EcoBeautyScore

# EcoBeautyScore Association

# Methodology Documentation

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Version 1.6
January 2025

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EcoBeautyScore

# 1 Context and Goal of the study

## 1.1 Objectives of EcoBeautyScore

The objective of the EcoBeautyScore (EBS) is to deliver a harmonized industry scoring system based on the environmental impact assessment of cosmetics products. This system aims to provide a harmonized communication to consumers and encourage enhanced environmental performance of products. It will offer consumers clear, transparent, and comparable environmental impact information, utilizing a common science-driven methodology.

This includes:

- A common methodology, database, and tool for environmental impact assessment of cosmetics products.
- A common scoring mechanism & harmonized layout to communicate the environmental impact of cosmetics products to consumers, ensuring consistency and comparability.
- Foster a culture of eco-design within the industry

The overall methodological propositions related to the environmental footprinting tool shall reflect the objectives of the Framework of the EBS association above mentioned: the environmental footprinting methodology must use a science-based approach and must allow for meaningful differentiation between products to allow consumers to make more environmentally informed choices.

### 1.1.1 Reference to Product Environmental Footprint

The EcoBeautyScore association used the Product Environmental Footprint (PEF)[1] as a reference for the development of their harmonized industry scoring system. However, adaptations have been made to account for the specificities of the cosmetics industry. A clear rationale justifying the methodological choices is provided in this document when an adaptation from PEF is required.

*Why is EBS using PEF as a reference?*

Life Cycle Assessment (LCA) has been recognized by the European Commission as the most effective method for assessing the overall environmental footprint of products and services. The PEF initiative was launched by the European Commission to enhance the harmonization of LCA at the European level. The PEF guidance serves as the reference measurement system in Europe for environmental footprinting, incorporating parameters for EU conditions and global normalization. While the EBS association acknowledges the significance of the PEF method, they also recognize that improvements are necessary for cosmetics products in terms of methodology and datasets, as outlined in subsequent sections of the document.

## 1.2 Intended applications of the results

The goal of EBS is to provide a label that allows the consumer to compare easily the environmental impact of one cosmetic product vs. other cosmetic products that fulfil the same cosmetic function. Therefore the results of the life cycle impact assessment are used to define classes of environmental performance (= scores A, B, C, D and E) per product segment (see section 4). These scores per product are communicated as part of the consumer-facing EcoBeautyScore label. For each cosmetic product segment, a separate scoring scale A – E is defined based on the respective geographical scope. (see section 4, p. 45).

# 2 Scope of the study

## 2.1 Product system(s)

As overarching principle, all formulated cosmetic products that are sold for use by the consumer are in scope of EBS with the exceptions described in section 2.1.2. That includes professional retail products.

If a product is generally in scope of EBS, additional pre-requisites need to be met to publish a score on a product. The product needs to belong to a product segment (see below) for which a footprinting methodology and database, as well a scoring scale are defined by EBS.

Refillable products (mother pack) and their refills (daughter pack) are treated as stand-alone products for the footprinting assessment.

### 2.1.1 Product Segmentation

The EBS score allows the comparison of formulated cosmetic products by the consumer based on their relative environmental impact. It is reasonable for the consumer to compare only products that deliver the same function (see section 2.3, p. 9), since only those products can be actually exchanged for each other by the consumer. Therefore, the multitude of different cosmetic products in scope of EBS is divided into product segments. This segmentation is done based on the delivery of the same primary benefit to the same body zone.

A product segment is defined using 2 levels with the first level L1 being the product family and second level L2 the primary benefit.

*Example: L1 = Hair and L2 = Wash → product segment = "Hair Wash".*

The guiding principle of the segmentation is that it shall be consumer-centric and group products in a few segments as possible to reduce complexity and set-up and maintenance effort.

One single score scale (A-E) is set per product segment (and geographical scope).

EBS is approaching the development of the footprinting methodology and database, as well the scoring scale in a staggered approach product segment by product segment. It means that the number of product segments with a valid EBS methodology and database is expected to row over the years. For the first EBS launch, 4 segments are under study: Hair – Wash, Hair – Treat, Face Care – Moisturize and Treat, Body Care – Wash.

### 2.1.2 Products out of scope of EBS

As of now the following products are not within the scope of EBS scoring application:

- Products **exclusively for professional use**, so-called "back bar" products.
- Products **not intended for sale** like samples and testers.
- Multi-packs (grouped or bundled products). The individual products with the bundle can be assessed separately.
- **Devices** (e.g. razor, toothbrush) and **products falling under other regulations** than the cosmetic regulations (e.g. medical products).

### 2.1.3 Products temporarily not covered by EBS (status 2024)

As EBS methodology and database are in its first version, within a product segment, certain sub-segments may not be temporarily covered by EBS. These exemptions are defined in the respective definition of the product segment. The current exceptions are:

- Products that are a combination of a substrate and a formula (e.g. face sheet masks) are currently not covered until the footprinting methodology for these products has been defined.
- Likewise, products that use a propellant are currently not covered since the footprinting methodology does not reflect yet the specificities of the life cycle of these products.
- Products that have a significantly higher concentration than regular products of that product segment and which are delivered in a format that is directly ready-to-use by the consumer, so-called ready-to-use concentrates, are not covered separately in the methodology. The sampling has shown that they make up a minor part of overall portfolio of EBS members.
- SVHC-containing products with concentration higher than 0,1% following European Union's REACH Regulation (EC No. 1907/2006) threshold. SVHC are substances heavily regulated under the EU's REACH (Registration, Evaluation, Authorization and Restriction of Chemicals) regulation EC No. 1907/2006, essentially due to their risks to human health but also on the environment. Given the high scrutiny of the European regulator to ultimately phase out the use of SVHCs and replacing them with safer alternatives, good performance scores of cosmetics products containing SVHCs could harm the overall credibility of the EBS scoring methodology.
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## 2.2 Geographical Scope

The objective of EBS is, ultimately, to deploy the score worldwide.

The geographical scope of EBS methodology has two axes: the geographical scope of (a) the footprint and of (b) the scoring.

1. The environmental impact assessment is global, relying on global average data for some parameters such as distribution distances or household waste water treatment connectivity rate. This approach was selected based on analysis performed showing very strong correlation rate in the product aggregated footprint ranking between two models (one relying on regional average parameters, another one relying on global average parameters), informing on the low impact of regional versus global parameters on the ultimate products ranking. Therefore, the more practical approach was selected in the context of a future worldwide deployment of EBS.
2. The first version of the scoring scale calibration is built based on a sampling of products sold in Europe, in alignment with the scope of the first EBS launch (Europe countries of EU and UK, Norway, Switzerland). This scale calibration geographical scope might evolve as the EBS score is deployed beyond Europe.

## 2.3 Product Function(s) and Functional Unit

A variety of different cosmetic product types is in the scope of EBS. These do deliver a multitude of different cosmetic benefits (= functions). The functional unit for all product segments will be the use of one application of product for a specific service/consumer benefit/function/final use for a global geographical scope.

The product segments in EBS are defined based on the same functional unit, i.e. the same primary cosmetic benefit delivered to the same body zone. For each product segment the respective primary benefit and body zone are associated to a clear definition. The functional unit of each 4 segments considered in first EBS launch are presented in Annex (see section 7.1.1). Definitions of the product performance are in line with the European Ecolabel criteria for soaps, shampoos and hair conditioners[2] and the Shadow-PEFCR study on shampoo.[3]

### 2.3.1 Reflection about PEF Key Requirements for FU

The PEF method requires the FU to be defined based on the function(s) or service(s) provided by the product ("what"), the extent of the function or service ("how much"), the expected level of quality ("how well"), and the duration or lifetime of the product ("how long") (see section 3.2.1 of the PEF method).

The PEF definition of the functional unit for the 4 segments in EBS first launch are described in Annex (see section 7.1.1).

### 2.3.2 Reference flow - Dosage and supplementary reference flows

The dosage is the **amount of cosmetic product required to deliver the function** as defined in the FU.

Depending on products, an **additional amount of (warm) water** might be required to deliver the function. This supplementary reference flow of the so-called “rinse water” is considered in the life cycle assessment as part of the use stage.

**Default dosages and default rinse water volumes** (i.e. reference values) are provided by EBS - following the same principles across product segment. These default dosages and rinse water volumes are not changeable for now.

| | |
|---|---|
| Dosage | $m_{dose}$ |
| Rinse water volume | $V_{rinse\ water}$ |

Since one product segment is typically covering different technologies that deliver the same primary benefit, each product segment is divided into **sub-segments.** The **default values for dosage and the presence of rinse water (and its volume) are defined for each sub-segment**.

*For example: Solid shampoos and liquid shampoos are different technologies of the same product segment “Hair Wash”. Obviously, a smaller amount of a solid shampoo is required to deliver the same function than of a liquid shampoo.*

Depending on the packaging type the dosage requires **re-scaling based on the leftover rate** $R_{leftover}$ (see section 0, p. 31).

$$m_{dose,corr} = \frac{m_{dose}}{1 - R_{leftover}}$$

### *2.3.2.1 Principles to determine the Default Dosage*

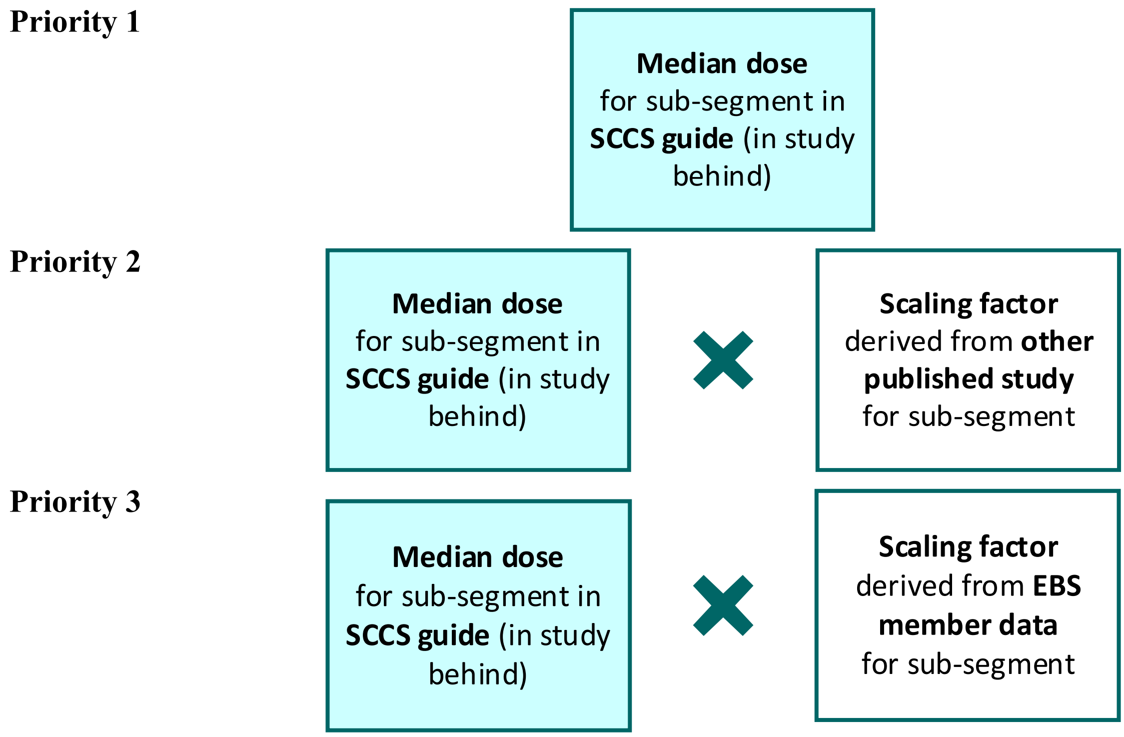
For each product sub-segment, a default dose value is determined and agreed by EBS. Preferably it is based on published scientific studies, which measured the amount dosed by consumers in one application.

The amount a consumer doses per application is typically a broad non-normal distribution since consumer habits differ significantly for the same product. Therefore, the **median amount per application** is selected as the representative default value for $m_{dose}$ per sub-segment.

EBS has selected the "Notes of Guidance for the Testing of Cosmetic Ingredients and Their Safety Evaluation" by the Scientific Committee on Consumer Safety (SCCS)[4] as the most reliable and recognized sources for dose data. This guide is a document compiled by the SCCS members and is published by EC. The document contains relevant information on the different aspects of testing and safety evaluation of cosmetic substances in Europe.

The SCCS guide is providing the daily amounts used, as well as usage frequency. Behind the daily amounts referenced are mainly two studies.[5,6] In these studies the authors have investigated in a large consumer study the consumption of various cosmetic products for a couple of countries representative for the European region. EBS is extrapolating these European habits and practices data to the global region. That extrapolation can be done due to the comparative nature of the score as per the EBS goal.

The studies behind the SCCS guide are not necessarily covering all sub-segments defined by EBS for a given segment. Sometimes a median dose might not be provided at all for certain segments. If that is the case, values have been extrapolated using scaling factors or taken from other data sources according to the below hierarchy:



**Priority 4**

**Median dose** for sub-segment **from other published study**

**Priority 5**

**Median dose** for sub-segment **from EBS member data**

The dose values for the segments and sub-segments already defined by EBS are available in the annex 7, p. 60.

### *2.3.2.2 Principles to determine the Default Rinse Water Volumes*

Cosmetic rinse-off products are often used in conjunction with other personal care rinse-off products. For example, in one showering or bathing event the consumer might use multiple products like a body wash, a shampoo and a hair conditioner. Additionally, other functions might be fulfilled like well-being (enjoying the warm water). Even more additional water might be consumed unused while waiting for the warm water to "arrive" at the shower/tap.

The principle of EBS is to only account for the amount of water that can be attributed to the use of the single product being assessed. The default values for the rinse water are derived from a data collection among EBS member companies. For leave-on products the members agreed to set the water volume to zero. Values for $V_{rinse\ water}$ per product segment are available in the annex 7, p. 60)

### *2.3.2.3 Special Case: Monodose and Dilutable Products*

Monodose products are cosmetic products presented in individual units that contain a pre-measured amount of product sufficient for one application. Monodose products are commonly found in formats such as sachets, ampoules, or other individual packets; however, they are not restricted to these forms and may also include other solid or liquid formats. Monodose products may also be referred to as single-dose or unit-dose products. Products with this specificity can appear in any given product segment. This is the only product type for which dose is provided by the user (mandatory company-specific input).

Dilutable products are products which require to be diluted by the consumer with water. Products with this specificity can appear in any given product segment. The resulting product after the mixing with water is then ready to be used and treated in the EBS methodology as a regular liquid product of the same product subsegment. The additional amount of tap water required is taken into account by the EBS methodology.

## 2.4 System Boundary of the footprinting method

The system boundary of cosmetic products assessed in the EBS footprinting method includes the following life cycle stages:

- Ingredients production

- Packaging production (primary, secondary and tertiary)
- Transport of ingredients and packaging to the manufacturing site (as well as any other transportation happening during the materials production)
- Manufacturing
- Distribution
- Use phase (e.g. use of water to rinse the product)
- End-of-life of packaging
- End-of-life of ingredients

These life cycle stages are summarized in more details in Figure 1.

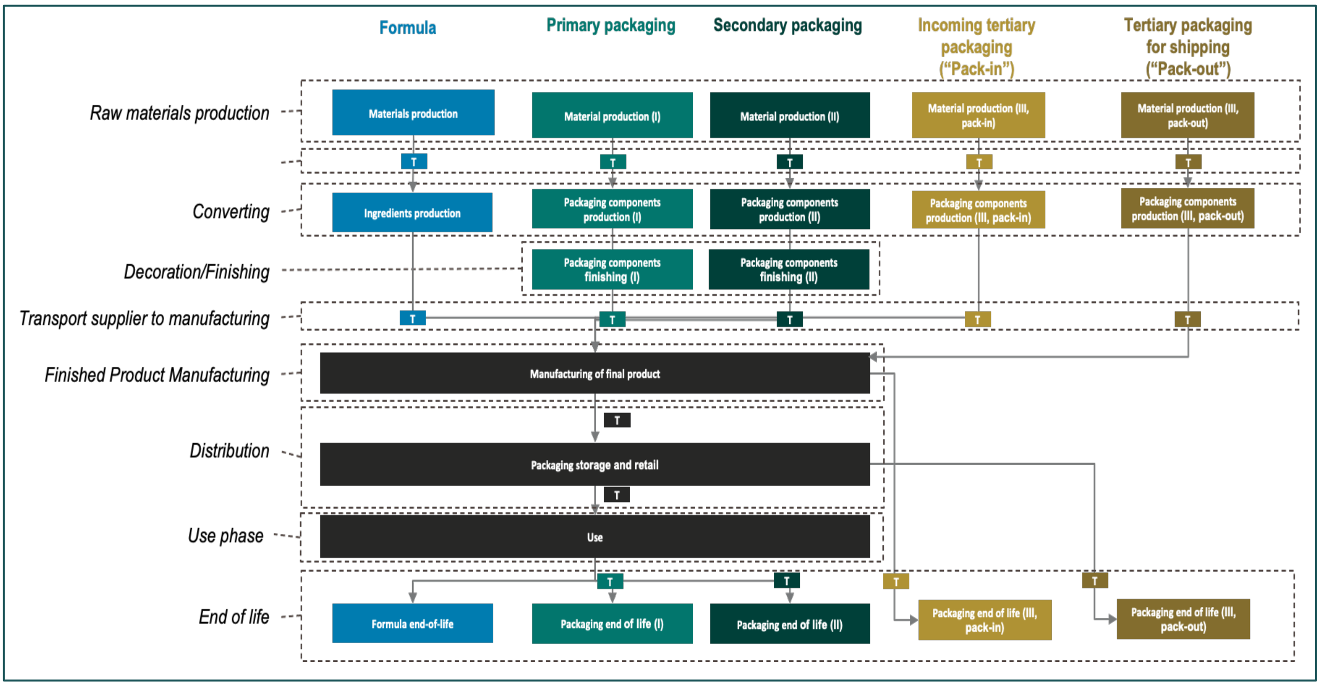



*Figure 1: System boundary of the EBS footprinting method*

The system boundary excludes as per now:

- Additional packaging (e.g. gift boxes), considered as low impact
- E-commerce
- Stages not listed above such as research and development activities related to product development, commuting of workers, administrative work in conformity with usual practices in LCA.

## 2.5 Life cycle inventories modelling framework and Handling of multifunctional processes

### 2.5.1 Life cycle inventories modelling framework

Life cycle inventories (LCI) can be built following two types of modelling frameworks: attributional (where the impacts of the current supply chain are assessed) and consequential (where impacts related to the consequences of the analysed decision are assessed). The LCI modelling framework of the EBS footprinting method is **attributional**.

### 2.5.2 Handling multifunctional processes

It is common to encounter processes producing multiple products or services. However, Life Cycle Assessment (LCA) usually requires determining the impacts related to one of the output products/services. Ensuring a fair sharing of the impacts between co-products is not an easy task, which is why the ISO standards recommend to follow a hierarchy of recognized approaches.

In the EBS footprinting method, allocation based on underlying physical relationship will be prioritized. Economic allocation can be used when the underlying physical relationship between co-products does not capture their functionalities. Clear justification shall be given in that event.

### 2.5.3 Packaging end-of-life

The end-of-life of packaging can as well be associated with production of co-products or services, and therefore requires to follow a specific approach.

The EBS footprinting method uses the Circular Footprint Formula (CFF) as defined in the PEF[1] to model the end-of-life of packaging. It is defined as follows:

**Materials**

$$(1-R_1)*E_v+R_1*\left(A*E_{recycled}+(1-A)*E_v*\frac{Q_{S,in}}{Q_P}\right)+(1-A)*R_2*\left(E_{recycled,EoL}-E_{v*}*\frac{Q_{S,out}}{Q_P}\right)$$

**Energy**

$$(1-B)*R_3*(E_{ER}-LHV*X_{ER.heat}*E_{SE,heat}-LHV*X_{ER,elec}*E_{SE,elec})$$

**Disposal**

$$(1-R_2+R_3)*E_D$$

*Table 1 : EBS footprinting packaging end-of-life parameters*

| Parameter | Definition | Data source |
|---|---|---|
| $A$ | Allocation factor of burdens and credits between supplier and user of recycled materials | PEF |
| $B$ | Allocation factor of energy recovery processes. It applies both to burdens and credits | PEF |
| $Q_{S,in}$ | Quality of the ingoing secondary material, i.e. the quality of the recycled material at the point of substitution | PEF |

| Parameter | Definition | Data source |
|---|---|---|
| $Q_{S,out}$ | Quality of the outgoing secondary material, i.e. the quality of the recyclable material at the point of substitution | PEF |
| $Q_P$ | Quality of the primary material, i.e. quality of the virgin material | PEF |
| $R_1$ | Proportion of material in the input to the production that has been recycled from a previous system | input from companies for each packaging item (see section 3.3) |
| $R_2$ | Proportion of the material in the product that will be recycled (or reused) in a subsequent system. Therefore, R2 shall take into account the inefficiencies in the collection and recycling (or reuse) processes. R2 shall be measured at the output of the recycling plant. | PEF |
| $R_3$ | Proportion of the material in the product that is used for energy recovery at EoL | PEF |
| $E_{recycled}$ | Specific emissions and resources consumed (per functional unit) arising from the recycling process of the recycled (reused) material, including collection, sorting and transportation process | databases (see section 3.3 and 3.9 for details) |
| $E_{recycled,EoL}$ | Specific emissions and resources consumed (per functional unit) arising from the recycling process at EoL, including the collection, sorting and transportation processes | databases (see section 3.3 and 3.9 for details) |
| $E_v$ | Specific emissions and resources consumed (per functional unit) arising from the acquisition and pre-processing of virgin material | databases (see section 3.3 and 3.9 for details) |
| $E_{v*}$ | Specific emissions and resources consumed (per functional unit) arising from the acquisition and pre-processing of virgin material assumed to be substituted by recyclable materials | databases (see section 3.3 and 3.9 for details) |
| $E_{ER}$ | Specific emissions and resources consumed (per functional unit) arising from the energy recovery process (e.g. incineration with energy recovery, landfill with energy recovery, etc.) | databases (see section 3.3 and 3.9 for details) |

| Parameter | Definition | Data source |
|---|---|---|
| $E_{SE,heat}$ $E_{SE,elec}$ | Specific emissions and resources consumed (per functional unit) that would have arisen from the specific substituted energy source, heat and electricity respectively | databases (see section 3.3 and 3.9 for details) |
| $E_D$ | Specific emissions and resources consumed (per functional unit) arising from the disposal of waste material at the analysed product's EoL, without energy recovery | databases (see section 3.3 and 3.9 for details) |
| $X_{ER,heat}$ $X_{ER,elec}$ | Efficiency of the energy recovery process for both heat and electricity | PEF |
| $LHV$ | Lower heating value of the material in the product used for energy recovery | PEF |

The following assumptions are made:

$$E_{recycled} = E_{recycled,EoL}$$

and:

$$E_v = E_{v*}$$

## 2.6 Life Cycle Impact Assessment methods

### 2.6.1 Life cycle impact assessment method

During the LCI step, all processes are described as elementary flows going in (resources) and out (emissions) of the system under study. All the elementary flows involved are then characterized regarding their potential effects on environment.
The life cycle impact assessment relies on 16 midpoint impact categories based on characterization methods recommended by the PEF (EF 3.1)[7]:

1. **Climate change** from Bern model - Global warming potential (GWP) over a 100-year time horizon based on IPCC 2021 AR6 (Forster et al., 2021).

2. **Ozone depletion** from Ozone Depletion Potential (ODP) from the World Meteorological Organization (WMO) 1999.

3. **Human toxicity, cancer effects** from USEtox with revision of characterisation factors for some cosmetic ingredients (see section 3.8.2).

4. **Human toxicity, non-cancer effects** from USEtox with revision of characterisation factors for some cosmetic ingredients (see section 3.8.2 and Annex 7.5).

5. **Particulate matter** in comparison to PM2.5 from UNEP 2016.
6. **Ionizing radiation human health** (HH) from Human health effect model as developed by Dreicer et al. 1995 (Frischknecht et al, 2000).
7. **Photochemical ozone formation** from LOTOS-EUROS model (Van Zelm et al, 2008) as implemented in ReCiPe 2008.
8. **Acidification** using Accumulated Exceedance from Seppälä et al. 2006 and Posch et al. 2008.
9. **Terrestrial eutrophication** using Accumulated exceedance from Seppälä et al. 2006 and Posch et al. 2008.
10. **Freshwater eutrophication** from EUTREND model (Struijs et al, 2009) as implemented in ReCiPe.
11. **Marine eutrophication** EUTREND model (Struijs et al, 2009) as implemented in ReCiPe.
12. **Freshwater ecotoxicity** from USEtox with revision and additional development of characterisation factors for cosmetic ingredients (see section 8.4).
13. **Land use** using Soil quality index based on LANCA model (De Laurentiis et al. 2019) and on the LANCA CF version 2.5 (Horn and Maier, 2018).
14. **Water resource depletion** from Available WAter REmaining (AWARE) as recommended by (UNEP, 2016)
15. **Mineral resource depletion** from CML 2002 (Guinée et al., 2002) and (van Oers et al. 2002).
16. **Fossil resource depletion** from CML 2002 (Guinée et al., 2002) and (van Oers et al. 2002).

About 25000 elementary flows are characterized as contributors to these 16 impact categories included. All the characterization factors not reported here but are publicly available from the corresponding methods' sources, only additional ones in freshwater ecotoxicity category developed specifically for cosmetic ingredients are reported in this document.
Some specific calculation rules include propositions for handling solid waste end-of-life, types of allocation, formula end-of-life, focusing on aligning with the PEF method while addressing industry-specific contexts (see section 3.8 and 3.9).

### 2.6.2 Normalization and Weighting factors

The normalization and weighting used to aggregate individual impact category footprints into a single score aligns with the PEF methodology.

