PRODUCT ENVIRONMENTAL PROFILE

Environmental Product Declaration

Emax 2 – E4.2 IEC type Air Circuit Breaker

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PEP ARE COMPLIANT WITH XP C08-100-1 :2016 OR EN 50693:2019 THE ELEMENTS OF THE PRESENT PEP CANNOT BE COMPARED WITH ELEMENTS FROM ANOTHER PROGRAM.	
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Manufacturer name and address	ABB S.p.A. Via E. Fermi 40 - 03100 Frosinone (FR) - Italy
Company contacts	EPD_ELSP@in.abb.com
Reference product	Emax 2 E4.2 circuit breaker IEC type withdrawable version equipped with Ekip Touch electronic trip unit
Description of the product	Emax 2 air circuit breaker is a multifunctional platform able to manage the next generation of electrical plants such as microgrids, evolving into a true Power Manager. Emax 2 is the first air circuit breaker that matches all the new grid requirements. It enables a direct communication to the new energy management cloud-computing platform ABB Ability™. Energy and Asset Manager
Functional unit	The functional unit to this study is a single circuit breaker (including its packaging and accessories), to protect during 20 years the installation against overloads and short-circuits in circuit with assigned voltage U and rated current In. This protection is ensured in accordance with the following parameters IEC Type Rated voltage [V]: 690 Rated current [A]: 4000 Rated breaking capacity [kA]: 100 Number of poles: 3/4 Tripping Curve: L, S, I
Others products covered	Emax2 E4.2 Withdrawable Circuit Breakers of types [IEC] N/S/H/V and ratings 800A to 4000A / 3poles /4poles
Reference lifetime	20 years
Product category	Electrical, Electronic and HVAC-R Products
Use Scenario	The use phase has been modeled based on the sales mix data (2021), and the corresponding low voltage electricity countries mix
Geographical representativeness	Raw materials & Manufacturing: [Europe / Global] Assembly: [Italy] Distribution / Use: [Global] specific sales mix EoL: [Global]
Technological representativeness	Materials and processes data are specific for the production of Emax2 E4.2 circuit breaker
LCA Study	This study is based on the LCA study described in the LCA report 1SDH002181A1001
EPD type	Products family declaration
EPD scope	“Cradle to grave”
Year of reported primary data	2021
LCA software	SimaPro 9.3.0.3 (2022)
LCI database	Ecoinvent v3.8 (2021)
LCIA methodology	EN 15804:2012+A2:2019

Contents

ABB Purpose & Embedding Sustainability

ABB is a leading global technology company that energizes the transformation of society and industry to achieve a more productive, sustainable future. By connecting software to its electrification, robotics, automation and motion portfolio, ABB pushes the boundaries of technology to drive performance to new levels. With a history of excellence stretching back more than 130 years, ABB's success is driven by about 105 thousand talented employees in over 100 countries.

ABB's Electrification business offers a wide-ranging portfolio of products, digital solutions and services, from substation to socket, enabling safe, smart and sustainable electrification. Offerings encompass digital and connected innovations for low voltage and medium voltage, including EV infrastructure, solar inverters, modular substations, distribution automation, power protection, wiring accessories, switchgear, enclosures, cabling, sensing and control.

ABB is committed to continually promoting and embedding sustainability across its operations and value chain, aspiring to become a role model for others to follow. With its ABB Purpose, ABB is focusing on reducing harmful emissions, preserving natural resources and championing ethical and humane behavior.

General Information

ABB's Frosinone factory represents a centre of excellence in ABB for the development and manufacture of low-voltage circuit breakers. The 150,000 square-meter facility with 800 employees is highly automated and produces more than three million circuit breakers every year. A Lighthouse Plant, selected by the Italian government as a model for digital transformation and Industry 4.0 strategies, Frosinone promotes smart, digitalized, and connected operations, increasing efficiency across the full value chain. Achieving zero production waste to landfill was a whole-factory program. Flexibility, lean production processes, capacity to efficiently and rapidly meet market demands, and process innovation are some of the most significant characteristics of this site

ABB IT-ELSP adopts and implements for its own activities an integrated Quality/Environmental/Health Management System in compliance with the following standards:

- UNI EN ISO 9001/2015 - Quality Management Systems – Requirements
- UNI EN ISO 14001/2015 - Environmental management systems – Specification with guidance for use
- UNI EN ISO 45001:2018 - Occupational Health and Safety Assessment Series – Requirements
- SA 8000:2014 - Social Accountability 8000 – SA 8000

ABB offers a wide range of low voltage Air Circuit Breakers for any application, also distribution. The primary scope of Low Voltage Circuit Breakers is to isolate parts of an electrical distribution system in the event of abnormal conditions. Abnormal conditions are generally caused by faults on a system which can lead to dangerous situations for both people and the system itself. In addition to providing system protection, circuit breakers enable parts of the electrical distribution to be isolated for operation and maintenance.

