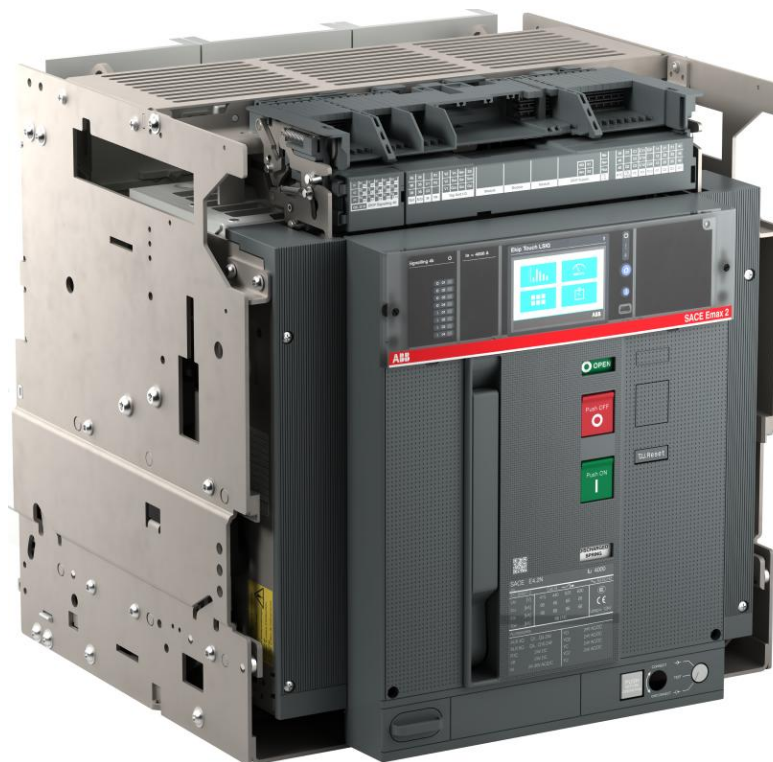


# PRODUCT ENVIRONMENTAL PROFILE

## Environmental Product Declaration

### Emax 2 E4.2 IEC Air Circuit Breaker

December 2025



REGISTRATION NUMBER ABBG-00015-V03.01-EN	IN COMPLIANCE WITH PCR-ED4-EN-2021 09 06 SUPPLEMENTED BY PSR-0005-ED3.1-EN-2023 12 08
VERIFIER ACCREDITATION NUMBER VH50	INFORMATION AND REFERENCE DOCUMENTS <a href="http://www.pep-ecopassport.org">www.pep-ecopassport.org</a>
DATE OF ISSUE 12-2025	VALIDITY PERIOD 5 years
INDEPENDENT VERIFICATION OF THE DECLARATION AND DATA, IN COMPLIANCE WITH ISO 14025: 2006	
INTERNAL <input type="checkbox"/>	EXTERNAL <input checked="" type="checkbox"/>
THE PCR REVIEW WAS CONDUCTED BY A PANEL OF EXPERTS CHAIRED BY JULIE ORGELET (DDEMAIN)	
PEPS ARE COMPLIANT WITH XP C08-100-1:2016 AND EN 50693:2019	
THE ELEMENTS OF THE PRESENT PEP CANNOT BE COMPARED WITH ELEMENTS FROM ANOTHER PROGRAM.	
DOCUMENT IN COMPLIANCE WITH ISO 14025: 2006 « ENVIRONMENTAL LABELS AND DECLARATIONS. TYPE III ENVIRONMENTAL DECLARATIONS »	
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<b>Company contacts</b>	EPD_ELSP@in.abb.com
<b>Reference product</b>	Emax 2 E4.2 N 4000A 3P circuit breaker IEC type withdrawable version equipped with Ekip electronic trip unit
<b>Description of the product</b>	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 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
<b>Functional unit</b>	The functional unit to this study is ‘Protect the installation from overloads and short circuits in a circuit with rated voltage $U_e$ , rated current $I_n$ , with $N_p$ poles, a rated breaking capacity $I_{cn}$ or $I_{cu}$ , and the tripping curve $C_d$ , in Industrial application area, according to the appropriate use scenario, and during the reference service life of the product of 20 years.’ IEC Type Rated voltage [V]: 690 Rated current [A]: 4000 Rated breaking capacity [kA]: 100 Number of poles: 3 Tripping Curve: L, S, I
<b>Other products covered</b>	Emax 2 E4.2 Withdrawable Circuit Breakers of types [IEC] N/S/H/V and ratings 800A to 4000A / 3poles /4poles
<b>Reference lifetime</b>	20 years
<b>Product category</b>	Electrical, Electronic and HVAC-R Products “Circuit Breaker”
<b>Use Scenario</b>	The use phase has been modeled based on the sales mix data (2024), and the corresponding low voltage electricity countries mix
<b>Geographical representativeness</b>	Raw materials & Manufacturing: [Europe / Global] Assembly: [Italy] Distribution / Use: [Global] specific sales mix EoL: [Global]
<b>Technological representativeness</b>	Materials and processes data are specific for production of Emax 2 Air circuit breaker
<b>LCA Study</b>	This study is based on the LCA study described in the LCA report 1SDH002181A1001
<b>EPD type</b>	Products family declaration
<b>EPD scope</b>	“Cradle to grave”
<b>Year of reported primary data</b>	2024
<b>LCA software</b>	SimaPro 10.2.0.3 (2025)
<b>LCI database</b>	Ecoinvent v3.10 (2025) & Carbon Minds cm.chemicals database v2.01 (March 2024)
<b>LCIA methodology</b>	EN 15804:2012+A2:2019/ EF3.1