*Table 2: PEF Normalisation Factors with adapted Freshwater ecotoxicity NF*

| Description | Value | Unit |
|---|---|---|
| Normalisation value for Climate Change | 7553.083163 | kg CO2-eq per person |
| Normalisation value for Ozone Depletion | 0.052348383 | kg CFC-11 eq per person |
| Normalisation value for Ionising Radiation | 4220.16339 | kBq U235 eq per person |
| Normalisation value for Photochemical Ozone Formation | 40.85919773 | kg NMVOC-eq per person |
| Normalisation value for Particulate Matter/Respiratory Inorganics | 0.000595367 | disease inc. per person |
| Normalisation value for Human Toxicity, non-cancer | 0.000128736 | CTUh per person |
| Normalisation value for Human Toxicity, cancer | 1.72529E-05 | CTUh per person |
| Normalisation value for Acidification | 55.56954123 | mol H+ eq per person |
| Normalisation value for Freshwater Eutrophication | 1.606852128 | kg P-eq per person |
| Normalisation value for Marine Eutrophication | 19.54518155 | kg N-eq per person |
| Normalisation value for Terrestrial Eutrophication | 176.7549998 | mol N-eq per person |
| Normalisation value for Freshwater Ecotoxicity | 60485.31218* | CTUe per person |
| Normalisation value for Land Transformation | 819498.1829 | Pt per person |
| Normalisation value for Resource Depletion, energy carriers | 65004.25966 | MJ per person |
| Normalisation value for Resource Depletion, mineral and metals | 0.063622615 | kg Sb-eq per person |
| Normalisation value for Water Use | 11468.70864 | m3 of water - eq per person |

**The EBS association worked on improving the normalization factor for the impact category Freshwater Ecotoxicity through the enrichment of its inventory coverage, hence the difference with the PEF normalisation factor for this impact category (see details in section 7.6).*

Weighting factors are given for each PEF impact category and are presented in Table 3.

*Table 3: PEF weighting factors*

| Impact category/ Aggregation set | PEF |
|---|---|
| Climate change | 21.06% |
| Ozone depletion | 6.31% |

| Impact category/ Aggregation set | PEF |
|---|---|
| Ionising radiation, HH | 5.01% |
| Photochemical ozone formation, HH | 4.78% |
| Particulate matter | 8.96% |
| Human toxicity, non-cancer | 1.84% |
| Human toxicity, cancer | 2.13% |
| Acidification | 6.20% |
| Eutrophication, freshwater | 2.80% |
| Eutrophication, marine | 2.96% |
| Eutrophication, terrestrial | 3.71% |
| Ecotoxicity, freshwater | 1.92% |
| Land use | 7.94% |
| Resource use, fossils | 8.32% |
| Resource use, minerals and metals | 7.55% |
| Water Use | 8.51% |

### 2.6.3 Interpretation

Results are presented in relevance to substances, materials, processes or life cycle stages for analysis and identification of predominant contributors as well as an aggregated score for comparative purpose.

Results interpretation shall be done with the consideration of the data quality and method limitations (see section 2.7 and section 5).

## 2.7 Data Quality Requirements

### 2.7.1 General principles

Data quality of LCIs used in the EBS LCA model is not assessed with the semi-quantitative DQR approach presented in the PEF methodology which considers geography, time and technological representativeness.

However, the diversity of cosmetic ingredients and their limited coverage in LCA databases involved using data, such as LCIs, characterization factors (CFs) or parameters of the model (e.g. removal rates), which may be more or less specific of the ingredient.

Therefore, a data representativeness (see definition in section 6 Glossary) indicator was defined and calculated for each product in order to provide an indication on the overall level of specific (or generic) data used in the assessment, 1 being the lowest possible value corresponding to the most specific data and 5 the highest value corresponding to the most generic data.

Data representativeness assessment currently focuses on data used in the calculation of impacts at the production and end-of-life of formula stages and not for packaging nor other life cycle stages. In particular, in the case of packaging, datasets for the production of materials, converting and finishing processes could probably be assessed with regards of how representative they are but since the lists of materials, converting and finishing processes are "closed" lists to choose items from, when describing a packaging, there is no way to know whether the material which is chosen is indeed the one which is used or a “close” material in case the real material is not covered in the EBS database.

All data representativeness indicators are based on calculation from data representativeness grades implemented in the EBS database at ingredient level:

- At INCI level for data representativeness grades for the production process of ingredients since LCA datasets were defined at INCI level,
- At INCI+CAS level for data representativeness grades for the freshwater ecotoxicity CFs since these were defined at INCI+CAS level.

### 2.7.2 Data representativeness grades at ingredient level

#### *2.7.2.1 Production process of ingredients*

Data representativeness grades for ingredients production were defined in the EBS database at INCI level as follows:

*Table 4: Data representativeness grades of ingredients for each type of LCA model*

| Type of LCA model for ingredient production | DR grade |
| --- | --- |
| Company specific / suppliers’ data | 1 |
| Material specific | 2 |
| EBS data development | 2.5 |
| Class proxy chemical structure | 3 |
| Class proxy function | 4 |
| Generic proxy | 5 |

**Compagny specific / suppliers’ data**

The LCI comes from primary data collected by a company or a supplier. For now, ingredient EBS database doesn’t contain any of these models, governance modalities need to be defined.

**Material specific**

The LCI comes from an external LCA database used by EBS (ecoinvent, SPICE) and cover the production process of the considered ingredient.

*For example, the production process of “SOLANUM TUBEROSUM (POTATO) STARCH” ingredient is covered by the “Potato starch {GLO}| potato starch production | Cut-off, U” dataset which is therefore a material specific dataset for this ingredient.*

**EBS data development**

The LCI was developed by EBS (unit process) to model the production of the ingredient (usually based on retrosynthesis information) when no production process dataset exists in external LCA databases used by EBS (ecoinvent, SPICE). EBS LCIs for ingredients are based on EBS modelling guidelines and rely on external LCA databases and other EBS LCIs for background data.

**Class proxy chemical structure**

The dataset, either from external LCA databases or developed by EBS, does not reflect the production process of the specific ingredient considered but the production process of another ingredient or a family of ingredients which have the same chemical structure.

*For example, the production process of the "BUTYLENE GLYCOL" ingredient is covered by the "Propylene glycol, liquid {RoW}| propylene glycol production, liquid | Cut-off, U" dataset which is therefore a "class proxy chemical structure" dataset for this ingredient (whereas it is a material specific dataset for the "PROPYLENE GLYCOL" ingredient).*

*Another example is the case of the production process of the "LAURIC ACID" ingredient from coconut feedstock which is covered by the "Fatty acid {RoW}| fatty acid production, from coconut oil | Cut-off, U" dataset which is therefore a "class proxy chemical structure" dataset for this ingredient as it is not specific to lauric acid production from coconut but to fatty acids from coconut in general.*

**Class proxy function**

The dataset, either from external LCA databases or developed by EBS, does not reflect the production process of the specific ingredient considered but the production process of another ingredient or a family of ingredients which do not have the same chemical structure but has a similar function.

*For example, the production process of the "THYMUS VULGARIS OIL" ingredient is covered by the "Rosemary essential oil {GLO}| production | Cut-off, U EBS" dataset which is therefore a "class proxy function" dataset for this ingredient since it represents the production process of another essential oil from a different feedstock.*

*Another example is the case of the "PRUNUS ARMENIACA (APRICOT) SEED POWDER" ingredient which is covered by the "Botanical powder {GLO}| production | Cut-off, U EBS" dataset which is therefore a "class proxy function" dataset for this ingredient as it is not specific to apricot seed powder production but to botanical powder in general.*

**Generic proxy**

Default value applied when no specific model or class/function proxy is defined.

#### *2.7.2.2 Freshwater ecotoxicity characterization factors (used at the end-of-life stage)*

Data representativeness grades for the freshwater ecotoxicity CFs of ingredients were defined in the EBS database at INCI+CAS level as follows:

*Table 5: Data representativeness grades of ingredients for each type of freshwater ecotoxicity CF*

| Type of freshwater ecotoxicity CF | DR grade |
|---|---|
| - EBS recalculated CF with complementary internal review OR EF 3.1 CF – high quality score | 1 |
| - EBS recalculated CF<br>- EF 3.1 CF – average quality score | 2 |
| - EF 3.1 CF – low quality score<br>- New CF developed by EBS | 3 |
| Semi-specific proxy classes | 4 |

| | |
|---|---|
| Generic proxy | 5 |

**EF 3.1 CF**

This corresponds to the case where freshwater ecotoxicity CF were directly taken from EF 3.1 reference package. EF 3.1 freshwater ecotoxicity CF are categorised in EBS with high, average or low quality score which corresponds in fact to the quality score defined by JRC for HC20 used to derive the effect factor part of the CF.

HC20 quality score principles are defined in the technical report on freshwater ecotoxicity and human toxicity cancer, and non-cancer methodological framework[22] and take into account both the numbers of trophic levels and species for which ecotoxicity data are available.

**EBS recalculated CF**

This corresponds to the case where EBS had collected ecotoxicity data and recalculated an effect factor for the ingredient, using available FF and XF values for the ingredient in the EF 3.1 database. A review was conducted on some of them, mentioned as "with complementary internal review" ensure a very high quality of CFs.

**New CF developed by EBS**

This corresponds to the case where EBS had collected ecotoxicity data and recalculated an effect factor for the ingredient but without any FF and XF values for the ingredient in the EF 3.1 database, most of the time due to the fact that the ingredient is not covered at all in the EF 3.1 database. Therefore, 4 semi-specific (based on biodegradability and bioaccumulation parameters, see section 7.5) or generic proxy values determined by EBS had to be used for the FF × XF parameter, which means that new CF developed by EBS are considered to be less specific than recalculated CF.

**Semi-specific proxy classes**

Four ecotoxicity classes were defined based on REACH, CLP and C&L classification and corresponding effect factors based on available ecotoxicity data (see section 7.5). When no ecotoxicity data could be collected for an ingredient, semi-specific proxy values could be used for effect factor based on ecotoxicity class, if determined, and for FF × XF using on proxy classes values based on biodegradability and bioaccumulation.

**Generic proxy**

Default value applied when no specific CF or semi-specific CF proxy is defined.

### 2.7.3 Calculation of data representativeness indicators

#### *2.7.3.1 Data representativeness sub-indicator for the production of ingredients*

Data representativeness sub-indicator for the production of ingredients ($DR_{Ing.prod}$) is based on a calculation involving:

- Production data representativeness grade for each ingredient used in the formula,
- Contribution of each ingredient of the formula to the aggregated footprint of the production of all ingredients,

Which corresponds to the following equation:

$$DR_{Ing.prod} = \frac{\sum_i DRg_{prod.i} \times AFP_{prod.i}}{\sum_i AFP_{prod.i}} = \frac{\sum_i DRg_{prod.i} \times AFP_{prod.i}}{AFP_{Ing.prod}}$$

With:

- $AFP_{prod.i}$: aggregated footprint value for the production stage of ingredient i
- $AFP_{Ing.prod}$: aggregated footprint value for the production stage of all ingredients
- $DRg_{prod.i}$: data representativeness grade for the production of ingredient i

#### *2.7.3.2 Data representativeness sub-indicator for the end-of-life of ingredients*

Data representativeness sub-indicator for the end-of-life of ingredients ($DR_{Ing.EOL}$) is based on a calculation involving:

- Freshwater ecotoxicity CF data representativeness grade for each ingredient used in the formula,
- Contribution of each ingredient of the formula to the aggregated footprint of the end-of-life of all ingredients,

Which corresponds to the following equation:

$$DR_{Ing.EOL} = \frac{\sum_i DRg_{Ecotox\ CF\ i} \times AFP_{EOL\ i}}{\sum_i AFP_{EOL\ i}} = \frac{\sum_i DRg_{Ecotox\ CF\ i} \times AFP_{EOL\ i}}{AFP_{Ing.EOL}}$$

With:

- $AFP_{EOL\ i}$: aggregated footprint value for the end-of-life of ingredient i
- $AFP_{Ing.EOL}$: aggregated footprint value for the end-of-life stage of all ingredients
- $DRg_{Ecotox\ CF\ i}$: data representativeness grade for the freshwater ecotoxicity characterisation factor of ingredient i

#### *2.7.3.3 Data representativeness aggregated indicator for production and end-of-life of ingredients*

The aggregated data representativeness indicator related to the formula ($DR_{formula}$) is based on a weighted average of the two data representativeness sub-indicators (for the production stage and the end-of-life stage of the formula's ingredients), using the contributions of the formula's production and end-of-life stages to the aggregated footprint of the formula's production and end-of-life, as weighting factors.

The following equation applies:

$$DR_{formula} = \frac{DR_{Ing.prod} \times AFP_{Ing.prod} + DR_{Ing.EOL} \times AFP_{Ing.EOL}}{AFP_{Ing.prod} + AFP_{Ing.EOL}}$$

With:

- $DR_{Ing.prod}$: data representativeness sub-indicator for the production stage of ingredients
- $DR_{Ing.EOL}$: data representativeness sub-indicator for the end-of-life stage of ingredients
- $AFP_{Ing.prod}$: aggregated footprint value for the production stage of ingredients
- $AFP_{Ing.EOL}$: aggregated footprint value for the end-of-life stage of ingredients

# 3 Life Cycle Inventory

## 3.1 List of mandatory company-specific data

### 3.1.1 Overview

For each cosmetic product modelled using the EBS tool and following the EBS footprinting method, some input data must be communicated by the company. These mandatory company-specific data describe what the product is, its formulation (content) and its packaging. They are necessary to ensure a realistic modelling of the product.

Some data can be communicated by the company if available but are not mandatory (e.g. density). If nothing is communicated by the company, a pre-defined value is used.

Other data needed for the modelling of the products are defined as default values (not changeable) to ensure a fair comparison between products (e.g. the dose or the quantity of rinsing water). This is aligned with the principles of the PEF.

*Table 6: Overview of company-specific data*

| Data | Type | Format | Control (if relevant) | Relevant section of the documentation |
|---|---|---|---|---|
| Name of the Product | Mandatory | Free field | n.a. | n.a. |
| Product Segment | Mandatory | Picklist from EBS database | See section 7 for full list | See section 2.1.1 |
| Product Sub-Segment | Mandatory | Picklist | See section 7 for full list | See section 2.3.2 |
| Primary packaging type | Mandatory | Picklist | See Table 7 for full list | See section 3.3 |
| Amount of primary packaging per secondary packaging | Mandatory | Free field | Must be >0<br>Integer | See section 3.3 |
| Scoring region | Mandatory | Picklist | "Europe" is the only choice as the EBS score is valid only for Europe at the moment (European Union+Switzerland, Norway and UK). Please refer to usage and maintenance document for further details | See section 2.2 |
| Final Assembly Zone | Mandatory | Picklist | Asia, Africa, Europe, Middle-East, North America, South America or Global | See section 3.5 |
| Presence of substances of very high concern (SVHC)? | Mandatory | Picklist | n.a. | See section 2.1.3 |
| Claimed Mass/Volume of Formula in Finished Product (Primary Packaging level) | Mandatory | Free field | >0 | n.a. |

| Data | Type | Format | Control (if relevant) | Relevant section of the documentation |
|---|---|---|---|---|
| Unit | Mandatory | Picklist | g or mL | n.a. |
| Density (g/mL) | Default, changeable | Free field | *Default = 1g/mL*<br>Must be >0 | n.a. |
| Is this product part of a refillable system? | Default, changeable | Picklist | *n.a.* | n.a. |
| Product specificity (Monodose/dilutable)<br>Is your product a monodose or dilutable product? | Default, changeable | Picklist | *Default = n.a.*<br>n.a. or monodose or dilutable | See section 2.3.2.3 for dilutables and for monodose |
| Monodose amount (g or mL) | Default, changeable | Free field | Can be filled only if previous = "monodose"<br>Must be >0 | See section 2.3.2.3 |
| Dilution factor (g water to add / g of product to be diluted) | Default, changeable | Free field | Can be filled only if previous = "dilutable"<br>Must be >0 | See section 2.3.2.3 |
| **For each ingredient:** | | | | |
| Substance Name | Mandatory | Free field | n.a. | n.a. |
| INCI Name | Mandatory | Free field | n.a. | n.a. |
| CAS number | Mandatory | Free field | format Number-Number-Number | n.a. |
| PCT in formula (%) | Mandatory | Free field | >0% and ≤100%<br>&<br>total of products' substances must be ≥99.99% and ≤100.01% | n.a. |
| Carbon origin | Default, changeable | Picklist | *Default = "unspecified"* | See section 6.1 |
| Feedstock | Default, changeable | Picklist | *Default = "unspecified"* | See section 6.1 |
| **For each packaging component:** | | | | |
| Packaging level | Mandatory | Picklist | Primary or Secondary | See section 3.3.1 |

| Data | Type | Format | Control (if relevant) | Relevant section of the documentation |
|---|---|---|---|---|
| Component Type | Mandatory | Picklist | See section Table 8 for full list | See section 3.3.1 |
| Number of components (primary pack) | Mandatory | Free field | Integer<br>Must be >0 | See section 3.3.1 |
| Recycling disruptors | Yes | Picklist | n.a. | See section 3.9.2 |
| **For each packaging material:** | | | | |
| Material | Mandatory | Picklist | See section 7.4.1 for full list | See section 3.3.2 |
| Material - Mass (g) | Mandatory | Free field | Must be >0 | n.a. |
| Material - %PCR | Mandatory | Free field | Must be ≥0% and ≤100% | See section 3.3.1 |
| Converting process | Default, changeable | Picklist | See section 7.4.2 for full list | See section 0 |
| Finishing | Default, changeable | Picklist | *Default = None*<br>See section 7.4.3 for full list | See section 3.3.4 |
| Finishing surface (cm2) | Default, changeable | Free field | *Can be filled only if previous is different to None*<br>Must be >0 | See section 3.3.4 |

## 3.2 Formula ingredient production

### 3.2.1 Types of ingredients (priority/non-priority)

One of the main challenges the cosmetic industry is facing for LCA-based environmental assessments of cosmetic products is related to its use of a huge diversity of ingredients and, consequently, data availability of LCI and characterization factors (CF) of ingredients. The

Personal Care Products Council (PCPC), which develops and publishes INCI (International Nomenclature Cosmetic Ingredient) names, currently lists over 35 000 INCI names, not accounting ingredients which do not have an official registered INCI name yet.

Ingredients used in cosmetic formulas could largely differ from one segment to another, even if there are common ingredients across segments e.g. water, and considering the number of possible ingredients, EBS has implemented a prioritisation approach of ingredients to be covered in the EBS databases as a first step. Therefore, EBS made a distinction between "priority" and "non-priority" ingredients.

"Priority ingredients" were defined as ingredients which needed to be identified specifically in order to be included in EBS databases. This means that availability of LCI and CF in LCA databases was checked for these ingredients and data development could be considered if needed. As a consequence, priority ingredients in a cosmetic formula of a product assessed following the EBS methodology have a corresponding entry in EBS databases with data to be used for environmental assessment, even if data could be more or less specific of the priority ingredient considered, depending on data availability.

"Priority ingredients" were defined, on a product segment basis as ingredients for which at least one the below criteria apply. Data has been collected at company level on a voluntary basis.

1. Ingredients that represent approximately 80% of total formula mass per the segment.
2. Ingredients representing highest amounts in a "subset" of formulas in the segment (i.e. for hair wash segment, sulphate-free shampoos, antidandruff shampoos, solid shampoos etc.).
3. Ingredients present in highest concentration in formulas, with a cut-off at 5 wt% on dry extract.
4. Most impacting ingredients based on internal or public studies and known from members as key contributors in the overall impact (based on LCA conducted by EBS members).

Regarding criteria 4, identification of the most impacting ingredients was done both from the production of ingredients perspective and from the end-of-life of ingredients perspective, especially with regards to the freshwater ecotoxicity impact for the end-of-life.

Therefore, based on these criteria, "priority ingredients" are assumed to represent the most important/relevant ingredients which need to be studied in order to conduct the environmental assessment of most products in a segment.

From this data collection process, "priority ingredients" were defined as a combination of an INCI name with a CAS number if available. Consolidated lists of priority ingredients were then prepared, based on priority ingredients identified for each segment, for the production stage and the end-of-life stage.

On the other hand, "non-priority ingredients" are all other ingredients, which are not identified specifically in EBS databases.

### 3.2.2 How we attribute a dataset to an ingredient (specific, chemical families, function families)

The availability for both the production datasets and CF of ingredients varies depending on the databases utilized (e.g., ecoinvent, USEtox, EF 3.1). For instance, it is possible to have access to sourcing and production data of an ingredient but not have end-of-life data (e.g. freshwater ecotoxicity CF, removal rate) for this same ingredient. This has implied selecting alternates for primary data sources for inventories of ingredients. Thus, the following strategy has been used for ingredients (sourcing & production and formula end-of-life) datasets:

- Mapping the priority ingredients for products segments, through specific data granted by members or using publicly available information e.g. information on the manufacturing process to implement a "retrosynthesis" approach up to identifying reactants having LCIs in databases, information from REACH dossiers on ecotoxicity reference concentrations, biodegradability, etc as agreed by EBS members.
- Find proxies:
    - For production LCI, by using the dataset of another ingredient as a proxy (chemical structure or function) and/or by applying a proxy approach based on a clustering of ingredients, clusters of ingredients being defined based on a chemical structure or function.
    - For end of life, by using semi-specific proxy classes values.
- Define default, conservative non-specific datasets to fill-in remaining data gaps when no dataset is available in the database for some ingredients, as agreed by EBS members.

All this activity was conducted by EBS members sharing data internally developed or through specific data development, and collective agreement on data selected.
As a guiding principle, the overall target is to have 99,99% of the total formula composition covered. The proxy datasets have been defined and agreed by all members.
The list of priority ingredients is covered, for both production and end-of-life data:

- With existing databases e.g. ecoinvent, World Food LCA Database (WFLDB), EF 3.1, etc.
- With datasets from Member Companies or developed within EBS.
- With proxy for clusters of ingredients (by chemical structure or function) adapted to the target ingredient.
- With default values ($75^{th}$ percentile values of ingredients not covered by proxy values) to avoid "no data no impact".

A total number of 690 priority ingredients i.e. 690 unique INCI names were identified for the first 4 EBS segments (Hair Wash, Face Moisturize & Treat, Hair Treat and Body Wash). Each of these INCI names may have been considered with several CAS numbers, feedstock or carbon origin. The number of priority ingredients, as unique INCI names, per segment is, keeping in mind that some ingredients are used in several segments:

- Hair Wash: 108
- Face Moisturize & Treat: 287
- Hair Treat: 368
- Body Wash: 228

For production data, in addition to priority ingredients, ingredients belonging to the "essential oils" (715 non-priority ingredients), "siloxanes" (632 non-priority ingredients) and "silanes" (66 non-priority ingredients) families were mapped to proxy values:

- "Rosemary essential oil {GLO}| production | Cut-off, U EBS" for essential oils

- "Polydimethylsiloxane {GLO}| polydimethylsiloxane production | Cut-off, U" for siloxanes
- "Dimethyldichlorosilane {GLO}| dimethyldichlorosilane production | Cut-off, U" for silanes

Ingredients belonging to these families were identified based on the COSING list of ingredients and their names or descriptions.
Regarding "non-priority ingredients", as mentioned in the previous section, ingredients which are not part of the priority ingredients' list do not have entries in EBS databases, since all ingredients were not identified in a comprehensive way. When assessing a cosmetic product whose formula contains "non-priority ingredients", default values, labelled as "generic proxy" values, are applied in several parts of the model, in order to avoid "no data no impact":

- For the production stage of ingredients, one "generic proxy" LCI data i.e. generic values for the 16 impact categories
- For the end-of-life of ingredients
  - One "generic proxy" ecotoxicity CF
  - One "generic proxy" human toxicity, non-cancer CF and one "generic proxy" human toxicity, cancer CF
  - One "generic proxy" removal rate value
  - One "generic proxy" fossil carbon content for each carbon origin (fossil, bio-based, mix, inorganic, unspecified)

This mapping of "non-priority ingredients" to "generic proxy" was made thanks to an algorithm implemented in the EBS tool which maps any ingredient not found in EBS databases to the "virtual" GENERIC PROXY ingredient which has corresponding "generic proxy" data.

### 3.2.3 Modelling guidelines for EBS datasets

Datasets were developed by EBS, to cover some ingredients for which no LCIs were available in usual LCA databases used in EBS.
Modelling guidelines were established for a generic chemical synthesis to ensure that all developed datasets followed the same methodology and assumptions and define default data when this no data available. It includes the main data input for synthetic ingredients, i.e. yield, substances quantities and transport, energy consumption, waste and emissions. Modeling guidelines are detailed in section7.3.1. It does not apply to natural ingredients (vegetal oils, essential oils and waters, plant extracts, wax…) which are covered in sections 7.3.2 to 7.3.5.

## 3.3 Packaging production

### 3.3.1 Overview

#### Packaging levels

This life cycle stage deals with the potential environmental impacts associated with the production of primary, secondary, and tertiary pack.
The different levels of packaging are defined as follow:

- 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

While the specificities of the primary and secondary packaging (e.g. type of packaging, materials and corresponding weight, % recycled material, etc) are shared by the user of the EBS method and are hence described based on primary data, tertiary packaging is modelled based on default values. The details of this default tertiary packaging (pack-in and pack-out) are described in the relevant sections hereafter.

### Definition of primary packaging types and components

To improve the accuracy of the results while reducing the complexity of the modelling, a primary packaging type and component names are introduced in the data asked from companies. This allows to determine defaults values or processes for elements that companies might not know about their pack because they buy the component already manufactured (e.g. which converting and finishing were applied during the manufacture of the packaging components – see section 3.3.4). These can therefore be based on an information companies have, i.e. the packaging type and the components.

The users are asked to choose a type of packaging that describes the best their pack from the fixed pick list in Table 7, and a component name for each of the components they share data on in the input file as per the fixed pick list in
Table 8.

*Table 7: Primary packaging types*

| Packaging Types |
|---|
| Aluminium can with valve[1] |
| Bottle with cap |
| Bottle with pump |
| Bottle with reducer |
| Box |
| Jar with brush |
| Jar with cap |
| Jar with dropper |
| Pen/brush |
| Pouch |
| Sachet |
| Stick |
| Tube with cap |
| Tube with roller |

[1] Note that the user may have a can with valve that is not made of Aluminium. In that case, the user should select the packaging type "Aluminium can with valve" and select the appropriate material in the packaging material section (see section 7.4.1 for full list).

*Table 8: Packaging component names*

| Component name |
|---|
| Bottle |
| Tube |
| Tub |
| Pot |
| Cup |
| Jar |
| Can |
| Pouch |
| Flexible packaging |
| Sachet |
| Cap |
| Lid |
| Closure |
| Pump |
| Dispenser |
| Aerosol components |
| Seal |
| Paper wrap |
| Carton |
| Cardboard box |
| Label (inc. ink and other related elements) |
| Foil |
| Accessories |
| Applicators |
| Aerosol |
| Trays |
| Clamshell |
| Thermoforms |
| Dunnage |
| Inserts |
| Plastic film |
| Case/Tray |
| Blister |
| Leaflet |
| Dropper |

### Description of primary and secondary packaging - amount of each component

The other additional information required to model packaging are the number of primary packaging per secondary pack, and the number of components in the packaging.
To illustrate this, let's take as an example 10 sachets of shampoo sold together in a cardboard box, itself wrapped in a plastic film (as per Figure 2).

