Environmental Product Declaration

In accordance with ISO 14025 and EN 50693:2019 for:

Distribution Transformer – 75kVA (111283)

from

Romagnole Produtos Elétricos S.A.

Declaration number:	EPD01
Production site:	Mandaguari, Paraná - Brazil
Programme:	EPD Italy®, www.epditaly.it
Programme operator:	EPDItaly
EPD registration number:	EPDITALY0295
Issue date:	2022-05-30
Valid until:	2027-05-30

General information

Programme information

Programme:	EPDItaly®
Address:	EPDItaly Via Gaetano De Castillia, 10 20124 – Milano Italy
Website:	www.epditaly.it
E-mail:	info@epditaly.it

Scope of application:	*Distribution Transformer – 75kVA (code 111283): three-phase distribution transformer in mineral cooled oil, with low level of loss and noise and 75kVA of nominal power. Cradle to grave with 35 years of reference service life (RSL).*
Functional unit:	*A single piece of transformer operating for 35 years*
CPC code:	*46121 - Electrical transformers*
Geography:	*World (raw materials), Brazil (production, use and end-of-life)*
LCA report	*[Romagnole-LCA] 75kVA transformer_final report_v2.0(2022)*
Product category rules (PCR):	*Core PCR EPDItaly007:20 Electronic and Electrical Products and Systems, revision 2 (2020-10-21)* *Sub PCR EPDItaly018:21 Electronic and Electrical Products and Systems – Power Transformers, version 3.5 (2021-12-13)*
Other references:	*Regulations of the EPDItaly Programme rev 5.0, 2020-01-07* EN 50693 is the framework reference for the Product Category Rules (PCR)
Core PCR review was conducted by:	*ICMQ S.p.A. – Certificazioni e controlli per le costruzioni* *Moderator: Eng. Vito D'Incognito, Take Care International*
Sub PCR review was conducted by	*ENEL S.p.A.; Life Cycle Engineering* *Moderator: Massimo De Pieri, Life Cycle Engineering*

Independent third-party verification of the declaration and data, according to ISO 14025:2006:
☐ internal ☒ external

Third party verification carried out by:
ICMQ spa - Via Gaetano De Castillia, 10 - 20124 – Milano/Italy

Procedure for follow-up of data during EPD validity involves third party verifier:
☒ Yes ☐ No

The EPD owner has the sole ownership, liability, and responsibility for the EPD.
EPDs relating to the same category of products but belonging to different programmes may not be comparable. EPDs of electronic and electrical products may not be comparable if they do not comply with EN 50693. For further information about comparability, see EN 50693 and ISO 14025.

Company information

Owner of the EPD:	Romagnole Produtos Elétricos S.A.
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Location of production site(s):	Mandaguari, State of Paraná, Brazil
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About the organization

Romagnole Produtos Elétricos S.A. is one of the largest manufacturers of electrical products in Brazil, with a wide range of distribution, industrial and power transformers, input cabins, electrotechnical hardware, structures for solar power plants, transmission towers, poles and other concrete artifacts used in electrical networks.

Acting in the market since 1962, Romagnole is a reference in its area of expertise, by combining quality of materials while caring for stakeholders' relationship. Romagnole products are present throughout the Brazilian territory, Americas, Africa, and the Middle East.

PROVIDING SOLUTIONS THAT TRANSFORM

Sustainability

Sustainability is one of the core values of Romagnole, present in the company governance through solid management projects, reduction in water and energy consumptions and environmental awareness. Romagnole holds the ISO 14001, ISO 9001 and ISO 45001 standards for integrated management system aligning environmental, quality and health responsibilities.