In the factory, the different components and subassemblies are assembled on the manufacturing line. All components and subassemblies are produced by ABB's suppliers and are only assembled in the factory.

Emax 2 product cluster

Emax 2 air circuit breaker is a multifunctional platform able to manage the next generation of electrical plants such as microgrids, evolving into a true Power Manager. Emax 2 is the first air circuit breaker that matches all the new grid requirements. It enables a direct communication to the new energy management cloud-computing platform ABB Ability™. Energy and Asset Manager

Product cluster E4.2 analyzed in this LCA includes both IEC and UL types of the same withdrawable circuit breaker, consisting of a fixed and moving part (which is inserted and removed via dedicated guide rails).

- **Emax2 E4.2 (IEC Type)**

Circuit breaker	E4.2
Rated voltage [V]	690
Rated current [A]	3200-4000
Rated short circuit breaking current [kA]	100
Number of poles	3/4

Table 1: Technical characteristics of IEC circuit breakers (Refer Technical catalogue for complete details).

Packaging is common for 3p & 4p with the following substance composition:

Material	Unit	E4.2
Corrugated Cardboard	g	1381
Wooden Pallet / Plywood	g	28200
Polyethylene	g	120
Steel	g	1200
Total weight	g	30901

Table 2: Weight of materials E4.2 - Packaging

No cut-off criteria have been applied to the analysis of the product and its packaging. Additional packaging for semifinished products along the supply chain haven't been considered.

Official declarations LB-DT 17-21D [11] and 1SDL000282R1265 [12] states compliance of ABB moulded case circuit breakers and air circuit breakers respectively to RoHS II and REACH regulations; annex 1SDL000571R0 [13] provides exemptions considered for RoHS II while annex 1SDL000572R0 [14] lists REACH substances present in a concentration above 0,1% adding reference to products where involved parts are mounted.

Constituent Materials

Emax2 E4.2 (IEC Type)

The representative product is E4.2 4000A N/S/H - 3P Withdrawable Circuit Breaker (IEC Type) which weighs 147kg including its installed accessories, paper documentation and packaging.

Materials	Name	IEC 62474 MC	Weight [g]	Weight %
Metals	Steel	M-119	48560	32.9%
	Cu and CU alloys	M-121	41459	28.1%
	Stainless Steel	M-100	2730	1.8%
	Aluminum	M-120	750	0.5%
	Precious metals	M-159	114	<0.1%
Plastics	Unsaturated Polyester	M-301	17787	12.1%
	Polyamide (PA)	M-258	3072	2.1%
	Polycarbonate (PC)	M-254	1799	1.2%
	Poly Propylene (PP)	M-252	351	0.2%
	Polyethylene Terephthalate (PET)	M-259	311	0.2%
	Polyethylene (PE)	M-251	257	0.2%
	Acrylonitrile Butadiene Styrene (ABS)	M-256	146	0.1%
	Other Polymers	NA	135	<0.1%
Others	Wood	M-340	28200	19.1%
	Paper / Cardboard	M-341	1644	1.1%
	Others	N/A	270	0.2%
Total			147585	100%

Table 3: Weight of materials E4.2 4000A N/S/H - 3P IEC Withdrawable Circuit Breaker