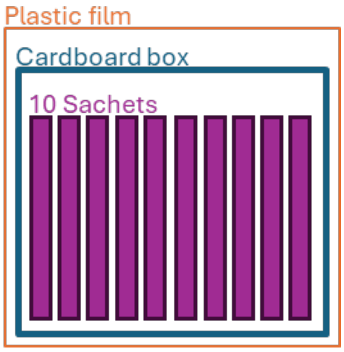



*Figure 2: Example to illustrate packaging additional information*

In this case, the primary pack is the sachet, while the secondary pack has two elements, i.e. the cardboard box and the plastic film. The information should be the following:

- Amount of primary packaging per secondary packaging: 10
- Number of components (primary pack) – Sachet: 10
- Number of components (primary pack) – Cardboard box: 1
- Number of components (primary pack) – Plastic film: 1

### Leftover rates

Often, when reaching the end of a product, part of the formula remains unconsumable because it is impossible to get it out of the packaging in an easy way (e.g. stuck at the bottom of the bottle of shampoo). The percentage of formula that is hence not accessible by the consumer is called the "leftover rate" (%), or $R_{leftover}$.
The leftover rate for a specific product will depend on both the packaging type and design, and the formula characteristics (e.g. viscosity). However, it is often an information that the companies do not possess readily available. Therefore, for simplification purposes, the packaging type is the only element used to determine the leftover rate in the EBS methodology.
For each packaging type as defined in Table 7, packaging experts have determined a default leftover rate (see Table 9 for full list).

*Table 9: Primary packaging types and corresponding default leftover rates*

| Packaging Types | Leftover rate |
|---|---|
| Aluminium can with valve | 10% |
| Bottle with cap | 4.7% |
| Bottle with pump | 8% |
| Bottle with reducer | 10% |
| Box | 0% |
| Jar with brush | 10% |
| Jar with cap | 0% |
| Jar with dropper | 10% |

| | |
|---|---|
| Pen/brush | 10% |
| Pouch | 1.3% |
| Sachet | 0% |
| Stick | 10% |
| Tube with cap | 6.7% |
| Tube with roller | 10% |

It is important to account for this leftover rate in the LCA of cosmetic products, as the formula left in the packaging has been produced and will be discarded through different potential routes just like the formula used by the consumer. In the EBS methodology, it is assumed that the formula leftover has the same fate than the formula used by the consumer, i.e. part of it will be discharged in wastewater, depending on the connectivity rate of the region, and the rest is emitted directly to freshwater. The way the leftover rate is accounted for is thus simply a re-scaling of the amount of formula and packaging amount needed per FU (cf section 2.3).

*Example: As described in section 2.3, the functional unit in the EBS method is one dose of product. Let's imagine a product with a dose of 10 g and the leftover rate of its packaging of 5%. Then the reference flow for one dose of that product is 10 g + 10 g * 5% = 10.5 g*

### 3.3.2 Material production

The potential environmental impacts related to the production of pack materials, i.e. *Material production I*, *Material production II*, *Material production III – pack-in* and *Material production III – pack-out* in Figure 1, are modelled using the SPICE database[8]. SPICE database is the most up-to-date and comprehensive packaging database for cosmetics products This database includes mostly ecoinvent datasets, but also additional datasets developed specifically by the SPICE Initiative.

The exhaustive list of materials available in the EBS model and their corresponding datasets is available in Annex 7.4.1.

*NB: The impacts calculated when applying the LCIA on these datasets correspond to the* $E_{recycled}$ *and* $E_v$ *parameters of the CFF (see section 2.5.3).*

#### Primary and secondary packaging

For primary and secondary packaging, materials for each packaging component are communicated as an input by the user of the EBS method, and corresponds to the line *Packaging material* in Table 6. For each material, the recycled content (i.e. percentage of the material that was produced through recycled routes, as opposed to virgin material) is also communicated as an input (i.e. the line *Material - %PCR* in Table 6).

NB: *Material - %PCR* corresponds to the parameter R1 in the CFF (see section 2.5.3).

#### Tertiary packaging (pack-in) default

The default tertiary packaging (pack-in) is made of two components:

- A box made of corrugated board
- A wooden pallet, covered in plastic film

The size and weight of these elements per kilogram of transported materials have been determined based on the same hypotheses than used in the SPICE tool[8]. They are as disclosed in Table 10.

*Table 10: Packaging pack-in materials assumptions*

| Element | Amount | Unit |
|---|---|---|
| Quantity of corrugated board | 0.061403509 | g per g of consumer pack |
| Quantity of wood | 0.082442949 | g per g of consumer pack |
| Quantity of plastic film | 0.001263026 | g per g of consumer pack |
| Number of rotations for corrugated board and plastic film | 1 | rotations |
| Number of rotations for pallet | 50 | rotations |

It is assumed that all materials used for the tertiary packaging have no recycled content (i.e. %PCR = 0%).

#### Tertiary packaging (pack-out) default

Similarly to pack-in, the default tertiary packaging (pack-out) is made of two components:

- A box made of corrugated board
- A wooden pallet, covered in plastic film

The size and weight of these elements per kilogram of transported final product have been determined based on the same hypotheses than used in the SPICE tool[8]. They are as disclosed in Table 11.

*Table 11: Packaging pack-out materials assumptions*

| Element | Amount | Unit |
|---|---|---|
| Quantity of corrugated board | 0.42 | g per mL of product transported |
| Quantity of wood | 0.37 | g per mL of product transported |
| Quantity of plastic film | 0.3 | g per mL of product transported |
| Number of rotations for corrugated board and plastic film | 1 | rotations |
| Number of rotations for pallet | 50 | rotations |

It is assumed that all materials used for the tertiary packaging have no recycled content (i.e. %PCR = 0%).

### 3.3.3 Packaging component production

The potential environmental impacts related to the converting of pack materials, i.e. *Packaging components production I*, *Packaging components production II*, *Packaging components production III – pack-in* and *Packaging components production III – pack-out* in Figure 1, are modelled using the SPICE database[8]. This database includes mostly ecoinvent datasets, but also additional datasets developed specifically by the SPICE Initiative.

The exhaustive list of converting processes available in the EBS model and their corresponding datasets is available in Annex 7.4.2.

#### Primary and secondary packaging

For primary and secondary packaging, converting of materials for each packaging component can be communicated as an input by the user of the EBS method, and corresponds to the line *Converting process* in Table 6. This input is not mandatory because companies might not know the converting used for the manufacturing of the pack component (e.g. if they did not manufacture the component themselves but bought it from a third party). Hence, a default converting process for each packaging component type is available in the EBS database, that will be applied for materials for which no primary data is available from the input data. The list of default converting processes is available in Annex 7.4.4.

#### Tertiary packaging (pack-in) default

The only element of pack-in that undergoes processing is the plastic used to make the films, and the processing applied is Extrusion.

#### Tertiary packaging (pack-out) default

The only element of pack-out that undergoes processing is the plastic used to make the films, and the processing applied is Extrusion.

### 3.3.4 Packaging component finishing

Finishing corresponds to the final treatment of a packaging component to create its final texture or decoration (e.g. galvanization of metals or offset printing on plastics). Finishing can be applied on the entire surface of the pack component or only a part of it, which is why the surface on which the finish is applied is a required information when modelling packaging.
The potential environmental impacts related to the finishing of pack materials, i.e. *Packaging component finishing I* and *Packaging component finishing II* in Figure 1, are modelled using the SPICE database[8]. This database includes mostly ecoinvent datasets, but also additional datasets developed specifically by the SPICE Initiative.
The exhaustive list of finishing processes available in the EBS model and their corresponding datasets is available in 7.4.3.

#### *3.3.4.1 Primary and secondary packaging*

For primary and secondary packaging, the finishing of each packaging component as well as the corresponding finishing surface can be communicated as an input by the user of the EBS method, and corresponds to the line *Finishing process* and *Finishing surface ($cm^2$)* in Table 6. This input is not mandatory because companies might not know the finishing during the manufacturing of the pack component (e.g. if they did not manufacture the component themselves but bought it from a third party). Hence, a default finishing process and finishing surface for each packaging component type is available in the EBS database, that will be applied for materials for which no primary data is available from the input data. The list of default finishing processes and finishing surfaces is available in Annex 7.4.4 and Annex 7.4.5.

#### *3.3.4.2 Tertiary packaging (pack-in) default*

No finishing is applied on tertiary packaging.

#### *3.3.4.3 Tertiary packaging (pack-out) default*

No finishing is applied on tertiary packaging.

## 3.4 Upstream transport scenarios – from material production to component producer, and from component producer or ingredient supplier to manufacturing site

The transport scenarios, which cover default modal of transport and distances, are following the PEF guidelines and are the following:

*Table 12: Transport scenarios (upstream transport)*

| Transport scenario | Geography | Truck (km) | Train (km) | Ship (km) | Plane (km) | Unit | Source |
|---|---|---|---|---|---|---|---|
| Raw Material <-> Supplier | GLO – GLO | 1000 | 0 | 18 000 | 0 | km | PEF [1] |
| Supplier <-> Manufacturing site | GLO – GLO | 1000 | 0 | 18 000 | 0 | km | PEF [1] |

The assumption is that our supply chains are global and therefore the supply can come from anywhere around the globe.

## 3.5 Manufacturing

The manufacturing – formula life cycle stage accounts for the resource use and emissions during the making and packing of a cosmetic product. Typically, this corresponds to the mixing of a formula and the filling into a container, e.g. a bottle or a jar.
The impacts associated to this life cycle stage come from water consumption, energy consumption, as well as waste generation.
The data of the Shampoo Shadow PEFCR[3] is used as a default global proxy for the manufacturing of all products (in all segments and sub-segment). This is appropriate for the segments currently developed by EcoBeautyScore since their production steps are similar and it is known from former studies of the personal care and cosmetic products that the manufacturing life cycle stage is not most relevant.
The above-mentioned source of data represents an average based on four company-specific shampoo manufacturing data in Germany, Italy, United Kingdom and the United States. All inventory data corresponds to global data, except the electricity consumption, that is based on the final assembly zone communicated by the company (Asia, Africa, Europe, Middle-East, North America, South America or Global). The average data extracted from the Shadow PEFCR report with adapted datasets is shown in the table below:

*Table 13: manufacturing scenario*

| | Value | Units | ecoinvent LCI Dataset |
|---|---|---|---|
| Electricity consumption | 1,27E-01 | kWh/kg | Electricity, low voltage {…}\| market group for electricity, low voltage \| Cut-off, U (Adapted to manufacturing region (RER, RAF, RAS, RME, RNA, RLA and GLO)) |
| Natural gas consumption | 7,17E-01 | MJ/kg | Heat, central or small-scale, natural gas {GLO}\| market group for \| Cut-off, U |

| | | | |
|---|---|---|---|
| Oil consumption | 9.56E-5 | MJ/kg | Heat, district or industrial, other than natural gas {RoW}\| heat production, light fuel oil, at industrial furnace 1MW \| Cut-off, U |
| Water use | 1.53E-3 | $m^3$/kg | Tap water {GLO}\| market group for \| Cut-off, U |
| Wastewater treatment | 1.43E-3 | $m^3$/kg | Wastewater, average {RoW}\| treatment of, capacity 1E9l/year \| Cut-off, U |

When EcoBeautyScore is developing other product segments the default manufacturing will require refinement, since other process steps (e.g. adding propellant) might be in scope.

## 3.6 Distribution (Downstream Transport and Storage)

The distribution life cycle stage includes all downstream transportation of the finished product from the manufacturing site to the final use location and the storage in between:

- transport from the manufacturing site to the retailer via a distribution centre (business-to-business (B2B))
- the storage of the finished product at said distribution centre and retailer
- transport from retail to household by the consumer

### 3.6.1 Downstream Transport

Table 14 presents the key datasets and activity data used for the default downstream transportation steps. These default values are taken from the PEF guidance[1].

*Table 14. Global distribution transport scenario*

| Transportation step and mode | ecoinvent LCI Datasets for transport modes | Distance (km)[1] | Allocation of transport mode[1] |
|---|---|---|---|
| B2B transport by truck | Transport, freight, lorry, unspecified {GLO}\| market group for transport, freight, lorry, unspecified \| Cut-off, U | 1,000 | 100% |
| B2B transport by boat | Transport, freight, sea, container ship {GLO}\| transport, freight, sea, container ship \| Cut-off, U | 18,000 | 100% |
| B2B transport by train | n/a | 0 | n.a. |
| B2B transport by plane | n.a. | 0 | n.a. |
| Consumer transport by car | Transport, passenger car {RoW}\| transport, passenger car \| Cut-off, U | 5 | 62% |
| Consumer transport by van | Transport, freight, lorry 3.5-7.5 metric ton, EURO3 {RoW}\| transport, freight, lorry 3.5-7.5 metric ton, EURO3 \| Cut-off, U | 5 | 5% |
| Consumer transport by other modes (public transport, bike, foot, …) | *neglected since very low impact* | n/a | 33% |

The B2B downstream transport of the finished product takes into account the transported mass of formula, primary, secondary and tertiary « pack-out » packaging (see section 0) by truck and boat.

The consumer transport by van is reflecting the transport of the formula, primary and secondary packaging based on mass. The van is approximated in PEF with a 3.5-7.5 t truck with 30% load ratio.

The impact of the consumer transport by car is calculated based on the volume that the product occupies in the trunk. According to PEF, the maximum volume to be considered available for consumer transport is 0.2 $m^3$ (around 1/3 of a trunk of 0.6 $m^3$) in case of products which are smaller than 0.2 $m^3$ = 200 L. This is generally the case for all cosmetic products.

The volume that the product occupies in the trunk is larger than the claimed volume of formula $V_{prod}$. In order to get to this occupation volume the claimed volume of the product is scaled with a factor derived from the respective volumes $V_{def,occup}$ and $V_{def,prod}$ of a default comparison product (Table 15). These values are specific to the product segment and provided in Annex 7.2, p. 65.

*Table 15: Parameters for consumer transport scenario*

| Parameter | Value |
|---|---|
| Car trunk volume available | 200,000 mL |
| Occupation volume | $\frac{V_{def,occup}}{V_{def,prod}} \cdot V_{prod}$ <br>(values are product segment specific, see Annex 7.2, p. 65) |

The distance that consumer travels from the POS is assumed to be 5 km for each transport mode. Allocation factor applies for consumer trips made by car and by van that reflect the percentage of trips made by each mode, 62 % and 5 % accordingly. For 33% of trips no impact modelled[9].

### 3.6.2 Downstream Storage

The storage at the distribution centre DC and point-of-sale PoS requires the use of electricity, modelled with a global electricity mix average, to fulfil the global footprinting scenario (Table 16).

*Table 16: dataset for storage electricity consumption*

| Sales zone | ecoinvent LCI Datasets for electricity consumption at storage |
|---|---|
| All | "Electricity, low voltage {GLO}\| market group for electricity, low voltage \| Cut-off, U" |

The default amounts for energy consumption at DC and PoS used in EBS are in line with the values used in the Shampoo Shadow PEFCR study.[3] The consumption per product is depending on the volume or area occupied. These are derived from the claimed volume of a product $V_{prod}$. using the respective values of a default comparison product. These default values are product segment-specific (see Table 17 and Annex 7.2, p. 65).

*Table 17: parameters for downstream storage scenario*

| Parameter | Value (unit) | Reference |
|---|---|---|
| Default electricity consumption at DC | 6 kWh/(m³·y) | Humbert et al.[10] |
| Default electricity consumption at PoS | 700 kWh/(m²·y) | Schönberger et al.[11] |
| Default occupation time in DC and in PoS | 0.08 y | Schönberger et al. [11] |
| Occupation volume | $\frac{V_{def,occup}}{V_{def,prod}} \cdot V_{prod}$ | default values are product segment specific, s. Annex 7.2, p. 65 |
| Occupation area | $\frac{A_{def,occup}}{V_{def,prod}} \cdot V_{prod}$ | default values are product segment specific, s. Annex 7.2, p. 65 |

## 3.7 Use phase

Additional supplementary reference flows that may be required to deliver the FU are taken into account as part of the use phase.

A key differentiating factor of the use phase of cosmetics is whether they are rinse-off or leave-on products. For rinse-off products, water is used to remove the product from the specific body zone.

### 3.7.1 Rinse-off vs. Leave-on Products

The use phase of rinse-off products is therefore characterized by the consumption of water and energy used to heat the water (Table 18). Leave-on products are attributed zero water and energy consumption.

The volume of the rinse water depends on the FU and is defined by segment. The values are provided in Annex 7, p. 60. The amount of energy required to heat the water is calculated based on parameters provided in the French guidance AFNOR BP X30-323-56.[12] These are in line with the Shampoo Shadow PEFCR study.[3] These references represent European consumer habits and have been extrapolated to a global region for the purpose of EcoBeautyScore.

*Table 18: Use phase scenario*

| Parameter | Parameter Name | Parameter Value | Unit | Reference |
|---|---|---|---|---|
| $V_{rinse\ water}$ | volume of rinse water | *segment-specific* | L | see Annex 7, p. 60 |
| $T_{initial}$ | initial temperature | 15 | °C | AFNOR BP X30-323-5[12] |
| $T_{final}$ | final temperature | 38 | °C | AFNOR BP X30-323-5[12] |
| $c_{H_2O}$ | specific heat capacity of water | 4180 | J/kg .K | phys. parameter |
| $\rho_{H_2O}$ | density of water | 1 | kg/L | phys. parameter |
| $\eta_{heating}$ | energy efficiency of heating systems | 0.9 | | AFNOR BP X30-323-5[12] |
| $Q_{heating}$ | energy required to heat 1 L of water | 0.1068 | MJ/L | $Q_{heating} = \frac{c_{H_2O} \cdot \rho_{H_2O} \cdot (T_{final} - T_{initial})}{\eta_{heating}}$ |

The energy mix used for residential water heating is a weighted global average. The global average is built based on member's previous study.

## 3.8 End-of-life of the formula

This life cycle stage encompasses the fate of a product's formula after usage, and its subsequent environmental impacts.

In the EBS methodology, it is assumed that after product use all formula ingredients go down the drain and thus become constituents of wastewater which can either go to a wastewater treatment plant (WWTP) where they can be partly removed from the wastewater or be directly discharged into freshwater bodies. Certain percent of formula ingredients thus always end up in the freshwater body. Furthermore, if a product is rinseable, there are additional impacts linked to the water used during the use phase, which ends up either as wastewater that is directly discharged to water streams, or as wastewater that is captured and treated at a WWTP.

The impact of the end-of-life of formula for all products (rinsed and non-rinsed products) is specifically related to:

- freshwater ecotoxicity as certain fraction of ingredients in a product's formula is potentially ending in the natural water bodies;
- human toxicity arising from potential direct or indirect ingestion with water or food by human of a very small fraction of ingredients ending in the natural water bodies;
- climate change related to carbon dioxide emissions originating from degradation of fossil-based ingredients.

Thus, characterization factors are applied to the quantity of ingredients released in natural water bodies for three impact categories – freshwater ecotoxicity, human toxicity cancer and non-cancer. For climate change, based on the assumption that all carbon content of ingredients ends up as carbon dioxide emissions due to degradation on a 100-year timeframe, fossil $CO_2$ characterisation factor (1) is applied to the carbon dioxide equivalent quantity of fossil carbon quantity in ingredients. However, other impact categories are not currently assessed; in particular:

- freshwater and marine eutrophication, for which the current degradation model applied to carbon and $CO_2$ emissions could possibly apply to phosphorus and nitrogen content of ingredients;
- photochemical ozone formation, for which the end-of-life model of ingredients would need to consider air emissions of gaseous ingredients e.g. propellants and the case of volatile ingredients which may be partly released to air at the end-of-life.

Future developments in the EBS methodology may address this limitation.

An overview of the impacts for this life cycle stage can be found in Figure 3.

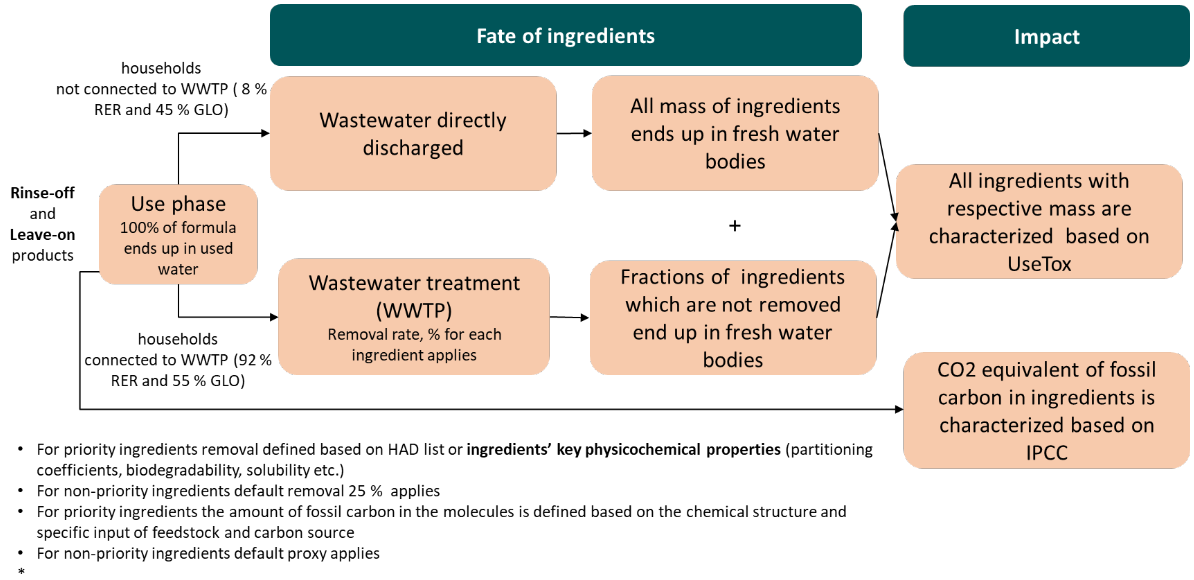



*Figure 3: End-of-life fate and characterisation of ingredients*

The fraction of each formula ingredient that undergo wastewater treatment based on the average European household-to-WWTP connectivity rate is set to 92% in Europe.[3] Thus, the remaining 8% is assumed to be directly discharged into natural water bodies. In the global model, WWTP connectivity rate considered is 55%, therefore 45% remaining assumed to be directly discharged[13].

### 3.8.1 Ingredients removal during WWT

For the removal rate, ingredients on the priority ingredients lists for segments were mapped to a list prepared by the Gesellschaft Deutscher Chemiker providing loading factors for approximately 250 chemicals or groups of chemicals (i.e.: polymers, amines, etc.). As a reminder, removal rate corresponds to 1 minus loading factor. When an ingredient can be directly identified in the HauptAusschuss Detergentien (HAD) list, a specific removal rate is applied to it based on the specific loading factor value. If no match is found using the HAD list directly, a second step is then undertaken to calculate ingredient specific removal rate based on physico-chemical properties of ingredients. For this, the HAD provides a matrix to aid in estimating loading factors based on the octanol-water partition coefficient (log Kow) and biodegradability of an ingredient [14]. Thus, data collection of two physico-chemical properties of priority ingredients through public (JRC, ECHA, etc.) and company-specific data was conducted. Based on this collected data, the HAD interpolation method is used for determining loading factors following Table 19 or directly removal rates following Table 20.

*Table 19: HAD loading factor estimation matrix*

| Log Kow | Loading factor (LF) | | |
|---|---|---|---|
| | Readily biodegradable | Inherently biodegradable | Poorly biodegradable |
| <2 | 0.13 | 0.6 | 1 |
| 2-4 | 0.1 | 0.5 | 0.75 |
| ≥4 | 0.07 | 0.3 | 0.4 |

*Table 20: Removal rate estimation matrix based on HAD loading factor matrix*

| Log Kow | Removal rate (RR) | | |
|---|---|---|---|
| | Readily biodegradable | Inherently biodegradable | Poorly biodegradable |
| <2 | 0.87 | 0.4 | 0 |
| 2-4 | 0.9 | 0.5 | 0.25 |
| ≥4 | 0.93 | 0.7 | 0.6 |

If no direct mapping can be done and insufficient data is collected to estimate an ingredient's removal rate, a semi-specific removal rate based on the available parameter (log Kow or biodegradability) and the worst-case scenario for the non-available parameter (i.e. poorly biodegradable or log Kow <2, respectively) is used. Otherwise, when no data is available at all, a default removal rate of 25% is applied.

### 3.8.2 Freshwater ecotoxicity and human toxicity

As mentioned above, the end-of-life of cosmetic formulas will have potential impacts on Freshwater ecotoxicity and Human toxicity impact categories. For the potential impacts of ingredients on Freshwater ecotoxicity and Human toxicity, characterization factors are defined by the PEF (EF 3.1) in line with USEtox® framework.

According to mapping by the CAS number, among all cosmetic ingredients which were defined as priority ingredients for the database, less than one quarter have defined characterization factors in the database adapted by the Joint Research Center (EC) for PEF based on USEtox® framework.

The poor coverage of some groups of chemicals can be explained by limitations of availability of measured data on environmental fate and toxicological properties and existing measurement methods. Additional uncertainties were spotted due to imprecision of the input data, potential chemicals misclassifications as well as data collection and curation inconsistencies. Systematic revision on characterization factors available in EF3.1 database was performed along with development of additional characterization factors to ensure that end-of-life characterization can be applied to all cosmetic ingredients available in the formulas. Detailed process and results of the systematic revision and development of characterization factors is provided in section 7.5.

For Human toxicity categories (cancer and non-cancer effects), EF3.1 CF database values are applied when available and based on EBS's expert review have good quality of underlying data. For the rest of ingredients, the proxy value corresponding to the 75%tile of the specific ingredient CF values is applied.

### 3.8.3 Carbon release during End-of- Life

The mass of $CO_2$ emission is calculated as equivalent to mass of the fossil carbon in each specific ingredient, defined based on carbon origin (section 3.1.1) and molecular weight for priority ingredients. The main assumption is that all ingredients are supposed to fully degrade over a 100-year timeframe and their carbon content ending up as $CO_2$ emissions. In case there are both fossil-derived and bio-derived carbon atoms in ingredients' structure, $CO_2$ emission only from fossil-based is counted. The rationale is that uptake of biomass during agricultural stage is equivalent to release during biodegradation. Generic proxy for molecular weight and fossil carbon content applies for non-priority ingredients, with different values considered for "fossil" and "mix" carbon origins.

