South Pole **Life Cycle Assessment**

Life Cycle Assessment of Lazer Sport's helmets

U101 & U103

External report

March 2024

south pole
The Climate Company

Details

Prepared for:

Fé van Dam, Product developer

Lazer Sport

Oude baan 3b
2800 Mechelen - Belgium
www.lazersport.com

Prepared by:

South Pole

Project Manager:

Miora Frossard
Associate Consultant
m.frossard@southpole.com

Project Leader:

Leen Labeeuw
Managing Consultant
l.labeeuw@southpole.com

Contact person:

Miora Frossard
Associate Consultant
m.frossard@southpole.com

Table of contents

List of tables

List of figures

Acronyms and abbreviations

ABS	Acrylonitrile butadiene styrene
BE	Belgium
CFC	Chlorofluorocarbon
CH_4	Methane
CN	China
CO_2	Carbon Dioxide
CTU	Comparative Toxic Units
DE	Germany
DK	Denmark
DQI	Data Quality Indicators
EF	Environmental Footprint
EOL	End-of-Life
EPS	Expanded polystyrene
FFP	Fossil Fuel Potential
FU	Functional Unit
GHG	Greenhouse Gas
GLO	Global
GWP	Global Warming Potential
HTP	Human Toxicity Potential
ILCD	International Reference Life Cycle Data System
IN	India
ISO	International Organization for Standardization
kg	Kilogram
km	kilometre
kWh	kilowatt hour
LCA	Life Cycle Assessment
LCI	Life Cycle Inventory
LCIA	Life Cycle Impact Assessment
LDPE	Low density polyethylene
LOP	Land Occupation Potential
LUC	Land-Use Change
m^2	Square Meter
m^3	Cubic Meter
MJ	Megajoule
NL	Netherlands
NO_2	Nitrogen Dioxide
ODP	Ozone Depletion Potential
PA6	Polyamide 6
PC	Polycarbonate
PE	Polyethylene
PEF	Product Environmental Footprint
PEFCR	Product Environmental Footprint Category Rules
PM2.5	Particulate Matter with a diameter of 2.5 micrometres
POM	Polyoxymethylene
PP	Polypropylene
PPP	Polluter Pays Principle
PT	Portugal
PU	Polyurethane
PVC	Polyvinyl chloride
RER	Europe
ROW	Rest of the World
SO_2	Sulphur Dioxide
TPR	Thermoplastic rubber
UK	United Kingdom
US	United States

Executive summary

A comprehensive cradle-to-grave Life Cycle Assessment (LCA) study has been performed on two helmets. The intended audience for this LCA are a wide range of internal stakeholders at Lazer Sport including process engineers, research and development scientists, and marketing teams.

This LCA report adheres to the guidelines set by ISO 14044: 2006 following each of the four main phases of LCA - goal definition, scope definition, inventory analysis, impact assessment, and interpretation. GaBi software version 10.7, ecoinvent 3.9 (Wernet, et al., 2016), Sphera and PlasticsEurope databases were used in constructing the LCA model, and the environmental impacts were evaluated using the EF3.1 (Environmental Footprint) impact assessment method.

The study sets out to achieve three primary objectives:

- Compare two helmets sold by Lazer Sport: U101 (One+ MIPS) M size and U103 (Verde Kineticore) M/L size, identifying any environmental impact differences between them
- Highlight key contributions to environmental impacts (hotspots) throughout the products life cycles and components
- Pinpoint potential areas within the examined system for improvement that merit further investigation.

The helmets under study have a similar composition, primarily composed of plastic components. However, the U103 is a new helmet which is not on the market yet, designed to have a lower environmental footprint. It uses recycled materials and is produced in Portugal, while the U101 is made of virgin materials and is manufactured in China. Additionally, the U103 is designed to be easily disassembled to make it recyclable.

Key insights from this study reveal significant variations between both helmets. The U101 exhibits the highest overall environmental impacts, primarily driven by the raw material acquisition and manufacturing stages. Therefore, the results of the study support using recycled materials and producing the helmets in Europe (or reducing the carbon intensity of the electricity mix) as actions to reduce the environmental footprint over the life cycle stage. Allowing the disassembly of the helmets and therefore their recycling also reduces the impacts on climate change at the end-of-life of the helmets.

Lazer Sport has already made significant efforts with the conception of U103, but there are further opportunities for improvement. Based on the study's findings, several recommendations to further improve Lazer Sport's helmets environmental performance have been proposed:

- Switching to recycled materials, as it was done for the U103;
- Including less components and less production processes when designing the helmets, as it was done for the U103;
- Switching to green electricity and/or improving energy efficiency of the processes;
- Implemented a waste collection and recycling system for the helmets at their end-of-life;
- Performing in-depth studies to evaluate accurately the hotspots of the main components of the helmets.

Through the implementation of these strategies, Lazer Sport can continually evolve its commitment to sustainable manufacturing.

1. Introduction

1.1 Overview and context

'Founded in 1919, Lazer has led the industry in helmet innovation, design, protection, and technology. A century of heritage, experience and passion means our helmets are some of the most advanced, lightweight, stylish, and well-ventilated on the market. As a company, we're constantly striving to forge new paths and disrupt the standard way of thinking. All our products are designed in Belgium and are available for every cyclist, based on the principle of universality, yet we've never forgotten our roots – we still ride our products over cobbled country roads, and we're still reaching to new heights to innovate, improve and create what we would want to use ourselves.

Our research and design facilities are located at the heart of Europe and one of the greatest cycling nations of the world - Belgium. It's here that our engineers take full advantage of our in-house wind tunnel, drop test and 3D printing facilities to develop our helmets.

We take pride in our rapid, creative R&D process. It is the cornerstone of our design principles, and vital to making Lazer the innovative and agile company it is today'. (Lazer Sport, 2023)

South Pole has previously performed two LCA studies on Lazer Sport's helmets LZB-27 and LZB-29. As a second step, South Pole had performed two new LCAs on different helmets (U101 and U103), conducted according to the requirements of the ISO 14040: 2006 and ISO 14044:2006 standards.

One of the helmets (U103) is a new product developed by Lazer Sport and will be released on the market in April 2024. Recycled materials are used for the main components, and less pieces compose the helmet, as part of a wider initiative of reducing the environmental footprint of the product.

The LCA study has been modelled in GaBi software version 10.7, using the ecoinvent 3.9.1 and Sphera databases (Wernet, et al., 2016) and EF3.1 impact assessment method. This study is not fully in compliance with PEF from the European Commission (PEFCR Guidance document, - Guidance for the development of Product Environmental Footprint Category Rules (PEFCRs)), but this study references the PEF for certain default values.

1.2 LCA methodology

The LCA methodology has been developed to understand better and address the potential impacts associated with certain products or services throughout their life cycle.

An LCA addresses the environmental aspects and potential impacts throughout a products life cycle, from raw materials acquisition through production, use, until end-of-life (EoL) treatment, recycling and final disposal. An LCA is based on a well-defined functional unit, allowing for direct comparisons among competing products or systems and alternate forms of the same product or system.

The LCA serves various purposes, including:

- Identifying opportunities to improve the environmental performance of products at various points in their life cycle. This information can guide decision-making processes, strategic planning, priority setting, and product or process design.
- Informing the selection of environmental performance indicators and measurement methods.

- Supporting marketing efforts by providing quantitative data on environmental performance.
- Guiding policy making and regulation

The principles, framework, requirements, and guidelines to perform an LCA are described by the international standards ISO 14040: 2006 and ISO 14044: 2006.

LCA comprises four phases (Figure 1):

- **Goal and scope definition**: defining the purposes of the study, determining the boundaries of the system life cycle under study, and identifying important assumptions that will be made.
- **Life cycle inventory (LCI)** analysis: compiling a complete record of the relevant material and energy flows throughout the life cycle, in addition to any release of pollutants and other environmental aspects being studied
- **Life cycle impact assessment (LCIA)**: using the inventory compiled in the previous stage to create a clear and concise picture of environmental impacts across a limited set of understandable impact categories, and
- **Interpretation**: identifying the meaning of the results of the inventory and impact assessment relative to the study's goal.

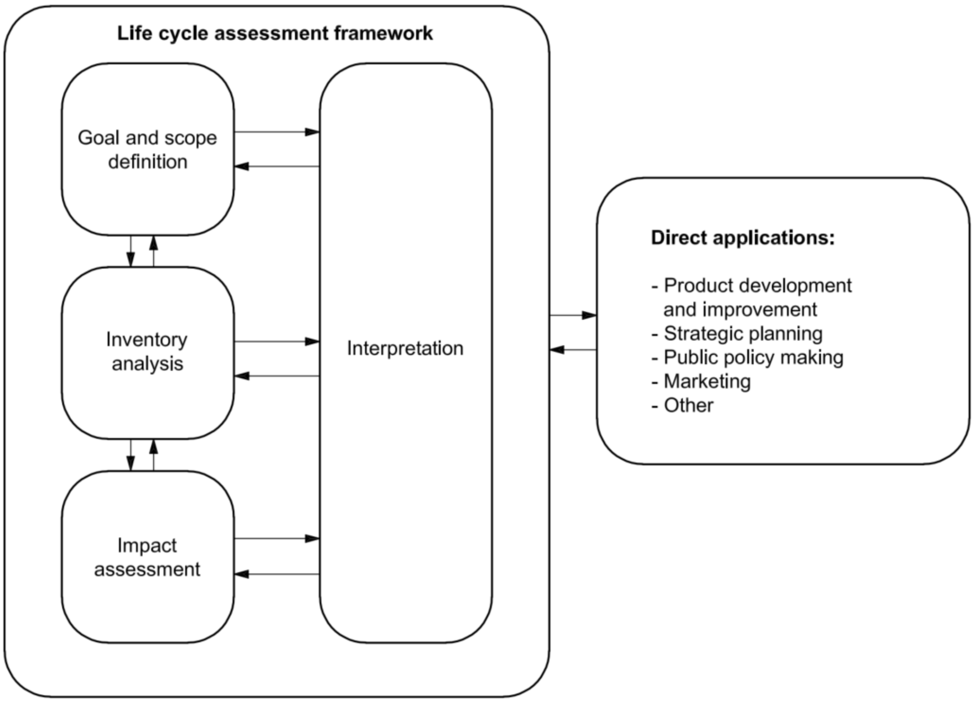


Figure 1. The four phases of LCA as defined by ISO 14040

2. Goal and Scope of the study

2.1 Goal of the study

The goal of this study was to formulate environmental profiles for two Lazer Sport's helmets, across their entire life cycles for the markets where they are sold.

This LCA study will allow Lazer Sport to identify the relative contribution to the environmental impact of all processes of the product systems under investigation.

The primary objectives of this study are to:

- Highlight key contributions to environmental impacts (hotspots) throughout the products life cycles
- Pinpoint potential areas within the examined system for improvement that merit further investigation
- Compare both helmets and the influence of the use of recycled materials and different production processes and supply chain
- Support marketing teams in communicating on the improvements made.

The envisioned applications of this comprehensive comparison of processes are to:

- Understand the environmental opportunities and risks associated with the helmets manufacturing
- Guide opportunities for reducing environmental impact
- Shape Lazer Sport's environmental policy towards improvements in product design
- Facilitate internal communication and offer internal stakeholders a clear view regarding the comparative environmental performance of these production methods

The intended audiences are a wide range of Lazer Sport's internal stakeholders, including product developers, research and development scientists and marketing teams. A third-party review was conducted by Amandine Vincenot and Béranger Hoppenot from the LCIE Bureau Veritas – CODDE department. This allows Lazer Sport to communicate externally about the results.

2.2 Scope of the study

2.2.1 Products under study

The helmets under study differ from their composition, as U103 uses recycled materials and U101 only virgin materials. The products under study are presented in Table 1.

Table 1. Summary of products under study

Name	Size	Mass (g)	Main Production Location	Main Materials
U101 (One+ MIPS)	M	517	China	EPS, ABS, PA, POM Virgin materials
U103 (Verde Kineticore)	Unisize M/L	495	Portugal	EPS, PC, PA, POM Including recycled content

The processes are conducted in different factories. All components of the U101 are produced in China, where final assembly also takes place. Most components of the U103 are produced in Portugal where it is also assembled, and most raw materials are sourced in Europe, with only a few components produced in China. From the final factories, the helmets are distributed to the global market. The product systems are described in more detail in Section 3.1. Another difference is the fact that U103 can be disassembled by the user to allow the separation of the components to recycle them.

2.2.2 Function and functional unit

The function of the helmets, produced by Lazer Sport, is to protect bike users. All helmets are designed with an expected lifespan of 2 years, based on health and safety reasons. The performance of the helmets should be that they can protect the user from a shock of maximum 250G to the head at a speed of 6.5 m/s on a flat anvil and 5.42m/s on a kerb anvil.

The functional unit describes the function provided by the product system and serves as a basis of comparison across systems. The functional unit for this LCA study is defined as:

The manufacturing, distribution, use and disposal of one helmet designed for use over a period of 2 years, protecting the user from a shock of maximum 250G to the head at a speed of 6.5 m/s on a flat anvil and 5.42m/s on a kerb anvil. This encompasses the entire lifecycle from cradle-to-grave.

The geographical coverage encompasses the consumer base of the products across these distinct markets: Europe, America, Asia and Middle East. The temporal boundary for the production data collection is for the year 2023, while market distribution data provided by Lazer Sport is from 2022.

2.2.3 System boundaries

The system boundary for each product system of this LCA study is cradle-to-grave, which includes: raw material acquisition, upstream transportation, manufacturing, finishing, packaging, distribution, use, end-of-life and waste stages associated with the waste from the manufacturing of the products. This boundary allows for all life cycle impacts to be captured.

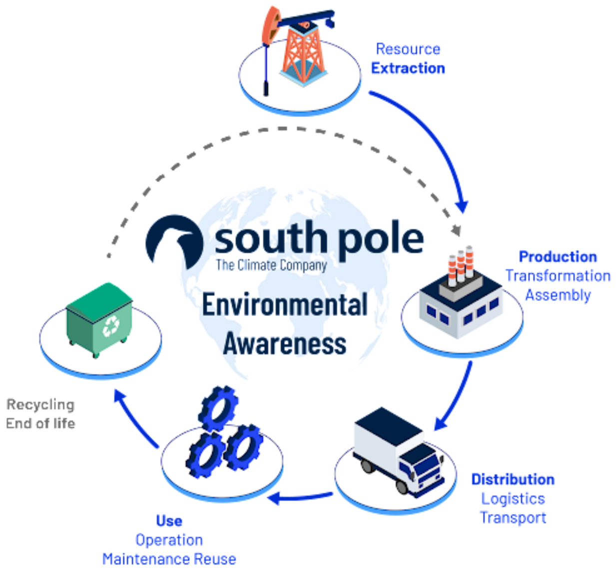


Figure 2. Cradle-to-grave, life cycle stages

No maintenance activities are required during the use phase of the products: consequently, it is believed that there are no additional emissions or environmental impacts occurring during the use phase of the product's lifecycle. Therefore, the environmental impacts associated with the use of the products are not considered in this study.

The cradle-to-grave stages for each of the products are described in Figure 3 and Figure 4. The U101 is assembled by the main supplier Supplier A, in China, with components and materials purchased from other suppliers in China. The U103 is assembled by Supplier B in Portugal, with components purchased from Portugal, Netherlands and China.

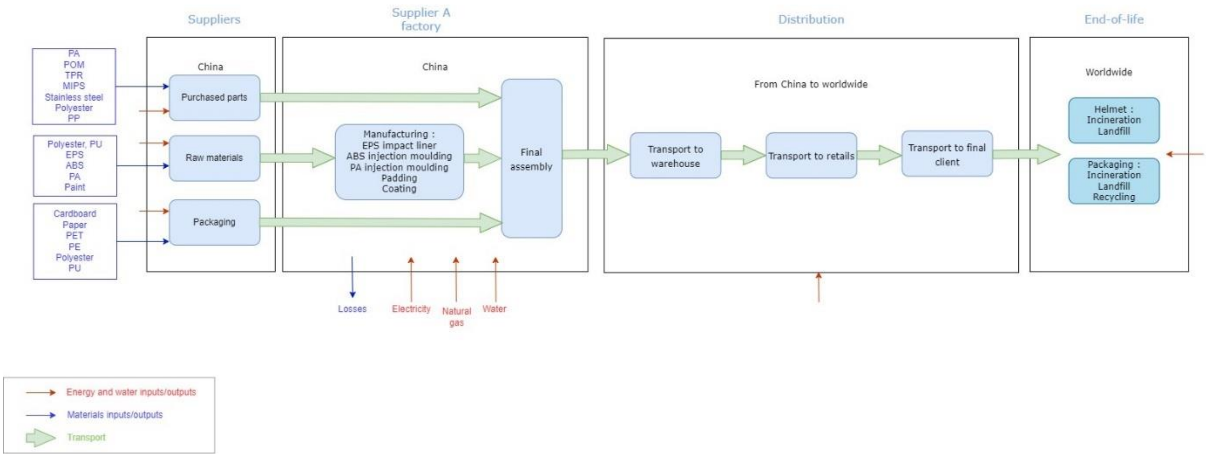


Figure 3. The process flow diagram for the product systems – U101 (cradle-to-grave)

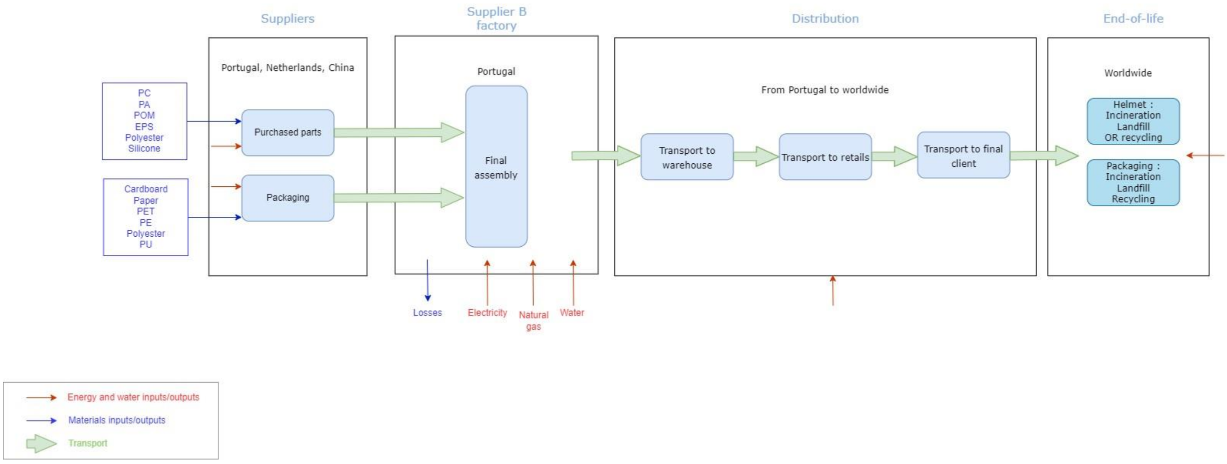


Figure 4. The process flow diagram for the product systems – U103 (cradle-to-grave)

The process flow diagrams for these product systems are illustrated in Figure 5 and Figure 6, detailing the cradle-to-gate steps.

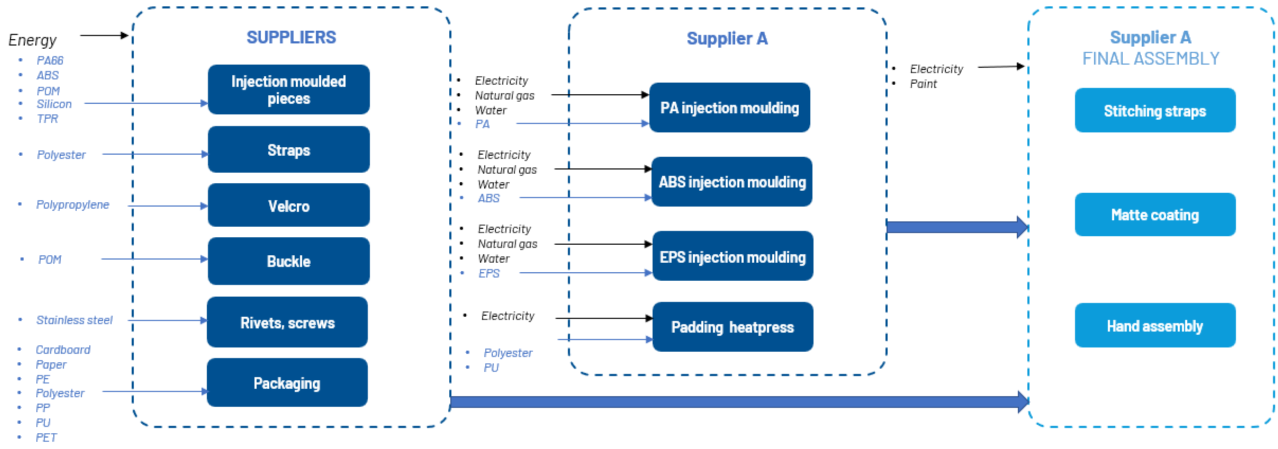


Figure 5. The process flow diagram for the product systems – U101 (cradle-to-gate)

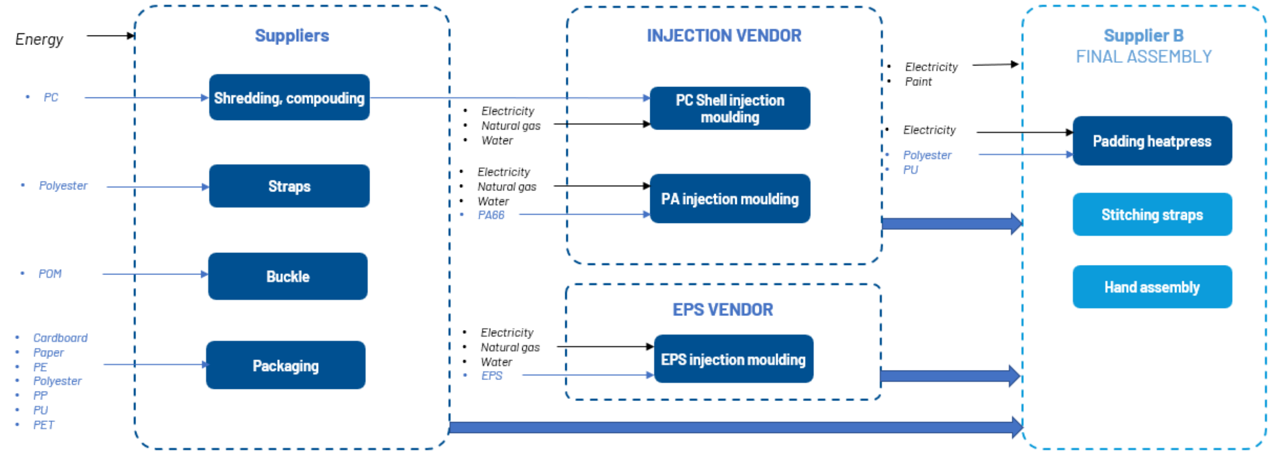


Figure 6. The process flow diagram for the product systems – U103 (cradle-to-gate)

2.2.4 Cut-off criteria and general exclusions

In the process of building a Life Cycle Inventory (LCI), according to the ISO 14044:2006, certain inputs and outputs may be excluded based on cut-off criteria. These criteria are established on the principles of mass, energy, and environmental significance. As per the ISO standards, these parameters should be applied as follows:

a) Mass: an appropriate decision, when using mass as a criterion, would require the inclusion in the study of all inputs that cumulatively contribute more than a defined percentage to the mass input of the product system being modelled.
b) Energy: similarly, an appropriate decision, when using energy as a criterion, would require the inclusion in the study of those inputs that cumulatively contribute more than a defined percentage of the product systems energy inputs.
c) Environmental significance: decisions on cut-off criteria should be made to include inputs that contribute more than an additional defined amount of the estimated quantity of individual data of the product system that are specially selected because of environmental relevance.

