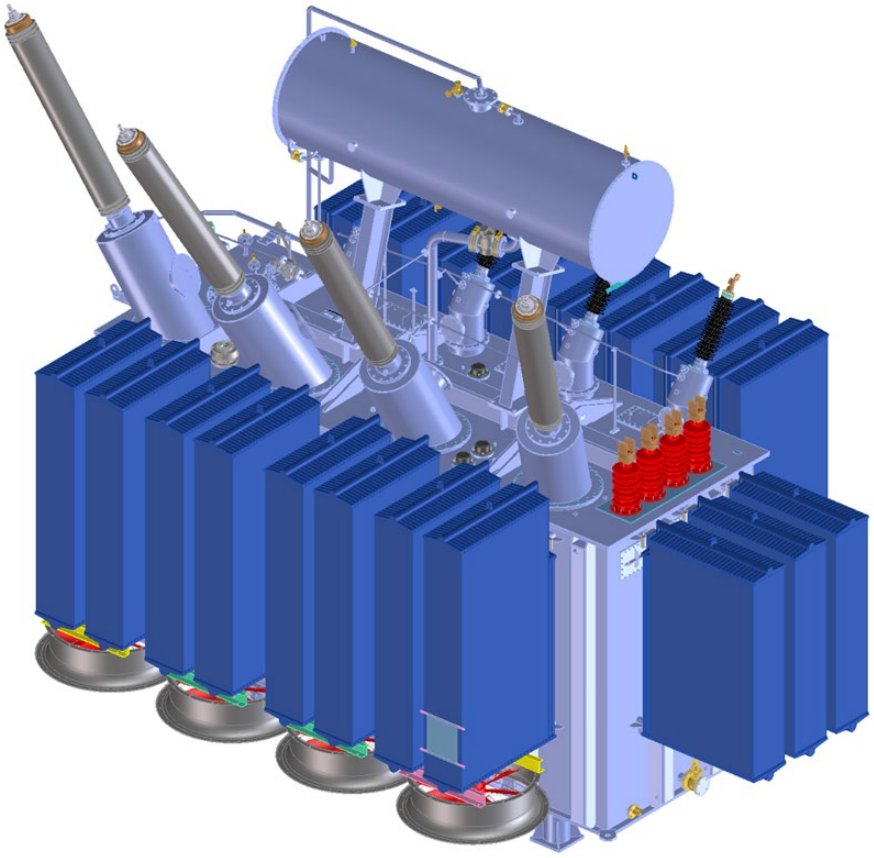
ENVIRONMENTAL PRODUCT DECLARATION

In compliance with ISO 14025 and EN 50693



Power transformer GST002/TR03201

Site Plant: Via Seriola, 74, 25035 Ospitaletto (BS), Italy

Program operator	EPDItaly
Publisher	EPDItaly
Declaration number	TAMINI01
Registration number	EPDITALY0389
Issue date	29/12/2022
Valid to	29/12/2027

GENERAL INFORMATION

EPD owner	**Tamini Trasformatori S.r.l.** Headquarters: Viale Cadorna, 56/A - 20025 Legnano (Milano) – Italy
Production site	**Tamini Trasformatori S.r.l.** Via Seriola, 74, 25035 Ospitaletto (BS), Italy
Reference product	Power transformer GST002/TR03201 (94 MVA)
Program operator	EPDItaly https://www.epditaly.it/; info@epditaly.it
Third-party verification	Independent verification of the declaration and data, in compliance with ISO 14025:2010. ☐ Internal ☒ External Verification conducted by: IMQ SpA, Via Marco Fabio Quintiliano, 43, 20138 – Milano (www.imq.it). (Certification Body accredited by Accredia)
CPC Code	46121 - Electrical transformers
Reference PCR	Core-PCR EPDItaly007 "Electronic and electrical products and systems", rev. 2, 21/10/2020. Sub-PCR EPDItaly018 "Power transformers", rev. 3.5, 13/12/2021 [PCR Committee: ENEL S.p.A.; Life Cycle Engineering; Moderator: Massimo De Pieri, Life Cycle Engineering]
Other reference documents	Regulation of the EPDItaly Programme – rev. 5.2 EN 50693:2019 "Product category rules for life cycle assessments of electronic and electrical products and systems".
Company contact	Roberto Saccò Roberto.sacco@tamini.it
Study developed by	Valentina Castellani, Sustainability consultant
Declaration of responsibility	The owner of the declaration will be responsible for the information and supporting evidence. EPDItaly disclaims any liability regarding the manufacturer's information data.
Comparability	EPDs relating to the same category of products but belonging to different programmes may not be comparable.

