SPICE TOOL
METHODOLOGICAL GUIDE

SPICE, co-founded by L'ORÉAL & Quantis

V2 - November 2022

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.	
Date	November 2022	
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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
- PIR: Post-Industrial Recycled
- PEF/OEF: Product Environmental Footprint/Organization Environmental Footprint
- PEFCR: Product Environmental Footprint Category Rules
- ROR: Rate of Restitution

1. Context

1.1. The SPICE Initiative

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.

In 2019, the SPICE initiative published a methodological guidance in order to propose methodological rules to use when carrying out the environmental assessment of cosmetics packaging.

In 2020, the SPICE initiative published the SPICE Tool, an online web-based tool aligned with the SPICE methodological guidance.

1.2. The SPICE Tool

The SPICE Tool is a cosmetic packaging environmental assessment platform aiming at embedding environmental sustainability within the packaging development process. The platform helps packaging developers make sustainable design choices, providing them with a better understanding of the environmental performance of different packaging alternatives through science-based metrics.

1.3. Purpose of the document

The purpose of this document is to present data and assumptions used in the SPICE Tool.

This document describes the environmental assessment methodology embedded within the SPICE Tool. This document aims to help users understand how packaging sustainability assessment is done while using the SPICE Tool. It can also support further results interpretation.

2. Goal

2.1. Reasons for developing the SPICE Tool

Packaging sustainability has become a priority for Cosmetics companies. To scale-up the development of more sustainable packaging, environmental assessments must be embedded in the packaging innovation process.

Therefore, packaging engineers, which are not (yet) sustainability experts, need to be equipped with an easy-to-use yet robust packaging sustainability assessment tool. Such a tool aims at supporting packaging engineers in making sustainable packaging design choices informed by science-based metrics, using a methodology that is shared within the industry.

2.2. Objectives of the SPICE Tool and intended application

Through the SPICE Tool, packaging developers can model different packaging scenarios and get an environmental sustainability assessment of these.

It allows them to compare different options and have a detailed understanding of environmental impact drivers across the packaging lifecycle stages (from raw materials to end-of-life). These should help packaging designers in selecting solutions having the best environmental performance and identifying improvement levers.

2.3. Intended Audience

The target audience of the SPICE Tool is packaging developers of cosmetics companies aiming to evaluate and compare the environmental sustainability performance of different cosmetics packaging options.

The SPICE Tool is a screening tool, allowing to provide quick answers based on readily available packaging specifications.

Assessments performed with the SPICE Tool:

- are not intended to be used in comparative assertions to be disclosed to the public
- may have to be completed with more in-depth analysis, when relevant, depending on the goal and scope of the assessment.

When comparing a brand's products within the brand's portfolio or comparing two versions of the same product, communications should follow the general communication guidance outlined in SPICE's Claims Guidance [6], based on ISO 14 021 [4].

2.4. Tool developer

The SPICE Tool has been developed by Quantis on behalf of the SPICE initiative.

2.5. Link with ISO standards and PEF

The methodology used in SPICE follows the main principles of PEF guidance [1] and ISO 14040 [2] & ISO 14044 [3] standards. However, it does not allow to be fully compliant with PEF guidance, ISO 14040, and ISO 14044.

A full PEF compliance requires to comply both on the procedural level (PEFCR creation process) and on a technical level (methodological rules). The tool and its methodology are not fully compliant with PEF, as the official PEF procedure for PEFCR development has not been followed. However, the SPICE initiative relies as much as possible on the PEF on a technical level.

The SPICE Tool follows PEF's technical requirements on the following aspects:

- Modeling principles (allocation rules, cut-off limits, circular footprint formula, hotspot analysis),
- PEF recommended characterization methods,
- Standardized assumptions (e.g. consumer transport).

The SPICE Tool does not follow PEF's technical requirements on the following aspects:

- SPICE do not use PEF-compliant datasets. As there is currently no centralized database containing all PEF datasets, the SPICE Tool relies on other sources for datasets (see section 5.1.3 page 27).
- SPICE do not use the panel-based set of weighting factors but use a set of weighting factors derived from planetary boundaries (see section 6.2.2 page 82)

While ISO 14040 and 14044 were used as reference during the design of the SPICE Tool and its methodology, there is no direct compliance with these standards. For instance, the SPICE Tool does not allow to carry out a detailed inventory analysis, as the tool database contains pre-computed impact factors. The use of the SPICE Tool as substantiation of an environmental claim cannot replace an external critical review conducted by experts in the framework of an ISO 14040 and ISO 14044-compliant LCA.

2.6. PEF international applicability

The SPICE Tool aims an international applicability, while The PEF guidance [1] has been developed under the authority of the European Commission, in a European context. At the technical level, there is no hurdle to its applicability in an international context. The modeling principles and the Life Cycle Impact Assessment methods are not geography-dependent and can thus be applied to other regions.

While this applies for the general PEF guidance [1], it can be underlined that for a given product category, at PEFCR level, the requirements (e.g. use phase modeling) may be representative of Europe.

2.7. Third-party review

A third-party review of the SPICE Methodology, Database and Tool was conducted in 2022 by a panel of four international experts. The report will be available on the SPICE website from December 2022.

2.8. Calculation principle

The SPICE Tool combines two types of inputs in order to generate environmental results (both at midpoint indicator and with an aggregated footprint) on packaging:

- The Packaging characteristics, which are input by the tool users
- The Database, which contains:
    - pre-calculated Life Cycle Impact Assessment results on a selection of activities, notably packaging materials, converting and finishing processes
    - generic data on some life cycle stages (see section 5.1.2, page 25)

Both types of data are combined by applying the calculation rules, as presented in this document. The following figure illustrates this overall architecture.

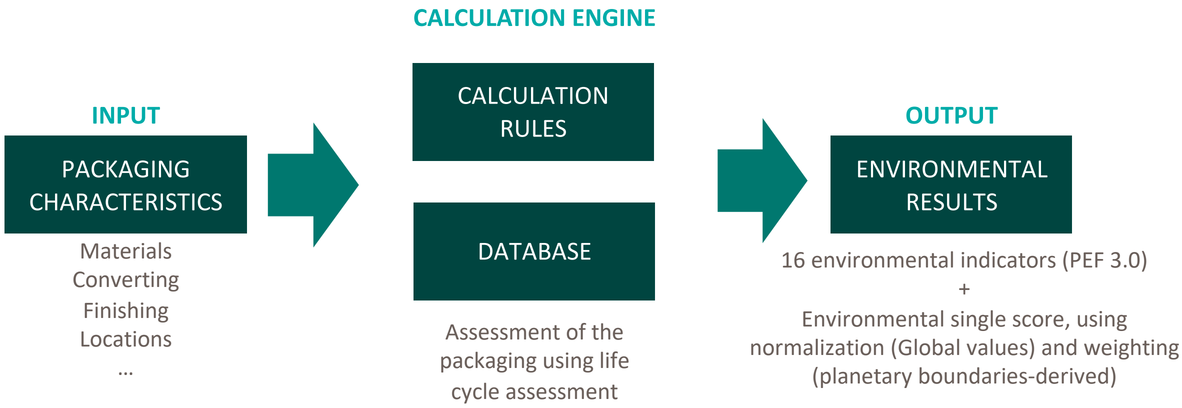


Figure 1 – Illustration of the assessment principles

3. Scope

3.1. Product systems to be studied

The product systems that can be assessed through the SPICE Tool correspond to cosmetics packaging. The system covers all packaging layers:

- Primary packaging (in direct contact with the content, e.g. a jar)
- Secondary packaging (handled by consumer, but not directly in contact with the content, e.g. a cardboard case)
- Tertiary packaging (used for shipping and distribution, e.g. grouping boxes and pallets)
    - Pack-in: tertiary packaging of incoming components
    - Pack-out: tertiary packaging for shipping the finished good

3.2. Function and Functional Unit

3.2.1. 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 presents the functional unit used in the SPICE Tool.

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

PEF requirements

The functional unit for a PEF study shall be defined according to the following aspects:

- The function(s)/service(s) provided: “what”;
- The extent of the function or service: “how much”;
- The expected level of quality: “how well”;
- The duration/lifetime of the product: “how long”

3.2.2. Packaging functions and functional unit used in the SPICE Tool

Packaging solutions fulfil different functions:

- to enable the delivery and application of the optimal amount of formula to the consumer;
- to minimize damage to the formula, at least until the expiration date;
- to maximize effectiveness of the formula;
- to maximize the complete dispensing of the formula (“Rate of restitution”) and avoiding formula loss;
- to allow for its shipping and transportation;
- to communicate about the product, e.g. product identification, ingredient declaration, net contents, use instructions, warning labels, certifications, expiration date.

These functions should be fulfilled as much and as well as required in order to maintain the usability of the formula

Based on these functions, the functional unit of cosmetics packaging used in the SPICE Tool is:

To contain, protect, and deliver 1mL or 1cm^3 of formula[1] to the consumer while:

- **facilitating optimal amount delivery,**
- **maximizing effective application of the formula,**
- **maximizing the complete dispensing of the formula,**
- **communicating about the product,**
- **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) using density, if necessary.

3.2.3. Rate of Restitution and FU calculations

The rate of restitution corresponds to the fraction of Formula that is delivered by the packaging.

A rate of restitution of 1 (or 100%) means the totality of the formula contained in the packaging is delivered to the consumer. A rate of restitution of 0.9 (or 90%) means that there are 10% of leftover of formula in the packaging after use.

The following table presents how it is used to assess the number of Functional units per packaging.

Table 1 – Rate of Restitution and Functional Unit calculations

Parameters	Value for a given packaging
Function	To deliver formula to the consumer
Functional Unit	To deliver 1 mL to the consumer
Claimed Volume *(Amount of Formula contained in the packaging)*	V (in mL)
Rate of Restitution	R (value between 0 and 1)
Calculations	**Value for a given packaging**
Numbers of Functional Units delivered by the packaging	$V \times R$
Impacts for one functional unit	$\text{Impacts for 1 FU} = \frac{\text{Impacts of for 1 pack}}{\text{V} \times \text{R}}$

3.3. System Boundary

3.3.1. Topic definition

The system boundary of a life cycle assessment represents the life cycle stages that are considered to fulfil the functional unit, throughout the whole value chain. This section presents which life cycle stages are included in the environmental impact assessment of cosmetics packaging when using the SPICE Tool.

3.3.2. System boundary considered in the SPICE Tool

The system boundary includes the following life cycle stages:

Table 2 – Life Cycles Stages and unit processes included in the system boundary

Life Cycle Stages	Unit processes
Raw Material production	Production of virgin and recycled materials (for primary and secondary packaging)
	Production of tertiary packaging of incoming components ("Pack-in")
	Production of tertiary packaging for shipping the finished good ("Pack-out")
Transport raw material production to supplier	Transportation from producer of packaging materials to producer of packaging component (PC)
Packaging components production	Transformation/Converting processes
Packaging components finishing	Finishing/Decoration processes
Transport supplier to manufacturing	Transportation from supplier of packaging component to final product manufacturing site
Distribution and 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 (covering recharge/refill activities) – but not reuse, see hereunder
End-of-life	Transport to waste treatment
	Recycling of packaging (for primary and secondary packaging)
	Incineration of packaging with energy recovery (for primary and secondary packaging)
	Incineration of packaging without energy recovery (for primary and secondary packaging)
	Landfilling of packaging (for primary and secondary packaging)
	End-of-life of tertiary packaging of incoming components ("Pack-in")
	End-of-life of tertiary packaging for shipping the finished good ("Pack-out")

Note: for all Life Cycle Stages, the infrastructures are included in the system boundary.

Following life cycle stages are excluded from the system boundary:

- The production and end-of-life of the Formula contained in the packaging and its contribution to distribution.
- Use:
  - In the case of rechargeable/refillable packaging: packaging reconditioning (washing, etc.) is not included
  - In the case of reuse for a different purpose: this type of reuse is not considered, see 4.2.1.1 page 21
- Manufacturing (of final product): Processes occurring at final product manufacturing site (notably the filling of the packaging with formula) are currently not captured in the system boundary due to lack of data
- The transportation-related impacts of cosmetics that are typically carried by the consumer (e.g., lipstick, mascara)
- Capital goods and equipment
- R&D activities
- End-of-life:
  - Littering of packaging: Mismanaged packaging waste (i.e. abandoned in nature) is not included in the system boundary. The leaking of plastics into the environment is a worldwide issue that is currently not captured by the LCA framework. Several initiatives are on-going to fill these methodological and data gaps[2], but they are not ready to be included in a full Life Cycle Impact Assessment.

Figure 2 presents the life cycle stages that are included in the system boundary.

[2] Notably, on the inventory side, the Plastic Leak project (https://quantis-intl.com/strategy/collaborative-initiatives/plastic-leak-project/) and on the impact assessment side, the MariLCA project (https://marilca.org/)

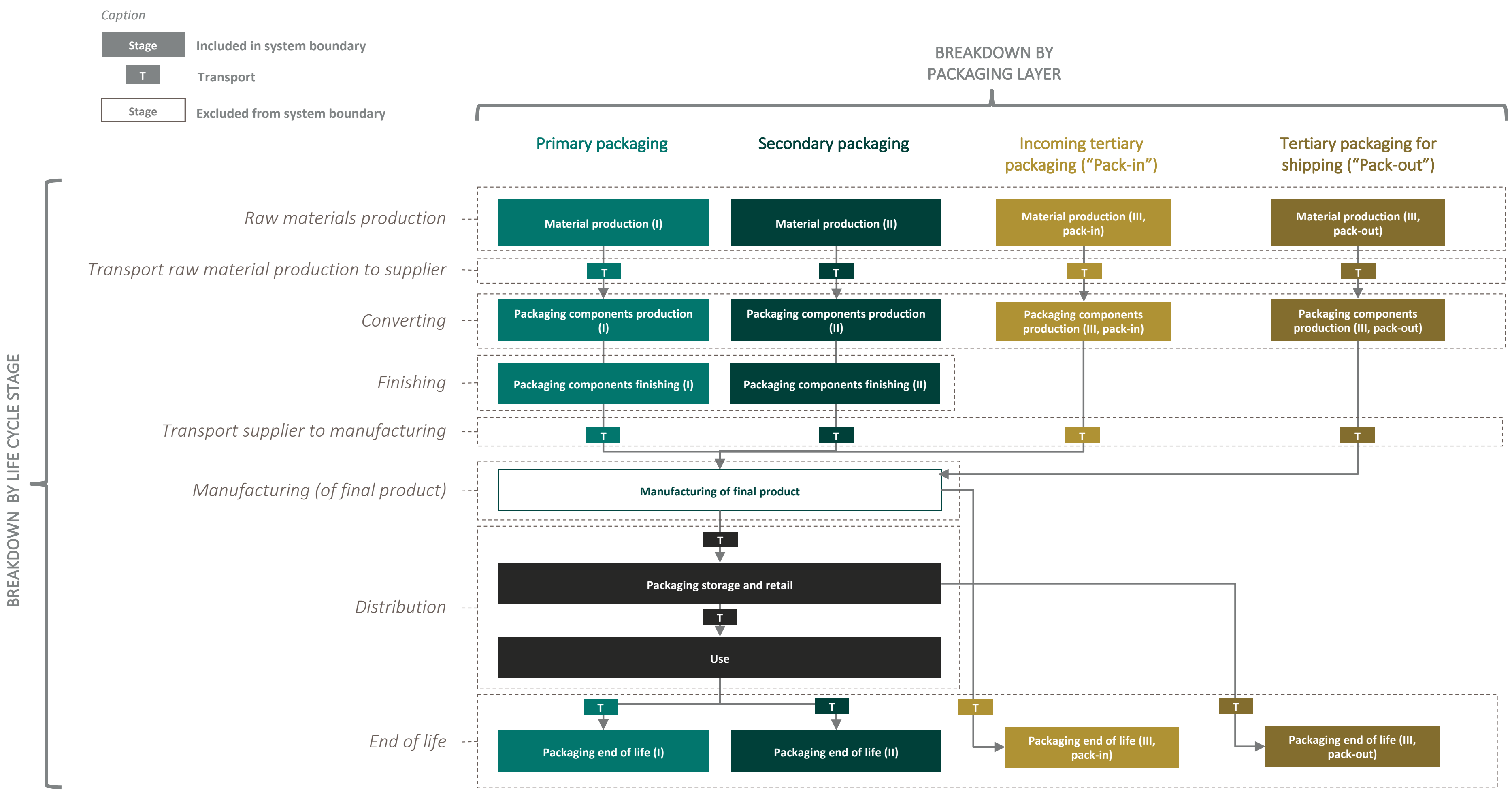


Figure 2 – System boundary of packaging in the SPICE Tool

3.4. Allocation

When possible, the system expansion/substitution is used in priority, as required by PEF. Otherwise, the allocation of co-products follows the default rules ecoinvent [8] allocation rules, namely the “true value” approach. It means that the allocation of co-products is based on their prices (economic allocation), except in some specific cases, notably for electricity and heat co-generation (in which case the energy is used to allocate between electricity and useful heat).

4. Project structure

The SPICE Tool proposes two main types of projects: Single Use Projects and Recharge/Refill projects.

4.1. Single Use projects

Single Use Projects allow user to specify the characteristics of a packaging, and to create alternative scenarios.

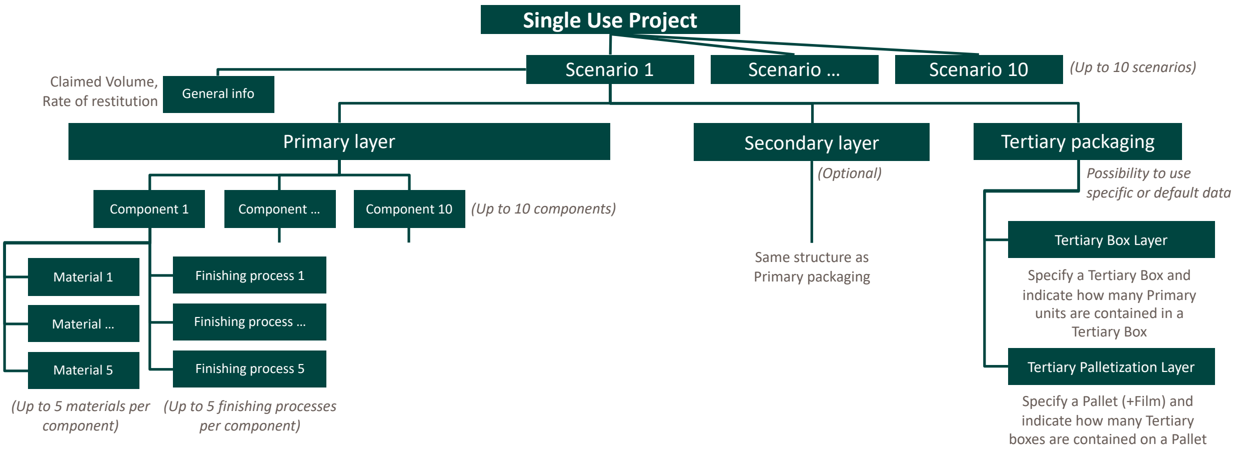


Figure 3 – Structure of a Single Use Project

4.2. Recharge/Refill projects

The recharge/refill projects correspond to a combination of single use projects:

- One corresponds to the “Mother” packaging, i.e. the packaging that will be recharged or refilled.
- The other corresponds to the “Daughter” packaging, i.e. the packaging that will be used to recharge or refill the “Mother” packaging.

For both packagings, the user must specify how many times they are used.

