EPD

Environmental Product Declaration

Indoor Voltage Transformer TJC 4 - 11000/√3//110/√3/110/3

Production site: Brno, Czech Republic

DOCUMENT KIND	IN COMPLIANCE WITH			
Environmental Product Declaration	ISO 14025 and EN50693			
PROGRAM OPERATOR	PUBLISHER			
The Norwegian EPD Foundation	The Norwegian EPD Foundation			
EPD-NORGE REGISTRATION NUMBER	ISSUE DATE			
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OWNING ORGANIZATION	DECLARATION NUMBER	REV.	LANG.	PAGE
ABB Switzerland Ltd, Group Technology Management	1VLG101076	A	en	1/20

EPD Owner	ABB Switzerland Ltd, Group Technology Management
Manufacturer name and address	ABB, s.r.o Vyskočilova, Praha, Czech republic
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Program operator	The Norwegian EPD Foundation Post Box 5250 Majorstuen, 0303 Oslo, Norway Ph.:+47 23 08 80 00 email: post@epd-norge.no
Declared product & Functional unit or declared unit	Indoor voltage transformer TJC 4 11000/√3//110/√3/110/3, which is used for metering and protection purposes of electric power distribution. The service duration of 20 years with a use rate of 100% .
Product description	The TJC 4 single-pole insulated voltage transformer are cast in epoxy resin and designed mostly for insulation voltage of 3,6 kV to 12 kV
CPC code	46121 - Electrical transformers
Independent verification	Independent verification of the declaration and data, according to ISO14025:2010 ☐ INTERNAL ☒ EXTERNAL Independent verifier approved by EPD Norway: Elisabet Amat
Approved by	Håkon Hauan, Manager director of EPD-Norway. Signature: Håkon Hauan
Reference PCR and version number	Core PCR: EPDItaly007 – PCR for Electronic and Electrical Products and Systems, Rev. 2, 2020/01/21. Sub PCR: EPDItaly015 - Electronic and electrical products and systems – Switches, Rev. 0, 2020/03/16.
Other reference documents	EN 50693:2019 - Product category rules for life cycle assessments of electronic and electrical products and systems
Product RSL description	20 years, this is a theoretical period selected for calculation purposes only and it is not representative for the minimum, average, nor actual service life of the product
Markets of applicability	Global (raw materials), Czech republic (production) Europe (distribution, use and end-of-life)

LCA study	This EPD is based on the LCA study described in the LCA report 1VLG101075.
EPD type	Specific product by a specific manufacturer
EPD scope	“Cradle to grave”
Year of reported primary data	2021
LCA software	SimaPro 9.3.0.3 (2021)
LCI database	Ecoinvent v3.8 (2021)
LCIA methodology	EN 50693:2019
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 Norway shall not be liable with respect to manufacturer, life cycle assessment data and evidences.

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 110 thousand talented employees in over 100 countries.

ABB's Electrification business offers a wide-ranging portfolio of products, digital solutions and services, from a substation to socket, enabling safe, smart and sustainable electrification. Offerings encompass digital and connected innovations for low 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 Brno ELDS (Electrification Distribution Solutions) specializes in reliable, high quality technical solutions and services for medium voltage (MV) and low voltage (LV) switchgear. ABB ELDS Brno is a global focus feeder factory for instrument transformers and sensors and MV air insulated switchgear (AIS) for primary applications. And regional focus feeder factory for MNS iS.

Brno site is also home to ABB's Technology Centre for the Czech Republic, which forms part of the global development teams for MV Primary AIS, instrument transformers & sensors and MNS low voltage switchgear.

ABB Brno ELDS 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 - Sistemi di Gestione Ambientale Requisiti e Guida per l'Uso
- UNI EN ISO 45001:2018 - Occupational Health and Safety Management system

The production of the instrument transformers, from which medium voltage indoor transformer TJC 4 is part of, is located in the ABB Brno Videnska factory. The instrument transformers are produced and assembled directly in the ABB factory combined with components produced by ABB's suppliers. Some sub-assemblies like a secondary terminal cover, and primary output are produced by suppliers in Poland, China and Czech Republic.

The TJC 4 single-pole insulated voltage transformer is cast in epoxy resin and designed mostly for insulation voltage of 3,6 kV to 12 kV.