COMPANY INFORMATION

Tamini is the leading Italian company in the world for the design and production of industrial, power and special transformers. Founded in 1916 in Milan, it supplies its products to the most important industrial sectors (i.e. steel, aluminum, mining, oil & gas, chemical and transportation) and the most highly qualified operators in the electrical energy sector related to production, distribution and transmission and one of the most advanced and qualified actors in the market of industrial and special transformers. Since 2014, Tamini has been part of the Terna Group. Tamini manages five production plants in Italy and operates through their own branches in USA and India. About 80% of company turnover comes from exports, especially to emerging countries. More than 9,000 Tamini transformers have been manufactured and installed for customers in more than 90 countries around the world. www.tamini.it

LIFE CYCLE ASSESSMENT INFORMATION

The company undertook the LCA study having as main goal to obtain EPDItaly certification of the environmental impact generated by the product during its life cycle, to be communicated to its clients. Other potential uses of the study include the identification of hotspots in the product life cycle, in support to the definition of improvement measures, and the monitoring of results over time.

The scope of the EPD is “from cradle to grave”. It includes the following modules, according to EN 50639:2019:

Manufacturing		Distribution	Installation	Use & Maintenance	End-of-Life
Upstream module	Core module	Downstream module			
Extraction of raw materials, and production of transformer components Transportation of raw materials and components to the manufacturing company	Manufacture of windings Assembly of transformer Transformer testing Product packaging	Transport of product to the site of installation	Installation of product and disposal of packaging materials	Energy dissipated during the service life Ordinary and extraordinary maintenance	De-installation of product and EoL of product materials

Geographical scope: the geographical scope of the study is the World for the production and supply of components, and Italy for the production stage and the downstream phases.

Temporal scope: the temporal scope of the study is 2019-2021, and the following 35 years assumed as service life of the product (starting from the year of installation, i.e. 2022). The temporal period associated to the inventory data collected (2019-2021) includes the year of production of the transformer (2022) and the past three years (2019-2021), which are considered in order to calculate average utilities’ consumption.

Database and LCA software used: the LCI of the system has been modelled in SimaPro software, version 9.4, using ecoinvent 3.8 LCI library.

Cut-off and exclusions: the system boundaries do not include the production, transportation and installation of capital goods (buildings, infrastructure, machinery, internal transport packaging) and general operations (staff travel, marketing and communication actions) that cannot be directly allocated to products, in compliance with PCR EPDItaly 007. Cut-off is applied to components that contribute to less than 1% of the mass of the transformer.

Allocation: Commodities use (electricity, natural gas and water) related to the activities performed in Tamini production site (in Ospitaletto) have been estimated by allocation of the total consumption of the production site in one year to the production of the transformer under study. Allocation has been performed by multiplying the hourly consumption (calculated as average of the hourly consumption during the three years considered) by the number of working hours dedicated to the production of the transformer under study.

The function of the system is to transform electricity from high voltage (HV) to medium voltage (MV), with operating conditions of 94 MVA at 70% load and 220/10.4 kV. The **functional unit** is: **a single piece of transformer GST002/TR03201 operating for 35 years**

System boundary: see description of production process and inventory assumptions and scenarios.

