pack-in")
	Production and end-of-life of packaging for shipping the finished good ("Pack-out")
Packaging materials transportation	Transportation from producer of packaging materials to producer of packaging component (PC)
Packaging components production and finishing	Transformation/Converting processes
	Finishing processes
Packaging components transportation	Transportation from supplier of packaging component to final product manufacturing site
Manufacturing of final product	Processes occurring at final product manufacturing site (such as filling, sealing…) allocated to packaging, using a mass-based allocation (empty packaging mass/finished product mass)
Product distribution & storage	Transport from final product manufacturing site to Retail
	Storage at Distribution Centre
	Storage at Retail
	Consumer transport (roundtrip from home to retail)
Use	Use of the packaging (may include recharge/refill activities)
Packaging end of life and littering	Transport to waste treatment
	Recycling of packaging
	Incineration of packaging with energy recovery
	Incineration of packaging without energy recovery
	Landfilling of packaging
	Reuse of packaging

Activities that are excluded:

- Corporate-level activities
- R&D activities

2.3. Database of materials and processes

2.3.1. Topic definition

An environmental footprint relies on databases that are used to quantify impacts of each life-cycle stage, notably to capture the impacts of activities located both upstream (e.g. material production, energy production, etc.) and downstream (incineration, landfilling, recycling) in the value chain.

FOCUS BOX – LCA Databases

Life Cycle Assessment Databases contain Life Cycle Inventories, i.e. lists of inputs and outputs (energy and materials) required to produce 1 unit of a given activity, such as the production of 1 kWh of electricity in France, the production of 1 kg of high-density polyethylene or the incineration of 1 kg of paper, etc.

LCA databases are a key component of reliable environmental assessment. The quality of their LCIs can be assessed through several factors, e.g. those defined by the ILCD Handbook:[2]

- Technological representativeness
- Geographical representativeness
- Time-related representativeness
- Completeness
- Precision/Uncertainty

2.3.2. Methodological requirements

The databases used for environmental footprints should be Life Cycle Inventory databases (as opposed to single-impact databases, e.g. GHG emissions factors).

Life Cycle Inventories (from existing or specially developed databases) used to assess the environmental footprint of cosmetics packaging should:

- have a high level of data quality in terms of:
    - completeness (i.e. each dataset should cover all relevant input and output flows),
    - Geographical, Technological and Time-related representativeness,
    - Precision/Uncertainty.
- have methodological consistency (consistent with the present guidelines and with other LCIs used for the assessment).

[2] http://eplca.jrc.ec.europa.eu/uploads/ILCD-Handbook-General-guide-for-LCA-DETAILED-GUIDANCE-12March2010-ISBN-fin-v1.0-EN.pdf Accessed in April 2018

2.4. Transportation and storage

2.4.1. Topic definition

The scope of an environmental footprint covers many transport and distribution steps. The aim of this section is to present the requirements for the transport stages accounting.

FOCUS BOX – Transport accounting: mass-based vs. volume based.

Freight transport in environmental assessment is generally assessed using a "tonne.kilometers" approach. This means that, for a given transport type, the allocation of the transport impact to a product is made by multiplying its mass by the transport distance (considering average load factors). This common approach is "mass-based," meaning that the main constraint for transport is the mass rather than the volume. In other terms, it means that one considers that the truck (or other transportation mode) is considered full when it reaches its mass limit rather than its volume capacity. This makes sense for dense products, which is the case for most cosmetics products.

2.4.2. Methodological requirements

As described in section 2.2, the following transport and storage steps should be considered:

Table 2 – Transport and storage stages to be included

Life Cycle Stage	Included transport and storage step
Packaging materials transportation	Transportation from extraction point (or agricultural production point or recycled material recovery point) to producer of packaging component (PC)
Packaging components transportation	Transportation from supplier of packaging component to final product manufacturing site
Product distribution	Transport from final product manufacturing site to distribution center Transport from distribution center to retail Consumer transport (roundtrip from home to retail) Transport from distribution center to consumer home (home delivery)
Product storage	Storage at distribution center
	Storage at retail
	Consumer transport (roundtrip from home to retail)
Packaging end of life	• Transport to recycling site • Transport to landfill site • Transport to incineration site

Transport accounting should identify the distance per transport type: truck, boat, plane, train, as well as car for consumer transport and truck for home delivery.

For all steps except consumer transport, the accounting of transport should be mass-based.

For consumer transport, transparent accounting should consider a fraction of the car trunk's volume, as recommended in the PEF 6.3 guidance. For instance, the car trip should be allocated to the product by using the following equation: the volume of the product transported divided by 0.2 m^3 (maximum useful volume considered for car's trunk).

2.5. End of life assessment method

2.5.1. Topic definition

The purpose of this section is to define how to account for packaging materials' end-of-life impacts. Indeed, using post-consumer recycled content (PCR) or recycling a packaging at its end-of-life leads to potential environmental impact reductions. Several methods exist to account for these steps.

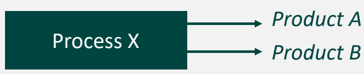
"Allocation" is commonly used to assign burdens associated with the upstream supply chain to each product of multi-output processes.

• End-of-life treats waste and, sometimes, produces valuable products (material and/or energy), which is a typical allocation issue.

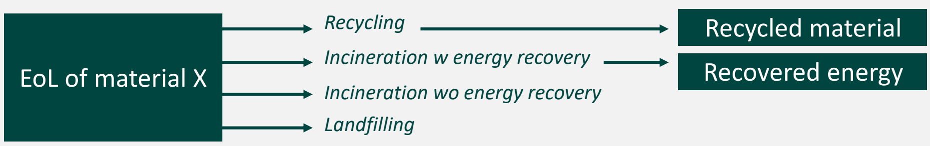
• Focus on how the burden of virgin material production and the burden of end-of-life treatment are allocated between the first application in one product system and its subsequent application in the same or another product system.

FOCUS BOX – End of life and littering modelling in Life Cycle Assessment

The principle of allocation in LCA corresponds to the way multi-output activities are accounted. For example, if the impacts of Process X are known, they should be allocated to Product A and Product B.

