R3PACK - REDUCE, REUSE, RETHINK PACKAGING TOWARDS NOVEL FIBRE-BASED PACKAGING AND REUSE SCHEMES

Grant Agreement No. 101060806

Work package: WP6 - Impacts assessment

Task: 6.1 - State of the art packaging LCA

Deliverable: D 6.1 - Part A

Dissemination level: Public

Issue date: May 2023

Lead beneficiary: Innovhub SSI

Funded by the European Union

This project has received funding from the European Union's Horizon Europe Research and Innovation programme under Grant Agreement No 101060806. This document reflects the views of the author(s) and does not necessarily reflect the views or policy of the European Commission. Whilst efforts have been made to ensure the accuracy and completeness of this document, the European Commission shall not be liable for any errors or omissions, however

DOCUMENT INFORMATION

HISTORY OF CHANGES		
Version	**Publication date**	**Changes**
1.0	10.05.2023	Draft to Reset
2.0	31.05.2023	Deliverable

ADDITIONAL AUTHOR(S) CONTRIBUTION	
Name	**Organization**
Barbara Del Curto, Romina Santi, Carlo Proserpio, Stefano Ferraresi	Polimi
Daniele Bussini, Chiara Cappelletti	Innovhub-SSI

DOCUMENT DISTRIBUTION		
Issue	**Date**	**Distributed to**
V1	31/05/2023	European Commission

VERIFICATION AND APPROVAL		
	Date	**Distributed to**
Approval final deliverable by (RE)SET	12/05/2023	Elodie Schott
	31/05/2023	Antoine Covillers

Funded by the European Union

This project has received funding from the European Union's Horizon Europe Research and Innovation programme under Grant Agreement No 101060806. This document reflects the views of the author(s) and does not necessarily reflect the views or policy of the European Commission. Whilst efforts have been made to ensure the accuracy and completeness of this document, the European Commission shall not be liable for any errors or omissions, however

TABLE OF CONTENT

Funded by the European Union

This project has received funding from the European Union's Horizon Europe Research and Innovation programme under Grant Agreement No 101060806. This document reflects the views of the author(s) and does not necessarily reflect the views or policy of the European Commission. Whilst efforts have been made to ensure the accuracy and completeness of this document, the European Commission shall not be liable for any errors or omissions, however

LCAs Results - State of the Art
SUBSTITUTION
PEF Report

Acronyms

CFF: Circular Footprint Formula

EF: Environmental Footprint

LCA: Life Cycle Assessment

LCI: Life Cycle Inventory

PEF: Product Environmental Footprint

PEFCRs: Product Environmental Footprint Category Rules

PP+M: PreProduction & Manufacturing

EoL: End-of-life

EF: Environmental Footprint

Definitions

Life cycle Assessment (LCA) – Compilation and evaluation of the inputs, outputs and the potential environmental impacts of a product system throughout its life cycle (ISO 14040:2006).

Product Environmental Footprint Category Rules (PEFCRs) – Product category specific, life cycle based rules that complement general methodological guidance for PEF studies by providing further specification at the level of a specific product category. PEFCRs help to shift the focus of the PEF study towards those aspects and parameters that matter the most, and hence contribute to increased relevance, reproducibility and consistency of the results by reducing costs versus a study based on the comprehensive requirements of the PEF method. Only the PEFCRs listed on the European Commission website (http://ec.europa.eu/environment/eussd/smgp/PEFCR_OEFSR_en.htm) are recognised as in line with this method.

1. SUMMARY

Funded by the European Union

This project has received funding from the European Union's Horizon Europe Research and Innovation programme under Grant Agreement No 101060806. This document reflects the views of the author(s) and does not necessarily reflect the views or policy of the European Commission. Whilst efforts have been made to ensure the accuracy and completeness of this document, the European Commission shall not be liable for any errors or omissions, however

The goal of the following work is the environmental impact evaluation of the state-of-the-art related to the packaging solutions selected to be substituted within the R3PACK project. The methodology followed is the Life Cycle Assesement (LCA) carried out through SimaPro software and following the PEF method with some adaptations (declared in the report). This report will analyse ten primary packaging belonging to nine different food categories defined in the R3PACK project. The functional unit is «one unit of food packaging of a determined capacity able to contain, preserve, protect the food inside and inform about it, guaranteeing proper food safety and shelf life». The main limitations and assumptions are due to the lack of primary data, replaced by proxy datasets. Since this report aims to show the main impact assessment results, these are limited to highlighting the most relevant life cycle stages, processes and impact categories. This state-of-the-art analysis will be necessary to set the baseline for comparisons with the newly developed cellulose-based packaging in D 6.3 Part. A (M36).

2. GENERAL INFORMATION ABOUT THE PRODUCTS IN SCOPE

This first part (A) of D6.1 provides the results of Life Cycle Assesment (LCA) studies related to ten existing packaging (state of the art) selected to be substituted. The general table below (Tab. 1) shows the relevant information for each product analysed, i.e., product name, format, nominal capacity (in grams or millilitres), reference food product category (among those covered by the R3PACK project), name of the company using the packaging. For all products, the study's publication date coincides with the deadline for the deliverable D6.1 A (M12, May 2023). The geographic validity of the research and the country where the product is consumed/sold is France, Europe.

Each packaging is marked with an identification number (LCA ID) to identify the LCA dedicated to it.

In cases where data relating to several packaging have been provided in the same food category, the one deemed most representative or the one for which more detailed data has been retrieved has been selected.

Tab 1. Products analyzed

	**Product**	Florette Shaker Ananas
	Format	PET Cup
	Capacity	400 ml
	Food category	Prepared fruits
	Company	Floréale
	LCA ID	01
	**Product**	Salad MDD
	Format	PET Tray
	Capacity	250 g
	Food category	Prepared salad
	Company	LSDH
	LCA ID	02
	**Product**	Sour cream
	Format	PP Cup
	Capacity	200 g
	Food category	Yoghurt
	Company	Yoplait
	LCA ID	03

Funded by the European Union

This project has received funding from the European Union's Horizon Europe Research and Innovation programme under Grant Agreement No 101060806. This document reflects the views of the author(s) and does not necessarily reflect the views or policy of the European Commission. Whilst efforts have been made to ensure the accuracy and completeness of this document, the European Commission shall not be liable for any errors or omissions, however

	**Product**	Greek yoghurt
	Format	PP Cup
	Capacity	450 g
	Food category	Yoghurt
	Company	Yoplait
	LCA ID	04
	**Product**	Pork chop
	Format	EPS Tray
	Capacity	500 g
	Food category	In-shop products
	Company	(none)
	LCA ID	05
	**Product**	Florette Mache
	Format	OPP Film
	Capacity	125 g
	Food category	Bagged salad
	Company	Floréale
	LCA ID	06
	**Product**	Butter classic
	Format	Aluminium & OPP Film
	Capacity	250 g
	Food category	Butter
	Company	Sodiaal
	LCA ID	07
	**Product**	Grated cheese
	Format	OPA & LDPE Film
	Capacity	180 g
	Food category	Cheese
	Company	Sodiaal
	LCA ID	08
	**Product**	Peanut curl
	Format	OPP Film
	Capacity	125 g
	Food category	Chips
	Company	Altho
	LCA ID	09
	**Product**	Savory biscuits
	Format	OPP Sachet & Cardboard
	Capacity	85- 105 g
	Food category	Savory biscuits
	Company	Europe Snacks
	LCA ID	10

3. GOAL OF THE STUDIES

The following environmental impact analyses aim to evaluate, define and interpret the environmental criticalities deriving from the life cycle of the existing packaging solutions selected to be substituted within the R3PACK project. This first part (Part

Funded by the European Union

This project has received funding from the European Union's Horizon Europe Research and Innovation programme under Grant Agreement No 101060806. This document reflects the views of the author(s) and does not necessarily reflect the views or policy of the European Commission. Whilst efforts have been made to ensure the accuracy and completeness of this document, the European Commission shall not be liable for any errors or omissions, however

A), defined in Task 6.1, is intended to provide data on the packaging's state-of-the-art related impacts. These data will be necessary to set comparisons with substituting paper-based solutions developed in WP4 and evaluate the actual environmental improvements.

The partner contributors to WP4 constitute the target audience of this study, and the commissioner is to be considered R3PACK project.

The impact evaluation will be conducted through Life Cycle Assessment (LCA) defined by standards ISO 14040 and 14044, using the SimaPro software (PRé Sustainability). The impact assessment will be carried out considering datasets and environmental indicators defined in the PEF methodology proposed by European Commission. The standard methods to measure the life cycle environmental performances have been included in the Commission Recommendation 2021/2279 published in December 2021. Environmental Footprint (EF) methods are in a transition phase, and – to date – no PEFCRs are available for packaging products. Some methodological limitations have been applied concerning the established PEF methodology[1]: limitations, assumptions and other non-PEF compliant elements are declared along the report.

4. SCOPE OF THE STUDIES

4.1. Functional unit and reference flow

The functional unit[2] of the analysed system is defined as follows: "**one unit** of **food packaging** responding to the four following aspects:

- **Function(s)/service(s) provided**: contain, preserve, protect during distribution and provide information about the content product defined in the "Food category" item in Table 1 (e.g. prepared fruits);
- **Extent of the function or service**: defined capacity/weight of the packaged product defined in the "Capacity" item in in Table 1 (e.g. 400 ml);
- **Expected level of quality**: guarantee food safety performances and shelf-life;
- **Duration/life time of the product**: equal to the expected shelf-life;
- **Reference flow**: the amount of product needed to fulfill the defined function that shall be measured in grams of packaging material(s).

4.2. System boundary

The nine food categories selected for substitution in R3PACK project have been: bagged salad, butter, cheese, chips, in-shop products, prepared salad, savory biscuits, prepared fruits and yoghurt. The project partners have selected a representative product for each category and are those in Table 1. Two products have been selected for the yoghurt category, one for Greek yoghurt and another for sour cream. The analyses will consider **primary packaging** raw material acquisition and pre-processing, manufacturing, distribution stage, use stage and end-of-life. Secondary packaging, packaging-related food waste, packaging geometric features (e.g. emptyability) and the packaging filling phase will be excluded from the system boundary because they are taken as unvaried characteristics for the substitution purpose. All the processes attributed to the packaging are listed in the Life Cycle Inventory (LCI) divided by life cycle stages. Here below, a list of the processes considered for each stage is provided:

[1] Zampori, L. and Pant, R., Suggestions for updating the Product Environmental Footprint (PEF) method, EUR 29682 EN, Publications Office of the European Union, Luxembourg, 2019, ISBN 978-92-76- 00654-1, doi:10.2760/424613, JRC11595. https://publications.jrc.ec.europa.eu/repository/handle/JRC115959

[2] Zampori, L. and Pant, R., Suggestions for updating the Product Environmental Footprint (PEF) method, EUR 29682 EN, Publications Office of the European Union, Luxembourg, 2019, ISBN 978-92-76- 00654-1, doi:10.2760/424613, JRC11595. §3.2.1 Functional unit and reference flow

Funded by the European Union

This project has received funding from the European Union's Horizon Europe Research and Innovation programme under Grant Agreement No 101060806. This document reflects the views of the author(s) and does not necessarily reflect the views or policy of the European Commission. Whilst efforts have been made to ensure the accuracy and completeness of this document, the European Commission shall not be liable for any errors or omissions, however

- **Raw material acquisition and pre-processing**: this life cycle stage begins when resources are extracted from nature and ends when product components enter the packaging production plant. In particular, it includes the pre-processing of material inputs. The transportation related to the acquisition of raw material is partly modelled by SimaPro (embedded in the Market processes, selected whenever available).
- **Manufacturing**: the production stage begins when the product components enter the production site and ends when the finished product leaves the production facility. The transportation related to the acquisition of material is partly modelled by SimaPro (embedded in the Market processes, selected whenever available).
- **Distribution stage/Use stage**: this phase corresponds to the packaged product's distribution and storage (warehouse/retail). For substitution, it won't be associated with any process both for the lack of primary data and considering that with the same functional unit (that should be adopted to establish comparative analyses in the following deliverables), impacts related to distribution and use stage are comparable between the state-of-the-art packaging and the one manufactured with newly developed materials. In the occurrence of substantial differences related to these phases between the state-of-the-art and new solutions, it will be necessary to retrieve and implement primary data relating to the two scenarios to structure a comparison.
- **End-of-life**: this stage begins when the user disposes of the packaging and ends when it is returned to nature as a waste product or enters another product's life cycle (i.e. as a recycled input). In this case, recycling operations, incineration and landfilling are considered. The following analyses will account for incineration and landfilling-related contributions to define the impact assessment results. At the same time, processes that offer environmental benefits, such as recycling and energy recovery, are excluded from the calculation due to the cut-off approach that will be described later. A specific waste scenario has been modelled for the analyses considering French data on packaging EoL.
- **System boundary diagram**: the following map in Figure 1 shows the different life cycle stages considered. Pre-processing and Manufacturing phases are merged in the process inventory and in the presentation of the results. As described above, distribution and use are not associated with any flow.

Funded by the European Union

This project has received funding from the European Union's Horizon Europe Research and Innovation programme under Grant Agreement No 101060806. This document reflects the views of the author(s) and does not necessarily reflect the views or policy of the European Commission. Whilst efforts have been made to ensure the accuracy and completeness of this document, the European Commission shall not be liable for any errors or omissions, however

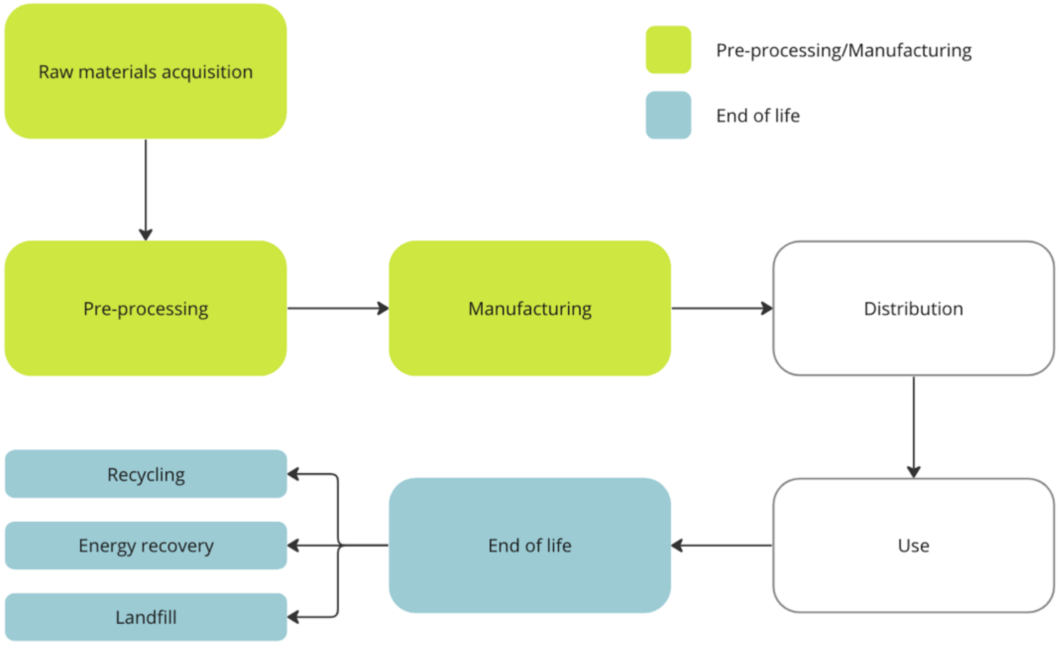


Figure 1: System boundaries diagram.

4.3. Environmental Footprint impact categories

LCA results are presented through various environmental impact categories. For the impact assessment all the 16 EF (Environmental Footprint) impact categories shown in Table 2 are taken into account together with an all-encompassing value expressed in Pt obtained by weighting the different categories through appropriate factors. In the interpretation phase, only the most relevant impact categories are considered. Table 2 shows the list of all the EF impact categories and related indicators and units are provided[3].

Tab 2. EF impact categories and related indicators and units.

EF Impact category	Impact category Indicator	Unit	Characterization model
Climate change, total[4]	Radiative forcing as global warming potential (GWP100)	kg CO2 eq	Baseline model of 100 years of the IPCC (based on IPCC 2013)
Ozone depletion	Ozone Depletion Potential (ODP)	kg CFC-11 eq	Steady-state ODPs as in (WMO 2014 + integrations)
Human toxicity, cancer	Comparative Toxic Unit for humans (CTUh)	CTUh	USEtox model 2.1 (Fankte et al, 2017)
Human toxicity, non-cancer	Comparative Toxic Unit for humans (CTUh)	CTUh	USEtox model 2.1 (Fankte et al, 2017)
Particulate matter	Impact on human health	disease incidence	PM method recomended by UNEP (UNEP 2016)
Ionising radiation, human health	Human exposure efficiency relative to U235	kBq U235 eq	Human health effect model as developed by Dreicer et al. 1995 (Frischknecht et al, 2000)
Photochemical ozone	Tropospheric ozone concentration increase	kg NMVOC eq	LOTOS-EUROS model (Van Zelm et al, 2008) as

[3] Zampori, L. and Pant, R., Suggestions for updating the Product Environmental Footprint (PEF) method, EUR 29682 EN, Publications Office of the European Union, Luxembourg, 2019, ISBN 978-92-76- 00654-1, doi:10.2760/424613, JRC11595. § 3.2.3 Environmental Footprint impact categories, Tab. 2

[4] The indicator "Climate Change, total" is constituted by three sub-indicators: Climate Change, fossil; Climate Change, biogenic; Climate Change, land use and land use change. The sub-indicators are further described in section 4.4.10. The sub-categories 'Climate change –fossil', 'Climate change – biogenic' and 'Climate change - land use and land use change', shall be reported separately if they show a contribution of more than 5% each to the total score of climate change.

Funded by the European Union

This project has received funding from the European Union's Horizon Europe Research and Innovation programme under Grant Agreement No 101060806. This document reflects the views of the author(s) and does not necessarily reflect the views or policy of the European Commission. Whilst efforts have been made to ensure the accuracy and completeness of this document, the European Commission shall not be liable for any errors or omissions, however

formation, human health			implemented in ReCiPe 2008
Acidification	Accumulated Exceedance (AE)	mol H+ eq	Accumulated Exceedance (Seppälä et al. 2006, Posch et al, 2008)
Eutrophication, terrestrial	Accumulated Exceedance (AE)	mol N eq	Accumulated Exceedance (Seppälä et al. 2006, Posch et al, 2008)
Eutrophication, freshwater	Fraction of nutrients reaching freshwater end compartment (P)	kg P eq	EUTREND model (Struijs et al, 2009) as implemented in ReCiPe
Eutrophication, marine	Fraction of nutrients reaching marine end compartment (N)	kg N eq	EUTREND model (Struijs et al, 2009) as implemented in ReCiPe
Ecotoxicity, freshwater	Comparative Toxic Unit for ecosystems (CTUe)	CTUe	USEtox model 2.1 (Fankte et al, 2017)
Land use	• Soil quality index[5] • Biotic production • Erosion resistance • Mechanical filtration • Groundwater replenishment	• Dimensionless (pt) • kg biotic production • kg soil • m3 water • m3 groundwater	Soil quality index based on LANCA (Beck et al. 2010 and Bos et al. 2016)
Water use	User deprivation potential (deprivation-weighted water consumption)	m3 world eq	Available WAter REmaining (AWARE) as recommended by UNEP, 2016
Resource use[6], minerals and metals	Abiotic resource depletion (ADP ultimate reserves)	kg Sb eq	CML 2002 (Guinée et al., 2002) and van Oers et al. 2002.
Resource use, fossils	Abiotic resource depletion – fossil fuels (ADP-fossil)[7]	MJ	CML 2002 (Guinée et al., 2002) and van Oers et al. 2002

5. LIFE CYCLE INVENTORY ANALYSIS

5.1. Data collection and quality

DATA COLLECTION

To build the life cycle inventory (LCI), a data collection form was sent to the partners involved. Given the scarcity of data recovered from the data collection T1, a simplified version of the form was formulated to retrieve the essential primary data necessary to conduct the analyses.