PRODUCT SYSTEM ANALYZED

The product analyzed is the life cycle of a three-phases oil-immersed transformer (GST002/TR03201) with a nominal power of 75 MVA in ONAN (Oil Natural Air Natural) and 94 MVA in ONAF (Oil Natural Air Forced) conditions. The nominal power considered for the study is 94 MVA, with 70% average load. The product has been designed according to the specific needs of the client and it will be installed in San Valentino Torio (SA), Italy.

Technical specifications of the transformer analyzed	
Power	75 MVA ONAN/94 MVA ONAF
Voltage	220±12x1.25%/ 65 ± 4 x 2.5% / 20.8-10.4 KV
Type of cooling	ONAN/ONAF
Service life	35 years

The following tables illustrate the components of the transformer and the material content. Total weight of the product excluding packaging is 153 140 kg. The product is compliant to the requirements of the European directive "2011/65/EU ROHS 2 - Restriction of dangerous substances in electrical and electronical equipment".

Component	Weight	
	kg	%
Core	39 287	25.7%
Frame	3 762	2.5%
Insulation of windings and core	4 230	2.8%
Tank	21 690	14.2%
Magnetic shields	2 055	1.3%
On-load tap changer	550	0.4%
De-energized tap changer	80	0.1%
Bushing HT	1 140	0.7%
Bushing tertiary	240	0.2%
Bushing MV	176	0.1%
Radiators	13 150	8.6%
Fans	1 080	0.7%
Mineral oil	42 000	27.4%
Windings	21 602	14.1%
Connection supports	570	0.4%
Connection braidings	700	0.5%
Gaskets	*28*	0.0%
Electric accessories	500	0.3%
Busbars	300	0.2%
	153 140	**100%**

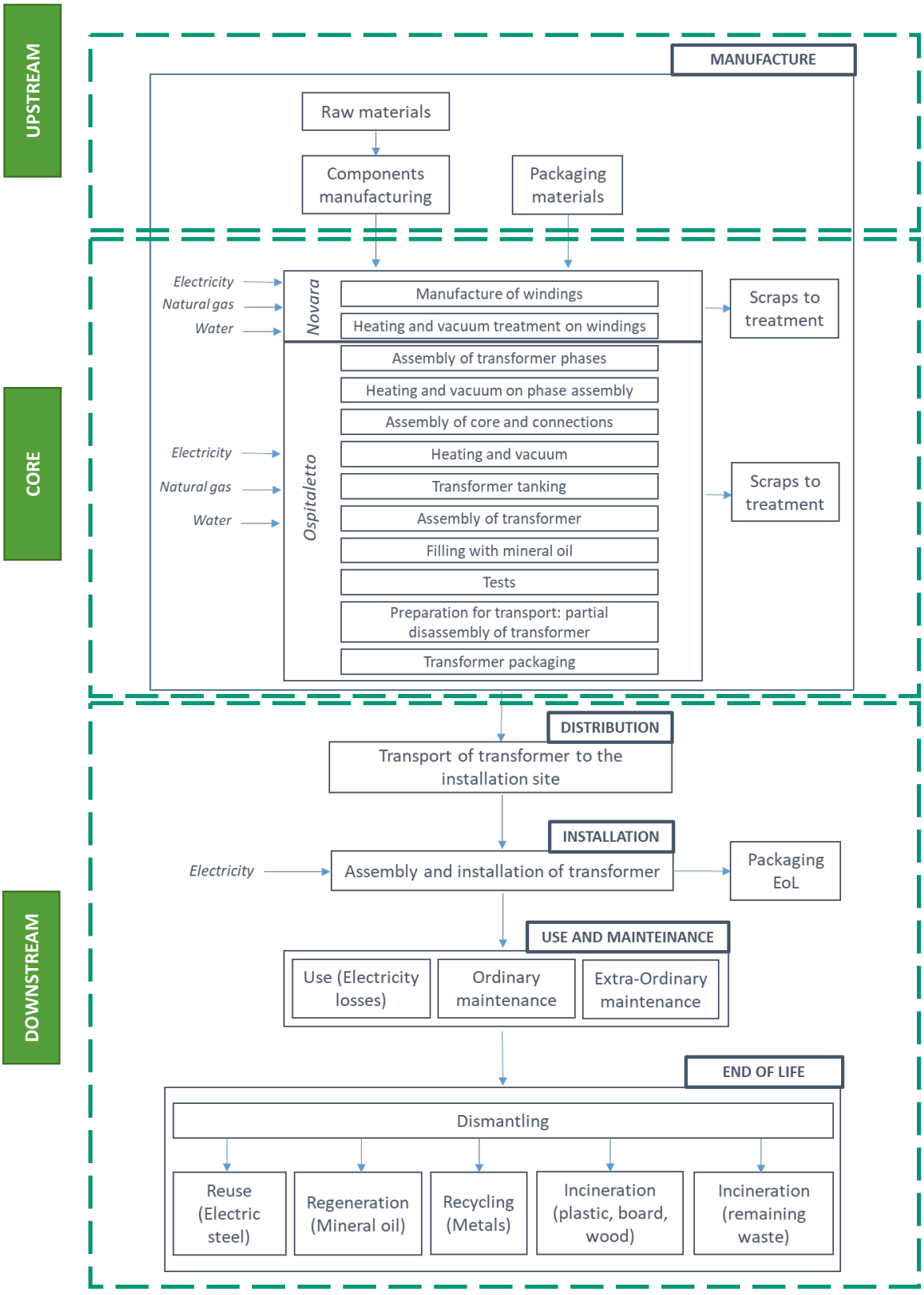
Material	Weight	
	kg	%
Electric steel	41 342	27.0%
Steel	39 720	25.9%
Copper	22 737	14.8%
Aluminium	114	0.1%
Wood	1 234	0.8%
Paper and board	4 353	2.8%
Epoxy resin	647	0.4%
Plastic	493	0.3%
Mineral oil	42 000	27.4%
Miscellaneous	500	0.3%
	153 140	**100%**

