Environmental Product Declaration

In accordance with ISO 14025 and EN50693 for:

400 kVA KNAN Distribution Transformer- FIT0400170 (110082)

from

Matelec

Production site:	Matelec s.a.l. – Gharfine, Lebanon
Programme:	EPD Italy®, www.epditaly.it
Programme operator:	EPD Italy
EPD registration number:	EPDITALY0357
Declaration number:	EPD-IT-22-002
Issue date:	2022-10-20
Valid until:	2024-04-20

Contact information

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Programme information

Programme:	EPD Italy® Via Gaetano De Castillia, 10 20124 – Milano/Italy www.epditaly.it
Reference Document:	Regulations of the EPDItaly Programme rev 5.2, 2022-02-16 Operating instructions IO-EPD-01 rev. 20/07/22

Accountabilities for PCR, LCA and independent, third-party verification
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, revision v.3.5 (2021-12-13) SIST EN 50693. Product category rules for life cycle assessments of electronic and electrical products and systems (2020)
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
Life Cycle Assessment (LCA)
LCA accountability: Life Cycle Assessment Center, University of Balamand, Lebanon ***All explanatory information regarding the LCA can be found in: *LCA report - Life cycle assessment of 400 kVA KNAN distribution transformer FIT0400170 (110082)*
Third-party verification
Independent third-party verification of the declaration and data, according to ISO 14025:2006: ☒ internal ☒ external Third-party verification carried out by: ICMQ – Via Gaetano De Castillia, 10 – 20124 – Milano/Italy
Procedure for follow-up of data during EPD validity involves third-party verifier: ☒ Yes ☐ No

Accountability/responsibility:

Matelec releases EPD Italy from any non-compliance with environmental legislation self-declared by the manufacturer. The holder of the declaration will be responsible for the information and supporting evidence; EPD Italy declines all responsibility for the manufacturer's information, data, and results of the evaluation of the life cycle of the product.

Scope of declaration:

This product EPD is based on the LCA study of Matelec's 400 kVA KNAN distribution transformer-FIT0400170 (110082) for which 2021-2022 is the reference year. The objective of the study was to conduct a cradle-to-grave LCA to publish third party verified data about the environmental performance of the product. EPDs relating to the same category of products but belonging to different programmes may not be comparable.
The database used is regarded as representative on the basis of a comparative study, which examined the data for a reference product of the EPD Owner.

Company information

Matelec s.a.l. was founded in 1974 to produce distribution transformers and has grown into a diversified electricity business player since then. Matelec enlarged its products offering to switch gears, package substations, and control and protection systems within its first decade. In parallel, Matelec expanded into engineering and contracting activities with the realization of complex HV, MV, and LV projects.

Throughout the years, Matelec expanded its manufacturing capabilities in the Mideast, Africa, and Europe with the acquisition or participation in many factories, namely Electrical Equipment Industries Co. (ELICO) in Jordan, International Transformers Matelec (ITM) in Egypt, Transfo Matelec in France, and lately Entreprise algérienne des équipements de transformation et de distribution électrique SPA (EDIEL SPA) in Algeria. Matelec is further exploring other geographic deployments and business ventures across these regions to optimize its global business portfolio.

Matelec employs more than 1000 people in the Mideast, Africa, and Europe.

Matelec guarantees high-quality products and services and provides its customers technical quality assistance in all project phases. Matelec is part of a multinational industrial group leader in the field of design, development, production, installation, sales and servicing of a range of electrical products and turnkey projects. In order to maintain its leadership, Matelec is committed to implementing a quality management system that meets the requirements of the international standard ISO 9001:2015. The system consists of a set of interacting processes continuously monitored, measured and analyzed. Actions are taken when results do not meet objectives providing a drive for continual improvement. It is the policy of Matelec to deliver error–free products on time. Quality, continual improvement and customer satisfaction are the personal responsibility of each employee. Moreover, Matelec's environmental, safety & health (ES&H) policy ensures that work is performed in a manner that protects the health and safety of employees and the public, preserves the quality of the environment, and prevents property damage. Having the ISO 14001:2015 and ISO 45001:2018, Matelec ensures that priority is given to ES&H issues in the planning and execution of all work activities.