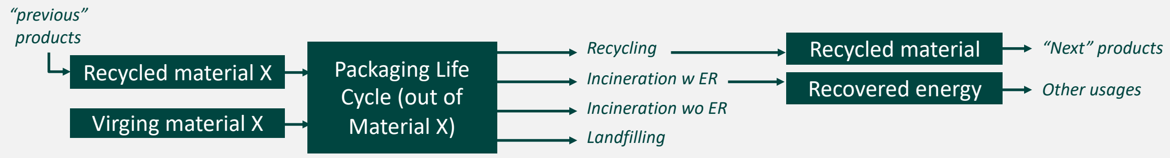


Modelling end-of-life in LCA requires the use of allocation methods, as it is generally a multi-output activity (treating waste on one hand and producing valuable products such material and/or energy on the other hand).



In addition to its multi-output aspect, end-of-life — most notably recycling — is linked with the life cycle of other products, specifically:

- "previous" products when integrating recycled material in the assessed product,
- "next" products, i.e. products that will use the recycled material generated by the assessed product.



Accounting for these different aspects is a key challenge in LCA, however several methods exist to do so. In order to be fair and comprehensive, accounting methods should take into account:

- the different waste treatment routes, notably recycling and energy recovery;
- the integration of post-consumer recycled material;
- the potential material quality loss during recycling;
- closed or open-loop recycling; and
- the allocation of impacts and benefits of recycling and energy recovery between products in a fair way.

2.5.2. Methodological requirements

The required accounting method for material impacts is the Circular Footprint Formula (CFF), as defined in the PEF 6.3 guidance.

FOCUS BOX – The Circular Footprint Formula (CFF)

The Circular Footprint Formula is a standardized approach, developed in the frame of the PEF/OEF initiative, to allocate impacts and benefits from circularity of materials through multiple cycles. It reflects a scientific consensus involving all main EU packaging and materials associations. It is applicable for product and organization footprinting.

The CFF accounts for:

- burdens and benefits from all waste treatment routes
- market offer and demand in the EU for different materials
- quality of ingoing and outgoing secondary material
- potential infinite number of loops

Note: Guidelines on the material flows that can be considered as "recycled content" are provided in section 2.8, page 19.

2.6. Environmental topics, impact categories and LCIA methods

2.6.1. Topic definition

Environmental topics correspond to the subject of interest in the frame of an environmental assessment and correspond to the environmental materiality of the sector. Impact categories correspond to the different types of environmental topics assessed in the course of an environmental footprint assessment. Life Cycle Impact Assessment (LCIA) methods correspond to the scientific models used to assess the indicator that quantifies each impact category.

FOCUS BOX – Approach for environmental topics and categories selection

Environmental topics relevant to the cosmetics industry have been selected using CosmeticsEurope recommendations related to sustainability, as presented in Appendix 3.1, page 37. A wide range of environmental indicators should be used in order to gain a comprehensive view of environmental hotspots. PEF recommendations propose a wide range of categories that are widely accepted. Starting from these recommendations, it has been identified that each recommended category can be used to cover the environmental topics of interest, as presented in Figure 2.

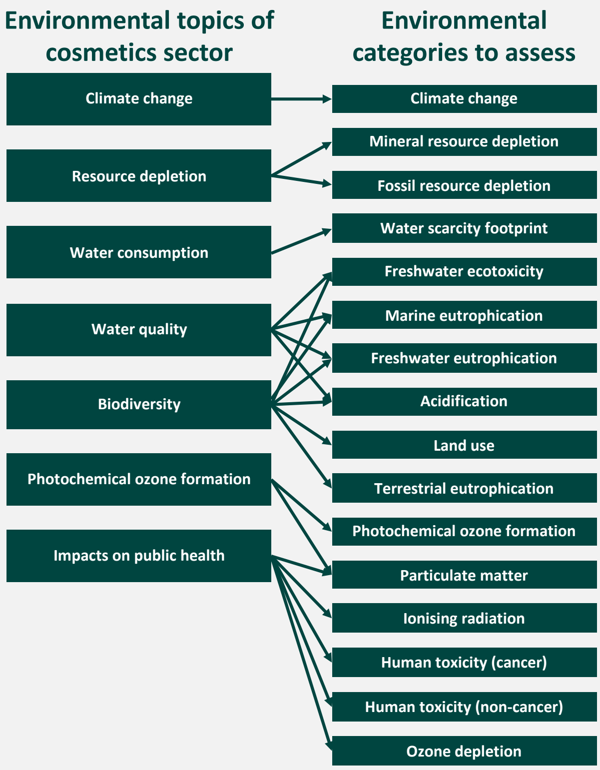


Figure 2 – Link between environmental topics and environmental categories

2.6.2. Methodological requirements

Multi-criteria assessment is necessary for robustness and relevance of the environmental footprint. The impact categories that should be covered, as well as the LCIA methods that should be used to assess environmental indicators, are those outlined in the most recent PEF recommendations, as published in April 2018 (PEF Guidance document, version 6.3). The full list is presented in Appendix 3.2 p41.

