Report

Product Carbon Footprint

Lighting systems

- AragF, Jovie, LuceoS -

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List of abbreviations

CO_2	Carbon dioxide
CO_2e	Carbon dioxide-equivalents
PCF	Product Carbon Footprint
GHG Protocol	Greenhouse Gas Protocol
GWP	Global Warming Potential
WBCSD	World Business Council for Sustainable Development
WRI	World Resources Institute

1 Introduction

Objective

The Product Carbon Footprint calculation and analysis of selected Trilux lighting systems is supposed to identify greenhouse gas emissions caused by those products. By calculating the Product Carbon Footprints (PCFs), Trilux establishes a significant environmental performance indicator for the respective product lines. It allows Trilux to distinguish itself from competitors, highlights the company's sustainability efforts and raises awareness of environmental issues such as climate change. On this basis, Trilux can also test materials and production processes in order to reduce the climate impact in those areas that can be directly influenced.

Calculation boundaries

Three types of lighting systems were selected for the present PCF: AragF, Jovie and LuceoS. The Product Carbon Footprint covers the entire life cycle from the procurement of raw materials to disposal or the recycling process. The assessment was carried out on the basis of available data from the year 2020.

The Footprint calculation was done for the third time. Therefore, the current calculation can build on existing experiences.

The methodology of the present analysis is based on the Product Life Cycle Accounting and Reporting Standard. Following this internationally acknowledged standard secures the plausibility, precision and reliability of the calculation.

2 Methodology

Targeting high transparency, confirmability and comparability of the results, the calculation was performed in alignment with the Greenhouse Gas Protocol (GHG Protocol) Product Life Cycle Accounting and Reporting Standard. This best practice standard was developed by the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD).

2.1 Principles of the GHG Protocol

The Product Carbon Footprint was carried out in accordance with the following principles:

- **Relevance**: The used methodology and written report shall serve the needs of the intended users.
- **Completeness**: The calculation shall cover all product life cycle GHG emissions and removals within the specified boundaries. Excluded emissions and removals shall be disclosed and justified.
- **Consistency**: Chosen methodologies, data and assumptions shall allow meaningful comparisons over time.
- **Transparency**: All relevant issues regarding the calculation process, methodology, data, assumptions, omissions and results shall be documented in a factual and coherent manner.
- **Accuracy**: Reported emissions and removals shall not be systematically greater than or less than actual emissions.

2.2 Functional unit and life cycle stages

Considerations between Trilux and CO$_2$OL led to the selection of three product lines. Functional unit is respectively **one entire lighting system** over its complete life cycle.

The following lighting systems were examined:

Table 1: Selected product lines

Product line
AragF 15 P-W 64-840 ET PC
Jovie 70-AB7L-LR/10000-740 8G1 ET
LuceoS H2_D2-L CDP 6500-840 ETDD

Based on the previous calculations, it was known that Trilux had the necessary product information for calculating the PCFs.

It was decided to take all life cycle phases into consideration, from the material acquisition & pre-processing phase to the end-of-life phase (see Figure 1). This means that all emissions during the product life cycle of the luminaires are included.

Figure 1: Life cycle stages following the GHG protocol

The considered emission sources include:

- material acquisition & pre-processing:
  - Used raw materials
  - Transport of raw materials from supplier to production site

- production
  - Used energy during production process
- distribution & storage
  - Transport between intermediate storage and final storage
  - Storage
- usage
  - Usage of lighting systems by consumer
- end-of-life
  - Disposal or recycling of lighting-systems

2.3 Data collection

The data collection was carried out with the help of an individually developed Excel-based questionnaire. Trilux was responsible for the collection of the data itself. In addition to the data collected, the specific product data sheets could also be used. CO_2OL checked the data for plausibility. Open questions were clarified in direct exchange between the product manager and the person responsible for the calculation process at CO_2OL.

2.4 Data quality

The specific components of the lighting systems are known in detail. Considering effort, benefit and availability of emission factors, single components were categorized into material groups. This affects foremost the material acquisition & pre-processing phase. Components made of the same material were summarized based on their weight. As these agglomerations are based on the single components one can act on the assumption that there will be no significant inaccuracies.

