PRODUCT ENVIRONMENTAL PROFILE

Environmental Product Declaration

ABB Retrofit Kit- CiC Megamax F5, CiC Novomax G5 - Emax 2 Air Circuit Breaker

REGISTRATION NUMBER ABBG-00704-V01.01-EN		IN COMPLIANCE WITH PCR-ED4-EN-2021 09 06 SUPPLEMENTED BY PSR-0005-ED3.1-EN-2023 12 08.
VERIFIER ACCREDITATION NUMBER VH51		INFORMATION AND REFERENCE DOCUMENTS www.pep-ecopassport.org
DATE OF ISSUE 01/2025		VALIDITY PERIOD 5 years
INDEPENDENT VERIFICATION OF THE DECLARATION AND DATA, IN COMPLIANCE WITH ISO 14025: 2006		
INTERNAL ☐	EXTERNAL ☒	
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 COMPONENTS OF THE PRESENT PEP MAY NOT BE COMPARED WITH COMPONENTS FROM ANY OTHER PROGRAM		
DOCUMENT IN COMPLIANCE WITH ISO 14025: 2006 « ENVIRONMENTAL LABELS AND DECLARATIONS. TYPE III ENVIRONMENTAL DECLARATIONS »		

EPD Owner	ABB S.p.A. Via Luciano Lama, 33, 20099 Sesto San Giovanni (MI) – Italy www.abb.com
Manufacturer name and address	ABB S.p.A. Via Friuli, 4 - 24044 Dalmine (BG) - Italy
Company contacts	EPD_ELSE@in.abb.com
Reference product	CiC Megamax F5 4000A 3P to E4.2 IEC air circuit breaker IEC type equipped with Ekip Touch electronic trip unit
Product family	Circuit Breaker
Description of the product	CiC Megamax F5 4000A 3P to E4.2 IEC 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. CiC Megamax F5 4000A 3P to E4.2 IEC to E2.2 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), Protect the installation from overloads and short circuits in a circuit with rated voltage Ue, rated current In, with Np poles, a rated breaking capacity Icu, and the tripping curve Cd in the industrial application area, according to the appropriate use scenario, and during the reference service life of the product of 20 years. This protection is ensured in accordance with the following parameters:
	IEC Type Rated voltage [V]: 690 Rated current [A]: 4000 Rated breaking capacity [kA]: 120 Number of poles: 3,4 Tripping Curve: L, S, I
Other products covered	CIC MEGAMAX E4.2 Circuit Breakers of types [IEC] and ratings 3200A / 3 pole and 4 pole
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 (2023), 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 to produce CiC Megamax F5, CiC Novomax G5 - Emax 2 circuit breaker
LCA Study	This study is based on the LCA study described in the LCA report 1SDH002491A1001
EPD type	Products family declaration
EPD scope	“Cradle to grave”
Year of reported primary data	2023
LCA software	SimaPro 9.6.0.1 (2024)
LCI database	Ecoinvent v3.10 (2024)
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 Dalmine 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 3 million circuit breakers every year. A Lighthouse Plant, selected by the Italian government as a model for digital transformation and Industry 4.0 strategies, Dalmine 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-ELSE 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

Moreover, Dalmine plant has in place an energy management system that covers all the activities and that is in compliance with the following standard:

- UNI EN ISO 50001:2018 – Energy Management System – Requirements with guidance for use

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.

CiC Megamax F5, CiC Novomax G5 - Emax 2 product cluster

CiC Megamax F5 4000A 3P to E4.2 IEC 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. CiC Megamax F5 4000A 3P to E4.2 IEC is an 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 CiC Megamax F5, CiC Novomax G5 - Emax 2 analyzed in this LCA is IEC type circuit breaker, consisting of a moving part (which is inserted and removed via dedicated guide rails).

- **CiC Megamax F5, CiC Novomax G5 - Emax 2 (IEC Type)**

Circuit breaker	
Rated voltage [V]	690
Rated current [A]	4000
Rated short circuit breaking current [kA]	120
Number of poles	3,4

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

Constituent Materials

CiC Megamax F5, CiC Novomax G5 - Emax 2 (IEC Type)

The representative product is CiC Megamax F5 4000A 3P to E4.2 IEC Air Circuit Breaker which weighs 181.22 kg including its installed accessories, paper documentation and packaging.