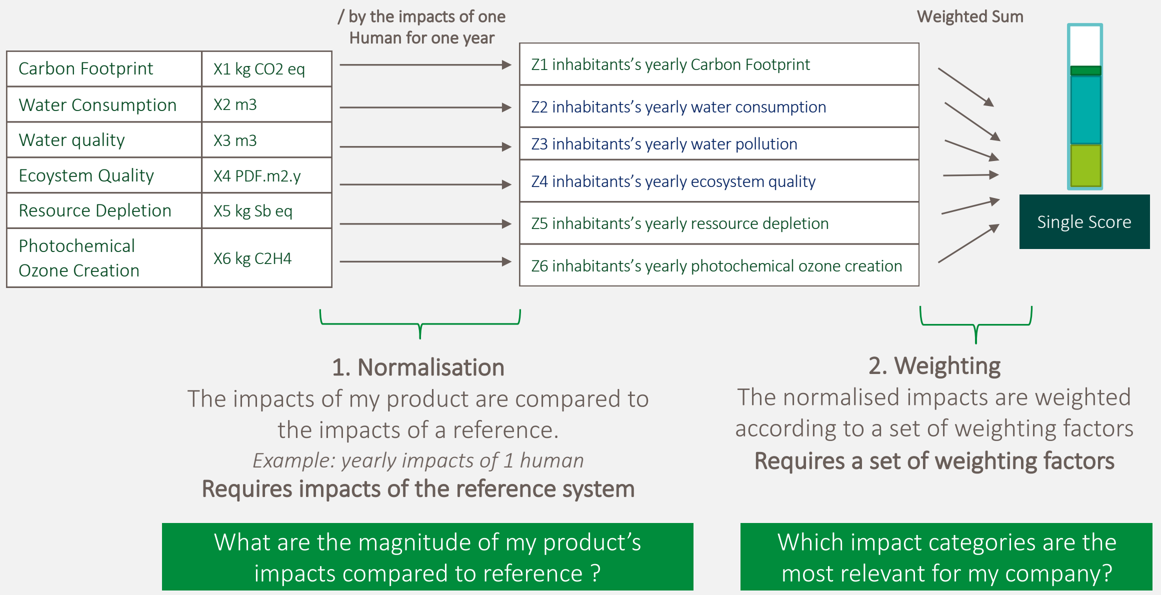
2.7. Aggregation of all environmental impact categories: proposition of a scoring methodology (normalization & weighting)

2.7.1. Needs for a normalization & weighting methodology

Environmental assessment generates multicriteria results that can make decision-making difficult when the ranking of different products differs from one impact category to another. The calculation of a single score that aggregates different environmental indicators can simplify the decision-making process by proposing a single metric for comparison.

FOCUS BOX – Normalization and weighting: what are we talking about?

The following figure presents the principle of environmental single score calculation through normalization and weighting:



The main advantage of a single score is that it facilitates decision-making. Its main drawback is the information loss it generates, as all impact categories are aggregated.

2.7.2. Methodological requirements

The calculation of a single score is not a mandatory step, however, if an environmental single score is calculated based on an environmental footprint, it should be calculated by applying the normalization and weighting process, using normalization and weighting.

Note 1: Guidelines on the sets of normalisation and weighting factors will be provided in a future version of this document.

Note 2: ISO 14040 and 14044 standards on Life Cycle Assessment prohibits the display of weighting (and thus of a single score) in the context of a comparative life cycle assessment intended to be disclosed to the public. The use of a single score within these guidelines is intended in the context of decision-making in a design context and not for a direct communication to the public.

2.8. Recycled materials

2.8.1. Topic definition

This topic covers the inclusion of recycled material in the production of packaging and how it should be accounted for when assessing the environmental footprint of products.

The ISO 14021 standard states that only "pre-consumer" and "post-consumer" materials should be considered as recycled content:

- Pre-consumer material: *"Material diverted from the waste stream during the manufacturing process. Excluded is reutilization of materials such as rework, regrind or scrap generated in a process and capable of being reclaimed within the same process that generated it."*
- Post-consumer material: *"Material generated by households or by commercial, industrial and institutional facilities in their role as end-users of the product which can no longer be used for its intended purpose. This includes returns of material from the distribution chain."*

When applied to cosmetics packaging, these definitions mean that:

- For primary and secondary packaging (i.e. B2C packaging): materials are considered as post-consumer once they have been used by consumers.
- For tertiary packaging (i.e. B2B packaging): materials are considered as post-consumer once they have been used by industry.

FOCUS BOX – Challenges for integration of recycled content

The inclusion of recycled materials raises several challenges for packaging designers. Besides the environmental performance of the secondary material, other aspects are critical for inclusion of recycled materials, such as:

- cost,
- technical performance,
- aesthetic impact,

- product safety and food contact certification,
- sourcing and availability.

2.8.2. Methodological requirements

When assessing the environmental impacts of packaging using the Circular Footprint Formula, only post-consumer materials (as defined by ISO 14021) can be considered for the recycled fraction (defined as “R1” in the CFF as presented in 3.4 p45).

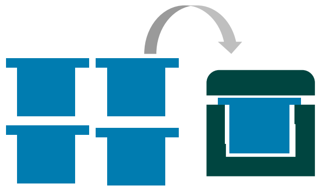
Pre-consumer materials (as defined by ISO 14021) are therefore excluded from the recycled fraction.

2.9. Multiple use packaging

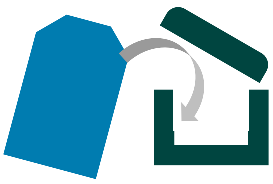
2.9.1. Topic definition

This topic covers packaging specifically designed to be used multiple times. This type of packaging can cover different concepts. The following items present the definition of different concepts applied to cosmetic packaging:

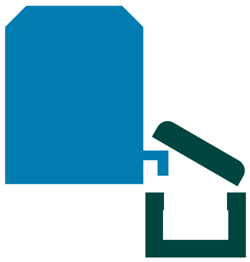
- **Recharge with another pack**,
  - e.g.: Plastic capsule (“daughter packaging”) for recharging a glass jar (“mother” packaging)



- **Refill from another pack.** The consumer transfers the formula from a pack into the “mother” packaging.
  - e.g.: Pouch (“daughter packaging”) for recharging a glass jar (“mother packaging”)



- **Refill from a fountain/distributor**. The consumer transfers the formula (typically at retail) from a fountain/distributor packing into the “mother” packaging.
  - e.g.: Fountain for recharging a perfume bottle



- **Reuse for a different purpose.** Some products can be designed for reuse, proposing a second life to their users through a different function. A reusable product is a product whose packaging (primary or secondary) is used for another purpose once the consumer has used all the formula.
    - e.g.: Jar reused as pen-holder

Note: Although the terms "refillable, rechargeable, and reusable" need to be differentiated for purposes of this guidance, all of these terms can be used interchangeably depending on the context (notably when communicating to consumers).

2.9.2. Methodological requirements

2.9.2.1. Rechargeable products

Recharges are usually products that contain less packaging compared to the "mother" product, but that need to be associated with a mother to be used.

A packaging can be considered as rechargeable if it has been designed to embed a new component containing the formula (i.e. a "recharge").