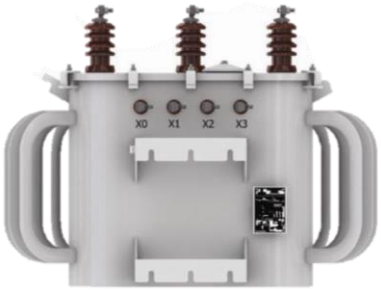
In 2020, the company received the Renewable Energy Certificate, based on a report on avoided greenhouse gas emissions (GHG) resulting from the use of energy produced by renewable sources. The report is produced by Sinerconsult Consultoria Treinamentos e Participação Ltda. And by COMERC Energia. It presents the results GHG emissions avoided in the consumption of electricity from non-polluting and renewable sources.

Owned certifications

Product information

Product name:	Distribution Transformer – 75kVA
Product description:	The 111283 Distribution Transformer is an electrical device that transfer energy from one circuit to another by magnetic coupling without requiring relative motion between its parts and comprises three coupled windings and a magnetic core to concentrate magnetic flux made of amorphous steel. It is a three-phase transformer in mineral cooled oil, with nominal power of 75kVA and final project mass (without packaging) of 527.58 kg. The packaging consists of wooden bars.
Production history	The 111283 Transformer has been produced since November 2021 for the specific request of Enel. To date 1,799.00 units were produced being 300 units delivered during 2021
Average dimensions:	1200 mm length x 1090 mm height x 780 mm width
Expedition weight:	625.03 kg
Product weight:	527.58 kg
Packaging weight:	97.45 kg
Type:	Distribution, oil-immersed
Number of phases:	3P
Voltage class:	low
Nominal primary voltage	17.5 kV
Nominal power:	75.0 kVA
Colled-oil type:	Mineral (paraffinic) oil
Products covered:	75VA three-phase oil immersed distribution transformer
Geographical scope:	Brazil

Distribution Transformer



LCA information

Functional unit / declared unit:

A single piece of transformer operating for 35 years

Time representativeness:

January 2021 to December 2021

Data representativeness:

Upstream module based on solid Bill of Materials on consolidated 111283 Transformer project and Romagnole's registration system for the 111283 supply chain. Core module data based on similar transformer manufacturing line over 2021. Transformer operation based on project requirements over electricity consumption. Overall data is considered as of good representativeness.

Database(s) and LCA software used:

SimaPro® software v.9.2.0.2 developed by PRé Consultants was used to create the product system model. The ecoinvent® database version 3.7.1 provided the life cycle background data for product system modelling.

System boundaries:

Cradle to grave with upstream, core and downstream modules;

Modules declared, geographical scope, share of specific data and data variation:

	Manufacturing			Distribution	Installation	Use and Maintenance	End-of-Life and Deinstallation
Module	**Upstream**		**Core**	**Downstream**			
Supply chain processes	extraction of raw materials and the production of semi-finished products and auxiliary items; electricity production; transport of raw materials to Romagnole plant		transformer assembling, waste and effluent management at plant; air emissions from paint solvents	transformer transport into the operation site, installation and packaging waste management, operating for 35 years (RSL) in Brazil, deinstallation and transformer EoL, including metal recycling, mineral oil incineration and final disposal of non-recyclable fractions at sanitary landfill. Transport of waste flows			
Modules declared	X	X	X	X	X	X	X
Geography	GLO	BR	BR	BR	BR	BR	BR
Specific data used	>95%						
Variation – sites	Not relevant						

Distribution:

The transformer is transported to Maracanau, Ceara State (north-eastern Brazil) by road transportation in diesel-powered lorries. The distance was estimated according to the most probable road from Mandaguari plant until Maracanau Municipality, 3,143.00 km.

Installation:

The installation phase implies in the transportation of 100km of the transformer and its packaging from energy company storage until the operation site. Then, the transformer is lifted and (generally) installed through manual/pneumatic tools. This phase also includes the disposal of the packaging of the Transformer, first returning until the energy company waste management central (100 km) and then transported until the waste management company that co-process it into energy (200km).