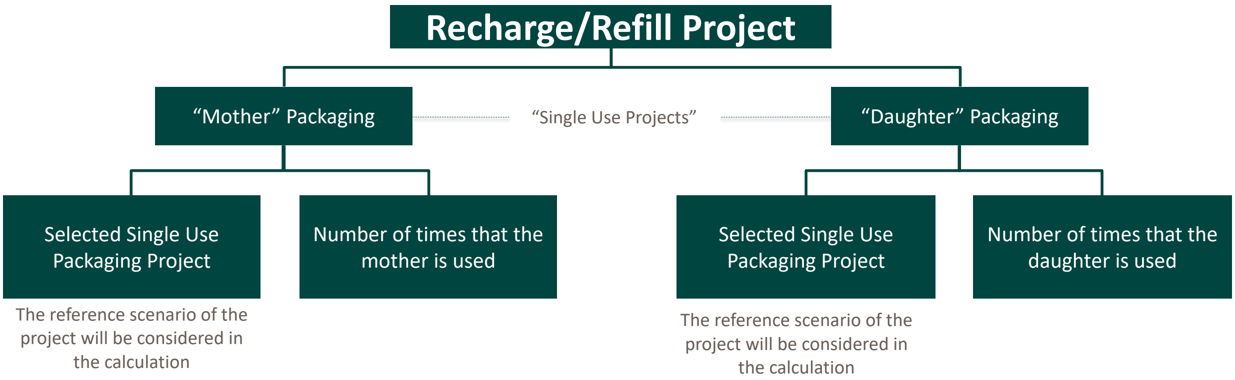


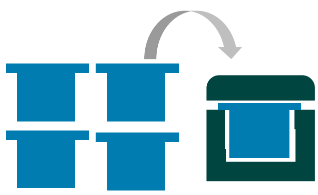
Figure 4 – Structure of a Recharge/Refill Project

4.2.1. Allocation for reuse, recharge and refill

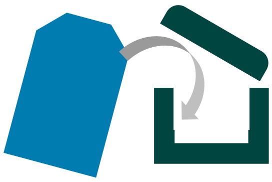
4.2.1.1. Topic definition

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:

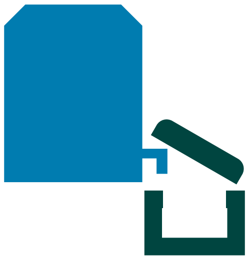
- **Recharge with another pack**,
  - e.g.: Plastic capsule (“daughter packaging”) for recharging a glass jar (“mother” packaging)



- **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. The reuse of a different purpose is not considered as reuse or recycling and cannot be modelled in the SPICE tool.
    - e.g.: Jar reused as penholder

Note: The terms "refillable, rechargeable, and reusable" have been differentiated in this guidance. These terms are sometimes used interchangeably in specific contexts; however, it is recommended to be specific about the type of reuse/refill to avoid any misinterpretation.

4.2.1.2. Calculations for assessing impacts at Recharge/Refill System level

The SPICE Tool allows to assess the potential impacts for the following systems:

- Recharge with another pack
- Refill from another pack
- Refill from a fountain/distributor

The following table presents the calculations that are performed by the tool when assessing a Recharge/Refill project.

Table 3 – Calculation for a Recharge/Refill project

	"Mother" packaging	"Daughter" Packaging
Function	To deliver formula to the consumer	To recharge or refill mother packaging with Formula
Functional Unit	To deliver 1 mL to the consumer	To deliver 1 mL to the consumer through a recharge or refill of the Mother packaging
Claimed Volume (from single use project)	Vm (in mL)	Vd (in mL)
Rate of Restitution (from single use project)	Rm (fraction between 0 and 1)	Rd (fraction between 0 and 1)
Number of uses of the pack	Nm (amount) *Number of times that the mother is used (totally filled, including the 1st filling)*	Nd (amount) *Number of times that the daughter is used in total (1 if is a single use recharge, probably more than 1 if it is a fountain/distributor)*
Impacts of for a consumer pack – (i.e. not per functional unit) *(from results of single use project calculation)*	Impact of 1 mother: Em	Impact of 1 daughter: Ed
Number (or fraction) of daughter(s) required for refilling the mother as expected (i.e. to « reach » Nm)	$\mathrm{D} = \frac{\mathrm{Vm} \times (Nm - 1)}{\mathrm{Vd} \times Rd \times Nd}$	
Impact of the whole recharge/refill system, for 1 FU (1 mL distributed) *Note: the restitution rate of the mother (Rm) is only applied for the « last » use, because the previous uses do not generate product loss.*	$\frac{\mathrm{Em} + \mathrm{D} \times Ed}{\mathrm{Vm} \times \frac{(Nm-1)+Rm}{Nm} \times Nm} = \frac{\mathrm{Em} + \mathrm{D} \times Ed}{\mathrm{Vm} \times (Nm - 1 + Rm)}$	
Impact of the whole recharge/refill system, for 1 FU (1 mL distributed), with breakdown between mother and daughter(s)	$\frac{\mathrm{Em}}{\mathrm{Vm} \times (Nm - 1 + Rm)}$	$\frac{\mathrm{D} \times Ed}{\mathrm{Vm} \times (Nm - 1 + Rm)}$

Note:

- Intermediate reconditioning steps (e.g. washing) and reverse logistics (transport from consumer to reconditioning site) may occur between two usages of the mother packaging. The SPICE Tool does not currently capture these potential additional steps.

5. Life Cycle Inventory

5.1. Data sources

The SPICE Tool combines different types of data sources in order to carry out the assessment:

- Data entered by users (which is specific to a packaging)
    - Specific data on the packaging, that are entered by users through the user interface,
    - Generic data on specific life cycle stages,
- Background database
    - Life Cycle Inventories (e.g. impacts of materials production).

5.1.1. Data entered by users

The following figure presents the architecture of the user interface in terms of data input.

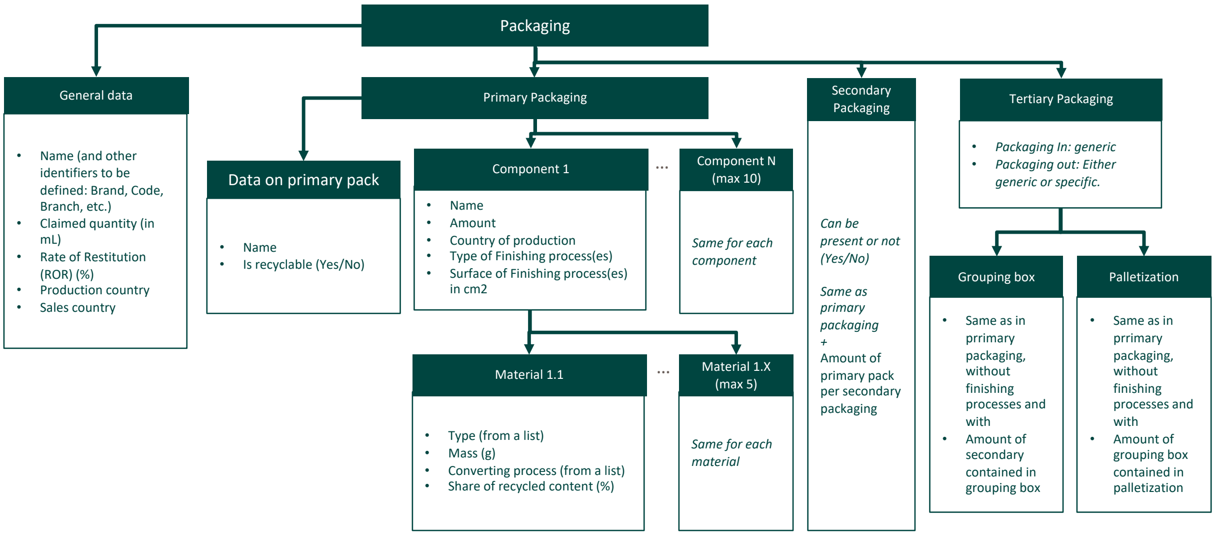


Figure 5 – Data entered by user

5.1.2. Type of data input per life cycle stage

Depending on the life cycle stage, different types of input data, either specific or generic can be used within the tool. The following table presents the type of data that can be used for each life cycle stage.

Table 4 – Type of data input for each Life Cycles Stages and unit processes included in the system boundary

Life cycle stages	Unit processes	Type of input data
Raw Material production	Production of primary and secondary materials	Manual input: Type and mass of material
	Production of tertiary packaging of incoming components ("Pack-in")	Automated calculation: based on mass of primary and secondary packaging
	Production of tertiary packaging for shipping the finished good ("Pack-out")	Automated calculation: based on mass of primary and secondary packaging or Manual input
Transport raw material production to supplier	Transportation from producer of packaging materials to producer of packaging component (PC)	Automated calculation: Generic transport scenario, scaled with the total packaging mass
Packaging components production	Transformation/Converting processes	Manual input: Type of process
Packaging components finishing	Finishing/Decoration processes	Manual input: Type of process and decorated surface
Transport supplier to manufacturing	Transportation from supplier of packaging component to final product manufacturing site	Automated calculation: Generic upstream transport scenario, depending on the location of the supplier of packaging component and of the final product manufacturing site, and scaled with the total packaging mass
Distribution and storage	Transport from final product manufacturing site to Retail	Automated calculation: Generic distribution transport scenario, depending on the location of the final product manufacturing site and of the zone of sales and scaled with the total packaging mass
	Storage at Distribution Centre	Automated calculation
	Storage at Retail	Automated calculation
	Consumer transport (roundtrip from home to retail)	Automated calculation: Generic, based on the generic assumption of 1L per product
Use	Use of the packaging (covering recharge/refill activities)	Manual input: type and number of recharge/refills

End-of-life	Transport to waste treatment	Automated calculation
	Recycling of packaging	Automated calculation
	Incineration of packaging with energy recovery	Automated calculation
	Incineration of packaging without energy recovery	Automated calculation
	Landfilling of packaging	Automated calculation
	End-of-life of tertiary packaging of incoming components (“Pack-in”)	Automated calculation
	End-of-life of tertiary packaging for shipping the finished good (“Pack-out”)	Automated calculation

5.1.3. List of Life Cycle Inventories used in the SPICE Tool

The SPICE Tool uses ecoinvent database (version 3.8) for generic activities (materials, processes, transport, electricity consumption, etc.), in its attributional “Cut-off” version.

In addition to the ecoinvent datasets, some activities (materials and processes) have been developed by the SPICE initiative (or granted by SPICE members to the SPICE initiative). In order to keep consistency across the SPICE Tool database, these specific datasets have been built on the same version of ecoinvent.

The following table presents the life cycle inventories used in the SPICE Tool.

The Acronyms used the table corresponds to the nomenclature of ecoinvent [8]:

- Geographies:
    - “GLO”: Global
    - “RER”: Regional Europe
    - “CH”: Switzerland
    - “RoW”: Rest of the World
- Other:
    - “Cut-off”: corresponds to the type of database model considered. The system model “Allocation, cut-off by classification”, or the cut-off system model, is based on the recycled content, or cut-off, approach. In this system model, wastes are the producer’s responsibility (“polluter pays”), and there is an incentivization to use recyclable products, that are available burden free (cut-off).
    - “U”: Unit process, which corresponds to disaggregated processes in ecoinvent.
    - “market for”: corresponds to a type of life cycle inventory that is representative of a market, supplied by a mix of region-specific processes.

Table 5 – Life Cycle Inventories used in the SPICE Tool

Type	Activity	LCI	LCI Source
Material	Glass	Glass production, FEVE	FEVE [10]
Material	Stainless steel	Steel, chromium steel 18/8 {GLO}| market for | Cut-off, U	ecoinvent [8]
Material	Steel	Steel, low-alloyed {GLO}| market for | Cut-off, U	ecoinvent [8]
Material	Aluminium	Aluminium, primary, ingot {IAI Area, EU27 & EFTA}| market for | Cut-off, U	ecoinvent [8]
Material	Tin	Tin {GLO}| market for | Cut-off, U	ecoinvent [8]
Material	Wood	Sawnwood, lath, hardwood, dried (u=10%), planed {GLO}| market for | Cut-off, U	ecoinvent [8]
Material	Medium Density Fiberboard	Medium density fibreboard {GLO}| market for | Cut-off, U	ecoinvent [8]
Material	Solid Bleached Board	Solid bleached board {GLO}| market for | Cut-off, U	ecoinvent [8]
Material	Solid Unbleached Board	Solid unbleached board {GLO}| market for | Cut-off, U	ecoinvent [8]
Material	Folding Box Board	Folding boxboard/chipboard {RER}| folding boxboard production | Cut-off, U	ecoinvent [8]
Material	Folding Box Board, white lined	Folding boxboard/chipboard {RER}| chipboard production, white lined | Cut-off, U	ecoinvent [8]
Material	Paper, woodfree, coated	Paper, woodfree, coated {RER}| market for | Cut-off, U	ecoinvent [8]
Material	Paper, wood containing, coated	Paper, woodcontaining, lightweight coated {RER}| market for | Cut-off, U	ecoinvent [8]
Material	Corrugated Board Box	Corrugated board box {GLO}| market for corrugated board box | Cut-off, U	ecoinvent [8]
Material	HDPE (Polyethylene, high density)	Polyethylene, high density, granulate {GLO}| market for | Cut-off, U	ecoinvent [8]
Material	PP (Polypropylene)	Polypropylene, granulate {GLO}| market for | Cut-off, U	ecoinvent [8]
Material	Synthetic rubber	Synthetic rubber {GLO}| market for | Cut-off, U	ecoinvent [8]
Material	PTFE (Polytetrafluoroethylene)	Tetrafluoroethylene {GLO}| market for | Cut-off, U	ecoinvent [8]
Material	LLDPE (Polyethylene, linear low density)	Polyethylene, linear low density, granulate {GLO}| market for | Cut-off, U	ecoinvent [8]
Material	LDPE (Polyethylene, low density)	Polyethylene, low density, granulate {GLO}| market for | Cut-off, U	ecoinvent [8]

Material	PET (Polyethylene terephthalate)	Polyethylene terephthalate, granulate, amorphous {GLO}| market for | Cut-off, U *adapted in order to take into account the antimony consumption flow (used for polymerization), using the same value as for bottle grade PET*	ecoinvent [8], with adaptation
Material	PETG (Polyethylene terephthalate glycol-modified)	PETG {GLO}| market for | Cut-off, U	Quantis
Material	PET, bottle grade (Polyethylene terephthalate)	Polyethylene terephthalate, granulate, bottle grade {GLO}| market for | Cut-off, U	ecoinvent [8]
Material	PS (Polystyrene)	Polystyrene, general purpose {GLO}| market for | Cut-off, U	ecoinvent [8]
Material	PMMA (Polymethyl methacrylate)	Polymethyl methacrylate, beads {GLO}| market for | Cut-off, U	ecoinvent [8]
Material	PVDC (Polyvinyldenchloride)	Polyvinylidenchloride, granulate {GLO}| market for | Cut-off, U	ecoinvent [8]
Material	PC (Polycarbonate)	Polycarbonate {GLO}| market for | Cut-off, U	ecoinvent [8]
Material	PU (Polyurethane)	Polyurethane, flexible foam {GLO}| market for | Cut-off, U	ecoinvent [8]
Material	Melamine formaldehyde resin	Melamine formaldehyde resin {GLO}| market for | Cut-off, U	ecoinvent [8]
Material	Epoxy resin	Epoxy resin {GLO}| market for epoxy resin | Cut-off, U	ecoinvent [8]
Material	Nylon 6	Nylon 6 {GLO}| market for | Cut-off, U	ecoinvent [8]
Material	SAN (Styrene Acrylonitrile)	Styrene-acrylonitrile copolymer {GLO}| market for | Cut-off, U	ecoinvent [8]
Material	ABS (Acrylonitrile-butadiene-styrene)	Acrylonitrile-butadiene-styrene copolymer {GLO}| market for | Cut-off, U	ecoinvent [8]
Material	POM (Polyoxymethylene)	Polyoxymethylene (POM)/EU-27	ecoinvent [8]
Material	EVA (Ethylene vinyl acetate)	Ethylene vinyl acetate copolymer {GLO}| market for | Cut-off, U	ecoinvent [8]
Material	LDPE film (Polyethylene, low density)	Packaging film, low density polyethylene {GLO}| market for | Cut-off, U	ecoinvent [8]
Material	PCT (Polycyclohexylenedimethylene Terephthalate)	PCT	Quantis
Material	PCTG (Glycol-Modified Polycyclohexylenedimethylene Terephthalate)	PCTG	Quantis
Material	PBT (Polybutylene)	Polybutylene Terephthalate	Quantis
Material	PK (Polyketone)	Polyketone	Quantis

Material	Cotton, woven	Textile, woven cotton {GLO}| market for | Cut-off, U	ecoinvent [8]
Material	Plastic pump, average composition	Average plastic pump composition from SPICE Members	SPICE
Material	Fragrance pump, average composition	Average fragrance pump composition from SPICE Members	SPICE
Material	Magnet	Permanent magnet, for electric motor {GLO}| production | Cut-off, U	ecoinvent [8]
Material	Zamak	Zamak 2	Quantis
Material	Mirror	Mirror	Quantis
Material	Cellulose Acetate	Carboxymethyl cellulose, powder {GLO}| market for | Cut-off, U	Quantis
Material	Brass	Brass {RoW}| market for brass | Cut-off, U	ecoinvent [8]
Material	Ceramics	Sanitary ceramics {GLO}| market for | Cut-off, U	ecoinvent [8]
Material	HDPE, from sugar cane	Green HDPE, with average national DLUC, Carbon content on HDPE and residual mix substitution {BR}| production | Cut-off, U	Based on supplier data
Material	Latex	Latex {RER}| production | Cut-off, U	ecoinvent [8]
Material	Surlyn	Surlyn {GLO}| market for | Cut-off, U	Quantis
Material	EVOH (Ethylene vinyl alcohol)	EVOH {GLO} Cut-off, U	Quantis
Material	SEBS (Styrene-ethylene-butylene-styrene)	SEBS {GLO}| market for | Cut-off, U	Quantis
Material	MBS (methacrylate-butadiene-styrene)	MBS {GLO}| market for | Cut-off, U	Quantis
Material	Leather	Finished leather, at plant/RER U	Quantis
Material	PVC (Polyvinyl chloride)	Polyvinylchloride, bulk polymerised {GLO}| market for | Cut-off, U	ecoinvent [8]
Material	Neodymium oxide	Neodymium oxide {GLO}| market for | Cut-off, U	ecoinvent [8]
Material	PA1010 (Polyamide), from castor oil	PA1010 (Polyamide), from castor oil	Based on supplier data
Material	TREVA bioplastic, from cellulose, 45% biobased	TREVA bioplastic, from cellulose, 45% biobased	Based on supplier data
Material	LDPE (Polyethylene, low density), from biomass residues	LDPE (Polyethylene, low density), from various waste and biomass residues	Based on supplier data
Material	PP (Polypropylene), from biomass residues	PP (Polypropylene), from various waste and biomass residues	Based on supplier data

Material	PA11 (Polyamide), for extrusion, from castor oil	PA11 (Polyamide), for extrusion, from castor oil	Based on supplier data
Material	PA11 (Polyamide), for injection, from castor oil	PA11 (Polyamide), for injection, from castor oil	Based on supplier data
Material	Transparent PA (Polyamide)	Transparent PA (Polyamide)	Based on supplier data
Material	Transparent PA (Polyamide), from castor oil, 62% bio-based	Transparent PA (Polyamide), from castor oil, 62% bio-based	Based on supplier data
Recycling	Glass, recycled	Glass recycling	FEVE [10]
Recycling	Steel, recycled	Steel, low-alloyed {RER}| steel production, electric, low-alloyed | Cut-off, U	ecoinvent [8]
Recycling	Aluminium, recycled	Aluminium, wrought alloy {RER}| treatment of aluminium scrap, post-consumer, prepared for recycling, at remelter | Cut-off, U	ecoinvent [8]
Recycling	Particle board, recycled	Particle board, from recycling, 100% secondary, at plant (Cut-off)/RER U	ecoinvent [8]
Recycling	Folding Box Board, white lined	Folding boxboard/chipboard {RER}| chipboard production, white lined | Cut-off, U	ecoinvent [8]
Recycling	Graphic paper, recycled	Graphic paper, 100% recycled {RER}| production | Cut-off, U	ecoinvent [8]
Recycling	Corrugated board, recycled	Corrugated board, from recycling, 100% secondary, at plant (Cut-off)/RER U	ecoinvent [8]
Recycling	Polyethylene (PE), recycled	Polyethylene (PE), from recycling, 100% secondary, at plant (Cut-off)/RER U	Quantis, based on American Chemistry Council, 2011 [11]
Recycling	Polyethylene terephthalate (PET), recycled	Polyethylene terephthalate, granulate, amorphous, recycled {Europe without Switzerland}| polyethylene terephthalate production, granulate, amorphous, recycled | Cut-off, U	Quantis, based on American Chemistry Council, 2011 [11]
Incineration	Glass, incineration	Waste glass {CH}| treatment of, municipal incineration | Cut-off, U	ecoinvent [8]
Incineration	Steel, incineration	Scrap steel {CH}| treatment of, municipal incineration | Cut-off, U	ecoinvent [8]
Incineration	Aluminium, incineration	Scrap aluminium {CH}| treatment of, municipal incineration | Cut-off, U	ecoinvent [8]
Incineration	Tin sheet, incineration	Scrap tin sheet {CH}| treatment of, municipal incineration | Cut-off, U	ecoinvent [8]
Incineration	Wood, untreated, incineration	Waste wood, untreated {CH}| treatment of, municipal incineration | Cut-off, U	ecoinvent [8]