Once a product is flagged as rechargeable, the environmental impact assessment is no longer done at product level, but at system level (i.e. the combination of the mother and a defined number of daughters). The mother is used N times.

This means that the total environmental impact is the sum of the mother's environmental impact plus N times daughters' environmental impact, while the number of units of service (i.e. functional units) is the number of units of service provided by N daughters.

All the potential operations required to recharge the packaging have to be taken into account.

Note: By default, a product declared as rechargeable is considered to be recharged once, i.e. the system corresponds to one empty mother plus 2 daughters (N=2, meaning 2 uses of the mother packaging).

A higher amount of uses of the mother packaging should be proven through relevant metrics that demonstrate the actual number of recharges that a consumer is likely to purchase for one single mother product.

2.9.2.2. Refillable products

A packaging can be considered as refillable if the user can directly pour a liquid formula in the former packaging, either from another packaging or with a fountain/distributor.

Once a product is flagged as refillable, the environmental impact assessment is no longer done at product level, but rather at system level (i.e. the combination of the mother and a defined number of daughters). The mother is used N times.

This means that the total environmental impact is the sum of the mother's environmental impact plus the impacts of the required amount of daughter packaging,[3] while the number of units of services (i.e. functional units) is N times the number of units of services provided by the mother.

All of the potential operations required to refill the packaging have to be taken into account.

Note: By default, a product declared as refillable is considered to be refilled once, i.e. the system corresponds to one full mother plus one refill (N=2, meaning 2 uses of the mother packaging).

A higher number of uses of the mother packaging should be proven through relevant metrics that demonstrate the actual number of refills that a consumer is ready to carry out for one single mother product.

[3] Note: The required amount of daughter packaging is either a fraction (e.g. a fraction of a fountain) or a number of daughters (e.g. refills of the mother packaging with multiple pouches)

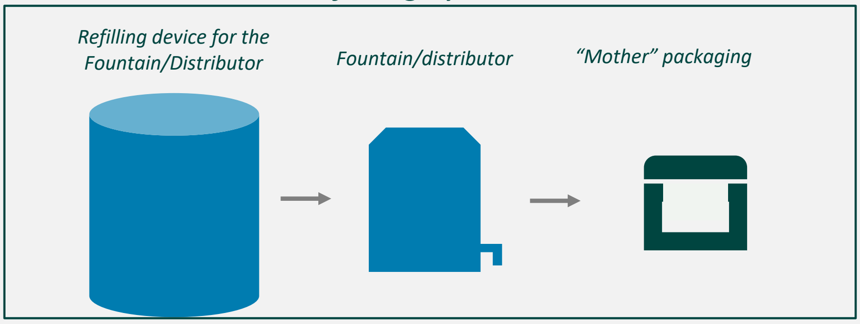
FOCUS BOX – Case of a refillable fountain/distributor

A fountain or distributor can be used once or multiple times, meaning that the fountain/distributor that is used to refill the mother packaging can also be refilled.

In that case, the fraction of the environmental impacts of each part of the overall refilling system (i.e. the mother packaging, the fountain/distributor and the refilling device for the fountain/distributor) should be allocated to 1 functional unit.

The following table illustrates the calculation of this share in a simplified case where 1 mL distributed to the consumer (i.e. 1 functional unit) corresponds to 1 mL contained in the mother packaging, meaning that it is assumed that there is a full restitution of the formula and no delivery inefficiencies.

Refilling system



	Refilling device for the fountain /distributor	*Fountain /distributor*	*Mother packaging*
Function	To refill Fountain /distributor	To refill mother packaging	To deliver 1 mL to the consumer
Capacity	X mL	Y mL	Z mL
Number of complete uses(1)	The refilling device is used L times	The fountain/ distributor is used M times	The mother is used N times(2)
Share of the pack/fountain/distributor/device to be allocated to 1 mL	$\frac{1}{X \times L}$	$\frac{1}{Y \times M}$	$\frac{1}{Z \times N}$

(1) One "Complete use" corresponds to 1 full packaging (e.g. 1 full mother, 1 full fountain/distributor…)

(2) N uses of the mother correspond to N-1 refills, provided that the mother is sold full

2.9.2.3. Reuse of packaging components for a different purpose

Packaging reused for a different purpose shall not be considered as reuse or recycling.

FOCUS BOX – Relevant metrics to prove the number of reuse N of the mother product

In each case, the mother product is, by default, considered to be used twice (N=2).

In order to specify this value, proof should be based on actual, up-to-date and significant metrics such as sales data.

Depending on the product's stage of development, different situations can be envisioned:

- Pre-launch:
    - Ratio based on a similar product (if available);
    - New type of design: where no data describing a similar product is available, statement on the product's benefits should clearly mention the underlying assumption *(e.g. for 3 uses of the mother)*
- Post-launch: the number of uses of the mother packaging should be based on actual and significant sales data

2.10. Take-back programs

2.10.1. Topic definition

Take back programs consist of the retrieval of used pack (at retail or dedicated location) with the objective of:

- reusing the packaging,
- or recycling the packaging.

2.10.2. Methodological requirements

2.10.2.1. Take-back programs for reuse

In order to account for take-back programs for reuse, one can divide the impacts of the pack by the amount of cycles it goes through, under the following conditions:

- relevant metrics demonstrate that customers actually use the take-back program for reuse, and
- relevant metrics demonstrate the amount of cycles for the packaging, i.e. how many times the company will reuse the packaging,

At each cycle, several operations are required to be able to reuse the packaging, e.g. the transport from consumer home to retail, the washing or refurbishing of the pack and its refill. These operations must be included in the assessment of a pack that is part of a take-back program.

2.10.2.2. Take-back programs for recycling

In order to account for take-back programs for recycling, one can use a specific end-of-life recycling rate for the packaging in the CFF (“R2”), under the following conditions:

- relevant metrics demonstrate that customers actually use the take-back program for recycling, and
- the new recycling rate combines the average recycling rate and actual take-back rate.