If an item meets one of the criteria but is expected to be significant to one of the other criteria it may not be neglected. For example, if a substance is small in mass but is expected to have a notable contribution to the environmental results, then it may not be excluded. For this study, an exclusion threshold of 5% has been adopted.

Processes that were omitted from the scope of the study include the following:

- Human energy inputs to processes.
- Production and disposal of infrastructures. Infrastructures include machines, transport vehicles, roads, etc., as well as their maintenance.
- Transport of employees to and from their normal place of work and business travel.
- Environmental impacts associated with support functions (e.g., R&D, product scanning, marketing, finance, software, management, etc.)

Any further specific exclusions are defined in the LCI in section 3.3.

2.2.5 Data quality requirements

The general data quality requirements and characteristics that need to be addressed in this study are shown in Table 2.

Time-related coverage, geographical coverage, technology coverage, completeness and representativeness were assessed through data quality indicators, described in section 2.2.6.

Table 2. Data quality requirements based on ISO 14044 (source: ISO 14044)

Aspect	Description from ISO	Application in this study
Time-related coverage	age of data and the minimum length of time over which data should be collected	General data must be representative of the year 2023. All data used will be less than 10 years old.
Geographical coverage	geographical area from which data for unit processes should be collected to satisfy the goal of the study	Data must be representative of the manufacturing and use locations included in the study (China, Portugal and Netherlands).
Technology coverage	specific technology or technology mix	Data must be representative of the processes used in the suppliers' factories: injection moulding, silkscreening, etc.
Precision	measure of the variability of the data values for each data expressed (e.g. variance)	Data used must be as representative as possible. A sensitivity analysis is conducted to assess the influence of the end-of-life scenario on total environmental impacts of the U103 helmet.
Completeness	percentage of flow that is measured or estimated	Specific data must be benchmarked with literature data, and simple validation checks (e.g., mass or energy balances) must be performed.
Representativeness	qualitative assessment of the degree to which the data set reflects the true population of interest (i.e. geographical coverage, time period and technology coverage)	The data used in the study must fulfil the defined time-related, geographical, and technological scopes.
Consistency	qualitative assessment of whether the study methodology is applied uniformly to the various components of the analysis	The study methodology must be consistently applied to all components of both helmets to ensure reliable and consistent results.
Reproducibility	qualitative assessment of the extent to which information about the methodology and data values would allow an independent practitioner to reproduce the results reported in the study	Information about the methodology and data, including reference sources, must be provided to enable independent practitioners to reproduce the study results.
Source of the data	assessment of the data sources used	Data must be derived from credible sources, and references must be provided to ensure transparency and reliability.
Uncertainty of the information	e.g. data, models, assumptions	A sensitivity analysis must be conducted to assess the impact of uncertainties in data, models, and assumptions on the study results.

2.2.6 Data quality indicators (DQIs)

In order to ensure data quality, key data parameters underwent rigorous quality checks utilising data quality indicators (DQIs). The application of DQIs to these parameters ensured their suitability for the intended purposes of the study. Each key data parameter was evaluated against a data quality matrix, assigning scores ranging from 1 (indicating the highest quality) to 5 (representing the lowest quality). The data quality matrix employed in this study was adapted from the work of Weidema et al. (2013) and is shown in Table 3. Data quality indicator scores for inventory data are provided in Appendix I.

Table 3. Data quality indicator matrix (adapted from Weidema et al. (2013))

Indicator score	1	2	3	4	5
Reliability of the source	Verified data based on measurements	Verified data partly based on assumptions or unverified data based on measurements	Unverified data partly based on assumptions	Qualified estimate (e.g. by an industrial expert)	Non-qualified estimate
Completeness	Representative data from a sufficient sample of sites over an adequate period to even out normal fluctuations	Representative data from a smaller number of sites but for adequate periods	Representative data from an adequate number of sites but shorter periods	Representative data but from a smaller number of sites and shorter periods or incomplete data from an adequate number of sites and periods	Representativeness unknown or incomplete data from a smaller number of sites and/or from shorter periods
Temporal correlation	Less than three years of difference to the year of study	Less than six years of difference	Less than ten years of difference	Less than 15 years of difference	Age of data unknown or more than 15 years of difference
Geographical correlation	Data from the area under study	Average data from a larger area in which the area under study is included	Data from an area with similar production conditions	Data from an area with slightly similar production conditions	Data from an unknown area or area with very different production conditions
Technical correlation	Data from enterprises, processes and materials under study	Data from processes and materials under study but different enterprises	Data from processes and materials under study but different technology	Data on related processes or materials but the same technology	Data on related processes or materials but different technology

2.2.7 Data collection procedures

A combination of quantitative and qualitative primary, secondary, and proxy data was utilised to compile the Life Cycle Inventory (LCI) for all processes within the designated system boundary, except for those conforming to the exclusions detailed in Section 3.3.

Lazer Sport supplied primary data either measured or extrapolated for the year 2023. The data were collected by the suppliers from the different factories. Those primary data included specifics pertaining directly to the product, such as raw material acquisition, upstream transportation, manufacturing, and market distribution for each region. These details include aspects like electricity consumption during process.

Secondary data, used to fill gaps where primary data were unavailable, were gathered from pre-existing sources including previous studies, the Sphera database, ecoinvent 3.9.1, PlasticsEurope, and relevant literature. These data cover aspects such as the distance traversed during the final product distribution to each market and process losses. Proxy data, acting as stand-ins where direct measurements were unfeasible, provided approximations based on correlated variables.

2.2.8 LCIA methodology and type of impact selected

The objective of the LCIA phase, as defined by ISO 14044, is to evaluate the magnitude and significance of the potential environmental impacts throughout the products life cycle. This phase involves applying characterization factors to the LCI data, thereby translating these data into environmental impact results. Multiple LCIA methods exist, each with slightly different characterization factors in terms of coverage, values, and underlying models.

For this particular study, the EF 3.1 LCIA method has been selected, outlined in Table 4.

The EF 3.1 method simplifies LCI results into indicator scores for various impact categories, offering broad coverage of environmental issues. These scores, representing the relative severity of environmental impacts, can be assigned at mid-point or end-point levels. At the mid-point level, impacts are independently scored in their appropriate reference units, such as kg of CO_2 equivalent for greenhouse gas emissions. This method provides direct, measurable impacts and a detailed understanding of environmental interactions. At the end-point level, potential ultimate environmental damages are considered. This includes potential damage to ecosystems, human health, and resources, providing an overall view of environmental impacts. This level is often used for strategic decision-making, focusing on the ultimate effects on human health, biodiversity, and resources, although it contains more uncertainties due to additional modelling steps.

To illustrate the difference, at the mid-point level, the contribution to climate change is measured in $kgCO_2e$, which tells us the amount of greenhouse gas equivalents that are released into the environment. To estimate the potential environmental damage caused by an amount of CO_2e released into the environment, end-point characterisation factors can be applied, and results expressed in terms of damage to ecosystems (species loss), human health (disability-adjusted life years, DALY) or resources (USD). In this study, characterised results are represented at the mid-point stage. The 16 impact categories included in EF3.1 are listed in Table 4.

Table 4. EF 3.1 (Environmental Footprint 3.1) impact category indicators (Quantis, PEFCR apparel and footwear)

Impact Category	Indicator	Unit
Acidification	Accumulated Exceedance	mol of H^+-eq
Climate Change (incl. biogenic, fossil, and land use and land use change)	Radiative forcing as Global Warming Potential (GWP100)	kg CO_2-eq
Ecotoxicity, freshwater (incl. inorganics and organics)	Comparative Toxic Unit for ecosystems	CTUe
Eutrophication, freshwater	Fraction of nutrients reaching freshwater and compartment	kg P-eq.
Eutrophication, marine	Fraction of nutrients reaching marine end and compartment	kg N-eq.
Eutrophication, terrestrial	Accumulated Exceedance	mol of N-eq.
Human toxicity, cancer (incl. inorganics and organics)	Comparative Toxic Unit for Humans	CTUh
Human toxicity, non-cancer (incl. inorganics and organics)	Comparative Toxic Unit for Humans	CTUh
Ionising Radiation	Human exposure efficiency relative to U235	kBq U235-eq.
Land Use	Soil quality index, Biotic production, Erosion resistance, Mechanical filtration, Groundwater replenishment	Pt
Ozone depletion	Ozone Depletion Potential	kg CFC-11-eq
Particulate matter	Impact on Human health	Disease incidences
Photochemical Ozone Formation, human Health	Tropospheric ozone concentration increase	kg NMVOC-eq
Resource use, fossils	Biotic resource depletion	MJ
Resource use, mineral and metals	Abiotic resource depletion	kg Sb-eq
Water use	User deprivation potential	m^3 world equiv.

The human toxicity and ecotoxicity impact categories have a significant level of uncertainty associated with the impact assessment methods used. According to the International Reference Life Cycle Data System (ILCD) Handbook (JRC, 2011), toxicity impact categories should be applied with caution. Santero and Hendry (2016) suggest that alternative tools might currently be more suitable for assessing the toxicity of materials (e.g., REACH), but these categories inclusion in LCAs should be regularly reconsidered as scientific understanding evolves. As a result, the human toxicity related impact categories metrics have been omitted from this study.

2.2.9 Allocation

In cases where there is more than one product in the system being studied, ISO 14044:2006 defines the following procedure for the allocation of material and energy flows and environmental emissions:

a) allocation should be avoided by

1) dividing the unit process to be allocated into two or more sub-processes and collecting the input and output data related to these sub-processes, or

2) expanding the product system to include the additional functions related to the co-products,

b) Where allocation cannot be avoided, the inputs and outputs of the system should be partitioned between its different products or functions in a way that reflects the underlying physical relationships between them; i.e. they should reflect the way in which the inputs and outputs are changed by quantitative changes in the products or functions delivered by the system.

c) Where physical relationships alone cannot be established or used as the basis for allocation, the inputs should be allocated between the products and functions in a way that reflects other relationships between them. For example, input and output data might be allocated between co-products in proportion to the economic value of the products.

In this study, allocation procedures for multi-product processes followed the ISO approach above.

In particular, allocation could not be avoided for some injection moulding processes, where energy consumption was allocated based on the number of pieces (especially for the U101). This shows limitations as energy consumption is different depending on the weight and the shape of a plastic piece, but no accurate data was available.

For secondary data, the main databases used in this study are ecoinvent v3.9 and Sphera database. For the Sphera database, it follows the ISO 14040 series allocation principle for products with multifunctionality. Ecoinvent 3.9.1 database defaults to an economic allocation for most processes with few exceptions, such as for energy, for which allocation is based on exergy (Ecoinvent). The allocation approach of specific ecoinvent modules is documented on their website and method reports[1].

In this study, for all materials, the Polluter Pays Principle (PPP) and the cut-off methodology are employed in all cases of recyclable waste treatment and end-of-life allocation. This means that the full environmental impact should be borne by the generator of the waste until the point when waste is transported to a recycling facility. Consequently, in this study, the environmental impacts of waste recycling aren't taken into account and are presumed to belong to the next product system (Figure 7). For this study, the final products are not assumed to be recycled in the main scenario. Due to the nature and function of the products, they are presumed to be destined for landfill or incineration. However, an alternative scenario is assessed where the U103 is assumed to be entirely recycled.

[1] see www.ecoinvent.org

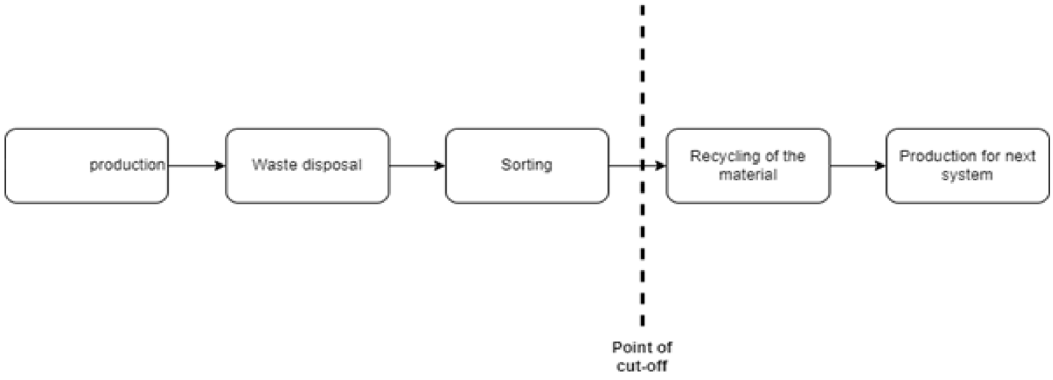


Figure 7. Cut-off methodology following polluter pays principle (PPP) (source: South Pole 2023)

3. Life Cycle Inventory (LCI)

3.1 Description of product system and LCI data

The whole life cycle of the product systems are broken down into major stages, namely: raw materials acquisition, manufacturing, packaging, distribution, and end of life (EoL). The products are manufactured mainly using injection moulding processes. A few additional processes are involved, such as silk screening (see Figure 5 and Figure 6). No significant impacts are assumed to occur during the use phase for this type of product.

In the following sections, the impacts are shown per life cycle step over the whole life cycle, according to the following definitions:

Table 5. Description of each life cycle step

Raw materials extraction	Extraction of the raw materials.
Upstream transportation	Transportation of the raw materials and purchased parts from the suppliers to the factory.
Packaging	Production and transport of the packaging parts.
Manufacturing	Production of the different components of the helmets, final assembly and losses treatment.
Distribution	Transportation of the products from the factory to the final consumers.
End-of-life	EoL treatment of the product and its packaging after use.

3.1.1 Raw materials acquisition stage

Main raw materials:

The core of the helmets is comprised of plastic materials (ABS, PA, EPS, PC). Those materials are synthesised from crude oil, which is extracted, refined, and then polymerized, which are then transformed into granulates that go through injection moulding. Additional components on the helmets are stainless steel screws and rivets, polyester straps or silicone logos.

The U101 helmet is entirely made from virgin materials, while the U103 includes recycled PA, recycled PC and recycled EPS.

Auxiliary materials:

The manufacturing of the helmets involves some auxiliary materials beyond the core inputs, such as paint, ink and glue, which are included in the scope of this study.

The raw materials used for finishing and packaging production are not accounted for in this stage, as they are individually analysed in their respective stages.

Components:

Table 6 and Table 7 show the list of the components for both helmets, their respective material, mass and the number of units required per single helmet.

Table 6. List of components - U101

Component	Mass (g/unit)	Material	Number of units	Manufacturer, location
Hardshell	269	ABS	1	Supplier A, China
Impact Liner	130	EPS	1	Supplier A, China
Snapbaskets Headband	0.27	PA6	3	Supplier A, China
Double snapbasket for hanger	0.16	PA6	2	Supplier A, China
Headband	6	PA6	1	External supplier, China
Snapbasket Mips	0.1	PA6	4	External supplier, China
Turnfitplus Headbasket/Retention System	14.19	PA6	1	External supplier, China
Turnfitplus Ratched/Retention System	1.06	PA6	1	External supplier, China
Turnfitplus Cover Left/Retention System	0.95	PA6	1	External supplier, China
Turnfitplus Cover Right/Retention System	0.95	PA6	1	External supplier, China
Turnfitplus Wheel/Retention System	2	PA6	1	External supplier, China
Hanger Headbasket	2.94	PA6	1	External supplier, China
Block/Retention System	0.1	PA6	1	External supplier, China
Screw/Retention System	0.21	Stainless steel	1	External supplier, China
Strap Divider	1.48	PA6	2	Supplier A, China
Buckle Male Part	2.6	POM	1	External supplier, China
Buckle Female Part	2.3	POM	1	External supplier, China
Strap Rubber Ring Z logo	0.7	silicone	1	External supplier, China
Strap Left	8.5	Polyester	1	External supplier, China

Strap Right	13.5	Polyester	1	External supplier, China
Velcro sticker Ø12 mm	0.1	Polypropylene	10	External supplier, China
Padding	11.7	Polyester and PU foam	1	External supplier, China
Z rivet	2	Stainless steel	8	External supplier, China
MIPS shell	33	PC	1	External supplier, China
MIPS Elastic hanger	0.46	TPR	4	External supplier, China
MIPS snap pin, to assemble hangers to the helmet	0.1	PA66	4	External supplier, China
MIPS hanger protector, protects the hanger from sharp PC edge	0.05	PA66	4	External supplier, China
MIPS holographic label	0.01	PVC	1	External supplier, China

Table 7. List of components - U103

Component	Mass (g/unit)	Material	Number of units	Manufacturer, location
PC outershell	248	PC, 65% recycled content	1	INJECTION VENDOR, Portugal
Impact Liner	162.8	EPS, 89% recycled content	1	EPS VENDOR, Portugal
Headband	7.7	PA6, 30% recycled content	2	INJECTION VENDOR, Portugal
Turnsys turnwheel	1.1	PA6, 30% recycled content	1	INJECTION VENDOR, Portugal
Turnsys Cover Right	1.25	PA6, 30% recycled content	1	INJECTION VENDOR, Portugal
Turnsys Cover Left	1.25	PA6, 30% recycled content	1	INJECTION VENDOR, Portugal
Headbasket	12.7	PA6, 30% recycled content	1	INJECTION VENDOR, Portugal
Turnsys Ratchet	0.77	POM	1	INJECTION VENDOR, Portugal
Clip to assemble PC outershell and EPS togheter	8.4	PA6, 30% recycled content	1	INJECTION VENDOR, Portugal
Buckle_MALE	2.74	POM	1	Buckle vendor, China
Buckle_FEMALE	2.83	POM	1	Buckle vendor, China
Strap Rubber Ring No logo	0.13	Silicone	1	External supplier, China
Straps	28.7	Polyester, 97% recycled content	1	External supplier, China
Padding	10.5	Polyester and PU foam	1	External supplier, China

Some assumptions and proxies were taken to model these materials, outlined below.

Recycled PA6:

The PA6 used in the U103 helmet has a recycled content of 30%. No recycled PA6 dataset is available in the databases and no data was available from the supplier. Therefore, recycled PET granulates were used as a proxy, assuming that the recycling process is similar.

Recycled PA granulates are then mixed and moulded with the virgin granulates; this is included in the 3.1.2 Manufacturing stage.

Recycled PC:

The PC used for the outershell of the U103 helmet has a recycled content of 65%. No primary data was provided from the supplier, however a description of the production process was available.

The recycled PC is produced from the shredding, compounding and extrusion of waste CDs. Therefore, the recycled PC granulates were modelled with the shredding of waste electronics as a proxy, and the process of extruding the flakes into strings is modelled with processes of extrusion and thermoforming of plastic sheets. An additional compound is used but was not modelled as no information on the type neither the quantity used was provided; therefore, the material is modelled as 100% of PC. A sensitivity analysis was made on the excluded flows (see Appendix III).

The recycled PC granulates are then mixed and moulded with the virgin granulates; this is included in the 3.1.2 Manufacturing stage.

Recycled EPS:

The supplier of the EPS material provided the results from the LCA they performed on their product. These results were directly integrated into the calculations for this study, using the right amount of EPS that is afterwards processed at the factory in Portugal.

Polyester and polypropylene fabric:

No information was available on the manufacturing of the polyester fabrics and Velcro. The same assumptions were made for both materials: the polyester and polypropylene fibres are considered to go through spinning and dyeing processes, and then woven into a fabric.

Recycled polyester:

The straps used in the U103 helmet are made from recycled polyester. No information was provided on the production of the recycled polyester, therefore it was assumed that they are produced from fibres retrieved from PET bottles.

This process was modelled using the dataset 'polyester fibre production, finished' from ecoinvent, replacing the virgin PET granulates by recycled PET granulates.

Rivets and screws:

Stainless steel rivets and screws are used in the U101 helmet; They were modelled using the same dataset of chromium steel.

Table 8 and Table 9 show the quantities of each material for both helmets, and the datasets in the modelling.

Table 8. LCI data on raw material acquisition – U101

Activity	Primary activity data (g/FU)	Secondary data name	Geography	Source
ABS production	272	acrylonitrile-butadiene-styrene copolymer	RoW	Ecoinvent 3.9.1
EPS production	133	polystyrene production, expandable	RoW	Ecoinvent 3.9.1
PA66 production	32.45	nylon 6-6 production	RoW	Ecoinvent 3.9.1
POM production	6.03	urea formaldehyde resin production	RoW	Ecoinvent 3.9.1
PC production	110	polycarbonate production	RoW	Ecoinvent 3.9.1
PU production	0.64	Polyurethane rigid foam	RoW	Ecoinvent 3.9.1
Woven polyester production	34.4	polyester fibre production, finished batch dyeing, fibre, cotton yarn production, polyester, ring spinning, for weaving weaving of synthetic fibre, for industrial use	RoW, GLO	Ecoinvent 3.9.1
Stainless steel production	16.3	chromium steel turning, average, conventional	RoW	Ecoinvent 3.9.1
TPR production	1.85	synthetic rubber production	RoW	Ecoinvent 3.9.1
Silicon production	0.704	silicone product production	RoW	Ecoinvent 3.9.1
PVC production	0.010	Polyvinyl chloride sheet	RER	PlasticsEurope

Table 9. LCI data on raw material acquisition – U103

Activity	Primary activity data (g/FU)	Secondary data name	Geography	Source
PC production, 65% recycled	249	treatment of waste electric and electronic equipment, shredding extrusion of plastic sheets and thermoforming, inline polycarbonate production	GLO, RoW, RER	Ecoinvent 3.9.1
EPS production, 89% recycled	166	*LCA results from the supplier*		
PA6 production, 30% recycled	40.38	polyethylene terephthalate production, granulate, amorphous, recycled nylon 6-6 production	Europe without Switzerland, RER	Ecoinvent 3.9.1
POM production, virgin	6.40	urea formaldehyde resin production	RER	Ecoinvent 3.9.1
PU production, virgin	0.57	market for polyurethane rigid foam	RER	Ecoinvent 3.9.1
Woven polyester production, virgin	9.92	polyester fibre production, finished batch dyeing, fibre, cotton yarn production, polyester, ring spinning, for weaving weaving of synthetic fibre, for industrial use	RoW, GLO	Ecoinvent 3.9.1
Woven polyester production, 97% recycled	29.10	polyethylene terephthalate production, granulate, amorphous, recycled polyester fibre production, finished batch dyeing, fibre, cotton yarn production, polyester, ring spinning, for weaving weaving of synthetic fibre, for industrial use	RoW, GLO	Ecoinvent 3.9.1
Silicon production	0.13	Market for silicone product	RoW	Ecoinvent 3.9.1

3.1.2 Manufacturing stage

The manufacturing stage primarily involves energy consumption for the actual production of the helmets and other auxiliaries materials such as water, paint or glue.

Lazer Sport has several suppliers with different factories for the components. Table 10 and Table 11 indicate whether primary or secondary data was used to model the manufacturing of each component. When secondary data is used, the sources or datasets used are detailed in the respective following sections.