Tab. 3 shows a *fac-simile* of the data collection model: the partners were asked to specify, for each layer of the packaging, the material (possibly accompanied by the relative technical datasheet), the weight in grams of the layer itself and its manufacturing process(es). Partners were also asked to indicate packaging nominal capacity, the overall production technology and to provide a reference image of the product.

[5] This index is the result of the aggregation, performed by JRC, of the 4 indicators provided by LANCA model as indicators for land use.
[6] The results of this impact category shall be interpreted with caution, because the results of ADP after normalization may be overestimated. The European Commission intends to develop a new method moving from depletion to dissipation model to better quantify the potential for conservation of resources
[7] In the EF flow list, and for the current recommendation, Uranium is included in the list of energy carriers, and it is measured in MJ.

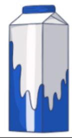
Funded by the European Union

This project has received funding from the European Union's Horizon Europe Research and Innovation programme under Grant Agreement No 101060806. This document reflects the views of the author(s) and does not necessarily reflect the views or policy of the European Commission. Whilst efforts have been made to ensure the accuracy and completeness of this document, the European Commission shall not be liable for any errors or omissions, however

Tab 3. Fac-simile of data collection model

Name of the product	*BEVERAGE MULTILAYER*		
Packaging capacity	*1 L*		
PRODUCT COMPOSITION - INBOUND OF RAW MATERIALS			
	Commercial name of the product (Material Data Sheet)	**Weight (g)**	**Process technology**
PACKAGING BODY			
First layer	*Solid bleached and unbleached board carton*	*11*	*(Sulfate pulp production)*
Aluminum foil	*aluminum*	*2.7*	
Adhesive	*Vinyl acetate*	*0.2*	
Ink	*printing ink*	*0.05*	
Varnish	*mix of organic and inorganic compound*	*0.05*	
Packaging production technology	*LAMINATION*		

Photo/image of the product



DATA QUALITY

With regard to materials, in most cases was indicated the general type of material (e.g. PET, aluminium, etc.), but not the exact grade and composition; for this reason, data retrieved from the databases available in SimaPro were used, specifically the Ecoinvent database[8], considering material grades suitable for food packaging. Similarly, for processes (e.g. extrusion, rolling, etc.) Ecoinvent databases were considered as well.

The retrieved data from partners are reported in Annex 1 at the end of this document.

5.2. LCI organization

In this paragraph, the inventory tables are provided and organized to keep the various phases of the packaging life cycle separate as described in the system boundary diagram.

PRE-PROCESSING AND MANUFACTURING LCI

Here below, for each product, a table describing the pre-processing (PP) and manufacturing (M) processes of the packaging is provided. The inventory is structured as a bill of materials: each component that makes the product up is associated with a position number that reflects the structure of the assemblies; quantity and weight in grams are indicated for each component/assembly.

Regarding pre-processing, the material (as declared by the company in the data collection form) is indicated for each layer, together with the corresponding raw material selected in SimaPro. With respect to manufacturing, a description of the processes used and an indication of the corresponding processes in SimaPro is provided. If the original datasets have been modified to adapt them to the French context by selecting, for example, energy data related to this geographical area, all the modifications made are reported in a dedicated column.

In correspondence with each table, any limitations and assumptions made during the compilation of the inventory are reported.

- **TABLE A1, PP-M LCI, PRODUCT 01 – Florette Shaker, PET Cup**

  Assumptions and limitations: the heat sealing process for components 1.1 and 1.2 has been omitted due to the lack of specific information retrieved in the data collection and suitable Ecoinvent datasets. Furthermore, no information

[8] Further information on Ecoinvent databases are available at https://ecoinvent.org

Funded by the European Union

This project has received funding from the European Union's Horizon Europe Research and Innovation programme under Grant Agreement No 101060806. This document reflects the views of the author(s) and does not necessarily reflect the views or policy of the European Commission. Whilst efforts have been made to ensure the accuracy and completeness of this document, the European Commission shall not be liable for any errors or omissions, however

has been provided regarding eventual printing processes and related ink, which therefore were not included in the analysis.

Tab A1. PP-M LCI, PRODUCT 01 – Florette Shaker, PET Cup

Table A1				Pre-processing		Manufacturing		
Position	Description	Quantity	Weight (g)	Material	Material (SimaPro)	Processing	Processing (Original SimaPro dataset)	Processing variations (available FR datasets)
1	PET Cup	1	12,4	/	/	Heat sealing	/	/
1.1	PET Foil Lid	1	0,8	PET	Polyethylene terephthalate, granulate, amorphous {RER}| production | Cut-off, U	Extrusion of plastic film	Extrusion, plastic film {RER}| extrusion, plastic film | Cut-off, U	• Water, cooling, unspecified natural origin, FR; • Electricity, medium voltage {FR}| market for | Cut-off, U
1,2	PET Shaker	1	11,6	PET	Polyethylene terephthalate, granulate, amorphous {RER}| production | Cut-off, U	Extrusion of plastic sheets and thermoforming	Extrusion of plastic sheets and thermoforming, inline {FR}| processing | Cut-off, U	/

- **TABLE A2, PP-M LCI, PRODUCT 02 – Salad MDD, PET Tray**

  Assumptions and limitations: no information has been provided regarding eventual printing processes and related inks or other labels, which therefore were not included in the analysis.

Tab A2. PP-M LCI, PRODUCT 02 – Salad MDD, PET Tray

Table A2				Pre-processing		Manufacturing		
Position	Description	Quantity	Weight (g)	Material	Material (SimaPro)	Processing	Processing (Original SimaPro dataset)	Processing variations (available FR datasets)
2	PET Tray	1	30	/	/	Inline manual closing	/	/
2.1	PET Lid	1	10	PET	Polyethylene terephthalate, granulate, amorphous {RER}| production | Cut-off, U	Extrusion of plastic sheets and thermoforming	Extrusion of plastic sheets and thermoforming, inline {FR}| processing | Cut-off, U	/
2.2	PET Bowl	1	20	PET	Polyethylene terephthalate, granulate, amorphous {RER}| production | Cut-off, U	Extrusion of plastic sheets and thermoforming	Extrusion of plastic sheets and thermoforming, inline {FR}| processing | Cut-off, U	/

Funded by the European Union

This project has received funding from the European Union's Horizon Europe Research and Innovation programme under Grant Agreement No 101060806. This document reflects the views of the author(s) and does not necessarily reflect the views or policy of the European Commission. Whilst efforts have been made to ensure the accuracy and completeness of this document, the European Commission shall not be liable for any errors or omissions, however

- **TABLE A3, PP-M LCI, PRODUCT 03 – Sour cream, Cup**

  Assumptions and limitations: the sealing process for components 3.2 and 3.3 and the closing process for components 3.1 and 3.3 have been omitted due to the lack of specific information retrieved in the data collection and suitable Ecoinvent datasets. The manufacturing process for the monolayer Aluminium Lid (3.2) was not declared, thus, sheet rolling was assumed as the most suitable option. Furthermore, no information has been provided regarding eventual printing processes and related ink, which therefore were not included in the analysis.

Tab A3. PP-M LCI, PRODUCT 03 – Sour cream, Cup

Table A3				Pre-processing		Manufacturing		
Position	Description	Quantity	Weight (g)	Material	Material (SimaPro)	Processing	Processing (Original SimaPro dataset)	Processing variations (available FR datasets)
3	Cup	1	12,36	/	/	Inline closing and sealing	/	/
3.1	PET Overcap	1	3,05	PET	Polyethylene terephthalate, granulate, amorphous {RER}| production | Cut-off, U	Extrusion of plastic sheets and thermoforming	Extrusion of plastic sheets and thermoforming, inline {FR}| processing | Cut-off, U	/
3.2	Aluminium Lid	1	0,81	Aluminium	Aluminium alloy, AlMg3 {GLO}| market for | Cut-off, U	Sheet rolling	Sheet rolling, aluminium {RER}| processing | Cut-off, U	• Water, unspecified natural origin, FR; • Electricity, medium voltage {FR}| market for | Cut-off, U
3.3	PP Bowl	1	8,5	PP	Polypropylene, granulate {RER}| production | Cut-off, U	Extrusion of plastic sheets and thermoforming	Extrusion of plastic sheets and thermoforming, inline {FR}| processing | Cut-off, U	/

- **TABLE A4, PP-M LCI, PRODUCT 04 – Greek yoghurt, Cup**

  Assumptions and limitations: the sealing process for components 4.2 and 4.3 and the closing process for components 4.1 and 4.3 have been omitted due to the lack of specific information retrieved in the data collection and suitable Ecoinvent datasets. The manufacturing process for the monolayer Aluminium Lid (4.2) was not declared, thus, sheet rolling was assumed as the most suitable option. Furthermore, no information has been provided regarding eventual printing processes and related ink, which therefore were not included in the analysis.

Funded by the European Union

This project has received funding from the European Union's Horizon Europe Research and Innovation programme under Grant Agreement No 101060806. This document reflects the views of the author(s) and does not necessarily reflect the views or policy of the European Commission. Whilst efforts have been made to ensure the accuracy and completeness of this document, the European Commission shall not be liable for any errors or omissions, however

Tab A4. PP-M LCI, PRODUCT 04 – Greek yoghurt, Cup

Table A4				Pre-processing		Manufacturing		
Position	Description	Quantity	Weight (g)	Material	Material (SimaPro)	Processing	Processing (Original SimaPro dataset)	Processing variations (available FR datasets)
4	Cup	1	20,25	/	/	Inline closing and sealing	/	/
4.1	PET Overcap	1	5	PET	Polyethylene terephthalate, granulate, amorphous {RER}| production | Cut-off, U	Extrusion of plastic sheets and thermoforming	Extrusion of plastic sheets and thermoforming, inline {FR}| processing | Cut-off, U	/
4.2	Aluminium Lid	1	1,25	Aluminium	Aluminium alloy, AlMg3 {GLO}| market for | Cut-off, U	Sheet rolling	Sheet rolling, aluminium {RER}| processing | Cut-off, U	• Water, unspecified natural origin, FR; • Electricity, medium voltage {FR}| market for | Cut-off, U
4.3	PP Bowl	1	14	PP	Polypropylene, granulate {RER}| production | Cut-off, U	Extrusion of plastic sheets and thermoforming	Extrusion of plastic sheets and thermoforming, inline {FR}| processing | Cut-off, U	/

- **TABLE A5, PP-M LCI, PRODUCT 05 – Pork chop, Wrapped Tray**

  Note: for the "In-shop products" food category a specific EPS tray was not supplied by the partners, therefore a suitable one for the reference product (2 pork chops) was selected by the authors. Specifically, the product is made up of an expanded polystyrene tray and a PVC film.

  Assumptions and limitations: the wrapping process (manual or automatic) has been omitted as considered negligible and due to the absence of suitable Ecoinvent datasets.

Funded by the European Union

This project has received funding from the European Union's Horizon Europe Research and Innovation programme under Grant Agreement No 101060806. This document reflects the views of the author(s) and does not necessarily reflect the views or policy of the European Commission. Whilst efforts have been made to ensure the accuracy and completeness of this document, the European Commission shall not be liable for any errors or omissions, however

Tab A5. PP-M LCI, PRODUCT 05 – Pork chop, Wrapped Tray

Table A5				Pre-processing		Manufacturing		
Position	Description	Quantity	Weight (g)	Material	Material (SimaPro)	Processing	Processing (Original SimaPro dataset)	Processing variations (available FR datasets)
5	Wrapped Tray	1	13,8	/	/	Wrapping	/	/
5.1	PVC Wrapping Film	1	2,9	PVC	Polyvinylchloride, suspension polymerised {RER}| polyvinylchloride production, suspension polymerisation | Cut-off, U	Bubble extrusion of plastic film	Extrusion, plastic film {RER}| extrusion, plastic film | Cut-off, U	• Water, cooling, unspecified natural origin, FR; • Electricity, medium voltage {FR}| market for | Cut-off, U
5.2	PSE Tray	1	10,9	EPS	Polystyrene, expandable {RER}| production | Cut-off, U	Extrusion of plastic sheets and thermoforming	Extrusion of plastic sheets and thermoforming, inline {FR}| processing | Cut-off, U	/
						Foaming	Polymer foaming {RER}| processing | Cut-off, U	• Water, cooling, unspecified natural origin, FR; • Electricity, medium voltage {FR}| market for | Cut-off, U

- **TABLE A6, PP-M LCI, PRODUCT 06 – Florette Mache, OPP Film**

  Assumptions and limitations: The laminating process (6.2) has been modified changing the typology of adhesive (Polyurethane adhesive instead of acrylic binder as specificated in data collection). The printing process has been omitted due to the absence of suitable Ecoinvent datasets, only the date of ink has been considered.

Tab A6. PP-M LCI, PRODUCT 05 – Pork chop, Wrapped Tray

Table A6				Pre-processing		Manufacturing		
Position	Description	Quantity	Weight (g)	Material	Material (SimaPro)	Processing	Processing (Original SimaPro dataset)	Processing variations (available FR datasets)
6	Bag	1	5,58	/	/	/		/
6.1	OPP Film	1	0,16	Ink	Printing ink, offset, without solvent, in 47% solution state {RER}|	Printing Ink	/	/
6.2	OPP Film	1	0,32	Adhesive	Polyurethane adhesive {GLO}| market for polyurethane adhesive | Cut-off, U	Lamination	Laminating service, foil, with acrylic binder {RER}| processing | Cut-off, U	• Electricity, medium voltage {FR}| market for | Cut-off, U
6.3	PP Foil	1	5,1	PP	Polypropylene, granulate {RER}| production | Cut-off, U	Extrusion of plastic film	Extrusion, plastic film {RER}| extrusion, plastic film | Cut-off, U	• Water, cooling, unspecified natural origin, FR; • Electricity, medium voltage {FR}| market for | Cut-off, U

Funded by the European Union

This project has received funding from the European Union's Horizon Europe Research and Innovation programme under Grant Agreement No 101060806. This document reflects the views of the author(s) and does not necessarily reflect the views or policy of the European Commission. Whilst efforts have been made to ensure the accuracy and completeness of this document, the European Commission shall not be liable for any errors or omissions, however

- **TABLE A7, PP-M LCI, PRODUCT 07 – Butter, Aluminium, & OPP Film**

  Assumptions and limitations: The manufacturing process for the layer Aluminium Lid (7.2) was not declared, thus, sheet rolling was assumed as the most suitable option.

Tab A7. PP-M LCI, PRODUCT 07 – Butter, Aluminium, & OPP Film

Table A7				Pre-processing		Manufacturing		
Position	Description	Quantity	Weight (g)	Material	Material (SimaPro)	Processing	Processing (Original SimaPro dataset)	Processing variations (available FR datasets)
7	Aluminium & OPP Film	1	1,95	/	/	Lamination	Laminating service, foil, with acrylic binder {RER}| processing | Cut-off, U	• Electricity, medium voltage {FR}| market for | Cut-off, U
7.1	OPP Film	1	1,28	PP	Polypropylene, granulate {RER}| production | Cut-off, U	Extrusion of plastic film	Extrusion, plastic film {RER}| extrusion, plastic film | Cut-off, U	• Water, cooling, unspecified natural origin, FR; • Electricity, medium voltage {FR}| market for | Cut-off, U
7.2	Aluminium Lid	1	0,67	Aluminium	Aluminium alloy, AlMg3 {GLO}| market for | Cut-off, U	Sheet rolling	Sheet rolling, aluminium {RER}| processing | Cut-off, U	• Water, unspecified natural origin, FR; • Electricity, medium voltage {FR}| market for | Cut-off, U

- **TABLE A8, PP-M LCI, PRODUCT 08 – Grated cheese, OPA & LDPE Film**

  Assumptions and limitations: The printing process has been omitted due to the absence of suitable Ecoinvent datasets, only the date of ink has been considered.

Tab A8. PP-M LCI, PRODUCT 08 – Grated cheese, OPA & LDPE Film

Table A8				Pre-processing		Manufacturing		
Position	Description	Quantity	Weight (g)	Material	Material (SimaPro)	Processing	Processing (Original SimaPro dataset)	Processing variations (available FR datasets)
8	Grated Cheese Bag	1	5,06	/	/	/		/
8.1	OPA & LDPE Film	1	0,11	Ink	Printing ink, offset, without solvent, in 47% solution state {RER}|	Printing Ink	/	/
8.2	Complexing Film	1	0,15	Adhesive	Acrylic binder, with water, in 54% solution state {RER} | Cut-off, U	Lamination	Laminating service, foil, with acrylic binder {RER}| processing | Cut-off, U	• Electricity, medium voltage {FR}| market for | Cut-off, U
8.3	LDPE Foil	1	3,5	LDPE	Polyethylene terephthalate, granulate, amorphous {RER}| production | Cut-off, U	Extrusion of plastic film	Extrusion, plastic film {RER}| extrusion, plastic film | Cut-off, U	• Water, cooling, unspecified natural origin, FR; • Electricity, medium voltage {FR}| market for | Cut-off, U
8.4	OPA Foil	1	1,3	PA	Nylon 6 {RER}| production | Cut-off, U	Extrusion of plastic film	Extrusion, plastic film {RER}| extrusion, plastic film | Cut-off, U	• Water, cooling, unspecified natural origin, FR; • Electricity, medium voltage {FR}| market for | Cut-off, U

Funded by the European Union

This project has received funding from the European Union's Horizon Europe Research and Innovation programme under Grant Agreement No 101060806. This document reflects the views of the author(s) and does not necessarily reflect the views or policy of the European Commission. Whilst efforts have been made to ensure the accuracy and completeness of this document, the European Commission shall not be liable for any errors or omissions, however

- **TABLE A9, PP-M LCI, PRODUCT 09 – Peanut curl, OPP Film**

  Assumptions and limitations: The Metallization process for OPP film (9.2) has been omitted due to the lack of specific information retrieved in the data collection (type of metal and type of process). The printing process has been omitted due to the absence of suitable Ecoinvent datasets, only the date of ink has been considered.

Tab A9. PP-M LCI, PRODUCT 09 – Peanut curl, OPP Film

Table A9				Pre-processing		Manufacturing		
Position	Description	Quantity	Weight (g)	Material	Material (SimaPro)	Processing	Processing (Original SimaPro dataset)	Processing variations (available FR datasets)
9	Bag	1	5,57	/	/	/		/
9.1	OPP Film	1	0,414	Ink	Printing ink, offset, without solvent, in 47% solution state {RER}|	Printing Ink	/	/
9.2	OPP Film	1	0,296	Adhesive	Acrylic binder, with water, in 54% solution state {RER} | Cut-off, U	Lamination	Laminating service, foil, with acrylic binder {RER}| processing | Cut-off, U	• Electricity, medium voltage {FR}| market for | Cut-off, U
9.3	PP Foil	1	4,86	PP	Polypropylene, granulate {RER}| production | Cut-off, U	Extrusion of plastic film	Extrusion, plastic film {RER}| extrusion, plastic film | Cut-off, U	• Water, cooling, unspecified natural origin, FR; • Electricity, medium voltage {FR}| market for | Cut-off, U

- **TABLE A10, PP-M LCI, PRODUCT 10 – Savory biscuits, OPP & Cardboard**

  Assumptions and limitations: The metallization process for OPP film (10.2) has been omitted due to the lack of specific information retrieved in the data collection (type of metal and type of process).

  For the Cardboard box (10.1) has been used a dataset for production of a Folding boxboard carton that haven't specific data on recycled cardboard.