2.11. Recyclability

2.11.1. Topic definition

<u>Recyclable packaging</u>:

Several definitions exist for the recyclability of a packaging. Within this guide, we use the term "recyclable" as defined by the Ellen MacArthur Foundation:[4]

"A packaging (1) or packaging component (2,3) is recyclable if its successful post-consumer (4) collection, sorting and recycling (5) is proven to work in practice and at scale"

Notes

1. *[...] A package can be considered recyclable if its main packaging components, together representing >95% of the entire packaging weight, are recyclable according to the above definition, and if the remaining minor components are compatible with the recycling process and do not hinder the recyclability of main components. [...]*
2. *A packaging component is a part of a packaging that can be separated by hand or by using simple physical means e.g. a cap, a lid and (non in-mold) labels.*
3. *A packaging component can only be considered recyclable if that entire component, excluding minor incidental constituents, is recyclable according to the definition above. If just one material of a multi-material component is recyclable, one can only claim recyclability of that material, not of the component as a whole.*
4. *ISO 14021 defines post-consumer material as material generated by households or by commercial, industrial and institutional facilities in their role as end users of the product which can no longer be used for its intended purpose. This includes returns of material from the distribution chain. It excludes pre-consumer material (e.g. production scraps).*
5. *Packaging for which the only proven way of recycling into applications that do not allow any further use-cycles (e.g. plastics-to-roads) cannot be considered "recyclable packaging".*

4 https://www.ellenmacarthurfoundation.org/assets/downloads/EllenMacArthurFoundation_NewPlasticsEconomy_26-1-2016.pdf (Accessed in December 2018)

In this guidance, the recyclability of packaging is broken down into two topics, corresponding to the two main conditions of the definition:

1. The existence of successful post-consumer collection, sorting and recycling that is proven to work in practice and at scale.
2. The absence of recycling disruptors, i.e. of materials that are incompatible with existing sorting and/or recycling systems or that can impact the final quality of recycled materials.

The following figure presents an overview of these two topics:

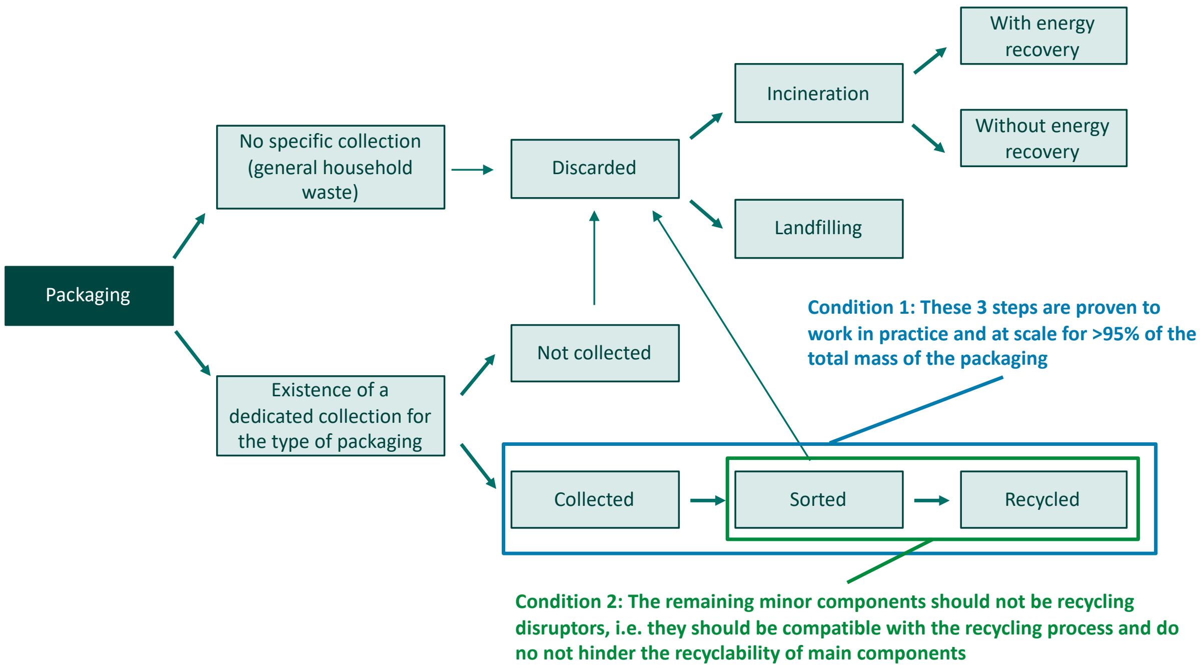


Figure 3 – Overview of the end-of-life of a packaging and recyclability conditions

2.12. End-of-life streams per country

2.12.1. Topic definition

At end-of-life, packs can potentially follow different routes, notably:

- Recycling,
- Incineration (with or without energy recovery),
- Landfilling,
- Littering in nature,
- Composting.

Depending on the type of pack, its materials and the country where it is used, the average scenario (i.e. the percentage of each end-of-life route that these packaging follow) will differ.

The data sources used to define the end-of-life scenarios per country should be as recent and as representative as possible. Typical data sources are:

- PEF Guidance 6.3 (Annex C),
- Eurostat data,
- UNSTAT data,
- Country-specific data (national environment agencies).

FOCUS BOX – Definition

<u>Compostable:</u>

Several definitions exist for the compostability of a packaging (e.g. EN13432 for Europe, ASTM D400 and D6868 for the US). The Ellen MacArthur Foundation[4] proposes the following definition:

"A packaging or packaging component (1) is compostable if it is in compliance with relevant international compostability standards (2) and if its successful post-consumer (3) collection, (sorting), and composting is proven to work in practice and at scale." (4)

Notes

6. *ISO 18601:2013: A packaging component is a part of packaging that can be separated by hand or by using simple physical means (e.g. a cap, a lid and (non in-mold) labels).*
7. *Including ISO 18606, ISO 14021, EN13432, ASTM D-6400 and AS4736.*
8. *ISO 14021's usage of the term clarifies post-consumer material as material generated by households or by commercial, industrial and institutional facilities in their role as*

end users of the product which can no longer be used for its intended purpose. This includes returns of material from the distribution chain.