Use stage:

The total energy consumed by the 75kVA transformer during 35 RSL is 154,045.04 kWh (losses and operational consumptions). This value was calculated according to IEC 60076-1 technical standard, expressed in kWh via the following equation (PCR0018 v.3.5).

$$E_d[kWh] = [P_{load} \times K^2{}_{load} + P_{noload}] \times t_{years} \times RSL + P_{aux} \times f_{aux} \times t_{years} \times RSL$$

End-of-Life:

EoL stage assumes that the discontinued equipment is sent for material recovering. The disassembling process is manual or done with the aid of pneumatic tools at the secondary metal recovering market. Most valuable fractions (steel, aluminium and copper) are recycled within the default recycling recovering rate established in BSI EN 50693:2019. Mineral oil is incinerated without energy recovering and the remaining parts, based on mass balance, are sent to sanitary landfill. Based on direct consultation and project assumptions the transport distances from energy company storage into the disassembly facility is 100km, from disassembly facility to recycling plant and to the oil treatment company is 200 km, meanwhile the range into a landfill is 50 km.

Table 1. End-of-life baseline scenario definition per functional unit (downstream module).

Processes		Value	Unit
Collection process	From energy company storage to recovering market	527.58	kg
Recovery system specified by type	Reuse	0.00	kg
	Recycling	281.29	kg
	Incineration for energy recovery	0.00	kg
Disposal specified by type	Product or material for final deposition	105.46	kg
	Incineration	140.84	kg
Assumption for scenario development	Assuming that 100% of the transformer is sent for disassembling (based on direct consultation with energy company), assuming that 80% of steel is recycled, 70% of aluminium is recycled, 60% of cooper parts are recycled (G.5 section from BSI EN 50693:2019 - Default values for R2) and that the mineral oil is incinerated. Following mass balance principle and Brazilian environmental laws, the remaining parts of the product are sent for final disposal at sanitary landfills		

Allocation:

Allocation can be defined as the impact factors distribution between the reference product and the coproducts when they are simultaneous and dependent. At Romagnole value chain there is one type of situation where allocation may be required located at three points in end-of-life processes (i.e., the recycling processes) that occurs: at assembling line (core module) due to process waste generation, at transformer installation step (downstream module) due to wooden packaging waste generation that follows for energy recovering and at EoL (downstream module) due to metal recovering from obsolete transformers. Additionally, inputs and outputs at core module were disaggregated and apportioned to the 111283 transformer based on production-hour principle, which also may be considered as an economic allocation approach.

- **Data apportion at assembling line:** based on Romagnole's engineering sector total production-hour registration over 2021 at Mandaguari manufacturing lines, adjusted by the total production-hour needed to produce the 111283 Transformer.

- **Assembling line recyclable waste flows, transformer discarded packaging and EoL**: regarding to the recycling of steel, amorphous-steel, copper and aluminium generated during transformer manufacturing and recovered at EoL, as well as wood waste from packaging sent for energy recovering (co-processing) we considered the cut-off approach. According to the core EPDItaly core-PCR (PCR007), for recovery and recycling processes, which take place outside the boundaries of the product system, only impacts related to the transport of the waste to the treatment platform should be considered. Therefore, all the impacts of the waste transportation by road were fully attributed to the Romagnole product.

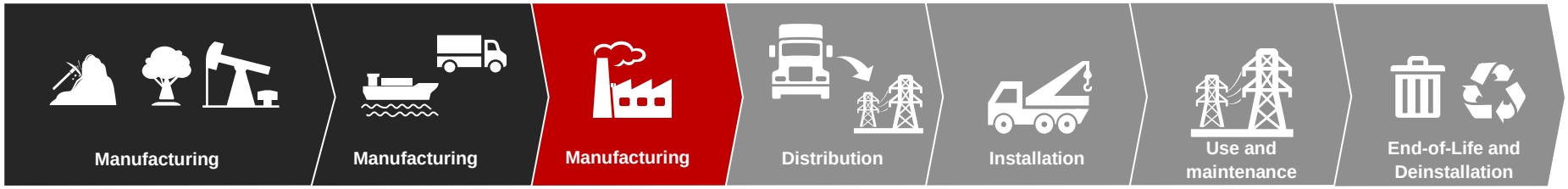
Cut-off criteria:

The cut-off criteria are applied to support an efficient calculation procedure. According to EN 50693 (2019) and PCR018 (2021), specifically the following flows and operations may be cut-off:

- Production, use and disposal of the packaging of components and semi-finished intermediates;
- Materials making up the transformer itself whose total mass does not exceed 1% of the total weight of the device;
- Material and energy flows related to dismantling phase, whenever it is reasonable to assume that dismantling is performed by adopting manual tools (e.g., screwdrivers, hammers, etc.);
- Devices external to the product itself required for installation;
- Maximum 5% of the overall environmental impact of the analysed product system;

In this LCA, all input and output flows have been considered at 100%, including raw materials as per the product composition provided by the manufacturer as well as the final product. Cut-off criteria was the environmental relevance for infrastructure impacts, although some irrelevant inputs may eventually not be considered, e.g., the cardboard used to clean the moulding machine. For inbound logistics, mass-based cut-off criteria was applied for minor components (screws, washers, rivets, etc). The coverage of inbound logistics was of 99.9% of mass composition for the transformer. At core module welding smokes were cut-off.
The only cut-off criterion was the environmental relevance of the production of capital equipment, construction activities, and infrastructure, maintenance and operation of capital equipment, personnel-related activities, energy and water use related to company management and sales activities, although some irrelevant inputs may eventually not be considered, e.g., the cardboard used to clean the moulding machine.

Description of the system boundaries:



Upstream module Core module Downstream module

Upstream module

The distribution transformer is majorly made of steel and amorphous-steel, aluminium/copper, paper/paperboard and oil (tank filled for cooling purposes). There are also minor parts of polymers, chemicals (painting, varnish…), rubber and wood for packaging. The upstream module considers all upstream processes to extract such materials and process them into the final components that are inserted into Romagnole manufacturing line, including auxiliary consumptions at the factory such as electricity and others. This. This stage of the life-cycle accounts also for the road and maritime transport of all materials and components from suppliers to Romagnole plant (inbound logistics).

Core module

The distribution transformer manufacturing is an assembling line. Metal sheets are cut, bended, calendared, moulded and welded into the final distribution transformer structure (tank, lid and bars). Those parts are cleaned and painted. In parallel, the core is made of amorphous-steel and assembled from several different pieces that are cut to be geometrically positioned into the magnetic core that is wrapped with wildings prepared with insulated conductor wires and covered with insulating paper. Core and transformer body meet at the final assembling, with connections, cables and other minor parts and are tested for security, functioning and tightness. After packaging, the transformer is stored and ready for shipment. The manufacturing line at Romagnole plant requires ancillary inputs, such as electricity and water to operate and generate wastes and other outputs. Electricity consumed at Romagnole plant is 100% from renewable source (hydro) meanwhile a major part of wastes is recycled.

Downstream module

This module encompasses all steps after product expedition from Romagnole manufacturing plant until its End-of-life (EoL). The Transformer is distributed to Ceara state by large diesel-truck through road transportation. The installation requires a lifting device that works for transport (from energy company storage into the operation point) and to elevate and install the transformer. During 35 years of Reference Service Life (RSL) the distribution transformer will convert energy voltage for urban consumption and consumes medium voltage electricity from Brazilian national grid to operate and through losses in the transformation. During this period, an inspection should be made every 12 months of transformer operation to check for leakages, corrosion, and others. Every 5 years, some tests should be made as for example, oil sample for quality analysis, insulating check, etc. If there are no anomalies, no maintenance is necessary. According to Romagnole product specialists, in Brazil many transformers operate until its failure and maintenance is not a controlled practice. When discontinued, a distribution transformer is generally disassembled for metal recovering due to its high aggregated value. In Brazil this may be done at secondary scrap market or by specialized recycling companies. Steel, aluminium, copper and other metallic fractions are recovered and reinserted into the market. Other fractions are more likely to be discarded to sanitary landfill following Brazilian environmental laws. Mineral oil may be recycled or incinerated in waste management specialized companies depending on its quality when discarded.