Table 10. Manufacturing processes and primary data availability - U101

Component	Manufacturing processes	Primary or secondary data
Hardshell	Injection moulding	Secondary data
Impact Liner	Injection moulding (over the other components)	Primary data
Snapbaskets Headband	Injection moulding	Primary data
Double snapbasket for hanger	Injection moulding	Primary data
Headband	Injection moulding	Primary data
Snapbasket Mips	Injection moulding	Primary data
Turnfitplus Headbasket/Retention System	Injection moulding	Primary data
Turnfitplus Ratched/Retention System	Injection moulding	Primary data
Turnfitplus Cover Left/Retention System	Injection moulding	Primary data
Turnfitplus Cover Right/Retention System	Injection moulding	Primary data
Turnfitplus Wheel/Retention System	Injection moulding	Primary data
Hanger Headbasket	Injection moulding	Primary data
Block/Retention System	Injection moulding	Primary data
Strap Divider	Injection moulding	Primary data
Buckle parts	Injection moulding	Secondary data
Strap Rubber Ring Z logo	Injection moulding	Secondary data
Padding	Heatpress	Secondary data
MIPS PC shell	Silkscreening, vacuum forming, cutting	Primary data
Other MIPS parts	Injection moulding	Secondary data

Table 11. Manufacturing processes and primary data availability - U103

Component	Manufacturing processes	Primary or secondary data
Outershell	Injection moulding	Primary data
Impact Liner	Injection moulding and expansion	Primary data
Headband	Injection moulding	Primary data
Turnsys turnwheel	Injection moulding	Primary data
Turnsys Cover Right	Injection moulding	Primary data
Turnsys Cover Left	Injection moulding	Primary data
Headbasket	Injection moulding	Primary data
Turnsys Ratchet	Injection moulding	Primary data
Clip to assemble PC outershell and EPS together	Injection moulding	Primary data
Buckle parts	Injection moulding	Primary data
Strap Rubber Ring No logo	Injection moulding	Secondary data
Padding	Heatpress	Secondary data

Electricity and natural gas are the primary energy sources utilised across all production systems. When available, primary data for energy consumption were used.

Whenever possible, electricity mixes used are country-specific based on the locations where the components are manufactured. These include: China, Netherlands, Portugal. When secondary datasets are used for specific manufacturing processes (e.g., injection molding), the electricity mix is a regional average based on the location.

Injection moulding processes

A large share of the helmets is composed of plastic pieces manufactured through injection moulding processes by suppliers.

For the U101 helmet, the same electricity and additive consumptions were given for each injection molding process, regardless of the weight or the shape of the pieces, as more detailed data was not available. This is one of the main limitations of the study, as highlighted in 6. Limitations of the study. However, the same limitation was raised in the previous LCA study for Lazer Sport and a sensitivity analysis was performed. The conclusion was that using the ecoinvent dataset for injection moulding for all the small plastic parts induced a variation of less than 4% of the overall results (South Pole, LCA of Lazer Sport's helmets 2023).

For the U103 helmet, the values are more precise as they were provided separately for each component.

The primary data of energy consumption for both helmets are provided in Table 12. For all other components not listed in this table, the default injection moulding dataset from ecoinvent was used.

Table 12. Consumptions for each injection moulding process

Injection moulding	**Electricity (kWh)**	**Additive (g)**	**Paint or pigment (g)**	**Water (L)**
U101 - all PA components	0.03	0.05	0	0
U103 – PC outershell	0.375	0	0	0.02
U103 – Headband	0.056	0	0.6	0.008
U103 – turnsys turnwheel	0.009	0	0.08	0.001
U103 – turnsys cover R	0.009	0	0.07	0.001
U103 – turnsys cover L	0.009	0	0.07	0.001
U103 – headbasket	0.025	0	0.56	0.002
U103 – turnsys racthet	0.008	0	0	0.001
U103 - Clip	0.023	0	0.53	0.006
U103 – Buckle male	0.0036	0.012	0	0
U103 – Buckle female	0.0036	0.012	0	0

The scraps are reinjected in a close loop. A loss rate of 0.6.% is applied to model remaining losses, based on default injection moulding process from ecoinvent 3.9.1.

According to the suppliers for the U101, some parts are molded together into one mold. This means that within a same injection moulding process, several pieces are molded at the same time; therefore, the consumption for one process is provided for the whole mold. There, for one component it is divided by the number of pieces molded together. Table 13 shows for each part how many pieces are in one mold during the injection moulding process. For the U103 helmet, quantities were provided directly for one piece.

Table 13. Number of pieces per mold – injection moulding processes – U101

Component	Number of pieces into one mold
Hardshell	1
Impact Liner	1
Snapbaskets Headband	2
Double snapbasket for hanger	2
Headband	2
Snapbasket Mips	4
Turnfitplus Headbasket/Retention System	1
Turnfitplus Ratched/Retention System	8
Turnfitplus Cover Left/Retention System	1
Turnfitplus Cover Right/Retention System	1
Turnfitplus Wheel/Retention System	4
Hanger Headbasket	2
Block/Retention System	8
Strap Divider	4

Sikscreening, vacuum forming and CNC cutting

The outer shell of the MIPS part of the U101 is made of polycarbonate sheets. The part undergoes three distinct processes : silkscreening, vacuum forming and CNC cutting. The total ink, water and energy consumptions needed for the whole PC outershell are given below. The losses from production process and quality defects are sent back to vendor to be recycled.

Table 14. Energy, water and ink consumptions for the manufacturing of the MIPS outershell – U101

PC shell manufacturing process		
Losses during manufacturing (%)		70% of manufacturing losses and 3% of quality losses
Silkscreen	Electricity (kWh)	0.25
Vacuum forming	Electricity (kWh)	0.30
	Water (kg)	10
	Natural gas (kWh)	2.55
CNC cutting	Electricity (kWh)	0.15

Padding heatpress

The paddings for both helmets are composed of PU foam and polyester fabrics, that are heatpressed and glued together, through a rolling machine. The quantities of glue used into the padding processing were provided by the suppliers. However, the electricity consumption was not provided, therefore default values from literature were used.

In the previous LCA study of Lazer Sport's helmets, the same assumption was used and a sensitivity analysis was performed in order to see if this has a high influence on the results. The conclusion was that a variation of 30% of the electricity consumption to heatpress the padding changed the overall results by less than 0.3% (South Pole, LCA of Lazer Sport's helmets 2023).

The quantities of electricity and glue used to manufactured the padding are given in Table 15.

Table 15. Electricity and glue consumptions, manufacturing of the paddings

	Electricity (kWh)	glue (g)
U101 padding	0.199	1.76
U103 padding	0.178	3.67

EPS impact liner production

The EPS impact liner for the U101 helmet is manufactured by Supplier A in China. It is molded over other pieces to assembly the helmet. The consumptions for this process are provided in Table 16.

According to the supplier, 2% of losses occur during the process.

Table 16. Energy and water consumptions, injection moulding of EPS impact liner – U101

	Electricity (kWh)	Water (L)	Natural gas (m^3)
EPS injection moulding	0.8	36	0.43

The EPS part for the U103 helmet is manufactured in Portugal, using 89% of recycled EPS. The consumptions for the injection moulding and expansion processes are provided in Table 17.

According to the supplier, 2% of losses occur during the process.

Table 17. Energy and water consumptions, injection moulding of EPS impact liner – U103

	Electricity (kWh)	Water (L)	Natural gas (m^3)	Compressed air (L)
EPS injection moulding	3.821	18.61	0.49	846

Matte coating

The impact liner of the U101 is matte coated, while no paint is used in the production of the U103 helmet. The total ink and electricity consumption are given in Table 18.

Table 18. Electricity and ink consumptions of matte coating of impact liner – U101

	Electricity (kWh)	Matte ink (g)
Matte coating – Impact liner and visor	0.3	78

Only 4.36 g of matte ink ends up on the helmet. The losses of matte ink are sent to a wastewater storage inside the factory to be collected and recycled by an external part.

Final assembly

The helmets are assembled by hand. 10 g of glue is used in the assembly of the U101. For the U103 helmet, no glue is used as the helmet is designed to be easily disassembled. Therefore, the components are assembled with a clip and straps.

A detailed description of all LCI data employed for the manufacturing stage across each product system is provided in Table 19 and Table 20 below.

Table 19. LCI data on manufacturing – U101

Activity	Secondary data name	Geography	Source
Electricity	market group for electricity, medium voltage	CN	Ecoinvent 3.9.1
Natural gas	market for heat, district or industrial, natural gas	RoW	Ecoinvent 3.9.1
Water	market for tap water	RoW	Ecoinvent 3.9.1
Additives	market for glass fibre	GLO	Ecoinvent 3.9.1
Paint and ink	alkyd paint production, white, solvent-based, product in 60% solution state	RoW	Ecoinvent 3.9.1
Glue	market for vinyl acetate	GLO	Ecoinvent 3.9.1
Waste treatment	treatment of waste plastic, mixture, sanitary landfill	RoW	Ecoinvent 3.9.1
Injection moulding	Injection moulding	RoW	Ecoinvent 3.9.1

Table 20. LCI data on manufacturing – U103

Activity	Secondary data name	Geography	Source
Electricity	market for electricity, medium voltage	PT	Ecoinvent 3.9.1
Natural gas	market for heat, district or industrial, natural gas	RER	Ecoinvent 3.9.1
Water	market for tap water	Europe without Switzerland	Ecoinvent 3.9.1
Compressed air	compressed air production, 800 kPa gauge, >30kW, average generation	RER	Ecoinvent 3.9.1
Electricity	market group for electricity, medium voltage	CN	Ecoinvent 3.9.1
Additives	market for glass fibre	GLO	Ecoinvent 3.9.1
Paint/pigment	alkyd paint production, white, solvent-based, product in 60% solution state	RER	Ecoinvent 3.9.1
Glue	market for vinyl acetate	GLO	Ecoinvent 3.9.1
Waste treatment	treatment of waste plastic, mixture, sanitary landfill	RoW	Ecoinvent 3.9.1
Injection moulding	Injection moulding	RoW	Ecoinvent 3.9.1

3.1.3 Packaging stage

This stage includes both primary and secondary packaging materials.

Detailed LCI information can be found in Table 21 and Table 22 below. The packaging materials include cardboard boxes, hangtags, stickers, labels, PE bags, plastic hanger, PU foam. For both helmets, some of the paper and cardboard materials are from recycled sources and other from virgin materials. The U103 helmet uses less packaging than the U101, and in particular less plastic materials.

Table 21. LCI data on packaging materials – U101

Activity	Primary activity data (g/FU)	Secondary data name and source	Geography	Notes
Non-recycled cardboard production	176.88	corrugated board box production	RoW	Ecoinvent 3.9.1
Recycled kraft paper production	276.6	kraft paper production	RoW	Ecoinvent 3.9.1
Printed paper production	12.45	offset printing, per kg printed paper	RoW	Ecoinvent 3.9.1
Copper paper production	6.81	paper production, woodfree, coated, at non-integrated mill	RoW	Ecoinvent 3.9.1
PET labels production	0.2	polyethylene terephthalate production, granulate, amorphous extrusion, plastic film	RoW	Ecoinvent 3.9.1
Recycled testliner production	1.9	containerboard production, linerboard, testliner	RoW	Ecoinvent 3.9.1
PP production	0.01	polypropylene production, granulate injection moulding	RoW	Ecoinvent 3.9.1
LDPE production	195	polyethylene production, low density, granulate extrusion, plastic film	RoW	Ecoinvent 3.9.1
Woven polyester production	1.38	polyester fibre production, finished batch dyeing, fibre, cotton yarn production, polyester, ring spinning, for weaving weaving of synthetic fibre, for industrial use	RoW, GLO	Ecoinvent 3.9.1
PU foam production	0.5	Polyurethane rigid foam (PU)	RER	PlasticsEurope

Table 22. LCI data on packaging materials – U103

Activity	Primary activity data (g/FU)	Secondary data name and source	Geography	Notes
Recycled kraft paper production	289	kraft paper production	RER	Ecoinvent 3.9.1
Printed paper production, recycled	11.6	offset printing, per kg printed paper containerboard production, linerboard, testliner	RoW, RER	Ecoinvent 3.9.1
Non recycled cardboard and paper	4.44	containerboard production, linerboard, kraftliner	RER	Ecoinvent 3.9.1
Copper paper production	0.67	paper production, woodfree, coated, at non-integrated mill	RoW	Ecoinvent 3.9.1
Recycled testliner production	1.45	containerboard production, linerboard, testliner	RER	Ecoinvent 3.9.1
LDPE production	10.5	polyethylene production, low density, granulate extrusion, plastic film	RoW	Ecoinvent 3.9.1

3.1.4 Upstream transportation stage

The upstream transportation stage includes all inbound transportation of raw materials and packaging as elaborated upon in 3.1.1 Raw materials acquisition stage and 3.1.3 Packaging stage, in addition to the intermediate transportation between the different factories. This includes transport legs from the raw materials acquisition to the suppliers' factories, and from the factories to final assembly.

For the U101 helmet, road transportation serves as the exclusive mode of transport as most components are manufactured within China.

For the U103 helmet, final assembly takes place in Portugal and a few components are manufactured in China, therefore some ship transport is involved.

Table 23. Upstream transport data – U101

	Tier 1[2] (Supplier A)		**Tier 2**	
Component	Country	Distance to tier 1 (km)	Country	Distance to tier 2 (km)
Hardshell	China	340, truck	-	-
Impact liner	China	305, truck	-	-
Snapbasket MIPS	China	285, truck	China	25, truck
Other PA parts	China	336, truck	China	33, truck
Buckle parts	China	366, truck	-	-
Strap Rubber Ring Z logo	China	402, truck	China	15, truck
Straps	China	261, truck	-	-
Velcro sticker Ø12 mm	China	331, truck	-	-
Padding - fabric	China	328, truck	China	8, truck
Padding – PU foam	China	328, truck	China	13, truck
Z rivets	China	336, truck	-	-
MIPS parts	China	329, truck	China	35, truck
Paint	China	273, truck	-	-

Table 24. Upstream transport data – U103

	Tier 1 (Supplier B)		**Tier 2**		**Tier 3**	
Component	**Country**	**Distance to tier 1 (km)**	**Country**	**Distance to tier 2 (km)**	**Country**	**Distance to tier 3 (km)**
PC outershell	Portugal	17, truck	Netherlands	2100, truck	Netherlands	25.3, truck
Impact liner	Portugal	100, truck	Portugal	2850, truck	Austria	-
Buckle	Portugal	24000 boat, 200 truck	China	750 boat, 50 truck		
Straps	Portugal	80, truck	Portugal	-	-	-
Padding fabric	Portugal	525, truck	China	-	-	-
Padding foam	Portugal	525, truck	Portugal	600, truck	Italy	2400, truck
PA66 components	Portugal	17, truck	Spain	860, truck	-	-
POM ratchet	Portugal	17, truck	Portugal	-	-	-
Strap rubber ring	Portugal	80, truck	Portugal	16800 boat, 215 truck	China	402, truck

Transport data from packaging suppliers to the factory was provided for most materials. When no information was available on the origin of the suppliers, default upstream transport values from the PEF were used.

[2] *Tier 1 refers to the direct supplier of the final factory, tier 2 to tier 1's supplier, and tier 3 to tier 2's supplier.*

Table 25. Distance to tier 1 – packaging – U101

	Country	Distance to tier 1 (Supplier B) (km)
Non-recycled cardboard production	China	320, truck
Recycled kraft paper production	China	320, truck
Printed paper production	Unknown	PEF values[3]
Copper paper production	China	320, truck
PET labels production	China	320, truck
Recycled testliner production	China	320, truck
PP production	China	869, truck
LDPE production	Unknown	PEF values
Woven polyester production	China	331, truck
PU foam production	Unknown	PEF values

Table 26. Distance to tier 1 – packaging – U103

	Country	Distance to tier 1 (Supplier B) (km)
Recycled kraft paper production	Portugal	155, truck
Printed paper production, recycled	Portugal	8, truck
Non recycled cardboard and paper	Portugal	85, truck
Copper paper production	China	17000 boat, 200 truck
Recycled testliner production	Portugal	3, truck
LDPE production	China	17000 boat, 145 truck

Table 27 below provides a full description of the LCI data used for the upstream transportation stage.

Table 27. LCI data on upstream transportation

Activity	Secondary data	Geography	Source
Truck transport	Truck, Euro 0 - 6 mix, more than 32t gross weight / 24.7t payload capacity	GLO	Sphera
Fuel for truck and train	Diesel mix at filling station	CN	Sphera
Transportation for material	Container ship, 5.000 to 200.000 dwt payload capacity, deep sea	GLO	Sphera
Fuel for ship	Heavy fuel oil at refinery (1.0 wt.% S)	RER	Sphera
Freight train	Rail transport cargo - Diesel, average train, gross tonne weight 1,000t / 726t payload capacity	CN	Sphera
Air freight	Cargo plane	GLO	Sphera

[3] 130 km by truck, 240 km by train and 270 km by ship

3.1.5 Distribution stage

The U101 helmet is manufactured in China while the U103 helmet is manufactured in Portugal.

After final assembly, they both follow to same route:

- The helmets are sent to warehouses across the world, mainly in Europa, Asia and America;
- From the warehouses, the helmets are sent to local warehouses;
- From the local warehouses, the helmets are sent to retailers; and,
- From the retailers, the helmets are bought by the final consumers.

The only step that differs between both helmets is the first leg, as the products are shipped from a different location to the same warehouses.

The data for transportation from warehouses to local warehouses and from local warehouses to retails was provided by Lazer Sport in 2022 for the previous study; it was assumed that no major changes has occurred and that the distribution shares are similar for the U101 and will be similar for the U103. The helmets are transported via truck and boat.

The transportation from retailers to final consumers employs default distribution parameters from the draft Product Environmental Footprint Category Rules (PEFCR) for Apparel and Footwear (Quantis, 2022) as secondary data sources (see Table 28). A split between transportation through passenger car, van or with no impacts is provided, where impacts from the passenger car are allocated based on the volume of the product.

Table 28. Distribution scenario – from retailers to final clients

Region	Share in the scenario	Distance (km)
Passenger car	62%	5
Van (lorry<7.5t, EURO 3)	5%	5
No impacts	33%	-

Table 29. LCI data on distribution

Leg	Transport mode	Source	Secondary data name and source
From factory to warehouses	Truck	Primary data	GLO: Truck, Euro 0 – 6 mix, more than 32t gross weight / 24.7t payload capacity Sphera CN: Diesel mix at filling station Sphera
	Boat		GLO: Container ship, 5.000 to 200.000 dwt payload capacity, deep sea Sphera IN: Heavy fuel oil at refinery (1.0 wt.% S) Sphera
From warehouses to local warehouses	Truck		GLO: Truck, Euro 0 – 6 mix, more than 32t gross weight / 24.7t payload capacity Sphera CN: Diesel mix at filling station Sphera
	Boat		GLO: Container ship, 5.000 to 200.000 dwt payload capacity, deep sea Sphera IN: Heavy fuel oil at refinery (1.0 wt.% S) Sphera
From local warehouses to retails	Truck		GLO: Truck, Euro 0 – 6 mix, more than 32t gross weight / 24.7t payload capacity Sphera CN: Diesel mix at filling station Sphera
From retails to final consumer	Passenger car	Secondary data	RoW: market for transport, passenger car ecoinvent 3.9.1
	Van		GLO: Truck, Euro 0 - 6 mix, up to 7.5t gross weight / 2.7t payload capacity Sphera RER: Diesel mix at filling station Sphera

3.1.6 Use stage

Environmental impacts associated with the helmets' cleaning and use are disregarded due to their insignificant contribution to overall impact. Consequently, the impacts from the use phase of the helmets have been deemed negligible and excluded from this analysis.

3.1.7 End-of-life (EoL) stage

The end-of-life stage includes the disposal and treatment of the final product (product and packaging). The scenario for end-of-life was built based on the share of sales in the different locations and municipal waste management statistics between recycling, incineration and landfill.

Lazer Sport does not implement a specific recycling program for the products and their packaging materials. Given the composition and structure of the helmets, it is assumed a typical helmet (U101) is unsuitable for recycling at the end of their life cycle. Consequently, the helmets are expected to be treated by landfill and incineration; this is what is assumed for the end-of-life of both helmets in this study.

However, the U103 helmet is designed to be easily dismantled, and will come with instructions to guide the customer on how to dispose it properly. Therefore, in this study an alternative scenario where the U103 helmet is 100% recycled is assessed and compared with the reference scenario where it is landfilled and incinerated (see 4.7 End-of-life scenarios – U103).

Regarding the packaging, the plastic parts are not assumed to be recycled as a conservative approach. Small component parts such as the stickers, the Velcro, or the PU foam are not considered as likely to follow a recycling path. Therefore, they are considered residual waste.

The paper and cardboard elements are considered partly recycled based on location-specific statistics.

Table 30 and Table 31 show the sources considered for the management of residual waste and cardboard waste in the different regions.

Table 30. Residual waste - statistics

Region	Sources
Europe	The World Bank (2018)
North America	The World Bank (2018)
Asia	The World Bank (2018)
Oceania	The World Bank (2018)
South America	The World Bank (2018)

Table 31. Paper/cardboard waste - statistics

Region	Sources
Europe	Paper and cardboard waste management - Eurostat
North America	Paper and cardboard waste management (EPA, 2018)
Asia	Municipal waste treatment in East Asia and Pacific Region (World Bank Group, 2018)
Oceania	Municipal waste treatment in Sydney (A Brief Insight into the Complex World of Waste Management)
South America	Municipal waste treatment in South America (World Bank Group, 2018)

It is assumed that the distance covered for waste collection, both from the production stage and the end-of-life stage, is 100km. The datasets used to model EOL treatment of the helmets and their packaging are listed in Table 32. A sorting process is added for the treatment of the paper and board.

Table 32. LCI datasets applied on EOL

Activity	Secondary data name	Geography	Sources
Plastic incineration	treatment of waste plastic, mixture, municipal incineration	RoW	Ecoinvent 3.9.1
Plastic landfilling	treatment of waste plastic, mixture, sanitary landfill	RoW	Ecoinvent 3.9.1
Metal incineration	treatment of scrap copper, municipal incineration	RoW	Ecoinvent 3.9.1
Metal landfilling	treatment of scrap steel, inert material landfill	RoW	Ecoinvent 3.9.1
Paper and cardboard incineration	treatment of waste graphical paper, municipal incineration	RoW	Ecoinvent 3.9.1
Paper and cardboard landfilling	treatment of waste graphical paper, sanitary landfill	RoW	Ecoinvent 3.9.1
Waste collection	Truck, Euro 0 - 6 mix, more than 32t gross weight / 24.7t payload capacity	GLO	Ecoinvent 3.9.1
Sorting of paper waste	treatment of waste paper, unsorted, sorting	RoW	Ecoinvent 3.9.1

3.2 Assumptions

1. The study makes an assumption that the intrinsic quality and lifespan of the helmets are similar from one product to the other. This assumption plays a crucial role in comparing the environmental impacts per functional unit (one helmet). It is based on the absence of existing studies or data from Lazer Sport that can differentiate the helmets on the basis of their quality or lifespan. Therefore, the comparison has been made on the premise of similar quality and lifespan for both helmets.
2. It is assumed that the helmets will not require any cleaning or repair during their lifecycle use, hence no environmental impacts are associated with the use stage. This assumption is based on the typical use patterns of such products, eliminating the need to account for resources used for maintenance activities in the life cycle assessment.
3. It is assumed that, upon reaching the end of their life cycle, the helmets will be treated as municipal waste that are subject to either landfilling or incineration, and recycling processes are not considered for the product due to its nature. An alternative scenario is assessed for the U103 as it is designed to allow disassembling at end-of-life.
4. It is assumed that, at the end of life, all packaging materials are subjected to landfilling, incineration, or recycling processes. The proportion allocated to each waste treatment method aligns with data derived several sources (see Table 31). These assumptions aim to accurately reflect current waste management practices for packaging materials within these regions. However, it should be acknowledged that changes in these practices or advancements in recycling technologies could necessitate amendments to these assumptions in future studies

3.3 Exclusions

In addition to the general exclusions described in section 2.2.4:

- The transportation of raw materials from tier 2 and 3 suppliers has not been explicitly included in absence of precise data. In its place, global market materials processes were selected to reflect typical procurement assumptions.
- Potential losses during transportation have not been incorporated into our assessment, as specific data on these losses is not available. As such, this analysis assumes optimal transportation conditions.
- The use of pallets for material or product transportation has been excluded from this analysis. This decision was made due to the unavailability of data concerning the frequency or scale of pallet usage.