9. *At scale implies that there are significant and relevant geographical areas, as measured by population size, where the packaging is actually composted in practice.*

2.12.2. Methodological requirements

When applying the Circular Footprint Formula, the end-of-life scenario should at least consider the following end-of-life treatments:

- Landfilling,
- Incineration (with and without energy recovery),
- Recycling.

In the case of compostable packaging, the impact of the composting process can be added, and the associated environmental impacts should be representative of the actual process that is suited for the packaging (home-composting or central composting facility, or a combination of both if the packaging can be compostable in all types of composting facilities).

The end-of-life scenarios should reflect the probable fate of the packaging, not the intended fate.

End-of-life scenarios should be specific for each of these material categories:

- Glass,
- Metal,
- Wood,
- Paper/Cardboard,
- Plastic,
- Non-recyclable Materials.

2.13. Renewably sourced plastics

2.13.1. Topic definition

Renewably sourced plastics are plastics made from a renewable source of carbon, i.e. either:

- from biomass, or
- from captured greenhouse gases.

In terms of chemical nature, renewably sourced plastics can either be identical to fossil-based plastics (e.g. polyethylene from sugar cane is chemically identical to fossil-based polyethylene) or only be produced from biomass (e.g. PLA).

The concept of "renewably sourced" does not cover the end-of-life characteristics (i.e. recyclability, compostability, biodegradability) of such plastics. A plastic that is renewably sourced is not necessarily compostable and/or biodegradable and/or recyclable.

FOCUS BOX – Feedstock generations for renewably sourced plastics

Renewably sourced plastics can be based on different types of feedstocks, which are commonly referred to as generations. The Ellen MacArthur Foundation[5] defines these generations as follows:

- ***1st generation:*** *Biomass from plants that are rich in carbohydrates and that can be used as food or animal feed (e.g. sugar cane, corn, and wheat).*
- ***2nd generation****: Biomass from plants that are not suitable for food or animal feed production. They can be either non-food crops (e.g. cellulose) or waste materials from 1st-generation feedstock (e.g. waste vegetable oil, bagasse, or corn stover).*
- ***3rd generation****: Biomass derived from algae, which has a higher growth yield than either 1st- and 2nd- generation feedstock, and therefore has been allocated its own category.*
- ***4th generation****: Virgin feedstock from captured greenhouse gases. While not yet rigorously defined, GHG-based feedstock has already been coined '4th-generation feedstock' in a biofuel context.*

2.13.2. Methodological requirements

[5] The New Plastics Economy, Ellen MacArthur Foundation https://www.ellenmacarthurfoundation.org/assets/downloads/EllenMacArthurFoundation_TheNewPlasticsEconomy_Pages.pdf (accessed in November 2018)

The environmental impacts of renewably sourced plastics should be assessed:

- across the entire supply chain,
- using the whole set of indicators and methodological requirements defined in this guidance.

2.14. Finishing and decoration processes

2.14.1. Topic definition

Finishing and decoration processes correspond to processes that are applied to a packaging in order to:

- embellish a packaging or a packaging component
- and/or provide additional functions to a packaging or a packaging component (e.g. print information on it).

Typical finishing and decoration processes for cosmetics packaging include:

- Offset Printing,
- Coating/Lacquering,
- Heat shrinking,[6]
- Spray metallization,
- Metallization sputtering,
- Physical Vapor Deposition (PVD),
- Galvanization,
- Anodizing,
- Glass engraving,
- Glass polishing,
- Etc.

Although these processes usually leave only a limited quantity of material on the packaging itself, it should not be assumed that their environmental impact is negligible. All of these processes require energy and materials, and some of them can contribute significantly to the overall impacts of the pack.

2.14.2. Methodological requirements

Finishing and decoration processes should be included in the environmental assessment of a packaging. The quantification of the impacts of finishing and decoration processes should take into account the decorated surface.

[6] Regarding shrinking sleeves: The sleeve itself is to be considered has a separate component (similarly to a cap or a label), while the finishing process covers the printing and the shrinking process.

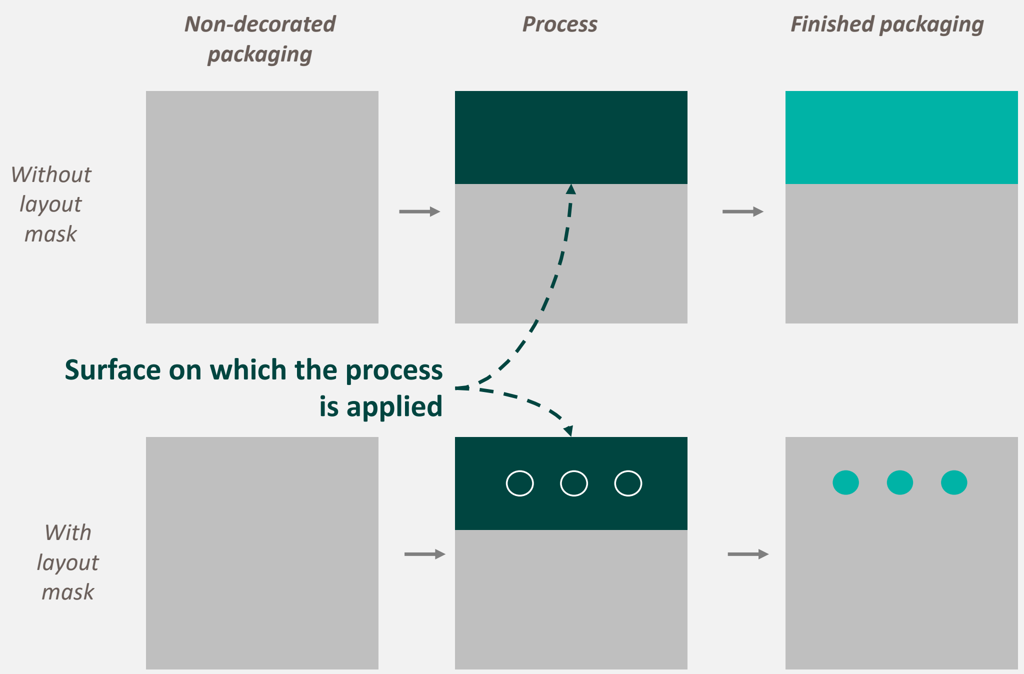
FOCUS BOX – Decorated surface

The decorated surface corresponds to the surface on which the decoration process is applied.