Overall, this allowed a comparison to be made between the total weight of the luminaire and the components determined. The differences found are shown in Table 2. These differences result on the one hand from small components that are difficult to detect and on the other hand from emission factors for certain materials that cannot be determined. The omissions only apply to the life cycle phase of material acquisition & pre-processing. With regard to transport and disposal, the total weight has been used. Due to the proportion of the total weight, these omissions are not expected to lead to significant inaccuracies in the results.

Table 2: Overview – Not considered material

Lighting system	Overall material weight (kg)	Weight of not considered material (kg)	Share of total weight [%]
AragF 15 P-W 64-840 ET PC	2.8	0.139	**4.96%**
Jovie 70-AB7L-LR/10000-740 8G1 ET	10.7	1.05	**9.81%**
LuceoS H2_D2-L CDP 6500-840 ETDD	4.1	0.199	**4.85%**

The transport distances were at least collected on country level (e.g. material X was transported from country Y to country B). Were available city level was preferred (e.g. material X was transported from city Y to city B). On country level conservative assumptions regarding the distances were made. It is likely that numbers referring to the transport contain inaccuracies. Based on already conducted calculations it is apparent that the influence of the overall transport is negligible and will therefore not cause significant inaccuracies in the overall calculations.

Considering the production phase, Trilux provided precise energy consumption data. This applies also to the storage phase adding up to high data precision in the production and the storage phase.

Life expectancy of the lighting systems as well as the specific energy consumption in the use phase was determined within the quality control of Trilux. Precise data is therefore available.

Produced waste and end-of-life treatment was, equal to the material acquisition, summed up to material groups.

The overall activity data quality can be estimated as sound.

2.5 Greenhouse gas emissions and global warming potential

The Product Carbon Footprint at hand comprises all greenhouse gases mentioned in the Kyoto protocol: Carbon dioxide, methane, nitrous oxide, perfluorocarbon, chlorofluorocarbons, nitrogen trifluoride and sulphur hexafluoride. As those vary in their specific global warming potential (GWP) they are converted into CO_2-equivalents (CO_2e). Table 3 displays the mentioned greenhouse gases and their respective global warming potential in CO_2e over a period of 100 years.

Greenhouse Gas	GWP
Carbon dioxide (CO_2)	1
Methane (CH_4)	21
Nitrous oxide (N_2O)	310
Perfluorocarbon (PCFs)	6.500 - 9.200
Chlorofluorocarbons (HFCs)	140 - 11.700
Nitrogen trifluoride (NF3)	17.200
Sulphur hexafluoride (SF_6)	23.900

Table 3: Greenhouse gases Kyoto Protocol

Including all greenhouse gases allows to calculate the products' impact on anthropogenic climate change. This overall statement is possible as the used emission factors are estimated in CO_2e.

Emission factors allow the conversion of activity data into reliable emission values. Therefore, the choice of adequate emission factors for every activity data is of great importance. Every emission factor is checked and selected based on specific criteria. The following criteria are considered:

- Technology: Does the chosen factor reflect the right technology?
- Time: Does the factor refer to the right time period?
- Geography: Does the factor reflect the right geographic location?
- Completeness: Is the chosen factor representative?
- Reliability: Is the source of the factor and the calculation method verified and reliable?

In order to choose the right emission factor additional information on the activity data (composition, origin, age, etc.) was collected if necessary.

The emission factors used come from two central sources: Firstly, the emission factors of the Ecoinvent database (status 2020) were used. Ecoinvent is a Swiss not-for-profit organisation that has been collecting, checking, updating and making available life cycle data of various products and processes for more than 20 years.

On the other hand, individual emission factors from the Probas database of the Federal Environment Agency were used. The selected emission factors were calculated by the Ökoinstitut.

The overall quality of the emission factors can be rated as very high.

3 Results

Result unit

In the following, the results of the Product Carbon Footprints of the different lighting systems are presented. The calculated and displayed results are described in kg CO_2e per lighting system.

Functional unit

The functional unit corresponds to **one unit of the respective lighting system** over its entire service life.

