EPD

Environmental Product Declaration

REX615 Protection and Control Relay

Production site: Vaasa, Finland

DOCUMENT KIND Environmental Product Declaration	IN COMPLIANCE WITH ISO 14025 and EN 50693			
PROGRAM OPERATOR The Norwegian EPD Foundation	PUBLISHER The Norwegian EPD Foundation			
REGISTRATION NUMBER OF THE PROGRAM OPERATOR NEPD-6565-5829-EN	ISSUE DATE 2024-05-07			
VALID TO 2029-05-07	STATUS Approved	SECURITY LEVEL Public		
OWNING ORGANIZATION ABB Switzerland Ltd, Group Technology Management	ABB DOCUMENT ID 2RCA058827	REV. A	LANG. EN	PAGE 1/21

EPD Owner	ABB Switzerland Ltd, Group Technology Management
Organization No.	CHE-101.538.426
Manufacturer name and address	ABB Oy Muottitie 2 A, Vaasa, Finland
Company contact	Markus Kortesluoma – markus.kortesluoma@fi.abb.com Product Line Manager
Program operator	The Norwegian EPD Foundation Post Box 5250 Majorstuen, 0303 Oslo, Norway phone: +47 23 08 80 00, email: post@epd-norge.no
Declared product	REX615 Protection and Control Relay
Product description	The REX615 is a freely configurable all-in-one protection and control relay for power generation and distribution applications. A wide application coverage combined with a fully modular and scalable hardware and software ensures maximum flexibility and optimal cost-effectivity throughout the relay life cycle – from tailoring to adapting to changing and new application-specific requirements.
Functional unit	To protect a power system against faults such as short circuit and overload, using an auxiliary voltage of 110 V DC, during a service life of 10 years and with a use rate of 100 % in Europe.
Reference flow	A single REX615 protection and control relay, including related connectors and packaging.
Independent verification	Independent verification of the declaration and data, according to ISO 14025:2010 ☐ INTERNAL ☒ EXTERNAL Independent verifier approved by EPD-Norge: Elisabet Amat Signature: 
Approved by	Håkon Hauan, CEO EPD-Norge Signature: 
Reference PCR	EN 50693:2019 – Product Category Rules for Life Cycle Assessments of Electronic and Electrical Products and Systems. EPDItaly007 – Electronic and Electrical Products and Systems, Rev. 3.0, 2023/01/13.
Program instructions	The Norwegian EPD Foundation/EPD-Norge, General Programme Instructions 2019, Version 3.0, 2019/04/24.
LCA study	This EPD is based on the LCA study described in the LCA report 2RCA058826.
EPD type	Specific product with extrapolation rules
EPD scope	Cradle-to-grave
Product RSL	10 years
Geographical representativeness	Manufacturing (suppliers): Global Manufacturing (ABB): Finland Downstream: Europe
Reference year	2023
LCA software	SimaPro 9.5 (2023)
LCI database	Ecoinvent v3.9.1 (2022)
Comparability	EPDs published within the same product category, though originating from different programs, may not be comparable. Full conformance with a PCR allows EPD comparability only when all stages of a life cycle have been considered. However, variations and deviations are possible.
Liability	The owner of the declaration shall be liable for the underlying information and evidence. EPD-Norge shall not be liable with respect to manufacturer, life cycle assessment data, and evidence.

Contents

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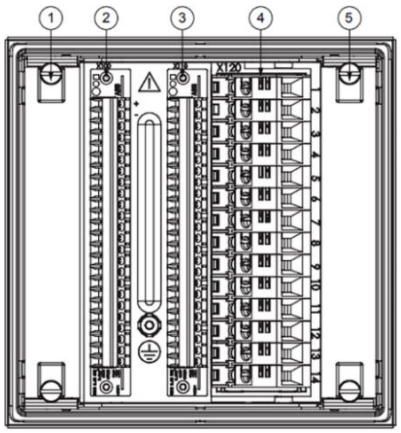
General Information