The surfaces to consider are the following:

- without layout-mask (total decoration of the component): actual decorated surface
- with layout-mask (e.g. partial decoration, ...): overall/maximum surface of the mask (covering all the decorated areas)

The following figure illustrates this concept.



- If the finishing/decoration process is applied to both the inside and the outside of a packaging (e.g. surface treatment bath), then the whole surface (both inside and outside) should be considered.

2.15. Tertiary pack and distribution

2.15.1. Topic definition

This topic covers both:

- the tertiary packaging of incoming components ("Pack-in")
- and the packaging for shipping the finished good ("Pack-out").

Typical tertiary packaging typically includes:

- grouping boxes,
- plastic films,
- pallets,
- etc.

2.15.2. Methodological requirements

Accounting for tertiary packaging

Tertiary packaging should be included in the assessment of a packaging. The quantification of tertiary packaging should rely on actual data as much as possible.

The quantification, i.e. the types and quantities, of tertiary packaging per product should be based on the following data, in order of preference:

- Product specific data;
- Average data per product, at production-site level;
- Average data per product, at company level;
- Average data per product, from sources external to company.

Definition of End-of-life of tertiary packaging:

The end-of-life scenarios for each type of tertiary packaging should be based on the following data, in order of preference:

- Specific data per type of tertiary packaging;
- Average data representative of type of tertiary packaging, from sources external to company
- Average data representative of primary packaging of the same materials as tertiary packaging

3. Appendix

3.1. Rationale for environmental topics selection

Life Cycle Assessment is by definition a multicriteria approach, i.e. it aims to provide a holistic view of environmental impacts at product/service level. The relevant topics for the cosmetics industry have been identified mostly by taking into account the recommendations of CosmeticsEurope, as published in its dedicated report *Good Sustainability Practice (GSP) for the Cosmetics Industry*.[7] The following table presents the selected environmental topics and the rationale for selection.

Table 3 – Rationale for environmental topic selection

Selected environmental topics	Rationale for selection	Examples of direct link with packaging
Climate change	A carbon footprint of packaging is a "must-have" when carrying out a life-cycle assessment. CosmeticsEurope "supports factual, transparent communication to consumers about **genuine and meaningful product impacts related to greenhouse gas emissions** and other environmental indicators in order to shape consumer behaviour towards appropriate and responsible choices."	All packaging generates GHG emissions throughout its whole life cycle (e.g. during energy production for electricity production, for material production or conversion, transport, incineration at end-of-life, etc.)

[7] https://www.cosmeticseurope.eu/files/4214/6521/4452/GSP_Brochure.pdf accessed in April 2018

Selected environmental topics	Rationale for selection	Examples of direct link with packaging
Resource depletion	CosmeticsEurope recommends looking "into the question of the extent of using **limited resources**."	Use of fossil-based resources as material (notably polymers) Use of rare metals for finishing (e.g. gold)
Water consumption	CosmeticsEurope cites water consumption reduction as an improvement lead: • *"Individual company goals should take into consideration **cutting water** and energy consumption"* • *"Explore options for optimization of cleaning procedures with the aim of using **less washing water** and/or reducing its temperature"* • *"Define criteria in order to select raw materials with respect to their environmental balance (energy and **water consumption**, emission to water and air, waste formation)."*	Water consumption occurs at many steps of the packaging life cycle, e.g. feedstock cultivation for bio-based materials, finishing processes, etc.
Water quality	CosmeticsEurope cites water pollution reduction as an improvement lead, by stating that companies should: "*Define criteria in order to select raw materials with respect to their environmental balance (energy and water consumption, **emission to water** and air, waste formation).*	Waterborne emissions occur at many steps of the packaging life cycle, e.g. end of life, feedstock cultivation for bio-based materials, finishing processes, etc.
Biodiversity	The use of renewable materials is an important topic for the packaging sector. They avoid the use of fossil-based resources but require arable land. As the availability of arable land	Biodiversity is an important topic when

Selected environmental topics	Rationale for selection	Examples of direct link with packaging
	is finite, using it to produce bio-based materials competes with other uses, such as food production. Using land to produce bio-based resources also has potential impacts on biodiversity, as *"by extracting land from nature, there is less space for natural ecosystems and the species dependent on those ecosystems [which] may cause a* ***loss of ecosystem, species and genetic diversity****"*[8] Also, CosmeticsEurope cites responsible land use as an improvement lead: "*Consider the use of chemicals derived from renewable resources (originating from biological organisms), risk of transmission of diseases in the case of animal derived materials, the CITES list of endangered or protected species or responsible land use in case of plant derived materials*"	assessing bio-based materials. Although the whole complexity of biodiversity is not fully captured in life cycle assessment, several environmental impact categories are interlinked with biodiversity issues.
Photochemical ozone formation	CosmeticsEurope cites photochemical ozone reduction as an improvement lead: "*In the case of volatile substances, consider their potential to induce* ***ground-level ozone formation*** *and optimize your product's environmental profile by selecting appropriate ingredients*"	Photochemical Ozone Creation is an environmental issue linked to volatile substances in aerosols products, which can potentially lead to the creation of "summer smog."
Impacts on public health	The topic of public health is key for the cosmetics industry, and companies put a lot of effort into ensuring the delivery of products that are safe for application on hair/skin etc.	Emissions leading to impacts on health occur at

[8] Land Use in LCA, Ester van der Voet, CML, 2001 (http://www.leidenuniv.nl/cml/ssp/publications/wp2001-015.pdf)

Selected environmental topics	Rationale for selection	Examples of direct link with packaging
	In addition to a product's direct impact on health during use phase, the principle of Life Cycle Thinking requires an examination of a product's impacts throughout the entire life cycle (i.e. all potential impacts due to emissions throughout the whole value chain). CosmeticsEurope cites: • human health hazards as an improvement lead: "*consider the environmental and/or **human health hazard** associated with substances used as ingredients in cosmetic products*" • Life Cycle Thinking as a starting principle: "*Life Cycle Assessment (LCA) is a structured, internationally standardised concept for quantifying the emissions, resources consumed, as well as potential environmental and **health impacts that are associated with goods and services (products).***"	many steps in the packaging life cycle, e.g. end of life of the pack, transport, etc.