Incineration	Paperboard, incineration	Waste paperboard {CH}| treatment of, municipal incineration | Cut-off, U	ecoinvent [8]
Incineration	Paper, incineration	Waste graphical paper {CH}| treatment of, municipal incineration with fly ash extraction | Cut-off, U	ecoinvent [8]
Incineration	PP, incineration	Waste polypropylene {CH}| treatment of, municipal incineration | Cut-off, U	ecoinvent [8]
Incineration	Rubber, incineration	Waste rubber, unspecified {CH}| treatment of, municipal incineration | Cut-off, U	ecoinvent [8]
Incineration	PE, incineration	Waste polyethylene {CH}| treatment of, municipal incineration | Cut-off, U	ecoinvent [8]
Incineration	PET, incineration	Waste polyethylene terephtalate {CH}| treatment of, municipal incineration with fly ash extraction | Cut-off, U	ecoinvent [8]
Incineration	Plastic, mixture, incineration	Waste plastic, mixture {CH}| treatment of, municipal incineration | Cut-off, U	ecoinvent [8]
Incineration	Textile, incineration	Waste textile, soiled {CH}| treatment of, municipal incineration | Cut-off, U	ecoinvent [8]
Incineration	Bio-based PE, incineration	Waste polyethylene, biobased {CH}| treatment of, municipal incineration | Cut-off, U	Quantis (adaptation from ecoinvent [8])
Incineration	Bio-based PET, incineration	waste polyethylene terephthalate, 100% biobased {CH}| treatment of waste polyethylene terephthalate, municipal incineration | Cut-off, U	Quantis (adaptation from ecoinvent [8])
Incineration	Bio-MEG PET, incineration	waste polyethylene terephthalate, biobased MEG {CH}| treatment of waste polyethylene terephthalate, municipal incineration | Cut-off, U	Quantis (adaptation from ecoinvent [8])
Incineration	Bio-based PP, incineration	Waste polypropylene, biobased {CH}| treatment of, municipal incineration | Cut-off, U	Quantis (adaptation from ecoinvent [8])
Incineration	Bio-based waste plastic mixture, incineration	Waste plastic, biobased, mixture {CH}| treatment of, municipal incineration | Cut-off, U	Quantis (adaptation from ecoinvent [8])
Landfill	Glass, landfilling	Waste glass {CH}| treatment of, inert material landfill | Cut-off, U	ecoinvent [8]
Landfill	Steel, landfilling	Scrap steel {CH}| treatment of, inert material landfill | Cut-off, U	ecoinvent [8]
Landfill	Aluminium, landfilling	Waste aluminium {CH}| treatment of, sanitary landfill | Cut-off, U	ecoinvent [8]
Landfill	Tin sheet, landfilling	Scrap tin sheet {CH}| treatment of, sanitary landfill | Cut-off, U	ecoinvent [8]

Landfill	Wood, untreated, landfilling	Waste wood, untreated {CH}| treatment of, sanitary landfill | Cut-off, U	ecoinvent [8]
Landfill	Paperboard, landfilling	Waste paperboard {CH}| treatment of, sanitary landfill | Cut-off, U	ecoinvent [8]
Landfill	Paper, landfilling	Waste graphical paper {CH}| treatment of, sanitary landfill | Cut-off, U	ecoinvent [8]
Landfill	PP, landfilling	Waste polypropylene {CH}| treatment of, sanitary landfill | Cut-off, U	ecoinvent [8]
Landfill	PE, landfilling	Waste polyethylene {CH}| treatment of, sanitary landfill | Cut-off, U	ecoinvent [8]
Landfill	PET, landfilling	Waste polyethylene terephtalate {CH}| treatment of, sanitary landfill | Cut-off, U	ecoinvent [8]
Landfill	PS, landfilling	Waste polystyrene {CH}| treatment of, sanitary landfill | Cut-off, U	ecoinvent [8]
Landfill	Plastic, mixture, landfilling	Waste plastic, mixture {CH}| treatment of, sanitary landfill | Cut-off, U	ecoinvent [8]
Landfill	Municipal solid waste, landfilling	Municipal solid waste {CH}| treatment of, sanitary landfill | Cut-off, U	ecoinvent [8]
Landfill	Bio-based PE, landfilling	Waste polyethylene, biobased, with carbon storage {CH}| treatment of, sanitary landfill | Cut-off, U	Quantis (adaptation from ecoinvent [8])
Landfill	Bio-based PET, landfilling	Waste polyethylene terephthalate, 100% biobased, with carbon storage {CH}| treatment of waste polyethylene terephthalate, sanitary landfill | Cut-off, U	Quantis (adaptation from ecoinvent [8])
Landfill	Bio-MEG PET, landfilling	Waste polyethylene terephthalate, biobased MEG, with carbon storage {CH}| treatment of waste polyethylene terephthalate, sanitary landfill | Cut-off, U	Quantis (adaptation from ecoinvent [8])
Landfill	Bio-based PP, landfilling	Waste polypropylene, biobased, with carbon storage {CH}| treatment of, sanitary landfill | Cut-off, U	Quantis (adaptation from ecoinvent [8])
Landfill	Bio-based waste plastic mixture, landfilling	Waste plastic, biobased, mixture, with carbon storage {CH}| treatment of, sanitary landfill | Cut-off, U	Quantis (adaptation from ecoinvent [8])
Landfill	Bio-based waste plastic mixture, landfilling, with 5% degradation	Waste plastic, biobased, mixture, with carbon storage, with 5% degradation {CH}| treatment of, sanitary landfill | Cut-off, U	Quantis (adaptation from ecoinvent [8])
Landfill	Bio-based waste plastic mixture, landfilling, with 50% degradation	Waste plastic, biobased, mixture, with carbon storage, with 50% degradation {CH}| treatment of, sanitary landfill | Cut-off, U	Quantis (adaptation from ecoinvent [8])

Converting process	Blow moulding	Blow moulding | production | Cut-off, U	ecoinvent [8] (with electricity made country dependent)
Converting process	Injection moulding	Injection moulding | processing | Cut-off, U	ecoinvent [8] (with electricity made country dependent)
Converting process	Calendering, rigid sheets	Calendering, rigid sheets | production | Cut-off, U	ecoinvent [8] (with electricity made country dependent)
Converting process	Extrusion, co-extrusion	Extrusion, co-extrusion | of plastic sheets | Cut-off, U	ecoinvent [8] (with electricity made country dependent)
Converting process	Stretch Blow moulding	Stretch blow moulding | production | Cut-off, U	ecoinvent [8] (with electricity made country dependent)
Converting process	Thermoforming, with calendering	Thermoforming, with calendering | production | Cut-off, U	ecoinvent [8] (with electricity made country dependent)
Converting process	Thermoforming of plastic sheets	Thermoforming of plastic sheets {RoW}| processing | Cut-off, U	ecoinvent [8] (with electricity made country dependent)
Converting process	Polar fleece production	Polar fleece production {GLO}| market for | Cut-off, U	ecoinvent [8] (with electricity made country dependent)
Converting process	Glass converting	No impact	(included in material)
Converting process	Cardboard folding	No impact	(included in material)
Converting process	Textile processing	No impact	(weaving included in material)
Converting process	Wood processing	No impact	(assumed to be negligible)
Converting process	Extrusion of plastic sheets and thermoforming, inline	Extrusion of plastic sheets and thermoforming, inline | processing | Cut-off, U	ecoinvent [8] (with electricity made country dependent)
Converting process	Liquid packaging board manufacturing process	Liquid packaging board container | production | Cut-off, U	ecoinvent [8] (process only, with electricity made country dependent)
Converting process	Deep drawing, steel	Deep drawing, steel, 650 kN press, automode | deep drawing, steel, 650 kN press, automode | Cut-off, U	ecoinvent [8] (with electricity made country dependent)
Converting process	Impact extrusion of aluminium	Impact extrusion of aluminium, 1 stroke without electricity| processing | Cut-off, U	ecoinvent [8] (with electricity made country dependent)
Converting process	Sheet rolling, aluminium	Sheet rolling, aluminium | processing | Cut-off, U	ecoinvent [8] (with electricity made country dependent)

Converting process	Sheet rolling, steel	Sheet rolling, steel | processing | Cut-off, U	ecoinvent [8] (with electricity made country dependent)
Converting process	TREVA-specific injection moulding	TREVA-specific injection moulding	Based on supplier data
Finishing process	Anodising, aluminium sheet	Anodising, aluminium sheet, {RER}| processing | Cut-off, U)	ecoinvent [8] (with electricity made country dependent)
Finishing process	Physical Vapour Deposition, aluminium	Aluminium coat, packaging, physical vapour deposition {RER}| selective coating, packaging, physical vapour deposition | Cut-off, U	Adapted ecoinvent [8] LCI (with electricity made country dependent)
Finishing process	Sputtering, aluminium coat	Aluminium coat, packaging, sputter deposition, {RER}| selective coating, packaging, sputtering | Cut-off, U	Adapted ecoinvent [8] LCI (with electricity made country dependent)
Finishing process	Offset printing	Printed paper, offset {CH}| offset printing, per kg printed paper | Cut-off, U	ecoinvent [8] (process only, with electricity made country dependent)
Finishing process	Acid etching	Anti-reflex-coating, etching, solar glass	ecoinvent [8] (with electricity made country dependent)
Finishing process	Lacquering	Glass lacquering	SPICE
Finishing process	Electroplating, nickel	Nickel electroplating	Quantis
Transport	Train	Transport, freight train {GLO}| market group for | Cut-off, U	ecoinvent [8]
Transport	Plane	Transport, freight, aircraft, unspecified {GLO}| market for transport, freight, aircraft, unspecified | Cut-off, U	ecoinvent [8]
Transport	Truck	Transport, freight, lorry, unspecified {GLO}| market for | Cut-off, U	ecoinvent [8] note: this LCI considers an average load rate that includes average share of empty return trips
Transport	Boat	Transport, freight, sea, transoceanic ship {GLO}| market for | Cut-off, U	ecoinvent [8]
Transport	Municipal Waste Collection Truck	Municipal waste collection service by 21 metric ton lorry {CH}| market for municipal waste collection service by 21 metric ton lorry | Cut-off, U	ecoinvent [8]

Note:

Converting processes with “No impact”: the impact of the process is already accounted for and included in the material dataset, and as there is a need to put a converting process for each material in the tool, processes with no impact were created to avoid double counting.

Table 6 – Life Cycle Inventories used for electricity mixes in the SPICE Tool

Zone or Country	LCI (source: ecoinvent [8])
Northern America	Electricity, medium voltage {RNA}| market group for | Cut-off, U
Middle East	Electricity, medium voltage {RME}| market group for | Cut-off, U
Latin America and the Caribbean	Electricity, medium voltage {RLA}| market group for | Cut-off, U
Europe	Electricity, medium voltage {RER}| market group for | Cut-off, U
Asia	Electricity, medium voltage {RAS}| market group for | Cut-off, U
Africa	Electricity, medium voltage {RAF}| market group for | Cut-off, U
Global	Electricity, medium voltage {GLO}| market group for | Cut-off, U
Zimbabwe	Electricity, medium voltage {ZW}| market for electricity, medium voltage | Cut-off, U
Zambia	Electricity, medium voltage {ZM}| market for electricity, medium voltage | Cut-off, U
South Africa	Electricity, medium voltage {ZA}| market for | Cut-off, U
Yemen	Electricity, medium voltage {YE}| market for electricity, medium voltage | Cut-off, U
Kosovo	Electricity, medium voltage {XK}| market for electricity, medium voltage | Cut-off, U
Viet Nam	Electricity, medium voltage {VN}| market for electricity, medium voltage | Cut-off, U
Venezuela	Electricity, medium voltage {VE}| market for electricity, medium voltage | Cut-off, U
Uzbekistan	Electricity, medium voltage {UZ}| market for electricity, medium voltage | Cut-off, U
United States	Electricity, medium voltage {US}| market group for | Cut-off, U
Uruguay	Electricity, medium voltage {UY}| market for electricity, medium voltage | Cut-off, U
Ukraine	Electricity, medium voltage {UA}| market for | Cut-off, U
Tanzania, United Republic Of	Electricity, medium voltage {TZ}| market for | Cut-off, U
Taiwan, Province of China	Electricity, medium voltage {TW}| market for | Cut-off, U
Turkey	Electricity, medium voltage {TR}| market for | Cut-off, U
Tunisia	Electricity, medium voltage {TN}| market for electricity, medium voltage | Cut-off, U
Trinidad and Tobago	Electricity, medium voltage {TT}| market for electricity, medium voltage | Cut-off, U

Turkmenistan	Electricity, medium voltage {TM}| market for electricity, medium voltage | Cut-off, U
Tajikistan	Electricity, medium voltage {TJ}| market for electricity, medium voltage | Cut-off, U
Thailand	Electricity, medium voltage {TH}| market for | Cut-off, U
Togo	Electricity, medium voltage {TG}| market for electricity, medium voltage | Cut-off, U
Syrian Arab Republic	Electricity, medium voltage {SY}| market for electricity, medium voltage | Cut-off, U
Sweden	Electricity, medium voltage {SE}| market for | Cut-off, U
Slovenia	Electricity, medium voltage {SI}| market for | Cut-off, U
Slovakia	Electricity, medium voltage {SK}| market for | Cut-off, U
South Sudan	Electricity, medium voltage {SS}| market for electricity, medium voltage | Cut-off, U
Serbia	Electricity, medium voltage {RS}| market for | Cut-off, U
El Salvador	Electricity, medium voltage {SV}| market for electricity, medium voltage | Cut-off, U
Singapore	Electricity, medium voltage {SG}| market for electricity, medium voltage | Cut-off, U
Senegal	Electricity, medium voltage {SN}| market for electricity, medium voltage | Cut-off, U
Sudan	Electricity, medium voltage {SD}| market for electricity, medium voltage | Cut-off, U
Saudi Arabia	Electricity, medium voltage {SA}| market for | Cut-off, U
Russian Federation	Electricity, medium voltage {RU}| market for | Cut-off, U
Romania	Electricity, medium voltage {RO}| market for | Cut-off, U
Qatar	Electricity, medium voltage {QA}| market for electricity, medium voltage | Cut-off, U
Paraguay	Electricity, medium voltage {PY}| market for electricity, medium voltage | Cut-off, U
Portugal	Electricity, medium voltage {PT}| market for | Cut-off, U
Korea, Democratic People's Republic of	Electricity, medium voltage {KP}| market for electricity, medium voltage | Cut-off, U
Poland	Electricity, medium voltage {PL}| market for | Cut-off, U
Philippines	Electricity, medium voltage {PH}| market for electricity, medium voltage | Cut-off, U
Peru	Electricity, medium voltage {PE}| market for | Cut-off, U
Panama	Electricity, medium voltage {PA}| market for electricity, medium voltage | Cut-off, U

Pakistan	Electricity, medium voltage {PK}| market for electricity, medium voltage | Cut-off, U
Oman	Electricity, medium voltage {OM}| market for electricity, medium voltage | Cut-off, U
New Zealand	Electricity, medium voltage {NZ}| market for electricity, medium voltage | Cut-off, U
Nepal	Electricity, medium voltage {NP}| market for electricity, medium voltage | Cut-off, U
Norway	Electricity, medium voltage {NO}| market for | Cut-off, U
Netherlands	Electricity, medium voltage {NL}| market for | Cut-off, U
Nicaragua	Electricity, medium voltage {NI}| market for electricity, medium voltage | Cut-off, U
Nigeria	Electricity, medium voltage {NG}| market for electricity, medium voltage | Cut-off, U
Niger	Electricity, medium voltage {NE}| market for electricity, medium voltage | Cut-off, U
Namibia	Electricity, medium voltage {NA}| market for electricity, medium voltage | Cut-off, U
Malaysia	Electricity, medium voltage {MY}| market for | Cut-off, U
Mauritius	Electricity, medium voltage {MU}| market for electricity, medium voltage | Cut-off, U
Mozambique	Electricity, medium voltage {MZ}| market for electricity, medium voltage | Cut-off, U
Mongolia	Electricity, medium voltage {MN}| market for electricity, medium voltage | Cut-off, U
Montenegro	Electricity, medium voltage {ME}| market for electricity, medium voltage | Cut-off, U
Myanmar	Electricity, medium voltage {MM}| market for electricity, medium voltage | Cut-off, U
Malta	Electricity, medium voltage {MT}| market for | Cut-off, U
Macedonia, the Former Yugoslav Republic of	Electricity, medium voltage {MK}| market for | Cut-off, U
Mexico	Electricity, medium voltage {MX}| market for | Cut-off, U
Moldova, Republic of	Electricity, medium voltage {MD}| market for electricity, medium voltage | Cut-off, U
Morocco	Electricity, medium voltage {MA}| market for electricity, medium voltage | Cut-off, U
Latvia	Electricity, medium voltage {LV}| market for | Cut-off, U
Luxembourg	Electricity, medium voltage {LU}| market for | Cut-off, U
Lithuania	Electricity, medium voltage {LT}| market for | Cut-off, U
Sri Lanka	Electricity, medium voltage {LK}| market for electricity, medium voltage | Cut-off, U

Libya	Electricity, medium voltage {LY}| market for electricity, medium voltage | Cut-off, U
Lebanon	Electricity, medium voltage {LB}| market for electricity, medium voltage | Cut-off, U
Kuwait	Electricity, medium voltage {KW}| market for electricity, medium voltage | Cut-off, U
Korea, Republic of	Electricity, medium voltage {KR}| market for | Cut-off, U
Cambodia	Electricity, medium voltage {KH}| market for electricity, medium voltage | Cut-off, U
Kyrgyzstan	Electricity, medium voltage {KG}| market for electricity, medium voltage | Cut-off, U
Kenya	Electricity, medium voltage {KE}| market for electricity, medium voltage | Cut-off, U
Kazakhstan	Electricity, medium voltage {KZ}| market for electricity, medium voltage | Cut-off, U
Japan	Electricity, medium voltage {JP}| market for | Cut-off, U
Jordan	Electricity, medium voltage {JO}| market for electricity, medium voltage | Cut-off, U
Jamaica	Electricity, medium voltage {JM}| market for electricity, medium voltage | Cut-off, U
Italy	Electricity, medium voltage {IT}| market for | Cut-off, U
Israel	Electricity, medium voltage {IL}| market for electricity, medium voltage | Cut-off, U
Iceland	Electricity, medium voltage {IS}| market for | Cut-off, U
Iraq	Electricity, medium voltage {IQ}| market for electricity, medium voltage | Cut-off, U
Iran (Islamic Republic of)	Electricity, medium voltage {IR}| market for | Cut-off, U
Ireland	Electricity, medium voltage {IE}| market for | Cut-off, U
India	Electricity, medium voltage {IN}| market group for electricity, medium voltage | Cut-off, U
Indonesia	Electricity, medium voltage {ID}| market for | Cut-off, U
Hungary	Electricity, medium voltage {HU}| market for | Cut-off, U
Haiti	Electricity, medium voltage {HT}| market for electricity, medium voltage | Cut-off, U
Croatia	Electricity, medium voltage {HR}| market for | Cut-off, U
Honduras	Electricity, medium voltage {HN}| market for electricity, medium voltage | Cut-off, U
Hong Kong	Electricity, medium voltage {HK}| market for electricity, medium voltage | Cut-off, U
Guatemala	Electricity, medium voltage {GT}| market for electricity, medium voltage | Cut-off, U
Greece	Electricity, medium voltage {GR}| market for | Cut-off, U