Funded by the European Union

This project has received funding from the European Union's Horizon Europe Research and Innovation programme under Grant Agreement No 101060806. This document reflects the views of the author(s) and does not necessarily reflect the views or policy of the European Commission. Whilst efforts have been made to ensure the accuracy and completeness of this document, the European Commission shall not be liable for any errors or omissions, however

Tab A10. PP-M LCI, PRODUCT 10 – Savory biscuits, OPP & Cardboard

Table A10				Pre-processing		Manufacturing		
Position	Description	Quantity	Weight (g)	Material	Material (SimaPro)	Processing	Processing (Original SimaPro dataset)	Processing variations (available FR datasets)
10	Savory Biscuit	1	25,75	/	/	/		/
10.1	Cardboard Box	1	24			Flat cut	Folding boxboard carton production {RER}| production | Cut-off, U	• Variation amount of Varnish and Ink • Electricity, medium voltage {FR}| market for | Cut-off, U
10.2	OPP Film	1	0,15	Adhesive	Acrylic binder, with water, in 54% solution state {RER} | Cut-off, U	Lamination	Laminating service, foil, with acrylic binder {RER}| processing | Cut-off, U	• Electricity, medium voltage {FR}| market for | Cut-off, U
10.3	PP Foil	1	1,6	PP	Polypropylene, granulate {RER}| production | Cut-off, U	Extrusion of plastic film	Extrusion, plastic film {RER}| extrusion, plastic film | Cut-off, U	• Water, cooling, unspecified natural origin, FR; • Electricity, medium voltage {FR}| market for | Cut-off, U

END-OF-LIFE LCI

Regarding the LCI of the end-of-life phase, a dedicated waste scenario has been defined for each material. Each waste scenario is composed of the different waste treatments i.e. recycling, incineration and landfill. The percentage of wasted material destined for each waste treatment was defined on the basis of data relating to waste management in the French context; the sources are indicated in the "data source" column (Tab. B). Furthermore, the table below shows the process with which each waste treatment is modelled in SimaPro. The specific waste scenario for each product consists of a single waste process if the product is mono-material, or of the combination of two or more waste processes if the product is made up of components in different materials; in the latter case, the percentages of material destined for each waste process are defined on the basis of weight percentage of each material on the packaging composition.

Funded by the European Union

This project has received funding from the European Union's Horizon Europe Research and Innovation programme under Grant Agreement No 101060806. This document reflects the views of the author(s) and does not necessarily reflect the views or policy of the European Commission. Whilst efforts have been made to ensure the accuracy and completeness of this document, the European Commission shall not be liable for any errors or omissions, however

- **TABLE B, EOL LCI**

Tab B. END-OF-LIFE LCI

		Table B				End of Life		
		Waste type	Material % per waste treatement	Data description	Data source	Waste treatement	Waste treatment (SimaPro dataset)	Notes
Waste scenario	Waste process	PA	27	France post-consumer plastics packaging waste treatment	Plastics Europe, 2022	PA Recycling	PA (waste treatment) {GLO}| recycling of PA| Cut-off, U	
			44	France post-consumer plastics packaging waste treatment	Plastics Europe, 2022	PA Incineration	Waste plastic, mixture {CH}| treatment of waste plastic, mixture, municipal incineration | Cut-off, U	
			29	France post-consumer plastics packaging waste treatment	Plastics Europe, 2022	PA Landfill	Waste plastic, mixture {CH}| treatment of waste plastic, mixture, sanitary landfill | Cut-off, U	
	Waste process	PET	27	France post-consumer plastics packaging waste treatment	Plastics Europe, 2022	PET Recycling	PET (waste treatment) {GLO}| recycling of PET | Cut-off, U	
			44	France post-consumer plastics packaging waste treatment	Plastics Europe, 2022	PET Incineration	Waste polyethylene terephthalate {CH}| treatment of waste polyethylene terephthalate, municipal incineration | Cut-off, U	
			29	France post-consumer plastics packaging waste treatment	Plastics Europe, 2022	PET Landfill	Waste polyethylene terephthalate {CH}| treatment of waste polyethylene terephthalate, sanitary landfill | Cut-off, U	
	Waste process	PP	27	France post-consumer plastics packaging waste treatment	Plastics Europe, 2022	PP Recycling	PP (waste treatment) {GLO}| recycling of PP | Cut-off, U	
			44	France post-consumer plastics packaging waste treatment	Plastics Europe, 2022	PP Incineration	Waste polypropylene {CH}| treatment of, municipal incineration | Cut-off, U	
			29	France post-consumer plastics packaging waste treatment	Plastics Europe, 2022	PP Landfill	Waste polypropylene {CH}| treatment of, sanitary landfill | Cut-off, U	
	Waste process	PVC	27	France post-consumer plastics packaging waste treatment	Plastics Europe, 2022	PVC Recycling	PVC (waste treatment) {GLO}| recycling of PVC | Cut-off, U	
			44	France post-consumer plastics packaging waste treatment	Plastics Europe, 2022	PVC Incineration	Waste polyvinylchloride {CH}| treatment of, municipal incineration | Cut-off, U	
			29	France post-consumer plastics packaging waste treatment	Plastics Europe, 2022	PVC Landfill	Waste polyvinylchloride {CH}| treatment of, sanitary landfill | Cut-off, U	
	Waste process	EPS	27	France post-consumer plastics packaging waste treatment	Plastics Europe, 2022	EPS Recycling	PS (waste treatment) {GLO}| recycling of PS | Cut-off, U	
			44	France post-consumer plastics packaging waste treatment	Plastics Europe, 2022	EPS Incineration	Waste expanded polystyrene {CH}| treatment of, municipal incineration | Cut-off, U	
			29	France post-consumer plastics packaging waste treatment	Plastics Europe, 2022	EPS Landfill	Waste polystyrene {CH}| treatment of, sanitary landfill | Cut-off, U	datasets for PS
	Waste process	Aluminium	58	France post-consumer aluminium packaging waste treatment	Citeo Adelphe, 2021	Aluminium Recycling	Aluminium (waste treatment) {GLO}| recycling of aluminium | Cut-off, U	
			42	France MSW treatment	Eurostat, 2018	Municipal Waste (62% Incineration + 38% Landfill	Municipal solid waste {FR}| market for municipal solid waste | Cut-off, U	
	Waste process	Aluminium&OPP	100	France MSW treatment	Eurostat, 2018	Municipal Waste	Municipal solid waste {FR}| Cut-off, U	
	Waste process	Cardboard	72	France post-consumer cardboard packaging waste treatment	Citeo Adelphe, 2021	Paper Recycling	Paper (waste treatment) {GLO}| recycling of paper | Cut-off, U	
			28	France MSW treatment	Eurostat, 2018	Municipal Waste	Waste paperboard {FR}| market for waste paperbord | Cut-off, U	

Funded by the European Union

This project has received funding from the European Union's Horizon Europe Research and Innovation programme under Grant Agreement No 101060806. This document reflects the views of the author(s) and does not necessarily reflect the views or policy of the European Commission. Whilst efforts have been made to ensure the accuracy and completeness of this document, the European Commission shall not be liable for any errors or omissions, however

END-OF-LIFE MODELLING CHOICES

To date, a cut-off approach has been applied to the end-of-life modeling which excludes from the calculation of the impact those processes that bring environmental benefits. This means that credits and impacts connected to recycling and secondary energy derived from energy recovery processes are equal to zero (Fig.2). The impacts that are calculated in the end-of-life scenario therefore concern incineration and disposal in landfill.

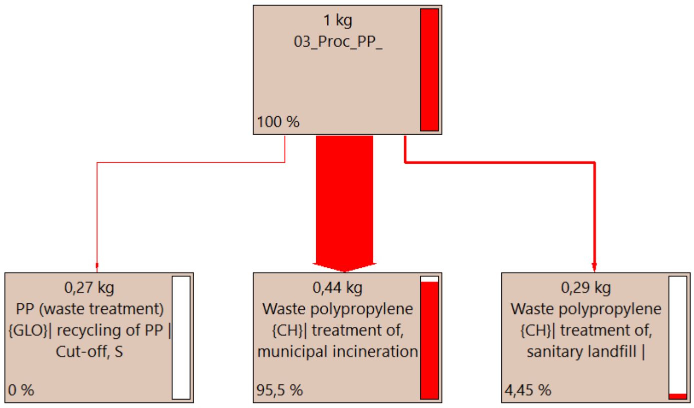


Figure 2: An example of waste process

In order to calculate credits and impacts connected to recycling and energy recovery in the PEF Method, the use of the Circular Footprint Formula (CFF) is prescribed[9]. CFF is composed of three parts corresponding, respectively, to material, energy and disposal (Fig. 3).

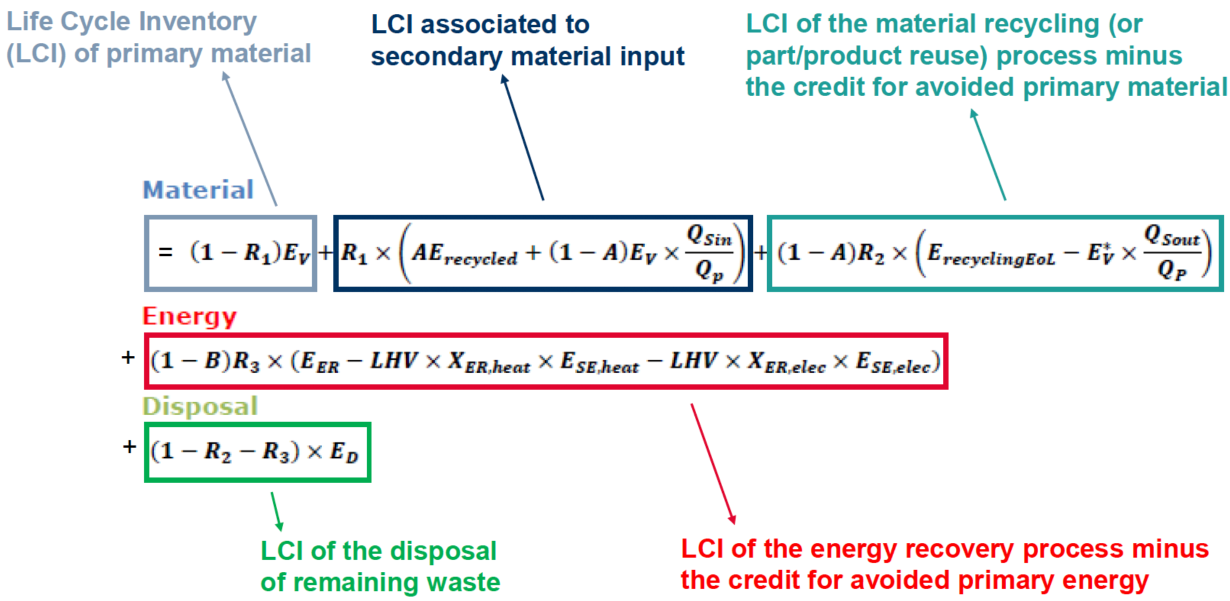


Figure 3: Circular Footprint Formula (CFF)

[9] Zampori, L. and Pant, R., Suggestions for updating the Product Environmental Footprint (PEF) method, EUR 29682 EN, Publications Office of the European Union, Luxembourg, 2019, ISBN 978-92-76- 00654-1, doi:10.2760/424613, JRC11595. § 4.4.8.1 The Circular Footprint Formula (CFF)

Funded by the European Union

This project has received funding from the European Union's Horizon Europe Research and Innovation programme under Grant Agreement No 101060806. This document reflects the views of the author(s) and does not necessarily reflect the views or policy of the European Commission. Whilst efforts have been made to ensure the accuracy and completeness of this document, the European Commission shall not be liable for any errors or omissions, however

The CFF allows the connection with subsequent and preceding life cycles via debiting (Fig. 4, left) and crediting (Fig. 4, right) which in the cut-off approach, are not considered[10].

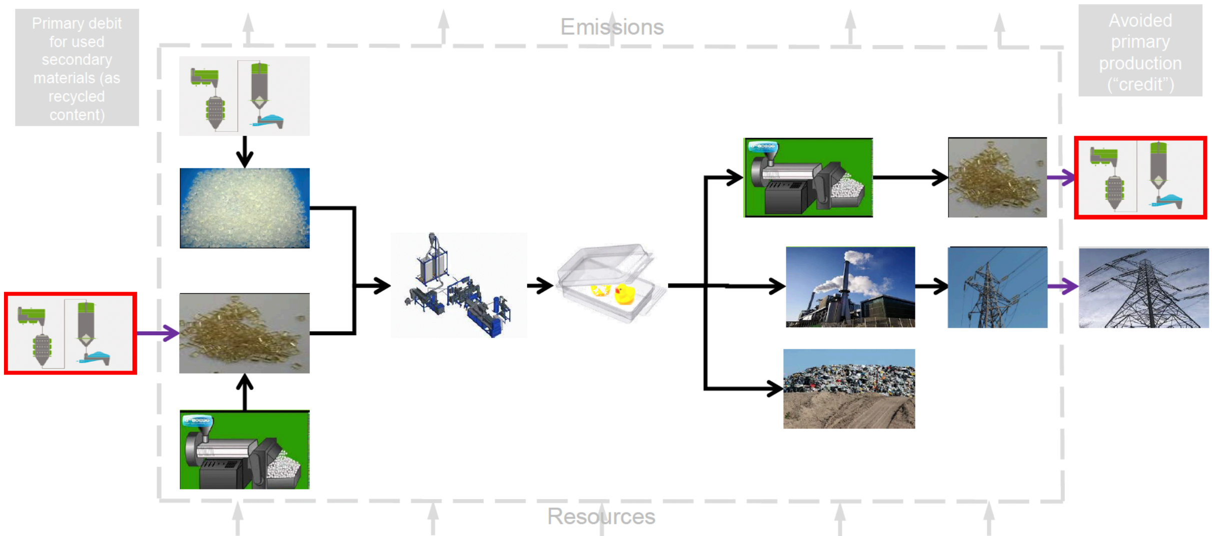


Figure 4: CFF debiting (left) and crediting (right)

Circular Footprint Formula is likely to be implemented in the following deliverable thanks to the recent release of the new EF 3.1 database[11] containing the needed datasets for the calculation in Sima Pro.

6. IMPACT ASSESSMENT RESULTS

PEF results

In this section, the impact assessment results are presented through 16 environmental impact indicators defined by the PEF method as described above at §4.3. The selected calculation method in SimaPro for the impact assessment is the EF 3.0, as defined in the Product Environmental Footprint.

For each product, results are presented as follow:

- **Characterised** results of all EF impact categories: the multiple impact contributions are transformed into results for each of the 16 impact categories through characterization factors. Each category has a specific unit of measure.
- **Normalised** and **weighted** results: by weighting the different EF impact categories through appropriate factors the relative shares of the impacts of the analysed system can be expressed in Pt. In this way it is possible to establish comparisons among different contributions.
- Weighted results as **single score** in µPt for all the life cycle stages (Pre-processing and Manufacturing + End-of-Life): the weighted results are then aggregated into an all-encompassing indicator for each life cycle stage.

10 Wolf, M. A., The Circular Footprint Formula (CFF) and its practical application training. Environmental Footprint (EF) transition phase, 2019. Webinar available in: https://ec.europa.eu/environment/eussd/videos/2019-10-08%2016.01%20The%20Circular%20Footprint%20Formula.mp4

11 Environmental Footprint database 3.1: https://simapro.com/products/environmental-footprint-database/

Funded by the European Union

This project has received funding from the European Union's Horizon Europe Research and Innovation programme under Grant Agreement No 101060806. This document reflects the views of the author(s) and does not necessarily reflect the views or policy of the European Commission. Whilst efforts have been made to ensure the accuracy and completeness of this document, the European Commission shall not be liable for any errors or omissions, however

PRODUCT 01 – Florette Shaker, PET Cup

Characterised results

- **Characterised** results of all EF impact categories

Tab 4. Characterised results PRODUCT 01 - Florette Shaker, PET Cup

Impact category	**Unit**	**Total**	**01. Florette Shaker_PET Cup – PP+M**	**01. Florette Shaker_PET Cup – EoL**
Climate change	kg CO2 eq	5,41E-02	4,27E-02	1,14E-02
Ozone depletion	kg CFC11 eq	2,00E-07	2,00E-07	2,10E-11
Ionising radiation	kBq U-235 eq	1,21E-02	1,21E-02	9,26E-06
Photochemical ozone formation	kg NMVOC eq	1,29E-04	1,25E-04	3,80E-06
Particulate matter	disease inc.	1,73E-09	1,71E-09	2,16E-11
Human toxicity, non-cancer	CTUh	5,02E-10	4,77E-10	2,50E-11
Human toxicity, cancer	CTUh	2,95E-11	2,76E-11	1,87E-12
Acidification	mol H+ eq	1,79E-04	1,76E-04	2,78E-06
Eutrophication, freshwater	kg P eq	8,58E-06	8,56E-06	1,50E-08
Eutrophication, marine	kg N eq	4,34E-05	3,38E-05	9,66E-06
Eutrophication, terrestrial	mol N eq	3,49E-04	3,34E-04	1,46E-05
Ecotoxicity, freshwater	CTUe	5,66E-01	5,61E-01	4,56E-03
Land use	Pt	1,07E-01	1,05E-01	2,34E-03
Water use	m3 depriv.	1,98E-02	1,98E-02	2,64E-05
Resource use, fossils	MJ	1,14E+00	1,14E+00	1,62E-03
Resource use, minerals and metals	kg Sb eq	4,97E-07	4,97E-07	3,74E-10

Weighted results

- Normalised and **weighted** results

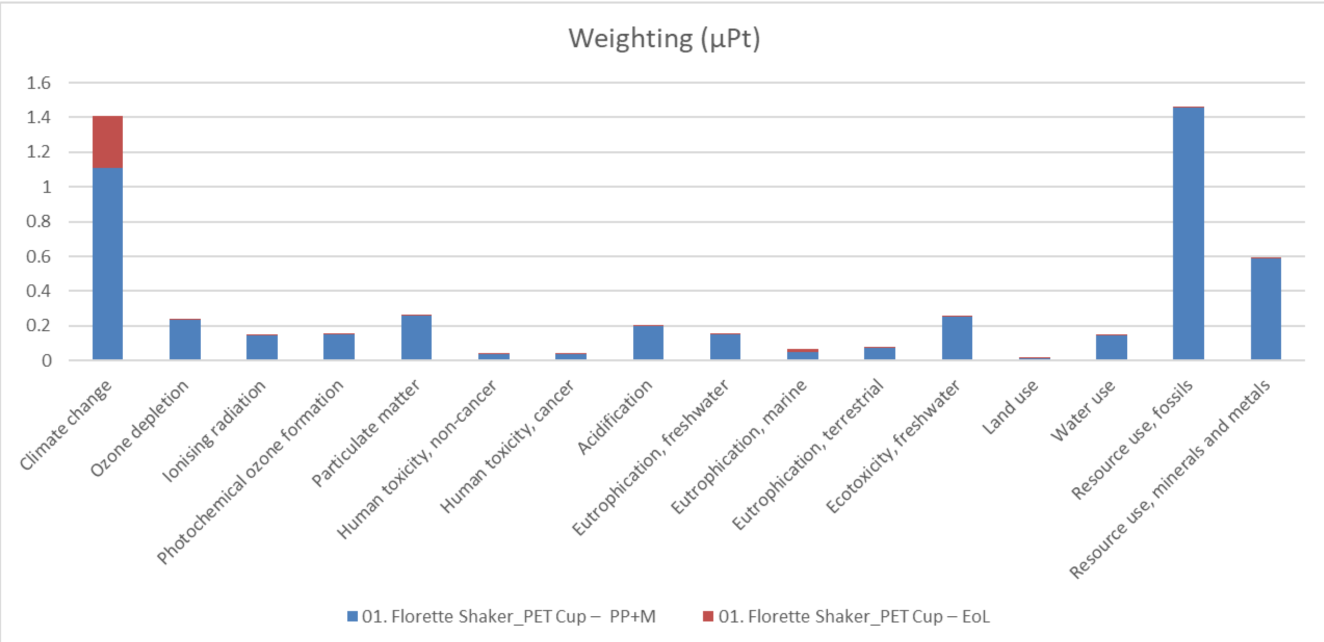


Figure 5: Normalised and weighted results - PRODUCT 01 - Florette Shaker, PET Cup

Funded by the European Union

This project has received funding from the European Union's Horizon Europe Research and Innovation programme under Grant Agreement No 101060806. This document reflects the views of the author(s) and does not necessarily reflect the views or policy of the European Commission. Whilst efforts have been made to ensure the accuracy and completeness of this document, the European Commission shall not be liable for any errors or omissions, however

Single score

- Weighted results as single score in µPt for all the life cycle stages (Pre-processing and manufacturing: 01. Florette Shaker_PET Cup – PP+M; End-of-Life: 01. Florette Shaker_PET Cup – EoL).
- For product 01 – Florette Shaker, PET Cup, the most relevant life cycle stage is PP+M (93,6%). The most relevant processes (processes details are shown in table A1) are related to component 1.2 PET Shaker and are Polyethylene terephthalate pre-processing and manufacturing.