Geographic scenarios

A distinction is made between three geographical scenarios (Germany, France and the Netherlands) for distribution and use per lighting system.

Life cycle phases

The breakdown of the overall result follows the specifications of the Product Life Cycle Accounting and Reporting Standard and differentiates between the following life cycle phases:

- material acquisition & pre-processing
- production
- distribution & storage
- use
- end-of-life

Lighting systems

The following lighting systems were considered:

Table 4: Considered lighting systems

Lighting system
AragF 15 P-W 64-840 ET PC
Jovie 70-AB7L-LR/10000-740 8G1 ET
LuceoS H2_D2-L CDP 6500-840 ETDD

3.1 Results overview - General

Table 5 gives an overview of the average emissions at the beginning. These figures are also shown graphically in Figure 2.

For all products, it becomes clear that the main emissions occur in the areas of use and material acquisition & pre-processing. In the area of use, the emissions depend on the service life, the needed wattage and the electricity mix. Accordingly, it must be taken into account that, for example, a longer service life is basically a positive, environmentally friendly product characteristic, which, however, has a negative effect on the Footprint. Furthermore, Trilux has no influence on the respective electricity mix used. In specific cases, consideration should be given to how the use of green electricity can be presented. In principle, this would lead to a considerable shift in the emission focus, as green electricity causes almost no emissions.

In the further course of the presentation of the results no interpretation of the results is given.

Table 5: Results overview - General

Ø	*Material acquisition & pre-processing*	*Production*	*Distribution & storage*	*Use*	*End-of-life*
kg CO_2-equivalents					
AragF 15 P-W 64-840 ET PC	**63.691**	**2.683**	**2.296**	**897.504**	**0.892**
Jovie 70-AB7L-LR/10000-740 8G1 ET	**106.196**	**2.683**	**1.784**	**3,896.479**	**3.408**
LuceoS H2_D2-L CDP 6500-840 ETDD	**72.463**	**2.683**	**0.733**	**897.504**	**1.306**