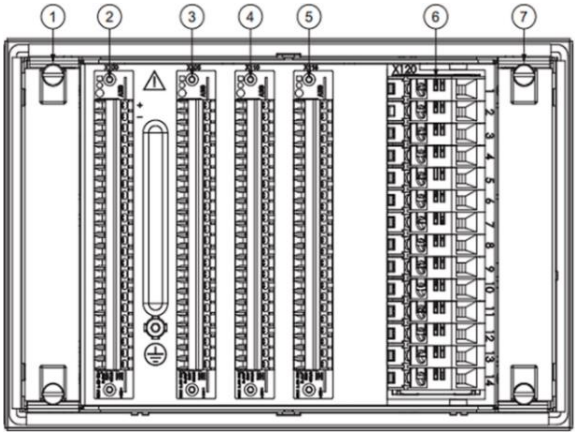
This Environmental Product Declaration is a “specific product EPD” with extrapolation rules. A representative product configuration is declared as reference product, and the results can be extrapolated for other configurations according to the provided extrapolation rules. The EPD covers all configurations of REX615, including related connectors and packaging.

The REX615 is a freely configurable all-in-one protection and control relay for power generation and distribution applications. A wide application coverage combined with a fully modular and scalable hardware and software ensures maximum flexibility and optimal cost-effectivity throughout the relay life cycle – from tailoring to adapting to changing and new application-specific requirements.

REX615 has modular hardware with a withdrawable plug-in unit design assisting relay installation, testing and maintenance. REX615 offers two different relay size variants: standard housing and wide housing. The relay size variant and module content can be selected according to application needs. The REX615 size variants and module slots are illustrated below.



1 X000
2 X100
3 X110
4 X120
5 X130



1 X000
2 X100
3 X105
4 X110
5 X115
6 X120
7 X130

General technical specifications of the REX615 reference product configuration are presented below.

Description		REX615_100D (Reference Product)
Config.	X000	COM0037
	X100	PSM0004
	X105*	-
	X110	BIO0005
	X115*	-
	X120	AIM0016
	X130	AIM0006
	Backplane	BPL0003
	CPU	CPU0011
	Display	DIS0043
	Housing	Standard
Size	Width (frame)	177 mm
	Width (housing)	164 mm
	Height (frame)	177 mm
	Height (housing)	160 mm
	Depth	201 mm
	Weight	4.0 kg
Ratings	Nominal auxiliary voltage U_n	100, 110, 120, 220, 240 V AC, 50 and 60 Hz
		60, 110, 125, 220, 250 V DC
	Burden of auxiliary voltage supply P_q	DC < 13.0 W (nominal) / < 18.0 W (max.)
		AC < 16.0 W (nominal) / < 21.0 W (max.)
	Measured nominal power @ 110 V DC	9.3 W

*Only available for wide housing

The REX615 is manufactured by ABB located in Vaasa, Finland. The manufacturing site uses 100 % renewable energy for the electricity (50/50 wind and hydro) and for heating (bioenergy) and is certified according to the following standards:

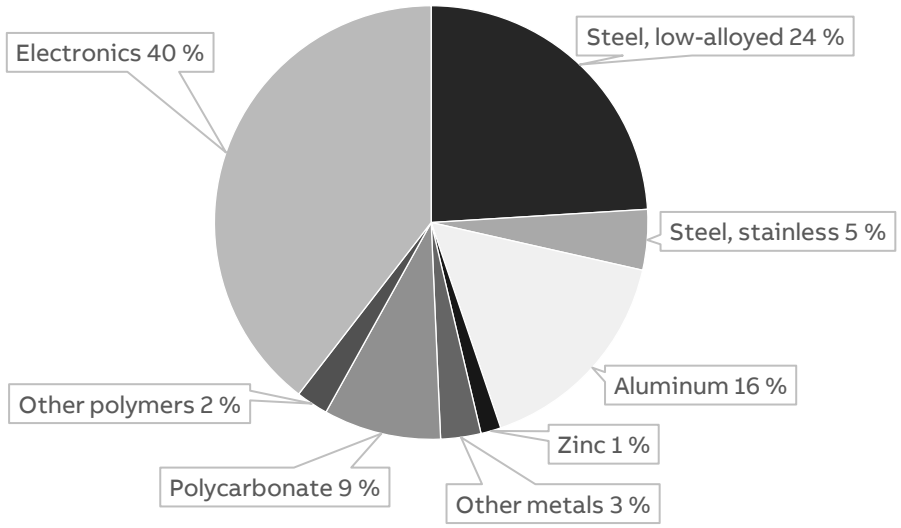
- ISO 9001:2015 – Quality Management Systems
- ISO 14001:2015 – Environmental Management Systems
- ISO 45001:2018 – Occupational Health and Safety Management Systems
- ISO 50001:2018 – Energy management systems

Constituent Materials

The constituent materials of the REX615 Reference Product are presented below.