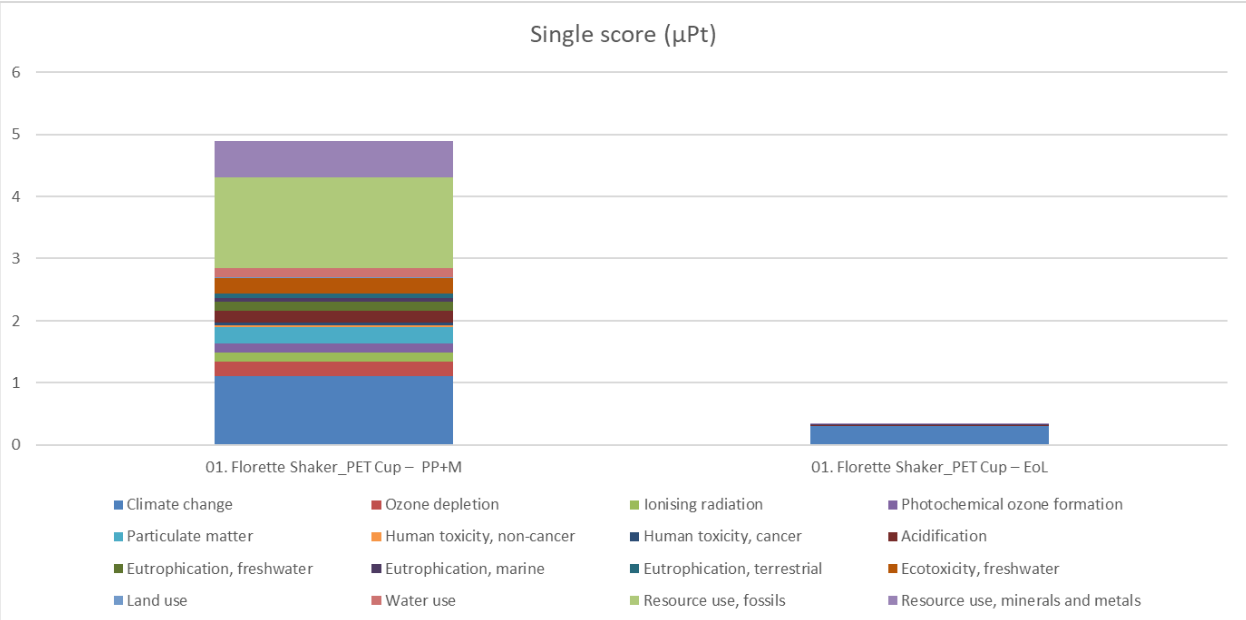


Figure 6: Weighted results as single score in µPt - PRODUCT 01 - Florette Shaker, PET Cup

Funded by
the European Union

This project has received funding from the European Union's Horizon Europe Research and Innovation programme under Grant Agreement No 101060806. This document reflects the views of the author(s) and does not necessarily reflect the views or policy of the European Commission. Whilst efforts have been made to ensure the accuracy and completeness of this document, the European Commission shall not be liable for any errors or omissions, however

PRODUCT 02 – Salad MDD, PET Tray

Characterised results

- **Characterised** results of all EF impact categories

Tab 5. Characterised results PRODUCT 02 – Salad MDD, PET Tray

Impact category	**Unit**	**Total**	**02. Salad MDD_PET Tray – PP+M**	**02. Salad MDD_PET Tray – EoL**
Climate change	kg CO2 eq	1,31E-01	1,04E-01	2,77E-02
Ozone depletion	kg CFC11 eq	4,85E-07	4,85E-07	5,08E-11
Ionising radiation	kBq U-235 eq	3,01E-02	3,00E-02	2,24E-05
Photochemical ozone formation	kg NMVOC eq	3,14E-04	3,04E-04	9,20E-06
Particulate matter	disease inc.	4,19E-09	4,14E-09	5,23E-11
Human toxicity, non-cancer	CTUh	1,22E-09	1,16E-09	6,06E-11
Human toxicity, cancer	CTUh	7,13E-11	6,68E-11	4,52E-12
Acidification	mol H+ eq	4,35E-04	4,28E-04	6,72E-06
Eutrophication, freshwater	kg P eq	2,08E-05	2,08E-05	3,64E-08
Eutrophication, marine	kg N eq	1,05E-04	8,19E-05	2,34E-05
Eutrophication, terrestrial	mol N eq	8,45E-04	8,10E-04	3,54E-05
Ecotoxicity, freshwater	CTUe	1,37E+00	1,36E+00	1,10E-02
Land use	Pt	2,50E-01	2,44E-01	5,66E-03
Water use	m3 depriv.	4,98E-02	4,97E-02	6,40E-05
Resource use, fossils	MJ	2,78E+00	2,78E+00	3,91E-03
Resource use, minerals and metals	kg Sb eq	1,21E-06	1,21E-06	9,04E-10

Weighted results

- Normalised and **weighted** results

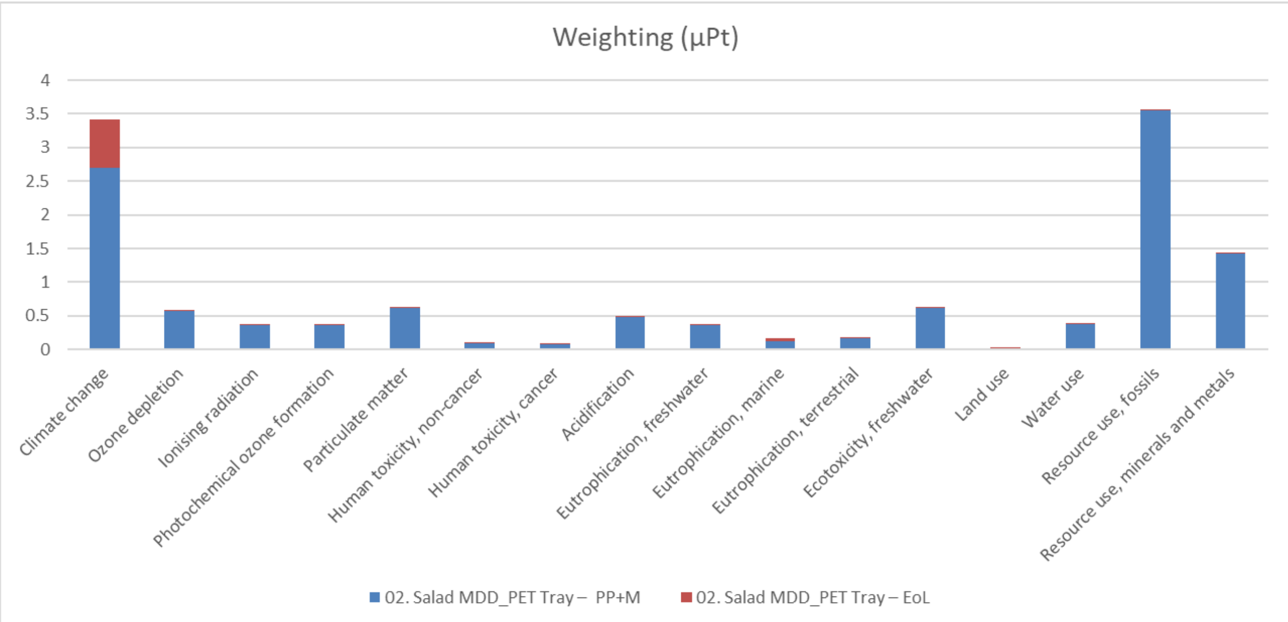


Figure 7: Normalised and weighted results - PRODUCT 02 – Salad MDD, PET Tray

Funded by the European Union

This project has received funding from the European Union's Horizon Europe Research and Innovation programme under Grant Agreement No 101060806. This document reflects the views of the author(s) and does not necessarily reflect the views or policy of the European Commission. Whilst efforts have been made to ensure the accuracy and completeness of this document, the European Commission shall not be liable for any errors or omissions, however

Single score

- Weighted results as single score in **µP**t for all the life cycle stages (Pre-processing and manufacturing: 02. Salad MDD_PET Tray – PP+M; End-of-Life: 02. Salad MDD_PET Tray – EoL).
- For product 02 – Salad MDD, PET Tray, the most relevant life cycle stage is PP+M (93,6%). The most relevant processes (processes details are shown in table A2) are related to component 2.2 PET Bowl and are Polyethylene terephthalate pre-processing and manufacturing.

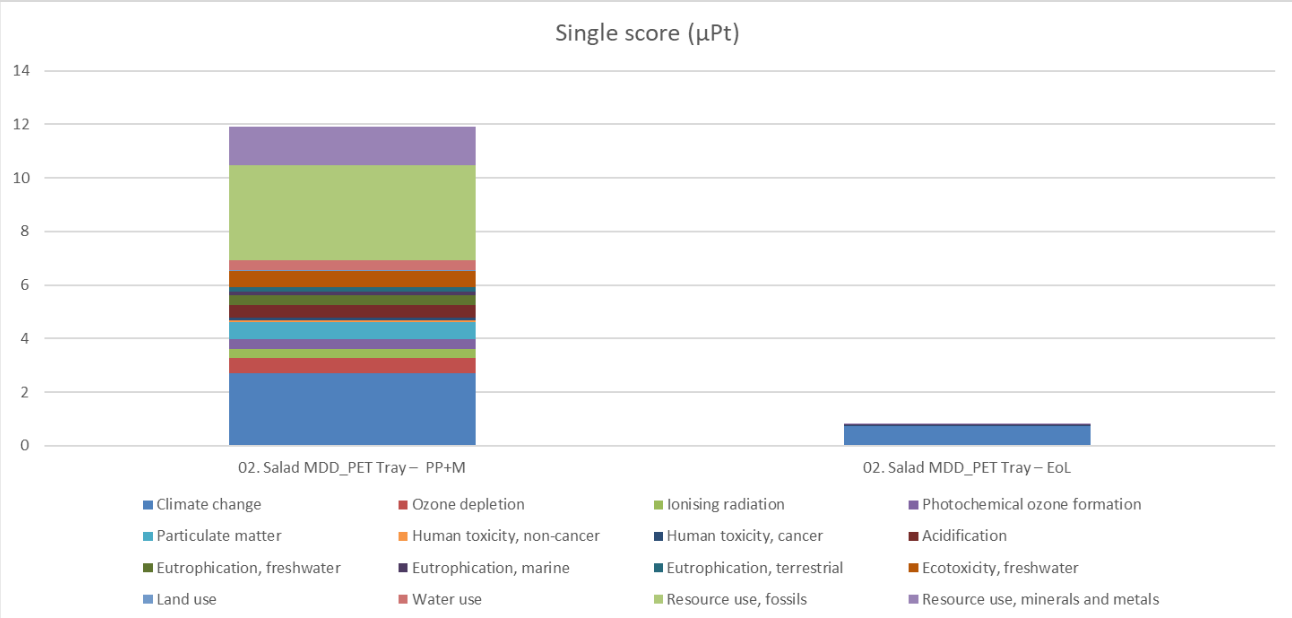


Figure 8: Weighted results as single score in µPt - PRODUCT 02 – Salad MDD, PET Tray

Funded by the European Union

This project has received funding from the European Union's Horizon Europe Research and Innovation programme under Grant Agreement No 101060806. This document reflects the views of the author(s) and does not necessarily reflect the views or policy of the European Commission. Whilst efforts have been made to ensure the accuracy and completeness of this document, the European Commission shall not be liable for any errors or omissions, however

PRODUCT 03 – Sour cream, Cup

Characterised results

- **Characterised** results of all EF impact categories

Tab 6. Characterised results PRODUCT 03 – Sour cream, Cup

Impact category	Unit	Total	03. Sour cream_Cup – PP+M	03. Sour cream_Cup – EoL
Climate change	kg CO2 eq	4,98E-02	3,70E-02	1,28E-02
Ozone depletion	kg CFC11 eq	4,97E-08	4,97E-08	2,23E-11
Ionising radiation	kBq U-235 eq	1,15E-02	1,14E-02	8,99E-06
Photochemical ozone formation	kg NMVOC eq	1,16E-04	1,12E-04	3,07E-06
Particulate matter	disease inc.	2,10E-09	2,08E-09	2,15E-11
Human toxicity, non-cancer	CTUh	4,02E-10	3,85E-10	1,68E-11
Human toxicity, cancer	CTUh	2,66E-11	2,47E-11	1,88E-12
Acidification	mol H+ eq	1,52E-04	1,50E-04	2,19E-06
Eutrophication, freshwater	kg P eq	6,88E-06	6,86E-06	2,58E-08
Eutrophication, marine	kg N eq	3,21E-05	2,79E-05	4,23E-06
Eutrophication, terrestrial	mol N eq	2,91E-04	2,79E-04	1,12E-05
Ecotoxicity, freshwater	CTUe	4,35E-01	4,25E-01	9,99E-03
Land use	Pt	6,78E-02	6,54E-02	2,37E-03
Water use	m3 depriv.	1,95E-02	1,94E-02	3,03E-05
Resource use, fossils	MJ	1,16E+00	1,16E+00	1,60E-03
Resource use, minerals and metals	kg Sb eq	3,30E-07	3,30E-07	4,11E-10

Weighted results

- Normalised and **weighted** results

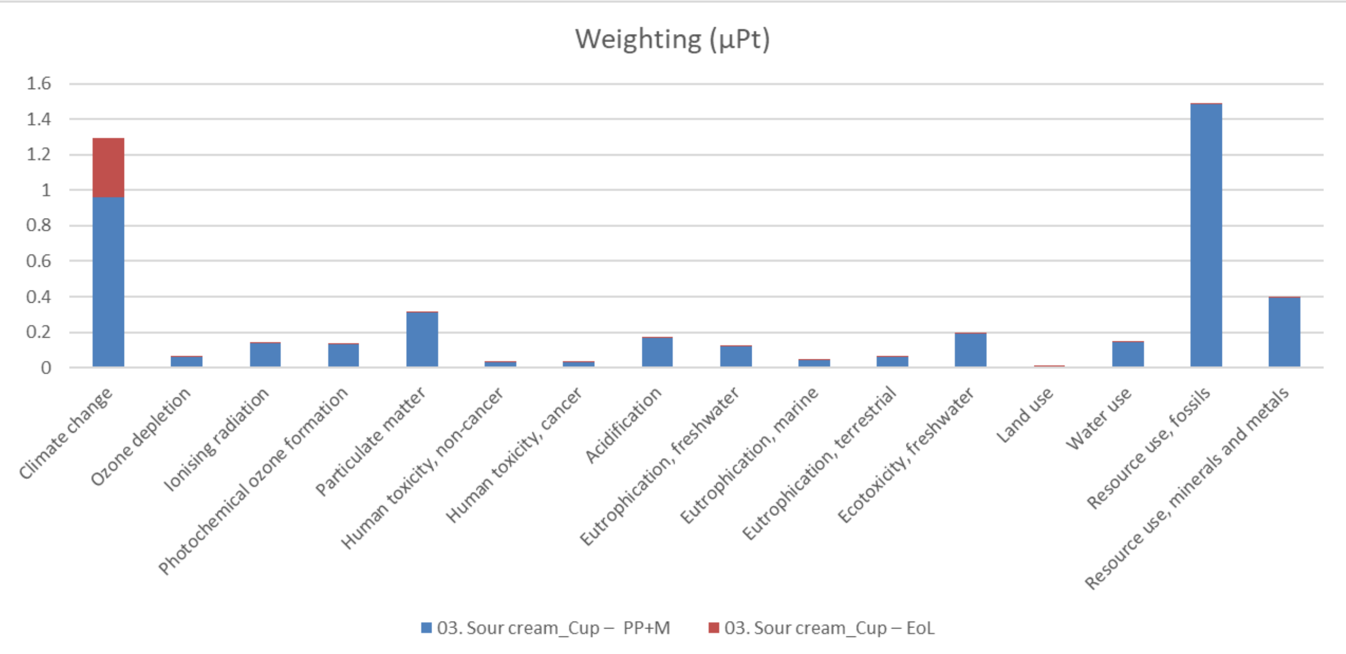


Figure 9: Normalised and weighted results - PRODUCT 03 – Sour cream, Cup

Funded by the European Union

This project has received funding from the European Union's Horizon Europe Research and Innovation programme under Grant Agreement No 101060806. This document reflects the views of the author(s) and does not necessarily reflect the views or policy of the European Commission. Whilst efforts have been made to ensure the accuracy and completeness of this document, the European Commission shall not be liable for any errors or omissions, however

Single score

- Weighted results as single score in µPt for all the life cycle stages (Pre-processing and manufacturing: 03. Sour cream_Cup – PP+M; End-of-Life: 03. Sour cream_Cup – EoL).
- For product 03 – Sour cream, Cup, the most relevant life cycle stage is PP+M (92,2%). The most relevant processes (processes details are shown in table A3) are related to component 3.3 PP Bowl and are Polypropylene pre-processing and manufacturing.

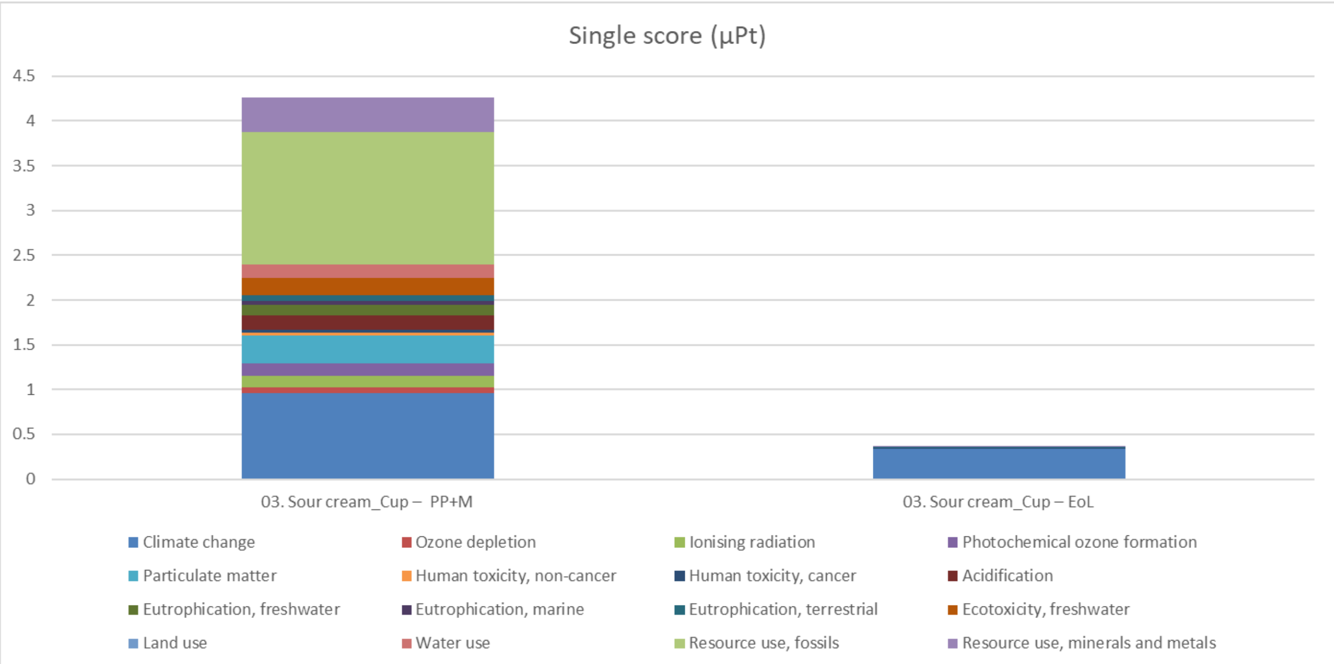


Figure 10: Weighted results as single score in µPt - PRODUCT 03 – Sour cream, Cup

Funded by the European Union

This project has received funding from the European Union's Horizon Europe Research and Innovation programme under Grant Agreement No 101060806. This document reflects the views of the author(s) and does not necessarily reflect the views or policy of the European Commission. Whilst efforts have been made to ensure the accuracy and completeness of this document, the European Commission shall not be liable for any errors or omissions, however