Materials	Name	IEC 62474 MC	[g]	Weight %
Metals	Steel	M-119	72642.0	40.1%
	Cu and Cu Alloys	M-121	58937.7	32.5%
	Stainless Steel	M-100	4971.0	2.7%
	Aluminium	M-120	746.1	0.4%
	Precious Metals	M-159	51.5	<0.1%
Plastics	Unsaturated Polyester	M-301	20291.3	11.2%
	Polycarbonate	M-254	1299.4	0.7%
	Polyamide	M-258	1118.7	0.6%
	Polyethylene	M-251	426.5	0.2%
	Elastomer	M-320	370.1	0.2%
	Polypropylene	M-252	270.6	0.2%
	PolyVinylChloride	M-250	16.7	<0.1%
	Polyarylamide	M-272	13.4	<0.1%
Other	Wood	M-340	20000.0	11.0%
	Paper/Cardboard	M-341	73.0	0.1%
Total			181228.0	100.0%

Table 3: Material composition of CiC Megamax F5 4000A 3P to E4.2 IEC

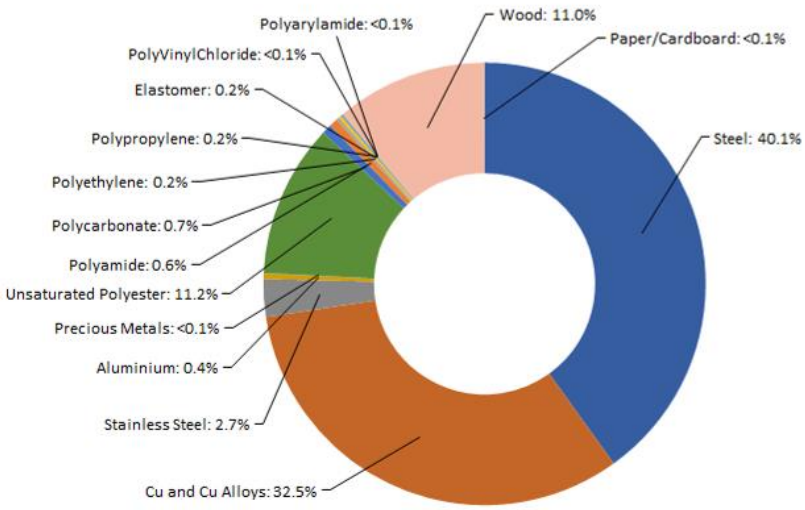

Figure 1: Material composition of CiC Megamax F5 4000A 3P to E4.2 IEC

Packaging weighs 20761 g, with the following substance composition:

Material	Unit	Total	%
Plywood	g	20000	96
Polyethylene	g	237.8	1
Steel	g	523.2	3
Total	g	20761	100

Table 2: Weight of Packaging for CiC Megamax F5 4000A 3P to E4.2 IEC

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 have been considered.

Official declarations LB-DT 17-21D [13] and LB-DT 18-21D [14] states compliance of ABB moulded case circuit breakers and air circuit breakers respectively to RoHS II and REACH regulations; annex 1SDL000571R0 [15] provides exemptions considered for RoHS II while annex 1SDL000572R0 [16] lists REACH substances present in a concentration above 0,1% adding reference to products where involved parts are mounted.

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), Protect the installation from overloads and short circuits in a circuit with rated voltage Ue, rated current In, with Np poles, a rated breaking capacity Icu, and the tripping curve Cd in the industrial application area, according to the appropriate use scenario, and during the reference service life of the product of 20 years. This protection is ensured in accordance with the following parameters:

Product	Number of poles	Rated breaking capacity [kA]	Tripping Curve
CiC Megamax F5, CiC Novomax G5	3,4	120	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 “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 the ABB component suppliers, sourced all over the world. All primary data collected are from 2023, which is a representative production year for production technology of DR NOVOMAX G30 at ABB Dalmine, Italy. The geographical and technological representativeness for the Secondary data is Ecoinvent v3.9 [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. The distribution phase considers global destinations based on the 2023 sales mix from SAP ERP data; installation impacts align with these distribution locations. End-of-life treatment (Global) follows IEC 62635 and ecoinvent data, while the use phase(Global) is assessed using actual 2023 sales mix data across the entire product range.