### 3.8.4 Impact of wastewater treatment process and direct water release for water from the use phase

For the impact of wastewater treatment process in 16 categories, corrected ecoinvent LCI dataset "Wastewater, unpolluted {RoW}| market for wastewater, unpolluted | Cut-off, U_EBS" applies to the relevant volume of the water generated during the use phase according to segment and subsegment of the product with consideration of connectivity rate and evaporation rate. This dataset was corrected by EBS association to balance water input and output. For direct water discharge in the environment due to the connectivity rate not being 100%, a characterization factor applies in Water Scarcity impact category according to the AWARE methodology (WULCA, 2022). World value of -42,95 $m^3$ world eq/$m^3$ applies only considering the portion of water that is either evaporated or being used and then directly re-emitted into the environment.

## 3.9 End–of-life of the packaging

The modelling of the End-of-life of packaging follows the CFF from the PEF (see section 2.5.3 in Scope). The parameters recommended by the PEF[1] are used.

### 3.9.1 Transport to municipal waste treatment facilities

In order to be treated at end-of-life, packaging needs to be transported to waste treatment facilities. That step is modelled using an ecoinvent process, with a default distance for all packaging, as per Table 21.

*Table 21: Transport to municipal waste treatment facilities*

| Description | ecoinvent LCI Datasets | Values | Units |
|---|---|---|---|
| Transport to waste treatment facilities | Transport, freight, lorry, unspecified {GLO}\| market group for transport, freight, lorry, unspecified \| Cut-off, U | 50 | kg.km per kg of pack |

### 3.9.2 Recyclability

To determine whether a packaging is recyclable, a 3-step process is applied as described in Figure 4.

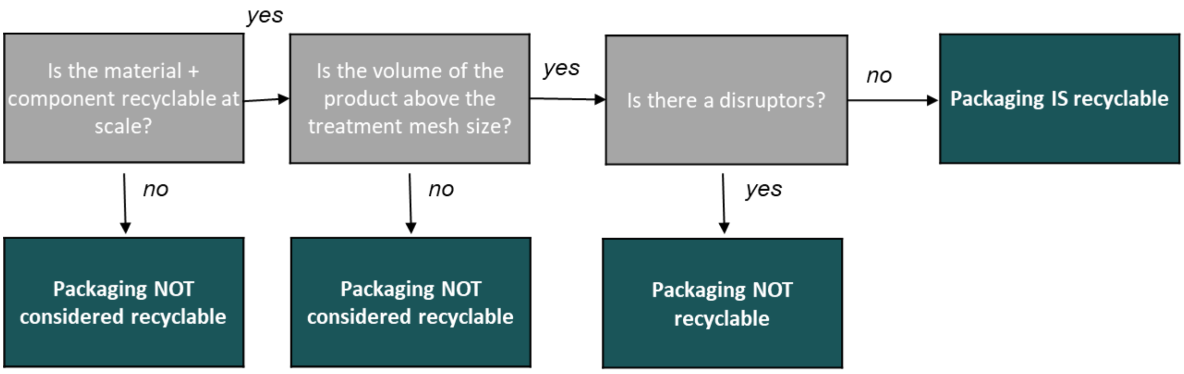



*Figure 4: 3-step process to determine recyclability*

The materials that are recyclable at scale are listed in Table 22 with specific criteria.

*Table 22: Materials recyclable at scale*

| Material group | Material | Material |
|---|---|---|
| PLASTIC | HDPE | minimum 90% monomaterial-PE or monomaterial-PP by weight of the total structure |
| PLASTIC | LDPE | minimum 90% monomaterial-PE or monomaterial-PP by weight of the total structure |
| PLASTIC | LLDPE | minimum 90% monomaterial-PE or monomaterial-PP by weight of the total structure |
| PLASTIC | PET | minimum 90% monomaterial-PET or monomaterial-PP or monomaterial-PE by weight of the total structure |
| GLASS | GLASS | Minium 90% monomaterial by weight of total structure |
| METAL | ALUMINIUM | Minium 90% monomaterial by weight of total structure |
| METAL | STEEL | Minium 90% monomaterial by weight of total structure |
| METAL | TINPLATE CAN | Minium 90% monomaterial by weight of total structure |
| PAPER | BAGASSE MOLDED PULP | Minium 90% monomaterial by weight of total structure |
| PAPER | CARTONBOARD/PAPER | Minium 90% monomaterial by weight of total structure |
| PAPER | CORRUGATED BOARD | Minium 90% monomaterial by weight of total structure |
| PAPER | PAPER | Minium 90% monomaterial by weight of total structure |

A treatment mesh size was defined to assess whether products will fall through the standard mesh size, and is listed in Table 23.

*Table 23: Mesh size to determine recyclability*

| Material group | Material | Min Volume for mesh size |
|---|---|---|
| PLASTIC | HDPE | <20ml |
| PLASTIC | HDPE | <20ml |
| PLASTIC | LDPE | <20ml |
| PLASTIC | LDPE | <20ml |
| PLASTIC | LLDPE | <20ml |
| PLASTIC | LLDPE | <20ml |
| PLASTIC | PET | <20ml |

| | | |
|---|---|---|
| PLASTIC | PET | <20ml |
| GLASS | GLASS | No minimum |
| METAL | ALUMINIUM | No minimum |
| METAL | STEEL | No minimum |
| METAL | TINPLATE CAN | No minimum |
| PAPER | BAGASSE MOLDED PULP | No minimum |
| PAPER | CARTONBOARD/PAPER | No minimum |
| PAPER | CORRUGATED BOARD | No minimum |
| PAPER | PAPER | No minimum |

The user of the method must determine whether its packaging is recyclable or not, based on the following list of disruptors:

- Opaque PET pack
- Packaging containing carbon black pigments
- Non mono material flexible
- Pumps (if with metal spring or ball)
- Metallized aspect (as they reflected the IR ray in the sorting centers)
- Opaque and opale glass

If the packaging fulfils any of these criteria, then the packaging is not recyclable and a "No" should be entered into the input data. When this is the case, $R_2$ for all elements and materials of this products will be set to 0%, as the packaging cannot undergo recycling. The parameters reflecting the other routes (i.e. landfill and incineration) are then re-scaled up to make 100% again.

### 3.9.3 Other EoL routes: incineration with energy recovery and landfill

In the EBS methodology, two other EoL routes than recycling are considered for cosmetics packaging: incineration with energy recovery and landfill. There is therefore a need to determine the environment impacts related to these routes in the application of the CFF (see section 2.5.3). Datasets from common databases are used for that, as described in Annex 7.4.6. To model the energy recovery, the datasets used are the following for the European consumption geography:

- ESE,heat: Heat, central or small-scale, natural gas {GLO}| market group for heat, central or small-scale, natural gas | Cut-off, U
- ESE,elec: Electricity, low voltage {RER}| market group for electricity, low voltage | Cut-off, U

# 4 Scoring

## 4.1 Why the need for Scoring?

The need for a scoring methodology within the EcoBeautyScore association is driven by several factors:

The Aggregated Footprint Value, which represents the environmental impact of products per usage dose, varies greatly across a wide range. This wide range of values makes it challenging to compare products without the use of performance classes.

In certain product segments, such as rinsed off products, the footprint values of all products may be very similar. This similarity would make it difficult for consumers to compare products without the use of performance classes.

The value ranges for environmental performance will be specific to each product segment. Therefore, it is necessary to establish a single scale and define performance classes for each segment.

There is no universal benchmark available that can be used to define an EcoBeautyScore.

To facilitate easy comparison of environmental performance within a product segment, it is crucial to define segment-specific thresholds or limits. These thresholds help divide the range of values into distinct performance classes.

## 4.2 EBS Approach to Scoring

During the development of the scoring methodology for the EcoBeautyScore (EBS), various options were considered, taking inspiration from the Product Environmental Footprint (PEF) methodology and existing scoring schemes in the market. The following outlines the approach that EBS is adopting in terms of setting a scale and distributing aggregated footprint values along that scale:

The main aspects of the scoring methodology are:

(1) Portfolio Approach
(2) Sampling
(3) Threshold Setting

### 4.2.1 Portfolio Approach

Two options were evaluated for anchoring the scale: a portfolio assessment approach (using a group of products to establish upper and lower limits) versus a pseudo-industry average (identifying a typical 'average' product within a segment).

- Scale centered on a “average” representative product
- Scale based on a representative sampling of actual products allowing to define a 90/10 repartition (A representing 10 % of the best products, and E, 10 % of the worst products, inspired by Ecocert methodology).

Pros & cons and simulated representations have been generated, based on the first sandbox results on 3 different segments (hair wash, lips, and face care) and studied from feasibility and relevancy criteria.

EBS recommendation, to allow an easy and robust representation of product scoring, is to adopt a representative sampling method. The latter being based on a selection of products sampled in each company including best-sellers (without weighting them by number of units) and relevant product diversity (packaging type, product volume, galenic form, ingredient composition).

The EBS approach favors the portfolio assessment method over the generation of a pseudo-industry average product.

The portfolio assessment approach is commonly used in academic literature and other eco-labelling schemes (e.g. Decathlon), providing an actual benchmarking scale based on the current market. It is more applicable to diverse product segments such as cosmetics and personal care. In this approach, a representative sample of products within each segment is evaluated, and the range of Footprint Values obtained is used to define thresholds for different classes of environmental performance.

The rationale behind the portfolio assessment method is to consider the entire range of possible scores within an EBS segment, enabling the development of a meaningful rating system for consumers. This method also facilitates ongoing scoring for new products and new members.

On the other hand, determining an "average" product (pseudo-industry average) is not practical, given the proposed segmentation approach and the wide range of formats, galenic, product types, formula and raw materials diversity and packaging/delivery approaches in the cosmetics and personal care industry. It would be complex to execute, not representative of a “real product” and would require regular updates to remain relevant due to frequent launches and product updates, so the “average product” would be obsolete as soon as defined. To define a relevant “average product” would require having a detailed and exhaustive understanding of all products compositions and packaging/delivery systems at a given time in the market which is obviously not possible.

It's important to note that while the PEF example for defining performance classes is based on the pseudo-industry average segment product approach, it is not a mandatory requirement for the EBS.

### 4.2.2 Sampling Principle

The EBS approach favors a representative sampling method as a building block of the overall portfolio assessment. This approach involves selecting and assessing a subset of products currently available on the market within a segment to obtain a representative distribution of Aggregated Footprint Values.

Key points regarding the representative sampling approach are as follows:

- Aggregated Footprint Values are calculated for a statistically representative subset of products within a segment.
- Boundaries for classes of performance are defined based on the values obtained from this representative subset.
- The size of the subset can be determined based on the resource and tooling capacity of EBS and may evolve over time.

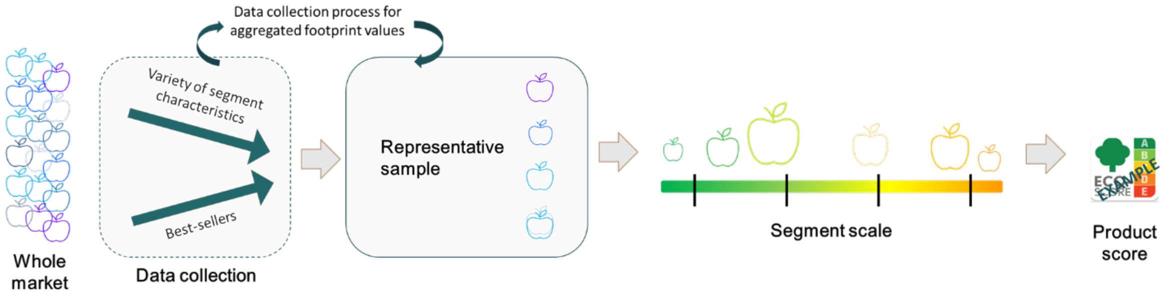



*Figure 5: overview of high-level scoring methodological principles process*

The rationale behind the representative sampling approach is to make the assessment process more practical and efficient and to anchor it in real products impact evaluation. It would not be feasible to assess every eligible product for an EcoBeautyScore prior to setting a rating scale in terms of time and resources. By using a representative sample, the process is streamlined, and new products and members can be assigned to EcoBeautyScores on an ongoing basis.

However, it is acknowledged that there is a risk that the sample may not accurately represent the market situation during the scale calibration phase. To mitigate this risk, the sampling process is designed carefully, and the representation of EBS members in the overall market is considered. If necessary, corrections can be made when recalculating the scale with the scale validity period to be determined at a later stage.

#### *4.2.2.1 Product Item Definition*

The portfolio approach requires a clear definition of what is a single item in the overall population. EBS defines a unique product item as an item that produces one specific EBS score. That means a product item is a unique combination of formula and packaging type/size/material. In many cases a product item will not be equal to a SKU (Stock Keeping Unit). For example, different languages on a label will be treated as different SKUs within companies, but they are considered the same product item in EBS, as long as the rest is all the same.

Similarly, products that only differ in the type of fragrance, but not the level of fragrance in the formula are grouped into the same product item. For confidentiality reasons, companies will not be able to provide the substance break-down of fragrance. Therefore, EBS uses an average fragrance LCI data set. Same applies for products with the same level of colorant to change the appearance of the product.

The following count as different product items: Products with different concentration of fragrance or colorant, as well as products with the same formula but packed in different size or different packaging material.

The "representative sample" will be pulled from all items of the complete population of a given segment.

#### *4.2.2.2 Defining the Representative Sample: Annex 9 for detailed process*


* Recommendation manufactured but could be units sold if simpler

In order to ensure a comprehensive and representative sampling process, every company within the EBS association was requested to contribute to the process. Those companies who participated in the calibration process provided aggregated footprint values of their sampled product items obtained by the EBS methodology. The sampled product items make up a minimum **10% of the full company portfolio** within that segment and geographical scope.

Number of sold products within a product segment may vary a lot from one company to another company simple rules of selection of a representative sampling have been defined for both large portfolios and also smaller portfolios (Less than 105 products in a given segment). The data is shared on a confidential basis and aggregated and anonymized into a total distribution of aggregated footprint values.

The EBS approach for product sampling from each company portfolio focuses on two axes of representativeness:

(1) Representativeness of EBS members' market share: This is achieved by including **"bestselling" products** within the sample selection, accounting for **30% of the sample**. These products are considered to be representative of the market share held by EBS members.

(2) Representativeness of **segment variety**: To capture the full range of products and their impacts, the sample includes a diverse selection of formats and technical specifications. This ensures that the sample represents the broad variety of products available to consumers and is practical to implement. This accounts for **70% of the sample**.

The rationale behind this approach is to include both the top-selling or top units products that consumers perceive as representative of the segment and a wide range of product types and impacts from EBS members, who collectively hold a significant share of the global cosmetic market. Stratifying the sampling in this manner fulfils the requirement of capturing both representativeness factors.

#### *4.2.2.3 Stratified Random Sampling*

Each company willing to participate to the Sampling submission in order to build the scale boundaries for a given product segment in a given geographical area ex EU + UK + Switzerland, was required to:

1. Identify the whole portfolio of products sold in 2022 for this product segment in a defined geographical zone. The first version of the scoring scale for the first go-live is built on products **sold in Europe** (countries of EU and United Kingdom, Norway and Switzerland).
2. For a given product Segment: Characterize & describe every product according to more than 8 different "meta descriptors" allowing each product to be assigned to a specific "Strata" - products belonging to a same strata have all the same "basic" characteristics. Meta descriptors allow to describe the main characteristics of a product its galenic, its type of packaging and presence or absence of some key raw materials differentiating the products within this segment
   Ex for "Hair Wash" segment (Shampoos), verification Rinse of (yes/no), product type (liquid, cream, solid, …), presence of specific Raw Substances Ex : silicone (yes/no), anti dandruff (yes/no), Sulphate (yes/no), main packaging nature (plastic rigid, laminate-polyfoil, glass, metal, carton/ size /Region where the product is sold (EU only, WW incl. EU), product is a refill or not a refill & refillable Main characteristics of each product are collected and each product can be classified in a specific "strata".

   Number and nature of the different strata allows to have a view of the diversity of product type for a given segment within a company portfolio and by aggregating whole different companies information of the Market.

3. **10% of the product portfolio of this segment will be selected as "Sampling"** –
   Example a company having 300 products in a Hairwash product segment will have to submit a total Sampling of 300x10%= 30 products minimum. The Sampling will have 30% = 9 selected products "best sellers" and 70% = 27 products randomly selected through the Randomization tool developed by EBS out of the 300-9= 291 products.

4. EBS has developed a simple randomization tool (XL macro) allowing each participating company to randomly select from their portfolio products which are belonging to different strata (At least one product by different strata existing in the company portfolio) to ensure that the randomized selected products are having different characteristics – in order to ensure a wide diversity of different products to be sampled.

   2 protocols have been developed :

- for mid to large size of product portfolios > 105 products
- a simplified for small size product portfolio <= 104 products allowing companies members of different company size and portfolio to participate.

Note : For EBS first year, products with a data representativeness higher than 3.75 have been excluded from calibration. It has been assessed this threshold ensures representativeness for all four segments in scope while excluding products relying heavily on generic proxies.

#### *4.2.2.4 One Product, One Value System*

The EBS approach favors a system where each product item is compared based on a simple product item-by-product item comparison using the principle "one product, one aggregated footprint value." The data used to determine the range and distribution of the representative sample will therefore not be weighted by sales or volume.

The rationale behind this unweighted approach is to represent the choices available to consumers when making purchasing decisions. It aligns with how consumers would typically evaluate and compare products based on their environmental impact. Additionally, this approach avoids the complexities associated with handling and aggregating commercially sensitive information.

#### *4.2.2.5 Setting Score Boundaries*

Five performance classes are defined. The choice of 5 performance classes was made to be consistent with existing labelling systems that consumers are familiar with, and therefore to make it easier for them to understand and accept the system. This was possible thanks to sufficient differentiation between products and a good distribution along the scale.

**Outer Scores A and E:** The boundaries for the outermost scores on the scale are set in the following way per product segment and geographical scope: The top and bottom 10% quantile of the distribution of the aggregated footprint values of the sample are defining the single-sided boundaries for the classes A and E, respectively and 80% of the Sample between B/C/D classes. By focusing on the variety of values within the core range, the scoring scale is based on the majority of products, rather than being skewed by outliers.

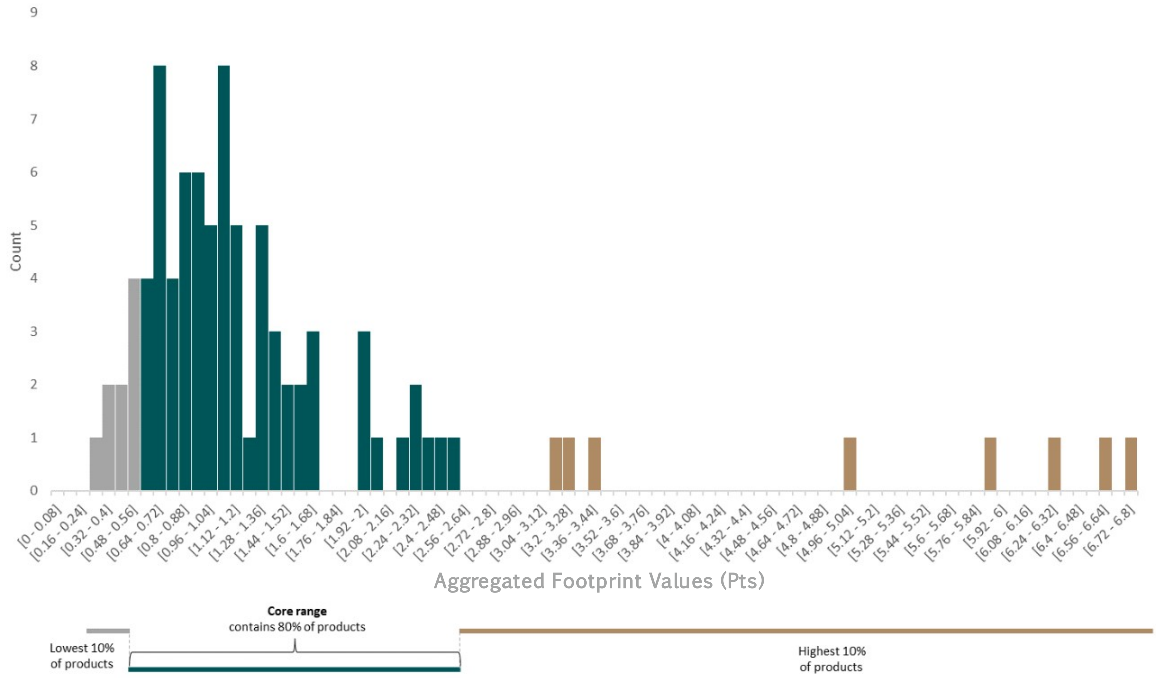



*Figure 6: Aggregated footprint values - core vs extremes*

EBS has observed that the distributions of aggregated footprint values per product segment are typically showing a very long tail towards the higher aggregated footprints. Absorbing the extreme ends of the distribution of footprints into the outmost scores is to prevent skewing the distribution of scores similarly towards the lower end. If the majority of scores would be on the lowest classes of performance (A = lowest relative environmental impact), this would lead to greenwashing risks and limit consumer choice. This approach allows the scoring methodology to concentrate the scores on the core range where the majority of products are found.

The single-sided boundary for the outermost scores has an additional advantage: When a product has a calculated Aggregated Footprint Values that is outside of the original range of the distribution that was used to build the scale, it will simply be placed in open-ended scores A or E.

**Middle Scores B, C and D:** The boundaries for the middle scores are defined by adopting regular intervals within the single-sided boundaries of A and E.

The rationale for this approach is to evenly divide the middle range of Aggregated Footprint Values into equal sections based on the values themselves. This establishes a direct link between the environmental impact and the EcoBeautyScore within the core range.

*Table 24: Boundary calculation method*

| Upper boundary (UB) | Calculation of upper boundary |
|---|---|
| Upper boundary Score **A:** | $UB_A = 0.1\ quantile\ of\ AFP_{prod} distribution$ |
| Upper boundary Score **B:** | $UB_B = UT_A + \frac{(UB_D - UB_A)}{3}$ |
| Upper boundary Score **C:** | $UB_C = UT_A + \frac{(UB_D - UB_A) \cdot 2}{3}$ |
| Upper boundary Score **D:** | $UB_D = 0.9\ quantile\ of\ AFP_{prod} distribution$ |

With $AFP_{prod}$ being the aggregated footprint value (AFP) of a given product.

The score boundaries are defined based on the aggregated footprint values per product which are reported with 3 significant figures. These are hard boundaries; the score assigned to a product will be determined by which side of the boundary its Aggregated Footprint Value falls on, regardless of how close it is to that boundary.

The boundaries are upper-including, as noted in table 26.

The refill system score is still under discussion and will be shortly integrated into the scoring methodology.

*Table 25: Criteria to assign a score to a product item*

| Score assigned | Criteria for Score to be assigned |
|---|---|
| A | $AFP_{prod} \leq UB_A$ |

| | |
|---|---|
| B | $UB_A < AFP_{prod} \leq UB_B$ |
| C | $UB_B < AFP_{prod} \leq UB_C$ |
| D | $UB_C < AFP_{prod} \leq UB_D$ |
| E | $UB_D < AFP_{prod}$ |

# 5 Limitations

## 5.1 Limitations related to the footprinting method

(1) No quantitative assessment of uncertainty is conducted
(2) Data quality is not assessed only through representativeness for ingredients, and for packaging data quality is not assessed at all.
(3) No specific value used today for dosage and rinsed water volume. Future developments of the EBS methodology may allow product-specific values for $m_{dose}$ and/or $V_{rinse\ water}$ once the criteria for substantiation and verification of these are defined.
(4) For the first EBS database, EBS association agreed to not integrate supplier-specific data (e.g. supplier specific ingredient LCI). In the next phase, EBS will work on supplier-specific data integration with a proper governance process.

## 5.2 Limitations related to the LCIA methods

(1) Some impact assessment methods are associated to high uncertainty (e.g. Freshwater Ecotoxicity, Human Toxicity Cancer and Human Toxicity Non-Cancer)
(2) Different impact assessment methods are associated to different levels of uncertainty, which make the aggregated score uncertainty especially difficult to assess
(3) High uncertainty related to normalisation factors, especially for Freshwater Ecotoxicity, Human Toxicity Cancer and Human Toxicity Non-Cancer

## 5.3 Limitations related to the inventories building

(1) All ingredients and packaging production inventories are global or national averages and are not reflecting the specific supply chain of companies
(2) Manufacturing is modelled entirely on default data and does not reflect the actual impacts of companies production lines.

## 5.4 Limitations of Scoring Scale

(1) It is not possible to create a scoring scale from ALL cosmetics products that exist in the market within a given segment. The aggregated footprint distribution that is the basis for setting the score boundaries is therefore a representation of the portfolios of those companies that are (a) members of the EBS association and (b) chose to participate in the sampling and scale setting exercise. While members of EBS span all geographies and represent both small and large companies, the scales are not an exhaustive compilation of the full market that exists.

# 6 Glossary and list of variables

## 6.1 Glossary

**Aggregated footprint (value):** the aggregated footprint represents the overall environmental performance of a product. It is a single numerical value that combines the results of all impact categories assessed in the environmental footprint by normalization and weighting. It allows for easy comparison between different products. The aggregated footprint is a single value expressed in points. The terminology used in EBS deviate from PEF (in which "single score" is used) as score defined class of performance in EBS context.

**Carbon origin:** a high-level description of the carbon origin used to produce the ingredient. Only five options are possible: inorganic, bio-based, fossil, mix (of bio-based and fossil, in the same molecule), and unspecified. It is used to model the end-of-life of the formula, and more specifically the fate of the carbon atoms in the ingredient, because the environmental impacts associated to the product will be different whether the carbon atoms in the molecule are from fossil or natural origin.
Exhaustive list of the different carbon origin options with descriptions:

- organic - bio-based origin: 100% of the ingredient's carbons are from bio-based origins. For example: vegetable oil, oil from tallow,
- - organic - fossil origin: 100% of the ingredient's carbons come from fossil sources. For example: tromethamine (from fossil sources),
- - organic - mix origin: carbons come from bio and fossil sources. Example: sodium laureth sulfate, with fossil head and bio-based tail,
- - unspecified: user doesn't know the carbon origin of the ingredient,
- - inorganic: the ingredient is an inorganic, and therefore does not contain carbon-hydrogen bonds.

**Class level proxy:** a "class level proxy" is the most representative type of proxy. It is a close representation of the element modelled. For example, when talking about proxies in the EBS database, the ingredients for which no specific production LCI is available, but one was found for a similar ingredient (e.g. with a close production route), that dataset was used to model the ingredient, and is then called a class level proxy.
**Company-specific data:** this term refers to directly measured or collected data from one or more facilities (site-specific data) that are representative for the activities of the company (company is used as synonym of organization). Company specific data covers site-specific, supplier-specific, or value chain-specific data. It may be obtained through meter readings, purchase records, utility bills, engineering models, direct monitoring, material/product balances, stoichiometry, or other methods for obtaining data from specific processes in the value chain of the company. In this project, company-specific data is synonym of "primary data" or "supply-chain specific data" and is essentially primary datasets of what is termed "life cycle inventories". Example: dataset for producing 1 kg of ingredient.
**Concentrated (cosmetic) product:** a product featuring a formula with higher concentration of actives (or lower concentration of solvent, typically water) than regular products; for each

product segment the respective reference measure and the threshold need to be defined: e.g concentrated hair wash products: surfactant concentration > 20%; hair treat hair: water concentration < 70%.