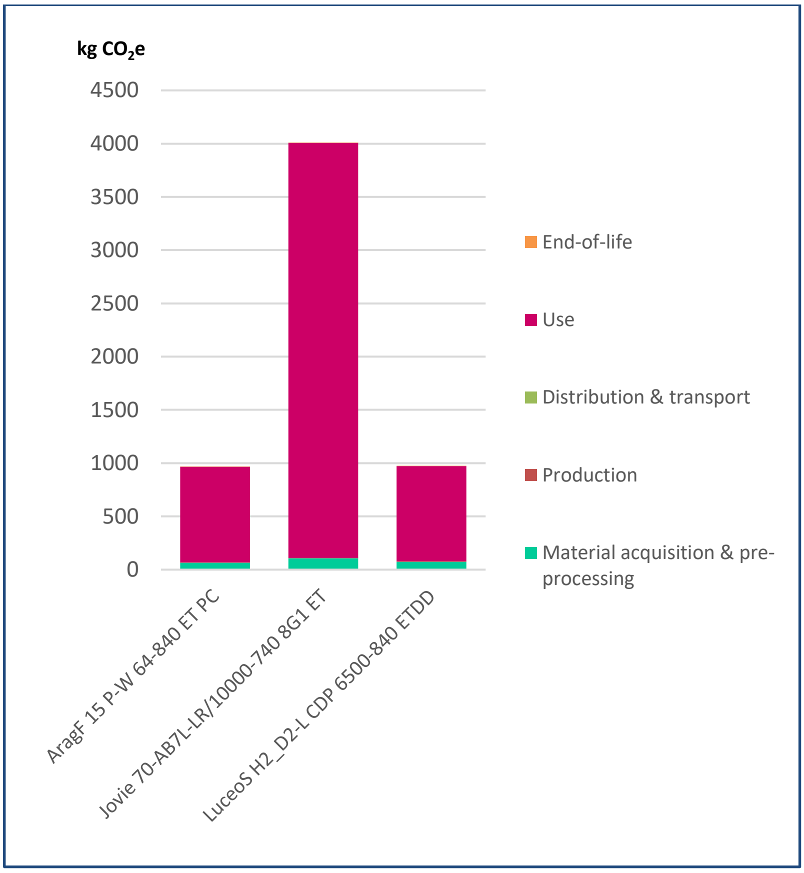


Figure 2: Results overview - General

3.2 Results summary – AragF 15 P-W 64-840 ET PC

	Material acquisition & pre-processing	*Production*	*Distribution & storage*	*Use*	*End-of-life*
kg CO_2-equivalents					
Ø	**63.691**	**2.683**	**2.298**	**897.504**	**0.892**
D	**63.691**	**2.683**	**2.634**	**1,185.515**	**0.892**
F	**63.691**	**2.683**	**1.622**	**190.281**	**0.892**
NL	**63.691**	**2.683**	**2.637**	**1,316.715**	**0.892**

Assessed Product

The Product Carbon Footprint describes the climate impact of the AragF 15 P-W 64-840 ET PC. The moisture-proof luminaire produced by TRILUX GmbH & Co. KG is suitable for applications with high demands on variability, efficiency, light quality and technology. The calculated emissions amount to an *average* of:

967.066 kg CO_2e

Functional unit

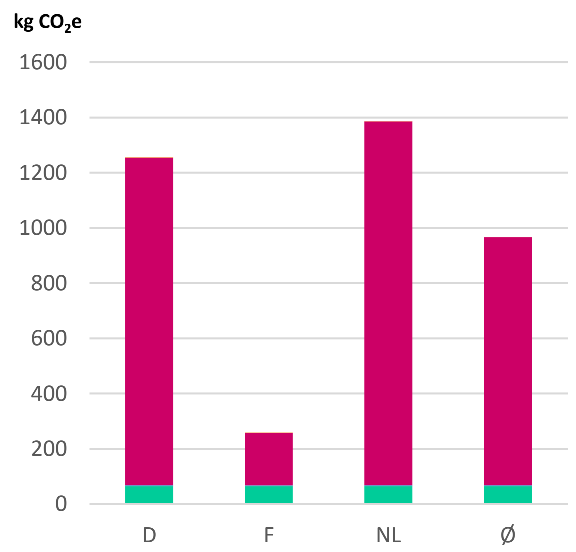
The functional unit of this Product Carbon Footprint is a typical AragF 15 P-W 64-840 ET PC over its entire life-cycle. For product distribution and use, three geographical regions (D, F & NL) are distinguished.

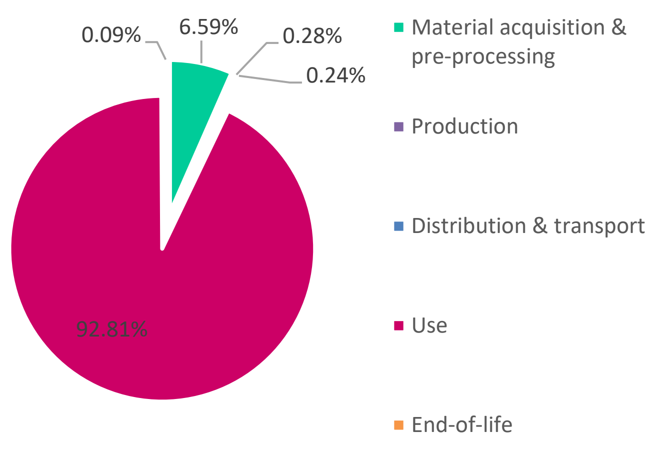
Key figures

Total weight: 2.8 kg
Service life: min. 50,000 h
Power: 41 Watt

Assessment

Standard: Product Life Cycle Accounting and Reporting Standard
Conducted by: CO_2OL, Bonn
Date: 6th August 2020
Contact person: Thorsten Herkel





Average allocation of emissions

3.3 Results summary – Jovie 70-AB7L-LR/10000-740 8G1 ET

	Material acquisition & pre-processing	*Production*	*Distribution & storage*	*Use*	*End-of-life*
kg CO_2-equivalents					
Ø	**106.196**	**2.683**	**1.784**	**3,896.479**	**3.408**
D	**106.196**	**2.683**	**0.094**	**5,146.870**	**3.408**
F	**106.196**	**2.683**	**5.150**	**826.098**	**3.408**
NL	**106.196**	**2.683**	**0.107**	**5,716.470**	**3.408**