PRODUCT 04 – Greek yoghurt, Cup

Characterised results

- **Characterised** results of all EF impact categories

Tab 7. Characterised results PRODUCT 04 – Greek yoghurt, Cup

Impact category	**Unit**	**Total**	**04. Greek yoghurt_Cup – PP+M**	**04. Greek yoghurt_Cup – EoL**
Climate change	kg CO2 eq	8,12E-02	6,01E-02	2,11E-02
Ozone depletion	kg CFC11 eq	8,30E-08	8,30E-08	3,64E-11
Ionising radiation	kBq U-235 eq	1,88E-02	1,88E-02	1,47E-05
Photochemical ozone formation	kg NMVOC eq	1,88E-04	1,83E-04	5,04E-06
Particulate matter	disease inc.	3,34E-09	3,30E-09	3,51E-11
Human toxicity, non-cancer	CTUh	6,44E-10	6,16E-10	2,76E-11
Human toxicity, cancer	CTUh	4,23E-11	3,92E-11	3,08E-12
Acidification	mol H+ eq	2,46E-04	2,42E-04	3,60E-06
Eutrophication, freshwater	kg P eq	1,11E-05	1,10E-05	4,10E-08
Eutrophication, marine	kg N eq	5,21E-05	4,51E-05	6,98E-06
Eutrophication, terrestrial	mol N eq	4,70E-04	4,52E-04	1,84E-05
Ecotoxicity, freshwater	CTUe	6,96E-01	6,80E-01	1,56E-02
Land use	Pt	1,10E-01	1,06E-01	3,88E-03
Water use	m3 depriv.	3,19E-02	3,18E-02	4,93E-05
Resource use, fossils	MJ	1,90E+00	1,90E+00	2,61E-03
Resource use, minerals and metals	kg Sb eq	5,36E-07	5,35E-07	6,71E-10

Weighted results

- Normalised and **weighted** results

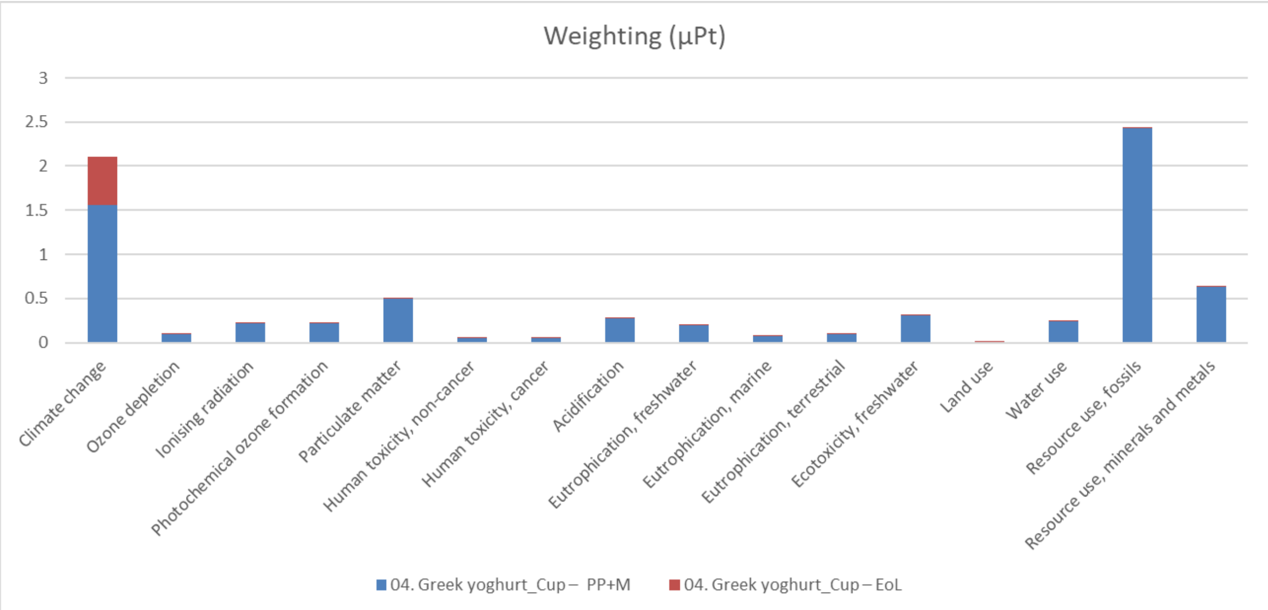


Figure 11: Normalised and weighted results - PRODUCT 04 – Greek yoghurt, Cup

Funded by the European Union

This project has received funding from the European Union's Horizon Europe Research and Innovation programme under Grant Agreement No 101060806. This document reflects the views of the author(s) and does not necessarily reflect the views or policy of the European Commission. Whilst efforts have been made to ensure the accuracy and completeness of this document, the European Commission shall not be liable for any errors or omissions, however

Single score

- Weighted results as single score in µPt for all the life cycle stages (Pre-processing and manufacturing: 04. Greek yoghurt_Cup – PP+M; End-of-Life: 04. Greek yoghurt_Cup – EoL).
- For product 04 – Greek yoghurt, Cup, the most relevant life cycle stage is PP+M (92,1%). The most relevant processes (processes details are shown in table A4) are related to component 4.3 PP Bowl and are Polypropylene pre-processing and manufacturing.

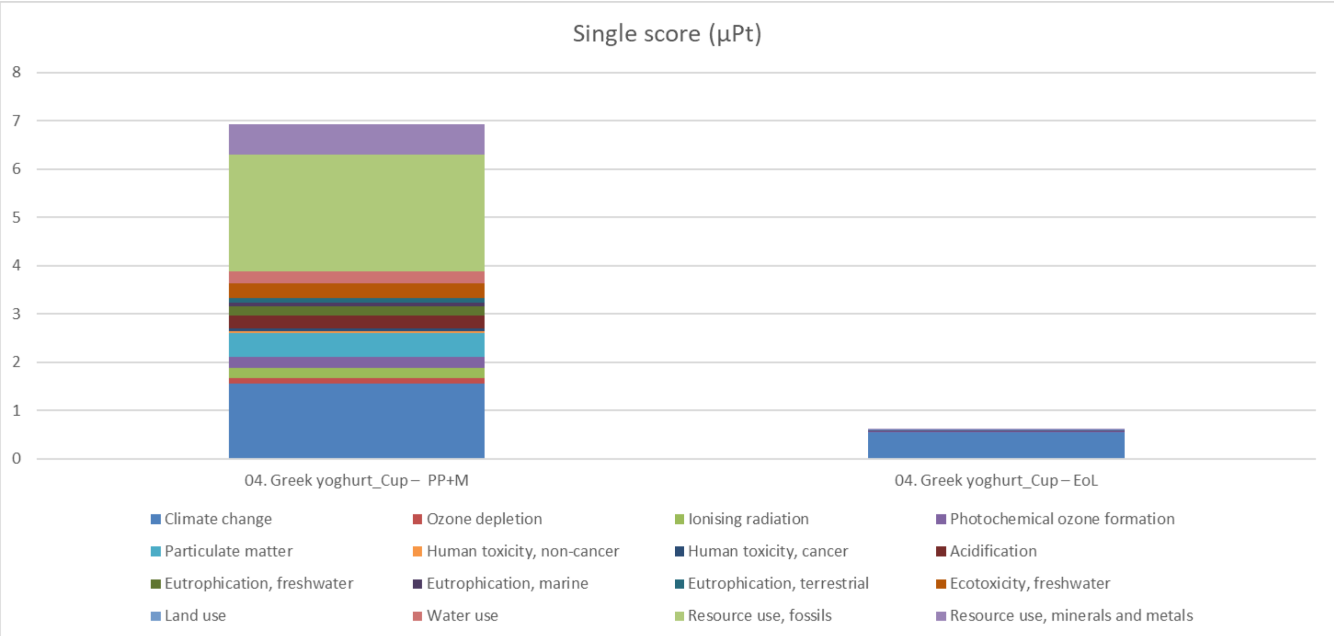


Figure 12: Weighted results as single score in µPt - PRODUCT 04 – Greek yoghurt, Cup

Funded by the European Union

This project has received funding from the European Union's Horizon Europe Research and Innovation programme under Grant Agreement No 101060806. This document reflects the views of the author(s) and does not necessarily reflect the views or policy of the European Commission. Whilst efforts have been made to ensure the accuracy and completeness of this document, the European Commission shall not be liable for any errors or omissions, however

PRODUCT 05 – Pork chop, Wrapped Tray

Characterised results

- **Characterised** results of all EF impact categories

Tab 8. Characterised results PRODUCT 05 – Pork chop, Wrapped Tray

Impact category	Unit	Total	05. Pork chop_Wrapped Tray – PP+M	05. Pork chop_Wrapped Tray – EoL
Climate change	kg CO2 eq	7,40E-02	5,54E-02	1,86E-02
Ozone depletion	kg CFC11 eq	4,87E-09	4,38E-09	4,97E-10
Ionising radiation	kBq U-235 eq	1,59E-02	1,57E-02	1,17E-04
Photochemical ozone formation	kg NMVOC eq	2,84E-04	2,78E-04	5,89E-06
Particulate matter	disease inc.	2,22E-09	2,16E-09	6,06E-11
Human toxicity, non-cancer	CTUh	3,40E-10	2,71E-10	6,90E-11
Human toxicity, cancer	CTUh	1,92E-11	1,59E-11	3,33E-12
Acidification	mol H+ eq	2,13E-04	2,06E-04	6,98E-06
Eutrophication, freshwater	kg P eq	5,12E-06	4,73E-06	3,88E-07
Eutrophication, marine	kg N eq	3,83E-05	3,38E-05	4,53E-06
Eutrophication, terrestrial	mol N eq	3,62E-04	3,41E-04	2,15E-05
Ecotoxicity, freshwater	CTUe	5,40E-01	2,65E-01	2,75E-01
Land use	Pt	7,12E-02	6,53E-02	5,97E-03
Water use	m3 depriv.	4,18E-02	4,09E-02	8,12E-04
Resource use, fossils	MJ	1,47E+00	1,46E+00	1,20E-02
Resource use, minerals and metals	kg Sb eq	1,51E-07	1,39E-07	1,14E-08

Weighted results

- Normalised and **weighted** results

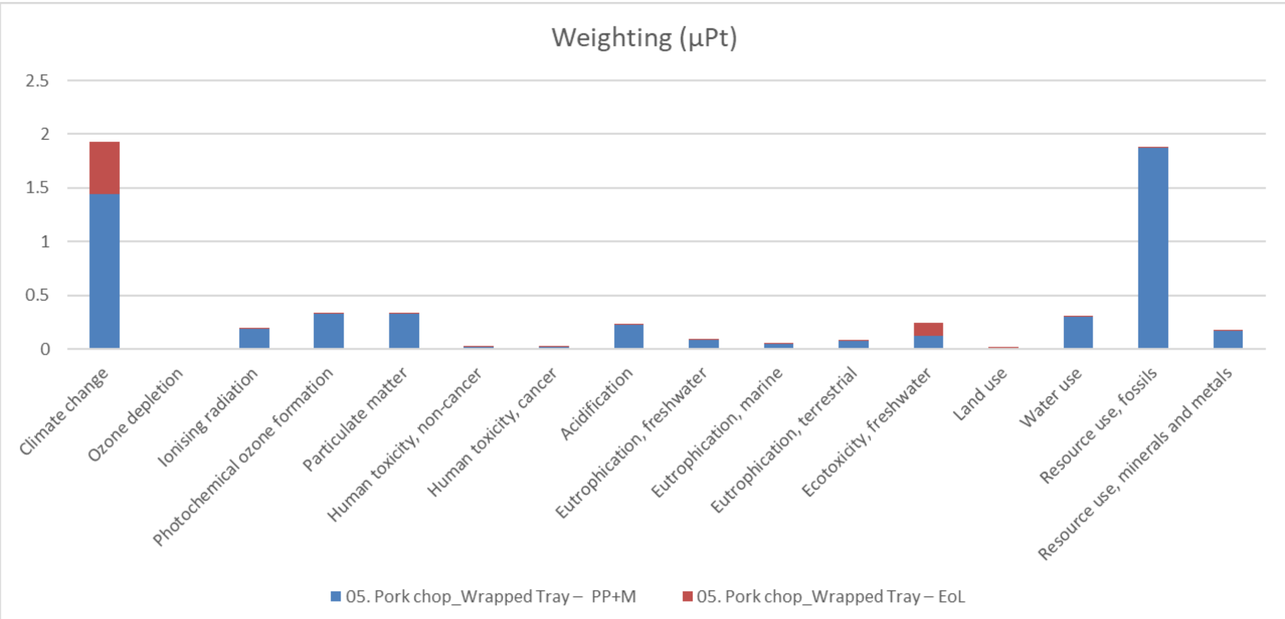


Figure 13: Normalised and weighted results - PRODUCT 05 – Pork chop, Wrapped Tray

Funded by the European Union

This project has received funding from the European Union's Horizon Europe Research and Innovation programme under Grant Agreement No 101060806. This document reflects the views of the author(s) and does not necessarily reflect the views or policy of the European Commission. Whilst efforts have been made to ensure the accuracy and completeness of this document, the European Commission shall not be liable for any errors or omissions, however

Single score

- Weighted results as single score in µPt for all the life cycle stages (Pre-processing and manufacturing: 05. Pork chop_Wrapped Tray – PP+M; End-of-Life: 05. Pork chop_Wrapped Tray – EoL).
- For product 05 – Pork chop, Wrapped Tray, the most relevant life cycle stage is PP+M (88,2%). The most relevant processes (processes details are shown in table A5) are related to component 5.2 PSE Tray and are Expandable Polystyrene pre-processing and manufacturing.

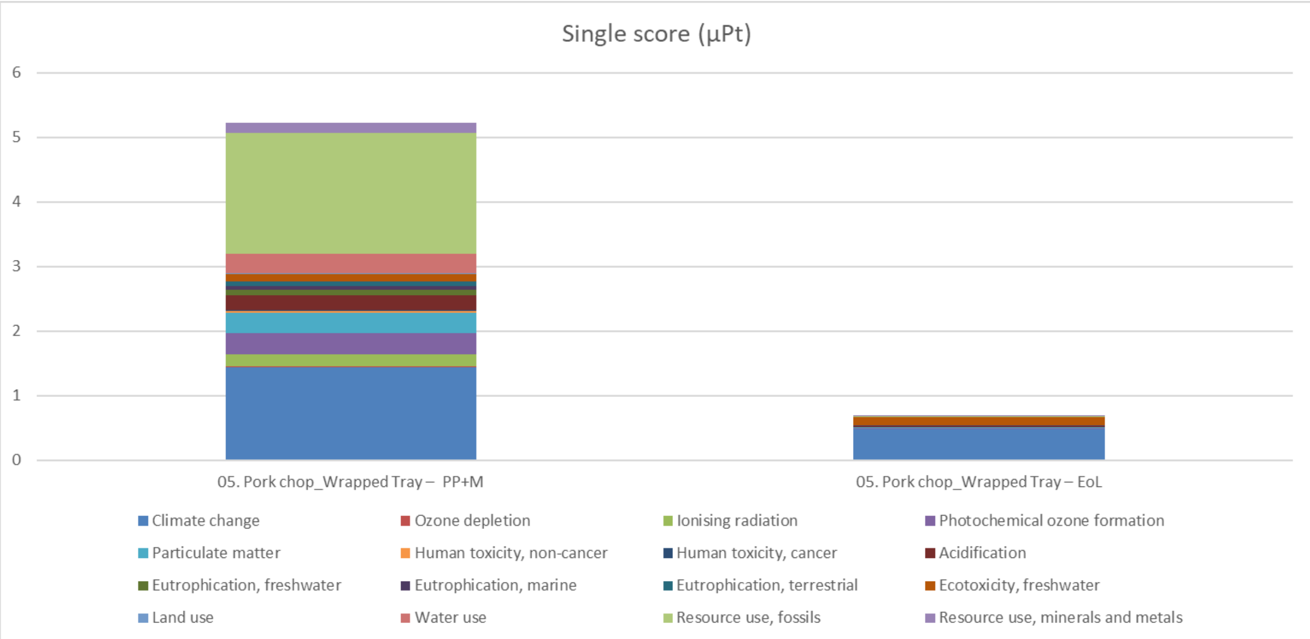


Figure 14: Weighted results as single score in µPt - PRODUCT 05 – Pork chop, Wrapped Tray

Funded by
the European Union

This project has received funding from the European Union's Horizon Europe Research and Innovation programme under Grant Agreement No 101060806. This document reflects the views of the author(s) and does not necessarily reflect the views or policy of the European Commission. Whilst efforts have been made to ensure the accuracy and completeness of this document, the European Commission shall not be liable for any errors or omissions, however

PRODUCT 06 – Florette Mache, OPP Film

Characterised results

- **Characterised** results of all EF impact categories

Tab 9. Characterised results PRODUCT 06 – Florette Mache, OPP Film

Impact category	**Unit**	**Total**	**06. Florette Mache_OPP Film – PP+M**	**06. Florette Mache_OPP Film – EoL**
Climate change	kg CO2 eq	2,15E-02	1,50E-02	6,42E-03
Ozone depletion	kg CFC11 eq	5,07E-10	5,03E-10	3,44E-12
Ionising radiation	kBq U-235 eq	4,40E-03	4,39E-03	2,13E-06
Photochemical ozone formation	kg NMVOC eq	4,92E-05	4,79E-05	1,36E-06
Particulate matter	disease inc.	6,82E-10	6,72E-10	9,06E-12
Human toxicity, non-cancer	CTUh	3,05E-10	2,99E-10	6,06E-12
Human toxicity, cancer	CTUh	2,38E-11	2,30E-11	8,58E-13
Acidification	mol H+ eq	5,52E-05	5,43E-05	8,99E-07
Eutrophication, freshwater	kg P eq	2,01E-06	2,00E-06	7,73E-09
Eutrophication, marine	kg N eq	1,30E-05	1,19E-05	1,05E-06
Eutrophication, terrestrial	mol N eq	1,10E-04	1,05E-04	4,67E-06
Ecotoxicity, freshwater	CTUe	1,48E-01	1,47E-01	1,31E-03
Land use	Pt	5,97E-02	5,86E-02	1,04E-03
Water use	m3 depriv.	1,05E-02	1,04E-02	1,15E-05
Resource use, fossils	MJ	5,33E-01	5,33E-01	6,79E-04
Resource use, minerals and metals	kg Sb eq	7,56E-08	7,55E-08	1,22E-10

Weighted results

- Normalised and **weighted** results

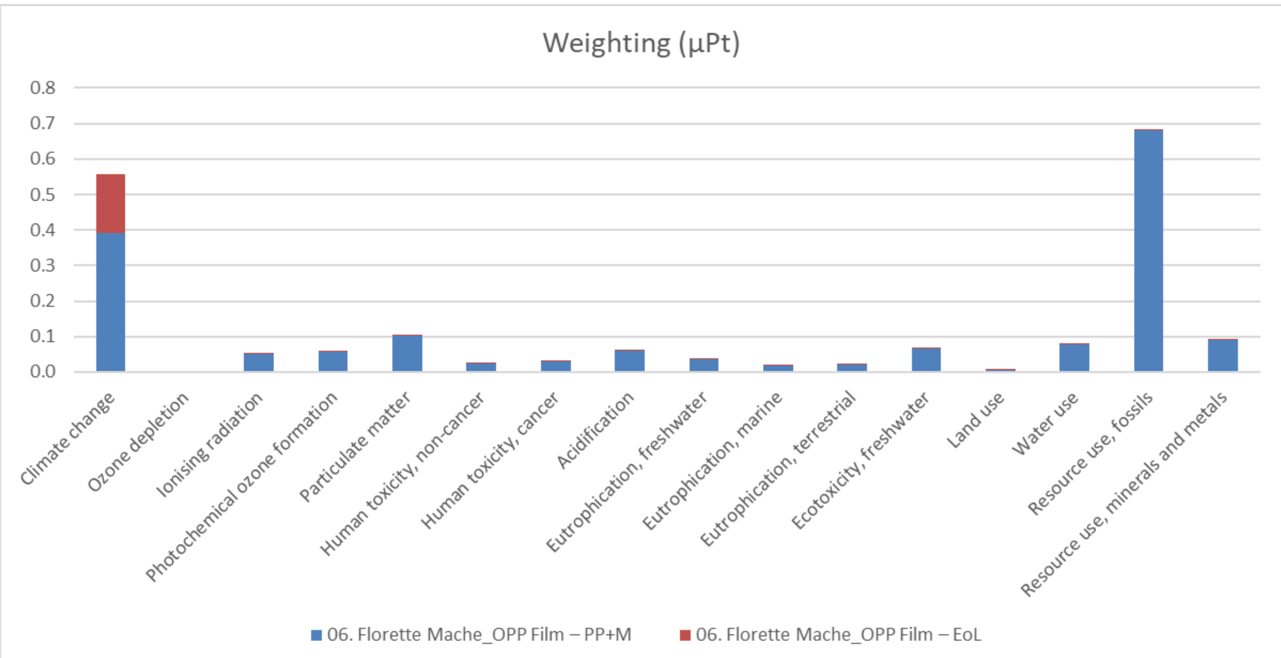


Figure 15: Normalised and weighted results - PRODUCT 06 – Florette Mache, OPP Film

Funded by the European Union

This project has received funding from the European Union's Horizon Europe Research and Innovation programme under Grant Agreement No 101060806. This document reflects the views of the author(s) and does not necessarily reflect the views or policy of the European Commission. Whilst efforts have been made to ensure the accuracy and completeness of this document, the European Commission shall not be liable for any errors or omissions, however

Single score

- Weighted results as single score in µPt for all the life cycle stages (Pre-processing and manufacturing: 06. Florette Mache_OPP Film – PP+M; End-of-Life: 06. Florette Mache_OPP Film – EoL)
- For product 06– Florette Mache_OPP Film, the most relevant life cycle stage is PP+M (90,6%). The most relevant processes (processes details are shown in table A6) are related to component 6.2 OPP Film and are Polypropylene pre-processing and manufacturing.