Gibraltar	Electricity, medium voltage {GI}| market for electricity, medium voltage | Cut-off, U
Ghana	Electricity, medium voltage {GH}| market for electricity, medium voltage | Cut-off, U
Georgia	Electricity, medium voltage {GE}| market for electricity, medium voltage | Cut-off, U
United Kingdom	Electricity, medium voltage {GB}| market for | Cut-off, U
Gabon	Electricity, medium voltage {GA}| market for electricity, medium voltage | Cut-off, U
France	Electricity, medium voltage {FR}| market for | Cut-off, U
Finland	Electricity, medium voltage {FI}| market for | Cut-off, U
Ethiopia	Electricity, medium voltage {ET}| market for electricity, medium voltage | Cut-off, U
Estonia	Electricity, medium voltage {EE}| market for | Cut-off, U
Spain	Electricity, medium voltage {ES}| market for | Cut-off, U
Eritrea	Electricity, medium voltage {ER}| market for electricity, medium voltage | Cut-off, U
Egypt	Electricity, medium voltage {EG}| market for electricity, medium voltage | Cut-off, U
Ecuador	Electricity, medium voltage {EC}| market for electricity, medium voltage | Cut-off, U
Algeria	Electricity, medium voltage {DZ}| market for electricity, medium voltage | Cut-off, U
Dominican Republic	Electricity, medium voltage {DO}| market for electricity, medium voltage | Cut-off, U
Denmark	Electricity, medium voltage {DK}| market for | Cut-off, U
Germany	Electricity, medium voltage {DE}| market for | Cut-off, U
Czech Republic	Electricity, medium voltage {CZ}| market for | Cut-off, U
Cyprus	Electricity, medium voltage {CY}| market for | Cut-off, U
Curaçao	Electricity, medium voltage {CW}| market for electricity, medium voltage | Cut-off, U
Cuba	Electricity, medium voltage {CU}| market for electricity, medium voltage | Cut-off, U
Costa Rica	Electricity, medium voltage {CR}| market for electricity, medium voltage | Cut-off, U
Colombia	Electricity, medium voltage {CO}| market for electricity, medium voltage | Cut-off, U
Congo	Electricity, medium voltage {CG}| market for electricity, medium voltage | Cut-off, U
Congo, Democratic Republic of the	Electricity, medium voltage {CD}| market for electricity, medium voltage | Cut-off, U

Cameroon	Electricity, medium voltage {CM}| market for electricity, medium voltage | Cut-off, U
Cote d'Ivoire	Electricity, medium voltage {CI}| market for electricity, medium voltage | Cut-off, U
China	Electricity, medium voltage {CN}| market group for | Cut-off, U
Chile	Electricity, medium voltage {CL}| market for | Cut-off, U
Switzerland	Electricity, medium voltage {CH}| market for | Cut-off, U
Canada	Electricity, medium voltage {CA}| market group for | Cut-off, U
Botswana	Electricity, medium voltage {BW}| market for electricity, medium voltage | Cut-off, U
Brunei Darussalam	Electricity, medium voltage {BN}| market for electricity, medium voltage | Cut-off, U
Brazil	Electricity, medium voltage {BR}| market for | Cut-off, U
Bolivia, Plurinational State of	Electricity, medium voltage {BO}| market for electricity, medium voltage | Cut-off, U
Belarus	Electricity, medium voltage {BY}| market for electricity, medium voltage | Cut-off, U
Bosnia and Herzegovina	Electricity, medium voltage {BA}| market for | Cut-off, U
Bahrain	Electricity, medium voltage {BH}| market for electricity, medium voltage | Cut-off, U
Bulgaria	Electricity, medium voltage {BG}| market for | Cut-off, U
Bangladesh	Electricity, medium voltage {BD}| market for electricity, medium voltage | Cut-off, U
Benin	Electricity, medium voltage {BJ}| market for electricity, medium voltage | Cut-off, U
Belgium	Electricity, medium voltage {BE}| market for | Cut-off, U
Azerbaijan	Electricity, medium voltage {AZ}| market for electricity, medium voltage | Cut-off, U
Austria	Electricity, medium voltage {AT}| market for | Cut-off, U
Australia	Electricity, medium voltage {AU}| market for | Cut-off, U
Armenia	Electricity, medium voltage {AM}| market for electricity, medium voltage | Cut-off, U
Argentina	Electricity, medium voltage {AR}| market for electricity, medium voltage | Cut-off, U
United Arab Emirates	Electricity, medium voltage {AE}| market for electricity, medium voltage | Cut-off, U
Albania	Electricity, medium voltage {AL}| market for electricity, medium voltage | Cut-off, U

Angola	Electricity, medium voltage {AO}| market for electricity, medium voltage | Cut-off, U

5.2. Material flows considered as recycled content in the SPICE Tool

Note: a dedicated “Recycled content Appendix” provides guidance on SPICE Tool users on how to consider material flow when specifying the recycled content. While this section highlights the key aspects of this appendix, further guidance can be found in the full document.

Regarding recycled content, the user of the tool is responsible for indicating the percentage of post-consumer recycled content that a packaging contains. The SPICE Initiative’s position stated in the SPICE Methodological Guidelines, and aligning with the Ellen MacArthur Foundation recommendations[3], is that **only post-consumer material** should be considered in the recycled fraction (R_1) when applying the Circular Footprint Formula (CFF)[4] for Life Cycle Assessment (LCA). Therefore, pre-consumer material is considered as virgin material from a LCA perspective in SPICE Methodological Guidelines.

5.2.1. Recycled materials: EN 45557 additional guidance

SPICE is aligned with the ISO 14021 norm and the EN 45557 further guidance for pre- and post-consumer material identification. The ISO 14021[5] standard states that only “pre-consumer” and “post-consumer” materials shall 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.”*

The norm EN 45557[6] on “general method for assessing the proportion of recycled material content in energy-related products” adds the following note to the definition:

“Same process means the same manufacturing operation for the same type of product in the same or different physical location.”

Some actors are using the term Post Industrial Recycled content (PIR) to refer to pre-consumer material. This is not the term used by the ISO and should therefore be avoided.

[3] Ellen Macarthur Foundation, New Plastics Economy Global Commitment (website)
[4] The CFF has been developed by the PEF (Product Environmental Footprint). It defines the rule to allocate the environmental burdens or benefits of recycling, reusing or recovering energy between, for example, the generator of the waste and the user of secondary materials.
[5] ISO 14021:2016 Environmental labels and declarations – Self-declared environmental claims (Type II environmental labelling)
[6] EN 45557:2019 General method for assessing the proportion of recycled material content in energy-related products

- 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."*

The norm EN 45557 adds the following note to the definition:

"This includes returns of products, or parts thereof, from the distribution of finished products for end-users".

In the Annex A, the norm specifies that post-consumer material includes "*finished products for the end-user that are either damaged, overstock of obsolete inventories from manufacturers, distributors and wholesalers which have not been put on the market."*

5.2.2. Recycled materials: EN 45557 additional guidance

The norm EN 45557 provides further guidance on how to identify pre- and post-consumer material for 3 material types: plastics, metals, and glass. This additional guidance on pre- and post-consumer material identification is available in the annex A of the norm.

5.2.2.1. Additional guidance for plastics

With respect to the definition of pre-consumer material:

- *"same process" refers to a repetition of a manufacturing operation or the production of the same type of product that has been already carried out. Manufacturing operations can be, for example, extrusion, injection moulding, blow moulding, thermoforming, welding or printing. Types of products can be, for example, packaging film, shrink film, pipes or profiles. E.g., the extrusion of a packaging film is a different process than the extrusion of a housing film;*
- *"waste generated" should be interpreted as waste output from a process with no change of composition.*

Other comments:

- If a material waste is only **regrinded** prior to being reused in the same process generating it (e.g., injection moulding operation). This cannot be considered as pre-consumer waste.
- The same criteria of pre- or post-consumer material applies to any recycling process (mechanical, chemical, …).

5.2.2.2. Additional guidance for metals

With respect to the definition of pre-consumer material:

- Scrap generated during smelting, refining, melting and casting **cannot be considered as pre-consumer material** since the scrap generated during these processes can be reused directly in them.
- Scrap generated during the subsequent manufacturing processes, including forming (rolling, drawing, …), finishing, surface treatments, can be claimed as **pre-consumer material**. Indeed, scrap from these processes will need to be smelted / refined / melted / casted prior to being reused by the same processes.

5.2.2.3. Additional guidance for glass

With respect to the definition of pre-consumer material:

- Internal cullet generated during the glass manufacturing process cannot be claimed as pre- nor post-consumer material, since it can be reused directly in the furnace without undertaking any additional process.
- Cullets generated during additional processing steps (e.g. during the decoration or conditioning process) can be claimed as pre-consumer material, despite being recognized as a by-products.

5.3. Recycled content and end-of-life recycling

5.3.1. Topic definition

The purpose of this section is to define how to account for the potential impacts and benefits when dealing with recycling. Indeed, using recycled content 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. This section presents:

- 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 another product system,
- the material flows considered as recycled content in the SPICE Tool.

5.3.2. Method used in SPICE Tool

The SPICE Tool uses the Circular Footprint Formula (CFF) from the PEF initiative, as defined in the PEF guidance [1].

The Circular Footprint Formula is a standardized approach, developed in the frame of the PEF/OEF initiative, to allocate potential 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.

Within the SPICE Tool, the CFF is used at material level. When a user selects a material, the CFF will be automatically applied.

The CFF takes into account the whole life cycle of materials, from production of the virgin material to its recycling and its disposal. Furthermore, it covers the different aspects linked to end-of-life and recycling by capturing:

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

The CFF 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 $(1 - R_2 - R_3) \times E_D$

Note: Within the SPICE Tool, the "Material" part is included in the "Raw Material Production" life cycle stage, while the "Energy" and "Disposal" parts are included in the "End-of-life" life cycle stage.

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.

Note: all these parameters are associated to each material. They are all generic and cannot be modified by the users, except for:

- R_1, i.e. the recycled content. This parameter can be manually modified by the user, from 0 to 100%.
- R_2:, i.e. the recycling rate at end-of-life. The value of this parameter cannot be changed directly by the user, however there are several inputs that influence its value, as presented in the following focus box.

Note: The CFF parameters, and notably the Qs/Qp ratios, are taken from the PEF [1] and have a European representativeness. They are used as a proxy of the Global situation.

FOCUS BOX – Recycling rate at end-of-life

The "R_2" parameter, i.e. the recycling rate at end-of-life, is determined for the primary pack on one side and for the secondary pack on the other side, using the following algorithm:

1. **Presence of a main material**. The tool automatically assesses if the packaging contains a main material, i.e. a material (or group of materials that can be recycled together) that contribute more than 50% to the total mass of the packaging. If there is no main material, it is considered that the materials are too diverse for the packaging to be oriented toward a specific recycling stream. In that case, the R_2 is set to zero. If there is a main material, then the following step is considered.
2. **Manual input from user about the recyclability of the packaging:** The user can manually input whether the packaging is recyclable or not, in order to able to capture the possibility that it is not recyclable, due to its intrinsic characteristics or the presence of recycling disruptors. If the user indicates that the packaging is not recyclable, then R_2 is set to zero. If not, then the following step is considered.
3. **Application of the generic value of R_2**. The generic value of R_2 for a given material depends on the type of material and the sales zone of the product. The section 5.11 page 65 presents the different values of R_2 considered in the tool.

Table 7 – Life Cycle Inventories used for CFF inputs in the SPICE Tool

Ev and Ev* (see Table 5 p28-30)	Material group for the EoL	Erec and ErecEoL (see Table 5 p30-31)	Einc (see Table 5 p31)	Elan (see Table 5 p32)
Glass	Glass	Glass, recycled	Glass, incineration	Glass, landfilling
Stainless steel	Steel	Steel, recycled	Steel, incineration	Steel, landfilling
Steel	Steel	Steel, recycled	Steel, incineration	Steel, landfilling
Aluminium	Aluminium	Aluminium, recycled	Aluminium, incineration,	Aluminium, landfilling
Tin	Steel	Steel, recycled	Tin sheet, incineration	Tin sheet, landfilling
Wood	Wood	No recycling	Wood, untreated, incineration	Wood, untreated, landfilling
Medium Density Fiberboard	Wood	No recycling	Wood, untreated, incineration	Wood, untreated, landfilling
Solid Bleached Board	Cardboard	Folding Box Board, white lined	Paperboard, incineration	Paperboard, landfilling
Solid Unbleached Board	Cardboard	Folding Box Board, white lined	Paperboard, incineration	Paperboard, landfilling
Folding Box Board	Paper	Folding Box Board, white lined	Paperboard, incineration	Paperboard, landfilling
Folding Box Board, white lined	Paper	Folding Box Board, white lined	Paperboard, incineration	Paperboard, landfilling
Paper, woodfree, coated	Paper	Graphic paper, recycled	Paper, incineration	Paper, landfilling
Paper, wood containing, coated	Paper	Graphic paper, recycled	Paper, incineration	Paper, landfilling
Corrugated Board Box	Cardboard	Corrugated board, recycled	Paperboard, incineration	Paperboard, landfilling
HDPE (Polyethylene, high density)	PE	Polyethylene (PE), recycled	PE, incineration	PE, landfilling
PP (Polypropylene)	PP	Polyethylene terephthalate (PET), recycled	PP, incineration	PP, landfilling
Synthetic rubber	No recycling group	No recycling	Rubber, incineration	Plastic, mixture, landfilling
PTFE (Polytetrafluoroethylene)	No recycling group	No recycling	Plastic, mixture, incineration	Plastic, mixture, landfilling
LLDPE (Polyethylene, linear low density)	PE	Polyethylene (PE), recycled	PE, incineration	PE, landfilling

LDPE (Polyethylene, low density)	PE	Polyethylene (PE), recycled	PE, incineration	PE, landfilling
PET (Polyethylene terephthalate)	PET	Polyethylene terephthalate (PET), recycled	PET, incineration	PET, landfilling
PETG (Polyethylene terephthalate glycol-modified)	No recycling group	No recycling	PET, incineration	PET, landfilling
PET, bottle grade (Polyethylene terephthalate)	PET	Polyethylene terephthalate (PET), recycled	PET, incineration	PET, landfilling
PS (Polystyrene)	No recycling group	No recycling	Plastic, mixture, incineration	PS, landfilling
PMMA (Polymethyl methacrylate)	No recycling group	No recycling	Plastic, mixture, incineration	Plastic, mixture, landfilling
PVDC (Polyvinyldenchloride)	No recycling group	No recycling	Plastic, mixture, incineration	Plastic, mixture, landfilling
PC (Polycarbonate)	No recycling group	No recycling	Plastic, mixture, incineration	Plastic, mixture, landfilling
PU (Polyurethane)	No recycling group	No recycling	Plastic, mixture, incineration	Plastic, mixture, landfilling
Melamine formaldehyde resin	No recycling group	No recycling	Plastic, mixture, incineration	Plastic, mixture, landfilling
Epoxy resin	No recycling group	No recycling	Plastic, mixture, incineration	Plastic, mixture, landfilling
Nylon 6	No recycling group	No recycling	Plastic, mixture, incineration	Plastic, mixture, landfilling
SAN (Styrene Acrylonitrile)	No recycling group	No recycling	Plastic, mixture, incineration	Plastic, mixture, landfilling
ABS (Acrylonitrile-butadiene-styrene)	No recycling group	No recycling	Plastic, mixture, incineration	Plastic, mixture, landfilling
POM (Polyoxymethylene)	No recycling group	No recycling	Plastic, mixture, incineration	Plastic, mixture, landfilling
EVA (Ethylene vinyl acetate)	No recycling group	No recycling	Plastic, mixture, incineration	Plastic, mixture, landfilling
LDPE film (Polyethylene, low density)	PE	Polyethylene (PE), recycled	PE, incineration	PE, landfilling

PCT (Polycyclohexylenedimethylene Terephthalate)	No recycling group	No recycling	Plastic, mixture, incineration	Plastic, mixture, landfilling
PCTG (Glycol-Modified Polycyclohexylenedimethylene Terephthalate)	No recycling group	No recycling	Plastic, mixture, incineration	Plastic, mixture, landfilling
PBT (Polybutylene)	No recycling group	No recycling	Plastic, mixture, incineration	Plastic, mixture, landfilling
PK (Polyketone)	No recycling group	No recycling	Plastic, mixture, incineration	Plastic, mixture, landfilling
Cotton, woven	No recycling group	No recycling	Textile, incineration	Municipal solid waste, landfilling
Plastic pump, average composition	No recycling group	No recycling	Plastic, mixture, incineration	Plastic, mixture, landfilling
Fragrance pump, average composition	No recycling group	No recycling	Plastic, mixture, incineration	Plastic, mixture, landfilling
Magnet	No recycling group	No recycling	Steel, incineration	Steel, landfilling
Zamak	No recycling group	No recycling	Aluminium, incineration,	Aluminium, landfilling
Mirror	No recycling group	No recycling	Glass, incineration	Glass, landfilling
Cellulose Acetate	No recycling group	No recycling	Plastic, mixture, incineration	Plastic, mixture, landfilling
Brass	No recycling group	No recycling	Steel, incineration	Steel, landfilling
Ceramics	No recycling group	No recycling	Steel, incineration	Steel, landfilling
HDPE, from sugar cane	PE	Polyethylene (PE), recycled	Bio-based PE, incineration	Bio-based PE, landfilling
Latex	No recycling group	No recycling	Plastic, mixture, incineration	Plastic, mixture, landfilling
Surlyn	No recycling group	No recycling	Plastic, mixture, incineration	Plastic, mixture, landfilling

EVOH (Ethylene vinyl alcohol)	No recycling group	No recycling	Plastic, mixture, incineration	Plastic, mixture, landfilling
SEBS (Styrene-ethylene-butylene-styrene)	No recycling group	No recycling	Plastic, mixture, incineration	Plastic, mixture, landfilling
MBS (methacrylate-butadiene-styrene)	No recycling group	No recycling	Plastic, mixture, incineration	Plastic, mixture, landfilling
Leather	No recycling group	No recycling	Textile, incineration	Municipal solid waste, landfilling
PVC (Polyvinyl chloride)	No recycling group	No recycling	Plastic, mixture, incineration	Plastic, mixture, landfilling
Neodymium oxide	No recycling group	No recycling	Steel, incineration	Steel, landfilling
PA1010 (Polyamide), from castor oil	No recycling group	No recycling	Bio-based waste plastic mixture, incineration	Bio-based waste plastic mixture, landfilling
TREVA bioplastic, from cellulose, 45% biobased	No recycling group	No recycling	Bio-based waste plastic mixture, incineration	Bio-based waste plastic mixture, landfilling
LDPE (Polyethylene, low density), from biomass residues	PE	Polyethylene (PE), recycled	Bio-based PE, incineration	Bio-based PE, landfilling
PP (Polypropylene), from biomass residues	PP	Polyethylene terephthalate (PET), recycled	Bio-based PP, incineration	Bio-based PP, landfilling
PA11 (Polyamide), for extrusion, from castor oil	No recycling group	No recycling	Bio-based waste plastic mixture, incineration	Bio-based waste plastic mixture, landfilling
PA11 (Polyamide), for injection, from castor oil	No recycling group	No recycling	Bio-based waste plastic mixture, incineration	Bio-based waste plastic mixture, landfilling
Transparent PA (Polyamide)	No recycling group	No recycling	Plastic, mixture, incineration	Plastic, mixture, landfilling
Transparent PA (Polyamide), from castor oil, 62% bio-based	No recycling group	No recycling	Bio-based waste plastic mixture, incineration	Bio-based waste plastic mixture, landfilling

5.4. Recyclability

5.4.1. At packaging level

The topic of recyclability is complex, as guidelines and practices may vary significantly from one region to another while evolving rapidly. While the topic has been addressed by the SPICE initiative, there is no harmonized guidelines for the cosmetics industry at global level on the matter.

That is why currently, the user of the tool is responsible for indicating if the packaging (either primary or secondary) is recyclable, depending on its specific context.

5.4.2. At material level

The SPICE Tool, considers a level of recycling for some materials, captured in the database of the SPICE Tool as the recycling rate (R2). The recycling rates apply to groups of material as presented in the following table. The detailed end-of-life scenarios for each of those groups are presented in section 5.11.1 page 65.

Table 8 – Material Groups used in the SPICE Tool

Material Group for End-of-Life	Comment
Glass group	Assumption: there is a recycling stream in practice and at scale
Steel group	Assumption: there is a recycling stream in practice and at scale
Aluminium group	Assumption: there is a recycling stream in practice and at scale
Wood group	Assumption: there is a recycling stream in practice and at scale
Paper and cardboard group	Assumption: there is a recycling stream in practice and at scale
PE group	Assumption: there is a recycling stream in practice and at scale
PP group	Assumption: there is a recycling stream in practice and at scale
PET group	Assumption: there is a recycling stream in practice and at scale
No recycling group	All other materials, for which it is assumed that there are no recycling streams in practice and at scale

Note: this Table gathers global coverage of end-of-life scenarios, due to the international nature of the tool. However, there might be some significant differences between geographic zones.

5.5. Biogenic carbon

5.5.1. Links with standards

There are severable ways to take into account biogenic carbon into life cycle assessment. Regarding the short-term emissions of biogenic carbon flows, SPICE follows the PEF guidelines [1], namely to consider a carbon neutral approach (no characterization of biogenic carbon emitted or captured as CO_2).