Assessed Product

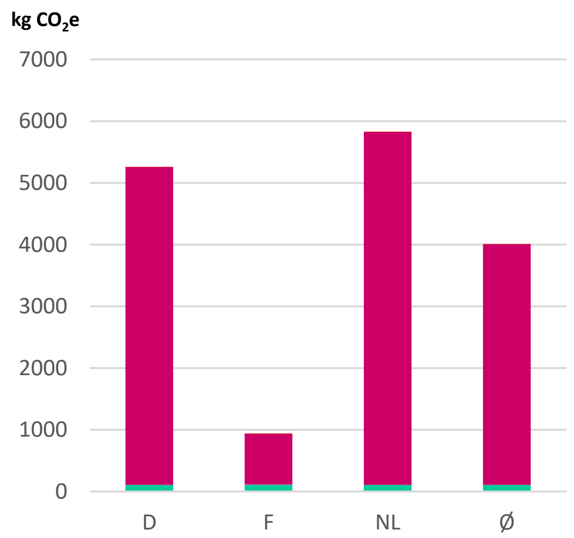
The Product Carbon Footprint describes the climate impact of the Jovie 70-AB7L-LR/10000-740 8G1 ET. The LED pole-mounted outdoor light produced by TRILUX GmbH & Co. KG is suitable for outdoor use on paths, side streets and traffic routes. The calculated emissions amount to an *average* of:

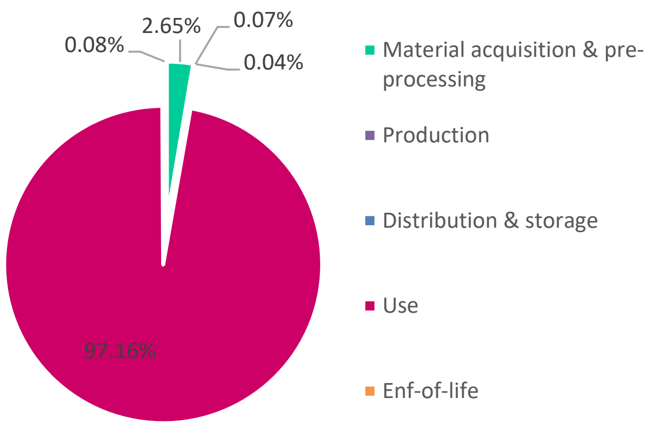
4,010.549 kg CO_2e

Functional unit
The functional unit of this Product Carbon Footprint is a typical Jovie 70-AB7L-LR/10000-740 8G1 ET over its entire life-cycle.
For product distribution and use, three geographical regions (D, F & NL) are distinguished.

Key figures
Total weight: 10.7 kg
Service life: min. 100,000 h
Power: 89 Watt

Assessment
Standard: Product Life Cycle Accounting and Reporting Standard
Conducted by: CO_2OL, Bonn
Date: 6th August 2020
Contact person: Thorsten Herkel





Average allocation of emissions

3.4 Results summary – LuceoS H2_D2-L CDP 6500-840 ETDD

	Material acquisition & pre-processing	*Production*	*Distribution & storage*	*Use*	*End-of-life*
kg CO_2- equivalents					
Ø	**72.463**	**2.683**	**0.733**	**897.504**	**1.306**
D	**72.463**	**2.683**	**0.086**	**1,185.515**	**1.306**
F	**72.463**	**2.683**	**2.023**	**190.281**	**1.306**
NL	**72.463**	**2.683**	**0.091**	**1,316.715**	**1.306**

Assessed Product

The Product Carbon Footprint describes the climate impact of the LuceoS H2_D2-L CDP 6500-840 ETDD. The LED pendant luminaire produced by TRILUX GmbH & Co is suitable for use in offices, salesrooms, showrooms, banks, counter halls, schools and educational institutions. The calculated emissions amount to an *average* of:

974.688 kg CO_2e

Functional unit

The functional unit of this Product Carbon Footprint is a typical Jovie LuceoS H2_D2-L CDP 6500-840 ETDD over its entire life-cycle.