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## 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 & Molded Case Circuit Breakers for different applications. 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.

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## 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 Emax 2 analyzed in this LCA is E4.2 withdrawable circuit breaker, consisting of a fixed and moving part. The SimaPro LCA model has been fully parametrized to include different configuration of poles, breaking capacity and switch versions

Official declarations 1SDL000282R1377 [13] and 1SDL000282R1378 [14] states compliance of ABB molded case circuit breakers and air circuit breakers respectively to RoHS II and REACH regulations; annex 1SDL000571R0 Ver 01 [15] provides exemptions considered for RoHS II.

### Emax 2 E4.2 IEC

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

Table 1: Technical characteristics of E4.2  
(Refer Technical catalogue for complete details).



# Constituent Materials

## E4.2 N 4000A 3P IEC

The representative product is E4.2 N 4000A 3P IEC Circuit Breaker which weighs 141.9 kg including its installed accessories and packaging.

Materials	Name	IEC 62474 MC	[g]	Weight %	
Metals	Steel	M-119	47233	33.3%	
	Cu and Cu Alloys	M-121	35357	24.9%	
	Stainless Steel	M-100	1896	1.3%	
	Aluminium	M-120	750	0.5%	
	Precious Metals	M-159	85	<0.1%	
Plastics	Unsaturated Polyester	M-301	18641	13.1%	
	Polyamide	M-258	2680	1.9%	
	Polycarbonate	M-254	1488	1.1%	
	Polybutylene Terephthalate	M-261	752	0.5%	
	Polypropylene	M-252	351	0.3%	
	Polyethylene Terephthalate	M-259	260	0.2%	
	Elastomer	M-320	216	0.2%	
	Polyethylene	M-251	180	0.1%	
	ABS	M-256	146	0.1%	
	Other Plastics	N/A	43	<0.1%	
	Other	Wood	M-340	30093	21.2%
		Paper/Cardboard	M-341	935	0.7%
		Others	N/A	786	0.6%
Total			141891	100.0%	