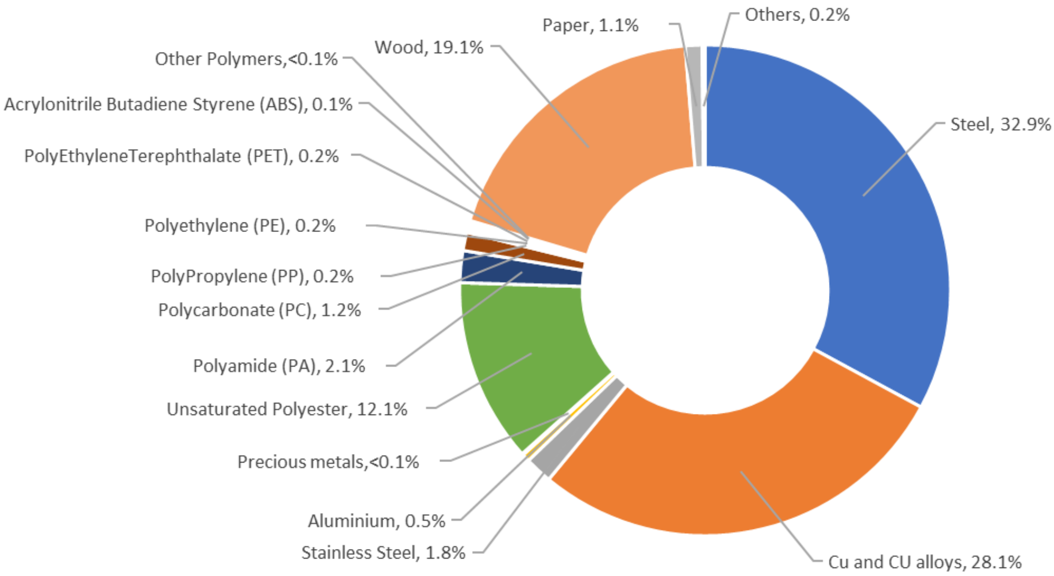

Figure 1: Composition of E4.2 4000A N/S/H - 3P IEC Withdrawable Circuit Breaker

LCA background information

Functional unit and Reference Flow

The functional unit is the reference unit used to quantify the performance of the service delivered by a product to the user. The main purpose of the functional unit is to provide a reference to which inputs and outputs are related in the LCA.

The functional unit to this study is a single circuit breaker (including its packaging and accessories), to protect during 20 years the installation against overloads and short-circuits in circuit with assigned voltage U and rated current In (see tables 1, p.5). This protection is ensured in accordance with the following parameters

Number of poles	3/4
Rated breaking capacity [kA]	100
Tripping Curve	L, S, I

The Reference Flow of the study is a single circuit breaker (including its packaging and accessories) with mass described in page 6 table 3.

System boundaries and life cycle stages

The life cycle of the Low Voltage Circuit Breaker, an EEPS (Electronic and Electrical Products and Systems), is a "from cradle to grave" analysis and covers the following main life cycle stages: manufacturing, including the relevant acquisition of raw material, preparation of semi-finished goods, etc. and processing steps; distribution; installation, including the relevant steps for the preparation of the product for use; use including the required maintenance steps within the RSL (reference service life of the product) associated to the reference product; end-of-life stage, including the necessary steps until final disposal or recovery of the product system.

The following table shows the stages of the product life cycle and the information stages according to EN 50693:2019 [3] for the evaluation of electronic and electrical products and systems.

Manufacturing	Distribution	Installation	Use	End-of-Life (EoL)
Acquisition of raw materials Transport to manufacturing site Components/parts manufacturing Assembly Packaging EoL treatment of generated waste	Transport to distributor/ logistic center Transport to place of use	Installation EoL treatment of generated waste (packaging)	Usage Maintenance	Deinstallation Collection and transport EoL treatment

Table 4: Phases for the evaluation of construction products according to EN50693:2019 [3].

Temporal and geographical boundaries

The ABB component suppliers are sourced all over the world. All primary data collected are from 2021, which is a representative production year. Secondary data are also representative for this year, as provided by ecoinvent [6].

The selected ecoinvent [6] processes in the LCA model have a global representativeness, due to the unclear origin of each component. In this way, a conservative approach has been adopted.

Boundaries in the life cycle

As indicated in the PCR capital goods such as buildings, machinery, tools and infrastructure, the packaging for internal transport which cannot be allocated directly to the production of the reference product, may be excluded from the system boundary.

Infrastructures, when present, such as processes deriving from the ecoinvent [6] database have not been excluded.

Data quality

In this LCA, both primary and secondary data are used. Site specific foreground data have been provided by ABB. Main data sources are the bill of materials & drawings which are available on the ERP (SAP) & Windchill. For all processes for which primary are not available, generic data originating from the ecoinvent database [6], allocation cut-off by classifica-tion, are used. The ecoinvent database available in the SimaPro software [7] is used for the calculations.

The data quality characterized by quantitative and qualitative aspects, is presented in Ap-pendix 1. Each data quality parameter has been rated according to DQR tables from Chapter 7.19.2.2 of the Product Environmental Footprint Guide v.6.3 to give an indication of geog-raphy, technology and temporal representativeness.

Environmental impact indicators

The information obtained from the inventory analysis is aggregated according to the effects related to the various environmental issues. According to “PCR-ed4-EN-2021 09 06” and EN 50693 [3] the environmental impact indicators must be determined using the characterization factors and impact assessment methods specified in EN 15804:2012+A2:2019 [8].