PEF however recently (December 2021) changed its requirement on long-term storage of biogenic carbon, and requires not to take it into account while waiting for additional scientific developments. Long-term storage of biogenic carbon is defined by ISO 14067 [27], but applies to long-lasting products (e.g. wood in buildings).

The SPICE methodology considers capture for long-term storage, and applies the concept for the fraction of the packaging materials that are landfilled and not degraded, as detailed in the following section.

5.5.2. Accounting in SPICE Tool

Biogenic carbon is considered in the SPICE Tool according to the carbon neutral approach, as described below:

- The **biogenic carbon uptake** arising from the **biomass growth is not considered** in the raw materials production.
- The **biogenic carbon emission** arising from the **incineration** of the bio-based fraction of materials is **not considered**.

Carbon storage and degradation as methane is assumed for **landfilling**, applying the following assumptions:

- Fossil and mineral materials (non-biodegradable plastics, metals, glass): no carbon storage and no degradation assumed.
- Paper and cardboard:
  - Biogenic Carbon content considered: 44% of mass[7]
  - Biogenic Carbon storage: 73% of carbon biogenic content[8], characterized as carbon uptake.
  - Biogenic Carbon released: 27% of carbon content
    - of which 50% released as CO_2: 13.5% of material biogenic carbon content, not characterized.

[7] Stoichiometric value for cellulose.

[8] his value is chosen based on ecoinvent 3.8 data for graphical paper landfill (27% degradation in 100 years), which is in line with [25]

        - of which 50% released as CH_4: 13.5% of material biogenic carbon content, characterized as biogenic methane.
- Bio-based PE:
    - Biogenic Carbon content considered: 85.6 % of mass[9]
    - Biogenic Carbon storage: 100% of carbon biogenic content, characterized as carbon uptake.
    - Biogenic Carbon released: 0% of carbon content
- Bio-based MEG PET:
    - Biogenic Carbon content considered: 12.5 % of mass (23% of MEG in PET, 55% of Carbon in MEG when polymerized)[10]
    - Biogenic Carbon storage: 100% of biogenic carbon content, characterized as carbon uptake.
    - Biogenic Carbon released: 0% of biogenic carbon content
- Bio-based PLA:
    - Biogenic Carbon content considered: 50% of mass[11]
    - Biogenic Carbon storage: 95% of biogenic carbon content, characterized as carbon uptake.
    - Biogenic Carbon released: 5% of biogenic carbon content[12]
        - of which 50% released as CO_2: 2.5% of material biogenic carbon content, not characterized.
        - of which 50% released as CH_4: 2.5% of material biogenic carbon content, characterized as biogenic methane.
- Other Bio-based plastics (Cellophane, Bio-based PHA, Bio-based PBS):
    - Biogenic Carbon content considered: 50% of mass[13]
    - Biogenic Carbon storage :50% of biogenic carbon content[14], characterized as carbon uptake.
    - Biogenic Carbon released: 50% of biogenic carbon content
        - of which 50% released as CO_2:25% of material biogenic carbon content, not characterized.
        - of which 50% released as CH_4: 25% of material biogenic carbon content, characterized as biogenic methane.
- Wood:
    - Biogenic Carbon content considered: 50% of dry mass[15]

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[9] Stoichiometric value for PE.
[10] Stoichiometric value for MEG when polymerized into PET, C_2H_4O instead of $C_2H_6O_2$.
[11] Stoichiometric value for PLA.
[12] This is assuming a low degradation rate of PLA in landfill, in absence of sufficient temperature to initiate the hydrolysis. It is based on [20] but assuming a bit more degradation.
13 Approximation
14 Approximation
15 Generic approximation confirmed in a synthesis by [21]

- Biogenic Carbon storage: 95% of biogenic carbon content[16], characterized as carbon uptake.
- Biogenic Carbon released: 5% of carbon content:
    - of which 50%[17] released as CO_2: 2.5% of material biogenic carbon content, not characterized.
    - of which 50% released as CH_4: 2.5% of material biogenic carbon content, characterized as biogenic methane.

16 This value is chosen based on ecoinvent 3.8 data for wood landfill (1.5% degradation in 100 years) and assuming a less optimistic conservation of the cellulose based on [25].
17 The fraction between CH_4 and CO_2 is based on [22], vol 5, chap 3. It is slightly pessimistic since it ignores potential oxidation during migration across the soil into the atmosphere.

5.6. Processes

5.6.1. Converting processes

Converting processes correspond to processes that transform a semi-finished raw material (metal ingot, polymer granulate etc.) into a packaging component (e.g. a can or a jar).

When selecting a converting process, the tool considers the electricity mix of the production zone of the component that is being described.

5.6.2. Finishing processes

Finishing and decoration processes are included in the system boundary. The quantification of the potential impacts of finishing and decoration processes is scaled to the decorated surface.

When selecting a finishing process, the tool considers the electricity mix of the production zone of the component that is being described.

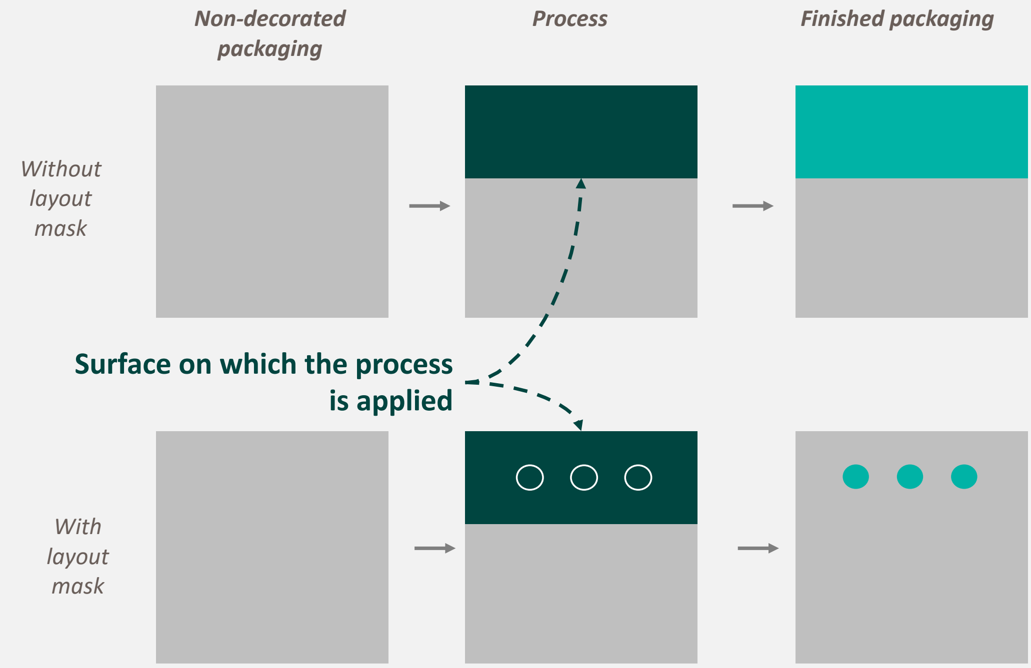
FOCUS BOX – Decorated surface

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.

5.7. Upstream transport scenarios

The following table presents the transport data that is considered in the tool regarding the transport from supplier to finished product manufacturing site.

Source: Average values representative of surveyed SPICE Corporate Members, 2020, with assumption that no plane is used during upstream transport.

Table 9 – Upstream transport scenarios used in the SPICE Tool

Transport scenario	Distance by Truck (km)	Distance by Train (km)	Distance by Boat (km)	Distance by Plane (km)
Europe <-> Europe	1165	151	17	0
Europe <-> Asia	797	15	14771	0
Europe <-> North America	1136	167	6889	0
Europe <-> South America	859	10	9042	0
Europe <-> Africa	695	10	5053	0
Europe <-> Middle East	683	10	4218	0
Asia <-> Asia	621	6	3975	0
Asia <-> North America	1211	163	11763	0
Asia <-> South America	1020	6	18817	0
Asia <-> Africa	672	6	6592	0
Asia <-> Middle East	827	6	6592	0
North America <-> North America	1998	411	560	0
North America <-> South America	1249	157	6172	0
North America <-> Africa (*)	902	157	10908	0
North America <-> Middle East (*)	902	157	58892	0
South America <-> South America	789	0	17455	0

Transport scenario	Distance by Truck (km)	Distance by Train (km)	Distance by Boat (km)	Distance by Plane (km)
South America <-> Africa (*)	711	0	11566	0
South America <-> Middle East (*)	711	0	11566	0
Africa <-> Africa (*)	312	0	1928	0
Africa <-> Middle East (*)	312	0	1928	0
Middle East <-> Middle East	246	0	1928	0
Global <-> Global	848	68	10030	0
Global <-> Europe	834	42	7995	0
Global <-> Asia	905	39	11707	0
Global <-> North America	1080	160	18925	0
Global <-> South America	910	34	11433	0
Global <-> Africa	658	34	7209	0
Global <-> Middle East	687	34	16639	0
	500	0	0	0

Note: for some scenarios marked with (*), the distinction between Africa and Middle East was not possible, so the same values apply to both scenarios.

5.8. Distribution: transport scenarios

The following table presents the transport data that is considered in the tool regarding the transport from finished product manufacturing site to retailers. The relevant transport scenario is automatically applied, depending on the locations input by the user in the tool. A survey was circulated among SPICE Members in order to identify the average situation for a given product travelling from a zone (e.g. Asia) to another zone (e.g. North America), expressed as an average distance per transport type. The replies from members have been consolidated and averaged in order to obtain the following transport scenarios.

Source: Average values representative of surveyed SPICE Corporate Members, 2020

Table 10 – Distribution transport scenarios used in the SPICE Tool

Transport scenario	Distance by Truck (km)	Distance by Train (km)	Distance by Boat (km)	Distance by Plane (km)
Europe <-> Europe	1165	151	17	1
Europe <-> Asia	797	15	14771	345
Europe <-> North America	1136	167	6889	422
Europe <-> South America	859	10	9042	578
Europe <-> Africa	695	10	5053	294
Europe <-> Middle East	683	10	4218	231
Asia <-> Asia	621	6	3975	90
Asia <-> North America	1211	163	11763	329
Asia <-> South America	1020	6	18817	533
Asia <-> Africa	672	6	6592	194
Asia <-> Middle East	827	6	6592	192
North America <-> North America	1998	411	560	24
North America <-> South America	1249	157	6172	402
North America <-> Africa (*)	902	157	10908	654
North America <-> Middle East (*)	902	157	58892	592

Transport scenario	Distance by Truck (km)	Distance by Train (km)	Distance by Boat (km)	Distance by Plane (km)
South America <-> South America	789	0	17455	341
South America <-> Africa (*)	711	0	11566	708
South America <-> Middle East (*)	711	0	11566	708
Africa <-> Africa (*)	312	0	1928	12
Africa <-> Middle East (*)	312	0	1928	12
Middle East <-> Middle East	246	0	1928	9
Global <-> Global	848	68	10030	318
Global <-> Europe	834	42	7995	374
Global <-> Asia	905	39	11707	319
Global <-> North America	1080	160	18925	480
Global <-> South America	910	34	11433	586
Global <-> Africa	658	34	7209	372
Global <-> Middle East	687	34	16639	347

Note: for some scenarios marked with (*), the distinction between Africa and Middle East was not possible, so the same values apply to both scenarios.

5.9. Distribution: storage

This life cycle stage corresponds to the operation of the distribution center and of the point of sale.

Table 11 – Distribution storage assumptions

Description	Value	Unit	Source
Electricity consumption at the distribution center	0.14	Wh/product	Cosmetics Europe (2017) [5]
Electricity consumption at point of sale	81.7	Wh/product	

5.10. Distribution: consumer transport

This life cycle stage corresponds to the transport of the consumer to buy the product at the point of sale.

Table 12 – Consumer transport assumptions

Description	Value	Unit	Source
Average distance per trip	4	km	Cosmetics Europe (2017) [5]
Share of trips that are done by car	80%	/	Cosmetics Europe (2017) [5]
Allocation of car trip to cosmetic packaging	1/200	/	PEF guidance [1], assuming 1L size per packaging and a 200 L trunk

The remaining 20% of shopping trips are assumed to be done by bus, bike and walking; as a matter of simplification, the potential impacts for this part are neglected (Cosmetics Europe (2017) [5]).

5.11. End-of-life modeling

5.11.1. End-of-life scenarios

This section presents the end-of-life scenarios considered in the SPICE Tool, for each group of material. For specific description on the accounting of recycling, see section 5.3 page 47.

Notes:

- if the user specifies a country as the “Sales zone”, the zone that corresponds to the country is considered (e.g., if France is selected, the European scenario is applied).
- “Non-recyclable material” group corresponds to materials for which there is no recycling stream in practice and at scale, as defined in section 5.4.2 page 54.
- The global scenario corresponds to a weighted average of the scenarios per region, based on population.

Sources:

- Europe: European Commission, PEF Guidance [1], Annex C (Annex C_CFF_Default Parameters_October2019.xlsx)
- USA:
    - Recycling rate per material and repartition of different MSW treatment: US EPA
- Canada:
    - MSW generation: Statcan [13]
    - Recycling rate: Statcan [14]
    - MSW generation and composition: Waste Atlas [15]
    - Repartition of Waste treatment: Canadian Council of Ministers of Environment [16]
- Japan:
    - Repartition waste MSW treatment: UNstats
    - MSW generation and composition Waste Atlas, http://www.atlas.d-waste.com/, 2012
    - Repartition of MSW by type of material: Mahajan Niyati, A Comparative Study of Municipal Solid Waste Management in India and Japan, Vol 25, 2015
    - Wood data: Yasushi Hiramatsu and al, Present State of Wood Waste Recycling and a New Process for Converting Wood Waste into Reusable Wood Materials, Vol 43. No.3, 2002
    - Information in MSW treatment technology: John Olmsted, Japan's Recycling: More Efficient than U.S.A
    - The Japan Containers and Packaging Recycling Association statistics (JCPRA)
- Other zones:
    - Repartition of MSW treatment per country: UNStats

Table 13 – End of life scenarios by Zone and Material Group

Zone	Material Group for End-of-Life	Recycling	Incineration (with energy recovery)	Incineration (without energy recovery)	Landfilling	Efficiency factor of energy recovery - electricity	Efficiency factor of energy recovery - heat
		(%)	*(%)*	*(%)*	*(%)*	*dimensionless*	*dimensionless*
Europe	Glass	66%	19%	0%	15%	0.10	0.31
Europe	Steel	74%	15%	0%	12%	0.10	0.31
Europe	Aluminium	69%	17%	0%	14%	0.10	0.31
Europe	Wood	30%	39%	0%	32%	0.10	0.31
Europe	Paper and cardboard	75%	14%	0%	11%	0.10	0.31
Europe	PE	29%	39%	0%	32%	0.10	0.31
Europe	PP	29%	39%	0%	32%	0.10	0.31
Europe	PET	42%	32%	0%	26%	0.10	0.31
Europe	Non-recyclable material	0%	55%	0%	45%	0.10	0.31
Africa	Glass	0%	0%	1%	99%	0.10	0.31
Africa	Steel	0%	0%	1%	99%	0.10	0.31
Africa	Aluminium	0%	0%	1%	99%	0.10	0.31
Africa	Wood	0%	0%	1%	99%	0.10	0.31
Africa	Paper and cardboard	0%	0%	1%	99%	0.10	0.31
Africa	PE	0%	0%	1%	99%	0.10	0.31
Africa	PP	0%	0%	1%	99%	0.10	0.31
Africa	PET	0%	0%	1%	99%	0.10	0.31
Africa	Non-recyclable material	0%	0%	1%	99%	0.10	0.31
Asia	Glass	2%	9%	0%	89%	0.10	0.31
Asia	Steel	4%	7%	0%	89%	0.10	0.31
Asia	Aluminium	4%	7%	0%	89%	0.10	0.31
Asia	Wood	4%	7%	0%	89%	0.10	0.31
Asia	Paper and cardboard	1%	10%	0%	89%	0.10	0.31
Asia	PE	2%	9%	0%	89%	0.10	0.31
Asia	PP	2%	9%	0%	89%	0.10	0.31
Asia	PET	2%	9%	0%	89%	0.10	0.31
Asia	Non-recyclable material	0%	10%	1%	90%	0.10	0.31
Middle East	Glass	0%	0%	12%	88%	0.10	0.31

Zone	Material Group for End-of-Life	Recycling	Incineration (with energy recovery)	Incineration (without energy recovery)	Landfilling	Efficiency factor of energy recovery - electricity	Efficiency factor of energy recovery - heat
		(%)	*(%)*	*(%)*	*(%)*	*dimensionless*	*dimensionless*
Middle East	Steel	0%	0%	12%	88%	0.10	0.31
Middle East	Aluminium	0%	0%	12%	88%	0.10	0.31
Middle East	Wood	0%	0%	12%	88%	0.10	0.31
Middle East	Paper and cardboard	0%	0%	12%	88%	0.10	0.31
Middle East	PE	0%	0%	12%	88%	0.10	0.31
Middle East	PP	0%	0%	12%	88%	0.10	0.31
Middle East	PET	0%	0%	12%	88%	0.10	0.31
Middle East	Non-recyclable material	0%	0%	12%	88%	0.10	0.31
North America	Glass	21%	9%	0%	70%	0.10	0.31
North America	Steel	25%	8%	0%	67%	0.10	0.31
North America	Aluminium	25%	8%	0%	67%	0.10	0.31
North America	Wood	10%	10%	0%	80%	0.10	0.31
North America	Paper and cardboard	43%	4%	0%	53%	0.10	0.31
North America	PE	7%	11%	0%	82%	0.10	0.31
North America	PP	7%	11%	0%	82%	0.10	0.31
North America	PET	7%	11%	0%	82%	0.10	0.31
North America	Non-recyclable material	0%	12%	0%	88%	0.10	0.31
South America	Glass	6%	0%	0%	94%	0.10	0.31
South America	Steel	6%	0%	0%	94%	0.10	0.31
South America	Aluminium	6%	0%	0%	94%	0.10	0.31
South America	Wood	6%	0%	0%	94%	0.10	0.31
South America	Paper and cardboard	6%	0%	0%	94%	0.10	0.31

Zone	Material Group for End-of-Life	Recycling	Incineration (with energy recovery)	Incineration (without energy recovery)	Landfilling	Efficiency factor of energy recovery - electricity	Efficiency factor of energy recovery - heat
		(%)	*(%)*	*(%)*	*(%)*	*dimensionless*	*dimensionless*
South America	PE	6%	0%	0%	94%	0.10	0.31
South America	PP	6%	0%	0%	94%	0.10	0.31
South America	PET	6%	0%	0%	94%	0.10	0.31
South America	Non-recyclable material	0%	0%	5%	95%	0.10	0.31
Global	Glass	9%	7%	1%	83%	0.10	0.31
Global	Steel	11%	6%	1%	83%	0.10	0.31
Global	Aluminium	11%	6%	1%	83%	0.10	0.31
Global	Wood	7%	8%	1%	84%	0.10	0.31
Global	Paper and cardboard	11%	7%	1%	81%	0.10	0.31
Global	PE	5%	9%	1%	85%	0.10	0.31
Global	PP	5%	9%	1%	85%	0.10	0.31
Global	PET	5%	9%	1%	85%	0.10	0.31
Global	Non-recyclable material	0%	11%	1%	88%	0.10	0.31

5.11.2. Energy recovery rates

Source for efficiency factors of energy recovery: European Commission, PEF Guidance [1], Annex C (Annex C_CFF_Default Parameters_October2019.xlsx)

Table 14 – Default values for energy recovery rates

Type of energy recovery	Recovery rate
Efficiency factor of energy recovery – electricity	10%
Efficiency factor of energy recovery – heat	31%

5.11.3. CFF parameters by material

Source for parameters A, B, Qsin/Qp and Qsout/Qp: European Commission, PEF Guidance [1], Annex C (Annex C_CFF_Default Parameters_October2019.xlsx), with extrapolation to similar materials when not available. The parameters linked to each type of Packaging Material, which come from European sources, are considered as a proxy for Global values.

Source for Lower Heating Values: primarily ecoinvent incineration datasets [8].

The material group for End-of-life has been applied to each material following the principles mentioned in section 5.4.2, page 54.

