

FAGERHULT

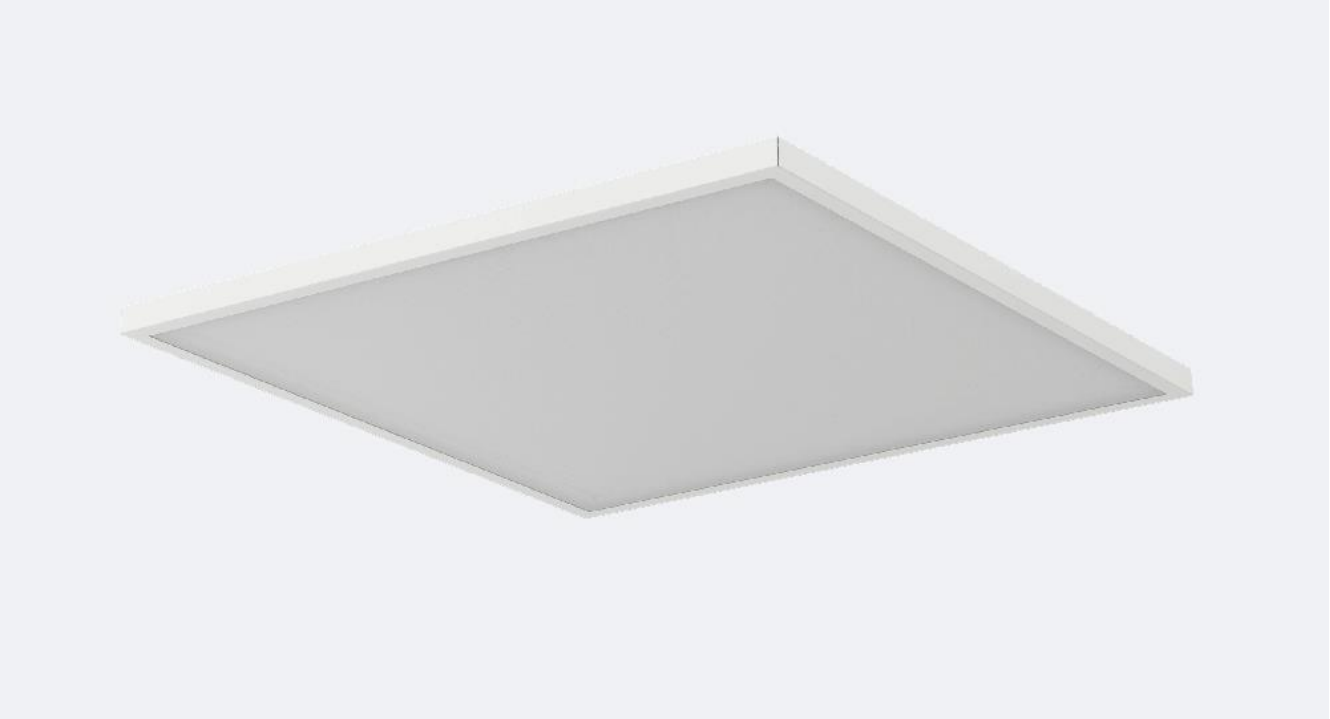
ENVIRONMENTAL PRODUCT DECLARATION

IN ACCORDANCE WITH EN 15804+A2 & ISO 14025

EPD HUB, HUB-7986
Published on 29.10.2026, last updated on 29.10.2026, valid until 28.10.2031

Multilume Slim Recessed Delta 600x600 mm

Fagerhults Belysning AB



This EPD is intended for business-to-business communication. Life Cycle Assessment study has been performed in accordance with the requirements of EN 15804, EPD Hub PCR version 1.2 (24 Mar 2025) and JRC characterization factors EF 3.1. The manufacturer has the sole ownership, liability, and responsibility for the EPD. EPDs within the same product category but from different programs may not be comparable. EPDs of construction products may not be comparable if they do not comply with EN 15804 and if they are not compared in a building context.

MANUFACTURER AND SITE

Manufacturer	Fagerhults Belysning AB
Address	Åvägen 1, 566 80 Habo, Sweden
Contact details	info@fagerhult.se
Website	www.fagerhult.com
Place of production	Habo, Sweden
Place(s) of raw material origin	Global, mainly EU
Place(s) of installation and use	Global
Period for data	Calendar year 2025

EPD STANDARDS, SCOPE AND VERIFICATION

Program operator	EPD Hub, hub@epdhub.com
Reference standard	EN 15804:2012+A2:2019/AC:2021 and ISO 14025
PCR	EPD Hub Core PCR version 1.2, 24 Mar 2025
Sector	Electrical product
Category of EPD	Third party verified EPD
Parent EPD number	
Scope of the EPD	Cradle to gate with options, A4-A5, B6, and modules C1-C4, D
EPD author	Josefin Carlsson, Fagerhults Belysning AB
EPD verification	Independent verification of this EPD and data, according to ISO 14025: ☐Internal verification ☒External verification
EPD verifier	Yazan Badour

PRODUCT SPECIFICATION

Product name	Multilume Slim Recessed Delta 600x600 mm
Product number / reference	
GTIN (Global Trade Item Number)	-
NOBB (Norwegian Building Product Database)	-
A1-A3 Specific data (%)	17,5

PRODUCT CLASSIFICATION

Declared operating voltage, Volt	220-240
Light source color temperature, Kelvin	3000
Protection index for water and dust (IP)	20/44
Impact resistance index (IK)	-
Luminous flux, Lumen	4388
Electrical power, Watt	30
Luminous efficiency, Lm/W	146
Additional characteristics	For more information, please go to our website www.fagerhult.com

PRODUCT DESCRIPTION

Multilume Slim is an energy-efficient recessed luminaire designed for ergonomic lighting in offices, classrooms, and other open spaces. The luminaire can be easily adapted to suit different ceiling types. Multilume Slim is available in two sizes, 300×600 mm and 600×600 mm, and with two optics, Opal and Delta. The luminaire is delivered with a separate stand-alone driver, and the body and driver are interconnected through a quick-connection system. The luminaire has an IP44 rating below a suspended ceiling and an IP20 rating above a suspended ceiling. This EPD represents the 600×600 mm version with a Delta louvre.

ABOUT THE MANUFACTURER

Fagerhult creates premium lighting solutions that enhance human well-being in professional and public environments. With sustainability and connectivity at heart, we focus on office, education, healthcare, retail and outdoor applications. We work closely with customers and partners in the European market and provide lighting solutions globally – with tailor-made solutions for our customers. The Fagerhult brand includes two manufacturing sites and eleven sales companies located around Europe.