Product information

Product name:

400 kVA KNAN distribution transformer-FIT0400170 (110082)

Product identification:

110082 – TR 400kVA KNAN 20/0,42kV - GST001/1056N

Product description:

Transformers are devices used to transmit electricity over large distances. They transform network voltage to different levels based on requirements and needs. The 110082 distribution transformer is a liquid immersed distribution transformer that transmits electricity over large distances. It converts medium network voltages to low network voltages. The FIT0400170 distribution transformer has a power of 400 kVA.

400 kVA KNAN distribution transformer-FIT0400170 (110082)

Weight	1800 kg
Power	400 kVA
Voltage	20/0.42kV
Frequency	50 Hz
Vector group	Dyn11
Type of cooling	KNAN

UN CPC code: 46121 – Electrical transformers

Geographical scope: Italy

LCA information

Functional unit:

One distribution transformer operational for 35 years

Reference service life:

35 years

Time representativeness:

September 2021 to August 2022

Database(s) and LCA software:

Foreground data were obtained from Matelec Database. SimaPro (Analyst) software (version 9.3.0.3) developed by Pré Consultants was used to model the product system. Ecoinvent (version 3.8), United States Life Cycle Inventory (USLCI) and Industry Data 2.0 databases were used to get the background data. Ecoinvent was updated in 2021, USLCI in September 2015 and Industry Data between 2015 and 2019.

Allocation:

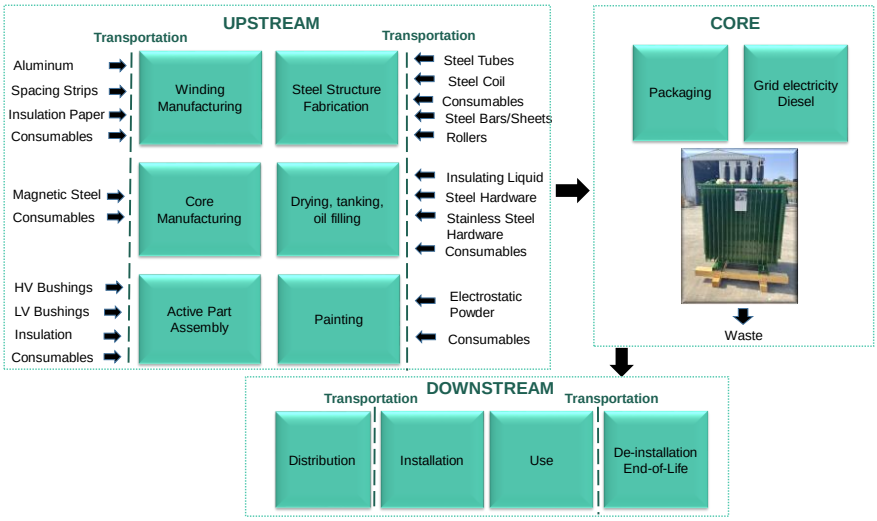
Allocation is performed to determine the amount of consumables needed for the distribution transformer. First, the total amount of consumables is computed for the year of study and for the whole production line (including distribution transformers and products). Then, the amount obtained is allocated to 1 kVA based on the total production of distribution transformers for that year and reverted back to 400 kVA.

Cut-off criteria:

0.1% cut-off criteria by mass is taken into consideration, meaning that the raw materials that weigh less than 0.1% of the total transformer mass are excluded from the scope of this work. In addition, this LCA study ensures that the total mass of those components excluded does not exceed 1% of the total mass of the transformer.

System boundaries

Cradle-to-grave, including manufacturing (upstream and core), and downstream (distribution, installation, use, de-installation and end-of-life) modules.