Type	Material	Weight [kg]	Weight %
Metals	Steel, low-alloyed	0.96	24
	Steel, stainless	0.18	5
	Aluminum	0.65	16
	Zink	0.06	1
	Other metals	0.12	3
Plastics	Polycarbonate	0.35	9
	Other polymers	0.10	2
Others	Electronics	1.58	40
Total		**4.00**	**100**

REX615 Reference Product



The constituent materials of the packaging are presented below. Both primary packaging (unit) and secondary packaging (bulk) are considered, and 30 pcs are assumed per pallet.

	Description	Material	Weight [kg]	Weight %
Unit (1st)	Packaging box	Cardboard	0.183	22
	Cushioning	Molded fiber pulp	0.131	15
	Self-sealing bags	PE	0.007	1
	Documentation	Printed paper	0.060	7
	Subtotal		**0.381**	**45**
Bulk (2nd)	Pallet	Wood	0.306	36
	Packaging box	Cardboard	0.083	10
	Packaging cover	Cardboard	0.037	4
	Protective edges	Cardboard	0.004	<1
	Cushioning	Kraft paper	0.034	4
	Plastic straps	PET	0.002	<1
	Subtotal		**0.466**	**55**
	Total**		**0.847**	**100**

**for REX615 products with wide housing, total weight is 1.18 kg

LCA Background Information

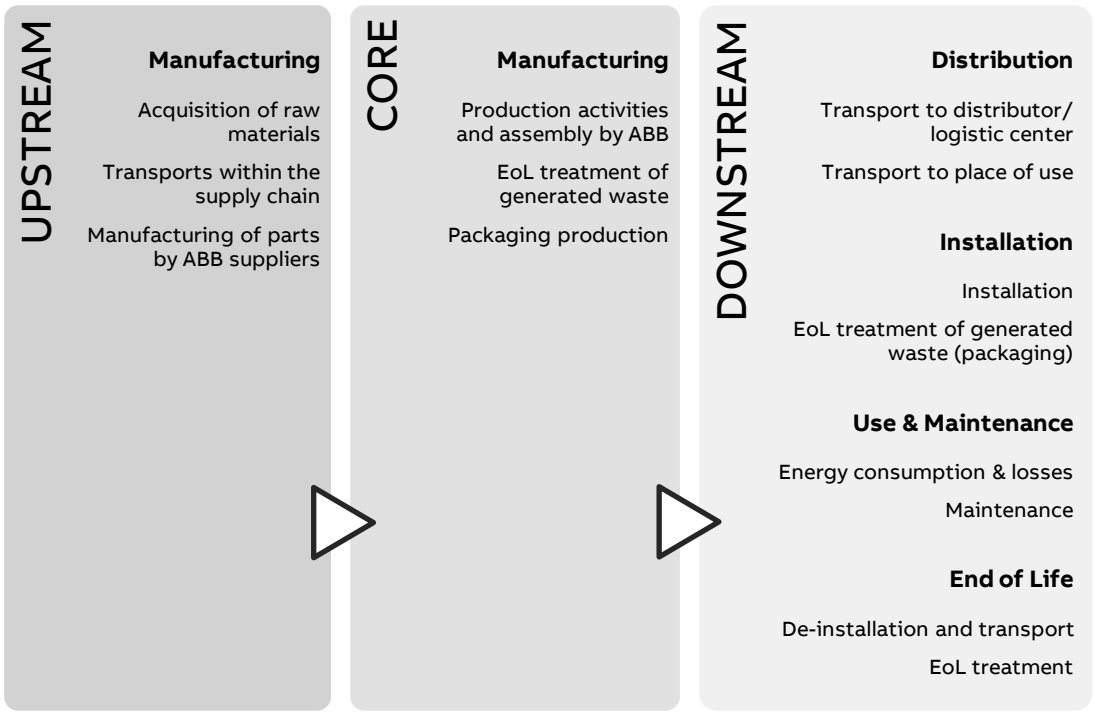
Functional Unit

The functional unit of this study is to protect a power system against faults such as short circuit and overload, using an auxiliary voltage of 110 V DC, during a service life of 10 years and with a use rate of 100 % in Europe. The reference flow is a single REX615 protection and control relay, including related connectors and packaging.