ENVIRONMENTAL DATA SUMMARY

Declared unit	1 unit
Declared unit mass, kg	4,51
Mass of packaging, kg	0,79
Functional unit	Provide lighting that delivers an outgoing artificial luminous flux of 1,000 lumens during a reference lifetime of 35,000 hours
Reference service life (years)	20
Assigned lifetime (hours)	100000
GWP-total, A1-A3 (kg CO_2e)	32,1
GWP-fossil, A1-A3 (kg CO_2e)	33,3
Secondary material, inputs (%)	0
Secondary material, outputs (%)	40,5
Total energy use, A1-A3 (kWh)	140
Net freshwater use, A1-A3 (m^3)	5,94E-01

LIFE CYCLE ASSESSMENT

SYSTEM BOUNDARY

This EPD covers the life-cycle modules listed in the following table.

Product stage			Assembly stage		Use stage							End of life stage				Beyond the system boundaries
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
x	x	x	x	x	ND	ND	ND	ND	ND	x	ND	x	x	x	x	x
Raw materials	Transport	Manufacturing	Transport	Assembly	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	Deconstr./demo.	Transport	Waste processing	Disposal	Reuse, Recovery, Recycling

Not declared = ND

CUT-OFF CRITERIA

The study does not exclude any modules or processes which are stated mandatory in EN 15804+A2 and EN 50693 and the EPD Hub PCR. The study does not exclude any hazardous materials or substances. No single neglected unit process exceeds 1% of the total mass or energy flows. The module-specific total neglected input and output flows also do not exceed 5% of energy usage or mass.

The production, maintenance and operation of capital equipment and infrastructure, and construction activities are excluded from the assessment unless considered in the background database. Personnel-related activities as well as energy and water use related to company management and sales activities are also excluded from this EPD.

VALIDATION OF DATA

Data collection for production, transport, and packaging was conducted using time and site-specific information, as defined in the general information section on page 1 and 2. Upstream process calculations rely on generic data as defined in the Bibliography section. Manufacturer-provided specific and generic data were used for the product's manufacturing stage. The analysis was performed in One Click LCA EPD Generator, with the 'Cut-Off, EN 15804+A2' allocation method, and characterization factors according to EN 15804:2012+A2:2019/AC:2021 and JRC EF 3.1.

ALLOCATION, ESTIMATES AND ASSUMPTIONS

All allocations are done as per the reference standards and the applied PCR. In this study, allocation has been done in the following ways:

Data type	Allocation
Raw materials	No allocation
Packaging materials	No allocation
Ancillary materials	No allocation
Manufacturing energy and waste	Physical Properties

PRODUCT AND MANUFACTURING SITES GROUPING

Type of grouping	No grouping
Grouping method	Not applicable
Variation in GWP-fossil for A1-A3, %	-

This EPD is product and factory specific.

PRODUCT RAW MATERIAL MAIN COMPOSITION

Raw material category	Amount, mass-%	Material origin
Metals	43	Global, mainly EU
Minerals	0	-
Fossil materials	51	Global, mainly EU
Bio-based materials	0	-
Electronic parts	6	Global, mainly EU

BIOGENIC CARBON CONTENT

Product's biogenic carbon content at the factory gate.

Biogenic carbon content in product, kg C	0
Biogenic carbon content in packaging, kg C	0,458

SUBSTANCES, REACH - VERY HIGH CONCERN

The product does not contain any REACH SVHC substances in amounts greater than 0,1 % (1000 ppm).

LCA SOFTWARE AND BIBLIOGRAPHY

This EPD has been created using One Click LCA Luminaire EPD Generator v2.2.9. The LCA and EPD have been prepared according to the reference standards, EN 50693, and ISO 14040/14044. Ecoinvent v3.10.1and One Click LCA databases were used as sources of environmental data. Allocation used in Ecoinvent 3.10.1 environmental data sources follow the methodology 'allocation, cut-off, EN 15804+A2'.

- EPD Hub Core Product Category Rules version 1.2, March 2025
- EPD Hub General Program Instructions version 1.3, March 2025
- EN 15804:2012+A2:2019/AC:2021 Sustainability of construction works - Environmental product declarations - Core rules for the product category of construction products
- EN 50693:2020 Product category rules for life cycle assessments of electronic and electrical products and systems
- EN 15941:2024 Sustainability of construction works - Data quality for environmental assessment of products and construction work - Selection and use of data
- EN 15942:2011 Sustainability of construction works - Environmental product declarations - Communication format business-to-business
- ISO 14025:2006 Environmental statements and programmes for products - Principles and general requirements
- ISO 14040:2006 Environmental management - Life cycle assessment - Principles and framework
- ISO 14044:2006 Environmental management - Life cycle assessment - Requirements and guidelines
- Paper and cardboard packaging waste treatment: EUROSTAT, https://ec.europa.eu/eurostat/data-browser/view/env_waspac__custom_8519259/default/table?lang=en
- Wooden packaging waste treatment: EUROSTAT, https://ec.europa.eu/eurostat/data-browser/view/env_waspac__custom_8519174/default/table?lang=en
- Plastic packaging waste treatment: EUROSTAT, https://ec.europa.eu/eurostat/data-browser/view/env_waspac__custom_8519242/default/table?lang=en
- Steel packaging waste treatment: EUROSTAT, https://ec.europa.eu/eurostat/data-browser/view/env_waspac__custom_13967225/default/table?lang=en
- ecoinvent 3.10.1
- One Click LCA database

PRODUCT LIFE CYCLE

MANUFACTURING (A1-A3)

The environmental impacts considered for the manufacturing stage accounts extraction, refining, and processing of all primary raw materials used in the production. The product is made of metals, plastics, and electronic components, including driver. The product is composed by components that arrive to the factory fully or semi-fabricated, as well as components that are manufactured and processed inhouse at production site.

All components and raw materials are transported from supplier to the production site. The transport distances vary depending on origin, typically ranging between 3 km to 1500 km. Distances are calculated taking the supplier's location with the manufacturing facility as the destination. Transportation modes include mainly road freight and container shipping are applicable, in rare cases also air.

The material losses occurring during the manufacturing processes are treated as per the waste handling practices in the factory, while scenario assumptions are made in the absence of exact data. The study also considers the fuels used by machines as well as losses during electricity transmission.

A market-based approach is used in modelling the electricity mix utilized in the factory. The use of renewable energy in manufacturing is demonstrated through contractual instruments (GOs, RECs, etc), and its use is ensured throughout the validity period of this EPD.

The product is packaged in a corrugated cardboard box. The product is being sent to the installation site on a wooden pallet wrapped in plastic film.

Co-product allocation is neglected as revenue of co-product is very low. Hence, the waste undergoes a conservative waste treatment as per the default end-of-life values of EN 50693.

TRANSPORT AND INSTALLATION (A4-A5)

Transportation distances from manufacturing site to customer locations are based on sales volume-based weighted averages. In the absence of exact data, conservative assumptions are made.