Technical specifications are as follow:

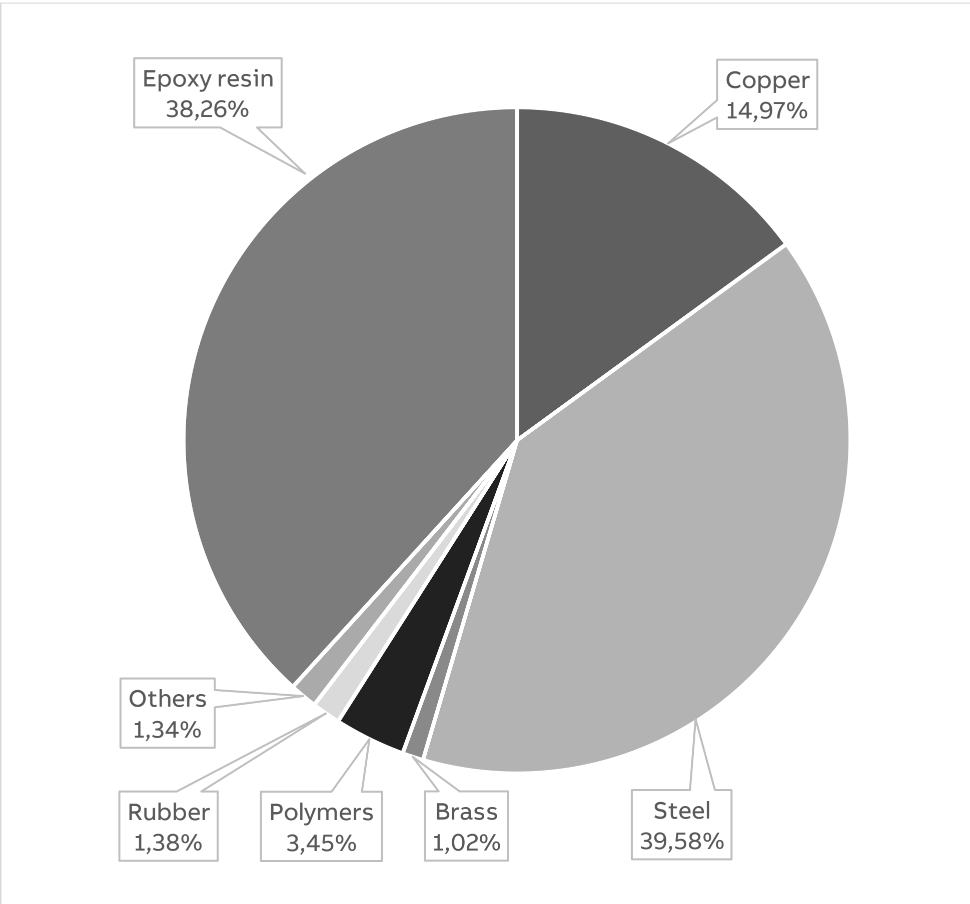
Type		**TJC 4 - 11000/√3//110/√3/110/3**
Outer height/width/length	**mm**	220/148/338
Insulation level	**kV**	12/28/75
Rated primary	**V**	11000
Rated secondary	**V**	110
Accuracy class	**-**	0,2
Rated output	**VA**	50
Frequency	**Hz**	50
Thermal burden	**VA**	400

Figure 1: ABB Brno Videnska

Constituent materials

The TJC 4 - 11000/√3//110/√3/110/3 considered in this study is 23.7 kg. Some small parts were excluded because of lack of data, as their mass is estimated to be well below 2% of the total weight, according to the EPDItaly015 cut-off criteria.

Materials	Name	CAS Number	Product weight [kg]	%	Packaging Weight [kg]	%
Metals	Aluminum	7429-90-5	-	-	0,0025	0,10
	Copper	7440-50-8	3,55	14,97	-	-
	Steel	7439-89-6	9,37	39,58	0,11	4,14
	Brass	86376-49-0	0,24	1,02	-	-
Plastics and rubbers	Polymers	-	0,82	3,45	0,024	0,92
	Rubber	9006-04-6	0,33	1,38	0,0033	0,13
Wooden base materials	Wood (pallet + case)	-	-	-	2,43	93,72
Others	Epoxy resin	-	9,06	38,26	-	-
	Others	-	0,32	1,34	0,026	0,99
Total			**23,7**	**100**	**2,59**	**100**



The single use packaging is also included in the analysis, specifically in the manufacturing core stage. The packaging is common for all the versions of TJC 4; it is composed of steel fixing bolts and a wooden pallet, resulting in a total weight of 2.59 kg.