- Some consumables such as threads, label carriers or ink for packaging materials have not been included, as assumed to be negligible. The following table shows the share that threads and label carriers represent in the helmet U103. As shown, it doesn't exceed 1%. The U101 being heavier than the U103, the share will not exceed these numbers.

Table 33. Mass of excluded inputs

	Mass in U103 (g)	**Share in U103**
Threads	0.5	0.1%
Label carriers	2.4	0.5%

3.4 Data quality analysis

Data quality was monitored with the use of data quality indicators, as previously described in section 2.2.6. The result of the DQI is shown in Appendix I.

4. Life Cycle Impact Assessment (LCIA)

This section discloses the Life Cycle Impact Assessment (LCIA) results derived from this study. The results comprise characterised mid-point assessments, environmental hotspot analyses that scrutinise significant areas of impact throughout the product life cycle, and an in-depth exploration identifying key contributors to the environmental impact. An alternative scenario is presented in Section 5 for further consideration. All outcomes are articulated in relation to the defined unit of analysis.

4.1 Environmental indicators

The study has been carried out, including all EF 3.1 impact categories previously listed in Table 4.

The most relevant indicators for the context of this LCA study of helmets have been identified in Table 34. This choice is supported by the contribution of each indicator on the overall environmental impacts, following the PEF methodology and calculation of a single score. The top 80% environmental impacts are carried by the following environmental indicators:

- U101: Climate change, Resource use of fossils, Particulate matter, Acidification, Photochemical ozone formation and Water use
- U103: Climate change, Resource use of fossils, Particulate matter, Acidification, Eutrophication freshwater, Resource use of minerals and metals and Photochemical ozone formation

The following sections will focus on these indicators. Detailed results and comparison for each indicator can be found in Appendix II.

Table 34. Definition of the environmental impact indicators accessed in detail in this study (Quantis, 2021)

Climate change/Global warming potential: Capacity of a greenhouse gas to influence radiative forcing, expressed in terms of a reference substance (for example, CO2-equivalent units) and specified time horizon (e.g. GWP 20, GWP 100, GWP 500, for 20, 100, and 500 years respectively). It relates to the capacity to influence changes in the global average surface-air temperature and subsequent change in various climate parameters and their effects, such as storm frequency and intensity, rainfall intensity and frequency of flooding, etc. (kg CO2eq)
Particulate matter: EF impact category that accounts for the adverse health effects on human health caused by emissions of Particulate Matter (PM) and its precursors (NOx, SOx, NH3). (disease incidences)
Acidification: EF impact category that addresses impacts due to acidifying substances in the environment. Emissions of NOx, NH3 and SOx lead to releases of hydrogen ions (H+) when the gases are mineralised. The protons contribute to the acidification of soils and water when they are released in areas where the buffering capacity is low, resulting in forest decline and lake acidification. (mol H+-eq)
Eutrophication, freshwater: Nutrients (mainly nitrogen and phosphorus) from sewage outfalls and fertilised farmland accelerate the growth of algae and other vegetation in water. The degradation of organic material consumes oxygen resulting in oxygen deficiency and, in some cases, fish death. Eutrophication translates the quantity of substances emitted into a common measure expressed as the oxygen required for the degradation of dead biomass. (kg P-eq)
Photochemical ozone formation, human health: A measure of emissions of precursors that contribute to ground level smog formation (mainly ozone O3), produced by the reaction of VOC and carbon monoxide in the presence of nitrogen oxides under the influence of UV light. Ground level ozone may be injurious to human health and ecosystems, and may also damage crops. (kg NMVOC eq.)
Resource use, fossil: EF impact category that addresses the use of non-renewable fossil natural resources (e.g. natural gas, coal, oil). (MJ)

Resource use, minerals and metals: The consumption of non-renewable resources leads to a decrease in the future availability of the functions supplied by these resources. (kg Sb eq)
Water use: It represents the relative available water remaining per area in a watershed, after the demand of humans and aquatic ecosystems has been met. It assesses the potential of water deprivation, to either humans or ecosystems, building on the assumption that the less water remaining available per area, the more likely another user will be deprived (see also http://www.wulca-waterlca.org/aware.html). (m3 world-eq)

4.2 Environmental impacts

The following graph shows the results for all environmental indicators, per life cycle stage. Hotspots are highlighted with darker colors. Results are also given in Table 39 and Table 40 in Annex II.

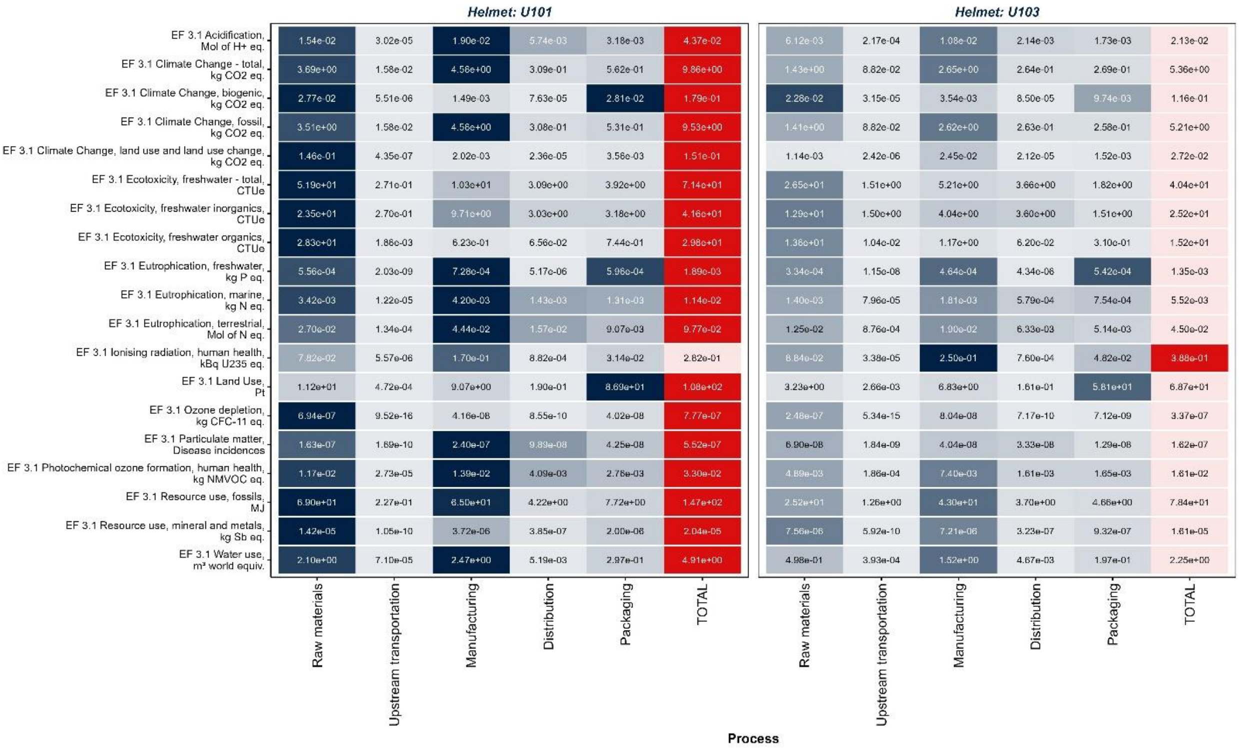


Figure 8. Environmental impacts - per life cycle stage - U101 and U103

4.3 Impacts on climate change

The Global Warming Potential (GWP) is measured for each stage of the helmets life cycle, presented in kilogram carbon dioxide equivalent.

Key findings from global warming potential analysis are:

- The total lifecycle climate change impact for each helmet is as follows:
  - U101: 9.86 kg CO_2e/helmet
  - U103: 5.36 kg CO_2e/helmet

- The manufacturing step the most significant contributors to GWP for both helmets: 46% for the U101 and 49% for the U103. The raw materials acquisition is the second one, with 37% and 27% respectively.

The carbon footprint of the U103 over the life cycle is 46% less than the carbon footprint of the U101.

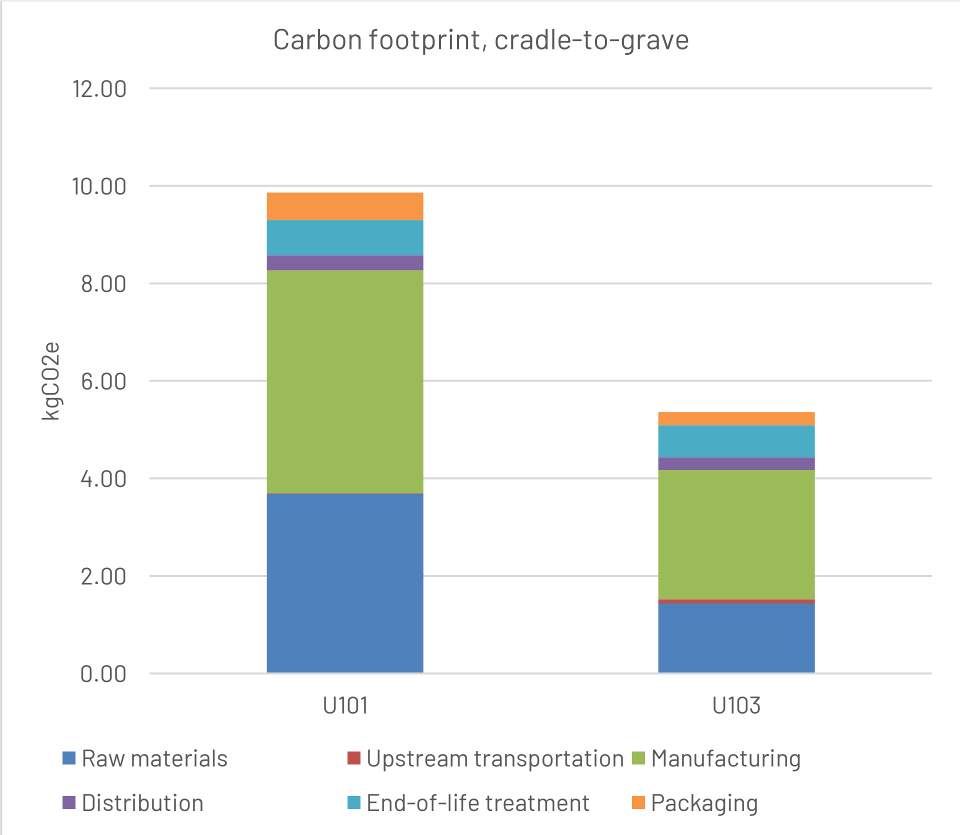


Figure 9. Climate change impacts per lifecycle stages for both helmets

In Figure 10, the carbon footprint per component is shown for both helmets. This includes for each component the raw materials acquisition, upstream transport and manufacturing steps, but doesn't include the paint and glue used during the final assembly of the U101.

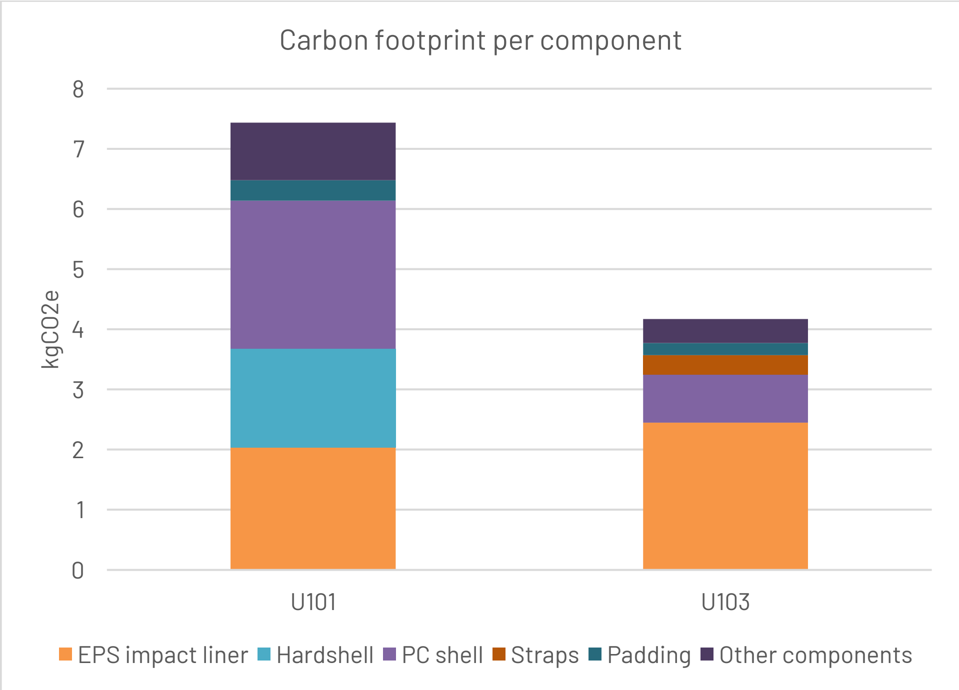


Figure 10. Climate impacts per components for both helmets

4.4 Environmental impacts, per life cycle stage (selected indicators)

Figure 11 and Figure 12 represent the proportional contribution of each life cycle stage as defined in Table 5 to selected impact categories (as listed in Table 34).

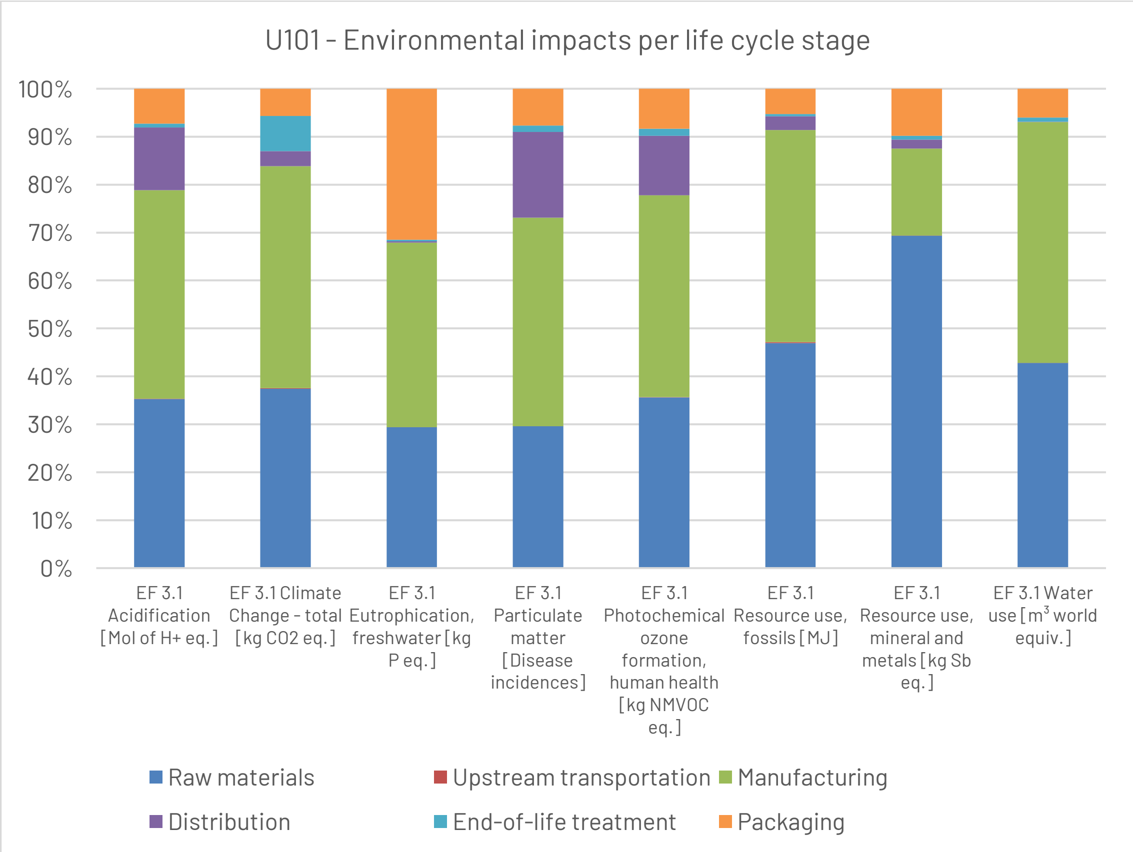


Figure 11. Contribution of each life cycle stage to chosen impact categories - U101

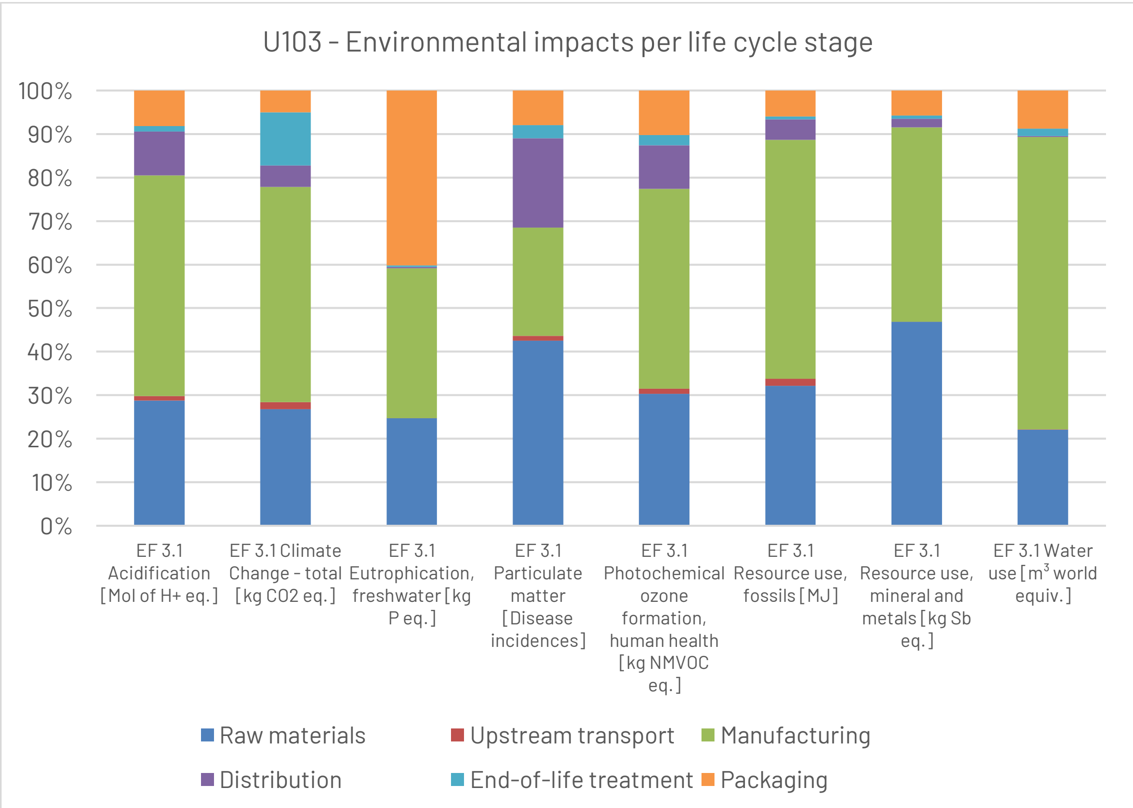


Figure 12. Contribution of each life cycle stage to chosen impact categories – U103

The contributions are similar for both helmets. Most of the environmental impacts are carried by the raw materials acquisition and the manufacturing step. The raw materials acquisition contributes 30-47% of the total impacts for the U101, while it contributes 28-47% of the total impacts of the U103.

The manufacturing step contributes 20-50% of the total impacts of the U101 for all indicators, while it contributes 25-65% for the U103. The contribution of the manufacturing step to the particulate matter indicator is more important for the U101 than for the U103, mainly because of the different electricity mixes (China vs Portugal).

The packaging supply (materials processing and transportation) is a low contributor for most indicators (less than 10%) except for Eutrophication, freshwater where it contributes 30 to 40%, mostly because of the cardboard materials. The distribution step is a high contributor to the particulate matter (20%) because of the use of trucks and ships. The end-of-life is a low contributor, except for impacts on climate change where it contributes more than 10%.

4.5 Environmental impacts, per component (selected indicators)

The present section shows the environmental impacts on cradle-to-gate (from raw materials acquisition to manufacturing), split per component.

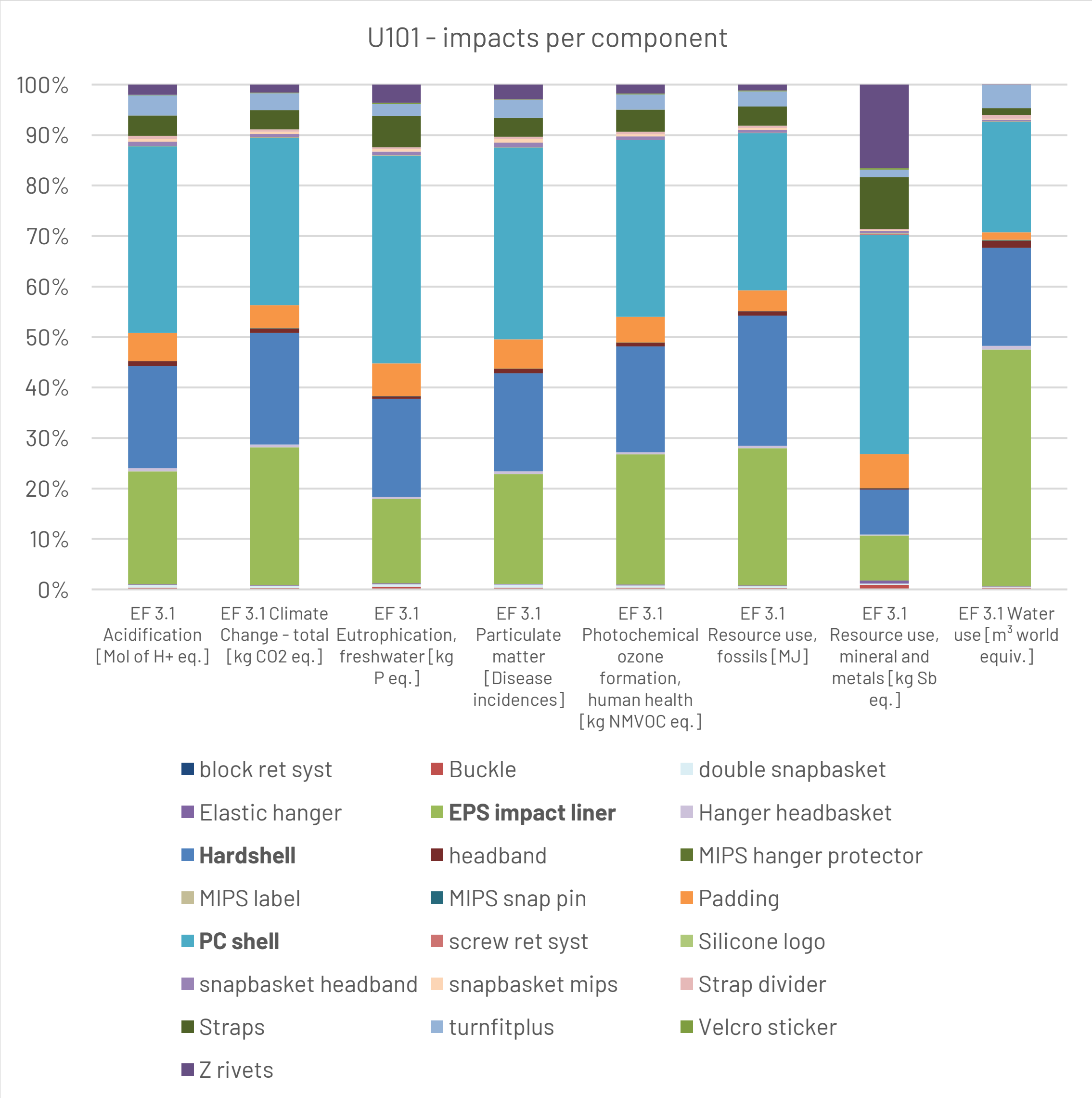


Figure 13. Contribution of each component to chosen impact categories – U101

In Figure 13, the contribution of each component to the environmental impacts of the U101 is shown. Most of the impacts comes from the MIPS PC shell, the EPS impact liner and the hardshell (in bold). These components are also the heaviest ones in the helmet, with respectively 33 g (6.4% of the total mass), 130 g (25.3% of the total mass) and 269 g (52.4% of the total mass). The PC shell in particular has high impacts compared with its relative mass, as it involves more steps in the manufacturing process, while the EPS impact liner and the hardshell only go through injection moulding.