Environmental impacts from packaging waste generated at the installation site is included. The packaging waste is modelled using EUROSTAT waste treatment statistic, where paper and cardboard packaging end-of-life is split into 83% recycling, 8% incineration, and 9% landfilling. Transport distance to local treatment facilities is assumed to be 50 km. The impacts of energy consumption and the used ancillary materials during installation are considered negligible.

PRODUCT USE AND MAINTENANCE (B1-B7)

Operational environmental impacts and resource consumption occur exclusively from operational energy use, module B6. All other modules within the use stage (B1–B5 and B7) have zero operational impacts or resource consumption.

The product consume electricity during use phase and the energy consumption is calculated using the following formula:
Energy consumption = Wattage x Assigned lifetime (hours)

The results do not include any energy savings from using controls. If a light management system is applicable, the following reduction factors of energy consumption are to be applied:

- Dimming: 0,90
- Presence detection: 0,75
- Daylight sensing: 0,75
- Combination of dimming and presence detection: 0,70
- Combination of presence sensor and daylight: 0,55
- Combination of dimming, presence detection and daylight sensing: 0,55
- Comprehensive Lighting Control: 0,50

Impacts due to electricity production include direct emissions to air, transformation, and transmission losses.

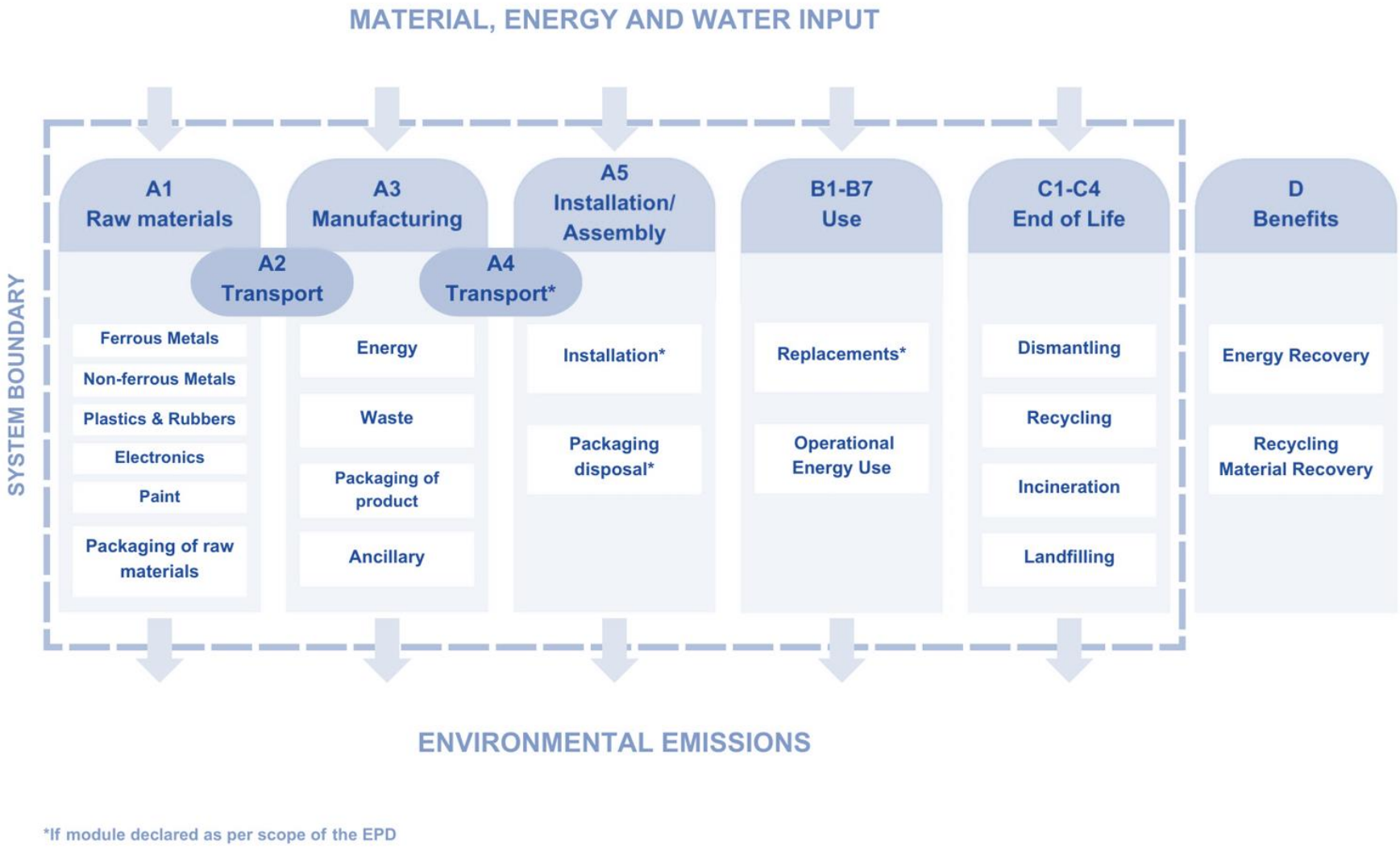
PRODUCT END OF LIFE (C1-C4, D)

Consumption of energy and natural resources in demolition process is assumed to be negligible. It is assumed that the waste is collected separately and transported to the waste treatment centre. According to EN 50693:2019, waste treatment includes de-pollution, dismantling, crushing, shredding, sorting,

recycling, energy recovery, and final disposal using default values from Table G.4 of EN 50693. The transport distance is 150 km while the transportation method is assumed to be lorry.

Recovered materials displace primary raw materials via recycling. Incineration with energy recovery displaces grid electricity and thermal energy production. Module D incorporates net benefits and loads resulting from both product end-of-life (Module C) and installation packaging disposal (Module A5).
The scenarios applied for Modules C1–C4 and D represent current industry practice and reflect a realistic baseline.

LIFE CYCLE FLOW DIAGRAM



*If module declared as per scope of the EPD

ENVIRONMENTAL IMPACT DATA, RESULTS PER DECLARED UNIT

The following results refers to one unit of the luminaire, with declared lumens for 100 000 hours.

The estimated impact results are only relative statements which do not indicate the end points of the impact categories, exceeding threshold values, safety margins or risks.