Note, the reference service life (RSL) of 10 years is a theoretical period selected for calculation purposes only – this is not representative for the minimum, average, nor actual service life of the product.

System Boundaries

The life cycle assessment is a “cradle-to-grave” analysis, and the system boundaries are defined according to EN 50693, as required by the PCR. For transparency reasons, the manufacturing stage is further divided into an upstream and core stage.



Data quality

Both primary and secondary data are used. The main sources for primary data are the bill of materials (BOM), CAD-files, technical drawings, and site-specific foreground data provided by ABB. Secondary raw material contents are also considered, which is provided by the suppliers for the main materials.

For all processes for which primary data are not available, generic background data originating from the ecoinvent v3.9.1 database, with system model “allocation, cut-off by classification”, are used. The LCA software used for the calculations is SimaPro 9.5.

Allocation rules

The utility consumption and waste generation by ABB, in the core manufacturing stage, is allocated to the production of one reference product according to applicable rules. For the end-of-life allocation, the “Polluter Pays” principle is adopted according to what is defined in the CEN/TR 16970 standard. However, the potential benefits and avoided loads from recovery and recycling processes are not considered because it is not required by the PCR.

Cut-off criteria

The PCR EPDItaly007 does not provide any details about cut-off criteria; it refers to chapter 4.2.3.3 in the standard EN 50693. According to EN 50693, the cut-off criteria can be set to a maximum of 5 % of the overall environmental impacts. In this LCA, labels as well as the tape and staples used in the packaging have been excluded as their weights are negligible.

Inventory Analysis

Manufacturing Stage (upstream)

The life cycle inventory in the upstream manufacturing stage is based on the primary data available from ABB and background data from ecoinvent. Datasets are applied accordingly, to the best of our knowledge, to represent each material, manufacturing process, and surface treatment. Modelling decisions and assumptions that are highly relevant to the results are as following:

- Secondary raw materials content is considered when selecting datasets.
- Printed wiring boards are modelled on a component level, i.e., each component is considered and mapped with the most representative dataset available.
- The amount of gold used in each connector is considered, due to its high impact.

Additionally, supply chain transports are added as far as data is available between ABB, the suppliers, and sub-suppliers. Only primary suppliers are considered. The rest of the transports are assumed to already be included in ecoinvent's "market for"-processes.

Manufacturing Stage (core)

In the core manufacturing stage, utility consumption and waste generation at the ABB manufacturing site are accounted for. The packaging materials are also considered. Modelling decisions and assumptions that are highly relevant to the results are as following:

- 100% renewable electricity and district heating is considered, which is procured by the ABB manufacturing site through Guarantees of Origins (GO's). In the use stage electricity is not calculated according to residual mix, but according to location-based approach.

Distribution

The transport distance from the ABB manufacturing site to the site of installation is assumed to be 300 km by lorry, as the actual distance is unknown. The environmental impacts can be multiplied accordingly if the actual distance is known.

	Dataset	Amount	Unit	Represent.
Transport	*Transport, freight, lorry 16-32 metric ton, EURO4 {RER}*	300	km	Assumption

Installation

The installation phase only implies manual activities, and the energy consumed is negligible. Therefore, this phase only considers the end-of-life of the packaging materials used.

	Scenario	Transport	Representation
Packaging End-of-Life	*Packaging waste by waste management operations* (Eurostat, 2021)	100 km by lorry (assumption)	Europe

Use

The use stage considers the measured nominal power consumption at 110 V DC over the reference service life of 10 years over the reference service life as defined in the functional unit. This is calculated using the following formula:

$$E_{use}[kWh] = \frac{P_{use} * 8760 * RSL * \alpha}{1000} = \frac{9.3\ \text{W} * 8760\ \text{hours} * 10\ \text{years} * 100\ \%}{1000} = 814.7\ kWh$$

Where:

- E_{use} = Total energy use over the reference service life
- P_{use} = Reference power consumption in watts
- *RSL* = Reference Service Life in years
- α = Use time rate
- 8760 is the number of hours in a year
- 1000 is the conversion factor from W to kW

The energy mix of the European Union is adopted to represent an average European downstream scenario.