LCA background information

Functional Unit

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. As a result, the reference flow can be determined, which refers to the measure of outputs from processes required to fulfil the function expressed by the functional unit.

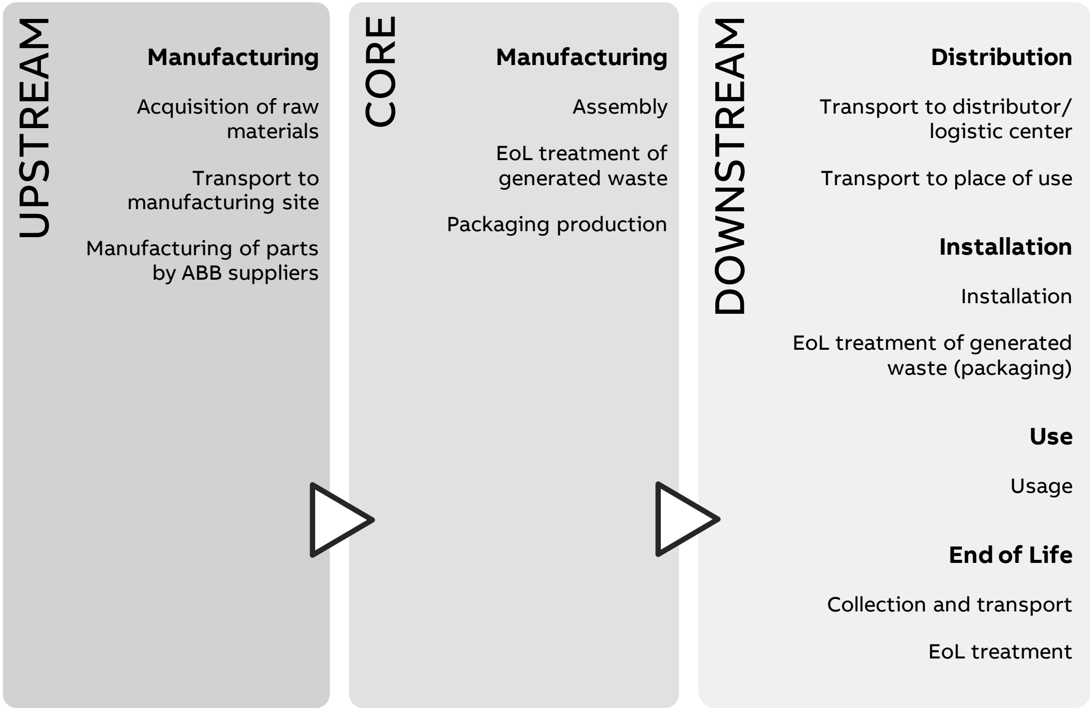
The functional unit this study is measuring the system voltage (3,6 kV to 12 kV) mainly for protection purposes during a service of 20 years and more. The Reference flow is single-pole insulated voltage transformer casted in epoxy resin and its related accessories and packaging.

Note, the reference service life (RSL) of 20 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 of voltage instrument transformer TJC 4, 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 upstream process (e.g. acquisition of raw material, preparation of semi-finished goods, etc.) and the main manufacturing and processing steps; distribution; installation, including the relevant steps for the preparation of the product for use. The usage includes the required maintenance steps within the RSL (reference service life of the product) associated with the reference product. The end-of-life stage includes the necessary steps until the 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 EN50693 for the evaluation of electronic and electrical products and systems.



The stages of the product life cycle and the information considered for the evaluation of the. TJC 4 are:

- Manufacturing upstream includes raw materials, and production activities of ABB suppliers, including transport of semifinished items and subassemblies to ABB Brno.
- Manufacturing core includes local consumptions (ABB Brno) due to manufacturing of the products (TJC 4), the relevant assembling and waste due to manufacturing. This includes also packaging production.
- The distribution stage includes the impacts related to the distribution of the product at the installation site.
- The installation stage includes the end of life of the packaging.
- The use and maintenance stages include the impact related to energy consumption during the service life of the product.
- End of life includes the operations for the disposal of the product at the end of its service life.

Temporal and geographical boundaries

The component suppliers are sourced in Asia and Europe. All primary data collected from ABB are from 2021, which is a representative production year. Secondary data are provided by Ecoinvent v3.8.

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

The results of this study are only applicable to TJC 4 produced in Brno in 2021.

Boundaries in the life cycle

As indicated in the PCR EPDItaly007, capital goods, such as buildings, machinery, tools and infrastructure, the reusable packaging for internal transport which cannot be allocated directly to the production of the reference product are excluded from the system boundary.