CORE ENVIRONMENTAL IMPACT INDICATORS – EN 15804+A2, EF 3.1

Impact category	Unit	A1	A2	A3	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
GWP – total[1)]	kg CO_2e	3,22E+01	2,41E-01	-4,05E-01	3,21E+01	1,92E-01	1,69E+00	ND	ND	ND	ND	ND	1,12E+02	ND	0,00E+00	1,31E-01	2,49E+00	1,27E+00	4,95E+01
GWP – fossil	kg CO_2e	3,22E+01	2,37E-01	9,11E-01	3,33E+01	1,92E-01	5,97E-02	ND	ND	ND	ND	ND	9,91E+01	ND	0,00E+00	1,31E-01	2,50E+00	1,27E+00	-7,45E+00
GWP – biogenic	kg CO_2e	5,07E-02	7,25E-05	-1,78E+00	-1,73E+00	4,35E-05	1,63E+00	ND	ND	ND	ND	ND	1,80E+00	ND	0,00E+00	2,85E-05	-3,16E-04	-1,10E-04	5,70E+01
GWP – LULUC	kg CO_2e	2,09E-02	3,69E-03	4,64E-01	4,88E-01	8,60E-05	2,13E-05	ND	ND	ND	ND	ND	1,11E+01	ND	0,00E+00	5,78E-05	9,95E-05	2,40E-05	-3,41E-02
Ozone depletion pot.	kg CFC_{-11}e	2,55E-06	5,75E-09	3,47E-08	2,59E-06	2,84E-09	4,80E-10	ND	ND	ND	ND	ND	2,97E-06	ND	0,00E+00	1,83E-09	1,51E-09	7,44E-10	-6,08E-08
Acidification potential	mol H^+e	2,25E-01	8,14E-04	8,52E-03	2,35E-01	6,56E-04	1,63E-04	ND	ND	ND	ND	ND	1,21E+00	ND	0,00E+00	4,35E-04	1,15E-03	3,63E-04	-9,18E-02
EP-freshwater[2)]	kg Pe	1,34E-02	2,26E-05	3,76E-04	1,38E-02	1,50E-05	7,06E-06	ND	ND	ND	ND	ND	8,78E-02	ND	0,00E+00	1,02E-05	3,98E-05	7,81E-06	-6,16E-03
EP-marine	kg Ne	3,21E-02	3,05E-04	4,40E-03	3,68E-02	2,15E-04	1,67E-04	ND	ND	ND	ND	ND	1,79E-01	ND	0,00E+00	1,41E-04	4,45E-04	1,25E-03	-9,85E-03
EP-terrestrial	mol Ne	3,12E-01	2,98E-03	3,38E-02	3,48E-01	2,34E-03	5,81E-04	ND	ND	ND	ND	ND	1,83E+00	ND	0,00E+00	1,54E-03	4,15E-03	1,69E-03	-1,14E-01
POCP ("smog")[3)]	kg NMVOCe	1,27E-01	1,21E-03	6,34E-03	1,34E-01	9,66E-04	2,13E-04	ND	ND	ND	ND	ND	4,87E-01	ND	0,00E+00	6,06E-04	1,10E-03	4,67E-04	-4,31E-02
ADP-minerals & metals[4)]	kg Sbe	2,22E-03	7,14E-07	7,03E-06	2,23E-03	5,36E-07	1,67E-07	ND	ND	ND	ND	ND	1,19E-02	ND	0,00E+00	4,29E-07	3,21E-06	1,19E-07	-9,29E-04
ADP-fossil resources	MJ	4,57E+02	3,44E+00	1,36E+01	4,74E+02	2,79E+00	4,77E-01	ND	ND	ND	ND	ND	1,33E+04	ND	0,00E+00	1,83E+00	1,21E+00	4,94E-01	-9,42E+01
Water use[5)]	m^3e depr.	1,01E+01	2,15E-02	1,48E+01	2,50E+01	1,38E-02	1,19E-02	ND	ND	ND	ND	ND	7,32E+02	ND	0,00E+00	8,50E-03	1,72E-01	8,17E-02	-1,90E+00

1) GWP = Global Warming Potential. 2) EP = Eutrophication potential. Required characterisation method and data are in kg P-eq. Multiply by 3,07 to get PO4e. 3) POCP = Photochemical ozone formation. 4) ADP = Abiotic depletion potential. 5) EN 15804+A2 disclaimer for Abiotic depletion and Water use and optional indicators except Particulate matter and Ionizing radiation, human health. The results of these environmental impact indicators shall be used with care as the uncertainties on these results are high or as there is limited experience with the indicator.

ADDITIONAL (OPTIONAL) ENVIRONMENTAL IMPACT INDICATORS – EN 15804+A2, EF 3.1

Impact category	Unit	A1	A2	A3	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D

Particulate matter	Incidence	1,95E-06	2,55E-08	1,00E-07	2,07E-06	1,92E-08	2,85E-09	ND	ND	ND	ND	ND	1,01E-05	ND	0,00E+00	1,04E-08	1,09E-08	3,58E-09	-5,61E-07
Ionizing radiation[6]	kBq U235e	1,47E+00	3,03E-03	7,99E-02	1,55E+00	2,43E-03	1,62E-03	ND	ND	ND	ND	ND	9,52E+02	ND	0,00E+00	1,48E-03	4,45E-03	6,80E-04	-8,29E-01
Ecotoxicity (freshwater)	CTUe	2,51E+02	4,16E+00	9,99E+00	2,65E+02	3,95E-01	1,69E+00	ND	ND	ND	ND	ND	1,66E+03	ND	0,00E+00	2,90E-01	5,16E+00	4,25E+00	-5,85E+01
Human toxicity, cancer	CTUh	1,60E-08	4,40E-11	1,55E-09	1,76E-08	3,17E-11	1,92E-11	ND	ND	ND	ND	ND	1,96E-07	ND	0,00E+00	2,22E-11	2,51E-10	1,30E-10	-9,17E-09
Human tox. non-cancer	CTUh	5,12E-07	2,66E-09	2,51E-08	5,39E-07	1,81E-09	1,04E-09	ND	ND	ND	ND	ND	1,02E-05	ND	0,00E+00	1,15E-09	1,02E-08	5,46E-09	-7,56E-07
SQP[7]	-	7,37E+01	3,76E+00	1,57E+02	2,34E+02	2,81E+00	3,59E-01	ND	ND	ND	ND	ND	3,13E+03	ND	0,00E+00	1,09E+00	1,29E+00	5,68E-01	-2,67E+03

6) EN 15804+A2 disclaimer for Ionizing radiation, human health. This impact category deals mainly with the eventual impact of low-dose ionizing radiation on the human health of the nuclear fuel cycle. It does not consider effects due to possible nuclear accidents, occupational exposure nor due to radioactive waste disposal in underground facilities. Potential ionizing radiation from the soil, from radon, and from some construction materials is also not measured by this indicator. 7) SQP = Land use related impacts/soil quality.