PCR-ed4-EN-2021 09 06 and the EN 50693:2019 [3] standard establish four indicators for climate change: Climate change (total) which includes all greenhouse gases; Climate change (fossil fuels); Climate change (biogenic) which includes the emissions and absorption of biogenic carbon dioxide and biogenic carbon stored in the product; Climate change (land use) - land use and land use transformation. Other indicators as per the PCR[1].

Allocation rules

Allocation coefficients are based on the Emax2 line’s occupancy area for electricity and methane consumption as well as the total amount of waste generated by the production line.

The total number of operators was considered for water consumption. All these flows have been allocated and divided by the total number of Emax2 E4.2 circuit breakers produced in 2021.

Limitations and simplifications

Raw materials life cycle stage includes the extraction of raw materials as well as the transport distances to the manufacturing suppliers. These distances are assumed to be 1000 km as per the PCR. This distance has been added to the one already included in the market processes used for the model, as a result of a conservative choice made by the LCA operators.

Application of grease lubricant on the circuit breakers operating mechanism has been excluded since it is negligible. Surface treatments like galvanizing, tin and silver plating as well as their related transport processes (back and forth from the finishing suppliers) have been considered in the LCA model. Specific phosphate surface treatment, Stearate coating have been excluded by operational choice (mass of the components involved < 0.9% of the final product, thus negligible). Scraps for metal working and plastic processes are included when already defined in ecoinvent[6].

Printed circuit boards (PCB) have been modelled with a representative cluster dataset including: every single component, the unpopulated board as well as the surface mounting technology (SMD) process. For some components with no equivalent on ecoinvent database[6], the dataset “Electronic component, passive, unspecified {GLO}| market for | Cut-off, S” was used.

Energy Models

LCA Stage	EN 15804:2012 +A2:2019 module	Energy model	Notes
Raw material extraction and processing	A1-A2	Electricity, {RER}| market group for | Cut-off Electricity, {GLO}| market group for | Cut-off	Based on materials and suppliers locations
Manufacturing	A3	Electricity, {IT}| market for | Cut-off	Specific Energy model for ABB Frosinone manufacturing plant, 100% renewable
Installation (Packaging EoL)	A5	Electricity, {GLO}| market group for | Cut-off	
Use Stage	B1	Electricity, [country]x | market for | Cut-off, S **	Low voltage, based on 2021 country sales mix
EoL	C1-C4	Electricity, {GLO}| market group for | Cut-off	

Table 5: Energy models used in each LCA stage

** Please refer the use phase page 14 for further description

Inventory analysis

In this LCA, both primary and secondary data are used. Site specific foreground data have been provided by ABB. For data collection, Bills of Material (BOM) extracted from ABB's internal SAP software were used. They are a list of all the components and assemblies that constitute the finished product, organized by level. Each item is matched with its code, quantity, weight and supplier. The BOMs were then processed, adding material, surface area and other weight data, taken from technical drawings. Finally, the manufacturing process and surface treatment were assigned, according to information provided by R&D personnel. Road distances between the suppliers and ABB were calculated using Google Maps, and marine distances using Distances & Time (Searates).

All primary data collected from ABB are from 2021, which was a representative production year. The ecoinvent cut-off by classification system processes [6] are used to represent the LCA model

Due to the large amounts of components in the Circuit Breaker, raw material inputs have been modelled with data from ecoinvent[6] representing either a European [RER] or Global [RoW] market coverage based on the supplier's location. These datasets are assumed to be representative.

Manufacturing stage

The Circuit Breakers are composed of a multitude of components, all of which are made from of numerous materials. Most of the inputs to the products' manufacturing stage are already produced component parts.

All the circuit breaker's components have been modelled according to their specific raw materials and manufacturing processes.

The single use packaging as well as paper documentation are also included in the analysis in the manufacturing stage. ABB receives packaging components from outside suppliers and packages the circuit breakers before shipping them.

Most of the inputs to the products' manufacturing stage are already produced component parts from the supply chain. In the ABB manufacturing plant, the different components and subassemblies are assembled into the circuit breaker. All the semi-finished and ancillary products are produced by ABB's suppliers

The entire supplier's network has been modelled with the calculation of each transportation stage, from the first manufacturing supplier to the next.

All the distances from the last subassembly suppliers' factories to the ABB manufacturing facility have been calculated.
In the ABB factory, the different components and subassemblies are assembled into the circuit breaker. All the semi-finished and ancillary products are produced by ABB's suppliers.

The energy mix used for the production phase is representative for ABB Frosinone production site and includes renewable energy only (Hydroelectric + Wind + Solar).