For product distribution and use, three geographical regions (D, F & NL) are distinguished.

Key figures

Total weight: 4.1 kg

Service life: min. 50,000 h

Power: 41 Watt

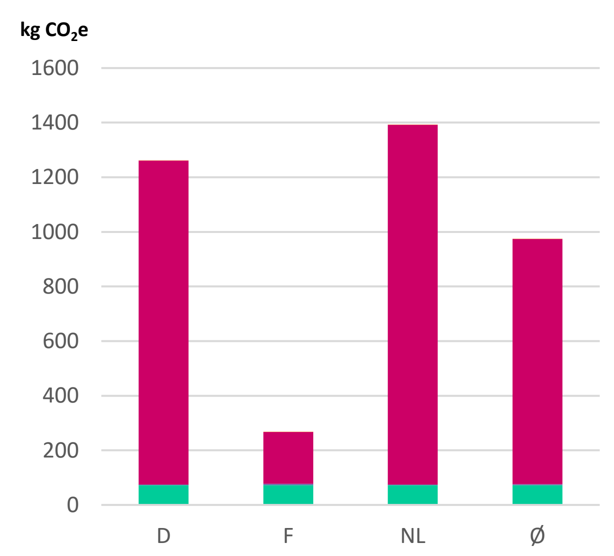
Assessment

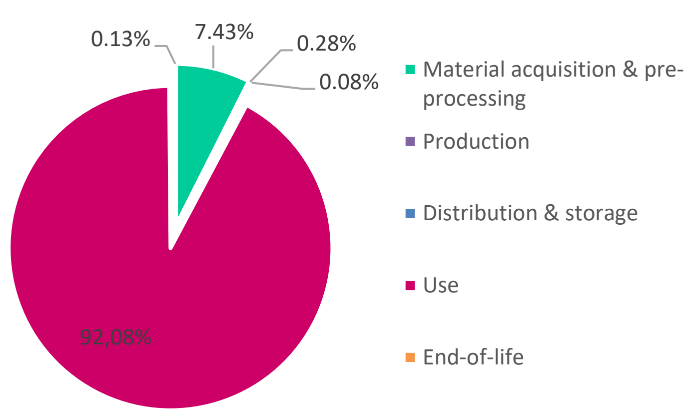
Standard: Product Life Cycle Accounting and Reporting Standard

Conducted by: CO_2OL, Bonn

Date: 6th August 2020

Contact person: Thorsten Herkel





Average allocation of emissions

4 Conclusion

The aim of calculating and analysing the Product Carbon Footprints (PCF) of selected lighting systems was to determine the amount of greenhouse gas emissions caused by the products of Trilux GmbH & Co. KG products. This goal was achieved.

Targeting high plausibility, precision and reliability of the calculation the methodological background of the presented analysis is the Product Life Cycle Accounting and Reporting Standard. This best practice standard was developed by the World Resources Institute (WRI) and World Business Council for Sustainable Development (WBCSD).

Data availability

The experience of already calculated lighting systems from 2016 could be used. Trilux was able to supply detailed data catalogues. Open points and queries were clarified between those responsible.

The data quality is to be rated as good, as is the quality of the emission factors used. The informative value of the results can therefore be rated as high.

Outlook

Trilux has now expanded the number of product carbon footprints to the lighting systems AragF, Jovie and LuceoS. This means that Trilux is continuing to consistently pursue the path it has chosen for climate protection.

Based on the results, reduction potentials can be discussed. In addition, it becomes clear what a great influence the use phase has, a life cycle phase that is almost completely beyond the influence of the company. This is where Trilux can provide the appropriate lighting management system and offer holistic solutions.

In future, it could be considered to offer selected lighting systems in a climate-neutral way. The compensation of the emissions caused can, for example, relate to the complete product life cycle, exclude the area of the use phase or only cover the areas directly influenced by Trilux. Climate-neutral lighting systems can bring further advantages to the market.