Table 2: Weight of materials E4.2 N 4000A 3P IEC

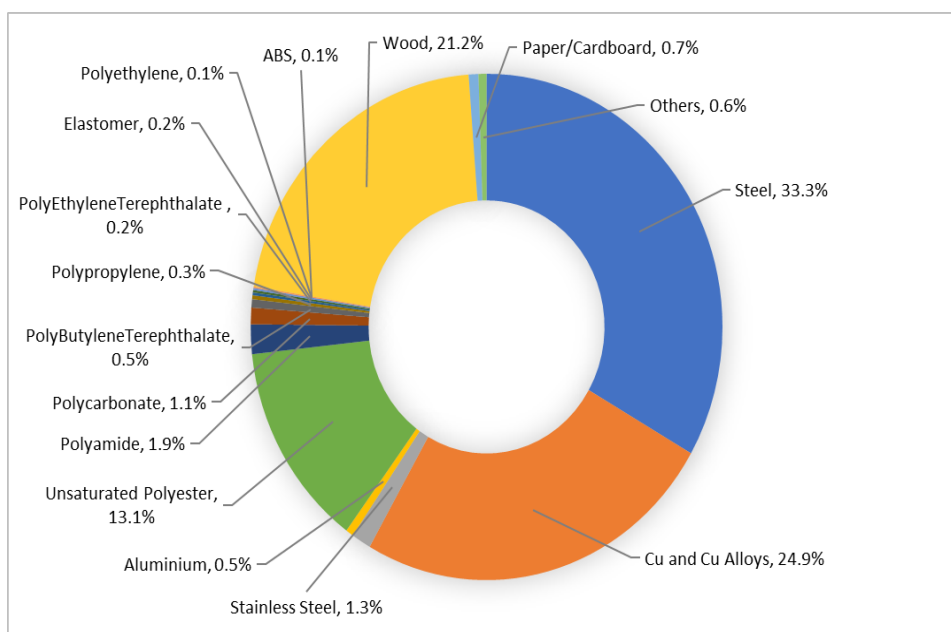


Figure 1: Composition of E4.2 N 4000A 3P IEC

The following table shows the weight of the packaging.

Material weight (g)	E4.2 - 3P IEC
Corrugated Cardboard	769
Wooden Pallet / Plywood	30093
Polyethylene	71
Steel	1307
Desiccant	518
Total weight	32758

Table 3: Weight of Packaging

Along the whole Emax E4.2 product cluster (IEC) a set of different build configurations have been covered by this analysis. Main differences consist of the number of poles, trip unit type, and short circuit breaking capacity. The LCA SimaPro model has been fully parametrized to fulfill each different configuration.



## 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. This protection is ensured in accordance with the following parameters for use in industrial application area.

E4.2 IEC 3P	
Number of poles	3
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 table 2.

### 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.

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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		Installation		Deinstallation
Components/parts manufacturing	Transport to distributor/ logistic center	EoL treatment of generated waste	Usage	Collection and transport
Assembly	Transport to place of use	(packaging)	Maintenance	
Packaging				EoL treatment
EoL treatment of generated waste				

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 2024, 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 classification, are used. The ecoinvent database available in the SimaPro software [7] is used for the calculations.

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The data quality characterized by quantitative and qualitative aspects, is presented in Appendix 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 geography, 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 [1] 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 [1] 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

An allocation key is used for consumption related to the manufacturing process in the production site, as well for company waste. Allocation coefficients are based on the production line's occupancy area for electricity, gas, water and waste generated.

## Cut-off criteria, limitations and simplifications

The cut-off criteria is employed in the LCA model according to PCR-ED4-EN-2021\_09\_06 [1].

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 assuming no specific data available PCR [1]. 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.

Surface treatments like galvanizing, silver plating as well as their related transport processes (back and forth from the finishing suppliers) have been considered in the LCA model. Scraps for metal working and plastic processes are included when already defined in Ecoinvent [6].

The only limitations and simplifications applied to this study are listed in the following table.

Category	Description
Packaging	An average raw material packaging content of 5% of the mass of the reference equipment has been considered as follow- Wood 50%, Cardboard 40%, Low density polyethylene 10%.
Tranports	Specific transport parameters along the entire supply chain of the two reference products have been considered as representative for all the products covered by the study
MU Emissions	Impacts related to the production, transportation and installation of capital goods (buildings, infrastructure, machinery, internal transport packaging) and general operations that cannot be directly allocated to products have been excluded

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## 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 supplier's locations
Manufacturing	A3	Electricity, {IT}  market for   Cut-off	Low voltage Country mix
Installation (Packaging EoL)	A5	Electricity, {GLO}  market group for   Cut-off	
Use Stage	B6	Electricity, [country]x   market for   Cut-off, S **	Low voltage, based on 2024 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 2024, which was a representative production year. The ecoinvent cut-off by classification system processes [6] are used to represent the LCA model.

### Manufacturing stage

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

The single use packaging as well as paper documentation are also included in the analysis in the manufacturing stage. An Average raw material packaging content of 5% of the mass of reference equipment has been considered as per PSR [2].