The complete energy mix has been modeled considering the GSE report on energy origins provided to ABB for the year 2021.

Distribution

The transport distances from ABB manufacturing plant to the distribution centers (regional distribution centers / local sales organizations) have been calculated considering the specific reference products sales mix data from 2021 (SAP ERP sales data as a source).
Reference product distribution is representative of the entire size and equivalent to distribution of other products listed in the extrapolation tables

The other parameter affecting the environmental impact for this LCA stage is the total mass of the product (including its packaging). Different mass values for each specific configuration covered by this study have been considered in the model.

An additional 10% distance by road has been considered to cover the last distribution stage to the end customer (usage location).

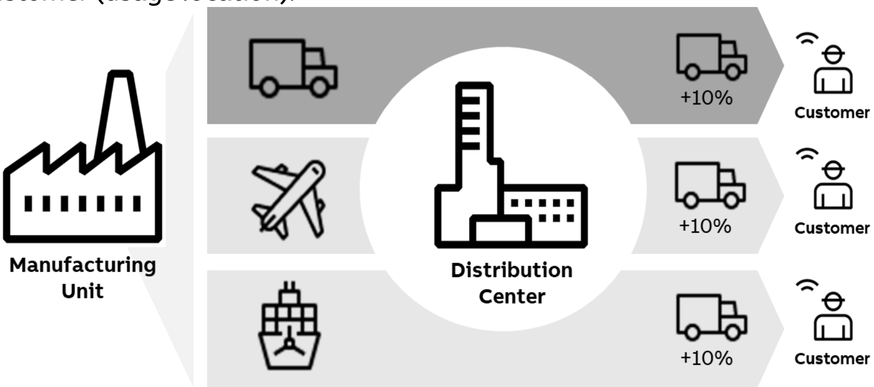

Figure 2: Distribution methodology.

Installation

The installation phase only implies manual activities, and no energy is consumed. This phase also includes the disposal of the packaging of the Low Voltage Circuit Breaker.

All the components needed to install the product (e.g. IP30 flange, lifting plates, etc.) have been included in the analysis.

For the disposal of the packaging after installation of the circuit breaker at the end of its life, a transport distance of 1000 km (according to PCR [1]) was assumed.
The actual disposal site is unknown and is managed by the customer. The disposal scenario of the packaging was calculated based on the latest Eurostat data (EU-27) available.

Use

During the use phase, circuit breakers dissipate some electricity due to power losses.
The respective energy for each specific configuration of the entire product family has been calculated according to the data provided in the catalogue of the circuit breaker and following the PCR [1] & PSR [2] rules:

The Energy model used for this phase was built based on the 2021 actual sales mix data for the entire product range (SAP ERP sales data as a source). This approach has been taken since this list of countries will be the most representative also for the other products listed in the extrapolation tables.

From Ecoinvent [6] database, the low voltage electricity country mix for each country(x) has been selected with its respective percentage on the total sales mix (Electricity, low voltage [country]x | market for | Cut-off, S).

Parameters		
Iu	[A]	2500
Iu	[%]	50
h/year	[h]	8760
RSL	[years]	20
Time operating coefficient	[%]	30

Table 6: Use phase parameters

The formula for the calculation of the electricity consumed is shown below and it is described as follows, where P_{use} is the power consumed by the switch at a given value of current:

$$E_{use}\,[kWh] = \frac{P_{use} * 8760 * RSL * \alpha}{1000}$$

The above calculations have been performed according to the number of poles (3) on which relevant current flows during use phase.

Since no maintenance happens during the use phase, the environmental impacts linked to this procedure have been considered as null in the analysis.

End of life

The end-of-life stage is modelled according to PCR [1] and IEC/TR 62635 [9]. The percentages for end-of-life treatments of materials are taken from IEC/TR 62635 [9].

Since no specific data is available, the transport distances from the place of use to the place of disposal are assumed to be 1000 km (local/domestic transport by lorry, according to PCR [1]).

Disassembly manuals can be provided to the customer to support product disposal.
All circuit moving and fixed parts are labelled with WEEE logo.

Environmental impacts

E4.2 IEC

The following table show the environmental impact indicators of the life cycle of a single E4.2 4000A N/S/H- 3P IEC Withdrawable Circuit Breaker as indicated by PCR [1] and EN 50693:2019 [3]. The indicators are divided into the contribution of the processes to the different stages (manufacturing, distribution, installation, use and end-of-life).