	Dataset	Amount	Unit	Represent.
Energy	*Electricity, medium voltage {RER}| market group for | Cut-off, S*	0.36	kg CO_2-eq./kWh	Europe

Maintenance is not considered because the REX615 does not have any required, planned, or preventive maintenance within its service life. Possible corrective maintenance is unusual, and thus considered negligible.

End of life

Decommissioning of the product only implies manual activities, and the energy consumed is negligible. Therefore, this phase only considers the end-of-life of the product.

	Scenario	Transport	Representation
Product End-of-Life	IEC/TR 62635 (Annex D.3)*	100 km by lorry (assumption)	Europe

*A conservative approach is adopted by considering all parts as either: requiring selective treatment, difficult to process, or going through a separation process; no individual part is considered as a single recyclable material.

Environmental Indicators

In accordance with the PCR EPDItaly007, the environmental impact indicators are determined by using the characterization factors and impact assessment methods specified in EN 15804:2012+A2:2019.

REX615 Reference Product

			Cradle-to-gate		Cradle-to-grave			
			UPSTREAM	CORE	DOWNSTREAM			
Impact category	Unit	Total	Manufacturing		Distribution	Installation	Use and maintenance	End-of-life
GWP – total	kg CO_2 eq.	4.09E+02	1.09E+02	1.82E+00	2.73E-01	3.36E-01	2.95E+02	2.58E+00
GWP – fossil	kg CO_2 eq.	3.98E+02	1.11E+02	1.37E+00	2.72E-01	3.10E-02	2.83E+02	2.52E+00
GWP – biogenic	kg CO_2 eq.	9.59E+00	-1.62E+00	3.93E-01	2.48E-04	3.05E-01	1.05E+01	6.03E-02
GWP – luluc	kg CO_2 eq.	9.81E-01	2.10E-01	6.15E-02	1.33E-04	1.19E-05	7.09E-01	5.13E-04
ODP	kg CFC-11 eq.	1.58E-05	1.06E-05	8.45E-08	5.96E-09	4.99E-10	5.09E-06	5.35E-09
AP	mol H+ eq.	2.46E+00	1.02E+00	9.95E-03	1.13E-03	1.20E-04	1.42E+00	2.43E-03
EP – freshwater	kg P eq.	3.95E-01	1.36E-01	6.37E-04	1.92E-05	2.74E-06	2.59E-01	1.38E-04
EP – marine	kg N eq.	4.23E-01	1.65E-01	3.32E-03	4.30E-04	1.79E-04	2.53E-01	1.75E-03
EP – terrestrial	mol N eq.	4.04E+00	1.76E+00	3.36E-02	4.59E-03	4.88E-04	2.23E+00	7.96E-03
POCP	kg NMVOC eq.	1.26E+00	5.26E-01	8.26E-03	1.65E-03	1.85E-04	7.19E-01	2.23E-03
ADP – minerals and metals	kg Sb eq.	3.66E-02	3.60E-02	2.69E-05	8.80E-07	6.80E-08	5.64E-04	3.11E-06
ADP – fossil	MJ, net calorific value	7.95E+03	1.40E+03	1.67E+01	3.88E+00	3.11E-01	6.52E+03	4.87E+00
WDP	m^3 eq.	9.49E+01	2.78E+01	3.49E-01	1.58E-02	3.48E-03	6.67E+01	9.28E-02

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-marine compartment; EP-terrestrial: Eutrophication potential-accumulated exceedance; POCP: Formation potential of tropospheric ozone; ADP-minerals & metals: Abiotic Depletion for non-fossil resources potential; ADP-fossil: Abiotic Depletion for fossil resources potential; WDP: Water deprivation potential.