**Connectivity rate:** percentage of households connected to wastewater treatment, usually in wastewater treatment plant units, enabling a partial removal of ingredients, before ending up in freshwater bodies in the environment. The quantity "1 - connectivity rate" corresponds to the percentage of wastewater and ingredients supposed to end up in freshwater bodies in the environment without any treatment. Connectivity rate is a parameter involved in the EBS end-of-life of ingredients model.

**Converting process:** in packaging production, a converting process is a process that a material undergoes to be converted into its final form (e.g. converting of pet granulates into a pet bottle).

**Cosmetic product:** product that is falling under the cosmetic regulatory.

**(Cosmetic) product segment:** ensemble of cosmetic products delivering the same primary benefit to the same body zone; the product segment is defined using 2 levels with L1 being the product family and L2 the function. Example: L1 = hair and L2 = wash > product segment = hair wash. One scoring scale will be defined per product segment (and per region), that means all products within one segment can be compared against each other using the EcoBeautyScore. Since they all provide the same primary benefit consumers may choose to exchange them based on the products EBS score.

**(Cosmetic) product subsegment:** a product sub-segment is a sub-group of products within a product segment based on certain product specificities. Sub-segments are defined to assign specific default values for dosage and rinse water volume to the sub-segment.

**Data mapping:** process of linking a ingredient from an input file to the relevant LCI dataset, to model the impacts of that ingredient in the most accurate way.

**Data representativeness:** semi quantitative assessment of the data representativeness of a given parameter with regards to how specific for the ingredient, formula, etc. Data representativeness is currently assessed at ingredient level for the life cycle inventory of the production stage and freshwater ecotoxicity end-of-life characterization factors, considering whether data is considered to be quite specific, to several levels of semi-specific up to generic. An aggregated data representativeness indicator is calculated for one product item based on data representativeness values of ingredients used in formula.

**Default data:** default data refer to industry-average parameters (e.g. product manufacturing scenarios, end-of-life scenarios, default transport distances).

**Dilutable (cosmetic) product:** this is a product that is sold in a concentrated liquid or solid form that is not ready-to-use. The consumer is required to dilute the product with additional water before using it.

**Dosage/dose:** amount of product needed to fulfil the defined functional unit, e.g. x gram of shampoo used to wash one head.

**(EcoBeauty) Score:** the bin/bucket/class into which a product is sorted by its aggregated footprinting value: e.g. "A" - "E"; this is the consumer-facing communication.

**Environmental labelling:** on a general point of view, the term may refer to self-declared environmental claims (ISO14021), ecolabels (ISO14024) or environmental product declarations (ISO14025). Within the EBS context, the term does not apply to the development, but is only meant as a consumer-friendly way of communicating a relative environmental score generated based on the set of environmental footprint indicators (or aggregated footprint of a product), calculated using a LCA-based approach, typically displayed on the packaging itself or digitally (e.g. on the website of the brand).

**Feedstock**: feedstock reflects the exact commodity, and in some cases the geography where that commodity was grown, used for the production of the ingredient. Not all ingredients of the database have that type of specificity, due to the limited availability of production datasets. Therefore, only a handful of ingredients are modelled in the EBS database with different feedstock, e.g. ethanol, fragrance, soaps, fatty acid, fatty alcohol, and glycerin.

**Finishing process:** the finishing process is defined as a process applied on a packaging component to modify its initial visual appearance e.g. printing, electroplating, anodization, metallization, lacquering, hot stamping, acid etching.

**Finishing surface:** the finishing surface corresponds to the surface on which the finishing process is applied.

**Footprint(ing) methodology:** this is the method to calculate the impact results, as well as the aggregated footprint value for a product.

**Functional unit:** functional unit (FU) is the quantified performance of a product system, e.g. hair wash segment shampoo = 1 shampooed head.

**Generic data:** generic data covers environmental datasets that are not directly collected, measured, or estimated by the company carrying out the assessment, but sourced from a third-party life-cycle-inventory database or other sources (e.g. from published production data, government statistics, or industry associations), literature studies, engineering studies and patents, and can also be based on financial data, and contain proxy data, and other generic data. In the case of the first version of the tool, generic data can be used to replace certain company-specific data if, for the given case, it is more accurate and complete than the available data (i.e. supplier-operated processes). Synonym: harmonized data, secondary data.

**Generic proxy:** a 'generic proxy' is the least representative type of proxy. It is used in situations where not even a close representation of the element can be found. For example, when talking about proxies in the EBS database, the ingredients for which no specific production LCI is available, and no production LCI was found for a similar ingredient, a generic proxy is used, which is the 75$^{th}$ percentile LCI of all ingredients in the EBS database.

**Impact results:** calculated impact value in one of the EF impact categories.

**Ingredient/chemical substance:** a chemical substance characterized by an INCI name and a CAS number. It is a form of matter having a constant chemical composition. Chemical substances can be simple substances (substances consisting of a single chemical element), chemical compounds, or alloys.

**LCI dataset:** a document or file with life cycle information of a specified product or other reference (e.g. site, process), covering descriptive metadata and quantitative life cycle inventory. A LCI dataset could be a unit process dataset, partially aggregated or an aggregated dataset.

**Leftover rate:** the leftover rate is the percentage of the product formula that is not actually consumable. It corresponds to the percentage of product that remains in the packaging at end-of-life and is therefore not used by the consumer.

**Loading factor:** quantity of a chemical substance, expressed as a percentage, which is not removed from wastewater after going through a wastewater treatment plant. the HAD

(HauptAusschuss Detergentien i.e. German main committee on detergents) provides a model with LF as an output determined from octanol-water partition coefficient (log Kow) and biodegradibility as inputs.

**Monodose:** Cosmetic products presented in individual units that contain a pre-measured amount of product sufficient for one application. Monodose products are commonly found in formats such as sachets, ampoules, or other individual packets; however, they are not restricted to these forms and may also include other solid or liquid formats. Monodose products may also be referred to as single-dose or unit-dose products.

**Non-priority ingredient/chemical substance:** any ingredient/chemical substance that is not on the priority list.

**Non-rinsed product:** a cosmetic product which intended use does not involve the use of water.

**Portfolio approach:** EBS-specific approach to define the scale (classes of performance) using a sample from the complete population.

**Primary data:** data from specific processes within the supply chain of the product, which can be site-specific, company-specific, or supply-chain specific.

**Primary packaging:** packaging which is in direct contact with the content, e.g. a jar.

**Priority list:** list of ingredients/chemical substances that were identified as “priority” for the set of segments currently covered by the method. It was built through a collaborative effort across all volunteering companies who shared with the association the most used ingredients in their portfolio. This list is dynamic, and more ingredients are to be added for each round of improvement and each new segment covered by the method.

**Product item:** a unique product that produces one specific EBS score (unique combination of formula and packaging type/size/material); the "sample" will be pulled from all products of the complete population of a given segment. In EBS, a SKU is not necessarily equal to a product item as defined in EBS (EBS does not differentiate by e.g. by language on the label).

**Proxy:** a proxy is a dataset or data point used in the model for something for which specific data is not available. There are different types of proxy, depending on how representative the dataset/data point is of the process or element to model.

**Reference flow:** the reference flow is the amount of product needed to fulfil the defined functional unit.

**Removal rate:** quantity of a ingredient, expressed as a percentage, which is removed from wastewater after going through a wastewater treatment plant. removal rates (RR) can be determined from loading factors (LF) with the equation. RR = 1 – LF. removal rate is a parameter involved in the EBS end-of-life of ingredients model.

**(Representative) sample:** the sampled set of product items used to represent the complete population of product items on the market belonging to a specific product segment; a sample is pulled from the complete population in order to define the scale for a given product segment.

**Rinsed product:** a cosmetic product that is intended to be removed from the human body using water.

**Scaling factor:** scaling factor is an extrapolation factor based on the volume claim of the product and the "reference volume". Some default values of the EBS model were determined based on the "reference volume" and need to be extrapolated for the product using the scaling factor.

**Score layout:** the graphical representation of the EcoBeautyScore.

**Scoring methodology (aka scale/score anchoring):** the process of how to define the boundaries/limits for the different bins/buckets/classes of the score (classes of performance); sometimes referred to as score anchoring.

**(Scoring) scale:** the range of aggregated footprint values for a given product segment and a geographical region. The scale is divided into classes of performance.

**Secondary data:** this refers to data that is not directly collected, measured, or estimated by the company, but sourced from a third party LCI database or other sources. Secondary data includes industry average data (e.g. from published production data, government statistics, and industry associations), literature studies, engineering studies and patents, and may also be based on financial data, and contain proxy data, and other generic data.

**Secondary packaging:** packaging which is handled by consumer, but not directly in contact with the content, e.g. a cardboard case.

**Segmentation:** the overall framework of defining product segments.

**Stock Keeping Unit (SKU):** in inventory management, a Stock Keeping Unit (SKU) is the unit of measure in which the stocks of a material are managed. Or to put it another way; is a distinct type of item for sale, purchased, or tracked in inventory, such as a product or service, and all attributes associated with the item type that distinguish it from other item types. (For a product, these attributes can include manufacturer, description, language, material, size, color, packaging, and warranty terms.) When a business records the inventory of its stock, it counts the quantity it has of each unit, or sku. [Wikipedia].
In EBS, a SKU is not necessarily equal to a product item as defined in EBS (EBS does not differentiate by e.g. by language on the label).

**Tertiary packaging:** all packaging that is neither primary, nor secondary packaging. This packaging is used to transport and distribute the finished good or intermediates, but not handled by the consumer.

**Boundaries:** a set of values for the aggregated footprint value which define the boundaries/limits of a class of performance; e.g. a value defining the A/B boundary.

## 6.2 List of Variables

*Table 26: List of variables*

| Variable | Variable Description |
|---|---|
| $AFP_{prod}$ | Aggregated footprint value of a product |
| $c_{H_2O}$ | specific heat capacity of water |
| $m_{dose}$ | Dosage = reference flow of cosmetic product to fulfil the FU, provided as mass |
| $m_{dose,corr}$ | dosage corrected with the leftover rate |
| $Q_{heating}$ | energy required to heat 1 L of water |
| $R_{leftover}$ | leftover rate |
| $T_{initial}$ | initial temperature of rinse water |
| $T_{final}$ | final temperature of rinse water |

| Variable | Variable Description |
|---|---|
| $UB_{Score}$ | Upper boundary of the aggregated footprint value for a specific score A, B, C or D. |
| $V_{rinse\ water}$ | Rinse water volume |
| $V_{prod}$ | Claimed volume of the product |
| $V_{def,prod}$ | Claimed volume of a default comparison product |
| $V_{def,occup}$ | Volume that a default comparison product occupies in distribution |
| $A_{def,occup}$ | Area that a default comparison product occupies in distribution |
| $\eta_{heating}$ | energy efficiency of heating systems |
| $\rho_{H_2O}$ | density of water |

# 7 Annex

## 7.1 Segment Specific Function and Functional Unit

### 7.1.1 Segment Specific Functional Unit

The functional unit of each of the 4 segments considered in first EBS launch are:
- Hair Wash: One hair wash carried out on average length hair
- Hair Treat: One hair treatment (conditioner) carried out on average length hair
- Face Care – Moisturize and Treat: A face treatment carried out on average face surface
- Body Care – Wash: One body wash carried out on average skin surface

Note: Hair wash and hair treat functional functional units are defined for average length hair. The aim of EBS is to compare products and not consumer habits which are driven by their physiology. the studies used in EBS to derive the fixed default dose per product sub-segement have taken averages across male and female panelists with a broad spectrum of hair lengths into account.

The PEF definition of the functional unit for the 4 segments in EBS first launch are described below:

- Hair - Wash:

| | |
|---|---|
| WHAT | wash the hair (remove sebum, environmental dirt, intentionally added agents through treatment/styling via solubilizing/emulsifying and rinse out with water as a solvent) |
| HOW MUCH | One dose of shampoo for average length hair |
| HOW WELL | Hair is left clean and free of sebum or dirt to a level that is satisfactory to the consumer |
| HOW LONG | One hair wash |

- Hair - Treat:

| | |
|---|---|
| WHAT | Treat the hair |
| HOW MUCH | One dose of conditioner for average length hair |
| HOW WELL | The hair fibers are left soft, nourished, and lubricated to a level that is satisfactory to the consumer |
| HOW LONG | One hair treat |

- Face Care - Moisturize & Treat:

| | |
|---|---|
| WHAT | Moisturize and treat the face |
| HOW MUCH | One dose of face product for an average surface. |
| HOW WELL | The face is moisturised and treated to a level that is satisfactory to the consumer. |
| HOW LONG | One face application |

- Body Care - Wash:

| | |
|---|---|
| WHAT | Wash the skin |
| HOW MUCH | One dose of body wash product for average skin surface |
| HOW WELL | The body is left clean and refreshed by these body products, which wash away organic and environmental dirt as well as dead skin cellsto level that is satisfactory to the consumer |
| HOW LONG | One body wash |

### 7.1.2 Default Dose and Rinse Water Volume by Subsegment

Default dose $m_{dose}$ and default rinse water volume $V_{rinse\ water}$ by subsegment
LO = leave-on, RO = rinse-off

*Table 27: default dose and rinse water volume by subsegment*

| Product family (L1) | Product segment (L2) | Sub-segment (L3) - code | $m_{dose}$ [g] | $V_{rinse\ water}$ [L] | reference $m_{dose}$ | reference $V_{rinse\ water}$ |
|---|---|---|---|---|---|---|
| 1. Hair | 1.1 Hair - Wash | 1.1.1 Solid (bars, powder, flakes) NO DRY SHAMPOO | 1.49 | 12 | From 1.1.4 with scaling factor (factor 0.27 based on industry knowledge (AVG of 3 EBS members) | Median of data collection among EBS members for 1. Hair |
| | | 1.1.2 Liquid/Gel | 5.5 | 12 | Median 5.5 g/day[5], 1 use/day[4] | Median of data collection among EBS members for 1. Hair |
| | | 1.1.3 Foam (foamer mechanism) | 5.5 | 12 | Re-application from 1.1.4 | Median of data collection among EBS members for 1. Hair |
| 1. Hair | 1.2 Hair - Treat | 1.2.1 Conditioner LO (viscoelastic) | 3.7 | 0 | From 1.2.5 with scaling factor (factor 0.5 based on | n.a., leave on (LO), not rinsed |

| Product family (L1) | Product segment (L2) | Sub-segment (L3) - code | $m_{dose}$ [g] | $V_{rinse\ water}$ [L] | reference $m_{dose}$ | reference $V_{rinse\ water}$ |
|---|---|---|---|---|---|---|
| | | | | | industry knowledge (AVG of EBS members) | |
| | | 1.2.2 Conditioner/Mask RO (viscoelactic) | 7.39 | 12 | Weighted median dose of female and male from literature[15] | Median of data collection among EBS members for 1. Hair |
| | | 1.2.3 Conditioner/Mask RO (solid) | 2 | 12 | From 1.2.4 with re-application of scaling factor from 1.1.1 | Median of data collection among EBS members for 1. Hair |
| | | 1.2.4 Oil/Serum/lotion/hybrid LO (viscoelastic - anhydrous or <5% water) | 1.13 | 0 | median dose of oil from literature[15] | n.a., leave on (LO), not rinsed |
| 2. Face Care | 2.2 Face Care - Moisturize & Treat | 2.2.1 all Spot Treatment (which don't belong to L2 Boost) | 0.2 | 0 | From 2.2.6 with the assumption that 50% of surface is treated. | n.a., not rinsed |
| | | 2.2.2 Waxes/Butters (thick textures) | 0.398 | 0 | Re-applicaton of 2.2.6 | n.a., not rinsed |
| | | 2.2.3 Serum/ Oils | 0.196 | 0 | From 2.2.6 with scaling factor (factor 0.49 derived from literature,[16] based on weighted median dose of female and male of moisturizin | n.a., not rinsed |

| Product family (L1) | Product segment (L2) | Sub-segment (L3) - code | $m_{dose}$ [g] | $V_{rinse\ water}$ [L] | reference $m_{dose}$ | reference $V_{rinse\ water}$ |
|---|---|---|---|---|---|---|
| | | | | | g cream vs. median dose of serum) | |
| | | 2.2.4 Essence / Cosmetic Water / Sprays | 0.8 | 0 | Industry knowledge, EBS members data | n.a., not rinsed |
| | | 2.2.5 Cream/Lotion/Masks | 0.398 | 0 | Median 0.851 g/day[5], 2.14 uses/day[4] | n.a., not rinsed |
| 3. Body Care | 3.1 Body Care - Wash | 3.1.1 Liquid/Gel wash \| Body | 7.63 | 30 | Median 10.91 g/day[6], 1.43 use/day, applied to 17500 cm² body surface[4] | Mean of data collection among EBS members for 1. 3.1 Body Care Wash \| Body |
| | | 3.1.2 Solid wash (ex: bars, powder, flakes) \| Body | 1.13 | 30 | From 3.1.1 with scaling factor (factor 0.148 derived from literature[17]) | Mean of data collection among EBS members for 1. 3.1 Body Care Wash \| Body |
| | | 3.1.3 Foam wash - foamer mechanism \| Body | 7.63 | 30 | Re-application from 3.1.1 | Mean of data collection among EBS members for 1. 3.1 Body Care Wash \| Body |
| | | 3.1.4 Shower crème / non-foaming cleanser \| Body | 7.63 | 30 | Re-application from 3.1.1 | Mean of data collection among EBS members for 1. 3.1 Body Care Wash \| Body |

EcoBeautyScore

| Product family (L1) | Product segment (L2) | Sub-segment (L3) - code | $m_{dose}$ [g] | $V_{rinse\ water}$ [L] | reference $m_{dose}$ | reference $V_{rinse\ water}$ |
|---|---|---|---|---|---|---|
| | | 3.1.5 Oil wash \| Body | 7.63 | 30 | Re-application from 3.1.1 | Mean of data collection among EBS members for 1. 3.1 Body Care Wash \| Body |
| | | 3.1.6 Exfoliators/Scrubs \| Body | 10.61 | 30 | | Mean of data collection among EBS members for 1. 3.1 Body Care Wash \| Body |
| | | 3.1.7 Liquid/Gel wash \| Hand | 7.63 | 30 | Re-application from 3.1.1 | Mean of data collection among EBS members for 1. 3.1 Body Care Wash \| Body |
| | | 3.1.8 Bar soap \| Hand | 1.13 | 30 | Re-application from 3.1.2 | Mean of data collection among EBS members for 1. 3.1 Body Care Wash \| Body |
| | | 3.1.9 Foam wash - foamer mechanism \| Hand | 7.63 | 30 | Re-application from 3.1.1 | Mean of data collection among EBS members for 1. 3.1 Body Care Wash \| Body |
| | | 3.1.10 Liquid/Gel wash \| Intimate | 7.63 | 30 | Re-application from 3.1.1 | Mean of data collection among EBS members for 1. 3.1 Body Care Wash \| Body |
| | | 3.1.11 Foam wash - foamer mechanism \| Intimate | 7.63 | 30 | Re-application from 3.1.1 | Mean of data collection among EBS members for 1. 3.1 Body |

| Product family (L1) | Product segment (L2) | Sub-segment (L3) - code | $m_{dose}$ [g] | $V_{rinse\ water}$ [L] | reference $m_{dose}$ | reference $V_{rinse\ water}$ |
|---|---|---|---|---|---|---|
| | | | | | | Care Wash \| Body |

## 7.2 Default Occupation Volume and Occupation Area by Segment

The table below provides the volumes $V_{def,occup}$ and areas $A_{def,occup}$ that a product with a default claimed volume $V_{def,prod}$ occupies during storage or in a car trunk in consumer transport. Values are provided only for those product segments which have been developed already in EBS. These default values are used to scale the claimed product volume $V_{prod}$ of the product to be assessed to its respective occupation volume and area.

Note: The occupied volume of the product is not the same as the volume claim of the product (quantity of formula, which is a parameter provided by the user) due to the volume of the packaging of the product. An extrapolation approach was therefore considered and is based on data presented in Table 29. This table provides, for each segment, a reference occupied volume on shelves and during car transportation corresponding to a reference volume claim (e.g. 280 mL occupied volume for a 250 mL product in the Hair Wash segment). The occupied volume of a specific product can therefore be extrapolated from data in this table and the specific volume claim of the product.

*Table 28: Default Occupation Volume and Occupation Area by Segment*

| Product family (L1) | Product segment (L2) | $V_{def,occup}$ [mL] | $V_{def,prod}$ [mL] | $A_{def,occup}$ [cm²] | reference |
|---|---|---|---|---|---|
| 1. Hair | 1.1 Hair - Wash | 280 | 250 | 14 | Shampoo Shadow-PEFCR[3] |
| 1. Hair | 1.2 Hair - Treat | 280 | 250 | 14 | Re-application from 1.1 |
| 2. Face Care | 2.2 Face Care - Moisturize & Treat | 180 | 50 | 20 | Member knowledge |
| 3. Body Care | 3.1 Body Care - Wash | 280 | 250 | 14 | Re-application from 1.1 |

# 7.3 Ingredient modeling guidelines

## 7.3.1 Ingredients from chemical synthesis

### *7.3.1.1 Yield and allocation*

#### *7.3.1.1.1 Yield*

The yield corresponds to the measure of a chemical reaction's efficiency. It is defined as:

$$Yield = \frac{obtained\ mass\ of\ product}{theoretical\ mass\ of\ product}$$

The theoretical mass of product corresponds to the amounts of the product that would be obtained thanks to a complete reaction.

> *Application*
> If industrial or primary yield is available, this industrial/primary data is used.
> If not, default yield is applied.

*Table 29: Default yield definition*

| | Yield (%) | Yield related emissions/waste (%) | Emissions/waste dataset (from ecoinvent, if not mentioned otherwise) |
|---|---|---|---|
| Generic reaction | 95% | 5% | Hazardous waste, for incineration {RoW}\| market for hazardous waste, for incineration \| Cut-off, U |

##### *7.3.1.1.2 Allocation*

Allocation principles for the modelling of ingredients shall follow the provisions described in section2.5.2.

#### 7.3.1.2 Waste

All co-products of the reaction that are not used are considered as wastes and modelled as Hazardous waste (Hazardous waste, for incineration {RoW}| market for hazardous waste, for incineration | Cut-off, U).

#### *7.3.1.3 Reactants*

##### 7.3.1.3.1 Reactants' proportion

Models are based on stoichiometric proportions of reactants.

> *Application*
> If industrial proportions / proportions from primary sources are available, they are used.
> If not, stoichiometric proportions are applied.

##### 7.3.1.3.2 Dataset geography

EBS refers to global datasets if available. If not:

- If the reactant is a key one, EBS will build a global dataset based on volumes.
- If the reactant is not a key one, EBS will use another origin (i.e. RoW).

> *Application*
> For all reactions.

##### 7.3.1.3.3 Reactant transportation

This subsection is dedicated to the transportation of a substance's raw materials (not the substance itself). It is modelled following PEF guidance[1]:

- 1000 km by truck (>32 t, EURO 4), for the sum of distances from harbour/ airport to factory (Transport, freight, lorry >32 metric ton, EURO4 {RoW}| market for transport, freight, lorry >32 metric ton, EURO4 | Cut-off, U)
- 18,000 km by ship (Transport, freight, sea, container ship {GLO}| market for transport, freight, sea, container ship | Cut-off, U)

This PEF guidance corresponds to transportation from a worldwide supplier to Europe.

*Application*
Applied if the LCI of a substance's raw material is not based on an ecoinvent "market for" dataset i.e. does not contain any emissions related to transportation.

#### *7.3.1.4 Other chemicals*

##### 7.3.1.4.1 Strong acid or strong base

*Application*
If literature data mentions strong acid/base use, it is modelled following these guidelines.

When literature mentions that a strong acid or base is needed, a strong base or acid is considered as an input of the reaction like any other reactant and with stoichiometric proportions.
If the acid or base type is not specified, default datasets are defined (strong base: sodium hydroxide, strong acid: hydrochloric acid). If they are not neutralized (see neutralization reaction in the next section), they are considered waste at the reaction's end.

*Table 30: Strong acid/base modelling*

| | Strong acid/base amount | Strong acid/base amount dataset | Solvent related waste | Emissions/waste dataset (from ecoinvent, if not mentioned otherwise) |
|---|---|---|---|---|
| Strong acid/base type mentioned in literature | stoichiometric proportions | Adapted to strong acid/base type | = Strong acid /base input | Hazardous waste, for incineration {RoW}\| market for hazardous waste, for incineration \| Cut-off, U |
| Strong acid/base type ***not*** mentioned in literature | stoichiometric proportions | Acid: Hydrochloric acid, without water, in 30% solution state {RoW}\| market for \| Cut-off, U<br>Base : Sodium hydroxide, without water, in 50% solution state {GLO}\| market for \| Cut-off, U | = Strong acid /base input | Hazardous waste, for incineration {RoW}\| market for hazardous waste, for incineration \| Cut-off, U |

##### 7.3.1.4.2 Strong acid or base neutralization

*Application*
If literature data mentions strong acid/base neutralization, it is modelled following these guidelines.

If a strong acid/base is used (see above) and regenerated, a neutralization step is usually necessary before product extraction.

This neutralization step is considered in the same process as the main reaction, with the quantity of neutralizing agent calculated based on stoichiometric proportions.

The ecoinvent dataset "Neutralising agent, sodium hydroxide-equivalent {GLO}| market for | Cut-off, U" is used for strong acid neutralization. No equivalent dataset exists for strong base neutralization, thus the ecoinvent dataset "Hydrochloric acid, without water, in 30% solution state {RoW}| market for | Cut-off, U" is used.

Resulting salts are considered as waste.

*Table 31: Neutralizing reaction modelling*

| | Strong acid/base amount | Strong acid/base amount dataset | Solvent related waste | Emissions/waste dataset (from ecoinvent, if not mentioned otherwise) |
|---|---|---|---|---|
| Neutralizing agent | stoichiometric proportions | Neutralizing strong acid: Neutralising agent, sodium hydroxide-equivalent {GLO}\| market for \| Cut-off, U<br>Neutralizing strong base: Hydrochloric acid, without water, in 30% solution state {RoW}\| market for \| Cut-off, U | = Neutralizing agent input | Hazardous waste, for incineration {RoW}\| market for hazardous waste, for incineration \| Cut-off, U |

#### 7.3.1.4.3 Solvent

*Application*

If literature data mentions a solvent use, this specific solvent is modelled.