Content information

Product components	Material classes*	Weight, kg	Weight-% (versus the product)
Other ferrous alloys, non stainless steels	M-119	302.71	48.53%
Aluminium and its alloys	M-120	54.48	8.72%
Copper and its alloys	M-121	1.64	0.26%
Paper/paperboard	M-341	18.42	2.95%
Wood	M-340	1.27	0.20%
Ceramics	M-160	4.37	0.70%
Oils and greases	M-410	140.84	22.53%
Chemicals (paints, varnish, dilutant, glues)	-	3.03	0.48%
Polyamide	M-208	0.11	0.02%
SBR	M326	0.72	0.12%
TOTAL	**-**	**527.58**[1]	**84.41%**
Packaging materials	**Material classes****	**Weight, kg**	**Weight-% (versus the product)**
Wood	M-340	97.45	15.59%
TOTAL	**-**	**97.45**	**15.59%**

**According to IEC 62474 - Material Declaration for Products of and for the Electrotechnical Industry;*

Substances of very high concern (SVHC)

These products contain no substances of very high concern (SVHC) on the REACH Candidate List published by the European Chemicals Agency in a concentration that exceed 0.01% (w/w).

[1] *small variations from the transformer project weight (530.00kg) are common within a expected range*

Environmental Information

Potential environmental impact – mandatory indicators according to core-PCR

Results per a single piece of transformer operating for 35 years								
		Manufacturing stage		Distribution stage	Installation stage	Use and Maintenance stage	End-of-Life and deinstallation stage	Total
Indicator	unit	upstream	core	downstream				
GWP-fossil	kg CO_2 eq	2.56E+03	0.52	145.60	12.95	2.67E+04	435.85	2.99E+04
GWP-biogenic	kg CO_2 eq	-215.45*	4.3E-04	0.10	9.30E-03	1.48E+04	43.50	1.47E+04
GWP-luluc	kg CO_2 eq	22.74	1.5E-06	1.92E-03	1.73E-04	2.35E+03	2.07E-03	2.38E+03
GWP-total	kg CO_2 eq	2.37E+03	0.52	145.71	12.96	4.39E+04	479.35	4.69E+04
ODP	kg CFC11 eq	1.54E-04	2.2E-08	3.28E-05	2.95E-06	2.56E-03	8.52E-03	1.13E-02
AP	mol H+ eq	19.97	7.6E-04	1.00	8.77E-02	210.54	0.28	231.88
EP-freshwater	kg P eq	0.13	3.1E-07	3.37E-04	3.04E-05	0.46	1.82E-03	0.59
POCP	kg NMVOC eq	11.19	1.0E-03	1.17	0.10	77.71	0.34	90.53
ADP-minerals & metals**	kg Sb eq	3.26E-02	5.1E-09	8.49E-06	7.66E-07	7.82E-04	2.29E-06	3.33E-02
ADP-fossil**	MJ	3.53E+04	1.50	2.04E+03	183.98	3.87E+05	532.01	4.25E+05
WDP**	m^3 depriv.	391.78	1.84	0.67	6.04E-02	1.64E+03	1.11	2.04E+03
Acronyms	GWP-fossil = Global Warming Potential fossil fuels; 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, Accumulated Exceedance; EP-freshwater = Eutrophication potential, fraction of nutrients reaching freshwater end compartment; POCP = Formation potential of tropospheric ozone; ADP-minerals & metals = Abiotic depletion potential for non-fossil resources; ADP-fossil = Abiotic depletion for fossil resources potential; WDP = Water (user) deprivation potential, deprivation-weighted water consumption.							