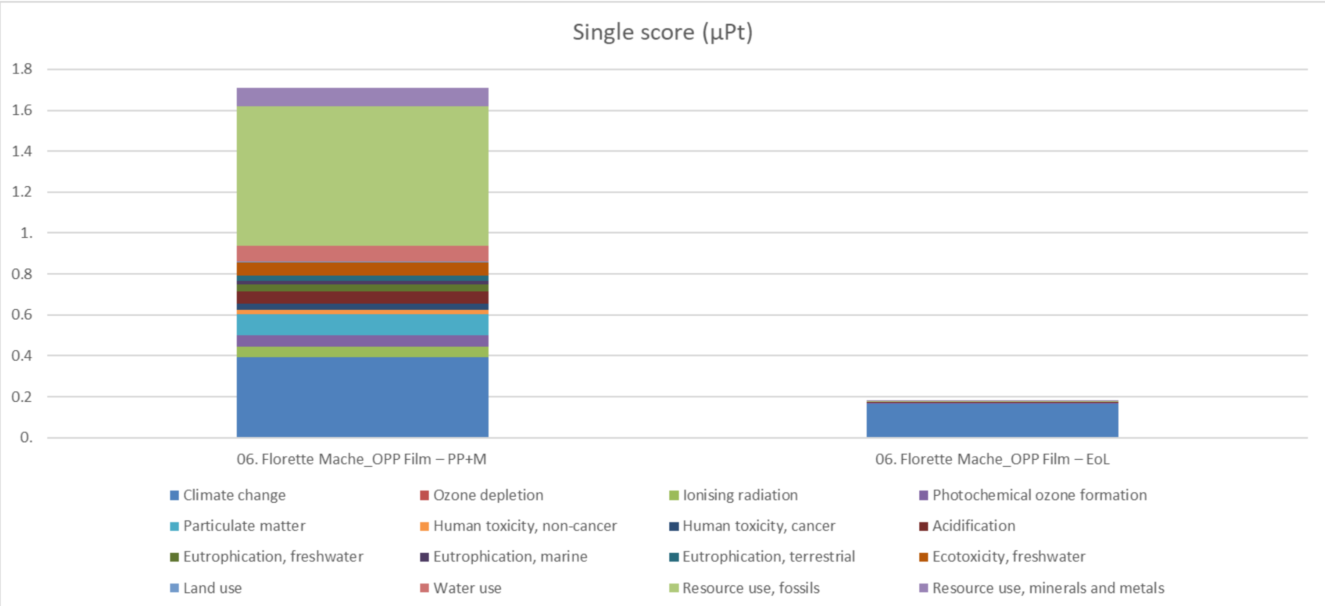


Figure 16: Weighted results as single score in µPt - PRODUCT 06 – Florette Mache, OPP Film

Funded by the European Union

This project has received funding from the European Union's Horizon Europe Research and Innovation programme under Grant Agreement No 101060806. This document reflects the views of the author(s) and does not necessarily reflect the views or policy of the European Commission. Whilst efforts have been made to ensure the accuracy and completeness of this document, the European Commission shall not be liable for any errors or omissions, however

PRODUCT 07 – Butter, Aluminium, & OPP Film

Characterised results

- **Characterised** results of all EF impact categories

Tab 10. Characterised results PRODUCT 07 – Butter, Aluminium, & OPP Film

Impact category	**Unit**	**Total**	**07. Butter_Al&OPP Film – PP+M**	**07. Butter_Al&OPP Film – EoL**
Climate change	kg CO2 eq	1,14E-02	1,02E-02	1,22E-03
Ozone depletion	kg CFC11 eq	1,21E-10	1,18E-10	2,54E-12
Ionising radiation	kBq U-235 eq	3,81E-03	3,81E-03	2,42E-06
Photochemical ozone formation	kg NMVOC eq	3,64E-05	3,55E-05	9,17E-07
Particulate matter	disease inc.	9,83E-10	9,69E-10	1,41E-11
Human toxicity, non-cancer	CTUh	1,77E-10	1,67E-10	9,23E-12
Human toxicity, cancer	CTUh	1,18E-11	1,15E-11	3,63E-13
Acidification	mol H+ eq	5,10E-05	5,04E-05	6,19E-07
Eutrophication, freshwater	kg P eq	2,79E-06	2,73E-06	5,97E-08
Eutrophication, marine	kg N eq	1,10E-05	9,47E-06	1,57E-06
Eutrophication, terrestrial	mol N eq	9,95E-05	9,69E-05	2,59E-06
Ecotoxicity, freshwater	CTUe	4,49E-02	4,00E-02	4,88E-03
Land use	Pt	3,17E-02	3,08E-02	9,11E-04
Water use	m3 depriv.	2,64E-03	2,62E-03	2,44E-05
Resource use, fossils	MJ	2,51E-01	2,50E-01	9,63E-04
Resource use, minerals and metals	kg Sb eq	7,76E-08	7,74E-08	1,92E-10

Weighted results

- Normalised and **weighted** results

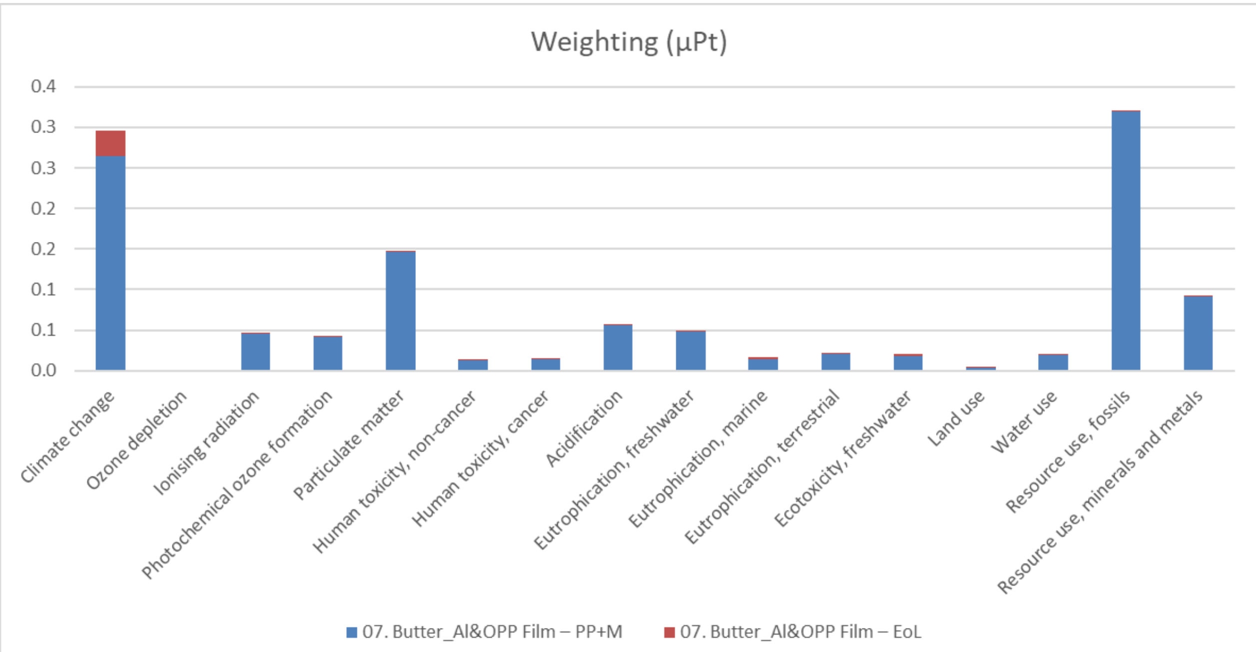


Figure 17: Normalised and weighted results - PRODUCT 07 – Butter, Aluminium, & OPP Film

Funded by the European Union

This project has received funding from the European Union's Horizon Europe Research and Innovation programme under Grant Agreement No 101060806. This document reflects the views of the author(s) and does not necessarily reflect the views or policy of the European Commission. Whilst efforts have been made to ensure the accuracy and completeness of this document, the European Commission shall not be liable for any errors or omissions, however

Single score

- Weighted results as single score in µPt for all the life cycle stages (Pre-processing and manufacturing: 07. Butter_Al&OPP Film – PP+M; End-of-Life: 07. Butter_Al&OPP Film – EoL)
- For product 07 – Butter_Al&OPP Film, the most relevant life cycle stage is PP+M (96,1%). The most relevant processes (processes details are shown in table A7) are related to component 7.2 Aluminium Lid and are Aluminium pre-processing and manufacturing.

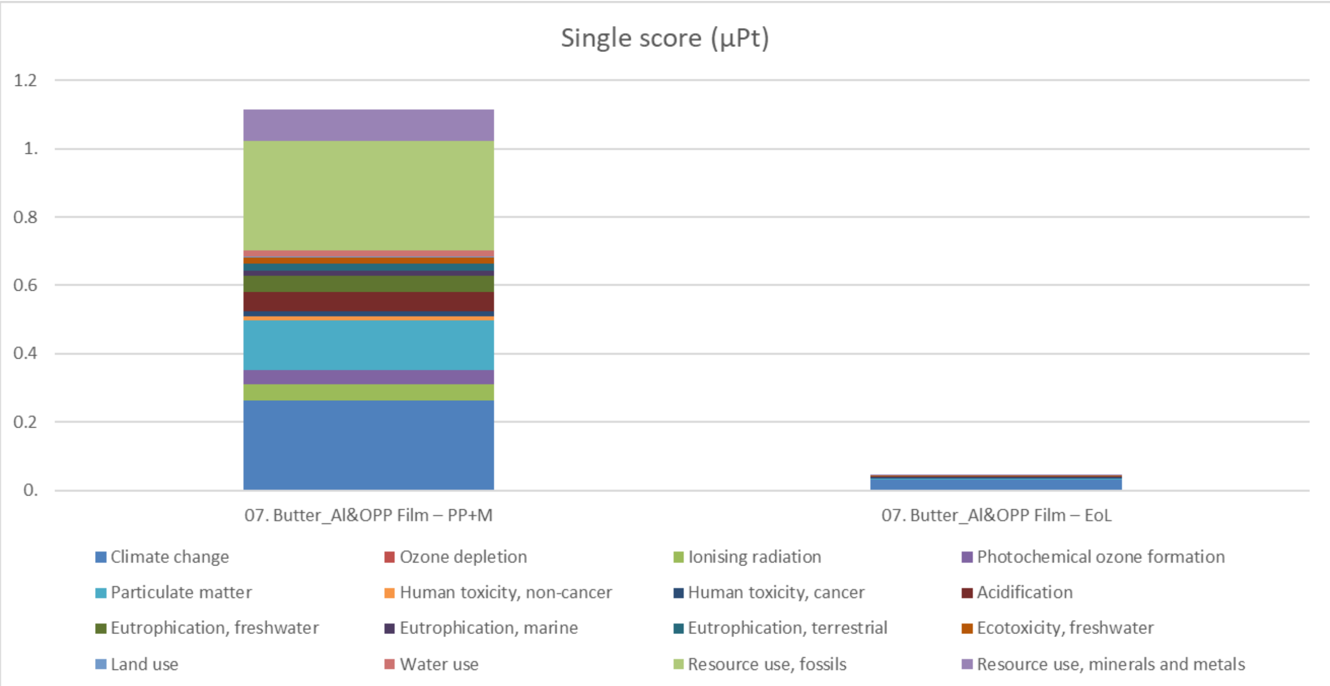


Figure 18: Weighted results as single score in µPt - PRODUCT 07 – Butter, Aluminium, & OPP Film

Funded by the European Union

This project has received funding from the European Union's Horizon Europe Research and Innovation programme under Grant Agreement No 101060806. This document reflects the views of the author(s) and does not necessarily reflect the views or policy of the European Commission. Whilst efforts have been made to ensure the accuracy and completeness of this document, the European Commission shall not be liable for any errors or omissions, however

PRODUCT 08 – Grated cheese, OPA & LDPE Film

Characterised results

- **Characterised** results of all EF impact categories

Tab 11. Characterised results PRODUCT 08 – Grated cheese, OPA & LDPE Film

Impact category	Unit	Total	08. Grated cheese OPA&LDPE Film – PP+M	08. Grated cheese OPA&LDPE Film – EoL
Climate change	kg CO2 eq	3,33E-02	2,68E-02	6,44E-03
Ozone depletion	kg CFC11 eq	5,73E-08	5,73E-08	1,18E-11
Ionising radiation	kBq U-235 eq	3,17E-03	3,17E-03	4,05E-06
Photochemical ozone formation	kg NMVOC eq	8,33E-05	8,19E-05	1,42E-06
Particulate matter	disease inc.	1,15E-09	1,14E-09	9,31E-12
Human toxicity, non-cancer	CTUh	2,91E-10	2,84E-10	7,52E-12
Human toxicity, cancer	CTUh	1,52E-11	1,44E-11	8,66E-13
Acidification	mol H+ eq	1,04E-04	1,03E-04	1,01E-06
Eutrophication, freshwater	kg P eq	3,11E-06	3,09E-06	1,44E-08
Eutrophication, marine	kg N eq	2,45E-05	2,26E-05	1,89E-06
Eutrophication, terrestrial	mol N eq	2,22E-04	2,17E-04	4,98E-06
Ecotoxicity, freshwater	CTUe	1,25E-01	1,20E-01	4,99E-03
Land use	Pt	6,55E-02	6,45E-02	1,01E-03
Water use	m3 depriv.	1,05E-02	1,05E-02	2,53E-05
Resource use, fossils	MJ	4,94E-01	4,93E-01	8,47E-04
Resource use, minerals and metals	kg Sb eq	1,91E-07	1,91E-07	2,56E-10

Weighted results

- Normalised and **weighted** results

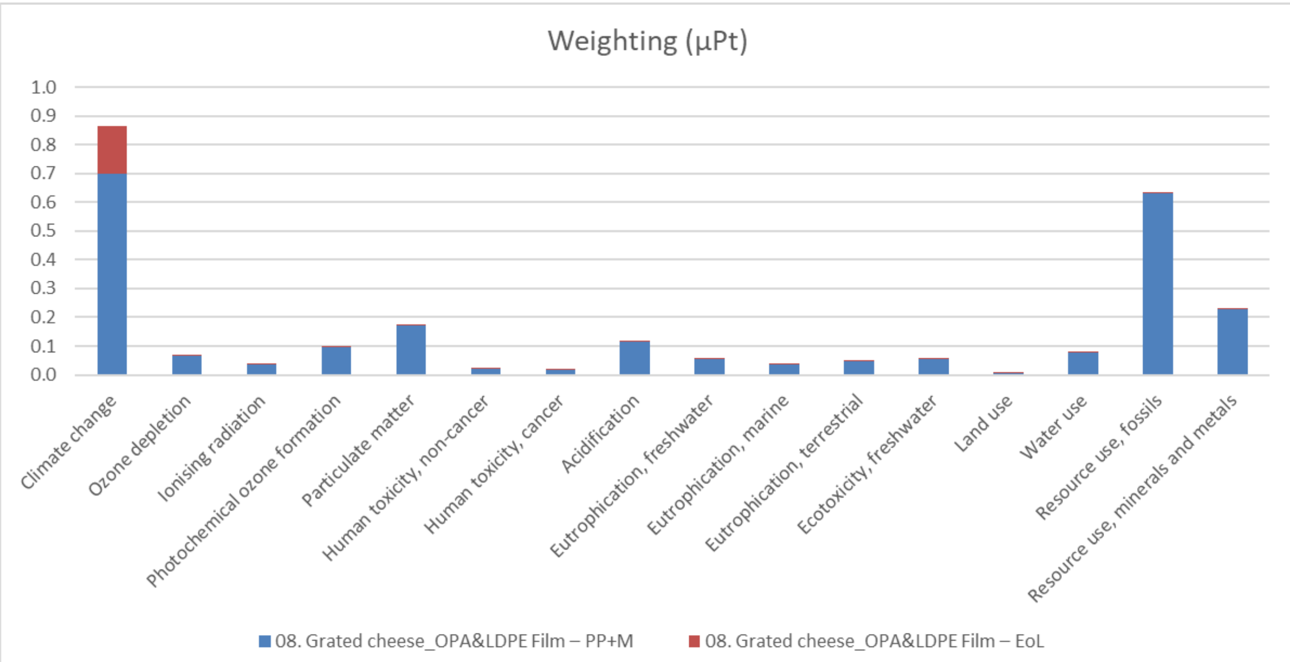


Figure 19: Normalised and weighted results - PRODUCT 08 – Grated cheese, OPA & LDPE Film

Funded by the European Union

This project has received funding from the European Union's Horizon Europe Research and Innovation programme under Grant Agreement No 101060806. This document reflects the views of the author(s) and does not necessarily reflect the views or policy of the European Commission. Whilst efforts have been made to ensure the accuracy and completeness of this document, the European Commission shall not be liable for any errors or omissions, however

Single score

- Weighted results as single score in µPt for all the life cycle stages (Pre-processing and manufacturing: 08. Grated cheese_OPA&LDPE Film – PP+M; End-of-Life: 08. Grated cheese_OPA&LDPE Film – EoL).
- For product 08. Grated cheese_OPA&LDPE Film, the most relevant life cycle stage is PP+M (92,8%). The most relevant processes (processes details are shown in table A8) are related to component 8.3 LDPE Foil and are Polyethylene terephthalate pre-processing and manufacturing.