If no solvent mentioned, a default solvent is included.

Solvents are assumed to be recycled internally: solvent input corresponds to solvent losses. Thus, only a small fraction of solvent is considered: 0.05 kg/kg of product. This value is based on internal expert judgment.

*Table 32: Solvent modelling*

| | Solvent consumption (kg/kg of product) | Solvent dataset | Solvent related waste (kg/kg of product) | Emissions/waste dataset (from ecoinvent, if not mentioned otherwise) |
|---|---|---|---|---|
| Solvent mentioned in literature | 0.05 | Adapted to the solvent type | 0.05 | Spent solvent mixture {RoW}\| market for spent solvent mixture \| Cut-off, U |
| No solvent mentioned in literature | 0.05 | Solvent, organic {GLO}\| market for solvent, organic \| Cut-off, U | 0.05 | Spent solvent mixture {RoW}\| market for spent solvent mixture \| Cut-off, U |

#### 7.3.1.4.4 Catalyst

*Application*
If literature data mentions the use of catalyst.

A catalyst consumption corresponding to 1 % of the catalyst amount is considered.

*Table 33: Catalyst modelling*

| | Catalyst consumption (kg) | Catalyst dataset | Catalyst related waste (kg) | Emissions/waste dataset |
|---|---|---|---|---|
| Catalyst mentioned in literature | 1% of catalyst amount | Adapted to the catalyst type | 1% of catalyst amount | Hazardous waste, for incineration {RoW}\| market for hazardous waste, for incineration \| Cut-off, U |

### *7.3.1.5 Energy consumption*

*Application*
If industrial energy consumption is available, this industrial data is used.
If no industrial energy consumption available, 2 options are considered:
- Standard energy consumption
- Energy consumption for high temperature / high pressure reaction

#### 7.3.1.5.1 Standard energy consumption:

A generic energy consumption is considered. It corresponds to 3.7 MJ per kg of product. This total energy demand contains a split of natural gas, electricity and steam from external energy sources. Energy data is based on ecoinvent default energy consumptions used in their modelling and are based on a data from a large chemical plant. Those values are a 5-year average of data (2011-2015) published by the Gendorf factory[19]. Heat amount is shared equally between "heat from natural gas" and "heat, other than natural gas" to consider that heat is not only produced through natural gas but also through other energy sources such as coal, oil.

*Table 34: Generic energy modelling*

| | Amount (MJ/kg of product) | Dataset (from ecoinvent, if not mentioned otherwise) |
|---|---|---|
| Heat, natural gas* | $0.5 \times 2.2 = 1.1$ | Heat, district or industrial, natural gas {GLO}\| market group for heat, district or industrial, natural gas \| Cut-off, U |
| Heat, other than natural gas* | $0.5 \times 2.2 = 1.1$ | Heat, district or industrial, other than natural gas {GLO}\| market group for heat, district or industrial, other than natural gas \| Cut-off, U |
| Heat, from steam | 0.3 | Heat, from steam, in chemical industry {RoW}\| market for heat, from steam, in chemical industry \| Cut-off, U |
| Electricity | 1.2 | Electricity, medium voltage {GLO}\| market group for electricity, medium voltage \| Cut-off, U |

* In ecoinvent datasets, only heat from natural gas is considered. The EBS association decided to share between heat from natural gas and other than natural gas in order to account the worldwide heat production.

#### 7.3.1.5.2 High energy consumption:

Heat for high energy consumption reaction is based on Kim et al[18]. This paper calculates several gate-to-gate energy consumption needed to produce 86 chemicals (43 inorganic ones and 43 organic ones). High heat consumption corresponds to the 90$^{th}$ percentile of steam consumption to produce the 43 organic chemicals. The value is 11.9 MJ.
Based on ecoinvent data, the total energy required for the production of 1 MJ of steam is 1.31 MJ, thus, the total energy to produce 11.9 MJ of steam is 15.6 MJ. Heat amount is shared equally between “heat from natural gas” and “heat, other than natural gas” to consider that heat is not only produced through natural gas but also through coal, oil...
Electricity input: same as standard electricity because it was assumed that not directly linked to the reaction but linked to plant utilities (so not well considered in the publication).

*Table 35: High energy modelling*

| | Amount (MJ/kg of product) | Dataset (from ecoinvent, if not mentioned otherwise) |
|---|---|---|
| Heat, natural gas | $0.5 \times 15.6 = 7.8$ | Heat, district or industrial, natural gas {GLO}\| market group for heat, district or industrial, natural gas \| Cut-off, U |
| Heat, other than natural gas | $0.5 \times 15.6 = 7.8$ | Heat, district or industrial, other than natural gas {GLO}\| market group for heat, district or industrial, other than natural gas \| Cut-off, U |
| Electricity | 1.2 | Electricity, medium voltage {GLO}\| market group for electricity, medium voltage \| Cut-off, U |

### *7.3.1.6 Utilities*

#### 7.3.1.6.1 Water

*Application*
Applied for all reactions.

A default water consumption is considered for all reactions. It is accounting for non-production water. Water data comes from ecoinvent default water consumption and are based on data from a large chemical plant. Those values are a 5-year average of data (2011-2015) published by the Gendorf factory[19].

*Table 36: Default water input modelling*

| | Amount (kg/kg of product) | Elementary flow (resource compartment) |
|---|---|---|
| Water, cooling | 16.4 | Water, cooling, unspecified natural origin, GLO |
| Water, well | 0.8 | Water, well, GLO |
| Water, river | 0.9 | Water, river, GLO |

*Table 37: Default water output modelling*

| | Amount (kg/kg of product) | Elementary flow (water compartment) |
|---|---|---|
| Water, to air | 1.4 | Water |

| | | |
|---|---|---|
| Water, to water | 16.7 | Water, GLO |

#### 7.3.1.6.2 Infrastructure

*Application*
Applied for all reactions.

The generic ecoinvent data for infrastructure is used.

*Table 38: Generic infrastructure modelling*

| | Amount (p/kg of product) | Dataset (from ecoinvent, if not mentioned otherwise) |
|---|---|---|
| Infrastructure | $4.E-10$ | Chemical factory, organics {GLO}\| market for chemical factory, organics \| Cut-off, U |

#### 7.3.1.6.3 Nitrogen

*Application*
Applied for all reactions.

Nitrogen data comes ecoinvent default nitrogen consumption and are based on a large chemical plant. Those values are a 5-year average of data (2011-2015) published by the Gendorf factory[19].

*Table 39: Generic nitrogen modelling*

| | Amount (kg/kg of product) | Dataset (from ecoinvent, if not mentioned otherwise) |
|---|---|---|
| Nitrogen | 0.019 | Nitrogen, liquid {RoW}\| market for nitrogen, liquid \| Cut-off, U |

### 7.3.2 Essential oils

A rosemary essential oil LCI model was developed by EBS based on the following data. This model was used as a proxy for the production of all essential oils.

*Table 40: Assumptions used for the rosemary essential oil LCI model*

| Parameter of the model | Description |
|---|---|
| Extraction process: | Steam distillation |
| Allocation | 100% of impacts are allocated to essential oil. |
| Extraction yield | 0.5% (w/w)[20] |
| Water consumption for steam distillation | 0.33 kg of water/kg of crop[21] |
| Water consumption to cool the extraction's outputs | 5.4 kg of water/kg of crop (based on heat transfer calculations) |
| Energy consumption | 0.92 kWh/kg of crop[21]<br>Energy source is considered 50% from natural gas (dataset "Heat, district or industrial, natural gas {GLO}\| market group for \| Cut-off, U" and 50% other than natural gas (dataset "Heat, district or industrial, other than natural gas {GLO}\| market group for \| Cut-off, U") |

| | |
|---|---|
| Crop waste | Modelled as industrial composting (dataset: Biowaste {RoW}\| treatment of biowaste, industrial composting \| Cut-off, U) |

### 7.3.3 Hydrosol

A rosemary hydrosol LCI model was developed by EBS based on the following data. This model was used as a proxy for the production of all hydrosols.

*Table 41: Assumptions used for the rosemary hydrosol LCI model*

| Parameter of the model | Description |
|---|---|
| Extraction process: | Steam distillation |
| Allocation | 100% of impacts are allocated to hydrosol |
| Extraction yield | 0.33 kg of hydrosol/kg of crop[20] |
| Water consumption for steam distillation | 0.33 kg of water/kg of crop[21] |
| Water consumption to cool the extraction's outputs | 5.4 kg of water/kg of crop (based on heat transfer calculations). |
| Energy consumption | 0.92 kWh/kg of crop[21]<br>Energy source is considered 50% from natural gas (dataset "Heat, district or industrial, natural gas {GLO}\| market group for \| Cut-off, U" and 50% other than natural gas (dataset "Heat, district or industrial, other than natural gas {GLO}\| market group for \| Cut-off, U") |
| Crop waste | Modelled as industrial composting (dataset: Biowaste {RoW}\| treatment of biowaste, industrial composting \| Cut-off, U). |

### 7.3.4 Botanical extracts

A botanical extract LCI model was developed by EBS based on the following data.

*Table 42: Assumptions used for the botanical extract LCI model*

| Parameter of the model | Description |
|---|---|
| Extraction process: | Solvent extraction (Ethanol/water ratio 70/30) |
| Allocation | 100% of impacts are allocated to the botanical extract |
| Extraction yield | 6 % (w/w) (based on member internal knowledge) |
| Optional pre-treatment | Crop drying, performed 50% mechanical and 50% sun dried |
| Solvent/crop ratio | 10/1 |
| Extraction duration and temperature | 4 hours at 90 °C |
| Energy consumption | 11.7 kWh/kg of crop<br>Energy consumption is calculated based on energy needed to heat the solvent and crop mixture and maintain temperature during extraction process.<br>Energy source is considered 50% from natural gas (dataset "Heat, district or industrial, natural gas {GLO}\| market group for \| Cut-off, U" and 50% other than natural gas |

| | |
|---|---|
| | (dataset “Heat, district or industrial, other than natural gas {GLO}\| market group for \| Cut-off, U”). |
| Solvent end-of-life | 10% of water is considered as evaporated<br>33% of water is considered as absorbed in the biomass<br>The remaining 57% of water is considered as wastewater<br>80% of ethanol is recovered through distillation<br>10% of ethanol is considered evaporated<br>10% of ethanol is considered as waste<br>Energy for ethanol distillation is based on energy needed to heat the solvent to its boiling point and to evaporate it. Energy source is considered 50% from natural gas (dataset “Heat, district or industrial, natural gas {GLO}\| market group for \| Cut-off, U” and 50% other than natural gas (dataset “Heat, district or industrial, other than natural gas {GLO}\| market group for \| Cut-off, U”). |
| Crop waste | Modelled as a biowaste with a generic end-of-life (dataset: Biowaste {RoW}\| market for biowaste \| Cut-off, U). |

### 7.3.5 Fragrance

Two types of fragrance families are modelled in EBS database:

- 100% natural fragrance: it is 50% of solvent (bio-based ethanol) and 50% of active material, modelled as essential oil (see section 7.3.2)
- Natural/synthetic mix: it is modelled as 80:20 Synthetic/Natural fragrance. For Natural fragrance, see point above. Synthetic fragrance is 50% of solvent (modelled as dipropylene glycol) and 50% of active substance (benzyl alcohol).

## 7.4 Packaging

### 7.4.1 List of packaging materials with datasets

*Table 43: List of packaging materials with their production datasets (virgin and recycled datasets)*

| Packaging material | Virgin production LCI | Recycled material LCI |
|---|---|---|
| ABS | Acrylonitrile-butadiene-styrene copolymer {GLO}\| market for acrylonitrile-butadiene-styrene copolymer \| Cut-off, S | No recycling |
| ALUMINIUM | Aluminium, primary, ingot {IAI Area, EU27 & EFTA}\| market for aluminium, primary, ingot \| Cut-off, S | Aluminium, wrought alloy {RER}\| treatment of aluminium scrap, post-consumer, prepared for recycling, at remelter \| Cut-off, U |

| Packaging material | Virgin production LCI | Recycled material LCI |
|---|---|---|
| BAGASSE MOLDED PULP | Paper, woodcontaining, lightweight coated {RER}\| market for paper, woodcontaining, lightweight coated \| Cut-off, S | Graphic paper, 100% recycled {RER}\| graphic paper production, 100% recycled \| Cut-off, S |
| BIO HDPE | 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 | Polyethylene, high density, granulate, recycled {Europe without Switzerland}\| polyethylene production, high density, granulate, recycled \| Cut-off, S |
| BIO LDPE | bioLDPE, various waste and residue biomass sources | Polyethylene, high density, granulate, recycled {Europe without Switzerland}\| polyethylene production, high density, granulate, recycled \| Cut-off, S |
| BIO LLDPE | bioLDPE, various waste and residue biomass sources | Polyethylene, high density, granulate, recycled {Europe without Switzerland}\| polyethylene production, high density, granulate, recycled \| Cut-off, S |
| BIO PBS | Polyethylene terephthalate, granulate, amorphous {GLO}\| market for, with antimony catalyst \| Cut-off, U | Polyethylene terephthalate, granulate, amorphous, recycled {Europe without Switzerland}\| polyethylene terephthalate production, granulate, amorphous, recycled \| Cut-off, S |
| BIO PET | Polyethylene terephthalate, granulate, amorphous {GLO}\| market for, with antimony catalyst \| Cut-off, U | Polyethylene terephthalate, granulate, amorphous, recycled {Europe without Switzerland}\| polyethylene terephthalate production, granulate, amorphous, recycled \| Cut-off, S |

| Packaging material | Virgin production LCI | Recycled material LCI |
|---|---|---|
| BIO PP | bioPP, various waste and residue biomass sources | Polyethylene terephthalate, granulate, amorphous, recycled {Europe without Switzerland}\| polyethylene terephthalate production, granulate, amorphous, recycled \| Cut-off, S |
| BIO PVC | Polyvinylchloride, bulk polymerised {GLO}\| market for polyvinylchloride, bulk polymerised \| Cut-off, S | No recycling |
| BOPA | Nylon 6 {RoW}\| market for nylon 6 \| Cut-off, S | No recycling |
| BOPP | Polypropylene, granulate {GLO}\| market for polypropylene, granulate \| Cut-off, S | Polyethylene terephthalate, granulate, amorphous, recycled {Europe without Switzerland}\| polyethylene terephthalate production, granulate, amorphous, recycled \| Cut-off, S |
| BRASS | Brass {RoW}\| market for brass \| Cut-off, U | No recycling |
| CARTON | Folding boxboard carton {RER}\| market for folding boxboard carton \| Cut-off, S | White lined chipboard carton {RER}\| white lined chipboard carton production \| Cut-off, S |
| CARTON, WHITE LINED | White lined chipboard carton {RER}\| market for white lined chipboard carton \| Cut-off, S | White lined chipboard carton {RER}\| white lined chipboard carton production \| Cut-off, S |
| CELLOPHANE | Carboxymethyl cellulose, powder {GLO}\| market for carboxymethyl cellulose, powder \| Cut-off, U | No recycling |
| CELLULOSE | Carboxymethyl cellulose, powder {GLO}\| market for carboxymethyl cellulose, powder \| Cut-off, U | No recycling |
| CERAMICS | Ceramic tile {GLO}\| market for ceramic tile \| Cut-off, S | No recycling |
| CORK | Sawnwood, lath, hardwood, dried (u=10%), planed, in mass {GLO}\| market for \| Cut-off, U | Particle board, from recycling, 100% secondary, at plant (Cut-off)/RER U |
| CORRUGATED BOARD | Corrugated board box {RoW}\| market for corrugated board box \| Cut-off, S | Corrugated board box, 100% secondary, at plant (Cut-off)/RER U |

| Packaging material | Virgin production LCI | Recycled material LCI |
|---|---|---|
| COTTON | Textile, woven cotton {GLO}\| market for textile, woven cotton \| Cut-off, U | No recycling |
| EPOXY RESIN | Epoxy resin, liquid {RoW}\| market for epoxy resin, liquid \| Cut-off, U | No recycling |
| EPS | Polystyrene, general purpose {GLO}\| market for polystyrene, general purpose \| Cut-off, S | No recycling |
| EVA | Ethylene vinyl acetate copolymer {RER}\| market for ethylene vinyl acetate copolymer \| Cut-off, S | No recycling |
| EVOH | EVOH {GLO}\| market for \| Cut-off, U_updated | No recycling |
| FRAGRANCE PUMP (AVERAGE) | Average fragrance pump average, SPICE | No recycling |
| GLASS | Packaging glass, FEVE | Packaging glass, recycling, FEVE |
| HDPE | Polyethylene, high density, granulate {GLO}\| market for polyethylene, high density, granulate \| Cut-off, S | Polyethylene, high density, granulate, recycled {Europe without Switzerland}\| polyethylene production, high density, granulate, recycled \| Cut-off, S |
| JUTE | Textile, woven cotton {GLO}\| market for textile, woven cotton \| Cut-off, U | No recycling |
| LATEX | Latex {RER}\| market for latex \| Cut-off, U | No recycling |
| LDPE | Polyethylene, low density, granulate {GLO}\| market for polyethylene, low density, granulate \| Cut-off, S | Polyethylene, high density, granulate, recycled {Europe without Switzerland}\| polyethylene production, high density, granulate, recycled \| Cut-off, S |
| LEATHER | Wet to finished cow leather, chrome finishing (GLO) from Quantis fashion _EF 3.1 | No recycling |

| Packaging material | Virgin production LCI | Recycled material LCI |
| --- | --- | --- |
| LLDPE | Polyethylene, linear low density, granulate {GLO}\| market for polyethylene, linear low density, granulate \| Cut-off, S | Polyethylene, high density, granulate, recycled {Europe without Switzerland}\| polyethylene production, high density, granulate, recycled \| Cut-off, S |
| MAGNET | Permanent magnet, for electric motor {GLO}\| market for permanent magnet, for electric motor \| Cut-off, S | No recycling |
| MBS | MBS {GLO}\| market for \| Cut-off, U | No recycling |
| MDF | Medium density fibreboard, in mass {GLO}\| market for \| Cut-off, U | Particle board, from recycling, 100% secondary, at plant (Cut-off)/RER U |
| MELANIME FORMALDEHYDE RESIN | Melamine formaldehyde resin {RoW}\| market for melamine formaldehyde resin \| Cut-off, S | No recycling |
| MIRROR | Mirror, Cut-off, U | No recycling |
| NOEDYMIUN OXIDE | Neodymium oxide {GLO}\| market for neodymium oxide \| Cut-off, U | No recycling |
| OPP | Polypropylene, granulate {GLO}\| market for polypropylene, granulate \| Cut-off, S | Polyethylene terephthalate, granulate, amorphous, recycled {Europe without Switzerland}\| polyethylene terephthalate production, granulate, amorphous, recycled \| Cut-off, S |
| PA (CASTOR OIL) | Transparent PA, 45% bio-based, from castor oil | No recycling |
| PA NYLON | Nylon 6 {RoW}\| market for nylon 6 \| Cut-off, S | No recycling |
| PA1010 (CASTOR OIL) | PA1010, from castor oil | No recycling |
| PA11 (CASTOR OIL) | PA11, from castor oil | No recycling |
| PAPER (WOOD CONTAINING) | Paper, woodcontaining, lightweight coated {RER}\| market for paper, woodcontaining, lightweight coated \| Cut-off, S | Graphic paper, 100% recycled {RER}\| graphic paper production, 100% recycled \| Cut-off, S |

| Packaging material | Virgin production LCI | Recycled material LCI |
|---|---|---|
| PAPER (WOOD FREE) | Paper, woodfree, coated {RER}\| market for paper, woodfree, coated \| Cut-off, S | Graphic paper, 100% recycled {RER}\| graphic paper production, 100% recycled \| Cut-off, S |
| PBS | Polybutylene Terephtalate (PBT), Cut-off, U | No recycling |
| PBT | Polybutylene Terephtalate (PBT), Cut-off, U | No recycling |
| PC | Polycarbonate {GLO}\| market for polycarbonate \| Cut-off, S | No recycling |
| PCT | PCT {GLO}\| market for \| Cut-off, U | No recycling |
| PCTG | PCTG, Cut-off, U | No recycling |
| PE MALEIC ANHYDRIDE | Polyethylene, low density, granulate {GLO}\| market for polyethylene, low density, granulate \| Cut-off, S | Polyethylene, high density, granulate, recycled {Europe without Switzerland}\| polyethylene production, high density, granulate, recycled \| Cut-off, S |
| PET | Polyethylene terephthalate, granulate, amorphous {GLO}\| market for, with antimony catalyst \| Cut-off, U | Polyethylene terephthalate, granulate, amorphous, recycled {Europe without Switzerland}\| polyethylene terephthalate production, granulate, amorphous, recycled \| Cut-off, S |
| PETG | PETG {GLO}\| market for \| Cut-off, U | No recycling |
| PK | Polyketone, Cut-off, U | No recycling |
| PLA | Polypropylene, granulate {GLO}\| market for polypropylene, granulate \| Cut-off, S | Polyethylene terephthalate, granulate, amorphous, recycled {Europe without Switzerland}\| polyethylene terephthalate production, granulate, amorphous, recycled \| Cut-off, S |
| PLASTIC PUMP (AVERAGE) | Average plastic pump average, SPICE | No recycling |
| PMMA | Polymethyl methacrylate, beads {GLO}\| market for polymethyl methacrylate, beads \| Cut-off, S | No recycling |
| POM | Polyoxymethylene (POM)/EU-27 | No recycling |

| Packaging material | Virgin production LCI | Recycled material LCI |
|---|---|---|
| PP | Polypropylene, granulate {GLO}\| market for polypropylene, granulate \| Cut-off, S | Polyethylene terephthalate, granulate, amorphous, recycled {Europe without Switzerland}\| polyethylene terephthalate production, granulate, amorphous, recycled \| Cut-off, S |
| PS | Polystyrene, general purpose {GLO}\| market for polystyrene, general purpose \| Cut-off, S | No recycling |
| PTFE | Tetrafluoroethylene {GLO}\| market for tetrafluoroethylene \| Cut-off, S | No recycling |
| PU | Polyurethane, flexible foam {RER}\| market for polyurethane, flexible foam \| Cut-off, S | No recycling |
| PVC | Polyvinylchloride, bulk polymerised {GLO}\| market for polyvinylchloride, bulk polymerised \| Cut-off, S | No recycling |
| PVDC | Polyvinylidenchloride, granulate {RER}\| market for polyvinylidenchloride, granulate \| Cut-off, S | No recycling |
| SAN | Styrene-acrylonitrile copolymer {GLO}\| market for styrene-acrylonitrile copolymer \| Cut-off, S | No recycling |
| SEBS | SEBS {GLO}\| market for \| Cut-off, U | No recycling |
| SOLID BLEACHED BOARD | Solid bleached and unbleached board carton {RoW}\| market for solid bleached and unbleached board carton \| Cut-off, S | White lined chipboard carton {RER}\| white lined chipboard carton production \| Cut-off, S |
| SOLID UNBLEACHED BOARD | Solid bleached and unbleached board carton {RoW}\| market for solid bleached and unbleached board carton \| Cut-off, S | White lined chipboard carton {RER}\| white lined chipboard carton production \| Cut-off, S |
| STAINLESS STEEL | Steel, chromium steel 18/8 {GLO}\| market for steel, chromium steel 18/8 \| Cut-off, S | Steel, low-alloyed {Europe without Switzerland and Austria}\| steel production, electric, low-alloyed \| Cut-off, S |

| Packaging material | Virgin production LCI | Recycled material LCI |
|---|---|---|
| STEEL | Steel, low-alloyed, 100% primary, at plant (Cut-off)/RER U | Steel, low-alloyed {Europe without Switzerland and Austria}\| steel production, electric, low-alloyed \| Cut-off, S |
| SURLYN | Surlyn {GLO}\| market for \| Cut-off, U - sulfuric acid replaced | No recycling |
| SYNTHETIC RUBBER | Synthetic rubber {GLO}\| market for synthetic rubber \| Cut-off, S | No recycling |
| TINPLATE CAN | Tin {GLO}\| market for tin \| Cut-off, S | Steel, low-alloyed {Europe without Switzerland and Austria}\| steel production, electric, low-alloyed \| Cut-off, S |
| TRANSPARENT PA | Transparent PA | No recycling |
| TREVA (CELLULOSE) | Cellulose-based TREVA bioplastic, 45% biobased | No recycling |
| WOOD | Sawnwood, lath, hardwood, dried (u=10%), planed, in mass {GLO}\| market for \| Cut-off, U | Particle board, from recycling, 100% secondary, at plant (Cut-off)/RER U |
| ZAMAK | Zamak 2_updated | No recycling |

1843
### 7.4.2 List of packaging converting processes with datasets

1844 *Table 44: List of packaging converting processes with their datasets*

| Converting processes | Converting LCI |
|---|---|
| Blow moulding | Blow moulding {GLO}\| market for \| Cut-off, U |
| Calendering, rigid sheets | Calendering, rigid sheets {GLO}\| market for \| Cut-off, U |
| Cardboard folding | No impact (included in material) |
| Deep drawing, steel | Deep drawing, steel, 650 kN press, automode {GLO} \| Cut-off, U |
| Extrusion of plastic sheets and thermoforming, inline | Extrusion of plastic sheets and thermoforming, inline {GLO}\| market for \| Cut-off, U |
| Extrusion, co-extrusion | Extrusion, co-extrusion {GLO}\| market for \| Cut-off, U |
| Polar fleece production | Polar fleece production {GLO}\| market for \| Cut-off, U |
| Glass converting | Glass processing {GLO} |
| Impact extrusion of aluminium | Impact extrusion of aluminium, 1 stroke {GLO} \| processing \| Cut-off, U |
| Injection moulding | Injection moulding {GLO}\| market for \| Cut-off, U |
| TREVA-specific injection moulding | TREVA-specific injection moulding, without elec {GLO}\| market for \| Cut-off, U |

| Converting processes | Converting LCI |
|---|---|
| Liquid packaging board manufacturing process | Liquid packaging board container {GLO} \| production \| Cut-off, U |
| Metal - no processing | No impact (included in material) |
| Sheet rolling, aluminium | Sheet rolling, aluminium {GLO}\| market for \| Cut-off, U |
| Sheet rolling, steel | Sheet rolling, steel {GLO}\| market for \| Cut-off, U |
| Stretch Blow moulding | Stretch blow moulding {GLO}\| market for \| Cut-off, U |
| Textile processing | No impact (included in material) |
| Thermoforming of plastic sheets | Thermoforming of plastic sheets {GLO}\| processing \| Cut-off, U |
| Thermoforming, with calendering | Thermoforming, with calendering {GLO}\| market for \| Cut-off, U |
| Wood processing | No impact (included in material) |
| Extrusion, plastic film | No impact (included in material) |