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## Distribution

The transport distances from ABB manufacturing plant to the distribution centers (regional distribution centers / local sales organizations) have been calculated considering the specific 2024 sales mix data for cluster (SAP ERP sales data as a source). An additional 1000km distance is considered as per the PCR [1].

## Installation

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

For the disposal of the packaging after installation of the product at the end of its life, a transport distance of 100 km (according to PSR [2]) 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 average data EU statistics, for countries other than EU 100% incineration has been considered.

## Use

Use and maintenance are modelled according to the PCR [1].

During the use phase, Coils dissipate some electricity due to power losses. They are calculated according to the data provided in the catalogue of the circuit breaker and following the PCR [1] & PSR [2] rules:

Parameters			
In	[A]		4000
In	[%]		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 voltage:

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

The Energy model used for this phase has been modeled based on the 2024 actual sales mix data (SAP ERP sales data as a source). 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] | market for | Cut-off, S).

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 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]).

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# Environmental impacts

## E4.2 N 4000A 3P IEC

The following table shows the environmental impact indicators of the life cycle of a E4.2 N 4000A 3P IEC 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	Manufacturing	Distribution	Installation	Use	End of Life
GWP-total	kg CO2 eq	6.86E+03	6.78E+02	1.57E+02	2.72E+01	5.95E+03	5.41E+01
GWP-fossil	kg CO2 eq	6.75E+03	7.06E+02	1.57E+02	1.48E+00	5.83E+03	5.19E+01
GWP-biogenic	kg CO2 eq	1.04E+02	-2.93E+01	2.67E-02	2.57E+01	1.06E+02	2.15E+00
GWP-luluc	kg CO2 eq	1.29E+01	9.86E-01	2.03E-02	1.22E-03	1.19E+01	5.71E-02
ODP	kg CFC11-eq	1.60E-04	2.79E-05	2.52E-06	3.00E-08	1.29E-04	8.79E-07
AP	mol H+ eq	5.08E+01	2.30E+01	6.84E-01	7.10E-03	2.69E+01	2.09E-01
EP-freshwater	kg P eq	4.80E+00	1.92E+00	4.16E-03	5.26E-04	2.84E+00	2.73E-02
EP-marine	kg N eq	6.45E+00	1.60E+00	2.65E-01	6.06E-03	4.48E+00	9.62E-02
EP-terrestrial	mol N eq	6.81E+01	2.03E+01	2.90E+00	2.71E-02	4.44E+01	5.06E-01
POCP	kg NMVOC eq	2.35E+01	5.98E+00	9.59E-01	8.47E-03	1.63E+01	1.80E-01
ADP-m&m	kg Sb eq	4.85E-01	4.33E-01	1.16E-04	3.40E-06	5.08E-02	4.09E-04
ADP-fossil	MJ	1.04E+05	9.71E+03	2.12E+03	2.11E+01	9.11E+04	8.98E+02
WDP	m3 of equiv. depriv.	1.63E+03	4.53E+02	4.64E+00	-7.53E-01	1.16E+03	1.67E+01
PENRE	MJ	1.03E+05	9.19E+03	2.12E+03	2.11E+01	9.11E+04	8.98E+02
PENRM	MJ	4.78E+02	4.78E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT	MJ	1.04E+05	9.71E+03	2.12E+03	2.11E+01	9.11E+04	8.98E+02
PERE	MJ	2.19E+04	2.19E+03	1.27E+01	1.67E+00	1.96E+04	9.22E+01
PERM	MJ	4.71E+02	4.71E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	MJ	2.23E+04	2.56E+03	1.27E+01	1.67E+00	1.96E+04	9.22E+01
SM	kg	4.10E+01	4.10E+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
PET	MJ	1.26E+05	1.23E+04	2.13E+03	2.27E+01	1.11E+05	9.90E+02
FW	m3	6.07E+01	1.21E+01	1.49E-01	-1.17E-02	4.79E+01	6.25E-01
HWD	kg	8.24E-01	4.87E-01	1.45E-02	1.02E-04	3.12E-01	1.09E-02
N-HWD	kg	5.88E+02	1.27E+02	4.17E+01	1.62E+01	2.82E+02	1.21E+02
RWD	kg	2.41E-01	2.07E-02	2.47E-04	4.20E-05	2.18E-01	2.60E-03
CfR	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MfR	kg	1.09E+02	2.00E+01	0.00E+00	7.34E+00	0.00E+00	8.14E+01
MfER	kg	1.57E+01	3.56E+00	0.00E+00	6.40E+00	0.00E+00	5.74E+00
EN	MJ by energy vector	1.37E+01	1.37E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PM	disease inc.	1.75E-04	7.40E-05	4.55E-06	1.20E-07	9.27E-05	3.76E-06
IRP	kBq U-235 eq	1.01E+03	7.92E+01	1.01E+00	1.64E-01	9.20E+02	1.02E+01
ETP-fw	CTUe	5.16E+04	3.45E+04	2.23E+02	1.68E+01	1.65E+04	3.71E+02
HTP-c	CTUh	2.47E-05	1.38E-05	3.09E-07	1.25E-08	1.01E-05	4.00E-07
HTP-nc	CTUh	2.84E-04	2.21E-04	1.56E-06	4.85E-08	6.12E-05	8.10E-07
SQP	Pt	3.09E+04	1.37E+04	5.92E+02	1.39E+01	1.63E+04	3.61E+02