USE OF NATURAL RESOURCES

Impact category	Unit	A1	A2	A3	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
Renew. PER as energy[8]	MJ	2,62E+01	5,74E-02	6,05E+01	8,67E+01	3,82E-02	-1,06E+01	ND	ND	ND	ND	ND	9,10E+03	ND	0,00E+00	2,51E-02	1,32E-01	1,39E-02	-2,96E+02
Renew. PER as material	MJ	0,00E+00	0,00E+00	1,46E+01	1,46E+01	0,00E+00	-1,46E+01	ND	ND	ND	ND	ND	0,00E+00	ND	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Total use of renew. PER	MJ	2,62E+01	5,74E-02	7,51E+01	1,01E+02	3,82E-02	-2,52E+01	ND	ND	ND	ND	ND	9,10E+03	ND	0,00E+00	2,51E-02	1,32E-01	1,39E-02	-2,96E+02
Non-re. PER as energy	MJ	4,00E+02	3,47E+00	1,19E+01	4,15E+02	2,79E+00	-4,31E-01	ND	ND	ND	ND	ND	1,33E+04	ND	0,00E+00	1,83E+00	-3,60E+01	-3,67E+01	-9,39E+01
Non-re. PER as material	MJ	5,65E+01	0,00E+00	1,66E+00	5,81E+01	0,00E+00	-1,66E+00	ND	ND	ND	ND	ND	0,00E+00	ND	0,00E+00	0,00E+00	-2,82E+01	-2,82E+01	0,00E+00
Total use of non-re. PER	MJ	4,56E+02	3,47E+00	1,36E+01	4,73E+02	2,79E+00	-2,09E+00	ND	ND	ND	ND	ND	1,33E+04	ND	0,00E+00	1,83E+00	-6,42E+01	-6,49E+01	-9,39E+01
Secondary materials	kg	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	ND	ND	ND	ND	ND	0,00E+00	ND	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Renew. secondary fuels	MJ	5,52E-03	1,94E-05	3,67E-01	3,73E-01	1,51E-05	3,53E-06	ND	ND	ND	ND	ND	1,18E-02	ND	0,00E+00	1,05E-05	5,16E-05	1,00E-05	-1,62E-03
Non-ren. secondary fuels	MJ	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	ND	ND	ND	ND	ND	0,00E+00	ND	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Use of net fresh water	m^3	2,48E-01	6,76E-04	3,45E-01	5,94E-01	4,12E-04	-5,14E-04	ND	ND	ND	ND	ND	1,74E+01	ND	0,00E+00	2,43E-04	3,08E-03	-4,09E-04	-9,84E-02

8) PER = Primary energy resources.

END OF LIFE – WASTE

Impact category	Unit	A1	A2	A3	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
Hazardous waste	kg	3,54E+00	1,56E-02	6,76E-02	3,62E+00	4,73E-03	3,36E-03	ND	ND	ND	ND	ND	1,35E+01	ND	0,00E+00	3,19E-03	4,75E-02	6,17E-02	-1,34E+00
Non-hazardous waste	kg	6,78E+01	2,93E-01	2,07E+00	7,02E+01	8,75E-02	1,15E+00	ND	ND	ND	ND	ND	4,48E+02	ND	0,00E+00	5,99E-02	1,29E+00	3,56E+00	-1,49E+01
Radioactive waste	kg	3,64E-04	7,30E-07	2,04E-05	3,85E-04	5,95E-07	4,11E-07	ND	ND	ND	ND	ND	2,03E-01	ND	0,00E+00	3,63E-07	1,10E-06	1,71E-07	-2,08E-04

END OF LIFE – OUTPUT FLOWS

Impact category	Unit	A1	A2	A3	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
Components for reuse	kg	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	ND	ND	ND	ND	ND	0,00E+00	ND	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Materials for recycling	kg	0,00E+00	0,00E+00	7,08E-01	7,08E-01	0,00E+00	4,36E-01	ND	ND	ND	ND	ND	0,00E+00	ND	0,00E+00	0,00E+00	1,83E+00	0,00E+00	0,00E+00
Materials for energy rec	kg	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	ND	ND	ND	ND	ND	0,00E+00	ND	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Exported energy	MJ	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	8,88E-01	ND	ND	ND	ND	ND	0,00E+00	ND	0,00E+00	0,00E+00	1,17E+01	0,00E+00	0,00E+00
Exported energy: Electricity	MJ	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	3,74E-01	ND	ND	ND	ND	ND	0,00E+00	ND	0,00E+00	0,00E+00	4,91E+00	0,00E+00	0,00E+00
Exported energy: Heat	MJ	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	5,05E-01	ND	ND	ND	ND	ND	0,00E+00	ND	0,00E+00	0,00E+00	6,75E+00	0,00E+00	0,00E+00

ENVIRONMENTAL IMPACTS – EN 15804+A1, CML

Impact category	Unit	A1	A2	A3	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
Global Warming Pot.	kg CO_2e	3,20E+01	2,39E-01	1,44E+00	3,36E+01	1,91E-01	1,16E-01	ND	ND	ND	ND	ND	1,11E+02	ND	0,00E+00	1,30E-01	2,49E+00	1,27E+00	-7,44E+00
Ozone depletion Pot.	kg CFC_{-11}e	1,57E-06	4,59E-09	3,30E-08	1,61E-06	2,26E-09	3,89E-10	ND	ND	ND	ND	ND	2,57E-06	ND	0,00E+00	1,46E-09	1,31E-09	6,35E-10	-5,12E-08
Acidification	kg SO_2e	1,58E-01	6,17E-04	5,65E-03	1,64E-01	5,01E-04	1,24E-04	ND	ND	ND	ND	ND	1,02E+00	ND	0,00E+00	3,33E-04	8,73E-04	2,60E-04	-7,88E-02
Eutrophication	kg PO_4^3e	1,98E-02	3,76E-04	1,72E-02	3,73E-02	1,22E-04	7,80E-05	ND	ND	ND	ND	ND	1,26E-01	ND	0,00E+00	8,11E-05	2,09E-04	1,36E-04	-7,49E-03
POCP ("smog")	kg C_2H_4e	9,77E-03	5,90E-05	5,16E-04	1,03E-02	4,46E-05	2,32E-05	ND	ND	ND	ND	ND	5,50E-02	ND	0,00E+00	2,99E-05	5,42E-05	2,56E-05	-5,89E-03
ADP-elements	kg Sbe	4,05E-04	7,00E-07	6,98E-06	4,13E-04	5,23E-07	1,62E-07	ND	ND	ND	ND	ND	1,19E-02	ND	0,00E+00	4,19E-07	3,15E-06	9,06E-08	-9,28E-04
ADP-fossil	MJ	3,50E+02	3,40E+00	1,22E+01	3,65E+02	2,75E+00	4,49E-01	ND	ND	ND	ND	ND	7,00E+02	ND	0,00E+00	1,81E+00	1,14E+00	4,84E-01	-8,05E+01

ADDITIONAL INDICATOR – GWP-GHG

Impact category	Unit	A1	A2	A3	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
GWP-GHG [9)]	kg CO_2e	3,22E+01	2,40E-01	1,37E+00	3,38E+01	1,92E-01	5,97E-02	ND	ND	ND	ND	ND	1,10E+02	ND	0,00E+00	1,31E-01	2,50E+00	1,27E+00	-7,48E+00

9) This indicator includes all greenhouse gases excluding biogenic carbon dioxide uptake and emissions and biogenic carbon stored in the product. In addition, the characterisation factors for the flows - CH4 fossil, CH4 biogenic and Dinitrogen monoxide - were updated. This indicator is identical to the GWP-total of EN 15804:2012+A2:2019 except that the characterization factor for biogenic CO2 is set to zero.