Resource use parameters	Unit	Total	Cradle-to-gate		Cradle-to-grave			
			UPSTREAM	CORE	DOWNSTREAM			
			Manufacturing		Distribution	Installation	Use and maintenance	End-of-life
PENRE	MJ, low cal. value	7.94E+03	1.40E+03	1.64E+01	3.88E+00	3.11E-01	6.52E+03	4.87E+00
PERE	MJ, low cal. value	1.48E+03	1.69E+02	6.29E+01	6.03E-02	6.50E-03	1.25E+03	4.68E-01
PENRM	MJ, low cal. value	4.22E+01	4.19E+01	3.46E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERM	MJ, low cal. value	3.77E+01	2.66E+01	1.11E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT	MJ, low cal. value	7.98E+03	1.44E+03	1.67E+01	3.88E+00	3.11E-01	6.52E+03	4.87E+00
PERT	MJ, low cal. value	1.52E+03	1.96E+02	7.40E+01	6.03E-02	6.50E-03	1.25E+03	4.68E-01
FW	m^3	6.17E+00	1.01E+00	5.05E-02	5.53E-04	1.20E-04	5.10E+00	3.29E-03
MS	kg	9.76E-01	6.90E-01	2.86E-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	0.00E+00
NRSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

PENRE: Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw material; PERE: Use of renewable primary energy excluding renewable primary energy resources used as raw material; PENRM: Use of non-renewable primary energy resources used as raw material; PERM: Use of 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); PERT: Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials); FW: Net use of fresh water; MS: Use of secondary materials; RFS: Use of renewable secondary fuels; NRSF: Use of non-renewable secondary fuels.

System output indicators	Unit	Total	Cradle-to-gate		Cradle-to-grave			
			UPSTREAM	CORE	DOWNSTREAM			
			Manufacturing		Distribution	Installation	Use and maintenance	End-of-life
HWD	kg	2.24E-02	1.40E-02	1.09E-04	2.47E-05	1.83E-06	8.26E-03	2.04E-05
NHWD	kg	3.30E+01	1.28E+01	5.65E-01	1.90E-01	1.78E-01	1.79E+01	1.42E+00
RWD	kg	5.09E-02	3.40E-03	3.78E-05	1.26E-06	1.25E-07	4.75E-02	8.49E-06
MER	kg	1.69E+00	0.00E+00	8.50E-01	0.00E+00	1.43E-01	0.00E+00	7.01E-01
MFR	kg	4.97E+00	4.84E-01	1.88E+00	0.00E+00	5.40E-01	0.00E+00	2.06E+00
CRU	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ETE	MJ	5.58E+00	0.00E+00	2.91E+00	0.00E+00	6.05E-01	0.00E+00	2.07E+00
EEE	MJ	3.01E+00	0.00E+00	1.53E+00	0.00E+00	3.36E-01	0.00E+00	1.15E+00

HWD: hazardous waste disposed; NHWD: non-hazardous waste disposed; RWD: radioactive waste disposed; MER: materials for energy recovery; MFR: material for recycling; CRU: components for reuse; ETE: exported thermal energy; EEE: exported electricity energy.

Extrapolation rules

Due to the large variations in environmental impacts between product configurations, extrapolation rules are established according to EN 50693. This allows for estimating more precise impacts of other relay configurations. The extrapolation rules are based on multilinear regression from the LCIA results of 3 product configurations. Also, the extrapolation rules have been tested with various REX615 configurations to ensure an accuracy of within ± 10% of the total environmental impacts. As a result, the following rules are established:

- The upstream manufacturing stage, core stage, distribution stage, use and maintenance stage, and end-of-life stage can be extrapolated, based on the number of hardware slots and housing type, using the following formula:

$$Impact = Impact_{ref} * (1 - a * (5 - n_{slots}) + b * x_{type})$$

where
  - *Impact* is the extrapolated value for any impact category
  - $Impact_{ref}$ is the impact value of the reference product
  - n_{slots} is the number of used module slots
  - x_{type} is 0 if standard housing and 1 if wide housing
  - *a* and *b* are calculated coefficients, that are presented in the three tables below

- The use stage is proportional to the actual, measured power consumption and can be extrapolated using the following formula:

$$Impact = Impact_{ref} * (\frac{P_{actual}}{9.3\ \mathrm{W}})$$

where
  - *Impact* is the extrapolated value for any impact category
  - $Impact_{ref}$ is the impact value of the reference product
  - P_{actual} is the actual, measured power consumption
  - Typical range: 9 - 13 W

Example 1: A REX615 relay with standard housing that have 4 hardware module slots in use, and a measured power consumption at 9.0 W.
- "GWP-total" in upstream = 109 kg CO2-eq * (1 – 0.09 * (5–4) + 0.13 * 0) = 99 kg CO2-eq
- "GWP-total" in use stage = 295 kg CO2-eq * (9.0 W / 9.3 W) = 285 kg CO2-eq