Table 7: Impact indicators

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\* Negative values in FW & WDP in installation is due to the Ecoinvent dataset “Waste wood, untreated [RoW]” treatment of waste wood, untreated, sanitary landfill | Cut-off, S”

Impact category	Unit	E4.2 N 4000A 3P IEC
Biogenic Carbon content of the product	kg	3.88E-02
Biogenic Carbon content of the associated packaging	kg	1.48E+04

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	Water deprivation potential

### Resource use indicators

PERE	Use of renewable primary energy excluding 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)
PENRE	Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw material
PNERM	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)
PET	Total use of primary energy in the lifecycle

### 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

CfR	Components for reuse
MfR	Materials for recycling
MfER	Materials for energy recovery
EN	Exported energy

### Other indicators

PM	Emissions of Fine particles
IRP	Ionizing radiation, human health
ETP-fw	Ecotoxicity, freshwater
HTP- c	Human toxicity, carcinogenic effects
HTP- nc	Human toxicity, non-carcinogenic effects
SQP	Impact related to Land use / soil quality

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## Extrapolation for Homogeneous Environmental Family

This LCA covers different build configurations 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 Extrapolation:

Circuit Breaker	GWP-total	GWP-fossil	GWP-biogenic	GWP-luluc	ODP	AP	EP-freshwater	EP-marine	EP-terrestrial	POCP	ADP-minerals &	ADP-fossil	WDP
IEC - 3P - 4000A N/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
IEC - 4P - 4000A N/S/H	1.28	1.27	0.92	1.28	1.07	1.44	1.44	1.36	1.38	1.37	1.35	1.25	1.37
IEC - 3P - 3200A N/S/H	0.96	0.96	1.02	0.96	0.99	0.95	0.95	0.95	0.95	0.95	0.96	0.96	0.96
IEC - 4P - 3200A N/S/H	1.05	1.05	1.00	1.06	1.01	1.08	1.07	1.06	1.06	1.06	1.05	1.04	1.07
IEC - 3P - 2000A-4000A V	1.01	1.01	1.00	1.00	1.00	1.01	1.01	1.01	1.01	1.01	1.01	1.00	1.01
IEC - 4P - 2000A-4000A V	1.36	1.34	0.89	1.35	1.10	1.54	1.54	1.46	1.48	1.46	1.46	1.33	1.46
IEC - 3P - 3200A-4000A N/MS, H/MS	0.90	0.91	1.03	0.92	0.81	0.92	0.91	0.91	0.91	0.91	0.89	0.91	0.92
IEC - 4P - 3200A-4000A N/MS, H/MS	0.99	0.99	1.01	1.01	0.84	1.04	1.03	1.01	1.02	1.01	0.98	0.99	1.03
IEC - 3P - 2000A-4000A V/MS	0.95	0.95	1.01	0.96	0.83	0.98	0.97	0.96	0.97	0.97	0.95	0.95	0.97
IEC - 4P - 2000A-4000A V/MS	1.30	1.28	0.90	1.30	0.92	1.50	1.49	1.41	1.44	1.42	1.39	1.27	1.42