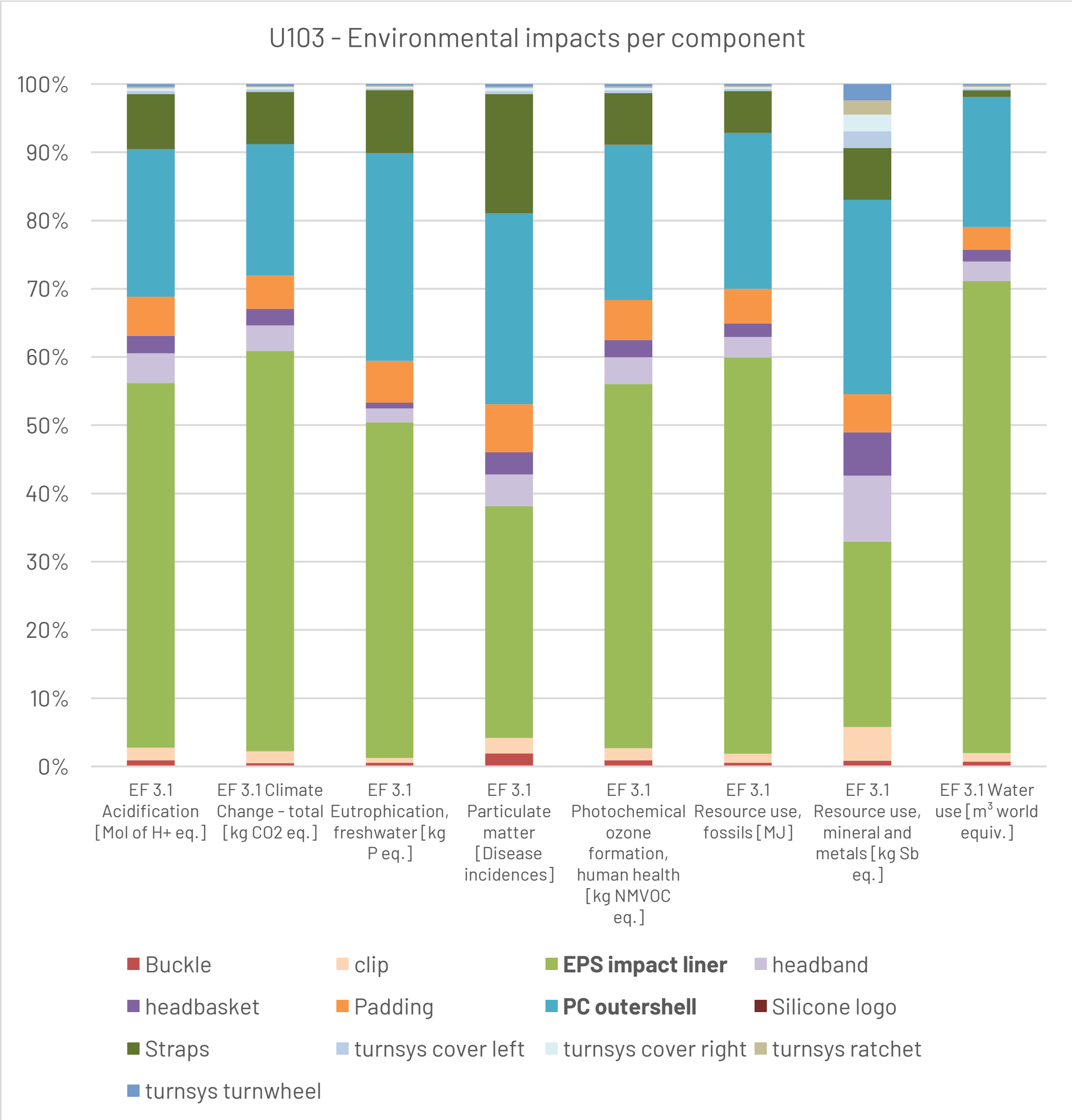


Figure 14. Contribution of each component to chosen impact categories – U103

Most of the impacts of the U103 are carried by the EPS impact liner and the PC outershell (in bold). These components are also the main ones of the helmet, respectively 163 g (33% of the total mass) and 248 g (50% of the total mass). The straps and the padding have also notable impacts, while the small pieces have negligible impacts over the total (less than a few percents).

4.6 Comparison of the two helmets

The U101 helmet has higher environmental impacts for all impact categories compared to the U103 helmet. Indeed, the U103 is designed to have a lower environmental footprint, using recycled materials and being produced in Portugal (therefore with a less carbon-intensive electricity mix).
The figure below shows the reduction in environmental impacts when switching from the U101 to the U103. Overall, the U103 has significantly lower impacts than the U101, up to a 70% reduction for Particulate matter, also mainly because of the different electricity mix. The reduction is between 22% and 55% for all other studied indicators.

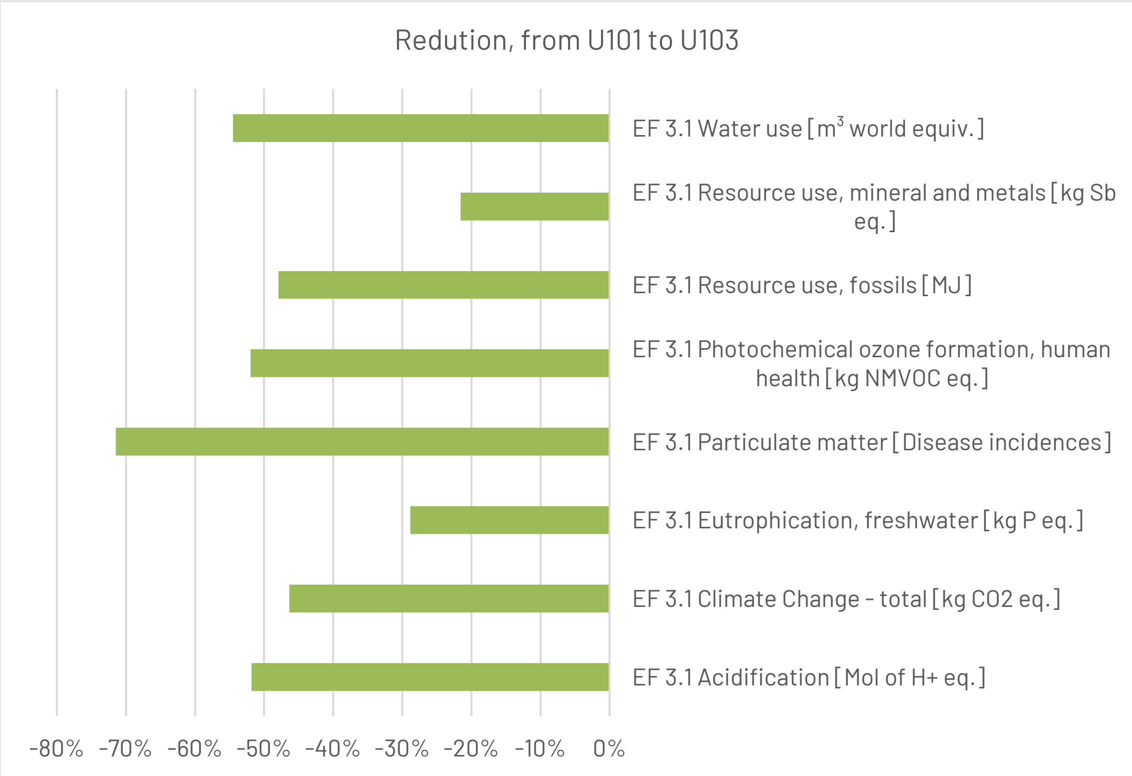


Figure 15. Reduction in environmental impacts when switching to U103, compared to U101

4.7 End-of-life scenarios – U103

The helmet U103 was designed by Lazer Sport to be easily disassembled. The customers are provided with instructions to separate the components of the helmets and guide them to properly dispose them, in order to recycle all the materials.

Therefore, an alternative scenario is assessed where the U103 is assumed to be fully recycled at end-of-life. In this scenario, it is assumed that all the parts of the helmet are recyclable. This assumption holds some limitations, as some of the parts might not be fully recyclable because of their shape or the lack of recycling infrastructures. Assumptions of the packaging materials remain the same (see 3.1.7 End-of-life (EoL) stage).

As this study uses the cut-off methodology, impacts from the recycling process at end-of-life are attributed to the user of the newly produced materials. Therefore, in this scenario, impacts from the U103 at end-of-life only include the transportation and sorting of the parts.

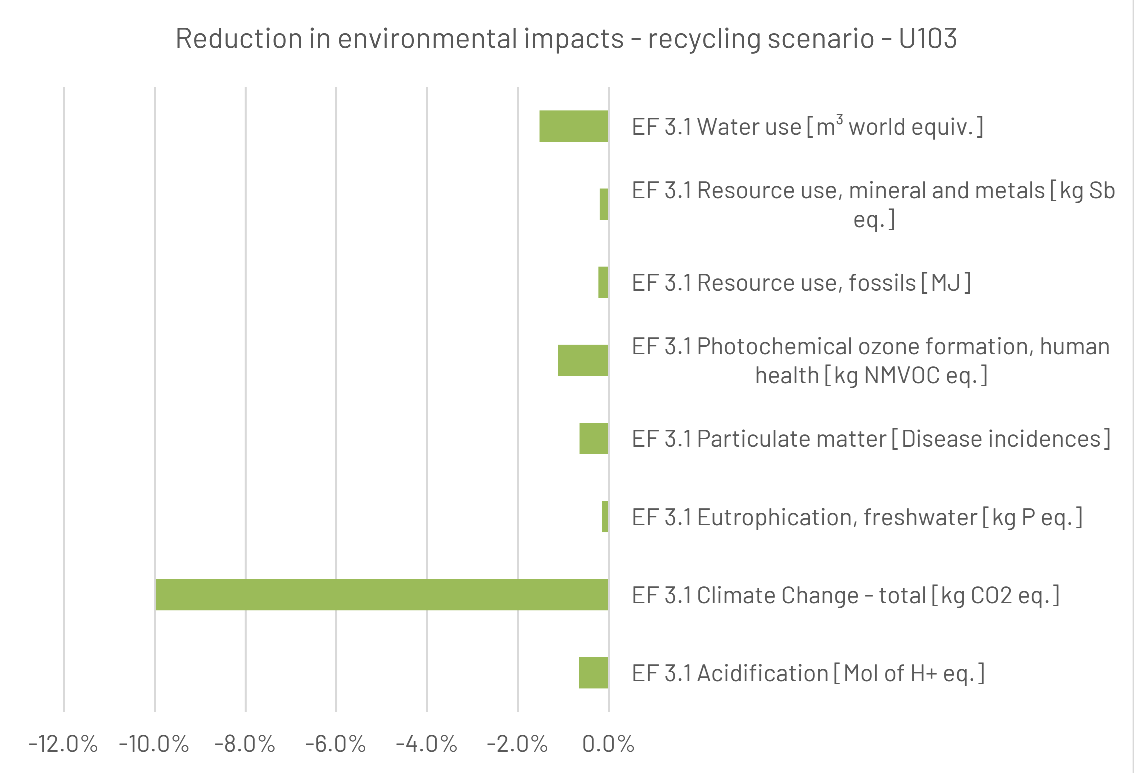


Figure 16. Reduction in environmental impacts, when switching to a 100% recycling scenario - U103

When switching to a 100% recycling scenario for the U103, the total environmental impacts are reduced by less than 2% for most indicators.

However, impacts on Climate change are lowered by almost 10%. The carbon footprint is reduced, reaching 4.82 kgCO2e, which increases the difference between the U101 and the U103 helmets, as in this scenario the U103 has a carbon footprint 52% lower than the U101 (46% in the standard scenario).

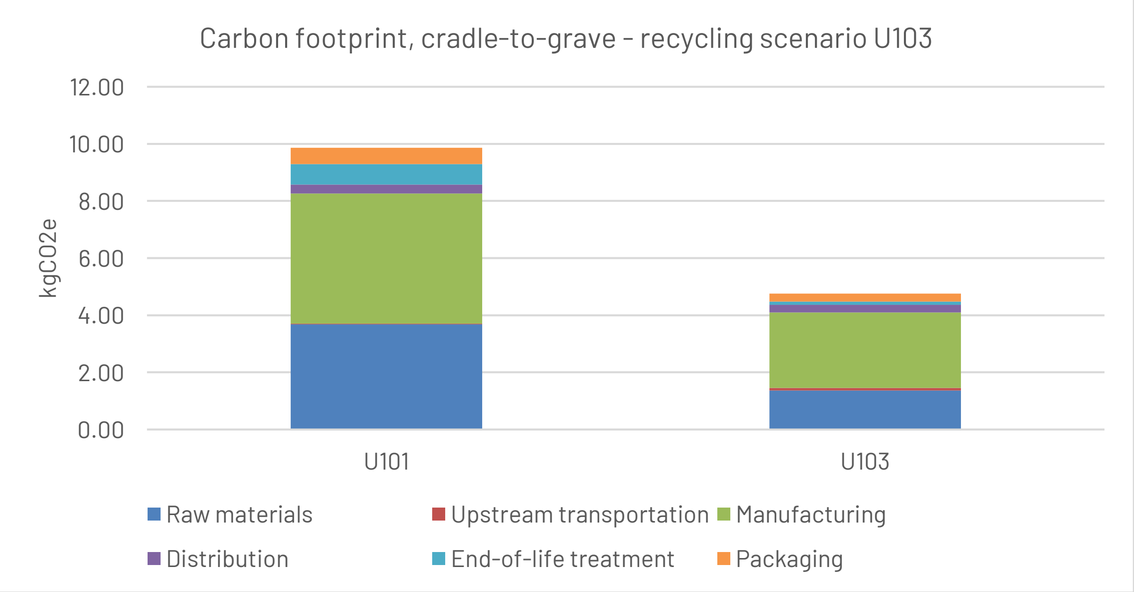


Figure 17. Comparison of both helmets, in a 100% recycling scenario for the U103

5. Conclusions and recommendations

5.1 Conclusions

The LCA study presented in this report generated the environmental profile of Lazer Sport's helmets produced by different suppliers in different locations. The functional unit used in this study was defined as one helmet over its lifespan. The system boundary was set as cradle-to-grave, the LCIA method used was EF 3.1 and the LCA model was constructed in GaBi software version 10.7.

This LCA estimates the environmental impacts of the compared product systems using a defined set of impact categories with a special focus on climate change (GWP) but it should not be used as the sole basis of comparative assertions: other social, economic and environmental aspects (beyond this study) should also be considered. The primary conclusions drawn from this study are summarised in the following sections.

5.1.1 Conclusions for global warming potential

Upon examining the Global Warming Potential (GWP) for each stage of the helmets life cycle, it has been observed that there are significant variations among both helmets. The following conclusions are summarised:

1. When analysing the GWP per helmet: the carbon footprint of the U103 helmet is 46% lower than the carbon footprint of the U101. This difference reaches 52% when assuming that the U103 will be 100% recycled. This suggests that the actions taken regarding the design of the U103 in order to reduce the environmental footprint of Lazer Sport's helmets were relevant.
2. It is clear that the manufacturing stage significantly contributes to the GWP across both helmets, indicating a potential area of impact reduction. A deeper look into this stage reveals that the GWP is primarily driven by a high number of components and production processes. Indeed, the U101 helmet has more components, and therefore a higher total energy consumption. Also, the U101 helmet is manufactured in China while the U103 is mainly manufactured in Portugal and Netherlands, where the electricity mix is less carbon-intensive than in China. A thorough reassessment of the energy efficiency and production processes could provide more insights to reducing the GWP impact.
3. The second main hotspot is the raw materials acquisition. Additionally, the difference in GWP between both helmets is driven by the use of recycled materials for the U103. Indeed, the U101 is not significantly heavier than the U103, even though it has more components, but it's entirely made of virgin materials. This highlights the importance of material choice and supply chain management.

5.1.2 Conclusions across all impact categories

The assessment of all impact categories can provide a more comprehensive picture of the overall environmental impacts of different product systems on the broader ecosystem.

1. For both helmets, environmental impacts are primarily attributable to the raw material acquisition and manufacturing stages.
2. Upstream transportation, distribution and end-of-life stages contribute minimally to the total lifecycle impact. The exceptions are the impact of the distribution step on particulate matter, notable because of the use of trucks and ships, and the impacts of packaging materials on Eutrophication because of the cardboard parts mainly.

3. On all impact categories, the U103 helmet presents a lower environmental impacts than the U101 helmet. This is particularly true for the impacts on Particulate matter as the U101 is manufactured in China while the U103 is manufactured in Europe. This is also responsible for a significant reduction in Resource use of fossils for the U103 compared with the U101.

4. Overall, the heaviest components of the helmets tend to have higher environmental impacts as these are driven by the quantity of raw materials extracted. However, this is also highly influenced by the choice of materials (especially virgin vs recycled) and the number and types of processes used to manufacture the parts.

6. Limitations of the study

The results within this report are limited by:

1. The scope, boundaries and reference period defined within this report.
2. The results are only valid for the specified product systems, results can not be transferred to other products with different materials or weight specifications or manufactured in other geographical locations. The results may also have constrained scalability.
3. Data input for this LCA study was received from Lazer Sport's suppliers, the accuracy of the data has not been independently verified. The data may have been estimated or extrapolated by experts from Lazer Sport and their suppliers to meet the declared unit for each product system.
4. In particular, the modelling of the injection moulding process and the way energy consumption is allocated hold some limitations. In particular for the U101, the same consumptions were considered for all plastic components, regardless of the shape or the weight of the pieces. However, this issue was already raised in a previous study, and a sensitivity analysis showed that using a secondary dataset for injection moulding processes for the small parts would induce a variation in results of less than 4%. It is assumed that the influence would be the same for these products.
5. The recycling of polycarbonate was modelled with the exclusion of some flows, but a sensitivity analysis showed that the overall environmental impacts would increase by less than 1% when including them.
6. Secondary data and proxies have been utilised for modelling certain processes. These data, while selected with care, may not mirror the actual processes perfectly, leading to potential deviations in the impact calculations. In particular, the modelling of some recycled materials rely on proxies in lack of more representative datasets. This is the case also for the padding components; however, a sensitivity analysis was performed in the previous LCA study for Lazer Sport, and it showed that a variation in energy consumption for the manufacturing of these parts would not have a significant influence on the results.
7. The U103 helmet is not available yet on the market and the modelling of the distribution and end-of-life relies on assumptions based on the other helmets sold by Lazer Sport.
8. This study doesn't account for potential differences in quality or how long different types of helmets might last. Different manufacturing methods or materials might produce helmets that last longer. In this study, we've assumed that all helmets are of similar quality and last for a similar amount of time.

7. Bibliography

Wernet, G., Bauer, C., Steubing, B., et al. (2016). The ecoinvent database version 3 (part I): overview and methodology. International Journal of Life Cycle Assessment, 21, 1218–1230. https://doi.org/10.1007/s11367-016-1087-8

ISO. (2006). ISO 14044:2006 - Environmental management — Life cycle assessment — Principles and framework. Retrieved from https://www.iso.org/standard/37456.html

International Organization for Standardization. (2019). ISO 14025:2006 - Environmental labels and declarations -- Type III environmental declarations -- Principles and procedures. Retrieved from https://www.iso.org/standard/37456.html

International Organization for Standardization. (2018). ISO 14040:2006 - Environmental management -- Life cycle assessment -- Principles and framework. Retrieved from https://www.iso.org/standard/38498.html

European Commission. (2010.). Guidance for the implementation of the EU Product Environmental Footprint (PEF) during the Environmental Footprint (EF) pilot phase (Version 6.3). Retrieved from https://eplca.jrc.ec.europa.eu/permalink/PEFCR_guidance_v6.3-2.pdf

Quantis. (2022). Draft Product Environmental Footprint Category Rules (PEFCR) apparel and footwear.

European Commission - Joint Research Centre. (2010). International Reference Life Cycle Data System (ILCD) Handbook - General guide for Life Cycle Assessment - Provisions and Action Steps. Retrieved from https://publications.jrc.ec.europa.eu/repository/handle/JRC58190

Eurostat (2023). Waste: Data Database. Retrieved from https://ec.europa.eu/eurostat/web/waste/data/database

EPA. (2018). Paper and Paperboard: Material-Specific Data. Retrieved from United States Environmental Protection Agency: https://www.epa.gov/facts-and-figures-about materials-waste-and-recycling/paper-and-paperboard-material-specific-data

McAlpin, J. (n.d.). A Brief Insight into the Complex World of Waste Management. Retrieved from Regional Development Australia Sydney: https://rdasydney.org.au/a-brief-insight-into-the complex-world-of-waste-management/

World Bank Group. (2018). What a Waste 2.0 - A global snapshot of solid waste management to 2050. Retrieved from https://datatopics.worldbank.org/what-a-waste/

South Pole. (2023). Life Cycle Assessment of helmets, Lazer Sport.