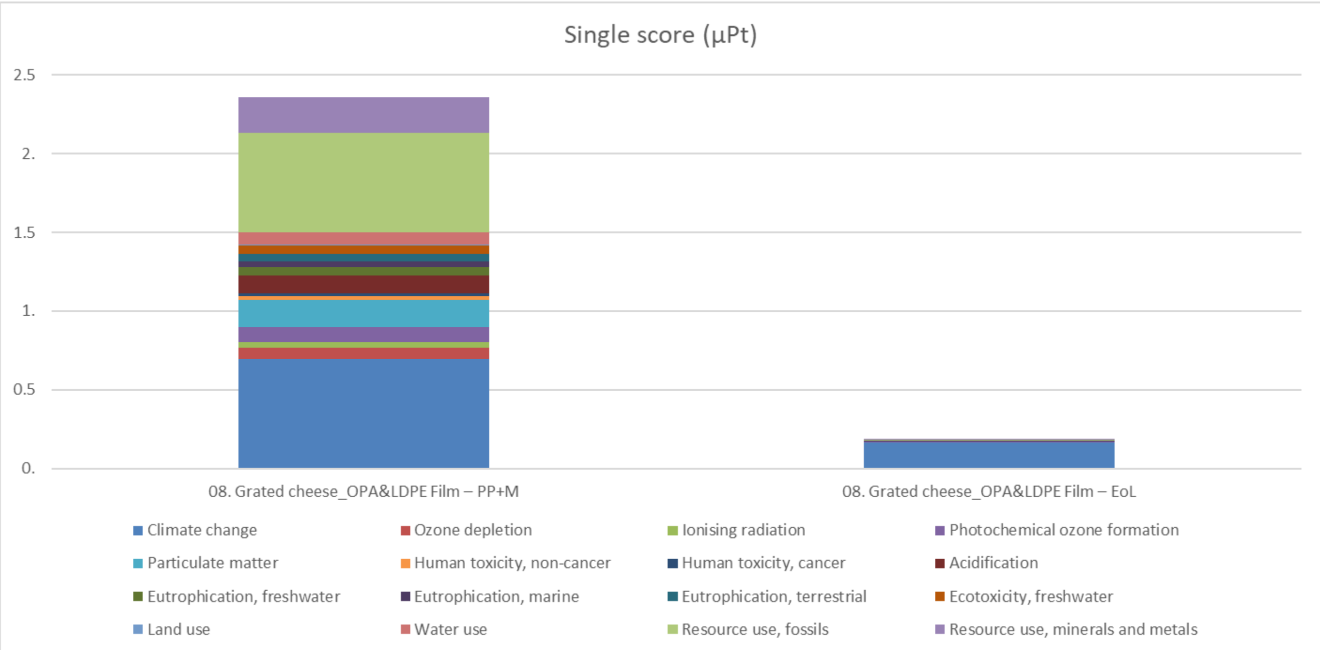


Figure 20: Weighted results as single score in µPt - PRODUCT 08 – Grated cheese, OPA & LDPE Film

Funded by the European Union

This project has received funding from the European Union's Horizon Europe Research and Innovation programme under Grant Agreement No 101060806. This document reflects the views of the author(s) and does not necessarily reflect the views or policy of the European Commission. Whilst efforts have been made to ensure the accuracy and completeness of this document, the European Commission shall not be liable for any errors or omissions, however

PRODUCT 09 – Peanut curl, OPP Film

Characterised results

- **Characterised** results of all EF impact categories

Tab 12. Characterised results PRODUCT 09 – Peanut curl, OPP Film

Impact category	Unit	Total	09. Peanut curl_OPP Film – PP+M	09. Peanut curl_OPP Film – EoL
Climate change	kg CO2 eq	2,13E-02	1,49E-02	6,41E-03
Ozone depletion	kg CFC11 eq	1,00E-09	9,99E-10	3,43E-12
Ionising radiation	kBq U-235 eq	3,60E-03	3,60E-03	2,12E-06
Photochemical ozone formation	kg NMVOC eq	4,79E-05	4,66E-05	1,36E-06
Particulate matter	disease inc.	6,45E-10	6,36E-10	9,04E-12
Human toxicity, non-cancer	CTUh	2,60E-10	2,54E-10	6,05E-12
Human toxicity, cancer	CTUh	1,91E-11	1,83E-11	8,56E-13
Acidification	mol H+ eq	5,32E-05	5,23E-05	8,98E-07
Eutrophication, freshwater	kg P eq	1,98E-06	1,97E-06	7,71E-09
Eutrophication, marine	kg N eq	1,35E-05	1,24E-05	1,04E-06
Eutrophication, terrestrial	mol N eq	1,06E-04	1,02E-04	4,66E-06
Ecotoxicity, freshwater	CTUe	1,49E-01	1,48E-01	1,31E-03
Land use	Pt	7,55E-02	7,44E-02	1,04E-03
Water use	m3 depriv.	9,84E-03	9,83E-03	1,15E-05
Resource use, fossils	MJ	5,00E-01	5,00E-01	6,78E-04
Resource use, minerals and metals	kg Sb eq	7,23E-08	7,21E-08	1,22E-10

Weighted results

- Normalised and **weighted** results

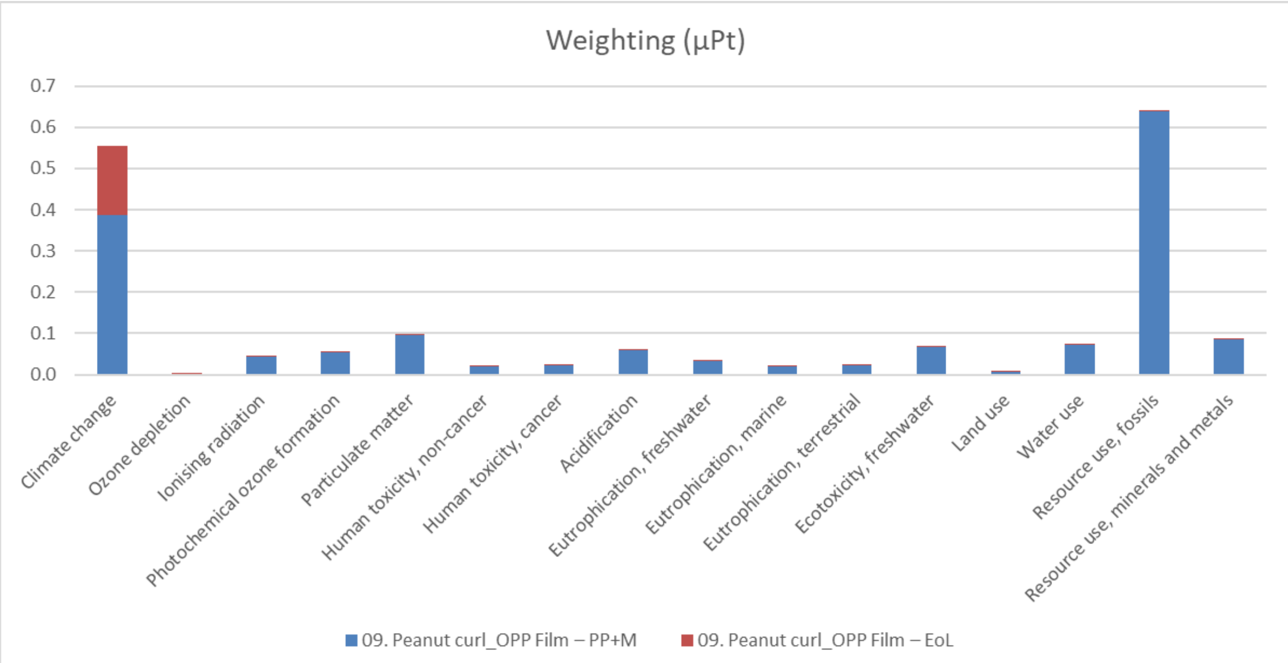


Figure 21: Normalised and weighted results - PRODUCT 09 – Peanut curl, OPP Film

Funded by the European Union

This project has received funding from the European Union's Horizon Europe Research and Innovation programme under Grant Agreement No 101060806. This document reflects the views of the author(s) and does not necessarily reflect the views or policy of the European Commission. Whilst efforts have been made to ensure the accuracy and completeness of this document, the European Commission shall not be liable for any errors or omissions, however

Single score

- Weighted results as single score in µPt for all the life cycle stages (Pre-processing and manufacturing: 09. Peanut curl_OPP Film – PP+M; End-of-Life: 09. Peanut curl_OPP Film – EoL).
- For product 09. Peanut curl_OPP Film, the most relevant life cycle stage is PP+M (90,2%). The most relevant processes (processes details are shown in table A9 are related to component 9.2 OPP Film and are Polypropylene pre-processing and manufacturing.

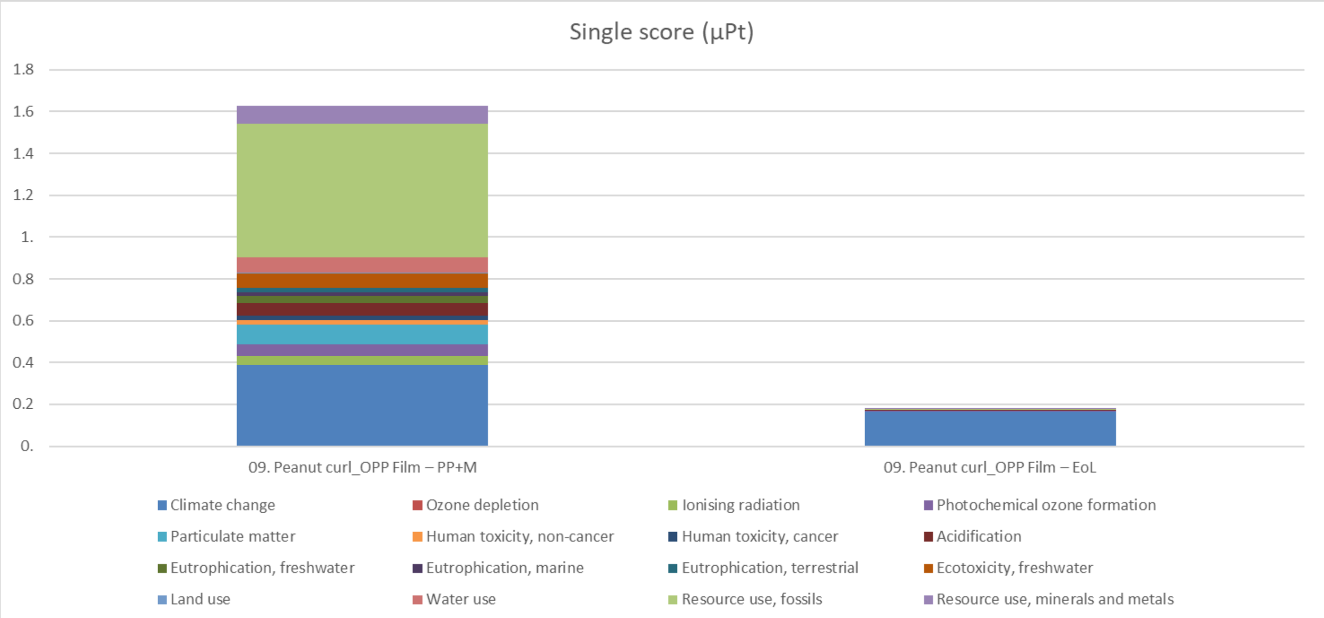


Figure 22: Weighted results as single score in µPt - PRODUCT 09 – Peanut curl, OPP Film

Funded by the European Union

This project has received funding from the European Union's Horizon Europe Research and Innovation programme under Grant Agreement No 101060806. This document reflects the views of the author(s) and does not necessarily reflect the views or policy of the European Commission. Whilst efforts have been made to ensure the accuracy and completeness of this document, the European Commission shall not be liable for any errors or omissions, however

PRODUCT 10 – Savory biscuits, OPP & Cardboard

Characterised results

- **Characterised** results of all EF impact categories

Tab 13. Characterised results PRODUCT 10 – Savory biscuits, OPP & Cardboard

Impact category	**Unit**	**Total**	**10. Savory biscuits OPP&Cardboard – PP+M**	**10. Savory biscuits OPP&Cardboard – EoL**
Climate change	kg CO2 eq	5,17E-02	4,46E-02	7,05E-03
Ozone depletion	kg CFC11 eq	1,27E-09	1,26E-09	9,16E-12
Ionising radiation	kBq U-235 eq	1,11E-02	1,11E-02	8,36E-06
Photochemical ozone formation	kg NMVOC eq	1,61E-04	1,56E-04	4,27E-06
Particulate matter	disease inc.	5,38E-09	5,33E-09	5,32E-11
Human toxicity, non-cancer	CTUh	7,71E-10	7,41E-10	3,00E-11
Human toxicity, cancer	CTUh	2,53E-11	2,40E-11	1,27E-12
Acidification	mol H+ eq	2,31E-04	2,29E-04	2,53E-06
Eutrophication, freshwater	kg P eq	1,88E-05	1,87E-05	3,94E-08
Eutrophication, marine	kg N eq	5,85E-05	5,27E-05	5,81E-06
Eutrophication, terrestrial	mol N eq	5,03E-04	4,93E-04	9,98E-06
Ecotoxicity, freshwater	CTUe	2,49E-01	2,28E-01	2,06E-02
Land use	Pt	2,64E+00	2,64E+00	3,02E-03
Water use	m3 depriv.	1,93E-02	1,91E-02	1,85E-04
Resource use, fossils	MJ	7,89E-01	7,86E-01	3,19E-03
Resource use, minerals and metals	kg Sb eq	1,53E-07	1,52E-07	7,11E-10

Weighted results

- Normalised and **weighted** results

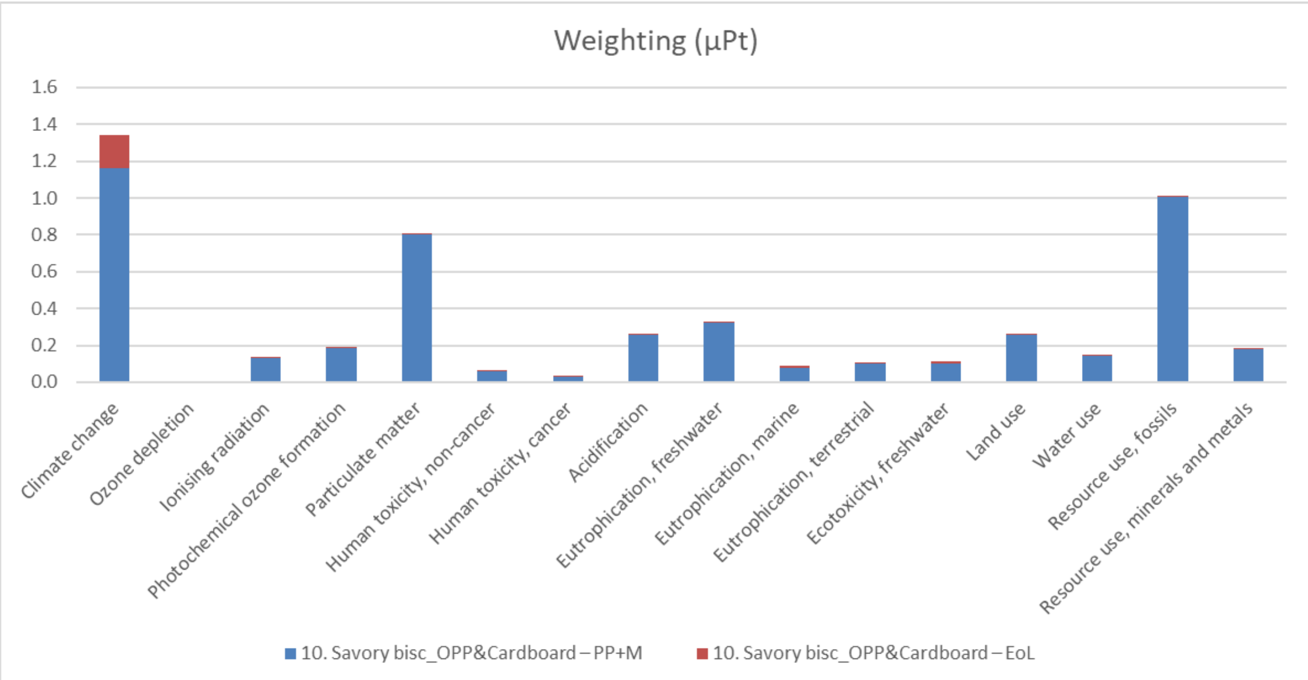


Figure 23: Normalised and weighted results - PRODUCT 10 – Savory biscuits, OPP & Cardboard

Funded by the European Union

This project has received funding from the European Union's Horizon Europe Research and Innovation programme under Grant Agreement No 101060806. This document reflects the views of the author(s) and does not necessarily reflect the views or policy of the European Commission. Whilst efforts have been made to ensure the accuracy and completeness of this document, the European Commission shall not be liable for any errors or omissions, however

Single score

- Weighted results as single score in µPt for all the life cycle stages (Pre-processing and manufacturing: 10. Savory bisc_OPP&Cardboard – PP+M; End-of-Life: 10. Savory bisc_OPP&Cardboard – EoL).
- For product 10. Savory bisc_OPP&Cardboard, the most relevant life cycle stage is PP+M (95,4%). The most relevant processes (processes details are shown in table A10) are related to component 10.1 Cardboard Box and are Folding boxboard carton pre-processing and manufacturing.

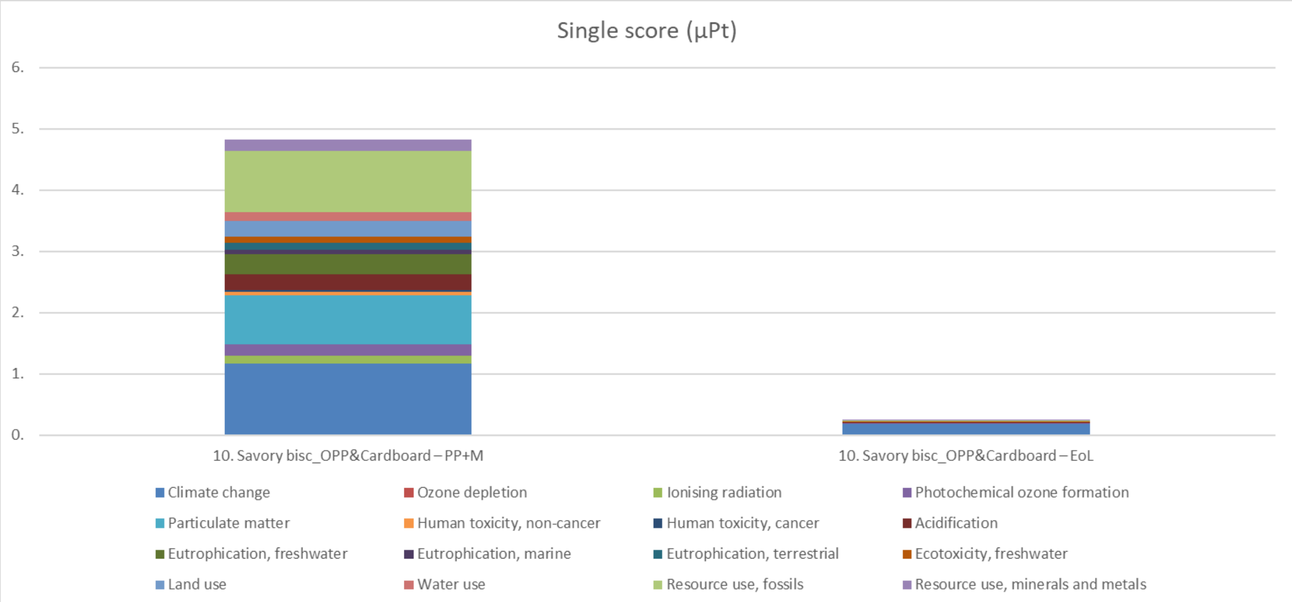


Figure 24: Weighted results as single score in µPt - PRODUCT 10 – Savory biscuits, OPP & Cardboard

Funded by the European Union

This project has received funding from the European Union's Horizon Europe Research and Innovation programme under Grant Agreement No 101060806. This document reflects the views of the author(s) and does not necessarily reflect the views or policy of the European Commission. Whilst efforts have been made to ensure the accuracy and completeness of this document, the European Commission shall not be liable for any errors or omissions, however

7. INTERPRETING PEF RESULTS

7.1. Relevant impact categories

In the previous section, characterized, normalised and weighted results for each EF impact category have been presented together with the single score for each life cycle stage. In this paragraph, the most relevant impact categories will be highlighted. As prescribed in the PEF method, impact categories cumulatively contributing at least 80% of the total environmental impact will be identified for each product based on the normalised and weighted results.

Below, for each product, a table is provided in which most relevant impact categories are ranked in descending order of impact on the total life cycle.