Impact category	Unit	Total	Manuf	Distr	Install	Use	EoL
GWP-total	kg CO2 eq	7.80E+03	7.96E+02	3.23E+02	1.78E+01	6.62E+03	4.67E+01
GWP-fossil	kg CO2 eq	7.62E+03	8.16E+02	3.23E+02	3.16E+00	6.43E+03	4.60E+01
GWP-biogenic	kg CO2 eq	1.64E+02	-2.20E+01	1.18E-01	1.46E+01	1.71E+02	5.93E-01
GWP-luluc	kg CO2 eq	1.65E+01	1.10E+00	2.41E-02	1.18E-03	1.53E+01	3.53E-02
ODP	kg CFC11 eq	5.58E-04	6.82E-05	7.37E-05	7.10E-07	4.12E-04	3.43E-06
AP	mol H+ eq	5.74E+01	2.39E+01	1.69E+00	1.66E-02	3.15E+01	2.60E-01
EP-freshwater	kg P eq	5.76E+00	1.97E+00	5.02E-03	2.62E-04	3.77E+00	1.22E-02
EP-marine	kg N eq	7.83E+00	1.76E+00	6.12E-01	9.75E-03	5.36E+00	8.79E-02
EP-terrestrial	mol N eq	8.12E+01	2.16E+01	6.70E+00	6.42E-02	5.23E+01	5.35E-01
POCP	kg NMVOC eq	2.26E+01	6.09E+00	1.75E+00	1.90E-02	1.46E+01	1.54E-01
ADP-m&m	kg Sb eq	8.37E-01	7.94E-01	1.19E-04	7.12E-06	4.28E-02	3.90E-05
ADP-fossil	MJ	1.10E+05	1.11E+04	4.56E+03	4.74E+01	9.39E+04	4.97E+02
WDP	m3	1.91E+03	6.15E+02	4.17E+00	1.70E-01	1.28E+03	3.95E+00
PENRE	MJ	1.10E+05	1.06E+04	4.56E+03	4.74E+01	9.38E+04	4.97E+02
PENRM	MJ	5.00E+02	5.00E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT	MJ	1.10E+05	1.11E+04	4.56E+03	4.74E+01	9.38E+04	4.97E+02
PERE	MJ	1.99E+04	2.36E+03	1.71E+01	6.38E-01	1.75E+04	4.48E+01
PERM	MJ	3.93E+01	3.93E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	MJ	2.00E+04	2.40E+03	1.71E+01	6.38E-01	1.75E+04	4.48E+01
SM	kg	4.94E+01	4.94E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	m3	7.80E+01	1.88E+01	1.56E-01	6.28E-03	5.89E+01	1.70E-01
HWD	kg	1.69E-01	6.58E-02	1.21E-02	1.12E-04	9.09E-02	5.10E-04
N-HWD	kg	6.37E+02	2.33E+02	2.71E+01	1.50E+01	3.23E+02	3.91E+01
RWD	kg	3.61E-01	3.58E-02	3.22E-02	3.12E-04	2.90E-01	1.97E-03
MfR	kg	1.27E+02	2.28E+01	0.00E+00	1.07E+01	0.00E+00	9.34E+01
MfER	kg	1.03E+01	0.00E+00	0.00E+00	9.17E+00	0.00E+00	1.12E+00
Efp	disease inc.	2.34E-04	8.04E-05	5.05E-06	3.70E-07	1.44E-04	4.23E-06
IrHH	kBq U-235 eq	9.99E+02	9.33E+01	2.06E+01	2.36E-01	8.82E+02	3.28E+00
ETX FW	CTUe	2.79E+05	2.04E+05	2.50E+03	3.94E+01	7.15E+04	9.91E+02
HTX CE	CTUh	8.09E-06	5.67E-06	3.39E-08	1.43E-09	2.32E-06	6.02E-08
HTX N-CE	CTUh	4.84E-04	4.17E-04	3.99E-06	5.95E-08	5.90E-05	3.74E-06
IrLS	Pt	3.39E+04	1.41E+04	8.42E+02	5.64E+01	1.86E+04	3.45E+02

Table 7: Impact indicators for E4.2 4000A N/S/H - 3P IEC

Impact category	Unit	Total
Biogenic Carbon content of the product	kg	2.26E-01
Biogenic Carbon content of the associated packaging	kg	1.83E+01

Table 8: Inventory flow other indicators

Environmental impact indicators

GWP-total	Global Warming Potential total (Climate change)
GWP-fossil	Global Warming Potential fossil
GWP-biogenic	Global Warming Potential biogenic
GWP-luluc	Global Warming Potential land use and land use change
ODP	Depletion potential of the stratospheric ozone layer
AP	Acidification potential
EP-freshwater	Eutrophication potential - freshwater compartment
EP-marine	Eutrophication potential - fraction of nutrients reaching marine end compartment
EP-terrestrial	Eutrophication potential -Accumulated Exceedance
POCP	Formation potential of tropospheric ozone
ADP-m&m	Abiotic Depletion for non-fossil resources potential
ADP-fossil	Abiotic Depletion for fossil resources potential, WDP
WDP	Water deprivation potential.