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

Data quality

In this EPD, both primary and secondary data are used. Site specific foreground data have been provided by ABB. Main data sources are the bill of materials available on the enterprise resource planning. For all processes for which primary are not available, generic data originating from the Ecoinvent v3.8 database, allocation cut-off by classification, are used.

The ecoinvent database is available in the SimaPro 9.3.0.3 software used for the calculations.

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 EPDItaly007 and EN 50693 the environmental impact indicators must be determined using the characterization factors and impact assessment methods specified in EN 15804:2012+A2:2019.

PCR EPDItaly007 and the EN 50693 standard establish four indicators for climate impact (GWP-GHG): GWP (total) which includes all greenhouse gases; GWP (fossil fuels); GWP (biogenic carbon) which includes the emissions and absorption of biogenic carbon dioxide and biogenic carbon stored in the product; GWP (land use).

Allocation rules

All the commodities - Natural Gas, Water, Electricity, Wastes are available for whole ABB Brno Videnska facility for 2021. Specific allocation related to TJC 4 production was done following was:

Natural Gas – measurement for whole facility ABB Videnska allocated by surface areas of ITS (Instrument Transformers and Sensors) production related buildings.
Water – measurement for whole facility ABB Videnska allocated per ITS production employees.
Electricity – sub measurements for ITS production.
Wastes – based on the data of HSE and Facility office.

The allocation coefficient for all listed commodities was defined as ratio between product weight and ITS production in 2021 (represented by total weight of all produced units).

Concerning end-of-life allocation, the "polluter pays" approach has been adopted. With this approach, waste treatment processes are allocated to the product system that generates the waste until the end-of-waste state is reached according to what is defined in CEN/TR 16970. Then environmental impact of recycling and energy recovery processes is allocated to the production system. The product system that uses the exported energy and recycled materials receive it burden free. Potential benefits and avoided loads from recovery processes are not considered (not required by EPDItaly007).

Limitations and simplifications

The raw material life cycle stage includes the extraction of raw materials but neglects the production of various components at ABB's suppliers (e.g. glue, grease and adhesive), as their mass represents less than 2% of that of the whole TJC 4, as stated in the paragraph of cut-off criteria of EPDItaly015: "Materials making up the switch it-self whose total mass does not exceed 2% of the total weight of the device".

This same applies to packaging, where small parts, such as sticking labels and grease, are even a smaller fraction of the total mass.

Surface treatments like tin plating, silver plating, copper plating and painting have been considered in the LCA model. MgO insulation layer treatment (Carlite) and phosphating have been excluded due to the model complexity and unavailability of reference data.

Scraps for metal working and plastic processes are included when already defined in ecoinvent.

Inventory analysis

The Ecoinvent v3.8 cut-off by classification system processes are used to model the background system of the processes. Secondary material constitutes are taken from ecoinvent database.

Due to the large amounts of components in the medium voltage instrument transformer, raw material inputs are modelled with data from ecoinvent representing a global market coverage. These datasets are assumed to be representative.

Manufacturing stage

The transformers are composed of many components, all of which are made from of numerous materials. Some of the inputs to the products' manufacturing stage are produced by the suppliers. Rest of the transformer parts are produced in the factory from raw materials.

Table summarizes the weights of the assembled version

Table 1: Product Weights

	Weight [kg]
TJC 4 11000/√3//110/√3/110/3	23,7

Voltage transformer production stages: Based on the production instructions, the operator winds the secondary coil onto self-holding base. Then the primary coil is winded on. This is followed by the competition of internal parts of the transformer where coils are assembled with magnetic core provided by supplier. For adaptation to APG casting the internal parts are covered by specific set of cushioning to compensate for shrinkage. After electrical pre-testing, the internal parts are correctly placed in the mold. Then the casting process stars with following steps: Preheating process, APG casting, post curing. Finally, the body is assembled with baseplate and other covers. After final testing is completed, labels are placed on the body and the transformer is transferred to the expedition area.

The single-use packaging is also included in the analysis, in the manufacturing core stage. Packing of transformer is done according to internal document PNP 7101, i.e. all is packed on the palettes, which are placed into the wooden or OSB crates and fixed. Transformers are fixated on the pallets using the screws.

Figure 2: Packing of transformers

The resulting weight depends on size of the panel and way of packaging. For modeling purposes 2021 material consumption was allocated by product weight.