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.

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-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 Emax 2 line's occupancy area for electricity, methane and water consumption as well as the total amount of waste generated by the production line.

All these flows have been allocated and divided by the total number of CiC Megamax F5, CiC Novomax G5 - Emax 2 circuit breakers produced in 2023.

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 [1]. This distance has been added to the one already included in the market processes used for the model, because 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. The RAL paints/color coatings used on the components are excluded from modelling. 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). 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 Dalmine manufacturing plant, 100% renewable

LCA Stage	EN 15804:2012 +A2:2019 module	Energy model	Notes
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 2023 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 12 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 2023, 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 Dalmine production site and includes renewable energy only (Hydroelectric).

The complete energy mix has been modeled considering the GSE report on energy origins provided to ABB for the year 2023.

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 2023 (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 1000 Km distance by road has been considered to cover the last distribution stage to the end customer (usage location).

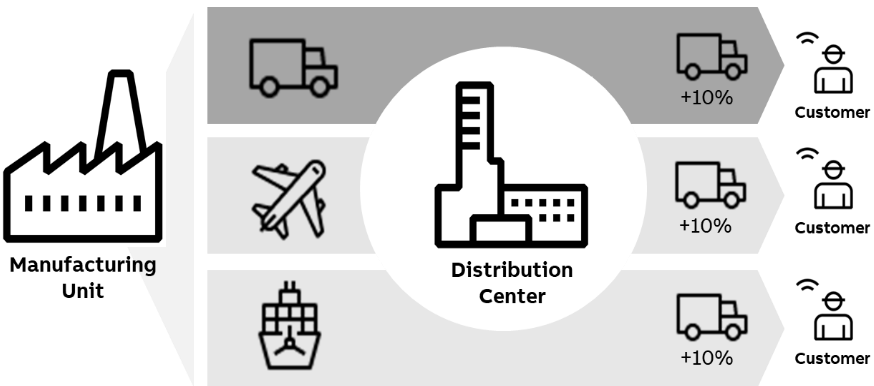

Figure 2: Distribution methodology.

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 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 2019 Eurostat data available and PSR [2] guidelines.

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 2023 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]	4000A
Load rate	[%]	50
h/year	[h]	8760
RSL	[years]	20
Time operating coefficient (α)	[%]	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:

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

$$P_{use} = 3*R*(0.5*I)^2$$

The above calculations have been performed according to the current rating 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