PRODUCTION PROCESS AND INVENTORY ANALYSIS

The study is cradle-to-grave, i.e. it includes all the life cycle phases of the product under investigation, from the extraction of raw materials to the dismantling and End of Life (EoL) of the product. The life cycle phases of the system under study are illustrated in Figure 1.

The transformer is assembled in the Tamini plant located in Ospitaletto (BS), in Italy. Windings are manufactured in another Tamini plant, located in Novara, Italy, and then transported to the Ospitaletto production site, where the transformer is assembled. Transformers production is partially manual; each product is designed on demand, to meet the specific needs of each client.

Figure 1 – Life cycle of transformer GST002/TR03201 (75/94 MVA)



Main characteristics of the inventory analysis	
Life cycle stage	**Description and assumptions**
Upstream	Manufacture of components is modelled based on project documents (materials and weight, including scraps) and considering the transport distance from the supplier to Tamini production site (calculated using Google maps and seadistances.org).
Core	Production of the transformer implies the use of electricity, natural gas and water. These inputs were calculated considering the average of the hourly consumption for each of the production sites involved (Novara and Ospitaletto) and the hours worked for the transformer under study. Electricity use in Tamini production sites is modelled using a dataset representing medium voltage residual electricity mix in Italy, which was created following the information on the share of energy sources used, as reported in the document "European Residual Mixes 2021", by the Association of Issuing Bodies.
Distribution	After being partially disassembled and packaged, the transformer is transported to the site of installation, where it is re-assembled. The site of installation is known (S.Valentino Torio, SA), so the real transport distance has been considered in the study.
Installation	Installation of the transformer entails the use of electricity for re-assembly of the parts transported separately, for oil filtration and vacuum creation before the filling of transformer with mineral oil. The electricity needed for these operations has been included in the inventory. Packaging of the transformer is sent to treatment in the installation phase. It is assumed that plastic is sent to incineration, whereas wood is partially (30%) recycled and partially (70%) incinerated.
Use and maintenance	Quantification of losses during the use phase was performed in accordance with the PCR018, with the following equation: $Ed[kWh]=(Pload \cdot kload2+Pnoload) \cdot tyear \cdot RSL+Paux \cdot faux \cdot tyear \cdot RSL$ The parameters considered are: Nominal power: 94 MVA; Kload: 70% Tyear: 8 760 hours RSL: 35 years Paux: 0, because ventilation is not working at the defined conditions. Losses have been associated to a dataset that represent high voltage residual Italian mix, modelled according to the document "European Residual Mixes 2021", by the Association of Issuing Bodies. Ordinary maintenance consists of a visual inspection of the transformer, to check that all the parts of the system are in good conditions. No input and output are associated to this activity in the inventory model. Extra-ordinary maintenance has been modelling adopting a conservative approach and assuming 1 cycle of regeneration of mineral oil every 7 years of service.
End of Life (EoL)	Dismantling operations include extraction and regeneration of mineral oil and disassembly of transformer. A survey to a company that provides dismantling services for this kind of equipment provided an estimation about the machines needed for dismantling and the number of hours needed to dismantle a transformer as the one studied. The EoL scenario for the materials in the transformer assumes: reuse of electric steel, regeneration of mineral oil, recycling of metals, and incineration of plastics, wood, board and all the materials that have been contaminated by oil.