ENVIRONMENTAL IMPACT DATA, RESULTS PER FUNCTIONAL UNIT

The following results refers to the functional unit, with 1000 lumens for 35 000 hours.

The estimated impact results are only relative statements which do not indicate the end points of the impact categories, exceeding threshold values, safety margins or risks.

CORE ENVIRONMENTAL IMPACT INDICATORS – EN 15804+A2, EF 3.1

Impact category	Unit	A1	A2	A3	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
GWP – total[1)]	kg CO_2 éq/FU	2,57E+00	1,92E-02	-3,23E-02	2,56E+00	1,53E-02	1,35E-01	ND	ND	ND	ND	ND	8,94E+00	ND	0,00E+00	1,04E-02	1,99E-01	1,01E-01	3,95E+00
GWP – fossil	kg CO_2 éq/FU	2,56E+00	1,89E-02	7,27E-02	2,66E+00	1,53E-02	4,76E-03	ND	ND	ND	ND	ND	7,91E+00	ND	0,00E+00	1,04E-02	1,99E-01	1,01E-01	-5,94E-01
GWP – biogenic	kg CO_2 éq/FU	4,04E-03	5,78E-06	-1,42E-01	-1,38E-01	3,47E-06	1,30E-01	ND	ND	ND	ND	ND	1,44E-01	ND	0,00E+00	2,28E-06	-2,52E-05	-8,76E-06	4,54E+00
GWP – LULUC	kg CO_2 éq/FU	1,67E-03	2,94E-04	3,70E-02	3,89E-02	6,86E-06	1,70E-06	ND	ND	ND	ND	ND	8,89E-01	ND	0,00E+00	4,61E-06	7,94E-06	1,91E-06	-2,72E-03
Ozone depletion pot.	kg CFC-$_{11}$e/FU	2,03E-07	4,58E-10	2,77E-09	2,06E-07	2,26E-10	3,83E-11	ND	ND	ND	ND	ND	2,37E-07	ND	0,00E+00	1,46E-10	1,20E-10	5,93E-11	-4,85E-09
Acidification potential	mole H^+e/FU	1,80E-02	6,49E-05	6,80E-04	1,87E-02	5,23E-05	1,30E-05	ND	ND	ND	ND	ND	9,69E-02	ND	0,00E+00	3,47E-05	9,17E-05	2,90E-05	-7,32E-03
EP-freshwater[2)]	kg Pe/FU	1,07E-03	1,80E-06	3,00E-05	1,10E-03	1,19E-06	5,63E-07	ND	ND	ND	ND	ND	7,00E-03	ND	0,00E+00	8,10E-07	3,17E-06	6,23E-07	-4,91E-04
EP-marine	kg Ne/FU	2,56E-03	2,43E-05	3,51E-04	2,94E-03	1,72E-05	1,33E-05	ND	ND	ND	ND	ND	1,43E-02	ND	0,00E+00	1,13E-05	3,55E-05	9,97E-05	-7,85E-04
EP-terrestrial	mol Ne/FU	2,49E-02	2,38E-04	2,70E-03	2,78E-02	1,87E-04	4,64E-05	ND	ND	ND	ND	ND	1,46E-01	ND	0,00E+00	1,22E-04	3,31E-04	1,35E-04	-9,08E-03
POCP ("smog")[3)]	kg NMVOCe/	1,01E-02	9,62E-05	5,06E-04	1,07E-02	7,71E-05	1,70E-05	ND	ND	ND	ND	ND	3,89E-02	ND	0,00E+00	4,84E-05	8,80E-05	3,73E-05	-3,44E-03
ADP-minerals & metals[4)]	kg Sbe/FU	1,77E-04	5,69E-08	5,60E-07	1,78E-04	4,28E-08	1,33E-08	ND	ND	ND	ND	ND	9,51E-04	ND	0,00E+00	3,42E-08	2,56E-07	9,46E-09	-7,41E-05
ADP-fossil resources	MJ/FU	3,64E+01	2,75E-01	1,08E+00	3,78E+01	2,23E-01	3,80E-02	ND	ND	ND	ND	ND	1,06E+03	ND	0,00E+00	1,46E-01	9,63E-02	3,94E-02	-7,52E+00
Water use[5)]	m^3e priv. /FU	8,07E-01	1,71E-03	1,18E+00	1,99E+00	1,10E-03	9,53E-04	ND	ND	ND	ND	ND	5,84E+01	ND	0,00E+00	6,78E-04	1,37E-02	6,51E-03	-1,51E-01

1) GWP = Global Warming Potential. 2) EP = Eutrophication potential. Required characterisation method and data are in kg P-eq. Multiply by 3,07 to get PO4e. 3) POCP = Photochemical ozone formation. 4) ADP = Abiotic depletion potential. 5) EN 15804+A2 disclaimer for Abiotic depletion and Water use and optional indicators except Particulate matter and Ionizing radiation, human health. The results of these environmental impact indicators shall be used with care as the uncertainties on these results are high or as there is limited experience with the indicator.

ADDITIONAL (OPTIONAL) ENVIRONMENTAL IMPACT INDICATORS – EN 15804+A2, EF 3.1

Impact category	Unit	A1	A2	A3	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
Particulate matter	Incidence /FU	1,55E-07	2,03E-09	7,99E-09	1,65E-07	1,54E-09	2,27E-10	ND	ND	ND	ND	ND	8,07E-07	ND	0,00E+00	8,27E-10	8,66E-10	2,85E-10	-4,48E-08
Ionizing radiation[6)]	kBq U235e/FU	1,17E-01	2,42E-04	6,37E-03	1,24E-01	1,94E-04	1,29E-04	ND	ND	ND	ND	ND	7,59E+01	ND	0,00E+00	1,18E-04	3,55E-04	5,43E-05	-6,61E-02
Ecotoxicity (freshwater)	CTUe/FU	2,00E+01	3,32E-01	7,97E-01	2,11E+01	3,15E-02	1,35E-01	ND	ND	ND	ND	ND	1,32E+02	ND	0,00E+00	2,31E-02	4,12E-01	3,39E-01	-4,66E+00
Human toxicity, cancer	CTUh/FU	1,27E-09	3,51E-12	1,23E-10	1,40E-09	2,53E-12	1,53E-12	ND	ND	ND	ND	ND	1,56E-08	ND	0,00E+00	1,77E-12	2,01E-11	1,04E-11	-7,31E-10
Human tox. non-cancer	CTUh/FU	4,08E-08	2,12E-10	2,00E-09	4,30E-08	1,44E-10	8,29E-11	ND	ND	ND	ND	ND	8,16E-07	ND	0,00E+00	9,15E-11	8,12E-10	4,36E-10	-6,03E-08
SQP[7)]	-/FU	5,88E+00	3,00E-01	1,25E+01	1,87E+01	2,24E-01	2,86E-02	ND	ND	ND	ND	ND	2,49E+02	ND	0,00E+00	8,73E-02	1,03E-01	4,53E-02	-2,13E+02