Steel is the most frequently used material, followed by epoxy resin, copper and polymers. All steel components (hot rolled steel, spring steel) are modelled with the same kind of steel: "Steel, low-alloyed {GLO}| market for | Cut-off, S", as it is representative for the large majority of the steel parts.

The manufacturing of the transformers is located in ABB facility of Brno, Czech Republic. In the factory, the different components and subassemblies are assembled into the transformer. Some of the components are produced by ABB's suppliers, some are produced directly in the ABB factory.

The energy mix used for the production is representative of Czech Republic. This dataset includes electricity inputs produced in this country and from imports and transformed to medium voltage, the transmission voltage, direct emissions to air and electricity losses during transmission.

Table 2: GHG emissions connected to electricity production for the manufacturing of ABB's products

Data source	Amount	Unit
Electricity, medium voltage {CZ}| market for | Cut-off, S	0,86	kg CO_2-eq/kWh

Distribution

The transport distances from ABB plant to the installation site is based on the average distance of all 2021 deliveries. It is considered only for Europe. It is calculated as approximately 546 km by road.

Installation

The installation phase only implies manual activities, and negligible energy is consumed. This phase also includes the disposal of the packaging of the TJC 4.

For the disposal of the packaging after installation and of the transformer at the end of its life, a transport distance of 100 km was assumed. The actual disposal site is unknown and is managed by the customer.

For LCA modeling of packaging disposal was used disposal according to Eurostat.

Use

Use and maintenance are modelled according to the PCR EPDItaly015 "Electronic and electrical products and systems - Switchboards" which defines specific rules for major product family the functional unit is used in.

For the use phase, the general European medium voltage electricity mix from Ecoinvent 3.8 is used.

Table 3: GHG emissions connected to electricity production for the use of ABB's products

Data source	Amount	Unit
Electricity, medium voltage {Europe without Switzerland}| market group for | Cut-off, S	0,406	kg CO_2-eq/kWh

During the use phase of the TJC 4, electricity induction transformer (transformers with magnetic core), dissipate some energy losses of two types: **losses in the magnetic core** (magnetic core) and **joule losses in the resistance of the primary and secondary coils**.

$$\Delta P = \Delta P_F + \Delta P_J \quad [\ W\ ]$$

where:

- ΔP - total losses of the transformer
- ΔP_F - losses in the magnetic core (C-core)
- ΔP_J - joule losses in the primary and secondary coils

$$E_{use}\ [kWh] = \Delta P * 8760 * RSL / 1000$$

where:

- ΔP - total losses of the transformer
- RSL is the service life of the product representing 20 years of service;
- 8760 is the number of hours in a year;
- 1000 is the conversion factor that allows the energy consumed in kWh over the product's service life to be expressed.

	TJC 4 11000/√3//110/√3/110/3
ΔP [W]	0,9037
E_{use} [kWh]	158,33

Since no maintenance happens during the use phase, the environmental impacts linked to this procedure are omitted from the analysis.

End of life

The transport distances from the place of use to the place of disposal are assumed to be 100 km.

The end-of-life stage is modelled according to PCR EPDItaly015 and IEC/TR 62635. In case of epoxy casted transformer, we are limited with very demanding process of disassembling which resulting into situation, that all the materials casted in the epoxy are typically landfilled. Only for components out of the epoxy body can the IEC/TR 62635 allocation be applied. This approach was applied for modeling of End of life waste scenario.

Environmental indicators

The following tables show the environmental impact indicators of the life cycle of TJC 4 11000/√3//110/√3/110/3, as requested by PCR EPDItaly007, PCR EPDItaly015 and EN 50693:2019.

The indicators are divided into the contribution of the processes to the different modules (upstream, core and downstream) and stages (manufacturing, distribution, installation, use and end-of-life).