### 7.4.3 List of packaging finishing processes with datasets

*Table 45: List of packaging finishing processes with their datasets*

| **Finishing processes** | **Finishing LCI** |
|---|---|
| Acid etching | Acid etching, glass substrate {GLO} |
| Acid etching, glass substrate | Acid etching, glass substrate, average bottle {GLO} |
| Anodising, aluminium sheet | Anodising, aluminium sheet {GLO}\| market for \| Cut-off, U |
| Glass lacquering | Glass lacquering {GLO} |
| Nickel electroplating | Nickel electroplating {GLO} |
| Offset printing | Offset printing {GLO} |
| Physical Vapour Deposition | Aluminium coat, packaging, physical vapour deposition {GLO}\| selective coating, packaging, physical vapour deposition \| Cut-off, U |
| Physical Vapour Deposition, aluminium, glass substrate | Physical Vapour Deposition, glass substrate, average bottle {GLO} |
| Sputtering | Aluminium coat, packaging, sputter deposition {2.2GLO}\| selective coating, packaging, sputtering \| Cut-off, U |

### 7.4.4 List of packaging default converting and finishing for all material x component combinations (component = "n.a." correspond to the default mapping for any other components than the ones called out specifically)

*Table 46: List of packaging default converting and finishing for all material ′ component combinations*

| Packaging material | Component | Default Converting process | Default Finishing process |
|---|---|---|---|
| BOPA | n.a. | Extrusion, co-extrusion | Offset printing |
| BOPP | n.a. | Extrusion, co-extrusion | Offset printing |
| EVOH | n.a. | Extrusion, co-extrusion | Offset printing |
| HDPE | n.a. | Blow moulding | Offset printing |
| HDPE | Plastic film | Extrusion, plastic film | Offset printing |
| LDPE | n.a. | Blow moulding | Offset printing |
| LDPE | Dunnage | Extrusion, co-extrusion | Offset printing |
| LDPE | Plastic film | Extrusion, plastic film | Offset printing |
| LLDPE | n.a. | Blow moulding | Offset printing |
| LLDPE | Plastic film | Extrusion, co-extrusion | Offset printing |
| PA NYLON | n.a. | Stretch Blow moulding | Offset printing |
| PA NYLON | Plastic film | Extrusion, plastic film | Offset printing |
| PBS | n.a. | Injection moulding | Offset printing |
| PE MALEIC ANHYDRIDE | n.a. | Blow moulding | Offset printing |
| PET | Bottle | Injection moulding | Offset printing |
| PET | Pouch | Thermoforming of plastic sheets | Offset printing |
| PET | Flexible packaging | Thermoforming of plastic sheets | Offset printing |
| PET | Plastic film | Thermoforming of plastic sheets | Offset printing |
| PET | Plastic film | Extrusion, co-extrusion | Offset printing |
| PET | n.a. | Injection moulding | Offset printing |
| PP | Tub | Injection moulding | Offset printing |
| PP | Pot | Injection moulding | Offset printing |
| PP | Cup | Injection moulding | Offset printing |
| PP | Jar | Injection moulding | Offset printing |
| PP | Cap | Injection moulding | Offset printing |
| PP | Lid | Injection moulding | Offset printing |
| PP | Closure | Injection moulding | Offset printing |
| PP | Plastic film | Extrusion, co-extrusion | Offset printing |
| PP | Dunnage | Extrusion, co-extrusion | Offset printing |
| PP | n.a. | Injection moulding | Offset printing |
| PU | Dunnage | Extrusion, co-extrusion | Offset printing |

| Packaging material | Component | Default Converting process | Default Finishing process |
|---|---|---|---|
| PU | n.a. | Injection moulding | Offset printing |
| PVC | Bottle, Jar | Blow moulding | Offset printing |
| PVC | Plastic film | Extrusion, co-extrusion | Offset printing |
| PVC | n.a. | Blow moulding | Offset printing |
| OPP | n.a. | Extrusion, co-extrusion | Offset printing |
| PLA | n.a. | Extrusion, co-extrusion | Offset printing |
| PS | n.a. | Extrusion, co-extrusion | Offset printing |
| EPS | n.a. | Injection moulding | Offset printing |
| ABS | n.a. | Injection moulding | Offset printing |
| EVA | n.a. | Injection moulding | Offset printing |
| LATEX | n.a. | Injection moulding | Offset printing |
| MBS | n.a. | Injection moulding | Offset printing |
| PBT | n.a. | Injection moulding | Offset printing |
| PC | n.a. | Injection moulding | Offset printing |
| PCT | n.a. | Injection moulding | Offset printing |
| PCTG | n.a. | Injection moulding | Offset printing |
| PETG | n.a. | Injection moulding | Offset printing |
| PK | n.a. | Injection moulding | Offset printing |
| PMMA | n.a. | Injection moulding | Offset printing |
| POM | n.a. | Injection moulding | Offset printing |
| PTFE | n.a. | Injection moulding | Offset printing |
| PVDC | n.a. | Injection moulding | Offset printing |
| SAN | n.a. | Injection moulding | Offset printing |
| SEBS | n.a. | Injection moulding | Offset printing |
| SYNTHETIC RUBBER | n.a. | Injection moulding | Offset printing |
| TRANSPARENT PA | n.a. | Injection moulding | Offset printing |
| BIO HDPE | n.a. | Blow moulding | Offset printing |
| BIO LDPE | n.a. | Blow moulding | Offset printing |
| BIO PBS | n.a. | Injection moulding | Offset printing |
| PLA | n.a. | Extrusion, co-extrusion | Offset printing |
| BIO LLDPE | n.a. | Extrusion, co-extrusion | Offset printing |
| BIO PET | n.a. | Injection moulding | Offset printing |
| BIO PP | n.a. | Injection moulding | Offset printing |
| BIO PVC | n.a. | Blow moulding | Offset printing |
| PA1010 (CASTOR OIL) | n.a. | Injection moulding | Offset printing |

| Packaging material | Component | Default Converting process | Default Finishing process |
| --- | --- | --- | --- |
| PA11 (CASTOR OIL) | n.a. | Injection moulding | Offset printing |
| PA11 (CASTOR OIL) | n.a. | Injection moulding | Offset printing |
| PA (CASTOR OIL) | n.a. | Injection moulding | Offset printing |
| TREVA (CELLULOSE) | n.a. | Injection moulding | Offset printing |
| EPOXY RESIN | n.a. | Injection moulding | No finishing |
| MELANIME FORMALDEHYDE RESIN | n.a. | Injection moulding | No finishing |
| SURLYN | n.a. | Injection moulding | No finishing |
| GLASS | n.a. | Glass converting | Glass lacquering |
| ALUMINIUM | Aerosol | Impact extrusion of aluminium | Anodising, aluminium sheet |
| ALUMINIUM | Tube | Impact extrusion of aluminium | Anodising, aluminium sheet |
| ALUMINIUM | Foil | Sheet rolling, aluminium | Anodising, aluminium sheet |
| ALUMINIUM | n.a. | Impact extrusion of aluminium | Anodising, aluminium sheet |
| STEEL | Pump | Sheet rolling, steel | No finishing |
| STEEL | Dispenser | Sheet rolling, steel | No finishing |
| STEEL | Aerosol components | Sheet rolling, steel | No finishing |
| STEEL | n.a. | Sheet rolling, steel | No finishing |
| TINPLATE CAN | n.a. | Sheet rolling, steel | No finishing |
| BRASS | n.a. | Sheet rolling, aluminium | No finishing |
| MAGNET | n.a. | Metal - no processing | No finishing |
| STAINLESS STEEL | n.a. | Sheet rolling, steel | No finishing |
| ZAMAK | n.a. | Metal - no processing | No finishing |
| PAPER (WOOD CONTAINING) | n.a. | Cardboard folding | Offset printing |
| PAPER (WOOD FREE) | n.a. | Cardboard folding | Offset printing |
| CARTON | n.a. | Cardboard folding | Offset printing |
| CORRUGATED BOARD | n.a. | Cardboard folding | Offset printing |
| CARTON, WHITE LINED | n.a. | Cardboard folding | Offset printing |

| Packaging material | Component | Default Converting process | Default Finishing process |
|---|---|---|---|
| MDF | n.a. | Cardboard folding | Offset printing |
| SOLID BLEACHED BOARD | n.a. | Cardboard folding | Offset printing |
| SOLID UNBLEACHED BOARD | n.a. | Cardboard folding | Offset printing |
| BAGASSE MOLDED PULP | n.a. | Cardboard folding | Offset printing |
| CELLOPHANE | n.a. | Extrusion of plastic sheets and thermoforming, inline | No finishing |
| CELLULOSE | n.a. | Extrusion of plastic sheets and thermoforming, inline | No finishing |
| CORK | n.a. | No processing | No finishing |
| COTTON | n.a. | Textile processing | No finishing |
| JUTE | n.a. | Textile processing | No finishing |
| CERAMICS | n.a. | No processing | No finishing |
| WOOD | n.a. | No processing | No finishing |
| LEATHER | n.a. | Textile processing | No finishing |
| FRAGRANCE PUMP (AVERAGE) | n.a. | No processing | No finishing |
| MIRROR | n.a. | No processing | No finishing |
| NOEDYMIUN OXIDE | n.a. | No processing | No finishing |
| PLASTIC PUMP (AVERAGE) | n.a. | No processing | No finishing |

1854

1855 ### 7.4.5 List of finishing surfaces per component

1856 *Table 47: List of finishing surfaces per component*

| Component | Finishing surface |
|---|---|
| **Bottle** | 80 cm2 |
| **Tube** | 50 cm2 |
| **Tub/Pot/Cup/Jar** | 45 cm2 |
| **Can** | 50 cm2 |
| **Pouch/Flexible packaging/Sachet** | 45cm2 |
| **Cap/Lid/Closure** | 10cm2 |

| Component | Finishing surface |
| --- | --- |
| **Pump/Dispenser/Aerosol components** | n.a. |
| **Seal** | n.a. |
| **Paper wrap** | 45cm2 |
| **Carton/Cardboard box** | 50cm2 |
| **Label (inc. ink and other related elements)** | 50cm2 |
| **Foil** | n.a. |
| **Accessories** | n.a. |
| **Applicators** | n.a. |
| **Aerosol** | 80cm2 |
| **Trays/Clamshell/Thermoforms** | n.a. |
| **Dunnage/inserts** | n.a. |
| **Plastic film** | 50cm2 |
| **Case/Blister** | n.a. |
| **Leaflet** | 50cm2 |
| **Dropper** | n.a. |

### 7.4.6 List of packaging default incineration and landfill for all material x component combinations (component = "n.a." correspond to the default mapping for any other components than the ones called out specifically)

*Table 48: List of packaging default incineration and landfill for all material ′ component combinations*

| Packaging material | Incineration LCI (Eer) | Landfilling LCI (Ed) |
| --- | --- | --- |
| ABS | Waste plastic, mixture {CH}\| treatment of waste plastic, mixture, municipal incineration \| Cut-off, U | Waste plastic, mixture {CH}\| treatment of waste plastic, mixture, sanitary landfill \| Cut-off, U |
| ALUMINIUM | Scrap aluminium {CH}\| treatment of scrap aluminium, municipal incineration \| Cut-off, U | Waste aluminium (corrected) {CH}\| treatment of waste aluminium, sanitary landfill \| Cut-off, U |

| Packaging material | Incineration LCI (Eer) | Landfilling LCI (Ed) |
| --- | --- | --- |
| BAGASSE MOLDED PULP | Waste graphical paper {CH}\| treatment of waste graphical paper, municipal incineration \| Cut-off, U | Waste paperboard, with carbon storage, with 27% degradation {CH}\| treatment of waste paperboard, sanitary landfill \| Cut-off, U |
| BIO HDPE | Waste polyethylene, biobased {CH}\| treatment of waste polyethylene, municipal incineration \| Cut-off, U | Waste polyethylene, biobased, with carbon storage {CH}\| treatment of waste polyethylene, sanitary landfill \| Cut-off, U |
| BIO LDPE | Waste polyethylene, biobased {CH}\| treatment of waste polyethylene, municipal incineration \| Cut-off, U | Waste polyethylene, biobased, with carbon storage {CH}\| treatment of waste polyethylene, sanitary landfill \| Cut-off, U |
| BIO LLDPE | Waste polyethylene, biobased {CH}\| treatment of waste polyethylene, municipal incineration \| Cut-off, U | Waste polyethylene, biobased, with carbon storage {CH}\| treatment of waste polyethylene, sanitary landfill \| Cut-off, U |
| BIO PBS | Waste polyethylene terephthalate {CH}\| treatment of waste polyethylene terephthalate, municipal incineration \| Cut-off, U | Waste polyethylene terephthalate {CH}\| treatment of waste polyethylene terephthalate, sanitary landfill \| Cut-off, U |
| BIO PET | Waste polyethylene terephthalate {CH}\| treatment of waste polyethylene terephthalate, municipal incineration \| Cut-off, U | Waste polyethylene terephthalate {CH}\| treatment of waste polyethylene terephthalate, sanitary landfill \| Cut-off, U |
| BIO PP | Waste polypropylene, biobased {CH}\| treatment of waste polypropylene, municipal incineration \| Cut-off, U | Waste polypropylene, biobased, with carbon storage {CH}\| treatment of waste polypropylene, sanitary landfill \| Cut-off, U |
| BIO PVC | Waste plastic, mixture {CH}\| treatment of waste plastic, mixture, municipal incineration \| Cut-off, U | Waste plastic, mixture {CH}\| treatment of waste plastic, mixture, sanitary landfill \| Cut-off, U |

| Packaging material | Incineration LCI (Eer) | Landfilling LCI (Ed) |
|---|---|---|
| BOPA | Waste plastic, mixture {CH}\| treatment of waste plastic, mixture, municipal incineration \| Cut-off, U | Waste plastic, mixture {CH}\| treatment of waste plastic, mixture, sanitary landfill \| Cut-off, U |
| BOPP | Waste polypropylene {CH}\| treatment of waste polypropylene, municipal incineration \| Cut-off, U | Waste polypropylene {CH}\| treatment of waste polypropylene, sanitary landfill \| Cut-off, U |
| BRASS | Scrap steel {CH}\| treatment of scrap steel, municipal incineration \| Cut-off, U | Scrap steel {CH}\| treatment of scrap steel, inert material landfill \| Cut-off, U |
| CARTON | Waste paperboard {CH}\| treatment of waste paperboard, municipal incineration \| Cut-off, U | Waste paperboard, with carbon storage, with 27% degradation {CH}\| treatment of waste paperboard, sanitary landfill \| Cut-off, U |
| CARTON, WHITE LINED | Waste paperboard {CH}\| treatment of waste paperboard, municipal incineration \| Cut-off, U | Waste paperboard, with carbon storage, with 27% degradation {CH}\| treatment of waste paperboard, sanitary landfill \| Cut-off, U |
| CELLOPHANE | Waste plastic, mixture {CH}\| treatment of waste plastic, mixture, municipal incineration \| Cut-off, U | Waste plastic, mixture {CH}\| treatment of waste plastic, mixture, sanitary landfill \| Cut-off, U |
| CELLULOSE | Waste plastic, mixture {CH}\| treatment of waste plastic, mixture, municipal incineration \| Cut-off, U | Waste plastic, mixture {CH}\| treatment of waste plastic, mixture, sanitary landfill \| Cut-off, U |
| CERAMICS | Scrap steel {CH}\| treatment of scrap steel, municipal incineration \| Cut-off, U | Scrap steel {CH}\| treatment of scrap steel, inert material landfill \| Cut-off, U |
| CORK | Waste wood, untreated {CH}\| treatment of waste wood, untreated, municipal incineration \| Cut-off, U | Waste wood, untreated, with carbon storage, with 5% degradation {CH}\| treatment of waste wood, untreated, sanitary landfill \| Cut-off, U |
| CORRUGATED BOARD | Waste paperboard {CH}\| treatment of waste paperboard, municipal incineration \| Cut-off, U | Waste paperboard, with carbon storage, with 27% degradation {CH}\| treatment of waste paperboard, sanitary landfill \| Cut-off, U |
| COTTON | Waste textile, soiled {CH}\| treatment of waste textile, | Municipal solid waste {CH}\| treatment of municipal solid waste, sanitary landfill \| Cut-off, U |

| Packaging material | Incineration LCI (Eer) | Landfilling LCI (Ed) |
|---|---|---|
| | soiled, municipal incineration \| Cut-off, U | |
| EPOXY RESIN | Waste plastic, mixture {CH}\| treatment of waste plastic, mixture, municipal incineration \| Cut-off, U | Waste plastic, mixture {CH}\| treatment of waste plastic, mixture, sanitary landfill \| Cut-off, U |
| EPS | Waste plastic, mixture {CH}\| treatment of waste plastic, mixture, municipal incineration \| Cut-off, U | Waste polystyrene {CH}\| treatment of waste polystyrene, sanitary landfill \| Cut-off, U |
| EVA | Waste plastic, mixture {CH}\| treatment of waste plastic, mixture, municipal incineration \| Cut-off, U | Waste plastic, mixture {CH}\| treatment of waste plastic, mixture, sanitary landfill \| Cut-off, U |
| EVOH | Waste plastic, mixture {CH}\| treatment of waste plastic, mixture, municipal incineration \| Cut-off, U | Waste plastic, mixture {CH}\| treatment of waste plastic, mixture, sanitary landfill \| Cut-off, U |
| FRAGRANCE PUMP (AVERAGE) | Waste plastic, mixture {CH}\| treatment of waste plastic, mixture, municipal incineration \| Cut-off, U | Waste plastic, mixture {CH}\| treatment of waste plastic, mixture, sanitary landfill \| Cut-off, U |
| GLASS | Waste glass {CH}\| treatment of waste glass, municipal incineration \| Cut-off, U | Waste glass {CH}\| treatment of waste glass, inert material landfill \| Cut-off, U |
| HDPE | Waste polyethylene {CH}\| treatment of waste polyethylene, municipal incineration \| Cut-off, U | Waste polyethylene {CH}\| treatment of waste polyethylene, sanitary landfill \| Cut-off, U |
| JUTE | Waste textile, soiled {CH}\| treatment of waste textile, soiled, municipal incineration \| Cut-off, U | Municipal solid waste {CH}\| treatment of municipal solid waste, sanitary landfill \| Cut-off, U |
| LATEX | Waste plastic, mixture {CH}\| treatment of waste plastic, mixture, municipal incineration \| Cut-off, U | Waste plastic, mixture {CH}\| treatment of waste plastic, mixture, sanitary landfill \| Cut-off, U |
| LDPE | Waste polyethylene {CH}\| treatment of waste polyethylene, municipal incineration \| Cut-off, U | Waste polyethylene {CH}\| treatment of waste polyethylene, sanitary landfill \| Cut-off, U |

| Packaging material | Incineration LCI (Eer) | Landfilling LCI (Ed) |
|---|---|---|
| LEATHER | Waste textile, soiled {CH}\| treatment of waste textile, soiled, municipal incineration \| Cut-off, U | Municipal solid waste {CH}\| treatment of municipal solid waste, sanitary landfill \| Cut-off, U |
| LLDPE | Waste polyethylene {CH}\| treatment of waste polyethylene, municipal incineration \| Cut-off, U | Waste polyethylene {CH}\| treatment of waste polyethylene, sanitary landfill \| Cut-off, U |
| MAGNET | Scrap steel {CH}\| treatment of scrap steel, municipal incineration \| Cut-off, U | Scrap steel {CH}\| treatment of scrap steel, inert material landfill \| Cut-off, U |
| MBS | Waste plastic, mixture {CH}\| treatment of waste plastic, mixture, municipal incineration \| Cut-off, U | Waste plastic, mixture {CH}\| treatment of waste plastic, mixture, sanitary landfill \| Cut-off, U |
| MDF | Waste wood, untreated {CH}\| treatment of waste wood, untreated, municipal incineration \| Cut-off, U | Waste wood, untreated, with carbon storage, with 5% degradation {CH}\| treatment of waste wood, untreated, sanitary landfill \| Cut-off, U |
| MELANIME FORMALDEHYDE RESIN | Waste plastic, mixture {CH}\| treatment of waste plastic, mixture, municipal incineration \| Cut-off, U | Waste plastic, mixture {CH}\| treatment of waste plastic, mixture, sanitary landfill \| Cut-off, U |
| MIRROR | Waste glass {CH}\| treatment of waste glass, municipal incineration \| Cut-off, U | Waste glass {CH}\| treatment of waste glass, inert material landfill \| Cut-off, U |
| NOEDYMIUN OXIDE | Scrap steel {CH}\| treatment of scrap steel, municipal incineration \| Cut-off, U | Scrap steel {CH}\| treatment of scrap steel, inert material landfill \| Cut-off, U |
| OPP | Waste polypropylene {CH}\| treatment of waste polypropylene, municipal incineration \| Cut-off, U | Waste polypropylene {CH}\| treatment of waste polypropylene, sanitary landfill \| Cut-off, U |
| PA (CASTOR OIL) | Waste plastic, mixture, biobased {CH}\| treatment of waste plastic, mixture, municipal incineration \| Cut-off, U | Waste plastic, mixture, biobased, with carbon storage {CH}\| treatment of waste plastic, mixture, sanitary landfill \| Cut-off, U |
| PA NYLON | Waste plastic, mixture {CH}\| treatment of waste plastic, | Waste plastic, mixture {CH}\| treatment of waste plastic, mixture, sanitary landfill \| Cut-off, U |

| Packaging material | Incineration LCI (Eer) | Landfilling LCI (Ed) |
|---|---|---|
| | mixture, municipal incineration \| Cut-off, U | |
| PA1010 (CASTOR OIL) | Waste plastic, mixture, biobased {CH}\| treatment of waste plastic, mixture, municipal incineration \| Cut-off, U | Waste plastic, mixture, biobased, with carbon storage {CH}\| treatment of waste plastic, mixture, sanitary landfill \| Cut-off, U |
| PA11 (CASTOR OIL) | Waste plastic, mixture, biobased {CH}\| treatment of waste plastic, mixture, municipal incineration \| Cut-off, U | Waste plastic, mixture, biobased, with carbon storage {CH}\| treatment of waste plastic, mixture, sanitary landfill \| Cut-off, U |
| PAPER (WOOD CONTAINING) | Waste graphical paper {CH}\| treatment of waste graphical paper, municipal incineration \| Cut-off, U | Waste paperboard, with carbon storage, with 27% degradation {CH}\| treatment of waste paperboard, sanitary landfill \| Cut-off, U |
| PAPER (WOOD FREE) | Waste graphical paper {CH}\| treatment of waste graphical paper, municipal incineration \| Cut-off, U | Waste graphical paper, with carbon storage, with 27% degradation {CH}\| treatment of waste graphical paper, sanitary landfill \| Cut-off, U |
| PBS | Waste plastic, mixture {CH}\| treatment of waste plastic, mixture, municipal incineration \| Cut-off, U | Waste plastic, mixture {CH}\| treatment of waste plastic, mixture, sanitary landfill \| Cut-off, U |
| PBT | Waste plastic, mixture {CH}\| treatment of waste plastic, mixture, municipal incineration \| Cut-off, U | Waste plastic, mixture {CH}\| treatment of waste plastic, mixture, sanitary landfill \| Cut-off, U |
| PC | Waste plastic, mixture {CH}\| treatment of waste plastic, mixture, municipal incineration \| Cut-off, U | Waste plastic, mixture {CH}\| treatment of waste plastic, mixture, sanitary landfill \| Cut-off, U |
| PCT | Waste plastic, mixture {CH}\| treatment of waste plastic, mixture, municipal incineration \| Cut-off, U | Waste plastic, mixture {CH}\| treatment of waste plastic, mixture, sanitary landfill \| Cut-off, U |
| PCTG | Waste plastic, mixture {CH}\| treatment of waste plastic, mixture, municipal incineration \| Cut-off, U | Waste plastic, mixture {CH}\| treatment of waste plastic, mixture, sanitary landfill \| Cut-off, U |

| Packaging material | Incineration LCI (Eer) | Landfilling LCI (Ed) |
|---|---|---|
| PE MALEIC ANHYDRIDE | Waste polyethylene {CH}\| treatment of waste polyethylene, municipal incineration \| Cut-off, U | Waste polyethylene {CH}\| treatment of waste polyethylene, sanitary landfill \| Cut-off, U |
| PET | Waste polyethylene terephthalate {CH}\| treatment of waste polyethylene terephthalate, municipal incineration \| Cut-off, U | Waste polyethylene terephthalate {CH}\| treatment of waste polyethylene terephthalate, sanitary landfill \| Cut-off, U |
| PETG | Waste polyethylene terephthalate {CH}\| treatment of waste polyethylene terephthalate, municipal incineration \| Cut-off, U | Waste polyethylene terephthalate {CH}\| treatment of waste polyethylene terephthalate, sanitary landfill \| Cut-off, U |
| PK | Waste plastic, mixture {CH}\| treatment of waste plastic, mixture, municipal incineration \| Cut-off, U | Waste plastic, mixture {CH}\| treatment of waste plastic, mixture, sanitary landfill \| Cut-off, U |
| PLA | Waste polypropylene {CH}\| treatment of waste polypropylene, municipal incineration \| Cut-off, U | Waste polypropylene {CH}\| treatment of waste polypropylene, sanitary landfill \| Cut-off, U |
| PLASTIC PUMP (AVERAGE) | Waste plastic, mixture {CH}\| treatment of waste plastic, mixture, municipal incineration \| Cut-off, U | Waste plastic, mixture {CH}\| treatment of waste plastic, mixture, sanitary landfill \| Cut-off, U |
| PMMA | Waste plastic, mixture {CH}\| treatment of waste plastic, mixture, municipal incineration \| Cut-off, U | Waste plastic, mixture {CH}\| treatment of waste plastic, mixture, sanitary landfill \| Cut-off, U |
| POM | Waste plastic, mixture {CH}\| treatment of waste plastic, mixture, municipal incineration \| Cut-off, U | Waste plastic, mixture {CH}\| treatment of waste plastic, mixture, sanitary landfill \| Cut-off, U |
| PP | Waste polypropylene {CH}\| treatment of waste polypropylene, municipal incineration \| Cut-off, U | Waste polypropylene {CH}\| treatment of waste polypropylene, sanitary landfill \| Cut-off, U |