ENVIRONMENTAL PERFORMANCE

The following tables report the results of environmental indicators, resource use indicators, and waste production indicators, expressed with reference to the functional unit of the study (D.U.), i.e. one piece of transformer GST002/TR03201 with a service life of 35 years.

Results of indicators describing environmental impacts per D.U.

			Upstream	Core		Downstream							
Impact category	**Unit**	**Total**	**Manufacturing**			**Distribution**		**Installation**		**Use and maintenance**		**EoL**	
Climate change	kg CO2 eq	**3.36E+07**	5.50E+05	4.82E+04	*2%*	7.80E+03	*0%*	1.59E+03	*0%*	3.30E+07	*98%*	1.77E+04	*0%*
Climate change - Fossil	kg CO2 eq	**3.36E+07**	5.40E+05	4.81E+04	*2%*	7.78E+03	*0%*	1.54E+03	*0%*	3.30E+07	*98%*	1.07E+04	*0%*
Climate change - Biogenic	kg CO2 eq	**1.06E+04**	9.17E+03	1.39E+02	*88%*	7.99E+00	*0%*	5.05E+01	*0%*	-5.76E+03	*-54%*	6.99E+03	*66%*
Climate change - Land use and LU change	kg CO2 eq	**3.65E+03**	7.73E+02	5.04E+00	*21%*	2.82E+00	*0%*	1.56E-01	*0%*	2.86E+03	*79%*	1.60E+00	*0%*
Ozone depletion	kg CFC11 eq	**5.03E+00**	7.14E-02	5.60E-03	*2%*	1.87E-03	*0%*	2.31E-04	*0%*	4.95E+00	*98%*	1.31E-03	*0%*
Acidification	mol H+ eq	**1.52E+05**	2.09E+04	9.12E+01	*14%*	3.96E+01	*0%*	6.18E+00	*0%*	1.31E+05	*86%*	2.54E+01	*0%*
Eutrophication, freshwater	kg P eq	**6.49E+03**	1.15E+03	3.21E+00	*18%*	4.89E-01	*0%*	2.54E-01	*0%*	5.33E+03	*82%*	1.33E+00	*0%*
Photochemical ozone formation	kg NMVOCeq	**7.23E+04**	4.46E+03	6.22E+01	*6%*	4.44E+01	*0%*	3.19E+00	*0%*	6.77E+04	*94%*	2.20E+01	*0%*
Resource use, minerals and metals	kg Sb eq	**5.45E+02**	5.33E+02	6.15E-02	*98%*	1.80E-02	*0%*	1.59E-03	*0%*	1.14E+01	*2%*	1.34E-02	*0%*
Resource use, fossils	MJ	**5.14E+08**	8.66E+06	7.23E+05	*2%*	1.22E+05	*0%*	2.35E+04	*0%*	5.04E+08	*98%*	8.43E+04	*0%*
Water use	m3 depriv.	**6.76E+06**	4.24E+05	5.24E+03	*6%*	4.21E+02	*0%*	3.04E+02	*0%*	6.33E+06	*94%*	8.95E+02	*0%*

Results of parameters describing resource use, referred to the D.U.