Appendix I

Data quality assessment

Table 35. Data quality assessment results – U101

Data description	Reliability of the source	Completeness	Temporal correlation	Geographical correlation	Technical correlation
U101					
Primary data for material	2	3	1	1	2
Primary data for inbound transportation	2	3	1	1	2
Primary data for manufacturing	3	3	1	1	2
Primary data for waste and losses	3	3	1	1	2
Primary data for packaging	2	1	1	1	2
Primary data for distribution	3	1	1	1	2
Secondary data for end-of-life	3	3	1	1	2

Table 36. Data quality assessment results – U103

Data description	Reliability of the source	Completeness	Temporal correlation	Geographical correlation	Technical correlation
U103					
Primary data for material	2	3	1	1	2
Primary data for inbound transportation	2	3	1	1	2
Primary data for manufacturing	3	3	1	1	2
Primary data for waste and losses	3	3	1	1	2
Primary data for packaging	2	1	1	1	2
Primary data for distribution	3	1	1	1	4
Secondary data for end-of-life	3	3	1	1	2

Completeness check

Table 37. Completeness check - U101 and U103

	U101	Complete?	U103	Complete?
Material production	x	yes	x	yes
Upstream transportation	x	yes	x	yes
Energy consumption	x	yes	x	yes
Loss and waste	x	yes	x	yes
Packaging	x	yes	x	yes
Distribution	x	yes	x	yes
End-of-life	x	yes	x	yes

Consistency check

Table 38. Consistency check - U101 and U103

	U101		U103		Compare?
Data source	Primary	OK	Primary	OK	Consistent
Data accuracy	Good	OK	Good	OK	Consistent
Data age	1 year	OK	1 year	OK	Consistent
Technology coverage	Production of existing product	OK	Production of a new product	OK	Consistent
Time-related coverage	Actual	OK	Actual	OK	Consistent
Geographical coverage	China	OK	China and Europe	OK	Consistent

Appendix II

Detailed environmental impacts

Table 39. Results for all environmental indicators – per life cycle stage – U101

	TOTAL	Raw materials	Upstream transportation	Manufacturing	Distribution	End-of-life treatment	Packaging
EF 3.1 Acidification [Mol of H+ eq.]	**4.37E-02**	1.54E-02	3.02E-05	1.90E-02	5.74E-03	3.39E-04	3.18E-03
EF 3.1 Climate Change - total [kg CO2 eq.]	**9.86E+00**	3.69E+00	1.58E-02	4.56E+00	3.09E-01	7.25E-01	5.62E-01
EF 3.1 Climate Change, biogenic [kg CO2 eq.]	**1.79E-01**	2.77E-02	5.51E-06	1.49E-03	7.63E-05	1.21E-01	2.81E-02
EF 3.1 Climate Change, fossil [kg CO2 eq.]	**9.53E+00**	3.51E+00	1.58E-02	4.56E+00	3.08E-01	6.03E-01	5.31E-01
EF 3.1 Climate Change, land use and land use change [kg CO2 eq.]	**1.51E-01**	1.46E-01	4.35E-07	2.02E-03	2.36E-05	2.28E-05	3.56E-03
EF 3.1 Ecotoxicity, freshwater - total [CTUe]	**7.14E+01**	5.19E+01	2.71E-01	1.03E+01	3.09E+00	1.92E+00	3.92E+00
EF 3.1 Ecotoxicity, freshwater inorganics [CTUe]	**4.16E+01**	2.35E+01	2.70E-01	9.71E+00	3.03E+00	1.91E+00	3.18E+00
EF 3.1 Ecotoxicity, freshwater organics [CTUe]	**2.98E+01**	2.83E+01	1.86E-03	6.23E-01	6.56E-02	1.19E-02	7.44E-01
EF 3.1 Eutrophication, freshwater [kg P eq.]	**1.89E-03**	5.56E-04	2.03E-09	7.28E-04	5.17E-06	6.64E-06	5.96E-04
EF 3.1 Eutrophication, marine [kg N eq.]	**1.14E-02**	3.42E-03	1.22E-05	4.20E-03	1.43E-03	1.02E-03	1.31E-03
EF 3.1 Eutrophication, terrestrial [Mol of N eq.]	**9.77E-02**	2.70E-02	1.34E-04	4.44E-02	1.57E-02	1.43E-03	9.07E-03
EF 3.1 Ionising radiation, human health [kBq U235 eq.]	**2.82E-01**	7.82E-02	5.57E-06	1.70E-01	8.82E-04	1.03E-03	3.14E-02
EF 3.1 Land Use [Pt]	**1.08E+02**	1.12E+01	4.72E-04	9.07E+00	1.90E-01	3.50E-01	8.69E+01
EF 3.1 Ozone depletion [kg CFC-11 eq.]	**7.77E-07**	6.94E-07	9.52E-16	4.16E-08	8.55E-10	1.03E-09	4.02E-08
EF 3.1 Particulate matter [Disease incidences]	**5.52E-07**	1.63E-07	1.69E-10	2.40E-07	9.89E-08	7.05E-09	4.25E-08

EF 3.1 Photochemical ozone formation, human health [kg NMVOC eq.]	**3.30E-02**	1.17E-02	2.73E-05	1.39E-02	4.09E-03	4.88E-04	2.76E-03
EF 3.1 Resource use, fossils [MJ]	**1.47E+02**	6.90E+01	2.27E-01	6.50E+01	4.22E+00	6.72E-01	7.72E+00
EF 3.1 Resource use, mineral and metals [kg Sb eq.]	**2.04E-05**	1.42E-05	1.05E-10	3.72E-06	3.85E-07	1.62E-07	2.00E-06
EF 3.1 Water use [m³ world equiv.]	**4.91E+00**	2.10E+00	7.10E-05	2.47E+00	5.19E-03	4.06E-02	2.97E-01

Table 40. Results for all environmental indicators – per life cycle stage – U103

	TOTAL	**Raw materials**	**Upstream transportation**	**Manufacturing**	**Distribution**	**End-of-life treatment**	**Packaging**
EF 3.1 Acidification [Mol of H+ eq.]	**2.13E-02**	6.12E-03	2.17E-04	1.08E-02	2.14E-03	2.71E-04	1.73E-03
EF 3.1 Climate Change - total [kg CO2 eq.]	**5.36E+00**	1.43E+00	8.82E-02	2.65E+00	2.64E-01	6.53E-01	2.69E-01
EF 3.1 Climate Change, biogenic [kg CO2 eq.]	**1.16E-01**	2.28E-02	3.15E-05	3.54E-03	8.50E-05	7.97E-02	9.74E-03
EF 3.1 Climate Change, fossil [kg CO2 eq.]	**5.21E+00**	1.41E+00	8.82E-02	2.62E+00	2.63E-01	5.73E-01	2.58E-01
EF 3.1 Climate Change, land use and land use change [kg CO2 eq.]	**2.72E-02**	1.14E-03	2.42E-06	2.45E-02	2.12E-05	1.71E-05	1.52E-03
EF 3.1 Ecotoxicity, freshwater - total [CTUe]	**4.04E+01**	2.65E+01	1.51E+00	5.21E+00	3.66E+00	1.66E+00	1.82E+00
EF 3.1 Ecotoxicity, freshwater inorganics [CTUe]	**2.52E+01**	1.29E+01	1.50E+00	4.04E+00	3.60E+00	1.65E+00	1.51E+00
EF 3.1 Ecotoxicity, freshwater organics [CTUe]	**1.52E+01**	1.36E+01	1.04E-02	1.17E+00	6.20E-02	9.10E-03	3.10E-01
EF 3.1 Eutrophication, freshwater [kg P eq.]	**1.35E-03**	3.34E-04	1.15E-08	4.64E-04	4.34E-06	5.02E-06	5.42E-04
EF 3.1 Eutrophication, marine [kg N eq.]	**5.52E-03**	1.40E-03	7.96E-05	1.81E-03	5.79E-04	8.93E-04	7.54E-04
EF 3.1 Eutrophication, terrestrial [Mol of N eq.]	**4.50E-02**	1.25E-02	8.76E-04	1.90E-02	6.33E-03	1.16E-03	5.14E-03
EF 3.1 Ionising radiation,	**3.88E-01**	8.84E-02	3.38E-05	2.50E-01	7.60E-04	7.76E-04	4.82E-02

human health [kBq U235 eq.]							
EF 3.1 Land Use [Pt]	**6.87E+01**	3.23E+00	2.66E-03	6.83E+00	1.61E-01	2.91E-01	5.81E+01
EF 3.1 Ozone depletion [kg CFC-11 eq.]	**3.37E-07**	2.48E-07	5.34E-15	8.04E-08	7.17E-10	8.75E-10	7.12E-09
EF 3.1 Particulate matter [Disease incidences]	**1.62E-07**	6.90E-08	1.84E-09	4.04E-08	3.33E-08	4.98E-09	1.29E-08
EF 3.1 Photochemical ozone formation, human health [kg NMVOC eq.]	**1.61E-02**	4.89E-03	1.86E-04	7.40E-03	1.61E-03	3.82E-04	1.65E-03
EF 3.1 Resource use, fossils [MJ]	**7.84E+01**	2.52E+01	1.26E+00	4.30E+01	3.70E+00	5.17E-01	4.66E+00
EF 3.1 Resource use, mineral and metals [kg Sb eq.]	**1.61E-05**	7.56E-06	5.92E-10	7.21E-06	3.23E-07	1.17E-07	9.32E-07
EF 3.1 Water use [m^3 world equiv.]	**2.25E+00**	4.98E-01	3.93E-04	1.52E+00	4.67E-03	3.80E-02	1.97E-01

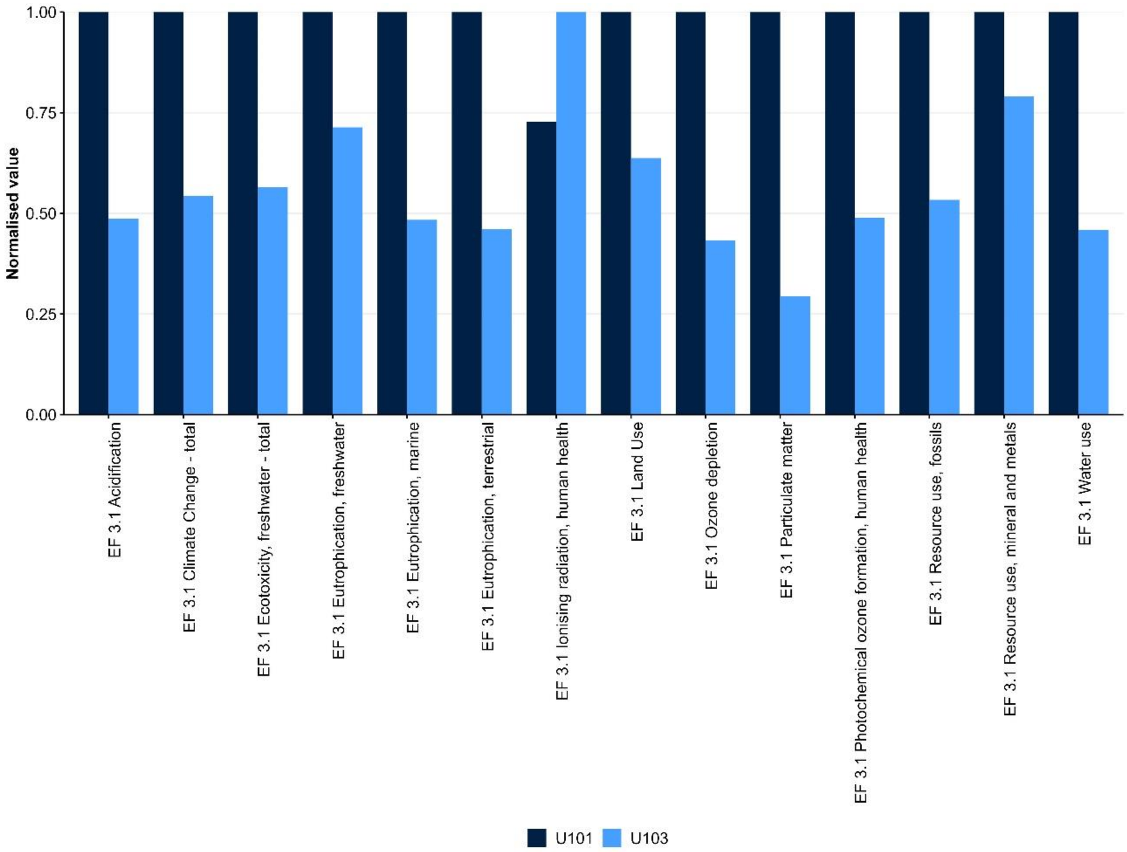


Figure 18. Environmental impacts – Comparison U101 and U103

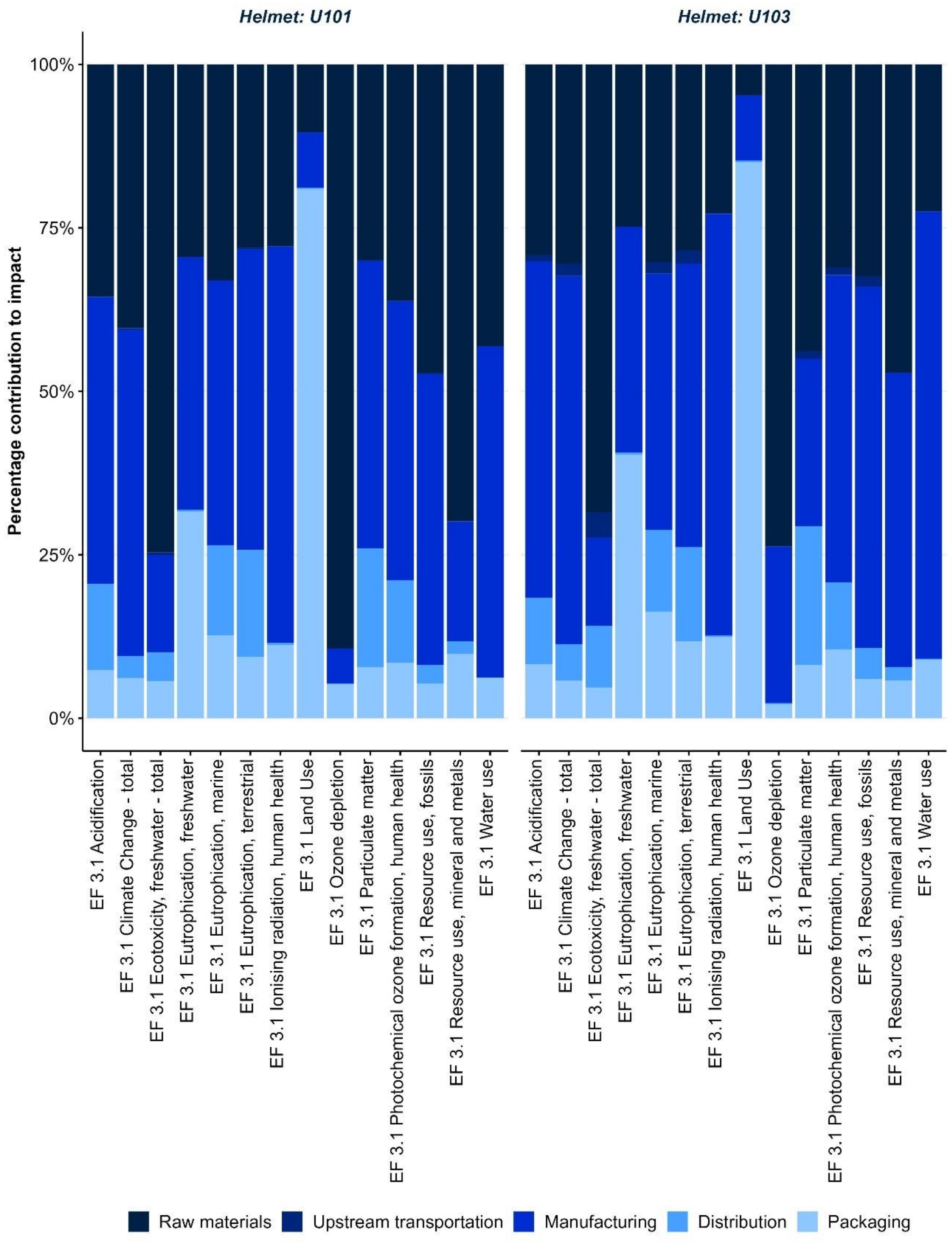


Figure 19. Contribution of each lifecycle stage, to all environmental indicators - U101 and U103

Appendix III

Sensitivity analysis – recycled PC

A sensitivity analysis has been made on the modelling of the recycled PC granulates. No data was provided on the washing of the raw materials nor the compound, therefore these inputs were excluded from the study. The purpose of this analysis is to check the influence of this exclusion on the total results.

An alternative modelling was made including the use of sodium hydroxide, chemicals and wastewater treatment extracted from the dataset "polyethylene terephthalate, granulate, amorphous, recycled" from ecoinvent 3.9.1.

The increase in environmental impacts is less than 1% overall. The indicator for which the increase is the highest is Land use, with a rise of 0.87% over the life cycle.

Appendix IV

Certificates of recycled materials

DIN CERTCO
Gesellschaft für Konformitätsbewertung mbH

CERTIFICATE

Certificate holder	**Sunpor Kunststoff GmbH** **Tiroler Str. 14** **3105 St. Pölten** **ÖSTERREICH**
Product	Products made of recycled material - flustix
Type, Model	Suncolor CirColor100
Testing basis	DIN EN ISO 14021:2021-10 DIN EN 15343:2008-02 Certification scheme Products made from recycled material - flustix (2023-02)
Mark of conformity	flustix RECYCLED 89 % PIR 8YF0033 DINCERTCO.DE/FLUSTIX
Registration No.	8YF0033
Valid until	2028-05-31
Right of use	This certificate entitles the holder to use the mark of conformity shown above in conjunction with the specified registration number. See annex for further information.

2023-05-23
Dipl.-Biol. Katharina Vehring, M. Eng.
Certification Body

GESELLSCHAFT FÜR KONFORMITÄTSBEWERTUNG MBH DIN CERTCO

ANNEX

Certificate	8YF0033 dated 2023-05-23
Technical data	Substance: Polystyrol Recycled content: 89 % Recyclate: Post-Industrial- Recycled Material (PIR) Product type: PS-Granules Colour: black
Testing laboratory/ Inspection body	DIN CERTCO Gesellschaft für Konformitätsbewertung mbH Alboinstr. 56 12103 Berlin GERMANY
Test report(s)	3366917 dated 2023-04-14

CERTIFICATE

for self-declared recycled content

LAZER SPORT NV

VINÇOTTE

Jan Olieslagerslaan 35
1800 Vilvoorde, Belgium

We verify that the hard shell of the helmet contains the following percentage of recycled content:

65%

Issued to:

Lazer Sport NV
Oude baan 3B
2800 Mechelen
Belgium

For the production of:

The hard shell of the helmet Verde KinetiCore.

Recycled content

The recycled content (polycarbonate) of the hard shell of the helmet consists out of 65% recycled content for all types of helmet out of the range Verde KinetiCore from Lazer.

VINÇOTTE

This certificate is awarded taking into account

- The rules and regulations in the verification protocol with reference, Vinçotte, 61180788_Lazer based on ISO14021 - Environmental -labels and declarations - Self-declared environmental claims (Type II environmental labelling) and ISO 14020 – Environmental statements and programmes for products – Principles and general requirements (ISO 14020:2022)
- The audit findings in the verification protocol with reference, Vinçotte, 61180788_Lazer

This certificate is only valid for the hard shell of the helmet.

Certificate number: **61180788_Lazer**

Issued on: **1st of March 2024**

This certificate expires on: **1st of March 2025**

On behalf of Vinçotte:

J.CARLE
Project engineer Sustainability & Environment

Control Union Certifications B.V.
Meeuwenlaan 4-6 , 8011 BZ , Zwolle , Netherlands , NL
+31 38 426 0100
www.controlunion.com

SCOPE CERTIFICATE

Scope Certificate Number: CU1015996GRS-2022-00162100

Control Union Certifications certifies that

Francisco de Oliveira & Ca, Lda.

License Number: CB-CUC- 1015996
Rua de Regatães, 369
4785-692 Trofa , Portugal , PT

has been audited and found to be in conformity with the
Global Recycled Standard (GRS)
- Version 4.0 -

Product categories mentioned below (and further specified in the product appendix) conform with the standard(s):
Product categories: Undyed yarns (PC0031), Dyed yarns (PC0029)

Process categories carried out under responsibility of the above-mentioned company for the certified products cover:
Dyeing (PR0008), Preparatory (PR0022), Trading (PR0030)
*The processes marked with an asterisk may be carried out by subcontractors.

This certificate is valid until:
2023-11-17

Audit criteria:
Global Recycled Standard V4.0; Content Claim Standard V3.1; Textile Exchange Standard Claims Policy V1.2

Place and date of issue:

Certification Body

Standard's logo

Zwolle, 2022-11-18
Last updated: 2022-11-08

On behalf of the Managing Director
Ricardo da Silva | Certifier

Certification Body Licensed by: Textile Exchange ; Licensing Code: CB-CUC
Certification body accredited by: Dutch Accreditation Council (RVA), Accreditation No: C 412
Inspection Body: Control Union Certifications B.V.
This Scope Certificate provides no proof that any goods delivered by its holder are GRS certified. Proof of GRS certification of goods delivered is provided by a valid Transaction Certificate (TC) covering them.
The issuing body may withdraw this certificate before it expires if the declared conformity is no longer guaranteed.
To authenticate this certificate, please visit www.TextileExchange.org/Certificates.

Control Union Certifications B.V.
Meeuwenlaan 4-6,8011 BZ,Zwolle,Netherlands,NL
+31 38 426 0100
www.controlunion.com

Scope Certificate Number: CU1015996GRS-2022-00162100 (continued)
Francisco de Oliveira & Ca, Lda.
Global Recycled Standard (GRS)

Products Appendix

Under the scope of this certificate, the following products are covered:

Product category	Product details	Material composition(*)	Label grade	Facility number
Dyed yarns (PC0029)	Filament (PD0069)	100.0%Recycled post-consumer Polyester (RM0189)	GRS	1015996
Undyed yarns (PC0031)	Filament (PD0069)	100.0%Recycled post-consumer Polyester (RM0189)	GRS	1015996

Note: * Quantification (percentages) of material composition is optional. [ ] Square brackets refer to certified components of a product.