| Packaging material | Incineration LCI (Eer) | Landfilling LCI (Ed) |
|---|---|---|
| PS | Waste plastic, mixture {CH}\| treatment of waste plastic, mixture, municipal incineration \| Cut-off, U | Waste polystyrene {CH}\| treatment of waste polystyrene, sanitary landfill \| Cut-off, U |
| PTFE | Waste plastic, mixture {CH}\| treatment of waste plastic, mixture, municipal incineration \| Cut-off, U | Waste plastic, mixture {CH}\| treatment of waste plastic, mixture, sanitary landfill \| Cut-off, U |
| PU | Waste plastic, mixture {CH}\| treatment of waste plastic, mixture, municipal incineration \| Cut-off, U | Waste plastic, mixture {CH}\| treatment of waste plastic, mixture, sanitary landfill \| Cut-off, U |
| PVC | Waste plastic, mixture {CH}\| treatment of waste plastic, mixture, municipal incineration \| Cut-off, U | Waste plastic, mixture {CH}\| treatment of waste plastic, mixture, sanitary landfill \| Cut-off, U |
| PVDC | Waste plastic, mixture {CH}\| treatment of waste plastic, mixture, municipal incineration \| Cut-off, U | Waste plastic, mixture {CH}\| treatment of waste plastic, mixture, sanitary landfill \| Cut-off, U |
| SAN | Waste plastic, mixture {CH}\| treatment of waste plastic, mixture, municipal incineration \| Cut-off, U | Waste plastic, mixture {CH}\| treatment of waste plastic, mixture, sanitary landfill \| Cut-off, U |
| SEBS | Waste plastic, mixture {CH}\| treatment of waste plastic, mixture, municipal incineration \| Cut-off, U | Waste plastic, mixture {CH}\| treatment of waste plastic, mixture, sanitary landfill \| Cut-off, U |
| SOLID BLEACHED BOARD | Waste paperboard {CH}\| treatment of waste paperboard, municipal incineration \| Cut-off, U | Waste paperboard, with carbon storage, with 27% degradation {CH}\| treatment of waste paperboard, sanitary landfill \| Cut-off, U |
| SOLID UNBLEACHED BOARD | Waste paperboard {CH}\| treatment of waste paperboard, municipal incineration \| Cut-off, U | Waste paperboard, with carbon storage, with 27% degradation {CH}\| treatment of waste paperboard, sanitary landfill \| Cut-off, U |
| STAINLESS STEEL | Scrap steel {CH}\| treatment of scrap steel, municipal incineration \| Cut-off, U | Scrap steel {CH}\| treatment of scrap steel, inert material landfill \| Cut-off, U |

| Packaging material | Incineration LCI (Eer) | Landfilling LCI (Ed) |
|---|---|---|
| STEEL | Scrap steel {CH}\| treatment of scrap steel, municipal incineration \| Cut-off, U | Scrap steel {CH}\| treatment of scrap steel, inert material landfill \| Cut-off, U |
| SURLYN | Waste plastic, mixture {CH}\| treatment of waste plastic, mixture, municipal incineration \| Cut-off, U | Waste plastic, mixture {CH}\| treatment of waste plastic, mixture, sanitary landfill \| Cut-off, U |
| SYNTHETIC RUBBER | Waste rubber, unspecified {CH}\| treatment of waste rubber, unspecified, municipal incineration \| Cut-off, U | Waste plastic, mixture {CH}\| treatment of waste plastic, mixture, sanitary landfill \| Cut-off, U |
| TINPLATE CAN | Scrap tin sheet {CH}\| treatment of scrap tin sheet, municipal incineration \| Cut-off, U | Scrap tin sheet {CH}\| treatment of scrap tin sheet, sanitary landfill \| Cut-off, U |
| TRANSPARENT PA | Waste plastic, mixture {CH}\| treatment of waste plastic, mixture, municipal incineration \| Cut-off, U | Waste plastic, mixture {CH}\| treatment of waste plastic, mixture, sanitary landfill \| Cut-off, U |
| TREVA (CELLULOSE) | Waste plastic, mixture, biobased {CH}\| treatment of waste plastic, mixture, municipal incineration \| Cut-off, U | Waste plastic, mixture, biobased, with carbon storage {CH}\| treatment of waste plastic, mixture, sanitary landfill \| Cut-off, U |
| WOOD | Waste wood, untreated {CH}\| treatment of waste wood, untreated, municipal incineration \| Cut-off, U | Waste wood, untreated, with carbon storage, with 5% degradation {CH}\| treatment of waste wood, untreated, sanitary landfill \| Cut-off, U |
| ZAMAK | Scrap aluminium {CH}\| treatment of scrap aluminium, municipal incineration \| Cut-off, U | Waste aluminium (corrected) {CH}\| treatment of waste aluminium, sanitary landfill \| Cut-off, U |

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## 7.5 Developments on USEtox Freshwater Ecotoxicity method

According to mapping by the CAS number, out of 671 cosmetic ingredients which were defined as priority ingredients for the database, only 201 have defined characterization factors in the database adapted by the Joint Research Center (EC) for PEF based on USEtox® framework. Only for a third of priority ingredients for the four segments selected for the go-live a CF in EF database was matched (Table 49).

*Table 49: Analysis of EF3.0 CF coverage across selected product segments.*

| | Total | Hair wash | Hair treat | Body wash | Face moisturize & treat |
|---|---|---|---|---|---|
| **Priority ingredients** [1] **(#)** | **671** | **108** | **368** | **228** | **216** |
| CF coverage - matched by CAS (# of ingredients / %) | **201** (30%) | **39** (36%) | **119** (32%) | **85** (37%) | **105** (49%) |

The poor coverage of some groups of chemicals can be explained by limitations of availability of measured data on environmental fate and toxicological properties and existing measurement methods. Additional uncertainties were spotted due to imprecision of the input data, potential chemicals misclassifications, as well as data collection and curation inconsistencies. Systematic revision on characterization factors available in EF3.1 database was performed along with development of additional characterization factors to ensure that end-of-life characterization can be applied to all cosmetic ingredients available in the formulas. Preliminary calculation indicated that the poor CF coverage across the list of priority ingredients directionally alters the robustness of results (hence an increased uncertainty) when it comes to differentiating products. Along with cosmetic ingredients poor coverage, some USEtox® method limitations indicated that work needs to be carried out to make freshwater ecotoxicity assessment more fit to the EBS purpose.

*Table 50: The areas of the focus defined to improve ecotoxicity assessment robustness.*

| Some limitations - USEtox 2.1 (2017) | Improvements in EF 3.0/EF3.1 (2019)* |
|---|---|
| USEtox 2.1 is meant for **chemicals hotspotting**, and is not appropriate for making absolute quantitative estimates of ecosystem impacts | - |
| USEtox 2.1 is **ecologically irrelevant** and not in accordance with EU ERA and Ecolabel principles (based on most sensitive trophic level) | Alignment with EU ERA and Ecolabel principles (HC20) |
| **High uncertainty of ecotoxicity results** (3 orders of magnitude) - robustness level III (EU JRC) | Robustness III level, mandatory ecotoxicity and use of USEtox in PEF studies |
| USEtox framework **not suited to model some elementary flow types** (incl. metals, organic salts, nanoparticles etc.) | Introduction of robustness factors to adequately characterizing different groups of elementary flows (organics, inorganics, metal non-essentials, metal essentials) |

| | |
|---|---|
| Lack of **transparency on data USEtox 2.1 uses**, intensive data needs for physico-chemical input data and some observed inconsistencies | Automated extraction procedure applied on the REACH-IUCLID database, use of new physico-chemical properties and toxicity data from more consistent and robust sources. Critical approach recommended with regards to data in order to ensure reliable and representative results |
| **Low data coverage for some industries (incl. cosmetics)**, the USEtox team has no mandate to bridge those data gaps | Wider coverage (6011 CFs vs 2499 in USEtox 2.1) |

**Adapted from Saouter et al., 2018*[22]

As defined in USEtox® framework, Characterization Factor for chemicals in Freshwater ecotoxicity impact category consists of fate factor (FF), exposure factor (XF) and effect factor (EF), the last one is contributing mostly to the differentiation of chemicals according to their final CF value and modeled based on data describing toxicological properties of the ingredients towards aquatic species (acute and chronic toxicity) (Figure 7).

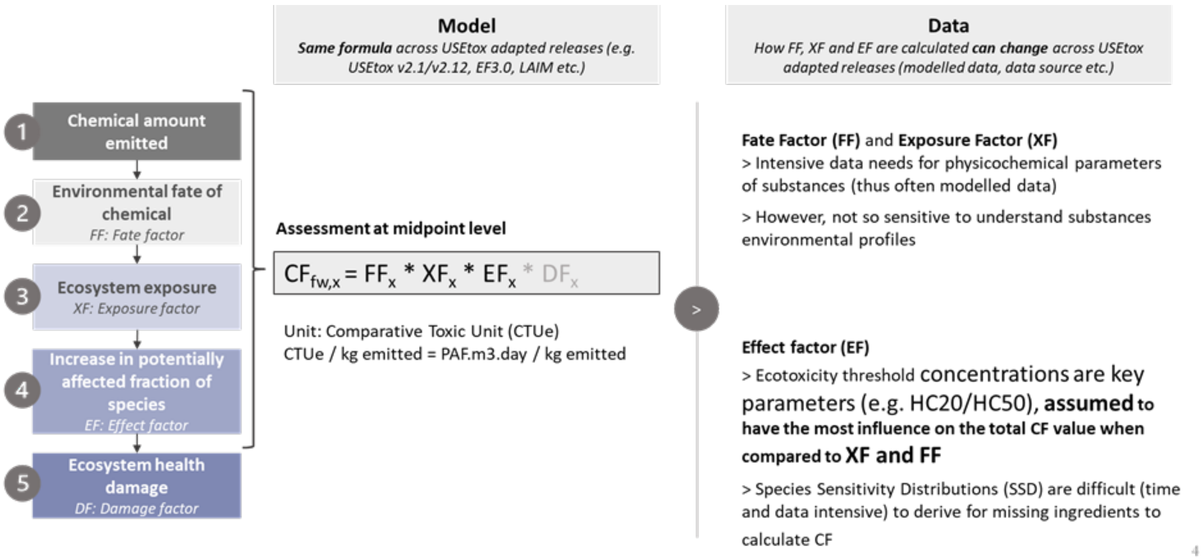


*Figure 7: Characterization Factor for chemicals, summary of the method and its application.*

According to USEtox® framework, the EF should be determined from HC20 value itself derived from Species Sensitivity Distribution (SSD) curve. In cases when a limited number of data (trophic levels) SSDs are less accurate as well as use of QSAR[23]. UNEP-SETAC Pellston workshop, June 2018 recommended a "read-across / simplified SSD" approach, but the details were not well defined. This is the commonly used deterministic approach to hazard characterization.

Using data of the most sensitive species with assessment factors is a simplified approach implemented by EBS to enable an easy calculation of effect factors and ensure that the most sensitive species is properly considered even with a limited amount of data.

In consistency with regulatory safety assessment an alternative method of calculation was proposed based on the Most Sensitive Species value which was set as HC5 equivalent. The approach chosen for characterization factors improvement is summarized in Figure 8.

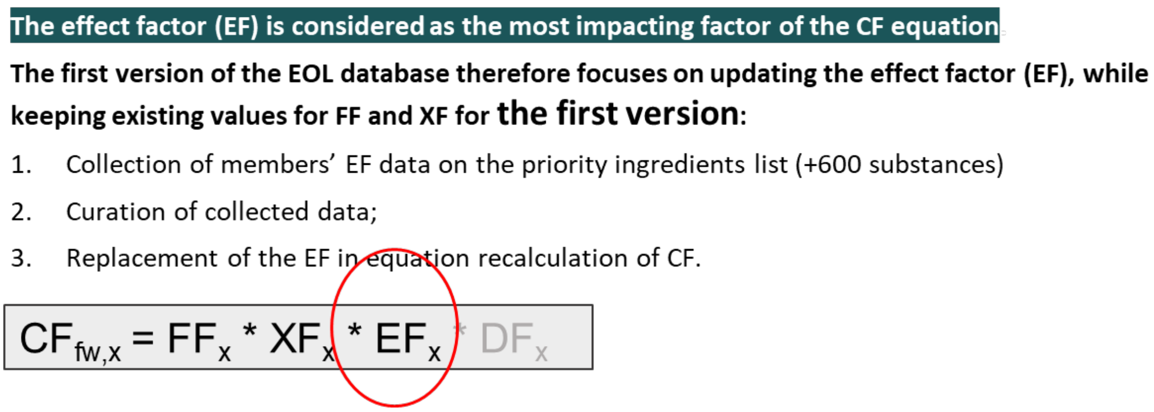


*Figure 8: Characterization factors improvement approach.*

The approach was adopted both for characterization factors which were identified based on CAS number match in EF 3.1 database and for the development of the new characterization factors for ingredients which were identified as priority ingredients but did not have characterization in EF 3.1 database.

In the scope of systematic revision of the databases and members' data, the underlying data used for the development of EF3.1 freshwater ecotoxicity characterization factors along with additional aquatic toxicity data on ingredients available in recognized databases (ECHA, EnviroTox) or shared by member companies have been assessed. Collected data originated both from ECHA and members' internal databases collected from various sources e.g. OECD SIDS, DID-list Part A, HERA, MSDS, studies, publications, internal tests. Collected datapoints for acute and chronic values were covering three usual trophic levels according to the regulatory requirements. Often, only the key value from a REACH dossier obtained with the most sensitive species.

A two-stage-process of curation was applied to prioritize data points to select the best available quality data is described in Figure 9**Error! Reference source not found.**.

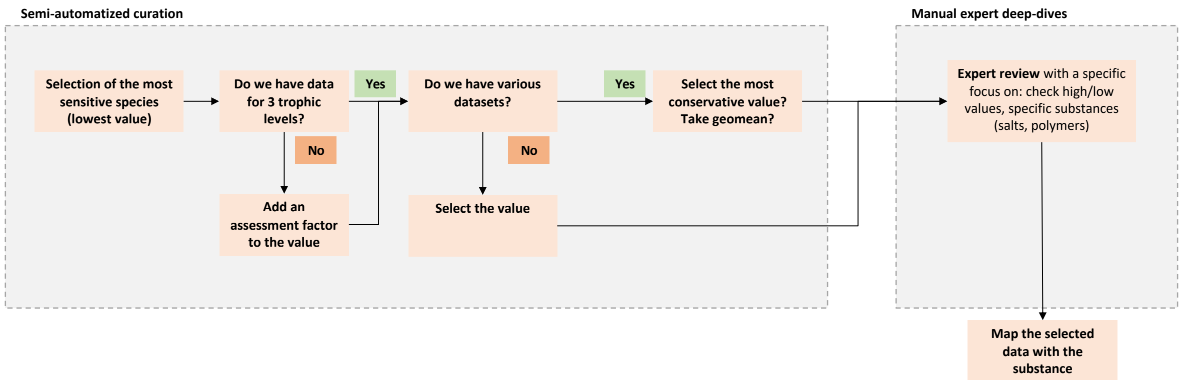


*Figure 9: Prioritizing data based on origin and quality.*

Selected value or value corresponding to the most sensitive species was used as a proxy value for HC5. When chronic values were not available, the lowest EC50acut value was used to derive the lowest EC10chr reference value using an acute-to-chronic factor 100 for metals and organometallics and 10 for other substances, including organics.

In case no chronic data was available, a assessment factor was applied depending on the number of trophic levels for which acute data is available[24, 25]:

SF = 1 if all 3 trophic levels have value;

SF = 5 if only 2 trophic levels have value;

SF = 10 if only 1 trophic level has value;

When chronic data is available in addition to acute values for three trophic levels:

SF = 1 if the trophic level with the lowest acute value has also chronic value;

In other cases, the SF value was based on the number of chronic values available.

The effect factor was calculated accordingly as:

$$EF_{EBS} = 1000 * \frac{0.05}{HC5_{EC10chr}} = 1000 * \frac{0.05}{\frac{LowestEC10_{chr}}{SF}}$$

CF values were then calculated using EF values derived according to the methodology described in Figure 8.

Specific case for cationic polymers were brought up because of the specific mode of action through which they cause toxicity towards aquatic species in the environment, primarily linked to their cationic charges, and the fact that this toxicity is mitigated because cationic charges are neutralized by adsorption of polymers to some materials present in surrounding water (e.g. organic matter, clay particles, anions). The goal was to see if "mitigation factors" of the aquatic toxicity of cationic polymers used in environmental risk assessment should also be used in our ecotoxicity method, or if that would be double counting of toxicity mitigation of these ingredients since their XF would already take into account the adsorption process leading to neutralization of cationic charges.

While cationic polymers are typically not bioavailable because their large molecular size prevents them from crossing biological membranes, cationic surfactants such as those used in cosmetic formulas are smaller and thus more bioavailable molecules. They can cross membranes, cause membrane disruption and other toxic effects irrespective of charge neutralization. Because of this fundamental difference in mode of action between these two types of cationic ingredients, it would be inaccurate to extrapolate mitigation factors from cationic surfactants to cationic polymers.

The most conservative mitigation factor published by the Canadian authorities[26] for cationic polymers, i.e. 7, was considered relevant to adjust their freshwater ecotoxicity CF in this USEtox® method. This mitigation factor accounts only for the middle factor in the XF denominator $K_{doc} * DOC$.

$$XF_{aquatic} = \frac{m_{dissolved}}{m_{total}} = \frac{1}{1 + (K_p \ + SUSP + K_{doc} \ * DOC + BCF_{fish} \ * BIO)}$$

Where:

$K_p$ - partition coefficient between water and suspended solids, l/kg

$SUSP$ – suspended matter concentration in freshwater, kg/l

$K_{doc}$ - partition coefficient between dissolved organic carbon and water, l/kg

$DOC$ – dissolved organic carbon concentration in freshwater, kg/l

$BCF_{fish}$ - bioconcentration factor in fish, l/kg

$BIO$ – concentration of biota in water, kg/l

Also, some cationic polymers showed up as outliers in the USEtox results (e.g. guar), which was deemed surprising based on experts' knowledge of such ingredients. This spurred a deep-dive into those ingredients. Specific case of cationic polymers was acknowledged by working group and values for relevant cationic polymers amongst priority ingredients were revised. The list of the cationic polymers is provided in Table 51.

*Table 51: The list of cationic polymers revised.*

| Polymer INCI | CAS | Result of the revision |
|---|---|---|
| GUAR HYDROXYPROPYLTRIMONIUM CHLORIDE | 65497-29-2 | New CF |
| POLYQUATERNIUM-10 | 68610-92-4 | New CF |
| POLYQUATERNIUM-11 | 53633-54-8 | New CF |
| POLYQUATERNIUM-16 | 95144-24-4 | New CF |
| POLYQUATERNIUM-28 | 131954-48-8 | New CF |
| POLYQUATERNIUM-37 | 26161-33-1 | New CF |
| POLYQUATERNIUM-4 | 92183-41-0 | New CF |
| POLYQUATERNIUM-22 | 53694-17-0 | Semi-specific proxy |
| POLYQUATERNIUM-46 | 174761-16-1 | Semi-specific proxy |
| POLYQUATERNIUM-47 | 197969-52-1 | Semi-specific proxy |
| POLYQUATERNIUM-7 | 26590-05-6 | Semi-specific proxy |

Suggestion to apply mitigation factor of 7 to XF x FF in accordance with authorities' publication[26], [27], as XF addresses exposure of pelagic aquatic species to mentioned ingredients. To ensure a robust scientific rationale, a conservative estimate (mitigation factor of 7) among a range of potential mitigation factors was selected. No double counting of adsorption effects as USEtox® data mainly collected from ecotoxicity studies were conducted in clean water as opposed to river water or water enriched with humic acids according to the study records.

None of cationic polymers in scope have specific FF and XF values based on EF 3.1 (all either have a new CF with semi-specific or generic FF x XF or "Proxy CF" i.e. class-level proxy CF based on semi-specific FF x XF and EF). All of their FF x XF (for semi-specific and generic values) and the generic proxy CF value are based on a statistical approach covering a set of data with XF values close to 1. Application of mitigation factor of 7 (1/7) to XF x FF values for these ingredients.

For cases when no input data to the USEtox® model available to derive FF an XF values (water solubility, vapor pressure, partitioning coefficient etc.), but EF could be calculated based on available ecotoxicity data the necessary prioritization was done and the FF x XF were defined as a proxy per class of ingredients. Four classes of ingredients were defined based on assessment of relevant criteria - biodegradability and bioaccumulation only (exclusion of toxicity as already accounted for through the EF).

Additionally, a statistical analysis was performed to underline trends and identify main predictors for the four classes of ingredients (Figure 10). The rationale of clustering ingredients into classes according to biodegradability, bioaccumulative properties and toxicity.

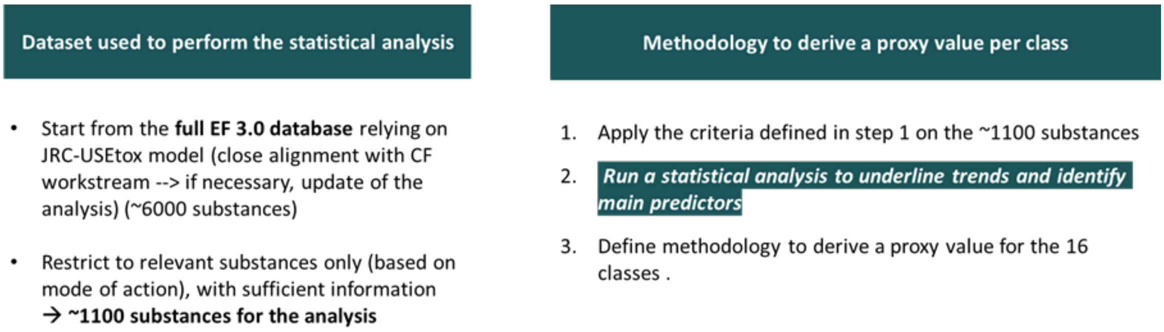


*Figure 10: The summary of methodological approach and statistical analysis performed.*

Focus on substances' readily biodegradability as a first simple and pragmatic approach relying on substances freshwater degradation rate. Main sources used - JRC database and substances' REACH dossiers.

Substance was considered "Not readily biodegradable" if Kdeg,w < 1.6E-07 s-1 (JRC threshold value for Biodegradable, failing 10-days substances).

Bioaccumulation was defined based on BAF fish or octanol-water partitioning coefficient (logKow values). Substance was considered potentially bioaccumulative if BAF > 500 or if logKow > 4 (CLP/GHS threshold).

Each unique combination of two properties allowed to define FF x XF proxy for four groups or classes and in combination with calculated EF value some additional CF for substance could be calculated.

For ingredients which were identified as priority, but EF could not be calculated due to lack of environmental toxicity data, additional four classes of toxicity were defined based on ecotoxicity data retrieved from Envirotox database (E/LC50) and JRC database (HC20). Toxicity classes were defined relying on REACH, CLP and C&L classifications – very toxic, toxic, harmful and not toxic.

The combination of biodegradability, bioaccumulation and toxicity properties could allow to group mentioned above substances into 16 clusters and semi-specific CF value could be assigned to each cluster or group.

Non-priority ingredients have been mapped to a generic proxy corresponding to the 75%tile of the specific ingredient CF values.

## 7.6 Improvements on the Normalisation Factor for USEtox Freshwater Ecotoxicity

It is a well-known issue in the LCA community that the normalisation factors (NF) for Freshwater Ecotoxicity and Human Toxicity impact categories are highly underestimated. Indeed, the three USEtox impact categories are the only ones of the EF 3.1 method package to be given the lowest grade of III for both “Inventory coverage completeness” and “Inventory robustness”, according to the JRC quality grading system[22].

An analysis of the EBS association identified that the cosmetic sector is among the sectors that are amongst the most poorly covered in terms of inventory coverage, with only 7 of the ingredients of the EBS priority list having an inventory in the calculation of the NF for Freshwater Ecotoxicity. Therefore, utilising the opportunity of being a large association of companies, the EBS association conducted some work to improve the coverage of the NF inventories by adding the Cosmetic industry.

The process was composed of 2 main steps, described in Figure 11 and in details in the text below.

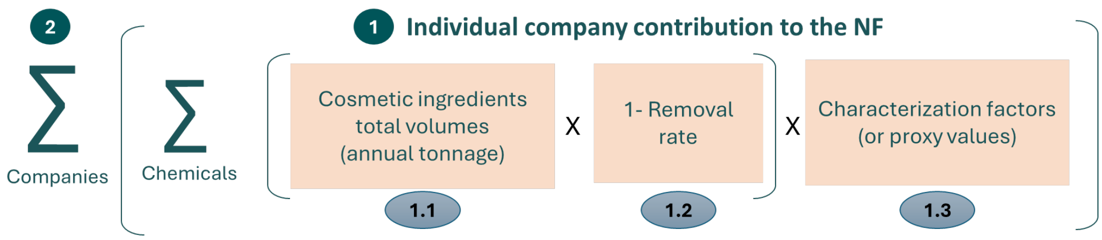


*Figure 11: Calculation of the contribution to the NF of Freshwater Ecotoxicity of participating EBS companies*

**Step 1 – Individual company’ contribution to the NF**

A tool was constructed in an excel spreadsheet that allowed companies to calculate their “company specific” contribution to the NF.

1.1 This tool starts by collecting the company’s total usage of chemicals in all their products for the year of reference, identifying the chemicals via INCI names and CAS numbers from the company’s internal systems.

1.2 These volumes were then adjusted according to removal rates to model the total emissions of chemicals of that company into the environment for the reference year (see section 3.8.1 for details about the removal rates calculations). This follows the same structure and reasoning than the building of the inventory for the pharmaceutical industry in the JRC NF.

1.3 Finally, the flows of chemicals emissions into the environment are multiplied by their corresponding CFs as defined in the Association (see Appendix 7.5 for details about the Freshwater Ecotoxicity CFs improvements).

This corresponds to the individual company’s contribution to the NF.

**Step 2 – Contribution to the NF of all companies participating in the exercise**

All individual companies’ numbers were collected and summed to make the contribution to the NF of all companies that participated in the exercise.

The number obtained was then added to the existing NF calculated by the JRC, making the new improved NF for Freshwater Ecotoxicity.

NB: That improvement to the NF for Freshwater Ecotoxicity is only a start to improve the coverage of the inventory for that NF. Indeed, companies participating are only a small fraction of all cosmetic companies, and therefore the new NF does not even cover the entire Cosmetic Industry (for more insights on the difference that would make, see Bohnes et al., 2024[28]). Additionally, other industries that are responsible to emissions of chemicals to the environment are not covered by the NF now such as the home case industry. Finally, there is still a high uncertainty related to the existing NF as most of the inventory flows included are based on extrapolations and assumptions. There is still much work to be done to reach a quality of NF acceptable for LCA.

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