6) EN 15804+A2 disclaimer for Ionizing radiation, human health. This impact category deals mainly with the eventual impact of low dose ionizing radiation on human health of the nuclear fuel cycle. It does not consider effects due to possible nuclear accidents, occupational exposure nor due to radioactive waste disposal in underground facilities. Potential ionizing radiation from the soil, from radon and from some construction materials is also not measured by this indicator. 7) SQP = Land use related impacts/soil quality.

USE OF NATURAL RESOURCES

Impact category	Unit	A1	A2	A3	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
Renew. PER as energy[8)]	MJ/FU	2,09E+00	4,58E-03	4,83E+00	6,92E+00	3,05E-03	-8,45E-01	ND	ND	ND	ND	ND	7,26E+02	ND	0,00E+00	2,00E-03	1,05E-02	1,11E-03	-2,36E+01
Renew. PER as material	MJ/FU	0,00E+00	0,00E+00	1,17E+00	1,17E+00	0,00E+00	-1,17E+00	ND	ND	ND	ND	ND	0,00E+00	ND	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Total use of renew. PER	MJ/FU	2,09E+00	4,58E-03	5,99E+00	8,08E+00	3,05E-03	-2,01E+00	ND	ND	ND	ND	ND	7,26E+02	ND	0,00E+00	2,00E-03	1,05E-02	1,11E-03	-2,36E+01
Non-re. PER as energy	MJ/FU	3,19E+01	2,77E-01	9,50E-01	3,31E+01	2,23E-01	-3,44E-02	ND	ND	ND	ND	ND	1,06E+03	ND	0,00E+00	1,46E-01	-2,87E+00	-2,93E+00	-7,49E+00
Non-re. PER as material	MJ/FU	4,50E+00	0,00E+00	1,32E-01	4,64E+00	0,00E+00	-1,32E-01	ND	ND	ND	ND	ND	0,00E+00	ND	0,00E+00	0,00E+00	-2,25E+00	-2,25E+00	0,00E+00
Total use of non-re. PER	MJ/FU	3,64E+01	2,77E-01	1,08E+00	3,78E+01	2,23E-01	-1,67E-01	ND	ND	ND	ND	ND	1,06E+03	ND	0,00E+00	1,46E-01	-5,12E+00	-5,18E+00	-7,49E+00
Secondary materials	kg/FU	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	ND	ND	ND	ND	ND	0,00E+00	ND	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Renew. secondary fuels	MJ/FU	4,40E-04	1,55E-06	2,93E-02	2,97E-02	1,20E-06	2,81E-07	ND	ND	ND	ND	ND	9,39E-04	ND	0,00E+00	8,36E-07	4,12E-06	8,01E-07	-1,29E-04
Non-ren. secondary fuels	MJ/FU	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	ND	ND	ND	ND	ND	0,00E+00	ND	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Use of net fresh water	m^3/FU	1,98E-02	5,39E-05	2,75E-02	4,74E-02	3,29E-05	-4,10E-05	ND	ND	ND	ND	ND	1,39E+00	ND	0,00E+00	1,94E-05	2,46E-04	-3,27E-05	-7,85E-03

8) PER = Primary energy resources.

END OF LIFE – WASTE

Impact category	Unit	A1	A2	A3	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
Hazardous waste	kg/FU	2,82E-01	1,25E-03	5,39E-03	2,89E-01	3,77E-04	2,68E-04	ND	ND	ND	ND	ND	1,08E+00	ND	0,00E+00	2,55E-04	3,79E-03	4,92E-03	-1,07E-01
Non-hazardous waste	kg/FU	5,41E+00	2,33E-02	1,65E-01	5,60E+00	6,98E-03	9,18E-02	ND	ND	ND	ND	ND	3,57E+01	ND	0,00E+00	4,78E-03	1,03E-01	2,84E-01	-1,19E+00
Radioactive waste	kg/FU	2,90E-05	5,82E-08	1,63E-06	3,07E-05	4,74E-08	3,28E-08	ND	ND	ND	ND	ND	1,62E-02	ND	0,00E+00	2,90E-08	8,77E-08	1,36E-08	-1,66E-05

END OF LIFE – OUTPUT FLOWS

Impact category	Unit	A1	A2	A3	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
Components for re-use	kg/FU	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	ND	ND	ND	ND	ND	0,00E+00	ND	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Materials for recycling	kg/FU	0,00E+00	0,00E+00	5,64E-02	5,64E-02	0,00E+00	3,47E-02	ND	ND	ND	ND	ND	0,00E+00	ND	0,00E+00	0,00E+00	1,46E-01	0,00E+00	0,00E+00
Materials for energy rec	kg/FU	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	ND	ND	ND	ND	ND	0,00E+00	ND	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Exported energy	MJ/FU	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	7,08E-02	ND	ND	ND	ND	ND	0,00E+00	ND	0,00E+00	0,00E+00	9,30E-01	0,00E+00	0,00E+00
Exported energy: Electricity	MJ/FU	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	2,98E-02	ND	ND	ND	ND	ND	0,00E+00	ND	0,00E+00	0,00E+00	3,92E-01	0,00E+00	0,00E+00
Exported energy: Heat	MJ/FU	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	4,03E-02	ND	ND	ND	ND	ND	0,00E+00	ND	0,00E+00	0,00E+00	5,38E-01	0,00E+00	0,00E+00