Site Appendix

Under the scope of this certificate, the following facilities have been audited and found to be in conformity:

Facility name & number	Address	Process categories
Francisco de Oliveira & Ca, Lda. (main) 1015996	Rua de Regatães, 369 4785-692 Trofa Portugal, PT	Dyeing (PR0008) Preparatory (PR0022) Trading (PR0030)

Associated Subcontractor Appendix

Subcontractor name & number	Address	Process categories
	No subcontractors	

Independently Certified Subcontractor Appendix

Subcontractor name & number	Certification body	Expiry date	Address	Process categories
	No certified subcontractors			

Place and date of issue:

Zwolle, 2022-11-18
Last updated: 2022-11-08

On behalf of the Managing Director
Ricardo da Silva | Certifier

Certification Body

Standard's logo

License Number CB-CUC-1015996

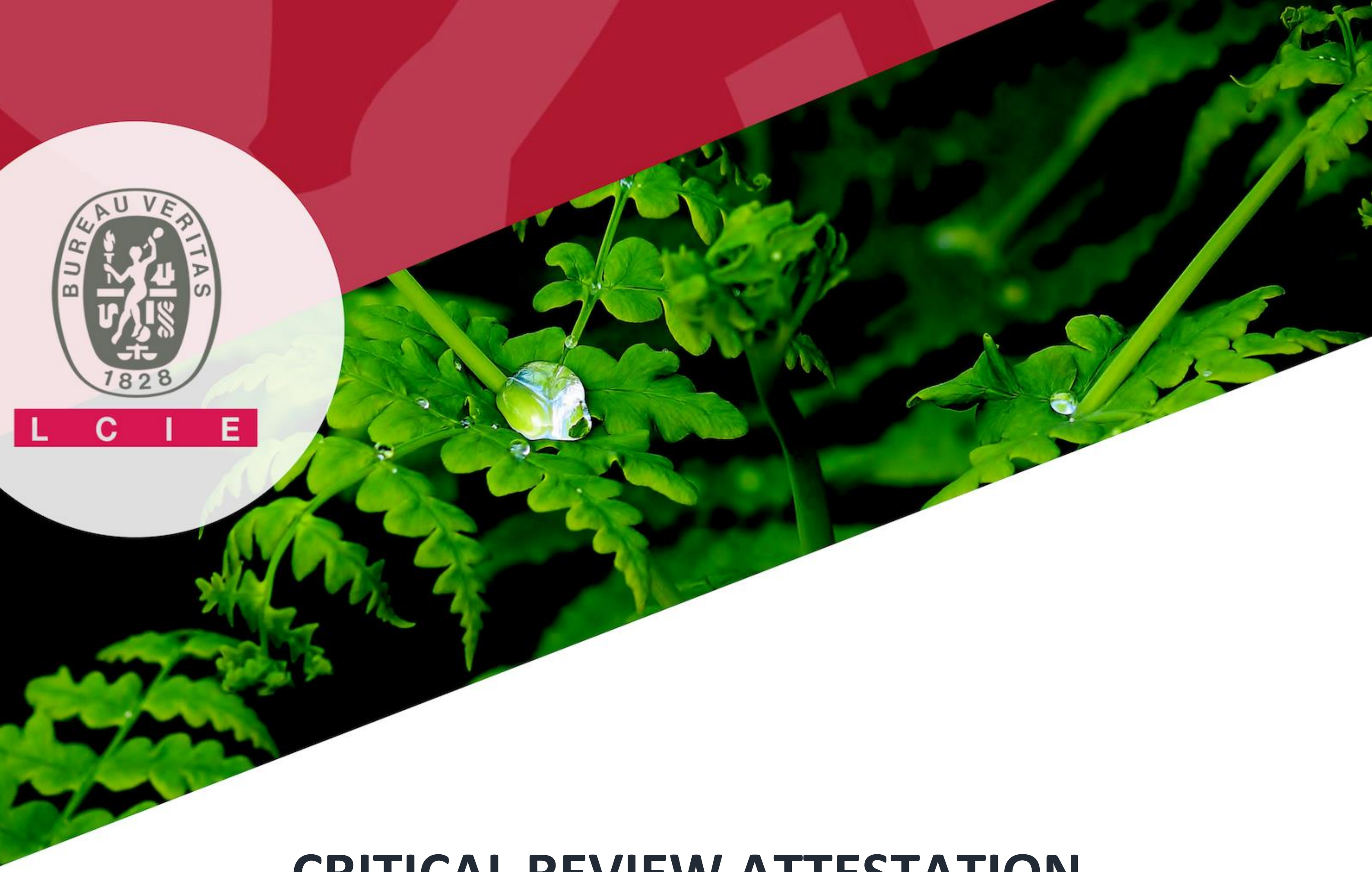
Date of issue: May 2023
Technical Department

We hereby certify that RECOMYDE® B30 P4, lot P4010, manufactured by NUREL S.A., does contain in its recipe a 99.2% recycled content, according to EN 15343.

Computer printed, valid without signature.

Disclaimer: The data indicated above are the results of our investigations and correspond to the state-of-the-art. The data refer to the state of the laws at the date of issue. Since the conditions of commercial production are not under our control, whether express or implied, NUREL S.A., makes no warranties with respect to the information contained herein.

Nurel S.A.
Ctra. Barcelona km 329
50016 Zaragoza. Spain
T +34 976 465 579
F +34 976 574 108
www.promyde.com



CRITICAL REVIEW ATTESTATION

LCIE n°	20542382 - 795165
CLIENT	Lazer Sport
LIFE CYCLE ASSESSMENT REPORT	"Life cycle assessment of Lazer Sport's helmets U101&U103 – internal version", performed by South Pole, 27th of March 2024
CONFORMITY TO	The Life Cycle Assessment study is compliant with ISO 14040:2006 and ISO 14044:2006. The critical review has been done in compliance with ISO 14071:2014. *Any change to the audited documents renders the attestation invalid. A new verification by Bureau Veritas is necessary.*
VERIFIER	Amandine VINCENOT & Béranger HOPPENOT, LCIE Bureau Veritas
LOCATION, DATE	At Moirans March 28, 2024
SIGNATURE	Amandine VINCENOT

SCOPE OF THE AUDIT

PRODUCTS	Helmets U101 & U103
GEOGRAPHICAL SCOPE	Manufacturing in China for U101 product and in Portugal for U103 product. Distribution and end-of-life according to the following allocation: - Europe – 63% - North America – 14% - Asia – 10% - South America – 9% - Oceania – 4%
LCA SYSTEM BOUNDARIES	Cradle-to-Grave
LCA RESULTS	The study shows that, except on the ionizing radiation, the impacts are lower on every indicator for the U103 products which is made with recycled materials. The impact on ionising radiations is explained by the manufacturing place of the product in Portugal which uses nuclear electricity. On climate change and the whole life cycle, the U101 emits 9.86 kg CO2 eq. and the U103 emits 5.36 kg CO2eq. When modelling an ideal scenario where the U103 is 100% recycled because of its easy dismantling, CO2 emissions are reaching 4.82 kg CO2eq.

CODDE – Department of LCIE Bureau Veritas
170 rue de Chatagnon – 38430 MOIRANS - +33 (0)4 76 07 36 46
www.codde.fr

LIFE CYCLE ASSESSMENT
CRITICAL REVIEW REPORT

Life cycle assessment of Lazer Sport's helmets U101&U103

LAZER SPORT

LCIE n°	20542382 - 795165
CLIENT	LAZER SPORT
VERSION OF THE REPORT	1
DATE OF THE VERSION	28 March 2024
UPDATE	Not applicable – initial version
LCIE DEPARTMENT	Department CODDE of LCIE Bureau Veritas
VERIFIER	VINCENOT Amandine & HOPPENOT Béranger
SIGNATURE	Amandine VINCENOT

SUMMARY

1. CRITICAL REVIEW STATEMENT

We hereby confirm that, following the checks performed, in accordance with the limits of the scope of our appointment, nothing has come to the verifiers' attention to suggest any data errors or deviations from the requirements by the "Life cycle assessment of Lazer Sport's helmets U101&U103" and its project report, in terms of :

- the underlying data collected and used for the LCA calculations,
- the way the LCA-based calculations has been carried out to comply with the calculation rules,
- the presentation of environmental performance included in the project report, and
- any other information included in the project report

with respect to the procedural and methodological requirements in ISO 14040/44:2006.

We confirm that, in accordance with the limits of the scope of our appointment, the company-specific data has been examined as regards plausibility and consistency. The declaration owner is responsible for its factual integrity and that the product does not violate relevant legislation.

We confirm that we have sufficient knowledge and experience of hardline products, relevant standards and the geographical area of the Lazer Sport products to carry out this verification.

We confirm that we have been independent in our role as verifiers, i.e. we have not been involved in the execution of the Life Cycle Assessment of Lazer Sport products and have no conflicts of interest regarding this verification.

Name and organization of verifiers:	Amandine VINCENOT & Béranger HOPPENOT, LCIE Bureau Veritas 170 Rue de Chatagnon 38430 MOIRANS FRANCE	
Date and location:	At Moirans March 28, 2024	
Signature:	Amandine VINCENOT	

2. PRINCIPLES AND SCOPE OF THE CRITICAL REVIEW

2.1. STANDARD REFRENCES

This verification released by LCIE Bureau Veritas is made according to the following standards:

- **ISO 14040:2006** « Life cycle assessment — Principles and framework »
- **ISO 14044:2006** « Life cycle assessment — Requirements and guidelines »
- **ISO 14071:2014** « Life cycle assessment — Critical review processes and reviewer competencies: Additional requirements and guidelines to ISO 14044:2006 »

2.2. PRINCIPLES OF THE CRITICAL REVIEW

In accordance with the ISO 14 044 standard, the critical review allows to "guarantee that:

- The methods used to perform the LCA are consistent with this International Standard
- The methods used to perform LCA are valid from a scientific and technical point of view
- The data used are appropriate and reasonable in relation to the objectives of the study
- Interpretations reflect the limitations identified and the objectives of the study
- The study report is transparent and consistent"

If the producer of the LCA study drafts a new version of the final LCA report, the critical review report and the critical review statement are no longer applicable.

2.3. SCOPE OF THE CRITICAL REVIEW

Established in 1919, Lazer has been at the forefront of helmet innovation, design, and technology in the industry, prioritizing protection. All of their products are crafted in Belgium and cater to cyclists of all levels. South Pole has previously conducted two LCA studies on Lazer Sport's LZB-27 and LZB-29 helmets. As a follow-up, South Pole has conducted two new LCAs on different helmets (U101 and U103), adhering to the ISO 14040:2006 and ISO 14044:2006 standards.

One of these helmets (U103) is a novel product developed by Lazer Sport, slated for release in April 2024. It incorporates recycled materials for its primary components and features a streamlined design aimed at reducing environmental impact, aligning with broader sustainability initiatives.

The LCA study is composed of:

- A life cycle assessment report for internal communication
- A life cycle assessment report for third party

The documents in the scope of this audit are listed in the following table:

Documents	Type of document	Version, Date
Life cycle assessment of Lazer Sport's helmets U101&U103 – for external communication	Report (PDF file)	V.01, 27/03/2024
Life cycle assessment of Lazer Sport's helmets U101&U103 – Internal version	Report (PDF file)	V.01, 27/03/2024

The scope of this audit is limited to these elements:

- **Products scope:** Helmets U101 & U103

Name	Size	Mass (g)	Main Production Location	Main Materials
U101 (One+)	Unisize M	517	China	EPS, PC, PA, POM Virgin materials
U103 (Verde)	Unisize M/L	495	Portugal	EPS, PC, PA, POM Including recycled content

- **Geographical scope:** Manufacturing in China for U101 product and in Portugal for U103 product. Distribution and end-of-life according to the following allocation:
    - Europe – 63%
    - North America – 14%
    - Asia – 10%
    - South America – 9%
    - Oceania – 4%
- **LCA results:** The study shows that, except on the ionizing radiation, the impacts are lower on every indicator for the U103 products which is made with recycled materials. The impact on ionising radiations is explained by the manufacturing place of the product in Portugal which uses nuclear electricity. On climate change and the whole life cycle, the U101 emits 9.86 kg CO_2 eq. and the U103 emits 5.36 kg CO_2eq. When modelling an ideal scenario where the U103 is 100% recycled because of its easy dismantling, CO_2 emissions are reaching 4.82 kg CO_2eq.
- **Life cycle steps included:** Cradle-to-Grave. The use phase is considered to have no impacts.
- **Excluded**: The use of pallets for the distribution stage and some consumables that have been considered negligible because representing less than 5% of the total mass of the product.
- **Assessment of life cycle inventories models**: No
- **Assessment of all individual data provided by the manufacturer**: No

2.4. BUREAU VERITAS VERIFIERS

The verifiers from Bureau Veritas in charge of this critical review is:

- VINCENOT Amandine & HOPPENOT Béranger, LCA & Ecodesign consultant
  LCIE Bureau Veritas
  170 Rue de Chatagnon
  38430 MOIRANS
  FRANCE

2.5. PROCESSUS AND AGENDA OF THE CRITICAL REVIEW

The critical review has been released in the end of the study in order to validate the objectives, the key hypotheses of the study and the granulometry level of the data collection, then at the end of the study to validate all the results.

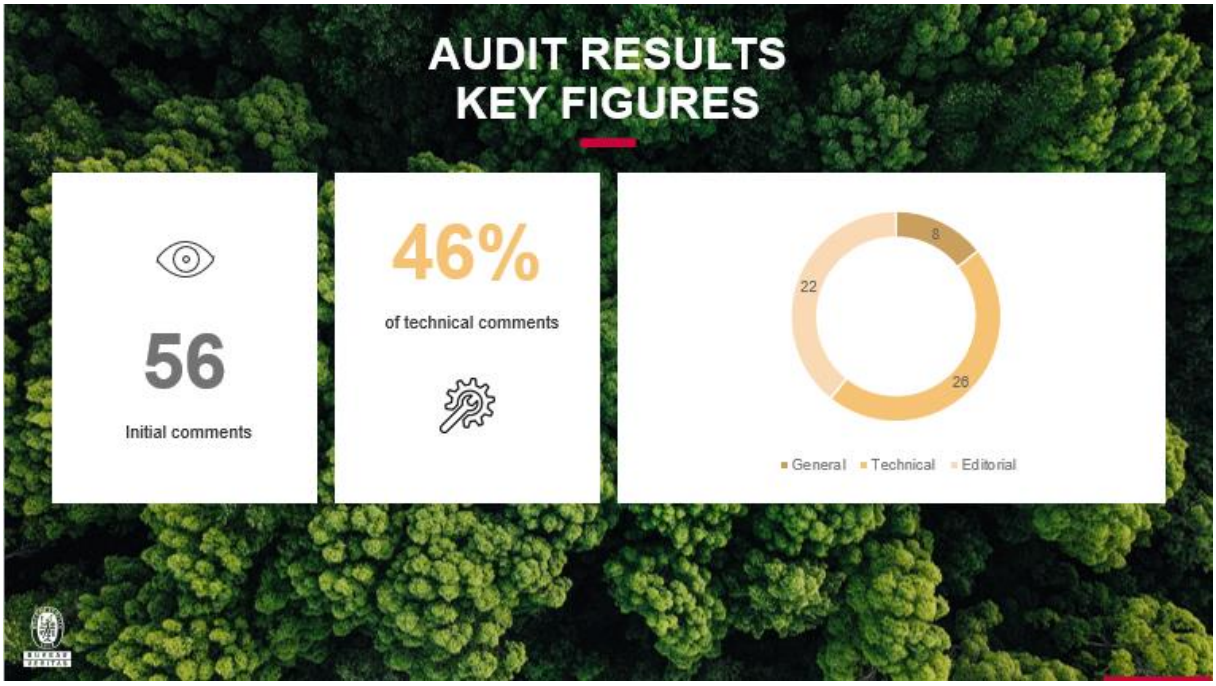
The agenda of the audit is summarized in the following table.

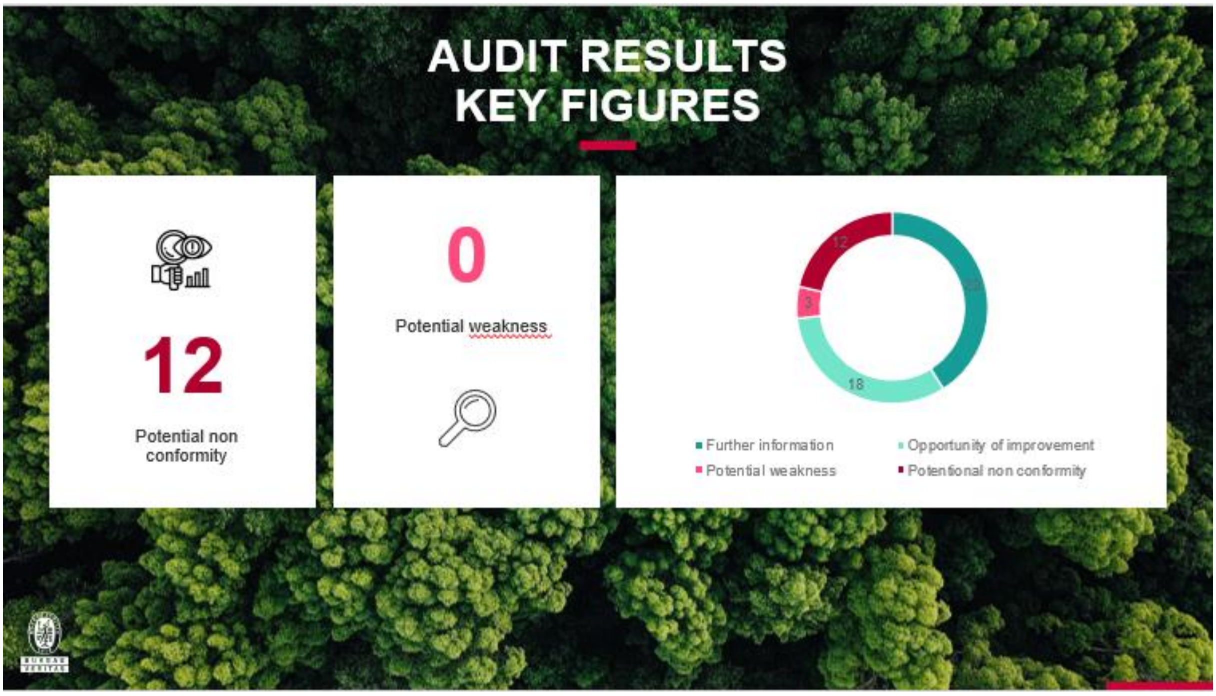
Action	Date	Type of meeting	Client	Bureau Veritas
Kick off meeting	16/2/2024	Visio	South Pole team	Amandine Vincenot
Review of the LCA	From 19/02/2024 to 01/03/2024	/	/	Amandine Vincenot Béranger Hoppenot
Treatment of the comments made by Bureau Veritas	From 01/03/2024 to 05/03/2024	/	South Pole team	/
Review of the comments	From 05/03/2024 to 05/03/2024	/	/	Amandine Vincenot Béranger Hoppenot
Treatment of the comments made by Bureau Veritas	From 05/03/2024 to 08/03/2024	/	South Pole team	/
Review of the comments	From 08/03/2024 to 12/03/2024	/	/	Amandine Vincenot Béranger Hoppenot
Treatment of the comments made by Bureau Veritas	From 12/03/2024 to 14/03/2024	/	South Pole team	/
Review of the comments	From 14/03/2024 to 15/03/2024	/	/	Amandine Vincenot Béranger Hoppenot
Treatment of the comments made by Bureau Veritas	From 15/03/2024 to 19/03/2024	/	South Pole team	/
Reception of the final documents	27/03/2024	/	South Pole team	/

3. CONCLUSIONS OF THE CRITICAL REVIEW

3.1. INITIAL VERIFICATION

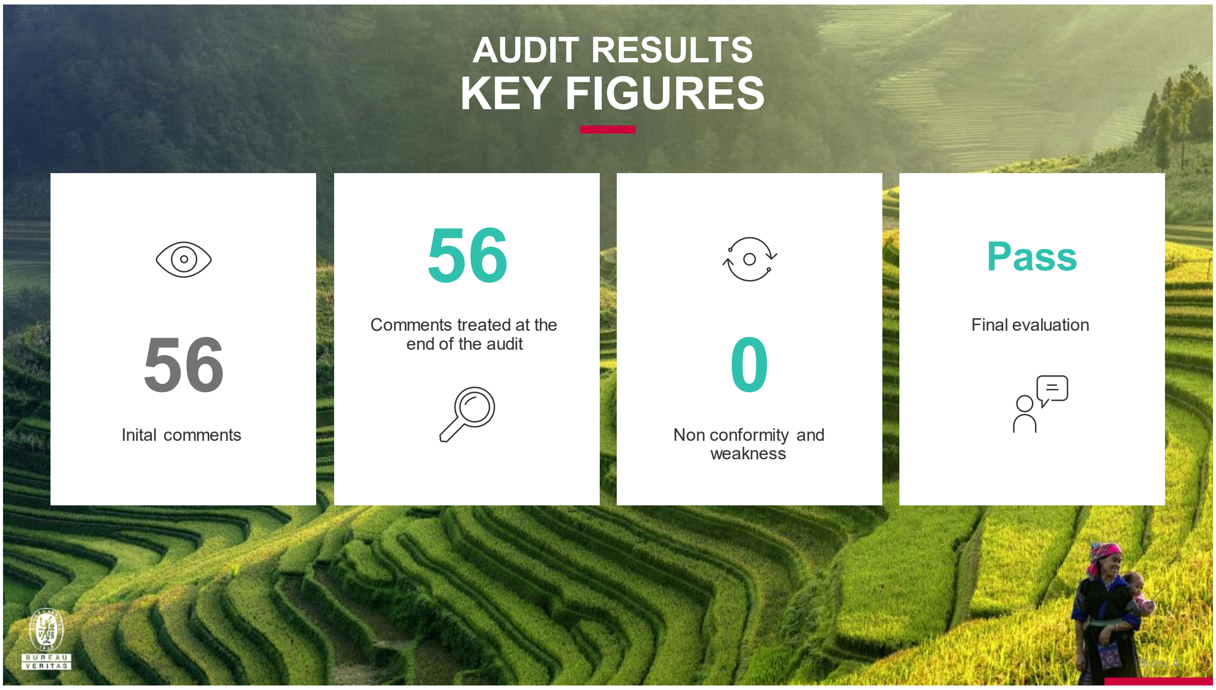
At the beginning of the audit, the critical review contained **56 comments**.





3.2. FINAL VERIFICATION

At the end of the audit, the critical review contains **0 comment**. South Pole has treated all comments made by the auditors.



All the comments and exchanges are presented in the appendix of this report.

The main strength points of this Life Cycle Assessment study are:

- The hypotheses and methods used are appropriate in relation to the objectives of the study and the type of equipment studied.
- The LCA report is detailed.
- Most of the data used is primary data from Lazer Sport's factories.
- The results and conclusions of the study are consistent. In addition, the analysis of the results associated with the of sensitivity analysis allow a good understanding of the ecological advantages and limits of product U101 and U103.
- Limits are well identified.
- The analysis of the results proved the U103 product is eco-designed compared to the U101 product.
- The report is transparent and objective on the hypothesis, dataset and quantity modelled.

The main points of improvement of this Life Cycle Assessment study are:

- Secondary data and proxy were used to modelled certain processes, especially for recycling processes. In order to get a better result with less incertitude, a collect on recycled plastic used by Lazer sport is recommended. Recycled plastic being one of the solutions to lower the general impact, primary data should be gathered on this material.

- The main point of improvement is the durability of each product. There were supposed to last as long as the other, but it is not based on technical evaluation. In future study comparing products, the lifetime of the products should be evaluated.

- U103 product is not yet on the market and its sells repartition can vary from the actual modelling. But, impact from transport not being a main contributor to the final result, variation will not change final conclusion

- The 100-0 methodology was a good first step to identify the product's main contributors in the manufacturing stage. It could be interesting for a further study to evaluate it using the Circular Footprint Formula from the PEF. This could give another view on the eco-design axis such as the end-of-life stage. However, representative data for the treatment at the End-of-life are required.

4. CRITICAL REVIEW PRACTITIONER'S SELF-DECLARATION AND SKILLS SELF-DECLARATION

We, the undersigned, hereby declare:

- Be employed neither full time nor part time by the sponsor or the producer of the LCA study (external review practitioners only)
- Not to have been involved in the definition of the field of study or in the execution of any of the tasks linked to the realization of the LCA study targeted, i.e. not having is part of the project team (s) of the sponsor or the director
- Have no personal financial, political or other interests related to the results of the study

Our skills in relation to the targeted critical review include knowledge and mastery:

- ISO 14040 and ISO 14044
- LCA methodology and practices, particularly in the context of LCI (including the creation of data sheets and the review of data sheets, if applicable)
- Critical review practices
- Scientific disciplines relevant to the important impact categories of the study
- Technical environmental aspects and other relevant performance characteristics of the product system (s) evaluated
- The language used for the study

We declare that the above information is true and complete. We will immediately inform all parties involved (sponsor of the critical review, producer of the LCA study, review practitioner (s)), as the case may be, if the validity of any of this information changes during the review process.