Table 15 – CFF parameters by material

Type of Packaging Material	Material Group for End-of-Life	Packaging Material	A	B	Lower Heating Value (Wh/g)	*Qsin/Qp*	*Qsout/Qp*
Glass	Glass	Glass	0.2	0	0.0	1	1
Metals	Steel	Stainless steel	0.2	0	0.0	1	1
Metals	Steel	Steel	0.2	0	0.0	1	1
Metals	Aluminium	Aluminium	0.2	0	0.0	1	1
Metals	Steel	Tin	0.2	0	0.0	1	1
Other Materials	Wood	Wood	0.8	0	3.9	0.75	0.75
Other Materials	Wood	Medium Density Fiberboard	0.2	0	3.9	0.75	0.75
Paper/Cardboard	Paper and cardboard	Solid Bleached Board	0.2	0	4.4	0.85	0.85
Paper/Cardboard	Paper and cardboard	Solid Unbleached Board	0.2	0	4.4	0.85	0.85
Paper/Cardboard	Paper and cardboard	Folding Box Board	0.2	0	4.4	0.85	0.85
Paper/Cardboard	Paper and cardboard	Folding Box Board, white lined	0.2	0	4.4	0.85	0.85
Paper/Cardboard	Paper and cardboard	Paper, woodfree, coated	0.2	0	3.9	0.85	0.85
Paper/Cardboard	Paper and cardboard	Paper, wood containing, coated	0.2	0	3.9	0.85	0.85
Paper/Cardboard	Paper and cardboard	Corrugated Board Box	0.2	0	4.4	0.85	0.85

Type of Packaging Material	Material Group for End-of-Life	Packaging Material	A	B	Lower Heating Value (Wh/g)	*Qsin/Qp*	*Qsout/Qp*
Plastics/Polymers	PE	HDPE (Polyethylene, high density)	0.5	0	11.8	1	1
Plastics/Polymers	PP	PP (Polypropylene)	0.5	0	9.1	1	1
Plastics/Polymers	Non-recyclable material	Synthetic rubber	0.5	0	10.0	0.75	0.75
Plastics/Polymers	Non-recyclable material	PTFE (Polytetrafluoroethylene)	0.5	0	5.3	0.75	0.75
Plastics/Polymers	PE	LLDPE (Polyethylene. linear low density)	0.5	0	12.8	1	1
Plastics/Polymers	PE	LDPE (Polyethylene. low density)	0.5	0	12.8	0.75	0.75
Plastics/Polymers	PET	PET (Polyethylene terephtalate)	0.5	0	6.4	1	1
Plastics/Polymers	Non-recyclable material	PS (Polystyrene)	0.5	0	10.7	0.75	0.75
Plastics/Polymers	Non-recyclable material	PMMA (Polymethyl methacrylate)	0.5	0	6.7	0.75	0.75
Plastics/Polymers	Non-recyclable material	PVDC (Polyvinyldenchloride)	0.5	0	5.3	0.75	0.75
Plastics/Polymers	Non-recyclable material	PC (Polycarbonate)	0.5	0	8.1	0.75	0.75
Plastics/Polymers	Non-recyclable material	PU (Polyurethane)	0.5	0	8.5	0.75	0.75
Plastics/Polymers	Non-recyclable material	Melamine formaldehyde rsein	0.5	0	5.3	0.75	0.75
Plastics/Polymers	Non-recyclable material	Epoxy resin	0.5	0	5.3	0.75	0.75
Plastics/Polymers	Non-recyclable material	Nylon 6	0.5	0	11.7	0.75	0.75
Plastics/Polymers	Non-recyclable material	SAN (Styrene Acrylonitrile)	0.5	0	5.3	0.75	0.75
Plastics/Polymers	Non-recyclable material	ABS (Acrylonitrile-butadiene-styrene)	0.5	0	10.0	0.75	0.75
Plastics/Polymers	Non-recyclable material	POM (Polyoxymethylene)	0.5	0	5.3	0.75	0.75
Plastics/Polymers	Non-recyclable material	EVA (Ethylene vinyl acetate)	0.5	0	5.3	0.75	0.75
Plastics/Polymers	PE	LDPE film (Polyethylene. low density)	0.5	0	12.5	0.75	0.75

Type of Packaging Material	Material Group for End-of-Life	Packaging Material	A	B	Lower Heating Value (Wh/g)	*Qsin/Qp*	*Qsout/Qp*
Plastics/Polymers	Non-recyclable material	PCT (Polycyclohexylenedimethylene Terephthalate)	0.5	0	6.4	1	1
Plastics/Polymers	Non-recyclable material	PCTG (Glycol-Modified Polycyclohexylenedimethylene Terephthalate)	0.5	0	6.4	1	1
Plastics/Polymers	Non-recyclable material	PBT (Polybutylene)	0.5	0	6.4	1	1
Plastics/Polymers	Non-recyclable material	PK (Polyketone)	0.5	0	7.8	1	1
Other Materials	Non-recyclable material	Cotton, woven	0.8	0	4.7	0.75	0.75
Other Materials	Non-recyclable material	Plastic pump, average composition	0.5	0	9.1	0.75	0.75
Other Materials	Non-recyclable material	Fragrance pump, average composition	0.5	0	9.1	0.75	0.75
Other Materials	Non-recyclable material	Magnet	0.5	0	0.0	0.75	0.75
Metals	Non-recyclable material	Zamak	0.5	0	0.0	0.75	0.75
Other Materials	Non-recyclable material	Mirror	0.5	0	0.0	0.75	0.75
Plastics/Polymers	Non-recyclable material	Cellulose Acetate	0.5	0	12.8	0.75	0.75
Metals	Non-recyclable material	Brass	0.5	0	0	0.75	0.75
Other Materials	Non-recyclable material	Ceramics	0.5	0	0	0.75	0.75
Plastics/Polymers	Non-recyclable material	PVC	0.5	0	6.0	0.75	0.75
Plastics/Polymers	Non-recyclable material	Latex	0.5	0	11.0	0.75	0.75
Plastics/Polymers	Non-recyclable material	Surlyn	0.5	0	12.8	0.75	0.75
Plastics/Polymers	Non-recyclable material	EVOH	0.5	0	12.8	0.75	0.75
Plastics/Polymers	Non-recyclable material	SEBS	0.5	0	12.8	0.75	0.75
Plastics/Polymers	Non-recyclable material	MBS	0.5	0	12.8	0.75	0.75
Other Materials	Non-recyclable material	Leather	0.5	0	4.6	0.75	0.75
Other Materials	Non-recyclable material	Neodymium oxide	0.2	0	0	0.75	0.75

Type of Packaging Material	Material Group for End-of-Life	Packaging Material	A	B	Lower Heating Value (Wh/g)	*Qsin/Qp*	*Qsout/Qp*
Plastics/Polymers	Non-recyclable material	PETG (Polyethylene terephthalate glycol-modified)	0.5	0	6.4	0.75	0.75
Plastics/Polymers	PET	PET, bottle grade (Polyethylene terephthalate)	0.5	0	6.4	1	1
Plastics/Polymers	PE	HDPE, from sugar cane	0.5	0	11.8	1	1
Plastics/Polymers	Non-recyclable material	PA1010 (Polyamide), from castor oil	0.5	0	11.7	0.8	0.8
Plastics/Polymers	Non-recyclable material	TREVA bioplastic, from cellulose, 45% biobased	0.5	0	5.3	0.8	0.8
Plastics/Polymers	PE	LDPE (Polyethylene, low density), from biomass residues	0.5	0	12.8	0.8	0.8
Plastics/Polymers	PP	PP (Polypropylene), from biomass residues	0.5	0	9.1	1	1
Plastics/Polymers	Non-recyclable material	PA11 (Polyamide), for extrusion, from castor oil	0.5	0	5.3	0.8	0.8
Plastics/Polymers	Non-recyclable material	PA11 (Polyamide), for injection, from castor oil	0.5	0	5.3	0.8	0.8
Plastics/Polymers	Non-recyclable material	Transparent PA (Polyamide)	0.5	0	5.3	0.8	0.8
Plastics/Polymers	Non-recyclable material	Transparent PA (Polyamide), from castor oil, 62% bio-based	0.5	0	5.3	0.8	0.8

5.12. Tertiary Packaging default data

Source: Average values representative of surveyed SPICE Corporate Members, 2021.

Table 16 – Default values for tertiary packaging

Component	Quantity	Unit
Plastic film	0.00126	g per g of transported item
Corrugated cardboard	0.0614	g per g of transported item
Wood pallet	0.0824	g per g of transported item
Number of pallet usage	10	usages (or “rotations”)

5.13. Other methodological choices

5.13.1. Electricity mixes and energy certificates

As SPICE is mainly addressed to packaging designers, the choices that user can make should reflect the options that are available at a design chase. In that perspective, the material database aims to capture a global average of the market for the materials, as opposed to supplier specific data.

Therefore, in the SPICE Database, regarding materials:

- datasets on material production and end-of-life use as far as possible global average consumptions grid mixes.
- Renewable energy certificates are not considered in the life cycle inventory.

In the SPICE Tool, users can apply different country specific electricity consumption grid mixes for some life cycle stages. The following table presents the type of approach for Life Cycle Stages including electricity consumption.

Table 17 – Type of electricity mixes per life cycle stages

Life cycle stages	Unit processes using electricity	Type of electricity mix	Comment
Raw Material production	Production of primary and secondary materials	Target: Global Average consumption grid mix (In practice: Mostly global or European representativeness)	Lack of LCI with Global representativeness
Packaging components production	Transformation/Converting processes	Country or region-specific consumption grid mix, depending on component's production zone defined by user	The location of the supplier (and thus the electricity mix) is usually not a design lever for the designer. Thus, a global value for electricity should be used to compare design choices. However, the SPICE Tool also provides regionalized grid mixes for companies that want to be representative of their actual supply chain.
Packaging components finishing	Finishing/Decoration processes	Country or region-specific consumption grid mix, depending on component's production zone defined by user	
Distribution and storage	Storage at Distribution Centre	Average consumption grid mix, depending on Sales zone defined by user	This level of geographical resolution has been chosen because these life cycle steps are not a major contributor, and the Sales zone is usually known early in the development process,
	Storage at Retail	Average consumption grid mix, depending on Sales zone defined by user	
End-of-life	Recycling of packaging	Target: Global Average consumption grid mix (In practice: Mostly global or European representativeness)	Lack of LCI with Global representativeness
	Incineration of packaging with energy recovery	For recovered electricity: Country or region-specific consumption grid mix, depending on Sales zone defined by user	This level of geographical resolution has been chosen because these life cycle steps are not a major contributor, and the Sales zone is usually known early in the development process,

	Incineration of packaging without energy recovery	Target: Global Average consumption grid mix (In practice: Mostly global or European representativeness)	Lack of LCI with Global representativeness
	Landfilling of packaging	Target: Global Average consumption grid mix (In practice: Mostly Swiss representativeness)	Lack of LCI with Global representativeness

5.13.2. Mass balance

Currently there is no material within the SPICE Tool whose life cycle inventory relies on a mass-balance approach.

Should such a material be integrated in the SPICE Tool, a preliminary assessment on the modeling approach and the claim substantiation will have to be made to avoid any misleading results.

5.14. Data quality requirements

Foreground processes and data sources have been assessed based on time-related coverage, geographical coverage, technology coverage, precision, completeness, representativeness, consistency, reproducibility, reliability of data source and uncertainty of the information as prescribed in ISO 14044 [3]. The structure of the pedigree matrix is the one from the ecoinvent database [24], as presented hereafter.

Table 18 – Pedigree matrix used data quality assessment

Indicator score	1	2	3	4	5
Reliability	Verified data based on measurements	Verified data partly based on assumptions or non-verified data based on measurements	Non-verified data partly based on qualified estimates	Qualified estimate (e.g. by industrial expert)	Non-qualified estimate
Completeness	Representative data from all sites relevant to the market considered, over an adequate period to even out normal fluctuations	Representative data from >50 of the sites relevant for the market considered, over an adequate period to even out normal fluctuations	Representative data from only some sites (<<50) relevant for the market considered or >50 of sites but from shorter periods	Representative data from only one sites relevant for the market considered or some sites but from shorter periods	Representativeness unknown or incomplete data from a smaller number of sites and from shorter periods
Temporal correlation	Less than 3 years of difference to the time-period of the dataset	Less than 6 years difference to the time-period of the dataset	Less than 10 years difference to the time-period of the dataset	Less than 15 years difference to the time-period of the dataset	Age of data unknown or more than 15 years of difference to the time-period of the dataset
Geographical correlation	Data from area under study	Average data from larger area in which the area under study is included	Data from area with similar production conditions	Data from area with slightly similar production conditions	Data from unknown or distinctly different area
Further technological correlation	Data from enterprises, processes and materials under study	Data from processes and materials under study but from different enterprises	Data from processes and materials under study but from different technology	Data on related processes or materials	Data on related processes on laboratory scale or from different technology

The data quality assessment results are presented in section 10.3 page 93, which lists all life cycle processes integrated in the database of the tool and their ratings.

The total data quality rating (DQR) is calculated as the average of the ratings attributed to each of the five criteria. In order to be used in the SPICE Tool database, a dataset must have a total DQR of 3 or under and be methodologically consistent with the rest of the database.

6. Life Cycle Impact Assessment

6.1. Impact Categories and characterization methods

The SPICE Tool relies on the set of midpoint impact categories and LCIA methods recommended by the European Commission in the frame of the PEF initiative in the PEF Guidance [1]. The following table presents the impact categories and associated LCIA methods.

Table 19 – Impact categories and LCIA methods used in the SPICE Tool

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). Note: the method has been completed with stratospheric CO_2 emission characterization using the approach defined in [23]
Ozone depletion	Ozone Depletion Potential (ODP)	kg CFC-11 eq	Steady-state ODPs as in (WMO 2014 + integrations)
Human toxicity, cancer	Comparative Toxic Unit for humans (CTUh)	CTUh	USEtox model 2.1 (Fankte et al, 2017)
Human toxicity, non-cancer	Comparative Toxic Unit for humans (CTUh)	CTUh	USEtox model 2.1 (Fankte et al, 2017)
Particulate matter	Impact on human health	disease incidence	PM method recommended by UNEP (UNEP 2016)
Ionizing 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)
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 2.1 (Fankte et al, 2017)

Impact category	Indicator	Unit	LCIA method
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)

6.2. Normalization and weighting factors for single score calculation

In addition to individual impact categories, the SPICE Tool provides an environmental single score. This environmental single score aims at facilitating decision making but does not replace the set of midpoint indicators.

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.

The SPICE Tool allows user to display both the single score results as well as the individual indicators results.

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

Note: 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 the tool is intended in the context of providing information in decision-making for packaging designers and not for a direct communication to the public.

The following figure presents the principle of the environmental single score calculation.

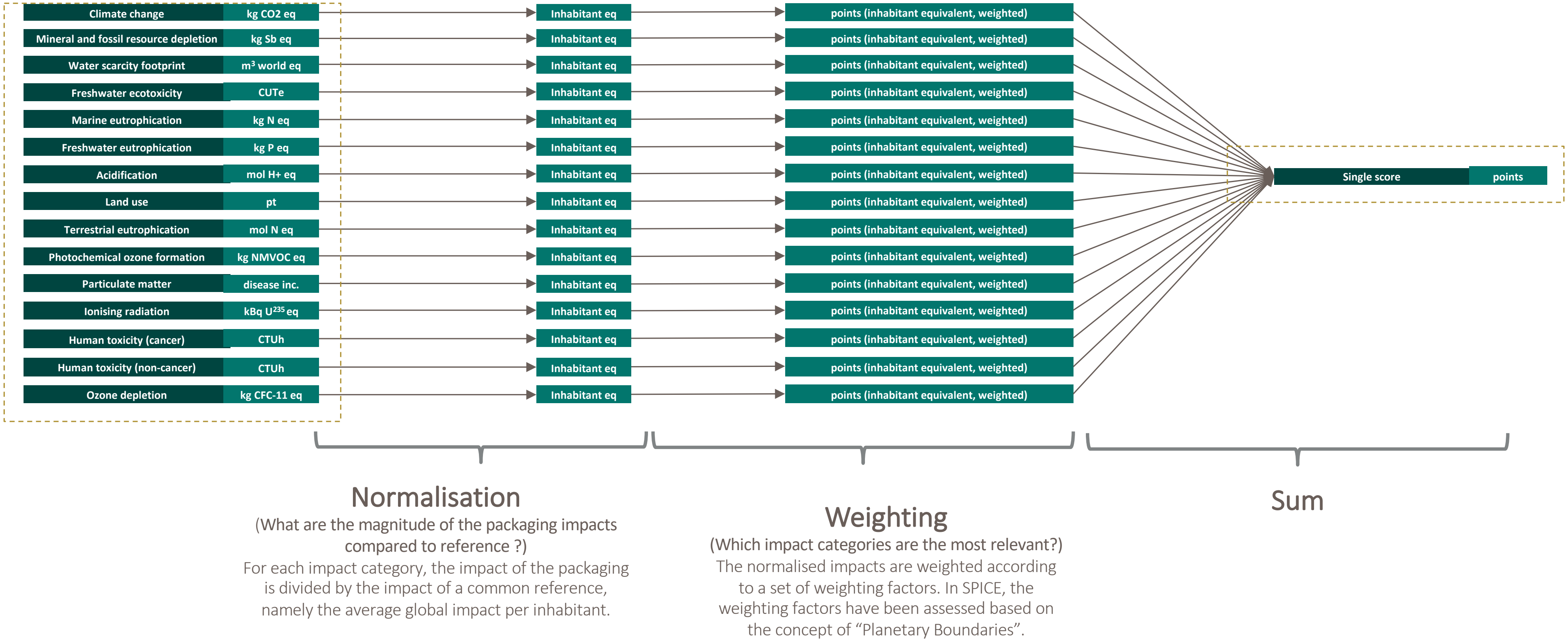


Figure 6 – Overview of the single score calculation

6.2.1. Global normalization values

The normalization values used in the SPICE Tool are representative of the yearly impact on Earth for each indicator, divided by the world population.

Source: Normalization factors for the Environmental Footprint Reference Package 3.0 [7].

Table 20 – Normalization values used in the SPICE Tool

Impact category	Normalization value	Unit
Normalisation value for Climate Change	8,10E+03	kg CO_2-eq per person
Normalisation value for Ozone Depletion	5,36E-02	kg CFC-11 eq per person
Normalisation value for Ionising Radiation	4,22E+03	kg U^{235} eq (to air) per person
Normalisation value for Photochemical Ozone Formation	4,06E+01	kg NMVOC-eq per person
Normalisation value for Particulate Matter/Respiratory Inorganics	5,95E-04	disease inc. per person
Normalisation value for Human Toxicity, non-cancer	2,30E-04	CTUh per person
Normalisation value for Human Toxicity, cancer	1,69E-05	CTUh per person
Normalisation value for Acidification	5,56E+01	mol H^+ eq per person
Normalisation value for Freshwater Eutrophication	1,61E+00	kg P-eq per person
Normalisation value for Marine Eutrophication	1,95E+01	kg N-eq per person
Normalisation value for Terrestrial Eutrophication	1,77E+02	mol N-eq per person
Normalisation value for Ecotoxicity	4,27E+04	CTUe per person
Normalisation value for Land Transformation	8,19E+05	Pt per person
Normalisation value for Resource Depletion, energy carriers	6,50E+04	MJ per person
Normalisation value for Resource Depletion, mineral and metals	6,36E-02	kg Sb-eq per person
Normalisation value for Water Scarcity	1,15E+04	m^3 of water - eq per person

6.2.2. Planetary Boundaries weighting factors

The weighting factors used in the SPICE Tool have been developed based on the concept of "Planetary Boundaries". For each impact category, the yearly level of impact is compared to the boundary of the planet. The ratio between both corresponds to the exceedance factor. The higher above the boundary, the more weight the indicator will have, and conversely.

The planetary boundaries exceedance factors have been taken from Vargas et al, 2019 [9] and translated into weighting factors as presented in Figure 7, page 83.

Note: The SPICE Tool uses the Planetary Boundaries weighting factors however the Panel-based weighting factors (as proposed by the PEF Guidance [1]).