ENVIRONMENTAL IMPACTS – EN 15804+A1, CML

Impact category	Unit	A1	A2	A3	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
Global Warming Pot.	kg CO_2 éq./FU	2,55E+00	1,91E-02	1,15E-01	2,68E+00	1,53E-02	9,22E-03	ND	ND	ND	ND	ND	8,85E+00	ND	0,00E+00	1,04E-02	1,99E-01	1,01E-01	-5,93E-01
Ozone depletion Pot.	kg CFC-$_{11}$e/FU	1,25E-07	3,66E-10	2,63E-09	1,28E-07	1,81E-10	3,10E-11	ND	ND	ND	ND	ND	2,05E-07	ND	0,00E+00	1,16E-10	1,04E-10	5,07E-11	-4,08E-09
Acidification	kg SO_2e/FU	1,26E-02	4,92E-05	4,50E-04	1,31E-02	3,99E-05	9,86E-06	ND	ND	ND	ND	ND	8,11E-02	ND	0,00E+00	2,66E-05	6,97E-05	2,08E-05	-6,28E-03
Eutrophication	kg PO_4^3e/FU	1,58E-03	3,00E-05	1,37E-03	2,98E-03	9,73E-06	6,22E-06	ND	ND	ND	ND	ND	1,01E-02	ND	0,00E+00	6,47E-06	1,66E-05	1,09E-05	-5,97E-04
POCP (“smog”)	kg C_2H_4e/FU	7,79E-04	4,70E-06	4,11E-05	8,25E-04	3,56E-06	1,85E-06	ND	ND	ND	ND	ND	4,38E-03	ND	0,00E+00	2,38E-06	4,32E-06	2,04E-06	-4,70E-04
ADP-elements	kg Sbe/FU	3,23E-05	5,59E-08	5,57E-07	3,29E-05	4,17E-08	1,29E-08	ND	ND	ND	ND	ND	9,50E-04	ND	0,00E+00	3,34E-08	2,51E-07	7,22E-09	-7,40E-05
ADP-fossil	MJ/FU	2,79E+01	2,71E-01	9,70E-01	2,91E+01	2,19E-01	3,58E-02	ND	ND	ND	ND	ND	5,59E+01	ND	0,00E+00	1,44E-01	9,07E-02	3,86E-02	-6,42E+00

ADDITIONAL INDICATOR – GWP-GHG

Impact category	Unit	A1	A2	A3	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
GWP-GHG [9)]	kg CO_2e/FU	2,57E+00	1,92E-02	1,10E-01	2,70E+00	1,53E-02	4,76E-03	ND	ND	ND	ND	ND	8,80E+00	ND	0,00E+00	1,04E-02	1,99E-01	1,01E-01	-5,97E-01

9) This indicator includes all greenhouse gases excluding biogenic carbon dioxide uptake and emissions and biogenic carbon stored in the product. In addition, the characterisation factors for the flows - CH4 fossil, CH4 biogenic and Dinitrogen monoxide - were updated. This indicator is identical to the GWP-total of EN 15804:2012+A2:2019 except that the characterization factor for biogenic CO2 is set to zero.

SCENARIO DOCUMENTATION

DATA SOURCES

Manufacturing energy scenario documentation – A3 (Energy data source)

1. Energy supply, electricity production, hydro, Electricity production, hydro, reservoir, non-alpine region, Sweden, ecoinvent 3.10.1, 0.0506 kgCO2e/kWh
2. Manufacturing, coke and refined petroleum products, refined petroleum products, Esterification of rape oil, Albania, ecoinvent 3.10.1, -0.800003 kgCO2e/kg
3. Energy supply, electricity production, solar photovoltaic, Electricity production, photovoltaic, 3kWp slanted-roof installation, multi-Si, panel, mounted, Sweden, ecoinvent 3.10.1, 0.10 kgCO2e/kWh
4. Energy supply, heat, steam and air conditioning, heat from wood fuel co-generation, Heat and power co-generation, wood chips, 6667 kW, state-of-the-art 2014, Sweden, ecoinvent 3.10.1, 0.0026 kgCO2e/MJ

TRANSPORT SCENARIO DOCUMENTATION – A4

Scenario parameter	Value
Capacity utilization (including empty return) %	50 %
Bulk density of transported products / kg/m³	530
Volume capacity utilization factor (factor: =1 or <1 or ≥1 for compressed or nested packaged products)	1

Transport scenario documentation - A4

1. Transport, freight, lorry >32 metric ton, EURO5, 337.0 km

INSTALLATION SCENARIO DOCUMENTATION - A5

Scenario parameter	Value
Ancillary materials for installation (specified by material) / kg or other units as appropriate	0
Water use / m³	0
Other resource use / kg	0
Direct emissions to ambient air, soil and water / kg	0

Installation scenario documentation - A5 (Energy data source)

Installation scenario documentation - A5 (Waste materials data source)

1. Corrugated board box production, 0.372 kg
2. Eur-flat pallet production, 0.0313 unit
3. Packaging film production, low density polyethylene, 0.0234 kg

USE STAGES SCENARIO DOCUMENTATION – B6-B7

Scenario information	Value
Ancillary materials specified by material / kg or units as appropriate	Not applicable
Net fresh water consumption / m³	0
Power output of equipment / W	30
Characteristic performance, e.g., energy efficiency, emissions, variation of performance with capacity utilization, etc. / Units as appropriate	
Further assumptions for scenario development, e.g., frequency and period of use, number of occupants / Units as appropriate	

Use stages scenario documentation - B6-B7 (Energy data source)

1. Energy supply, electricity transformation and distribution, distribution low voltage, Market for electricity, low voltage, Sweden, 3000.0 kWh

END OF LIFE SCENARIO DOCUMENTATION – C1-C4

Scenario information	Value
Collection process – kg collected separately	4,51
Collection process – kg collected with mixed construction waste	0
Recovery process – kg for re-use	0
Recovery process – kg for recycling	1,83
Recovery process – kg for energy recovery	0
Disposal (total) – kg for final deposition	1,61
Scenario assumptions e.g. transportation	Lorry, 16-32 metric ton, EURO5; 150 km

THIRD-PARTY VERIFICATION STATEMENT

EPD Hub declares that this EPD is verified in accordance with ISO 14025 by an independent, third-party verifier. The project report on the Life Cycle Assessment and the report(s) on features of environmental relevance are filed at EPD Hub. EPD Hub PCR and ECO Platform verification checklist are used.

EPD Hub is not able to identify any unjustified deviations from the PCR and EN 15804+A2 in the Environmental Product Declaration and its project report.

EPD Hub maintains its independence as a third-party body; it was not involved in the execution of the LCA or in the development of the declaration and has no conflicts of interest regarding this verification.

The company-specific data and upstream and downstream data have been examined as regards plausibility and consistency. The publisher is responsible for ensuring the factual integrity and legal compliance of this declaration.



Program assistant: Xinyuan Zhang

The software used in creation of this LCA and EPD is verified by EPD Hub to conform to the procedural and methodological requirements outlined in ISO 14025:2010, ISO 14040/14044, EN 15804+A2, and EPD Hub Core Product Category Rules and General Program Instructions.

Verified tools
Tool verifier: Hai Ha Nguyen
Tool verification validity: 28 March 2025 - 27 March 2028