TJC 4 11000/√3//110/√3/110/3

Impact category	Unit	Total	UPSTREAM	CORE	DOWNSTREAM			
			Manufacturing		Distribution	Installation	Use	End of life
GWP - total	kg CO_2 eq.	2,36E+02	1,08E+02	5,73E+01	2,37E+00	2,12E+00	6,42E+01	2,09E+00
GWP - fossil	kg CO_2 eq.	2,34E+02	1,07E+02	6,06E+01	2,37E+00	2,26E-01	6,21E+01	1,83E+00
GWP - biogenic	kg CO_2 eq.	2,17E+00	1,28E+00	-3,28E+00	2,15E-03	1,90E+00	2,02E+00	2,55E-01
GWP - luluc	kg CO_2 eq.	3,76E-01	1,74E-01	5,40E-02	9,37E-04	5,18E-05	1,46E-01	5,66E-04
ODP	kg CFC-11 eq.	1,76E-05	1,18E-05	2,00E-06	5,52E-07	4,09E-08	3,07E-06	1,65E-07
AP	mol H^+ eq.	3,19E+00	2,60E+00	2,36E-01	1,20E-02	1,37E-03	3,34E-01	4,46E-03
EP - freshwater	kg P eq.	3,45E-01	2,01E-01	8,17E-02	1,54E-04	1,83E-05	6,21E-02	1,16E-04
POCP	kg NMVOC eq.	1,02E+00	7,41E-01	1,20E-01	1,29E-02	1,94E-03	1,38E-01	4,69E-03
ADP – minerals and metals	kg Sb eq.	5,62E-02	5,59E-02	9,10E-05	8,30E-06	4,84E-07	1,46E-04	4,61E-06
ADP – fossil	MJ, net calorific value	3,72E+03	1,51E+03	8,38E+02	3,61E+01	2,79E+00	1,32E+03	1,26E+01
WDP	m^3 depriv.	8,86E+01	6,24E+01	1,15E+01	1,09E-01	-7,59E-03	1,44E+01	2,55E-01

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; 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	UPSTREAM	CORE	DOWNSTREAM			
			Manufacturing		Distribution	Installation	Use	End of life
PENRE	MJ, low cal. value	3,72E+03	1,51E+03	8,38E+02	3,61E+01	2,79E+00	1,32E+03	1,26E+01
PERE	MJ, low cal. value	5,36E+02	1,90E+02	1,17E+02	5,08E-01	3,49E-02	2,28E+02	3,61E-01
PENRM	MJ, low cal. value	1,35E+02	1,34E+02	1,01E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
PERM	MJ, low cal. value	3,65E+01	4,36E+00	3,21E+01	0,00E+00	0,00E+00	0,00E+00	0,00E+00
PENRT	MJ, low cal. value	3,58E+03	1,38E+03	8,37E+02	0,00E+00	0,00E+00	0,00E+00	0,00E+00
PERT	MJ, low cal. value	4,99E+02	1,85E+02	8,50E+01	0,00E+00	0,00E+00	0,00E+00	0,00E+00
FW	m^3	3,99E+00	1,64E+00	1,23E+00	4,02E-03	-2,04E-05	1,10E+00	6,85E-03
MS	kg	3,86E+00	3,80E+00	5,57E-02	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.

Waste production indicators	Unit	Total	UPSTREAM	CORE	DOWNSTREAM			
			Manufacturing		Distribution	Installation	Use	End of life
HWD	kg	6,08E-02	6,19E-02	6,10E-02	3,40E-04	9,42E-05	7,18E-06	4,69E-04
NHWD	kg	7,13E+01	7,16E+01	3,73E+01	5,65E+00	1,86E+00	6,39E-02	4,38E+00
RWD	kg	1,88E-02	1,87E-02	4,62E-03	4,08E-03	2,44E-04	1,81E-05	9,68E-03
MER	kg	1,54E+00	1,40E+00	0,00E+00	2,14E-01	0,00E+00	1,19E+00	0,00E+00
MFR	kg	1,55E+01	1,51E+01	6,41E-01	1,15E+01	0,00E+00	1,27E+00	0,00E+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	5,80E+00	4,79E+00	0,00E+00	6,10E-01	0,00E+00	4,17E+00	0,00E+00
EEE	MJ	2,90E+00	2,38E+00	0,00E+00	2,97E-01	0,00E+00	2,08E+00	0,00E+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.

Additional environmental information

Recyclability potential

According to the waste treatment scenario calculation in SimaPro, based on the recycling rate in the technical report IEC/TR 62635 Edition 1.0, the following recyclability potentials were calculated as by ratio between “MFR: material for recycling” and the total weight of the product.

All the materials which are part of an epoxy body of the transformer are not recyclable, there are landfilled together with the epoxy transformer body.

	Recyclability potential
TJC 4 - 11000/√3//110/√3/110/3	7,77%

Additional Norwegian requirements

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

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

Data source	Amount	Unit
Electricity, medium voltage {CZ}| market for | Cut-off, S	0,86	kg CO_2-eq/kWh

Dangerous substances

The product contains no substances given by the REACH Candidate list.

Indoor environment

The product meets the requirements for low emissions.

Carbon footprint

Carbon footprint has not been worked out for the product.

References

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