Resource use indicators

PENRE	Use of non-renewable primary energy excluding renewable primary energy resources used as raw material
PENRM	Use of non-renewable primary energy resources used as raw material
PENRT	Total use of non-renewable primary energy resources (primary energy and primary energy resources used as raw materials)
PERE	Use of renewable primary energy excluding non-renewable primary energy resources used as raw material
PERM	Use of renewable primary energy resources used as raw material
PERT	Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials)

Secondary materials, water and energy resources

SM	Use of secondary materials
RSF	Use of renewable secondary fuels
NRSF	Use of non-renewable secondary fuels
FW	FW: Net use of fresh water

Waste category indicators

HWD	Hazardous waste disposed
N-HWD	Non-hazardous waste disposed
RWD	Radioactive waste disposed

Output flow indicators

MfR	Materials for recycling
MfER	Materials for energy recovery

Other indicators

Efp	Emissions of Fine particles
IrHH	Ionizing radiation, human health
ETX FW	Ecotoxicity, freshwater
HTX CE	Human toxicity, carcinogenic effects
HTX N-CE	Human toxicity, non-carcinogenic effects
IrLS	Impact related to Land use / soil quality

Extrapolation for Homogeneous environmental family

This LCA covers different build configurations other than the representative product. All the analyzed configurations have the same main functionality, product standards and manufacturing technology

The different life cycle stages can be extrapolated to other products of the same homogeneous environmental family by applying a rule of proportionality to the parameters in the following tables, divided by different life cycle stages

E4.2 IEC Extrapolation:

Circuit Breaker	LCA Phase	GWP-total	GWP-fossil	GWP-biogenic	GWP-luluc	ODP	AP	EP-freshwater	EP-marine	EP-terrestrial	POCP	ADP-m&m	ADP-fossil	WDP
IEC-3P-4000N/S/H	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
IEC-3P-3200N/S/H	0.91	0.91	1.07	0.90	0.92	0.83	0.83	0.86	0.85	0.86	0.81	0.92	0.86	0.91
IEC-3P-2000-4000V	1.00	1.00	1.00	1.00	0.99	1.01	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
IEC-3P-3200N/MS,H/MS	0.82	0.82	1.09	0.79	0.80	0.79	0.77	0.80	0.79	0.80	0.76	0.83	0.82	0.82
IEC-3P-3200V/MS	0.91	0.91	1.02	0.89	0.88	0.97	0.94	0.93	0.94	0.94	0.95	0.91	0.96	0.91
IEC-4P-4000N/S/H	1.26	1.25	0.82	1.24	1.26	1.31	1.30	1.28	1.29	1.28	1.31	1.25	1.28	1.26
IEC-4P-3200N/S/H	1.13	1.13	0.91	1.10	1.15	1.08	1.08	1.10	1.09	1.10	1.06	1.14	1.10	1.13
IEC-4P-2000-4000V	1.25	1.24	0.82	1.24	1.25	1.32	1.31	1.28	1.29	1.29	1.32	1.24	1.28	1.25
IEC-4P-3200N/MS,H/MS	1.04	1.03	0.94	0.99	1.01	1.04	1.01	1.02	1.03	1.04	1.00	1.05	1.05	1.04
IEC-4P-3200V/MS	1.16	1.15	0.85	1.12	1.11	1.28	1.24	1.21	1.23	1.23	1.27	1.15	1.24	1.16

Table 9a: Manufacturing phase Extrapolation factors for E4.2 IEC Circuit Breaker
Reference product: E4.2 4000A N/S/H - 3P IEC

Circuit Breaker	LCA Phase	All
IEC-3P-4000N/S/H	Distr	1.00
IEC-3P-3200N/S/H		0.94
IEC-3P-2000-4000V		1.00
IEC-3P-3200N/MS,H/MS		0.93
IEC-3P-3200V/MS		0.98
IEC-4P-4000N/S/H		1.19
IEC-4P-3200N/S/H		1.12
IEC-4P-2000-4000V		1.19
IEC-4P-3200N/MS,H/MS		1.10
IEC-4P-3200V/MS		1.17
IEC-3P-4000N/S/H		1.00
IEC-3P-3200N/S/H		0.94
IEC-3P-2000-4000V		1.00