Table 21 – Weighting factors used in the SPICE Tool

Impact category	Weighting Factor	Unit
Weighting Factor for Climate Change	21.86%	dimensionless (%)
Weighting Factor for Ozone Depletion	0.65%	dimensionless (%)
Weighting Factor for Ionizing Radiation	0.035%	dimensionless (%)
Weighting Factor for Photochemical Ozone Formation	1.26%	dimensionless (%)
Weighting Factor for Particulate Matter	13.93%	dimensionless (%)
Weighting Factor for Human Toxicity, non-cancer	2.10%	dimensionless (%)
Weighting Factor for Human Toxicity, cancer	0.62%	dimensionless (%)
Weighting Factor for Acidification	1.24%	dimensionless (%)
Weighting Factor for Freshwater Eutrophication	7.53%	dimensionless (%)
Weighting Factor for Marine Eutrophication	1.29%	dimensionless (%)
Weighting Factor for Terrestrial Eutrophication	0,71%	dimensionless (%)
Weighting Factor for Ecotoxicity	1.98%	dimensionless (%)
Weighting Factor for Land Transformation	21.80%	dimensionless (%)
Weighting Factor for Resource Depletion, energy carriers	4.49%	dimensionless (%)
Weighting Factor for Resource Depletion, mineral and metals	19.33%	dimensionless (%)
Weighting Factor for Water Scarcity	1.20%	dimensionless (%)

The weighting factors proposed by the PEF [1] has not been retained in the tool for the following reasons:

- The planetary boundary approach seems a more science-based approach to assess the relative importance of environmental topics than a panel-based approach.
- A sensitivity analysis on the set of weighting factors showed that the influence on product ranking is limited [26].

6.2.1. Planetary boundaries derived weighting factors calculation principle

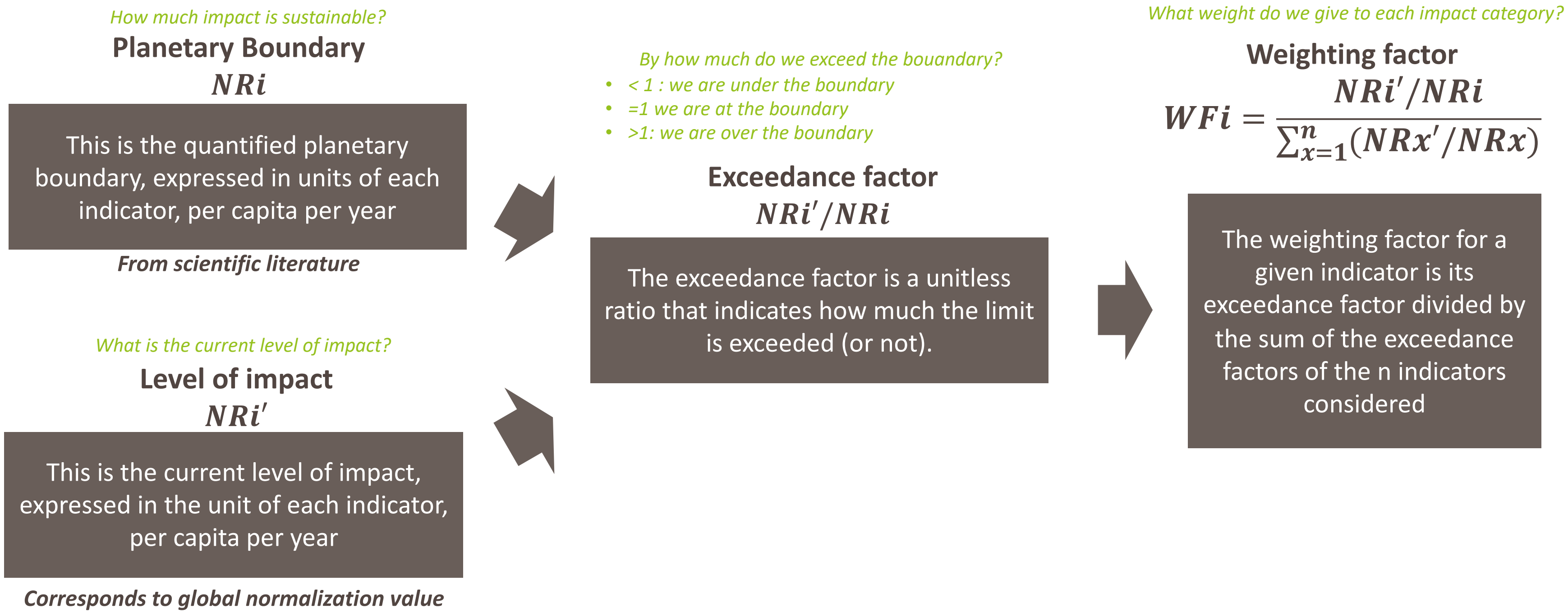


Figure 7 – Planetary-boundaries derived weighting factors calculation principle

Note: NRi and NRi' must be assessed using the same characterization methods in order for the exceedance factor to be meaningful. This is the case in the calculation for the set of weighting factors used in the SPICE Tool. Ideally, the characterization method should be the same as the one used in the LCIA assessment. While this is the case for most impact categories, it is not the case for:

- Land Use (which use soil organic matter for the exceedance factor calculation, whereas the LCIA used in SPICE tool is the LANCA method)
- Water scarcity (which use water consumption for the exceedance factor calculation, whereas the LCIA used in SPICE tool is Aware)
- Toxicity and ecotoxicity (which use USEtox v1.01 for the exceedance factor calculation, whereas the LCIA used in SPICE tool is USEtox EF3.0)

7. Limitations

It is important to understand how the methodology is designed so that the results generated by the tool are understood appropriately. The following limitations should be considered when interpreting the results.

7.1. Limitations of the Life Cycle Inventory

- The aim is to keep as much as possible a global perspective (notably on material production), as the location of production is generally not a design choice for packaging designers. However, a database with a 100% global representativeness and a high level of transparency and quality is not yet available. In order to tackle this, the SPICE Tool mainly relies on a transparent database with a good coverage, namely ecoinvent [8]. As such, some LCIs data implemented describe European operations, and consequently the database is not 100% representative of Global practices for materials manufacturing.
- On end-of-life:
    - Due to the international nature of the tool, it proposes a global coverage of end-of-life scenarios. For now, the tool uses an average per region (Europe, Asia etc.). However, there might be some significant differences between countries of the same continent. The possibility to apply an end-of-life scenario at country level will be considered as a future improvement of the tool.
    - While there are some significant differences between countries between end-of-life processes, some LCIs are taken as a proxy for global average, namely the LCIs of recycling that are mainly representative of Europe and the LCIs of landfilling, incineration and municipal waste collection truck that are mainly representative of Switzerland.
    - Parameters of the CFF, and notably the Qs/Qp ratios, are taken from the PEF [1] and have a European representativeness. They are used as a proxy of the Global situation.
    - Regarding accounting of long-term storage of biogenic carbon, the degradation rates are estimative and do not represent the variability of landfill condition.
- While effort has been to maintain consistency across the whole database, some LCIs come from different sources, as there are currently no database covering all the industry-specific activities.
- The transport scenarios are an average based on quite rough data shared by SPICE members, thus do not reflect the variability of potential transport routes for products.

The transport generally represents a minor contribution of the total impact, therefore much more accurate data are not to change the results significantly.

7.2. Limitations of the Life Cycle Impact Assessment

- Life cycle impact assessment results present potential and not actual environmental impacts. They are relative expressions, which are not intended to predict the final impact or risk on the natural media or whether standards or safety margins are exceeded. Additionally, these categories do not cover all the environmental impacts associated with human activities. Impacts such as noise, odors, electromagnetic fields and others are not included in the present assessment. The methodological developments regarding such impacts are not sufficient to allow for their consideration within life cycle assessment. Other impacts, such as potential benefits or adverse effects on biodiversity, are also only partly covered by current impact categories.
- Unlike environmental risk assessment conducted in a regulatory context, which uses a conservative approach, LCA seeks to provide the best possible estimate [19]. In other words, the LCIA tries to represent the most probable case in that the models (of transport and fate of contaminants in the environment and of toxic effects on biological receptors) do not attempt to maximize exposure and environmental damage, the worst-case scenario approach.
- The SPICE Tool uses an attributional LCA study, not a consequential LCA. In short, it focuses only on the environmentally relevant flows to and from the systems studied, and not on any marginal perturbations of those flows as a result of changes in the life cycle [18].
- LCIA methodologies such as PEF recommended characterization methods [1]:
  - do not and cannot characterize the wide array of emissions released to soil, air and water from processes. However, PEF recommended characterization methods provide the best estimate to evaluate environmental impact.
  - have been recommended by the PEF in a European context, while being used at a global level in the methodology. While the modeling principles and the Life Cycle Impact Assessment methods are not geography-dependent and can thus be applied to other regions, it is still a different context of application.
- The SPICE tool does not display a Life Cycle Inventory analysis in order to identify the origin of the impacts, results are provided as LCIA results only.
- Regarding the weighting factors used for the environmental single score: For some impact categories, the characterization method used for assessing the impact of packaging is not the same as the one used for assessing the exceedance factor of the planetary boundary. Further development on Planetary Boundaries is required to reflect the updated characterization methods recommend in PEF 3.0 [1].

8. Methodology and database update

8.1. New material or process

In order to reflect the options for packaging designers, data covering additional materials or processes are needed.

For adding a new material or processes, the following steps are followed:

1. Identification of data needs
    - SPICE members are surveyed in order to identify and prioritize data needs
    - Data from companies (within or outside the SPICE initiative) willing to share data are consolidated.
2. SPICE Committee validation
    - The data to be included in the tool are presented to the SPICE committee, who validates the inclusion.
3. Data collection and modeling
    - The dataset is developed based on data collected from participating companies
    - The data quality and methodological consistency are checked
    - The results are presented to SPICE Members prior to actual integration in the tool
4. Implementation in the tool

8.2. Transverse updates

Transverse updates correspond to changes that have an influence on the whole database or directly on the methodology. The two main transverse updates are:

- Methodological updates
- LCI database updates

8.2.1. Methodological updates

While not being a PEFCR, the SPICE methodology follows the principle of the PEF [1]. In case of an update of the PEF methodology, the following steps are followed:

1. Gap analysis: identification of changes between versions
2. Simulation of changes: Assessment of the influence of changes on the outputs of the tool and presentation to the SPICE Committee
3. SPICE Committee validation
4. Implementation in the tool

8.2.2. LCI database updates

SPICE Tool relies mainly on the ecoinvent database [8]. In case of a major update of ecoinvent, methodology, the following steps are followed

1. Gap analysis: identification of changes between versions
2. Simulation of changes: Assessment of the influence of changes on the outputs of the tool and presentation to the SPICE Committee
3. SPICE Committee validation
4. Implementation in the tool

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10. Appendix

10.1. Detailed LCI description

The detail of the LCI description is presented in a confidential document, which has been presented to third-party reviewers.

10.2. Pumps average composition

In order to facilitate the input of multi-parts components such as pumps, generic pump models can be selected in the material list. Pumps correspond to components that allow user to deliver the formula by pressing on them.

They correspond to average mixes of materials entering the composition of pumps. These averages have been established based on a survey of SPICE members.

Table 22 – Breakdown (in mass) by material for an average fragrance pump

Material	%
PP	22.87%
HDPE	19.65%
Stainless steel	14.34%
POM	17.73%
Glass	0.70%
PCT	3.68%
Aluminium, anodized	21.03%

Table 23 – Breakdown (in mass) by material for an average plastic pump

Material	%
PP	54.3%
HDPE	17.3%
LDPE	2.3%
PET	0.6%
Stainless steel	8.1%
POM	6.4%
Glass	0.2%
EVA	0.2%
ABS	9.8%
Rubber	0.9%

Note: In addition to the Materials listed in the following table, a process of plastic injection is also included in these generic pump models.

10.3. Data quality assessment results

The following table displays results of the data quality assessment. The data quality assessment relies on five criteria, as defined by the ecoinvent database [24]:

- Reliability (R)
- Completeness (C)
- Temporal representativeness (TiR)
- Geographical representativeness (GR)
- Technological representativeness (TeR)

A score of 1 to 5 is attributed to each criterion, as defined in section 5.14, page 76. The score can be interpreted as:

- 1 = Very good
- 2 = Good
- 3 = Fair
- 4 = Poor
- 5 = Unknown

The total data quality rating (DQR) is calculated as the average of the ratings attributed to each of the five criteria. A color scale has been added from dark green (highest quality) to white (lowest quality).

The data quality rating provides a synthetic vision on the overall quality of the selected Life Cycle Inventories (LCIs), with respect to the objective of the tool. It also helps identifying and prioritizing which LCIs could be updated or improved in future version of the SPICE Tool.

Table 24 – Data quality Rating of life cycle inventories used in the SPICE Tool

Type	Activity	LCI	Source	Reliability	Completeness	Temporal correlation	Geographical correlation	Further technological correlation	Data Quality Rating
Converting Process	Blow moulding	Blow moulding {GLO}| market for, without elec | Cut-off, U	Ecoinvent (with electricity made country dependent)	1	3	1	1	2	**1,6**
Converting Process	Calendering, rigid sheets	Calendering, rigid sheets, without elec {GLO}| market for | Cut-off, U	Ecoinvent (with electricity made country dependent)	1	2	1	1	2	**1,4**
Converting Process	Deep drawing, steel	Deep drawing, steel, 650 kN press, automode, without elec {GLO}| market for | Cut-off, U	Ecoinvent (with electricity made country dependent)	1	4	1	1	2	**1,8**
Converting Process	Extrusion of plastic sheets and thermoforming, inline	Extrusion of plastic sheets and thermoforming, inline, without elec {GLO}| market for | Cut-off, U	Ecoinvent (with electricity made country dependent)	2	3	1	1	2	**1,8**
Converting Process	Extrusion, co-extrusion	Extrusion, co-extrusion, without elec {GLO}| market for | Cut-off, U	Ecoinvent (with electricity made country dependent)	1	1	1	1	2	**1,2**
Converting Process	Impact extrusion of aluminium	Impact extrusion of aluminium, 1 stroke without electricity, RER| processing | Cut-off, U	Ecoinvent (with electricity made country dependent)	1	3	1	2	2	**1,8**
Converting Process	Injection moulding	Injection moulding, without elec {GLO}| market for | Cut-off, U	Ecoinvent (with electricity made country dependent)	1	3	1	1	2	**1,6**

Type	Activity	LCI	Source	Reliability	Completeness	Temporal correlation	Geographical correlation	Further technological correlation	Data Quality Rating
Converting Process	Liquid packaging board manufacturing process	Liquid packaging board container without electricity and input materials | production | Cut-off, U	Ecoinvent (with electricity made country dependent), input materials added by Quantis	1	3	1	2	2	**1,8**
Converting Process	Sheet rolling, aluminium	Sheet rolling, aluminium {GLO}| market for, without elec | Cut-off, U	Ecoinvent (with electricity made country dependent)	1	1	1	1	2	**1,2**
Converting Process	Sheet rolling, steel	Sheet rolling, steel {GLO}| market for, without elec | Cut-off, U	Ecoinvent (with electricity made country dependent)	2	1	1	1	2	**1,4**
Converting Process	Stretch Blow moulding	Stretch blow moulding {GLO}, without elec| market for | Cut-off, U	Ecoinvent (with electricity made country dependent)	1	3	1	1	2	**1,6**
Converting Process	Thermoforming, with calendering	Thermoforming, with calendering {GLO}, without elec| market for | Cut-off, U	Ecoinvent (with electricity made country dependent)	1	3	1	1	2	**1,6**
Converting Process	Thermoforming of plastic sheets	Thermoforming of plastic sheets, wo electricity {RoW}| processing | Cut-off, U	Ecoinvent (with electricity made country dependent)	2	1	1	2	2	**1,6**
Converting Process	Polar fleece production	Polar fleece production, energy use only {GLO}| market for | Cut-off, U	Ecoinvent (with electricity made country dependent)	1	4	1	1	2	**1,8**

Type	Activity	LCI	Source	Reliability	Completeness	Temporal correlation	Geographical correlation	Further technological correlation	Data Quality Rating
Converting process	TREVA-specific injection moulding	TREVA-specific injection moulding	Based on supplier data	1	3	1	1	1	**1,4**
Converting Process	Glass converting	No impact - Glass converting	(included in material)	N/A	N/A	N/A	N/A	N/A	**N/A**
Converting Process	Cardboard folding	No impact - Cardboard folding	(included in material)	N/A	N/A	N/A	N/A	N/A	**N/A**
Converting Process	Textile processing	No impact - textile processing	(included in material)	N/A	N/A	N/A	N/A	N/A	**N/A**
Converting Process	Metal - no processing	No impact - Metal processing	(included in material)	N/A	N/A	N/A	N/A	N/A	**N/A**
Converting Process	Wood processing	No impact - Wood processing	(assumed to be negligible)	N/A	N/A	N/A	N/A	N/A	**N/A**
Eincineration	PET, incineration	Waste polyethylene terephthalate {CH}| treatment of waste polyethylene terephthalate, municipal incineration | Cut-off, U	Ecoinvent	1	4	1	2	2	**2**
Eincineration	Glass, incineration	Waste glass {CH}| treatment of, municipal incineration | Cut-off, U	Ecoinvent	1	4	1	2	2	**2**
Eincineration	Steel, incineration	Scrap steel {CH}| treatment of, municipal incineration | Cut-off, U	Ecoinvent	1	4	1	2	2	**2**
Eincineration	Aluminium, incineration	Scrap aluminium {CH}| treatment of, municipal incineration | Cut-off, U	Ecoinvent	1	4	1	2	2	**2**
Eincineration	Tin sheet, incineration	Scrap tin sheet {CH}| treatment of, municipal incineration | Cut-off, U	Ecoinvent	1	4	1	2	2	**2**
Eincineration	Wood, untreated, incineration	Waste wood, untreated {CH}| treatment of, municipal incineration | Cut-off, U	Ecoinvent	1	4	1	2	2	**2**
Eincineration	Paperboard, incineration	Waste paperboard {CH}| treatment of, municipal incineration | Cut-off, U	Ecoinvent	1	4	1	2	2	**2**

Type	Activity	LCI	Source	Reliability	Completeness	Temporal correlation	Geographical correlation	Further technological correlation	Data Quality Rating
Eincineration	Paper, incineration	Waste graphical paper {CH}| treatment of, municipal incineration | Cut-off, U	Ecoinvent	1	4	1	2	2	**2**
Eincineration	PP, incineration	Waste polypropylene {CH}| treatment of, municipal incineration | Cut-off, U	Ecoinvent	1	4	1	2	2	**2**
Eincineration	Rubber, incineration	Waste rubber, unspecified {CH}| treatment of, municipal incineration | Cut-off, U	Ecoinvent	1	4	1	2	2	**2**
Eincineration	PE, incineration	Waste polyethylene {CH}| treatment of, municipal incineration | Cut-off, U	Ecoinvent	1	4	1	2	2	**2**
Eincineration	Plastic, mixture, incineration	Waste plastic, mixture {CH}| treatment of, municipal incineration | Cut-off, U	Ecoinvent	1	4	1	2	2	**2**
Eincineration	Textile, incineration	Waste textile, soiled {CH}| treatment of, municipal incineration | Cut-off, U	Ecoinvent	1	4	1	2	2	**2**
Eincineration	Bio-based PE, incineration	Waste polyethylene, biobased {CH}| treatment of, municipal incineration | Cut-off, U	Quantis (adaptation from ecoinvent)	1	4	1	2	2	**2**
Eincineration	Bio-based PET, incineration	waste polyethylene terephthalate, 100% biobased {CH}| treatment of waste polyethylene terephthalate, municipal incineration | Cut-off, U	Quantis (adaptation from ecoinvent)	1	4	1	2	2	**2**
Eincineration	Bio-MEG PET, incineration	waste polyethylene terephthalate, biobased MEG {CH}| treatment of waste polyethylene terephthalate, municipal incineration | Cut-off, U	Quantis (adaptation from ecoinvent)	1	4	1	2	2	**2**
Eincineration	Bio-based PP, incineration	Waste polypropylene, biobased {CH}| treatment of, municipal incineration | Cut-off, U	Quantis (adaptation from ecoinvent)	1	4	1	2	2	**2**
Eincineration	Bio-based waste plastic mixture, incineration	Waste plastic, biobased, mixture {CH}| treatment of, municipal incineration | Cut-off, U	Quantis (adaptation from ecoinvent)	1	4	1	2	2	**2**