Date: 28 March 2024

Name: Amandine VINCENOT & Béranger HOPPENOT

Signature:

5. EXCHANGES WITH VERIFIER DURING THE CRITICAL REVIEW

14044:200	Verification to		Review	Page	Paragraph number	Figure/Table	Type	Type	Detailed comment from Bureau Veritas	Additionnal recommandation from Bureau Veritas	Answer from client	Verification of the action by Bureau Veritas	Status	Answer from Client	Verification of the action by Bureau Veritas	Status	Answer from Client	Verification of the action by Bureau	Status	Answer from Client	Verification of the	Status
	General comment:																					
		Page setting	BH/AV	5	List of tables		ed	OI	The table 32 doesn't appears in the list of tables.		Corrected	Ok	Yes									
		Page setting	BH/AV	7	Acronyms and abbreviations		ed	OI	ABS abbreviation is not correctly classified.	To respect the alphabetic order, it should be the first abbreviation	Corrected	Ok	Yes									
		Release date of U103	BH/AV	9	1.1		ge	FI	Please add the estimated date of release in the market for the U103 product.		*to be confirmed with Lazer Sport*	NA	No	Added (April 2024)	Ok	Yes						
		Use of "mole"	BH/AV	/	/		ed	OI	The symbol for a mole is "mol". It should be written mol of H+-eq or Mol of N-eq as in the PEFCR apparel and footwear you quote.		Corrected	Still in interpretation graphics	No	Corrected	Still 4 "mole" references : figure 12, 13, 14, 15	No	Done	Ok	Yes			
		sentence split in two	BH/AV	/	/		ed	OI	Some sentence are split in two. Generally it involves the quote of two tables or two figures	Ex: pages 46 (between 3. and 4.), 44 (beginning), 36 (3.1.3), 34 etc.	Corrected	Still present, maybe it is the pdf publication ? Ex page 36. This stage includes both primary and secondary packaging materials. Detailed LCI information can be found in Table 20 and	No		NA	No	Done	The sentences are still split in two but it is not an issue to understand the report.	Yes			
		Duplicate	BH/AV	42	3.1.5	Table 29	ed	OI	In the first column of the table "Leg", "From factory to warehouses" is in double.		corrected. Also, the step from local warehouses to retails was missing from the table and is now added	Ok	Yes									
		Wrong reference	BH/AV	47	3.3		ed	OI	The subchapter 2.4 is mentioned but it doesn't exist.		corrected, it was 2.2.3	Ok	Yes									
		Wrong reference	BH/AV	47	3.4		ed	OI	The subchapter 2.2.6 is mentionned for the description of data quality indicator. However, it is, in reality the 2.2.5		Corrected	ok	Yes									
		Typo	BH/AV	38	3.1.4		ed	OI	The sentence "transportation of raw materials ad packaging" is missing a 'n' letter	NA	NA	NA	No	Corrected	Ok	Yes						
		Carton	BH/AV	37	3.1.3		ed	OI	It is mentionned "carton" as a packaging, did you mean "cardboard" ?	NA	NA	NA	No	Corrected	Ok	Yes						
4	Methodological fra		ework for LCA																			
4.1	General requireme		ts																			
		Number of LCA stages	BH/AV	8	Executive summary		ed	OI	It is mentionned "five main phases of LCA" instead of four.	"goal definition" and "scope definition" is one phase "goal and scope definiton"	Corrected	ok	Yes									
4.2	Goal and scope def		ition																			
4.2.1	General																					
4.2.2	Goal of the study																					
		Presentation of the products	BH/AV	11	2.1		ge	OI	The paragraph on the products' presentation should be put aside in a specific subchapter.	It better fit the "Scope" subchapter	Done	ok	Yes									
4.2.3	Scope of the study																					
4.2.3.	General																					
4.2.3.	Function and funct		nal unit																			
		Lifetime	BH/AV	12	2.2.1		te	NC	The lifetime must be precise and measurable. It can not be a range of lifetime.	Select a precise lifetime and justify why you choose this one. It could be based on material lifetime, number of utilisation, etc.	In the previous study it was presented this way. It's because there is no precise data from Lazer Sport on this matter, only a range. Should we use 2 or 5 ? Or an average ?	Use norms and tests made by Lazer Sport to determine the criteria of performance as well as the lifetime. Helmet providers usually suggest a lifetime after which the helmet must be change. You can also use bibliography.	No	After checking with Lazer Sport, we changed to 2 years as it's the minimum when used daily and in extreme conditions, according to them.	Ok	Yes						

	Functional unit	BH/AV	12	2.2.1		te	NC	This is not a functional unit. It should be a precise criteria of performance.	Please add a criteria of performance. As the products are sell in Europe, they probably must respect some shock resistance criteria. You could add a minimum resistance to shock, for instance. A correct functional unit can be "protect the head of a biker from a shock at maximum XXm/s for Y years/Y use"	Is it ok if we indicate that this is a declared unit, and correct it through the whole report? Or do we have to add a criteria of performance for declared units too? In the previous study we indicated that no performance criteria was considered.	The functional unit has to be stated correctly with a performance criteria as stated in the ISO 14044. It was a mistake on my part : for this study the declared unit will be identical to the functional unit and has no interest.	No		Na	No	Lazer Sport shared with us some compliance documents to some standards about the performance. Is it ok if we put the functional unit as: "The use of one helmet during two years, protecting the user from a shock of maximum 250G to the head at a speed of 6.5 m/s on a flat anvil and 5.42m/s on a kerb anvil"	This functional unit is great. You can add it to the report.	No	Done	Ok	Yes
4.2.	**System boundary**																				
	Maintenance acitivities	BH/AV	12	2.2.1		ed	OI	The last paragraph of the 2.2.1 section will fit better in 2.2.2 System Boundaries section		Corrected	ok	Yes									
	Process flow diagram - U101	BH/AV	14	2.2.2		ed	OI	In the Spoton, for PA and ABS injection moulding, the material flow inpout is not labelled correctly (EPS instead of PA/ABS)		Corrected	Ok	Yes									
	Cut-off criteria	BH/AV	14	2.2.2		te	NC	Add a table which allows to see the total mass excluded and what it represents at the scale of the product (%).		*to be done*		No	The inputs excluded listed in section 2.2 can not be quantified. In section 3.3, a table was added for threads and label carriers. Exclusions such as transportation losses are not available, but are assumed to be equal to 0 and should not exceed a few %. Similarly, no information is available for the ink for packaging materials but it's necessarily a negligible amount.	Ok	Yes						
	Reference to a sub-chapter	BH/AV	15	2.2.3		ed	FI	For futher specific exclusions, you mentioned 3.1 sub-chapter, didn't you meant 3.3 ?		Corrected	Ok	Yes									
	Page setting	BH/AV	13	2.2.2		ed	OI	The paragraph between the figure 2 and the figure 3 is not in justified		Do you mean that it should be removed?	No, it is just editorial : I meant the text in not aligned both to the right and left	No	Corrected	Ok	Yes						
	Manufacturing scheme	BH/AV	13	2.2.2	Figure 2	te	W	In Spoton's factory, we can see injection of ABS and PA but there is no material input for ABS and PA		Corrected	Ok	Yes									
4.2.	**LCIA methodology and types of impact**																				
4.2.	**Types and sources of data**																				
	Databases	BH/AV	9	1.1		ed	FI	In the sentence "The LCA study has been modelled in GaBi software version 10.7, using the ecoinvent 3.9.1 database (Wernet, et al., 2016) and EF3.1 impact assessment method.", please add Sphera database		Corrected	Ok	Yes									
4.2.	**Data quality requirements**																				
	Data quality requirements	BH/AV	17	2.2.4		te	NC	Add precision on the data quality requirements. The information must concerned this specific study and must be quantitative. A distinction must be done between the requirements and the actual data	The future must not be used neither "should" term. For time-related coverage, you could write for the requirements : the study must be representative of the 2023 year. For the actual data : data collection conducted in 2023 on a product sold in 2023... The datasets used might not all be representative for the 2023 year but the most recent dataset was selected and has a reference date from no later than 2013.	Corrected	Quantify every type of data quality as you did with the time coverage (Ex: geographical coverage - Portugal and chinese assembly, technology - bike helmet, technology based on materials and shape, uncertainty - cut-off rule of 5%, etc.). Moreover, a difference should be shown between the data requirements at the beginning of the study and the actual data (for instance, the scenario distribution of U103 is not representative of 2023 as it was not sold at this moment, it was extrapolate)	No	Table 2 has been modified. Regarding the actual data, there are two tables in Appendix where the data quality is assessed for each life cycle step.	Ok	Yes						
	typo	BH/AV	60	Appendix I	table 34	ed	OI	it is writtent U101 in the table for U103		NA	NA	No	Corrected	Ok	Yes						
4.2.	**Comparison between systems**																				
4.2.	**Critical review considerations**																				
	Critical review	BH/AV	12	2.1		te	NC	The name of the reviewers must be precised	Please add "The critical review was conducted by Amandine Vincenot and Béranger Hoppenot from the LCIE Bureau Veritas - CODDE department"	Added	Ok	Yes									
	Critical review	BH/AV	12	2.1		ed	W	In the sentence "A third-party review will be conducted at the end of the study", the future is used.	Please change to past so it is not confusing for the reader.	Corrected	Ok	Yes									

4.3	**Life cycle inve** **tory analysis (LCI)**																	
4.3.	**General**																	
	Link with a pragraph section	BH/AV	31	3.1.1		ed	Ol	the reference to the "7. Limitations of the study" is actually link with the **"6. Limitations of the study"**	The number is wrong	Corrected	Ok	Yes						
4.3.	**Collecting dat**																	
	REACH	BH/AV	20	2.2.7		ed	Ol	the H uppercase was forget in REACH mention		Corrected	ok	Yes						
	Recycled PC	BH/AV	27	3.1.1		ge	Fl	It is mentionned that "The recycled PC is produced from the shredding, compounding and extrusion of waste CDs." Can you add a source ?		This is the information we got from the supplier directly, so this refers to their specific production process, and not to recycled PC in general. However, I don't know if this is a document we are allowed to share, we can ask Lazer Sport if you think that's necessary. I modified the text to clarify that this is info from the supplier.	Ok	Yes						
	Recycled PC	BH/AV	27	3.1.1		te	Fl	What is the additional compound ? Precise the mass and why it is negligible		We don't have any information on the additional compound, neither on the composition or the mass, but it should not exceed 1 or 2%. Therefore, we decided to model this as 100% PC. The text was modified to clarify.	Ok	Yes						
	Nylon 6	BH/AV	28	3.1.1	Tables 8 & 9	te	Fl	It is mentionned you used nylon 6-6 dataset for the production of nylon 6. Why didn't you use the dataset "nylon 6".			NA	No	For the U101, it's PA66 that is used, it's now corrected in the report. However, for the U103, it's PA6, so indeed the virgin part should be nylon 6; it's now corrected.	Ok	Yes			
	TPR production	BH/AV	28	3.1.1	Tables 8 & 9	te	Fl	A polyurethane rigid foams is used to modelled TPR. However, it seems that TPR is a thermoplastic rubbers	Why didn't you use the dataset "synthetic rubber production"		NA	No	Indeed, it's now modified	Ok	Yes			
	PU production	BH/AV	28	3.1.1	Table 8	te	Fl	is the PU a foam or is the dataset "polyurethane rigid foam" an approximation ?		The PU is a foam	Ok	Yes						
	LCI U103	BH/AV	29	3.1.1	Table 9	te	Fl	Why using certain dataset with 'market for' included ?		'market for' are used when no information was provided on the origin of the raw material	Ok	Yes						
	Padding heatpress	BH/AV	32			te	Fl	Please add the value and your source for the amount of electricity modelled for the padding heatpress.		Na	NA	No	This is the article that was used : https://link.springer.com/article/10.1007/s10570-020-03033-9 0.178 kWh is used for the U103 and 0.199 kWh for the U101. This was very difficult to find a generic number from the literature for that, therefore this one has a high uncertainty. However, last year we did a sensitivity analysis to check the influence, and it showed that it has a very low influence on the overall results (less than 1%). Therefore the value was kept, and assumed that the influence is still low.	Ok for the source but can you, please add the value in the report ?	No	Done, see table 15	Ok	Yes
	Use of recycled material	BH/AV				te	NC	If you intend to communicate to the general public on this study or the recycled content of U103 product (PC and other material), the proof of purchase recycled materials must be added in appendix		NA	NA	No	Lazer Sport shared with us the certificates for the recycled materials. Should we put them all in appendix or is it enough to share them with you?	Please, add it in appendix	No	I'll add them at the end once the reports are done	The certificate for recycled PA mention a recycled content of 99.2%. In the modelling you only consider 30%. The modelling is valid anyway as it is maximizing.	Yes
	End of life U103	BH/AV	43	3.1.7		te	Fl	In the paragraph on the end-of-life treatment, it is not clear how is treated the U103 product for the reference scenario.		NA	NA	No	It's now clarified.	Ok	Yes			
	recycled EPS	BH/AV	4.2	48		te	fi	Following the integration of the recycled EPS LCA from the supplier, I do not see any change in the results and the graphics. Have the results been updated ?	Please check also the graphics from 4.4 which have not changed. I expected to see an important difference in the figure 14. Figure 18 and 19 also seem identical to the previous version	Na	NA		NA	NA	No	All results and graphs have been updated. However, results have not changed much, as the modelling we used before for the EPS already included recycled content	Ok	Yes

4.3.	**Calculating data**																	
4.3.	**General**																	
	EPS impact liner production	BH/AV	33	3.1.2	Tables 15 & 16	te	FI	There is a high difference between the consumption value of the U101 and U103 products. Is there an explaination of why the Portugese liner production is so consuming compare to the chinese one ?	The EPS mass for U101 is 130 g/FU and for U103 is 162.8 g/FU. So there is only a difference of 25% between the two mass.	Unfortunately we don't have an explanation as these data come from two different suppliers. However, the process is not exactly the same as in the case of the U101 the impact liner is molded over the other components to form the helmet, while in the case of the U103 it's an independent injection molding process.	Ok	Yes						
	Tier 1/ Tier 2/Tier 3	BH/AV	Transport	/		ed	FI	What is the meaning of Tier 1, Tier 2, and Tier 3 in transportation ?		It refers to the different steps through the supply chain. Tier 1 refors to the direct supplier of the final factory, tier 2 to the supplier's supplier, etc.	Please add this sentence in the report so it is clear to every reader.	No	It's now added in a footnote.	Ok	Yes			
	Upstream transport	BH/AV	39	3.1.4	Table 22 & 23	ed	FI	Please add the mean of transport in tables 22 & 23. It is precise for some lines but not for all		Corrected	Ok	Yes						
	Load rate of trucks	BH/AV	Transports	/		te	FI	Did you consider a % of load rate and a % of empty return rate when modelling a truck transport ?		A load rate of 61% (which includes empty returns) is used by default for all truck transport.	Ok	Yes						
	Recycling of carboard and paper	BH/AV	45	3.1.7	Table 31	te	FI	I can't find the value 99% of recycled share for Europe representatitvity	can you please share the link of these data ?	This is when exporting the waste treatment data for paper and cardboard for all Europe in 2020. However, after double checking it should be 98%. It's now corrected.	Can you please send me the internet link ?	No	https://ec.europa.eu/eurostat/databrowser/view/env_wastrt__custom_10249603/default/table?lang=en	ok	Yes			
	Manufacturing losses	BH/AV				te	FI	I found few information on the manufacturing losses of your products. Can you precise if you considered loss rate in your supplier manufactories ?		For injection moulding processes, the loss rate used in the modelling is the one from the default ecoinvent dataset (0.6%), as explained in section 3.1.2. The information was indeed missing for the EPS parts, but it's now added (2% for both helmets). For other components, the loss rates are indicated.	Ok	Yes						
4.3.	**Validation of data**																	
4.3.	**Relating data to unit process and functional unit**																	
4.3.	**Refining the system boundary**																	
4.3.	**Allocation**																	
4.3.	**General**																	
4.3.	**Allocation procedure**																	
4.3.	**Allocation procedures for reuse and recycling**																	
	Confusing sentence	BH/AV	21	2.2.8		ge	NC	the sentence "Consequently, in this study, the environmental impacts of waste processing aren't taken into account and are presumed to belong to the next product system" lets think no impacts are considered for the end of life	In the cut-off method, the impacts for waste incineration without energy recovery and for disposal must be considered, please precise the sentence.	Corrected	Ok	Yes						
4.4	**Life cycle impact assessment (LCIA)**																	
4.4.	**General**																	
4.4.	**Mandatory elements of LCIA**																	
4.4.	**General**																	
4.4.	**Selection of impacts categories, category indicators and characterization models**																	
4.4.	**Assignment of LCI results to the selected impact categories (classification)**																	
4.4.	**Calculation of category indicator results (characterization)**																	
4.4.	**Resulting data after characterization**																	
	Indicators selection	BH/AV				te	NC	The indicators selection used for the interpretation must be based on scientific method and be relevant form an environmental point of view. Please use the PEF methodology or another well-known methodology to select the indicators.		NA	NA		The current choice of indicators is justified in the report, and was partly based on last year's study. After checking the contribution of each indicator to the overall single score (from EF3.1 methodology), the choice of indicators is quite aligned with this, but not fully as it's not exactly the top 80%. For example, photochemical ozone formation contributes slightly more than water use for both helmets. However, we still think that this selection of indicators is relevant as the purpose was also to cover different types of environmental impacts and more tangible ones. In any case, the results are available in the report for all indicators. Should we update the choice of indicators, or is it fine to keep it like this?	As this study is to be disclosed, the indicator selection must be aligned with a scientific method of your choice (ISO 14044 - 4.4.5 & 5.3). In the case of PEF methodology, the indicators selected must reach 80% of contribution. You can add the indicators of your choice after selecting the most contributing ones.	No	The choice of indicators has been updated based on the PEF methodology, to include the top 80% impacts from the single score. Photochemical ozone formation and Resource use of minerals and metals were added as they contribute to the 80% total impacts of the U103. Photochemical ozone formation is the only one that was missing for the U101. Section 4.1 has been updated accordingly.	Ok	Yes
4.4.	**Optional elements of LCIA**																	
4.4.	**General**																	

4.4.	Normalization																				
4.4.	Grouping																				
4.4.	Weighting																				
4.4.	Additional LCI	data quality analysis																			
4.4.	LCIA intented	be used in comparative asseertions intented to be disclosed to the public																			
	Intended public	BH/AV				ge	FI	Do you confirm that this study and report will not be disclosed to general public ?		*to be confirmed with Lazer Sport*	Please, let us know as soon as possible. There are specific requirement from the ISO 14044 if the study aims to be disclosed to general public	No	This study will be disclosed to general public. As stated in the report, one of the purpose of this study is to support marketing teams. Lazer Sport also asked to remove the names of the suppliers so that they can share this report externally.	Ok	Yes	For information, Lazer Sport also asked to remove the distribution shares and the recommendations (5.2 section) from the external report.					
4.5	Life cycle inte	retation																			
4.5.	General																				
	Precise some terms	BH/AV	/	/		te	FI	Please, precise all the terms high, low, minimal, significant, negligible, notable, most of etc.	For instance, you can precise (<5%) when using the term "low impacts".	Corrected	Ok	Yes									
	Comparison with the scenario 100% recycling for U103 product	BH/AV	54	4.7		te	NC	It is important to recall the reader that, in this methode of LCA, the recycling of components doesn't considered any impacts. It doesn't mean, that, in reality, recycling a material is not polluant.		NA	NA	No	Added: "As this study uses the cut-off methodology, impacts from the recycling process at end-of-life are attributed to the user of the newly produced materials. Therefore, in this scenario, impacts from the U103 at end-of-life only include the transportation and sorting of the parts. "	Ok	Yes						
	Figure 10	BH/AV	49	4.3	figure 10	te	FI	I can not find the value 7.4 kg CO2 eq. attributated to the total impacts of U101 components in the table of result	Please check the graphic and precise if this graphic is on the acquisition of raw materials + manufacturing stages or something else	NA	NA		NA	Na	No	In figure 10, the paint and glue are not included, these are what is missing from the values in the table of results. This is now clarified in the report.	Ok	Yes			
	typo	BH/AV	51	4.4	Figure 12	ed	OI	The title mentionned U101 instead of U103		NA	NA	No	Corrected	Ok	Yes						
4.5.	Identification	significant issues																			
4.5.	Evaluation																				
4.5.	General																				
4.5.	Completeness	heck																			
		BH/AV	/	/		te	NC	Please add a completeness check to your study	An example can be find in Appendix B of the ISO 14044	This was added in Annex I.	Ok	Yes									
4.5.	Sensitivity che	k																			
	Sensitivity check	BH/AV	21	2.2.8		te	NC	Sensitivity analysis must be done on the allocation and hypothesis made in the study.		*to be done*	NA	No	Are you refering to the injection moulding processes? If so, a sensitivity analysis has been made in the previous study, and as the helmets and processes are very similar it was considered sufficient for the current study. Is it? We can share last year's report if you wish to check the sensitivty analysis.	According to the ISO 14044 - 4.5.3.3 & 5.3, sensitivty analysis are mandatory. In this case, it is indeed not interesting to evaluate the injection moulding processes as it was previously done. However, hypothesis have been made on recycled materials (PA6, PC, etc.) which are main contributors. From our expertise, we expected an increase of impacts for some incators because of the use of recycled materials. For instance, the need of water to wash the waste followed by water treatment doesn't seem to be modelled for the recycled PC.	No	We don't have any data on the water and washing product consumption. Should we add something to it in the modelling? Or should we do a sensitivity analysis?	This should be in a sensitivity analysis. Please, update the limitation and conclusion paragraphs with the results of the sensitivity analysis.	No	a summary of the sensitivty analysis has been added in Appendix, and it is listed in the limitations section.	Ok	Yes
4.5.	Consistency c	eck																			
		BH/AV	/	/		te	NC	Please add a consistency check to your study.	An example can be find in Appendix B of the ISO 14044	This was added in Annex I.	Ok but I wonder: is the U103 product ready to be commercialized and the production method tested ? Are you sure the mass, electricity consumption, etc. won't change when the production will be launched for real ?	No	The U103 is ready to be commercialized as it will be released next April. Normally none of this should change at this point.	Ok	Yes						
4.5.	Conclusions, l	itations and recommendations																			
	Greener electricity	BH/AV	57	5.2		ge	W	I recommend that you exercise caution with the mentions of green/greener electricity, espescially in the case of green certificat. It could methodologically be integrated in LCA studies but it is time consuming as you need to use the residual mix in every step.	Ok	ok	NA	Yes									
5	Reporting																				
5.1	General requi	ments and considerations																			

5.1	General requirements and considerations																					
5.2	Additional requirements and guide for third party reports																					
		Third party report	BH/AV				ge	FI	According to the ISO 14044 – 5.2 : "when results of the LCA are to be communicated to any third party [...], a third-party report shall be prepared. The third-party report can be based on study documentation that contains confidential information that may not be included in the third-party report. The third-party report constitutes a reference document, and shall be made available to any third party to whom the communication is made.". Will you communicate this report to any third party or will you write another document ?		NA	NA		The only thing that Lazer Sport asked to remove for the external report is the name of the suppliers. Therefore, the purpose was to keep this document as it is and only remove these. Do you see anything else that should be removed?	If Lazer Sport is ok to share every other information, this is fine for me.	Yes						
5.3	Further reporting requirements for comparative assertion intented to be disclosed to the public																					
		Claims disclosed to the public	BH/AV				ge	FI	We also want to know what type of claims you will made based on this study to asked you the proof interlinked with it. For example, if you want to communicate on the recycled content, you need to add the proof of it : it can be a material datasheet stating it is recycled matter, an invoice where the material name contains "recycled", etc.		NA	NA		Should Lazer Sport share with you in advance the list of claims that they wish to make in their marketing materials?	Yes, if some claims are already planned to be communicated, please share them with us	No	The question was shared with Lazer Sport, but they don't have the claims ready yet as they are planning to build them based on the LCA report	Ok	Yes