Indicator	Unit	Total	Manufacturing		Distribution	Installation	Use and Maintenance	EoL
			Upstream	Core	Downstream			
Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw material (PENRE)	MJ	**5.14E+08**	8.64E+06	7.23E+05	1.22E+05	2.35E+04	5.04E+08	8.43E+04
Use of renewable primary energy excluding renewable primary energy resources used as raw material (PERE)	MJ	**2.66E+07**	1.12E+06	1.38E+04	1.56E+03	1.84E+03	2.55E+07	2.87E+03
Use of non-renewable primary energy resources used as raw material (PENRM)	MJ	**2.79E+04**	2.79E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Use of renewable primary energy resources used as raw material (PERM)	MJ	**3.18E+04**	3.18E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total use of non-renewable primary energy resources (primary energy and primary energy resources used as raw materials) (PENRT)	MJ	**5.14E+08**	8.66E+06	7.23E+05	1.22E+05	2.35E+04	5.04E+08	8.43E+04
Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials) (PERT)	MJ	**2.66E+07**	1.16E+06	1.38E+04	1.56E+03	1.84E+03	2.55E+07	2.87E+03
Net use of fresh water (FW)	m^3	**1.72E+05**	1.11E+04	1.39E+02	1.63E+01	7.82E+00	1.61E+05	2.61E+01
Use of secondary materials (MS)	kg	**0.00E+00**	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Use of renewable secondary fuels (RSF)	MJ	**0.00E+00**	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Use of non-renewable secondary fuels (NRSF)	MJ	**0.00E+00**	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Results of waste production descriptive parameters, referred to the D.U.

Indicator	Unit	Total	Manufacturing		Distribution	Installation	Use and Maintenance	EoL
			Upstream	Core	Downstream			
Hazardous waste disposed (HWD)	kg	**5.63E+02**	3.65E+01	7.33E-01	2.96E-01	3.21E-02	5.26E+02	2.10E-01
Non-hazardous waste disposed (NHWD)	kg	**7.49E+05**	2.10E+05	5.36E+02	1.15E+04	2.74E+01	5.27E+05	1.80E+03
Radioactive waste disposed (RWD)	kg	**1.22E+03**	3.80E+01	6.50E-01	8.28E-01	5.51E-02	1.18E+03	4.54E-01
Materials for energy recovery (MER)	kg	**7.33E+03**	0.00E+00	7.07E+01	0.00E+00	3.52E+01	0.00E+00	7.23E+03
Material for recycling (MFR)	kg	**1.05E+05**	0.00E+00	4.13E+01	0.00E+00	1.49E+01	0.00E+00	1.05E+05
Components for reuse (CRU)	kg	**4.18E+04**	0.00E+00	4.31E+02	0.00E+00	0.00E+00	0.00E+00	4.13E+04
Exported thermal energy (ETE)	MJ	**0.00E+00**	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported electricity energy (EEE)	MJ	**0.00E+00**	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

REFERENCES

1. Life Cycle Assessment of transformer GST002/TR03201 -country code 110096 (94 MVA) produced by Tamini Trasformatori s.r.l. in Ospitaletto (BS). Study report v.01, released 16/11/2022.
2. ISO 14025:2006. Environmental labels and declarations –Type III environmental declarations –Principles and procedures.
3. EN 50693:2019 Product category rules for life cycle assessments of electronic and electrical products and systems
4. EPDItaly Regulation, Rev. 5.2 published 04/04/2022
5. Core-PCR EPDItaly007 “Electronic and electrical products and systems”, rev. 2, 21/10/2020.
6. Sub-PCR EPDItaly018 “Power transformers”, rev. 3.5, 13/12/2021