The following table show the environmental impact indicators of the life cycle of CiC Megamax F5 4000A 3P to E4.2 IEC air circuit breaker 4000A, 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	7.66E+03	1.38E+03	5.84E+02	1.62E+01	5.60E+03	8.98E+01
GWP-fossil	kg CO2 eq	7.50E+03	1.39E+03	5.84E+02	4.45E-01	5.43E+03	8.94E+01
GWP-biogenic	kg CO2 eq	1.55E+02	-1.78E+01	8.39E-02	1.58E+01	1.57E+02	3.80E-01
GWP-luluc	kg CO2 eq	6.61E+00	1.62E+00	4.54E-02	1.63E-04	4.87E+00	7.03E-02
ODP	kg CFC11-eq	1.26E-04	1.85E-05	9.13E-06	6.81E-09	9.75E-05	9.48E-07
AP	mol H+ eq	7.57E+01	5.32E+01	2.43E+00	3.03E-03	1.96E+01	3.71E-01
EP-freshwater	kg P eq	9.29E+00	4.36E+00	1.01E-02	1.34E-04	4.90E+00	2.30E-02
EP-marine	kg N eq	8.58E+00	3.30E+00	9.77E-01	3.16E-03	4.17E+00	1.27E-01
EP-terrestrial	mol N eq	9.18E+01	4.33E+01	1.07E+01	1.40E-02	3.69E+01	8.99E-01
POCP	kg NMVOC eq	2.93E+01	1.27E+01	3.47E+00	4.21E-03	1.28E+01	3.06E-01
ADP-m&m	kg Sb eq	8.15E-01	7.54E-01	2.01E-04	1.02E-06	6.12E-02	7.28E-05
ADP-fossil	MJ	1.06E+05	1.84E+04	7.79E+03	5.99E+00	7.84E+04	1.14E+03
WDP*	m3 of equiv. depriv.	2.33E+03	1.20E+03	1.24E+01	3.73E+01	1.07E+03	6.28E+00
PENRE	MJ	1.05E+05	1.81E+04	7.79E+03	5.99E+00	7.84E+04	1.14E+03
PENRM	MJ	3.79E+02	3.79E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT	MJ	1.06E+05	1.84E+04	7.79E+03	5.99E+00	7.84E+04	1.14E+03
PERE	MJ	2.86E+04	4.67E+03	3.27E+01	9.40E-02	2.38E+04	8.02E+01
PERM	MJ	2.85E+02	2.85E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	MJ	2.88E+04	4.95E+03	3.27E+01	9.40E-02	2.38E+04	8.02E+01
SM	kg	3.06E+00	3.06E+00	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	1.35E+05	2.34E+04	7.82E+03	6.08E+00	1.02E+05	1.22E+03
FW	m3	1.14E+02	3.03E+01	4.10E-01	8.70E-01	8.24E+01	2.75E-01
HWD	kg	5.48E-01	1.93E-01	5.37E-02	3.97E-05	2.97E-01	3.97E-03
N-HWD	kg	7.86E+02	2.71E+02	4.33E+01	9.86E+00	2.84E+02	1.79E+02
RWD	kg	1.93E-01	3.56E-02	6.52E-04	1.43E-06	1.55E-01	1.57E-03
CfR	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MfR	kg	2.07E+02	6.98E+01	0.00E+00	4.26E+00	0.00E+00	1.33E+02
MfER	kg	1.16E+01	0.00E+00	0.00E+00	1.05E+01	0.00E+00	1.07E+00
EN	MJ by energy vector	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PM	disease inc.	2.41E-04	1.60E-04	8.48E-06	5.11E-08	6.74E-05	5.14E-06
IRP	kBq U-235 eq	7.40E+02	1.38E+02	2.68E+00	5.82E-03	5.93E+02	6.43E+00
ETP-fw	CTUe	9.62E+04	7.69E+04	5.88E+02	3.40E+00	1.84E+04	2.82E+02
HTP-c	CTUh	4.70E-05	3.64E-05	7.00E-07	4.40E-09	9.73E-06	1.78E-07
HTP-nc	CTUh	6.04E-04	5.28E-04	5.90E-06	2.39E-08	6.93E-05	5.59E-07
SQP	Pt	4.21E+04	2.42E+04	9.57E+02	6.70E+00	1.65E+04	4.09E+02

Table 7: Impact indicators for CiC Megamax F5 4000A 3P to E4.2 IEC

Impact category	Unit	Total
Biogenic Carbon content of the product	kg	3.65E-2
Biogenic Carbon content of the associated packaging	kg	1.79E+1

Table 8: Impact indicators CiC Megamax F5 4000A 3P to E4.2 IEC

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

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

Extrapolation

This LCA covers different build configurations in addition to the representative product, considering the IEC types. All the analyzed configurations have the same main functionality, product standards and manufacturing technology. A sensitivity analysis has been conducted to identify the influential parameters that affect the environmental footprint of the product. For products other than the reference product, covered in this PEP, the environmental impacts for each phase of the lifecycles are obtained by multiplying the impacts of the reference product by the factors listed in the tables below. The extrapolation factors are calculated based on each variant BOMs analysis and their impact categories.