3.2. Impact categories and LCIA methods

The following table presents the impact categories and LCIA methods recommended by the PEF/OEF initiative, as published in April 2018 (PEF Guidance document, version 6.3).

Table 4 – Impact categories and LCIA methods

Impact category	Indicator	Unit	LCIA method
Climate change	Radiative forcing as Global Warming Potential (GWP100)	kg CO_2 eq	Baseline model of 100 years of the IPCC (based on IPCC 2013)
Ozone depletion	Ozone Depletion Potential (ODP)	kg CFC-11 eq	Steady-state ODPs as in (WMO 1999)
Human toxicity, cancer*	Comparative Toxic Unit for humans (CTUh)	CTUh	USEtox model (Rosenbaum et al, 2008)
Human toxicity, non-cancer*	Comparative Toxic Unit for humans (CTUh)	CTUh	USEtox model (Rosenbaum et al, 2008)
Particulate matter	Impact on human health	disease incidence	PM method recommended by UNEP (UNEP 2016)
Ionising radiation, human health	Human exposure efficiency relative to U^{235}	kBq U^{235} eq	Human health effect model as developed by Dreicer et al. 1995 (Frischknecht et al, 2000)
Photochemical ozone formation	Tropospheric ozone concentration increase	kg NMVOC eq	LOTOS-EUROS model (Van Zelm et al, 2008) as implemented in ReCiPe 2008
Acidification	Accumulated Exceedance (AE)	mol H+ eq	Accumulated Exceedance (Seppälä et al. 2006, Posch et al, 2008)

Impact category	Indicator	Unit	LCIA method
Eutrophication, terrestrial	Accumulated Exceedance (AE)	mol N eq	Accumulated Exceedance (Seppälä et al. 2006, Posch et al, 2008)
Eutrophication, freshwater	Fraction of nutrients reaching freshwater end compartment (P)	kg P eq	EUTREND model (Struijs et al, 2009) as implemented in ReCiPe
Eutrophication, marine	Fraction of nutrients reaching marine end compartment (N)	kg N eq	EUTREND model (Struijs et al, 2009) as implemented in ReCiPe
Ecotoxicity, freshwater	Comparative Toxic Unit for ecosystems (CTUe)	CTUe	USEtox model (Rosenbaum et al, 2008)
Land use	Soil quality index (covering Biotic production, Erosion resistance, Mechanical filtration and Groundwater replenishment)	Dimensionless (pt) (synthesis of kg biotic production, kg soil, m^3 water, m^3 groundwater)	Soil quality index based on LANCA (Beck et al. 2010 and Bos et al. 2016)
Water use	User deprivation potential (deprivation-weighted water consumption)	m^3 world eq	Available WAter REmaining (AWARE) as recommended by (UNEP, 2016)
Resource use, minerals and metals	Abiotic resource depletion (ADP ultimate reserves)	kg Sb eq	CML 2002 (Guinée et al., 2002) and (van Oers et al. 2002)
Resource use, fossils	Abiotic resource depletion – fossil fuels (ADP-fossil)	MJ	CML 2002 (Guinée et al., 2002) and (van Oers et al. 2002)

3.3. Normalization and weighting factors

3.3.1. Normalization

To be completed

3.3.2. Weighting

to be completed

3.4. Circular Footprint Formula

The Circular Footprint Formula is a combination of "material + energy + disposal", i.e.:

Material $(1-R_1)E_V + R_1 \times \left(AE_{recycled} + (1-A)E_V \times \frac{Q_{Sin}}{Q_p}\right) + (1-A)R_2 \times \left(E_{recyclingEoL} - E_V^{*} \times \frac{Q_{Sout}}{Q_P}\right)$

Energy $(1-B)R_3 \times (E_{ER} - LHV \times X_{ER,heat} \times E_{SE,heat} - LHV \times X_{ER,elec} \times E_{SE,elec})$

Disposal $(1-R_2-R_3) \times E_D$

Where:

- A: allocation factor of burdens and credits between supplier and user of recycled materials.
- B: allocation factor of energy recovery processes: it applies both to burdens and credits.
- Qs_{in}: quality of the ingoing secondary material, i.e. the quality of the recycled material at the point of substitution.
- Qs_{out}: quality of the outgoing secondary material, i.e. the quality of the recyclable material at the point of substitution.
- Q_p: quality of the primary material, i.e. quality of the virgin material.
- R_1: it is the proportion of material in the input to the production that has been recycled from a previous system.
- R_2: it is the proportion of the material in the product that will be recycled in a subsequent system. R_2 shall therefore take into account the inefficiencies in the collection and recycling processes. R_2 shall be measured at the output of the recycling plant.
- R_3: it is the proportion of the material in the product that is used for energy recovery at EoL.
- $E_{recycled}$ (E_{rec}): specific emissions and resources consumed arising from the recycling process of the recycled (reused) material, including collection, sorting and transportation process.
- $E_{recyclingEoL}$ (E_{recEoL}): specific emissions and resources consumed arising from the recycling process at EoL, including collection, sorting and transportation process.

- E_v: specific emissions and resources consumed arising from the acquisition and pre-processing of virgin material.
- E^*_v: specific emissions and resources consumed arising from the acquisition and pre-processing of virgin material assumed to be substituted by recyclable materials.
- E_{ER}: specific emissions and resources consumed arising from the energy recovery process (e.g. incineration with energy recovery, landfill with energy recovery, …).
- $E_{SE,heat}$ and $E_{SE,elec}$: specific emissions and resources consumed that would have arisen from the specific substituted energy source, heat and electricity respectively.
- E_D: specific emissions and resources consumed arising from disposal of waste material at the EoL of the analysed product, without energy recovery.
- $X_{ER,heat}$ and $X_{ER,elec}$: the efficiency of the energy recovery process for both heat and electricity.
- LHV: Lower Heating Value of the material in the product that is used for energy recovery.

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