Table 9: Manufacturing phase Extrapolation factors  
Reference product: E4.2 N 4000A 3P IEC

Circuit Breaker	LCA Phase	All
IEC - 3P - 4000A N/S/H	Distribution	1.00
IEC - 4P - 4000A N/S/H		1.18
IEC - 3P - 3200A N/S/H		0.97
IEC - 4P - 3200A N/S/H		1.06
IEC - 3P - 2000A-4000A V		1.00
IEC - 4P - 2000A-4000A V		1.22
IEC - 3P - 3200A-4000A N/MS, H/MS		0.95
IEC - 4P - 3200A-4000A N/MS, H/MS		1.03
IEC - 3P - 2000A-4000A V/MS		0.98
IEC - 4P - 2000A-4000A V/MS		1.20

Table 10: Distribution phase Extrapolation factors  
Reference product: E4.2 N 4000A 3P IEC

Installation phase impacts are same across all the variants.

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 11: Use phase Extrapolation factors  
Reference product: E4.2 N 4000A 3P IEC

Circuit Breaker	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 - 4000A N/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
IEC - 4P - 4000A N/S/H	1.02	0.99	1.02	0.97	0.99	0.99	0.97	1.01	1.01	1.00	0.98	0.99	1.06
IEC - 3P - 3200A N/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
IEC - 4P - 3200A N/S/H	1.02	0.99	1.02	0.97	0.99	0.99	0.97	1.01	1.01	1.00	0.98	0.99	1.06
IEC - 3P - 2000A-4000A V	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 - 4P - 2000A-4000A V	1.02	0.99	1.02	0.97	0.99	0.99	0.97	1.01	1.01	1.00	0.98	0.99	1.06
IEC - 3P - 3200A-4000A N/MS, H/MS	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 - 4P - 3200A-4000A N/MS, H/MS	1.02	0.99	1.02	0.97	0.99	0.99	0.97	1.01	1.01	1.00	0.98	0.99	1.06
IEC - 3P - 2000A-4000A V/MS	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 - 4P - 2000A-4000A V/MS	1.02	0.99	1.02	0.97	0.99	0.99	0.97	1.01	1.01	1.00	0.98	0.99	1.06

Table 12: Installation phase Extrapolation factors  
Reference product: E4.2 N 4000A 3P IEC

Circuit Breaker	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 - 4000A N/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
IEC - 4P - 4000A N/S/H	1.22	1.22	1.13	1.25	1.29	1.26	1.31	1.18	1.25	1.25	1.34	1.30	1.27
IEC - 3P - 3200A N/S/H	0.96	0.96	0.96	0.96	0.96	0.96	0.95	0.97	0.96	0.96	0.96	0.96	0.95
IEC - 4P - 3200A N/S/H	1.07	1.07	1.06	1.07	1.07	1.07	1.08	1.05	1.07	1.07	1.08	1.07	1.09
IEC - 3P - 2000A-4000A V	1.00	1.00	1.00	1.00	1.00	1.00	1.01	0.99	1.00	1.00	1.01	1.00	1.01
IEC - 4P - 2000A-4000A V	1.27	1.27	1.15	1.30	1.35	1.31	1.37	1.25	1.30	1.30	1.41	1.36	1.31
IEC - 3P - 3200A-4000A N/MS, H/MS	0.93	0.93	0.92	0.93	0.93	0.93	0.93	0.95	0.94	0.94	0.95	0.94	0.93
IEC - 4P - 3200A-4000A N/MS, H/MS	1.03	1.03	1.02	1.05	1.04	1.05	1.05	1.03	1.04	1.04	1.06	1.05	1.06
IEC - 3P - 2000A-4000A V/MS	0.97	0.97	0.97	0.98	0.98	0.98	0.99	0.97	0.98	0.98	0.99	0.98	0.99
IEC - 4P - 2000A-4000A V/MS	1.23	1.23	1.12	1.27	1.32	1.29	1.34	1.23	1.27	1.28	1.39	1.33	1.28

Table 13: End of Life phase Extrapolation factors  
Reference product: E4.2 N 4000A 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 N 4000A 3P IEC
Recyclability potential	77.4%

Table 14: Recyclability potential

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