Type	Activity	LCI	Source	Reliability	Completeness	Temporal correlation	Geographical correlation	Further technological correlation	Data Quality Rating
Elandfill	PET, landfilling	Waste polyethylene terephtalate {CH}| treatment of, sanitary landfill | Cut-off, U	Ecoinvent	5	4	1	2	2	**2,8**
Elandfill	PS, landfilling	Waste polystyrene {CH}| treatment of, sanitary landfill | Cut-off, U	Ecoinvent	1	4	1	2	2	**2**
Elandfill	Glass, landfilling	Waste glass {CH}| treatment of, inert material landfill | Cut-off, U	Ecoinvent	1	4	1	2	2	**2**
Elandfill	Steel, landfilling	Scrap steel {CH}| treatment of, inert material landfill | Cut-off, U	Ecoinvent	1	4	1	2	2	**2**
Elandfill	Aluminium, landfilling	Waste aluminium (corrected) {CH}| treatment of, sanitary landfill | Cut-off, U	Ecoinvent	1	4	1	2	2	**2**
Elandfill	Tin sheet, landfilling	Scrap tin sheet {CH}| treatment of, sanitary landfill | Cut-off, U	Ecoinvent	1	4	1	2	2	**2**
Elandfill	Wood, untreated, landfilling	Waste wood, untreated {CH}| treatment of, sanitary landfill | Cut-off, U	Ecoinvent	1	4	1	2	2	**2**
Elandfill	Paperboard, landfilling	Waste paperboard {CH}| treatment of, sanitary landfill | Cut-off, U	Ecoinvent	1	4	1	2	2	**2**
Elandfill	Paper, landfilling	Waste graphical paper {CH}| treatment of, sanitary landfill | Cut-off, U	Ecoinvent	1	4	1	2	2	**2**
Elandfill	PP, landfilling	Waste polypropylene {CH}| treatment of, sanitary landfill | Cut-off, U	Ecoinvent	1	4	1	2	2	**2**
Elandfill	PE, landfilling	Waste polyethylene {CH}| treatment of, sanitary landfill | Cut-off, U	Ecoinvent	1	4	1	2	2	**2**
Elandfill	Plastic, mixture, landfilling	Waste plastic, mixture {CH}| treatment of, sanitary landfill | Cut-off, U	Ecoinvent	1	4	1	2	2	**2**
Elandfill	Municipal solid waste, landfilling	Municipal solid waste {CH}| treatment of, sanitary landfill | Cut-off, U	Ecoinvent	1	4	1	2	2	**2**

Type	Activity	LCI	Source	Reliability	Completeness	Temporal correlation	Geographical correlation	Further technological correlation	Data Quality Rating
Elandfill	Bio-based PE, landfilling	Waste polyethylene, biobased, with carbon storage {CH}| treatment of, sanitary landfill | Cut-off, U	Quantis (adaptation from ecoinvent)	1	4	1	2	2	**2**
Elandfill	Bio-based PET, landfilling	Waste polyethylene terephthalate, 100% biobased, with carbon storage {CH}| treatment of waste polyethylene terephthalate, sanitary landfill | Cut-off, U	Quantis (adaptation from ecoinvent)	1	4	1	2	2	**2**
Elandfill	Bio-MEG PET, landfilling	Waste polyethylene terephthalate, biobased MEG, with carbon storage {CH}| treatment of waste polyethylene terephthalate, sanitary landfill | Cut-off, U	Quantis (adaptation from ecoinvent)	1	4	1	2	2	**2**
Elandfill	Bio-based PP, landfilling	Waste polypropylene, biobased, with carbon storage {CH}| treatment of, sanitary landfill | Cut-off, U	Quantis (adaptation from ecoinvent)	1	4	1	2	2	**2**
Elandfill	Bio-based waste plastic mixture, landfilling	Waste plastic, biobased, mixture, with carbon storage {CH}| treatment of, sanitary landfill | Cut-off, U	Quantis (adaptation from ecoinvent)	1	4	1	2	2	**2**
Elandfill	Bio-based waste plastic mixture, landfilling, with 5% degradation	Waste plastic, biobased, mixture, with carbon storage, with 5% degradation {CH}| treatment of, sanitary landfill | Cut-off, U	Quantis (adaptation from ecoinvent)	1	4	1	2	2	**2**
Elandfill	Bio-based waste plastic mixture, landfilling, with 50% degradation	Waste plastic, biobased, mixture, with carbon storage, with 50% degradation {CH}| treatment of, sanitary landfill | Cut-off, U	Quantis (adaptation from ecoinvent)	1	4	1	2	2	**2**
Erecycled & Erol	Polyethylene terephthalate (PET), recycled	Polyethylene terephthalate, granulate, amorphous, recycled {Europe without Switzerland}| polyethylene terephthalate production, granulate, amorphous, recycled | Cut-off, U	Ecoinvent	1	3	1	2	2	**1,8**

Type	Activity	LCI	Source	Reliability	Completeness	Temporal correlation	Geographical correlation	Further technological correlation	Data Quality Rating
Erecycled & Erol	Steel, recycled	Steel, low-alloyed {RER}| steel production, electric, low-alloyed | Cut-off, U	Ecoinvent	5	4	1	2	2	**2,8**
Erecycled & Erol	Aluminium, recycled	Aluminium, wrought alloy {RER}| treatment of aluminium scrap, post-consumer, prepared for recycling, at remelter | Cut-off, U	Ecoinvent	1	3	1	2	2	**1,8**
Erecycled & Erol	Particle board, recycled	Particle board, from recycling, 100% secondary, at plant (Cut-off)/RER U	Quantis	5	4	1	2	2	**2,8**
Erecycled & Erol	Folding Box Board, white lined	Folding boxboard/chipboard {RER}| chipboard production, white lined | Cut-off, U	Ecoinvent	1	3	2	2	2	**2**
Erecycled & Erol	Graphic paper, recycled	Graphic paper, 100% recycled {RER}| production | Cut-off, U	Ecoinvent	1	3	1	2	2	**1,8**
Erecycled & Erol	Corrugated board, recycled	Corrugated board, from recycling, 100% secondary, at plant (Cut-off)/RER U	Quantis	1	1	1	2	2	**1,4**
Erecycled & Erol	Polyethylene (PE), recycled	Polyethylene, high density, granulate, recycled {Europe without Switzerland}| polyethylene production, high density, granulate, recycled | Cut-off, U	Ecoinvent	1	3	1	2	2	**1,8**
Erecycled & Erol	Glass, recycled	Glass recycling, FEVE	FEVE	1	1	1	2	2	**1,4**
Ev & E*v	Stainless steel	Steel, chromium steel 18/8 {GLO}| market for | Cut-off, U	Ecoinvent	1	1	2	1	2	**1,4**
Ev & E*v	Steel	Steel, low-alloyed 100% primary {RER}| steel production, converter, low-alloyed | Cut-off, U	Ecoinvent, adapted by Quantis	1	3	1	2	2	**1,8**
Ev & E*v	Aluminium	Aluminium, primary, ingot {IAI Area, EU27 & EFTA}| market for | Cut-off, U	Ecoinvent	1	3	1	2	2	**1,8**
Ev & E*v	Tin	Tin {GLO}| market for | Cut-off, U	Ecoinvent	1	2	1	1	2	**1,4**

Type	Activity	LCI	Source	Reliability	Completeness	Temporal correlation	Geographical correlation	Further technological correlation	Data Quality Rating
Ev & E*v	Wood	Sawnwood, lath, hardwood, dried (u=10%), planed, in mass {GLO}| market for | Cut-off, U	Ecoinvent	1	3	1	1	2	1,6
Ev & E*v	Medium Density Fiberboard	Medium density fibreboard, in mass {GLO}| market for | Cut-off, U	Ecoinvent	5	2	1	1	2	2,2
Ev & E*v	Solid Bleached Board	Solid bleached and unbleached board {GLO}| market for | Cut-off, U	Ecoinvent	5	1	1	1	2	2
Ev & E*v	Solid Unbleached Board	Solid bleached and unbleached board {GLO}| market for | Cut-off, U	Ecoinvent	5	1	1	1	2	2
Ev & E*v	Folding Box Board	folding boxboard carton {RER}| folding boxboard carton production | Cut-off, U	Ecoinvent	2	1	1	2	2	1,6
Ev & E*v	Folding Box Board, white lined	white lined chipboard carton {RER}| white lined chipboard carton production | Cut-off, U	Ecoinvent	2	1	1	2	2	1,6
Ev & E*v	Paper, woodfree, coated	Paper, woodfree, coated {RER}| market for | Cut-off, U	Ecoinvent	1	4	1	2	2	2
Ev & E*v	Paper, wood containing, coated	Paper, woodcontaining, lightweight coated {RER}| market for | Cut-off, U	Ecoinvent	1	2	1	2	2	1,6
Ev & E*v	Corrugated Board Box	Corrugated board box {GLO}| market for corrugated board box | Cut-off, U	Ecoinvent	5	3	2	1	2	2,6
Ev & E*v	HDPE (Polyethylene, high density)	Polyethylene, high density, granulate {GLO}| market for | Cut-off, U	Ecoinvent	3	1	1	1	2	1,6
Ev & E*v	LLDPE (Polyethylene, linear low density)	Polyethylene, linear low density, granulate {GLO}| market for | Cut-off, U	Ecoinvent	3	1	1	1	2	1,6
Ev & E*v	PP (Polypropylene)	Polypropylene, granulate {GLO}| market for | Cut-off, U	Ecoinvent	3	1	1	1	2	1,6
Ev & E*v	PET (Polyethylene terephthalate)	Polyethylene terephthalate, granulate, amorphous {GLO}| market for | Cut-off, U	Ecoinvent	1	1	1	1	2	1,2

Type	Activity	LCI	Source	Reliability	Completeness	Temporal correlation	Geographical correlation	Further technological correlation	Data Quality Rating
Ev & E*v	PET, bottle grade(Polyethylene terephthalate)	Polyethylene terephthalate, granulate, bottle grade {GLO}| market for | Cut-off, U	Ecoinvent	3	1	1	1	2	**1,6**
Ev & E*v	PC (Polycarbonate)	Polycarbonate {GLO}| market for | Cut-off, U	Ecoinvent	1	3	1	1	2	**1,6**
Ev & E*v	EVA (Ethylene vinyl acetate)	Ethylene vinyl acetate copolymer {RER}| market for ethylene vinyl acetate copolymer | Cut-off, U	Ecoinvent	1	3	1	2	2	**1,8**
Ev & E*v	PMMA (Polymethyl methacrylate)	Polymethyl methacrylate, beads {GLO}| market for | Cut-off, U	Ecoinvent	1	3	1	1	2	**1,6**
Ev & E*v	PS (Polystyrene)	Polystyrene, general purpose {GLO}| market for | Cut-off, U	Ecoinvent	1	3	1	1	2	**1,6**
Ev & E*v	PVC (Polyvinyl chloride)	Polyvinylchloride, bulk polymerised {GLO}| market for | Cut-off, U	Ecoinvent	1	1	1	1	2	**1,2**
Ev & E*v	PVDC (Polyvinyldenchloride)	Polyvinylidenchloride, granulate {RER}| market for polyvinylidenchloride, granulate | Cut-off, U	Ecoinvent	1	3	1	2	2	**1,8**
Ev & E*v	PTFE (Polytetrafluoroethylene)	Tetrafluoroethylene {GLO}| market for | Cut-off, U	Ecoinvent	1	3	1	1	2	**1,6**
Ev & E*v	PU (Polyurethane)	Polyurethane, flexible foam {RER}| market for polyurethane, flexible foam | Cut-off, U	Ecoinvent	1	3	1	2	2	**1,8**
Ev & E*v	Synthetic rubber	Synthetic rubber {GLO}| market for | Cut-off, U	Ecoinvent	1	4	1	1	2	**1,8**
Ev & E*v	LDPE (Polyethylene, low density)	Polyethylene, low density, granulate {GLO}| market for | Cut-off, U	Ecoinvent	1	1	1	1	2	**1,2**
Ev & E*v	Melamine formaldehyde resin	Melamine formaldehyde resin {GLO}| market for | Cut-off, U	Ecoinvent	1	4	2	1	2	**2**
Ev & E*v	Epoxy resin	Epoxy resin {GLO}| market for epoxy resin | Cut-off, U	Ecoinvent	5	4	1	1	2	**2,6**
Ev & E*v	Nylon 6	Nylon 6 {GLO}| market for | Cut-off, U	Ecoinvent	5	3	2	1	2	**2,6**

Type	Activity	LCI	Source	Reliability	Completeness	Temporal correlation	Geographical correlation	Further technological correlation	Data Quality Rating
Ev & E*v	SAN (Styrene Acrylonitrile)	Styrene-acrylonitrile copolymer {GLO}| market for | Cut-off, U	Ecoinvent	1	3	1	1	2	**1,6**
Ev & E*v	ABS (Acrylonitrile-butadiene-styrene)	Acrylonitrile-butadiene-styrene copolymer {GLO}| market for | Cut-off, U	Ecoinvent	1	3	1	1	2	**1,6**
Ev & E*v	POM (Polyoxymethylene)	Polyoxymethylene (POM)/EU-27	Industry data 2.0	1	1	3	2	2	**1,8**
Ev & E*v	PCT (Polycyclohexylenedimethylene Terephthalate)	PCT, Cut-off, U	Quantis	1	4	2	1	2	**2**
Ev & E*v	PCTG (Glycol-Modified Polycyclohexylenedimethylene Terephthalate)	PCTG, Cut-off, U	Quantis	1	4	2	1	2	**2**
Ev & E*v	PBT (Polybutylene)	Polybutylene Terephtalate	Quantis	1	4	2	1	2	**2**
Ev & E*v	PK (Polyketone)	Polyketone	Quantis	1	4	2	1	2	**2**
Ev & E*v	Cotton, woven	Textile, woven cotton {GLO}| market for | Cut-off, U	Ecoinvent	1	2	1	1	2	**1,4**
Ev & E*v	Magnet	Permanent magnet, for electric motor {GLO}| production | Cut-off, U	Ecoinvent	1	3	1	1	2	**1,6**
Ev & E*v	Zamak	Zamak 2	Quantis	1	4	1	1	2	**1,8**
Ev & E*v	Mirror	Mirror, Cut-off, U	Quantis	1	4	1	1	2	**1,8**
Ev & E*v	Cellulose Acetate	Carboxymethyl cellulose, powder {GLO}| market for | Cut-off, U	Quantis	1	4	2	1	2	**2**
Ev & E*v	HDPE, from sugar cane	Bio-based HDPE from sugarcane (formerly Green HDPE), with NCS DLUC, without carbon content on HDPE and residual mix substitution {BR}| production | Cut-off, U - 18'06'2021 v3 PEF	Quantis	1	3	2	2	1	**1,8**
Ev & E*v	EVOH (Ethylene vinyl alcohol)	EVOH {GLO} Cut-off, U	Quantis	1	4	1	2	2	**2**
Ev & E*v	Ceramics	Ceramic tile {GLO}| market for | Cut-off, U	Ecoinvent	1	3	1	1	2	**1,6**
Ev & E*v	Leather	Leather, tanned	Quantis	1	1	2	2	1	**1,4**
Ev & E*v	Glass	Glass production, FEVE	FEVE	1	1	1	2	2	**1,4**

Type	Activity	LCI	Source	Reliability	Completeness	Temporal correlation	Geographical correlation	Further technological correlation	Data Quality Rating
Ev & E*v	LDPE film (Polyethylene, low density)	Packaging film, low density polyethylene {GLO}| market for | Cut-off, U	Ecoinvent	1	3	1	1	2	**1,6**
Ev & E*v	Pump, fragrance (average composition)	Average pump composition from SPICE Members	SPICE	1	2	1	2	1	**1,4**
Ev & E*v	Pump, plastic (average composition)	Average pump composition from SPICE Members	SPICE	1	2	1	2	1	**1,4**
Ev & E*v	Brass	Brass {RoW}| market for brass | Cut-off, U	Ecoinvent	1	4	1	2	2	**2**
Ev & E*v	Latex	Latex {RER}| production | Cut-off, U	Ecoinvent	1	3	1	2	2	**1,8**
Ev & E*v	Surlyn	Surlyn {GLO}| market for | Cut-off, U - sulfuric acid replaced	Quantis	1	4	1	1	2	**1,8**
Ev & E*v	SEBS (Styrene-ethylene-butylene-styrene)	SEBS {GLO}| market for | Cut-off, U	Quantis	1	4	1	1	2	**1,8**
Ev & E*v	MBS (methacrylate-butadiene-styrene)	MBS {GLO}| market for | Cut-off, U	Quantis	1	4	1	1	2	**1,8**
Ev & E*v	Neodymium oxide	Neodymium oxide {GLO}| market for | Cut-off, U	Ecoinvent	1	4	1	1	2	**1,8**
Ev & E*v	PETG (Polyethylene terephthalate glycol-modified)	PETG {GLO}| market for | Cut-off, U	Quantis	1	4	2	1	2	**2**
Ev & E*v	PA1010 (Polyamide), from castor oil	PA1010 (Polyamide), from castor oil	Based on supplier data	3	1	1	1	1	**1,4**
Ev & E*v	TREVA bioplastic, from cellulose, 45% biobased	TREVA bioplastic, from cellulose, 45% biobased	Based on supplier data	3	1	1	1	1	**1,4**
Ev & E*v	LDPE (Polyethylene, low density), from biomass residues	LDPE (Polyethylene, low density), from various waste and biomass residues	Based on supplier data	3	3	1	1	1	**1,8**
Ev & E*v	PP (Polypropylene), from biomass residues	PP (Polypropylene), from various waste and biomass residues	Based on supplier data	3	3	1	1	1	**1,8**
Ev & E*v	PA11 (Polyamide), for extrusion, from castor oil	PA11 (Polyamide), for extrusion, from castor oil	Based on supplier data	3	4	1	1	1	**2**
Ev & E*v	PA11 (Polyamide), for injection, from castor oil	PA11 (Polyamide), for injection, from castor oil	Based on supplier data	3	4	1	1	1	**2**

Type	Activity	LCI	Source	Reliability	Completeness	Temporal correlation	Geographical correlation	Further technological correlation	Data Quality Rating
Ev & E*v	Transparent PA (Polyamide)	Transparent PA (Polyamide)	Based on supplier data	3	4	1	1	1	**2**
Ev & E*v	Transparent PA (Polyamide), from castor oil, 62% bio-based	Transparent PA (Polyamide), from castor oil, 62% bio-based	Based on supplier data	3	4	1	1	1	**2**
Finishing Process	Physical Vapour Deposition, aluminium	Aluminium coat, packaging, physical vapour deposition without electricity, GLO| selective coating, packaging, physical vapour deposition | Cut-off, U	Ecoinvent (with electricity made country dependent)	1	3	2	2	2	**2**
Finishing Process	Anodising, aluminium sheet	Anodising, aluminium sheet, without electricity {GLO}| market for | Cut-off, U	Ecoinvent (with electricity made country dependent)	1	3	1	1	2	**1,6**
Finishing Process	Offset printing	Printing packaging, offset without electricity, GLO| offset printing, per m2 of printed packaging | Cut-off, U	Ecoinvent (with electricity made country dependent)	1	3	2	2	2	**2**
Finishing Process	Sputtering, aluminium coat	Aluminium coat, packaging, sputter deposition, wo electricity {GLO}| selective coating, packaging, sputtering | Cut-off, U	Ecoinvent (process only, with electricity made country dependent)	1	3	2	2	2	**2**
Finishing Process	Acid etching	Acid etching, no elec	Ecoinvent (with electricity made country dependent)	1	4	2	2	2	**2,2**
Finishing Process	Lacquering	Glass lacquering, no elec	SPICE	1	2	1	1	1	**1,2**
Finishing Process	Electroplating, nickel	Nickel electroplating, no elec	Quantis	1	4	1	1	2	**1,8**
Transport	Train	Transport, freight train {GLO}| market group for | Cut-off, U	Ecoinvent	1	2	1	1	2	**1,4**
Transport	Boat	Transport, freight, sea, transoceanic ship {GLO}| market for | Cut-off, U	Ecoinvent	5	2	2	1	2	**2,4**

Type	Activity	LCI	Source	Reliability	Completeness	Temporal correlation	Geographical correlation	Further technological correlation	Data Quality Rating
Transport	Lorry	Transport, freight, lorry, unspecified {GLO}| market for | Cut-off, U	Ecoinvent	1	2	2	1	2	1,6
Transport	Aircraft	Transport, freight, aircraft, unspecified {GLO}| market for transport, freight, aircraft, unspecified | Cut-off, U	Ecoinvent	1	1	1	1	2	1,2
Transport	Municipal solid waste collection lorry	Municipal waste collection service by 21 metric ton lorry {CH}| market for municipal waste collection service by 21 metric ton lorry | Cut-off, U	Ecoinvent	5	3	2	2	2	2,8

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