Products	GWP-total	GWP-fossil	GWP-bio-	GWP-luluc	ODP	AP	EP-fresh-	EP-marine	EP-terres-	POCP	ADP-miner-	ADP-fossil	WDP
CiC Megamax F5 4000A 3P to E4.2 IEC	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
CiC Megamax F5 3200A 3P to E4.2 IEC	0.92	0.93	1.03	0.91	0.94	0.86	0.87	0.89	0.88	0.89	0.87	0.93	0.91
CiC Megamax F5 3200A 4P to E4.2 IEC	1.13	1.13	0.93	1.12	1.14	1.10	1.11	1.12	1.12	1.12	1.12	1.13	1.09
CiC Megamax F5 4000A 4P to E4.2 IEC	1.22	1.21	0.89	1.23	1.20	1.27	1.27	1.25	1.26	1.25	1.27	1.22	1.20
CiC Novomax C5 3200A (T,S1) 3P to E4.2 IEC	0.92	0.92	1.05	0.90	0.94	0.87	0.87	0.89	0.88	0.89	0.88	0.93	0.91
CiC Novomax C5 3200A (T,S1) 4P to E4.2 IEC	1.12	1.12	0.95	1.11	1.13	1.10	1.11	1.11	1.11	1.11	1.12	1.13	1.08
CiC Novomax C5 4000A (T,S1) 3P to E4.2 IEC	0.99	0.99	1.01	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.99	1.00
CiC Novomax C5 4000A (T,S1) 4P to E4.2 IEC	1.21	1.21	0.90	1.23	1.20	1.27	1.27	1.25	1.25	1.25	1.27	1.21	1.20
CiC Novomax C5 3200A (S2) 3P to E4.2 IEC	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
CiC Novomax C5 3200A (S2) 4P to E4.2 IEC	1.22	1.21	0.90	1.23	1.20	1.27	1.27	1.25	1.26	1.26	1.28	1.22	1.20
CiC Novomax C5 4000A (S2) 3P to E4.2 IEC	1.08	1.08	0.97	1.10	1.06	1.15	1.15	1.12	1.13	1.12	1.14	1.07	1.10
CiC Novomax C5 4000A (S2) 4P to E4.2 IEC	1.32	1.31	0.86	1.36	1.27	1.46	1.46	1.40	1.42	1.41	1.45	1.31	1.32

Table 9a: Extrapolation factors for CiC Megamax F5, CiC Novomax G5 - Emax 2 Air Circuit Breaker
Reference product: CiC Megamax F5 4000A 3P to E4.2 IEC – Manufacturing

Products	LCA Stage	Factor
CiC Megamax F5 4000A 3P to E4.2 IEC	Distribution	1.00
CiC Megamax F5 3200A 3P to E4.2 IEC		0.95
CiC Megamax F5 3200A 4P to E4.2 IEC		1.11
CiC Megamax F5 4000A 4P to E4.2 IEC		1.17
CiC Novomax C5 3200A (T,S1) 3P to E4.2 IEC		0.94
CiC Novomax C5 3200A (T,S1) 4P to E4.2 IEC		1.10
CiC Novomax C5 4000A (T,S1) 3P to E4.2 IEC		0.99
CiC Novomax C5 4000A (T,S1) 4P to E4.2 IEC		1.16
CiC Novomax C5 3200A (S2) 3P to E4.2 IEC		1.00
CiC Novomax C5 3200A (S2) 4P to E4.2 IEC		1.17
CiC Novomax C5 4000A (S2) 3P to E4.2 IEC		1.05
CiC Novomax C5 4000A (S2) 4P to E4.2 IEC		1.23

Table 9b: Extrapolation factors for CiC Megamax F5, CiC Novomax G5 - Emax 2 Air Circuit Breaker
Reference product: CiC Megamax F5 4000A 3P to E4.2 IEC – Distribution

Please note for the installation phase extrapolation factors for CiC Megamax F5, CiC Novomax G5 - Emax 2 Air Circuit Breaker are same for all the variants.