Table 9b Distribution phase Extrapolation factors for E4.2 IEC
Reference product: E4.2 4000A N/S/H - 3P IEC

Circuit Breaker	In [A]	LCA Phase	Factor
N, S, H, V, N/MS, H/MS, V/MS	3200	Use	0.83
N, S, H, V	4000		1.00

Table 9c: Use phase Extrapolation factors for E4.2 IEC
Reference product: E4.2 4000A N/S/H - 3P IEC

Circuit Breaker	LCA Phase	GWP-total	GWP-fossil	GWP-biogenic	GWP-luluc	ODP	AP	EP-freshwater	EP-marine	EP-terrestrial	POCP	ADP-m&m	ADP-fossil	WDP
IEC-3P-4000N/S/H	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
IEC-3P-3200N/S/H	0.86	0.86	0.86	0.83	0.91	0.84	0.82	0.94	0.86	0.86	0.89	0.85	0.85	0.86
IEC-3P-2000-4000V	1.00	1.00	1.01	1.01	1.00	1.01	1.01	0.99	1.00	1.00	1.00	1.00	1.00	1.00
IEC-3P-3200N/MS,H/MS	0.84	0.84	0.82	0.81	0.89	0.82	0.80	0.92	0.84	0.85	0.87	0.84	0.83	0.84
IEC-3P-3200V/MS	0.98	0.98	0.96	0.99	0.98	0.99	0.99	0.97	0.99	0.99	0.98	0.99	0.99	0.98
IEC-4P-4000N/S/H	1.30	1.30	1.25	1.32	1.26	1.31	1.32	1.31	1.29	1.29	1.27	1.30	1.31	1.30
IEC-4P-3200N/S/H	1.12	1.12	1.06	1.08	1.14	1.09	1.08	1.23	1.11	1.11	1.13	1.10	1.11	1.12
IEC-4P-2000-4000V	1.31	1.31	1.26	1.33	1.26	1.32	1.33	1.29	1.30	1.29	1.27	1.30	1.32	1.31
IEC-4P-3200N/MS,H/MS	1.09	1.09	1.01	1.07	1.11	1.07	1.06	1.20	1.09	1.09	1.10	1.08	1.09	1.09
IEC-4P-3200V/MS	1.28	1.28	1.21	1.31	1.24	1.30	1.31	1.27	1.27	1.27	1.25	1.28	1.30	1.28

Table 9d: End of Life phase Extrapolation factors for E4.2 IEC
Reference product: E4.2 4000A N/S/H - 3P IEC

Additional environmental information

According to the waste treatment scenario calculation in Simapro[7], based on the recycling rate in the technical report IEC/TR 62635 Edition 1.0 [9] Table D.6, the following recyclability potentials were calculated. The recyclability potential is calculated based on the product weight (excluding packaging).

	E4.2 IEC- 3P - 4000 N/S/H
Recyclability potential	79.8%

Table 10: Recyclability potential of E4.2 – 3P

References

[1] PCR "PEP-PCR-ed4-EN-2021_09_06" - Product Category Rules for Electrical, Electronic and HVAC-R Products (published: 6th September 2021)

[2] PSR "PSR-0005-ed2-EN-2016 03 29" - SPECIFIC RULES FOR Electrical switchgear and control gear Solutions (Circuit breakers)

[3] EN 50693:2019 - Product category rules for life cycle assessments of electronic and electrical products and systems

[4] ISO 14040:2006 - Environmental management -Life cycle assessment - Principles and framework

[5] ISO 14044:2006 - Environmental management - Life cycle assessment - Requirements and guidelines

[6] ecoinvent v3.8 (2021). ecoinvent database version 3.8 - (https://ecoinvent.org/)

[7] SimaPro Software version 9.3.0.3 - PRé Sustainability

[8] UNI EN 15804:2012+A2:2019: Sustainability of constructions - Environmental product declarations (September 2019)

[9] IEC/TR 62635 - Guidelines for end-of-life information provided by manufacturers and recyclers and for recyclability rate calculation of electrical and electronic equipment - Edition 1.0 2012-10

[10] https://www.ecosystemspa.com/

[11] LB-DT 17-21D - RoHS II (MCCBs and ACBs)

[12] 1SDL000282R1265- REACH (MCCBs and ACBs)

[13] 1SDL000571R0 Ver 01 - RoHS Exemptions (MCCBs and ACBs)

[14] 1SDL000572R0 Ver 01 - SVHC present in excess of 0.1% (MCCBs and ACBs)