Example 2: REX615 relay with wide housing that have 6 hardware modules in use, and a measured power consumption at 9.8 W.
- "ADP-fossil" in distribution = 3.9 MJ * (1 – 0.03 * (5 – 6) + 0.21 * 1) = 4.8 MJ
- "ADP-fossil" in use stage = 6524 MJ * (9.8 W / 9.3 W) = 6875 MJ

An Excel tool for the extrapolation rules of REX615 is available at:
https://search.abb.com/library/Download.aspx?DocumentID=2RCA058828&LanguageCode=en&DocumentPartId=&Action=Launch

Impact category	Upstream		Core		Distribution		Use and maintenance		End-of-life	
	a	b	a	b	a	b	a	b	a	b
GWP – total	0.09	0.13	-	-0.01	0.03	0.21	-	0.41	0.08	0.06
GWP – fossil	0.09	0.13	-	0.17	0.03	0.21	-	0.35	0.08	0.06
GWP – biogenic	-0.03	-0.03	-	-0.64	0.03	0.21	-	0.42	-0.01	0.29
GWP – luluc	0.10	0.16	-	0.03	0.03	0.21	-	0.38	0.03	0.18
ODP	0.04	0.02	-	0.29	0.03	0.21	-	0.39	0.04	0.16
AP	0.10	0.09	-	0.12	0.03	0.21	-	0.39	0.04	0.15
EP – freshwater	0.10	0.04	-	0.21	0.03	0.21	-	0.40	0.03	0.17
EP – marine	0.10	0.09	-	0.15	0.03	0.21	-	0.38	0.03	0.19
EP – terrestrial	0.10	0.09	-	0.10	0.03	0.21	-	0.40	0.05	0.13
POCP	0.09	0.10	-	0.14	0.03	0.21	-	0.39	0.05	0.14
ADP – minerals and metals	0.11	0.01	-	0.16	0.03	0.21	-	0.38	0.03	0.19
ADP – fossil	0.09	0.10	-	0.22	0.03	0.21	-	0.39	0.03	0.18
WDP	0.09	0.07	-	0.30	0.03	0.21	-	0.35	0.05	0.13

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-marine compartment; EP-terrestrial: Eutrophication potential-accumulated exceedance; POCP: Formation potential of tropospheric ozone; ADP-minerals & metals: Abiotic Depletion for non-fossil resources potential; ADP-fossil: Abiotic Depletion for fossil resources potential; WDP: Water deprivation potential.

Resource use parameters	Upstream		Core		Distribution		Use and maintenance		End-of-life	
	a	b	a	b	a	b	a	b	a	b
PENRE	0.09	0.10	-	0.22	0.03	0.21	-	0.39	0.03	0.18
PERE	0.09	0.09	-	0.01	0.03	0.21	-	0.37	0.03	0.17
PENRM	0.03	0.08	-	0.18	-	-	-	-	-	-
PERM	-	-	-	0.39	-	-	-	-	-	-
PENRT	0.09	0.10	-	0.22	0.03	0.21	-	0.39	0.03	0.18
PERT	0.08	0.07	-	0.07	0.03	0.21	-	0.37	0.03	0.17
FW	0.09	0.08	-	0.07	0.03	0.21	-	0.35	0.05	0.13
MS	-0.00	-0.27	-	-0.06	-	-	-	-	-	-

PENRE: Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw material; PERE: Use of renewable primary energy excluding renewable primary energy resources used as raw material; PENRM: Use of non-renewable primary energy resources used as raw material; PERM: Use of 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); PERT: Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials); FW: Net use of fresh water; MS: Use of secondary materials; RFS: Use of renewable secondary fuels; NRSF: Use of non-renewable secondary fuels.

Waste production indicators	Upstream		Core		Distribution		Use and maintenance		End-of-life	
	a	b	a	b	a	b	a	b	a	b
HWD	0.07	-0.04	-	0.16	0.03	0.21	-	0.40	0.04	0.16
NHWD	0.08	0.19	-	0.11	0.03	0.21	-	0.45	0.05	0.13
RWD	0.09	0.06	-	0.26	0.03	0.21	-	0.37	0.03	0.19
MER	-	-	-	-	-	-	-	0.44	0.09	0.03
MFR	-0.00	0.26	-	0.00			-	0.36	0.00	0.25
CRU	-	-	-	-	-	-	-	-	-	-
ETE	-	-	-	-	-	-	-	0.43	0.08	0.04
EEE	-	-	-	-	-	-	-	0.43	0.08	0.04

HWD: hazardous waste disposed; NHWD: non-hazardous waste disposed; RWD: radioactive waste disposed; MER: materials for energy recovery; MFR: material for recycling; CRU: components for reuse; ETE: exported thermal energy; EEE: exported electricity energy.