Products	No.of poles	Rated current, In [A]	Total power losses [W]	Factor
CiC Megamax F5 3200A 3p to Emax E4.2	3	3200	765	0.83
CiC Megamax F5 3200A 4p to Emax E4.2	4	3200	765	0.83
CiC Megamax F5 4000A 3p to Emax E4.2	3	4000	927	1.00
CiC Megamax F5 4000A 4p to Emax E4.2	4	4000	927	1.00
CiC Novomax G5 3200A 3p (T, S1) to Emax E4.2 CiC Novomax G5 3200A 3p (S2) to Emax E4.2	3	3200	765	0.83
CiC Novomax G5 3200A 4p (T, S1) to Emax E4.2 CiC Novomax G5 3200A 4p (S2) to Emax E4.2	4	3200	765	0.83
CiC Novomax G5 4000A 3p (T, S1) to Emax E4.2 CiC Novomax G5 4000A 3p (S2) to Emax E4.2	3	4000	927	1.00
CiC Novomax G5 4000A 4p (T, S1) to Emax E4.2 CiC Novomax G5 4000A 4p (S2) to Emax E4.2	4	4000	927	1.00

Table 9c: Extrapolation factors for CiC Megamax F5, CiC Novomax G5 - Emax 2 Air Circuit Breaker. Reference product: CiC Megamax F5 4000A 3P to E4.2 IEC -Use Phase

Products	GWP-total	GWP-fossil	GWP-biogenic	GWP-luluc	ODP	AP	EP-freshwater	EP-marine	EP-terrestrial	POCP	ADP-minerals &	ADP-fossil	WDP
CiC Megamax F5 4000A 3P to E4.2 IEC	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
CiC Megamax F5 3200A 3P to E4.2 IEC	0.88	0.88	0.86	0.87	0.88	0.88	0.86	0.92	0.89	0.89	0.91	0.88	0.81
CiC Megamax F5 3200A 4P to E4.2 IEC	1.12	1.12	1.10	1.10	1.11	1.11	1.10	1.17	1.11	1.11	1.12	1.11	1.00
CiC Megamax F5 4000A 4P to E4.2 IEC	1.26	1.26	1.26	1.26	1.25	1.25	1.26	1.26	1.24	1.24	1.22	1.25	1.23
CiC Novomax C5 3200A (T,S1) 3P to E4.2 IEC	0.88	0.88	0.87	0.87	0.88	0.88	0.86	0.92	0.89	0.89	0.91	0.88	0.81
CiC Novomax C5 3200A (T,S1) 4P to E4.2 IEC	1.11	1.11	1.10	1.10	1.10	1.10	1.10	1.17	1.10	1.10	1.11	1.10	1.00
CiC Novomax C5 4000A (T,S1) 3P to E4.2 IEC	1.00	1.00	1.00	1.00	0.99	1.00	1.00	1.00	0.99	0.99	0.99	1.00	0.99
CiC Novomax C5 4000A (T,S1) 4P to E4.2 IEC	1.25	1.25	1.26	1.26	1.24	1.25	1.26	1.26	1.23	1.23	1.21	1.25	1.23
CiC Novomax C5 3200A (S2) 3P to E4.2 IEC	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
CiC Novomax C5 3200A (S2) 4P to E4.2 IEC	1.26	1.26	1.26	1.27	1.25	1.26	1.27	1.27	1.24	1.24	1.22	1.26	1.24
CiC Novomax C5 4000A (S2) 3P to E4.2 IEC	1.13	1.13	1.15	1.15	1.13	1.14	1.15	1.08	1.12	1.12	1.09	1.14	1.23
CiC Novomax C5 4000A (S2) 4P to E4.2 IEC	1.42	1.42	1.45	1.45	1.41	1.42	1.46	1.36	1.39	1.39	1.33	1.42	1.52

Table 9d: Extrapolation factors for CiC Megamax F5, CiC Novomax G5 - Emax 2 Air Circuit Breaker Reference product: - CiC Megamax F5 4000A 3P to E4.2 IEC -End of Life

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).

	CiC Megamax F5 4000A 3P to E4.2 IEC
Recyclability potential	82.8%

Table 10: Recyclability potential of CiC Megamax F5, CiC Novomax G5 - Emax 2

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-ed3.1-EN-2023 12 08” - 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 v3.10 (2024). Ecoinvent database version 3.9 - (https://ecoinvent.org/)

[7] SimaPro Software version 9.6.0.1 (2024) - 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] 1SDL000282R1377- RoHS II (MCCBs and ACBs)

[12] 1SDL000282R1378 - REACH (MCCBs and ACBs)

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

[14] 1SDL000572R0 Ver 01 - SVHC present more than 0.1% (MCCBs and ACBs)