** Negative GWP-biogenic value associated to the upstream core at manufacturing stage occurs due to the embodied biogenic carbon at paper/paperboard and wooden parts of the product (including packaging). Those values are expected to return to the atmosphere during the End-of-Life and deinstallation stage depending on the destination of each material. For transformer parts (i.e., paper/paperboard and wood chocks), within the degradation rate at sanitary landfill, a share of carbon is returned as biogenic carbon dioxide and biogenic methane. For the packaging, since it is sent for energy recovering and the allocation approach is cut-off, the product system does not account for the impacts or credits. Those emissions therefore will occur at the subsequent system that uses the energy. Thus, care should be taken into account when analysing this impact category.*

*** Disclaimer: The results of this environmental impact indicator shall be used with care as the uncertainties of these results are high or as there is limited experience with the indicator.*

Use of resources

Results per a single piece of transformer operating for 35 years									
			Manufacturing stage		Distribution stage	Installation stage	Use and Maintenance stage	End-of-Life and deinstallation stage	Total
Indicator		unit	upstream	core	downstream				
Primary energy resources - Renewable	Use as energy carrier (PERE)	MJ, net calorific value	5.47E+03	1.01E-02	2.62	0.24	5.04E+05	2.51	5.10E+05
	Use as raw materials (PERM)	MJ, net calorific value	2.04E+03	0.00	0.00	0.00	0.00	0.00	2.04E+03
	Total (PERT)	MJ, net calorific value	7.51E+03	1.01E-02	2.62	0.24	5.04E+05	2.51	5.12E+05
Primary energy resources - Non-renewable	Use as energy carrier (PENRE)	MJ, net calorific value	2.86E+04	1.50	2.04E+03	1.84E+02	3.88E+05	532.01	4.19E+05
	Use as raw materials (PENRM)	MJ, net calorific value	6.68E+03	0.00	0.00	0.00	0.00	0.00	6.68E+03
	Total (PERNT)	MJ, net calorific value	3.53E+04	1.50	2.04E+03	1.84E+02	3.88E+05	532.01	4.26E+05
Secondary material (MS)		kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Renewable secondary fuels (RSF)		MJ, net calorific value	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Non-renewable secondary fuels (NRSF)		MJ, net calorific value	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Net use of fresh water (FW)		m3	14.49	0.05	0.05	0.00	119.47	0.13	134.18

Waste production and output flows

Waste production

Results per a single piece of transformer operating for 35 years								
		Manufacturing stage		Distribution stage	Installation stage	Use and Maintenance stage	End-of-Life and deinstallation stage	Total
Indicator	unit	upstream	core	downstream				
Hazardous waste disposed (HWD)	kg	0.00	3.80	0.00	0.00	0.00	0.00	3.80
Non-hazardous waste disposed (NHWD)	kg	0.00	0.00	0.00	0.00	0.00	246.30	246.30
Radioactive waste disposed (RWD)	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Output flows

Results per a single piece of transformer operating for 35 years								
		Manufacturing stage		Distribution stage	Installation stage	Use and Maintenance stage	End-of-Life and deinstallation stage	Total
Indicator	unit	upstream	core	downstream				
Materials for energy recovery (MER)	kg	0.00	0.00	0.00	97.45	0.00	0.00	97.45
Material for recycling (MFR)	kg	0.00	27.65	0.00	0.00	0.00	281.29	308.94
Components for reuse (CRU)	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Exported thermal energy (ETE)	MJ	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Exported electricity energy (EEE)	MJ	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Additional information

Other certifications

Renewable electricity acquired according to Certificate de Energia Renovavel for the total amount consumed in 2021 (COMERC/SINERCONSULT, 2021)

References

BSI (2019) EN 50693:2019 – Product category rules for LCA of electronic and electrical products and systems. Final version, August 2019. British Standard.
BSI (2019) EN 15804+A2:2019 – Sustainability of construction works – Environmental product declarations – Core rules for the product category of construction products. British Standard.
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ISO (2006a) 14040: Environmental Management - Life Cycle Assessment - Principles and Framework.
ISO (2006b) 14044: Environmental Management - Life Cycle Assessment - Requirements and guidelines.

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