Sensitivity analysis

This chapter presents the results of a sensitivity analysis in different scenarios, to understand how the impact category “GWP – total” varies for REX615 relays produced and sold in different geographical locations.

The manufacturing stage depends on where the relay is sold, as the plant in Finland sells globally while the plant in China and India sells domestically. The choice of market affects ABB’s utility consumption, waste generation, and the packaging materials used. The relays are technically identical regardless of production site, and all three plants rely mainly on the same global supply network. Thus, the upstream manufacturing phase is assumed to be same. The downstream stage also depends on customer location, and the main variable is the energy mix in the use stage. For the distribution stage, only the weight was adjusted as the packaging materials differ. The end-of-life scenarios were not modified due to the lack of data.

Scenario	Total [kg CO_2 eq.]	UPSTREAM	CORE	DOWNSTREAM			
		Manufacturing		Distribution	Installation	Use and maintenance	End-of-life
Declared scenario Manufacturing site: Finland Use stage: Europe	4.09E+02	1.09E+02	1.82E+00	2.73E-01	3.36E-01	2.95E+02	2.58E+00
India Manufacturing site: India Use stage: India	1.19E+03	1.03E+02	8.18E-01	3.10E-01	5.91E-01	1.08E+03	2.58E+00
China Manufacturing site: China Use stage: China	8.98E+02	1.09E+02	1.26E+01	2.84E-01	4.87E-01	7.72E+02	2.58E+00

Additional Environmental Information

Circularity Values

The recycled content and recyclability potential of the product is calculated by dividing "MS: Use of secondary materials" in the upstream manufacturing stage and “MFR: material for recycling” in the end-of-life stage by the total weight of the product. This has been done for the same four configurations used for the extrapolation rules. The recycled content is based on primary data, and the recyclability potential is representative for Europe according to IEC/TR 62635. The results are presented below.

	Recycled content	Recyclability potential
Configuration 1 (reference product) Housing: Standard Slots: 5/5	17 %	52 %
Configuration 2 Housing: Standard Slots: 3/5	19 %	55 %
Configuration 3 Housing: Wide Slots: 7/7	10 %	51 %
Configuration 4 Housing: Wide Slots: 3/7	11 %	58 %

The recycled content and recyclability potential of the packaging is calculated by dividing "MS: Use of secondary materials" in the core manufacturing stage and “MFR: material for recycling” in the installation stage by the total weight of the packaging. The recycled content is based on primary data, and the recyclability potential is representative for Europe according to Eurostat (2021). The results are presented below.

	Recycled content	Recyclability potential
Packaging materials Housing: Standard	34 %	63 %
Packaging materials Housing: Wide	23 %	62 %

Greenhouse gas emissions from the use of electricity in the manufacturing phase

Production mix from import, medium voltage (production of transmission lines, in addition to direct emissions and losses in grid) of applied electricity for the manufacturing process.

Energy mix	Source	Amount	Unit
ABB FI custom energy mix; 50 % wind + 50 % hydro	Ecoinvent v3.9.1	0.028	kg CO_2-eq/kWh

Dangerous substances

For the product a REACH SVHC 240 declaration is provided.

Indoor environment

The product meets the requirements for low emissions.

Carbon footprint

Carbon footprint has not been worked out for the product.

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Program Operator and publisher		
The Norwegian EPD Foundation	Ph.	+47 23 08 80 00
Post Box 5250 Majorstuen,	email	post@epd-norge.no
0303 Oslo, Norway	web	www.epd-norge.no

Owner of the declaration		
ABB Swizerland Ltd, Group Technology Management		
Brown Boveri Straße 6, 5400 Baden, Switzerland	web	www.abb.com

Author		
Martina Kurki	Ph.	+358 50 3341214
ABB Oy	email	martina.kurki@fi.abb.com
Muottitie 2 A, Vaasa, Finland	web	www.abb.com