PRODUCT 01 – Florette Shaker, PET Cup

Tab 14. Most relevant impact categories PRODUCT 01 – Florette Shaker, PET Cup

Label	**Total (µPt)**	**%**
Resource use, fossils	1.46	27.9%
Climate change	1.41	26.9%
Resource use, minerals and metals	0.59	11.3%
Particulate matter	0.26	5.0%
Ecotoxicity, freshwater	0.25	4.9%
Ozone depletion	0.24	4.5%
Sum		**80.5%**

PRODUCT 02 – Salad MDD, PET Tray

Tab 15. Most relevant impact categories - PRODUCT 02 – Salad MDD, PET Tray

Label	**Total (µPt)**	**%**
Resource use, fossils	3.56	28.0%
Climate change	3.41	26.9%
Resource use, minerals and metals	1.43	11.3%
Particulate matter	0.63	5.0%
Ecotoxicity, freshwater	0.62	4.9%
Ozone depletion	0.57	4.5%
Sum		**80.4%**

PRODUCT 03 – Sour cream, Cup

Tab 16. Most relevant impact categories - PRODUCT 03 – Sour cream, Cup

Label	**Total (µPt)**	**%**
Resource use, fossils	1.48	32.1%
Climate change	1.30	28.0%
Resource use, minerals and metals	0.39	8.5%
Particulate matter	0.32	6.8%
Ecotoxicity, freshwater	0.20	4.2%
Sum		**79.6%**

Funded by the European Union

This project has received funding from the European Union's Horizon Europe Research and Innovation programme under Grant Agreement No 101060806. This document reflects the views of the author(s) and does not necessarily reflect the views or policy of the European Commission. Whilst efforts have been made to ensure the accuracy and completeness of this document, the European Commission shall not be liable for any errors or omissions, however

PRODUCT 04 – Greek yoghurt, Cup

Tab 17. Most relevant impact categories - PRODUCT 04 – Greek yoghurt, Cup

Label	Total (µPt)	%
Resource use, fossils	2.43	32.3%
Climate change	2.11	28.0%
Resource use, minerals and metals	0.64	8.4%
Particulate matter	0.50	6.7%
Ecotoxicity, freshwater	0.31	4.2%
Sum		**79.6%**

PRODUCT 05 – Pork chop, Wrapped Tray

Tab 18. Most relevant impact categories - PRODUCT 05 – Pork chop, Wrapped Tray

Label	Total (µPt)	%
Climate change	1.92	32.5%
Resource use, fossils	1.89	31.8%
Photochemical ozone formation	0.33	5.6%
Particulate matter	0.33	5.6%
Water use	0.31	5.2%
Sum		**80.8%**

PRODUCT 06 – Florette Mache, OPP Film

Tab 19. Most relevant impact categories - PRODUCT 06 – Florette Mache, OPP Film

Label	Total (µPt)	%
Resource use, fossils	0.69	36.2%
Climate change	0.56	29.6%
Particulate matter	0.10	5.4%
Resource use, minerals and metals	0.09	4.8%
Water use	0.08	4.1%
Sum		**80.03%**

PRODUCT 07 – Butter, Aluminium, & OPP Film

Tab 20. Most relevant impact categories - PRODUCT 07 – Butter, Aluminium, & OPP Film

Label	Total (µPt)	%
Resource use, fossils	0.32	27.6%
Climate change	0.30	25.5%
Particulate matter	0.15	12.8%
Resource use, minerals and metals	0.09	7.9%
Acidification	0.06	4.9%
Eutrophication, freshwater	0.05	4.2%
Sum		**82.9%**

Funded by the European Union

This project has received funding from the European Union's Horizon Europe Research and Innovation programme under Grant Agreement No 101060806. This document reflects the views of the author(s) and does not necessarily reflect the views or policy of the European Commission. Whilst efforts have been made to ensure the accuracy and completeness of this document, the European Commission shall not be liable for any errors or omissions, however

PRODUCT 08 – Grated cheese, OPA & LDPE Film

Tab 21. Most relevant impact categories - PRODUCT 07 – Butter, Aluminium, & OPP Film

Label	**Total (µPt)**	**%**
Climate change	0.86	34.1%
Resource use, fossils	0.63	24.9%
Resource use, minerals and metals	0.23	8.9%
Particulate matter	0.17	6.8%
Acidification	0.12	4.6%
Sum		**79.3%**

PRODUCT 09 – Peanut curl, OPP Film

Tab 22. Most relevant impact categories - PRODUCT 09 – Peanut curl, OPP Film

Label	**Total (µPt)**	**%**
Resource use, fossils	0.64	35.5%
Climate change	0.55	30.6%
Particulate matter	0.10	5.4%
Resource use, minerals and metals	0.09	4.7%
Water use	0.07	4.0%
Sum		**80.3%**

PRODUCT 10 – Savory biscuits, OPP & Cardboard

Tab 23. Most relevant impact categories - PRODUCT 10 – Savory biscuits, OPP & Cardboard

Label	**Total (µPt)**	**%**
Climate change	1.34	26.6%
Resource use, fossils	1.01	20.0%
Particulate matter	0.81	16.0%
Eutrophication, freshwater	0.33	6.5%
Acidification	0.26	5.1%
Land use	0.26	5.1%
Sum		**79.3%**

Funded by the European Union

This project has received funding from the European Union's Horizon Europe Research and Innovation programme under Grant Agreement No 101060806. This document reflects the views of the author(s) and does not necessarily reflect the views or policy of the European Commission. Whilst efforts have been made to ensure the accuracy and completeness of this document, the European Commission shall not be liable for any errors or omissions, however

7.2. Relevant impact categories overview and comments

IMPACT CATEGORIES OVERVIEW

The graphic below (Fig.25) groups the impacts of all the products into the consistent impact categories, presented as percentage contribution (Tab. 14-23).
From this graphic it is possible to highlight that, for all 10 products analysed, the two most relevant impact categories are climate change and fossil resources use. These results mainly derive from the extensive use of fossil-based polymeric materials in the manufacturing of the analysed packaging. In the end-of-life phase, the incineration and landfill processes, whose impact is included in the calculation, strongly impact climate change.The relative differences among the products, within the same impact categories, are mainly due to the type of constituent polymeric materials and the impact of their production process.

Funded by the European Union

This project has received funding from the European Union's Horizon Europe Research and Innovation programme under Grant Agreement No 101060806. This document reflects the views of the author(s) and does not necessarily reflect the views or policy of the European Commission. Whilst efforts have been made to ensure the accuracy and completeness of this document, the European Commission shall not be liable for any errors or omissions, however

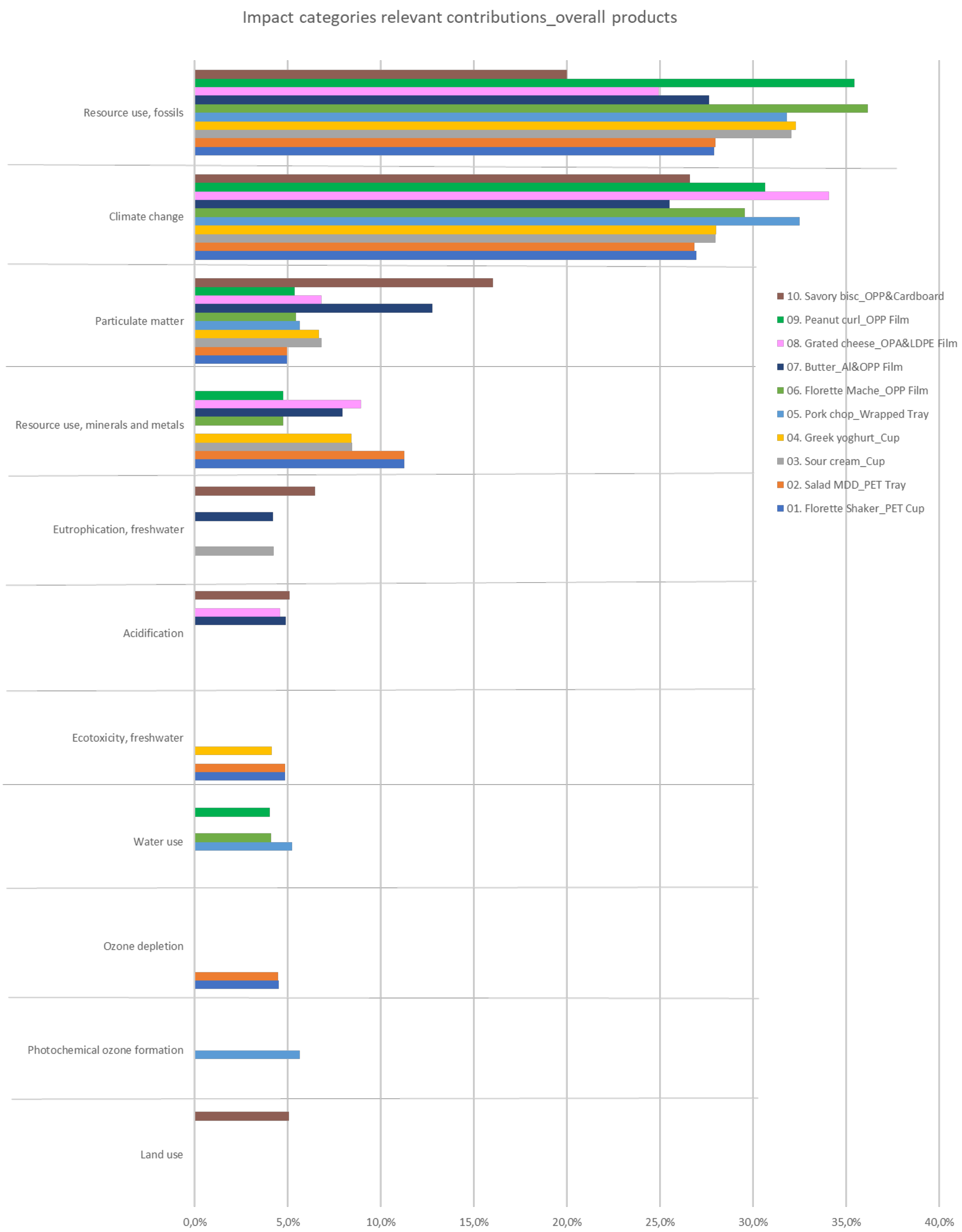


Figure 25: Impact categories relevant contributions on overall products

Funded by the European Union

This project has received funding from the European Union's Horizon Europe Research and Innovation programme under Grant Agreement No 101060806. This document reflects the views of the author(s) and does not necessarily reflect the views or policy of the European Commission. Whilst efforts have been made to ensure the accuracy and completeness of this document, the European Commission shall not be liable for any errors or omissions, however

8. ANNEXES

8.1. Annex I: Data collection

PRODUCT 01 – Florette Shaker, PET Cup

Name of the product	***Floréale*** *Prepared fruits – PET cup*		
Packaging capacity	*400 ml*		
PRODUCT COMPOSITION - INBOUND OF RAW MATERIALS			
	Commercial name of the product (Material Data Sheet)	Weight (g)	Process technology
PACKAGING BODY			
Shaker PET	Polyethylene terephtalate	*11,6*	*Thermoforming*
PET foil lid	Polyethylene terephtalate	*0,8*	Extrusion
Packaging production technology	*Thermoformed shaker*	12,4	

Image

Brief description: Preformed PET shaker, heat sealed with a thin PET foil lid

PRODUCT 02 – Salad MDD, PET Tray

Name of the product	***LSDH*** *Prepared salad – PET tray*		
Packaging capacity	*250 g*		
PRODUCT COMPOSITION - INBOUND OF RAW MATERIALS			
	Commercial name of the product (Material Data Sheet)	Weight (g)	Process technology
PACKAGING BODY			
(Bowl) Tray 192 mm x 192 x 53	PET	*20*	*thermoforming*
Lid	PET	*10*	*thermoforming*
		30	
Packaging production technology	*Manual filling (in line by operators), chilled*		

Image

Funded by the European Union

This project has received funding from the European Union's Horizon Europe Research and Innovation programme under Grant Agreement No 101060806. This document reflects the views of the author(s) and does not necessarily reflect the views or policy of the European Commission. Whilst efforts have been made to ensure the accuracy and completeness of this document, the European Commission shall not be liable for any errors or omissions, however

PRODUCT 03 – Sour cream, Cup

Name of the product	*Yoghurt – PP cup*		
Packaging capacity	*201g*		
PRODUCT COMPOSITION - INBOUND OF RAW MATERIALS			
	Commercial name of the product (Material Data Sheet)	**Weight (g)**	**Process technology**
PACKAGING BODY			
Cup	*PP*	*8,5*	*thermoforming*
Lid	*Aluminium*	*0,81*	
Overcap	*PET*	*3,05*	*thermoforming*
Packaging production technology	*Preformed cup*	12,36	

Image

PRODUCT 04 – Greek yoghurt, Cup

Name of the product	*Yoghurt – Cup with lid and over*		
Packaging capacity	*450g*		
PRODUCT COMPOSITION - INBOUND OF RAW MATERIALS			
	Commercial name of the product (Material Data Sheet)	**Weight (g)**	**Process technology**
PACKAGING BODY			
Cup	*PP*	*14*	*thermoforming*
Lid	*Aluminum*	*1,25*	
Overcap	*PET*	*5*	*thermoforming*
Packaging production technology	*Preformed cup*	20,25	

Image

Funded by the European Union

This project has received funding from the European Union's Horizon Europe Research and Innovation programme under Grant Agreement No 101060806. This document reflects the views of the author(s) and does not necessarily reflect the views or policy of the European Commission. Whilst efforts have been made to ensure the accuracy and completeness of this document, the European Commission shall not be liable for any errors or omissions, however

PRODUCT 05 – Pork chop, Wrapped Tray

Name of the product	*In shop – PSE Tray*		
Packaging capacity	*500 g*		
PRODUCT COMPOSITION - INBOUND OF RAW MATERIALS			
	Commercial name of the product (Material Data Sheet)	Weight (g)	Process technology
PACKAGING BODY			
Tray (5.2)	EPS	*10,9*	*Sheet extrusion and thermoforming + (foaming)*
Wrapping film (5.1)	PVC	*2,9*	Bubble extrusion
Packaging production technology		13,8	

Image

PRODUCT 06 – Florette Mache, OPP Film

Name of the product	***Floréale*** *Bagged salad – OPP film*		
Packaging capacity	*125g*		
PRODUCT COMPOSITION - INBOUND OF RAW MATERIALS			
	Commercial name of the product (Material Data Sheet)	Weight (g)	Process technology
PACKAGING BODY			
OPP film 15 µm – 13,7g/m²	OPP	*2,19*	*Extrusion*
Adhesive 2g/m²	Polyurethane adhesive	*0,32*	
Ink 1g/m²	Printing ink	0,16	Printing
OPP film 20µm 18,2g/m²	OPP	2,91	Extrusion
Packaging production technology	*Vertical Flowpack*	5,58	

Image

Brief description:
Bioriented Polypropylene bag, made of two plastic layers with the printing in between

Funded by the European Union

This project has received funding from the European Union's Horizon Europe Research and Innovation programme under Grant Agreement No 101060806. This document reflects the views of the author(s) and does not necessarily reflect the views or policy of the European Commission. Whilst efforts have been made to ensure the accuracy and completeness of this document, the European Commission shall not be liable for any errors or omissions, however

PRODUCT 07 – Butter, Aluminium, & OPP Film

Name of the product	*Butter – Aluminium & OPP film*		
Packaging capacity	*250g*		
PRODUCT COMPOSITION - INBOUND OF RAW MATERIALS			
	Commercial name of the product (Material Data Sheet)	Weight (g)	Process technology
PACKAGING BODY			
Aluminium	*Aluminium*	*0,67*	
Polypropylène	*Polypropylène*	*1,28*	
		1,95	
Packaging production technology	*Gluing between Alu/OPP*		

Image

PRODUCT 08 – Grated cheese, OPA & LDPE Film

Name of the product	***Entremont (Sodiaal)*** *Cheese – OPA & LDPE film*		
Packaging capacity	*180g*		
PRODUCT COMPOSITION - INBOUND OF RAW MATERIALS			
	Commercial name of the product (Material Data Sheet)	Weight (g)	Process technology
PACKAGING BODY			
Oriented Polyamid (17 g/m2)	Oriented Polyamid	*1,3*	*Extrusion*
Ink	Ink	*0,11*	Gravure Printing
Adhesive	Adhesive	*0,15*	Complexing
Polyethylene (50 g/m2)	Polyethylene	*3,5*	Extrusion
		5,06	
Packaging production technology	*Complexing*		

Image

PRODUCT 09 – Peanut curl, OPP Film

Funded by the European Union

This project has received funding from the European Union's Horizon Europe Research and Innovation programme under Grant Agreement No 101060806. This document reflects the views of the author(s) and does not necessarily reflect the views or policy of the European Commission. Whilst efforts have been made to ensure the accuracy and completeness of this document, the European Commission shall not be liable for any errors or omissions, however

Name of the product	*Altho Chips – pouch bag - OPP film*		
Packaging capacity	*125g*		
PRODUCT COMPOSITION - INBOUND OF RAW MATERIALS			
	Commercial name of the product (Material Data Sheet)	Weight (g)	Process technology
PACKAGING BODY			
OPPmat20	*Oriented Polypropilene*	*2,16*	*Extrusion*
Metallization		*0,0032*	*Metallization*
Adhesive		*0,296*	*Curing*
Printing – Inks		*0,414*	*Flexography / Helioprinting*
OPPmet25	*Oriented Polypropilene*	*2,7*	*Extrusion*
Varnish (Optional)			
Packaging production technology	*Lamination*	5,5732	

Image

Brief description: flat film size: 395 mm x 300mm (grammage 47 g/m2)

PRODUCT 10 – Savory biscuits, OPP & Cardboard

Name of the product	*Savory biscuits – OPP bags + cardboard*		
Packaging capacity	*Most common 85g (Min 85g/Max105g)*		
PRODUCT COMPOSITION - INBOUND OF RAW MATERIALS			
	Commercial name of the product (Material Data Sheet)	Weight (g)	Process technology
PACKAGING BODY			
Bag (Width 355mm / Length 180mm)	*Coex Gloss OPP 15µm*	*0,798525*	*Extrusion*
Bag (Width 355mm / Length 180mm)	*Coex Metallized OPP 15µm*	*0,792675*	
Bag (Width 355mm / Length 180mm)	*Metallization*	*0,0117*	
Bag (Width 355mm / Length 180mm)	*Adhesive*	*0,14625*	
		1,74915	
Cardboard box	*Hermicoat GD2 95% recycled 340gsm*	*23,51*	*Flat cut*
Cardboard box	*Ink*	*0,11*	
Cardboard box	*Acrylic varnish*	*0,34*	
Cardboard box	*Glue*	*0,04*	
		24,00	
Packaging production technology	*Lamination (bag)*	25,75	

Image

Brief description: 15 OPP/15 OPPmet bags
One supplier only : India
No printing on the bag
Printing on the box :
Offset printing
5-6 colors + acrylic varnish

Funded by the European Union

This project has received funding from the European Union's Horizon Europe Research and Innovation programme under Grant Agreement No 101060806. This document reflects the views of the author(s) and does not necessarily reflect the views or policy of the European Commission. Whilst efforts have been made to ensure the accuracy and completeness of this document, the European Commission shall not be liable for any errors or omissions, however

References

COMMISSION RECOMMENDATION (EU) 2021/2279 of 15 December 2021 on the use of the Environmental Footprint methods to measure and communicate the life cycle environmental performance of products and organisations. Available in: https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32021H2279

Wolf, M. A., The Circular Footprint Formula (CFF) and its practical application training. Environmental Footprint (EF) transition phase, 2019. Webinar available in: https://ec.europa.eu/environment/eussd/videos/2019-10-08%2016.01%20The%20Circular%20Footprint%20Formula.mp4

Zampori, L. and Pant, R., Suggestions for updating the Product Environmental Footprint (PEF) method, EUR 29682 EN, Publications Office of the European Union, Luxembourg, 2019, ISBN 978-92-76- 00654-1, doi:10.2760/424613, JRC11595. Available in : https://publications.jrc.ec.europa.eu/repository/handle/JRC115959

Funded by the European Union

This project has received funding from the European Union's Horizon Europe Research and Innovation programme under Grant Agreement No 101060806. This document reflects the views of the author(s) and does not necessarily reflect the views or policy of the European Commission. Whilst efforts have been made to ensure the accuracy and completeness of this document, the European Commission shall not be liable for any errors or omissions, however