Modules declared and geographical scope

	Raw material supply	Transport	Manufacturing	Distribution	Installation	Use	End-of-life and de-installation
Module	Upstream		Core	Downstream			
Supply chain processes	Extraction of raw materials, production of semi-finished products and their transportation to Matelec plant.		Transformer assembling and packaging. Management of waste at plant.	Transport of transformer to the operation site in Italy, installation and use of the transformer operating for 35 years. De-installation and end-of-life of transformer which includes recycling, incineration with and without energy recovery and insulating liquid (natural ester) incineration.			
Modules declared	X	X	X	X	X	X	X
Geography	RER	LB	LB	IT	IT	IT	IT

Manufacturing

Windings are formed of HV round wire windings, LV foil windings, and insulation. HV windings are made of aluminum wire and spacing strips. LV windings are made of aluminum foil and bars. Insulation is made of electrical insulation paper. The magnetic core is manufactured using electrical steel cut to length and assembled at the core manufacturing workshop. An electrical varnish is used to protect the core. Windings are assembled to the magnetic core at the active part assembly workshop. The electrical connections (HV and LV bushings) are made, and the necessary insulating material (pressboard) is used. The steel structure of the transformers is manufactured by cutting, bending, and welding the steel sheets. The assembled tank and cover are then treated and painted using powder paint. The final step is drying the active part in a diesel-heated oven. Active parts are then put inside the tank and filled with an insulating liquid (natural ester). At this stage, transformers are assembled using steel and stainless-steel hardware and are ready to be tested. Then, the rest of the accessories are mounted and the transformers are packed. During the production process, scrap from steel, aluminum, insulation presspaper and pressboard, as well as hazardous waste from the painting process are generated. Scrap is sent to a recycling facility in Tripoli, Lebanon, while the waste is disposed.

Distribution

The distribution phase includes the road transport of the 400 kVA KNAN distribution transformer - FIT0400170 (110082) from Matelec – Lebanon to the port of Beirut – Lebanon in diesel-powered lorries, the transoceanic shipment from the port of Beirut to Italy ports, and the transport from the Italian ports to the different warehouses in diesel-powered lorries. It is to be noted that the transoceanic distance considered is taken as the average of 4 distances by ship between the port of Beirut and each of the ports located closest to the 4 warehouses. An average distance by truck is then taken into consideration between each of the ports (located closest to the 4 warehouses) and the warehouses addresses. The distance from Matelec to the Port of Beirut is 41 km, the average transoceanic distance is 2782.63 km and the distance to the warehouses is 112.15 km.

Installation

The installation of the distribution transformer is assumed to take place using a crane that operates for 15 minutes. Since this machine has a lifetime of 10 000 hours, 2.50 E-05 piece of equipment is needed.

It is to be noted that the end-of-life of the packaging material (wood) is considered during this stage. It is assumed that 50% of the wood is incinerated with energy recovery and 50% is incinerated without any energy recovery.

Material	Amount (kg)	Waste Treatment	Percentage (%)
Wood	1.81E+01	Incineration with heat recovery	50
		Incineration	50

Use

The use phase includes the Italian electricity grid (medium voltage). The energy used by the distribution transformer during its reference service life of 35 years is 6.07E+05 kWh and it is calculated according to the following equation (PCR EPDItaly018, 2021):

$$E_d\ [\mathrm{kWh}] = [P_{load} * k_{load}^2 + P_{noload}] * t_{year} * RSL + P_{aux} * f_{aux} * t_{year} * RSL$$

Where:

E_d = The energy used by the distribution transformer during 35 years [kWh]
P_{load} = Load losses of the transformer = 3.25 kW
P_{noload} = No-load losses of the transformer = 0.387 kW
k_{load} = Average load factor of the transformer = 0.70
t_{year} = Total number of hours in a year = 8760 hours
RSL = Reference service life = 35 years
P_{aux} = Power loss due to auxiliary activities at no load = 0 kW
f_{aux} = Fraction of time in which ancillary equipment is operating = 0

**** No maintenance is needed for the distribution transformer during its 35 years' lifetime.*

De-installation and end-of-life

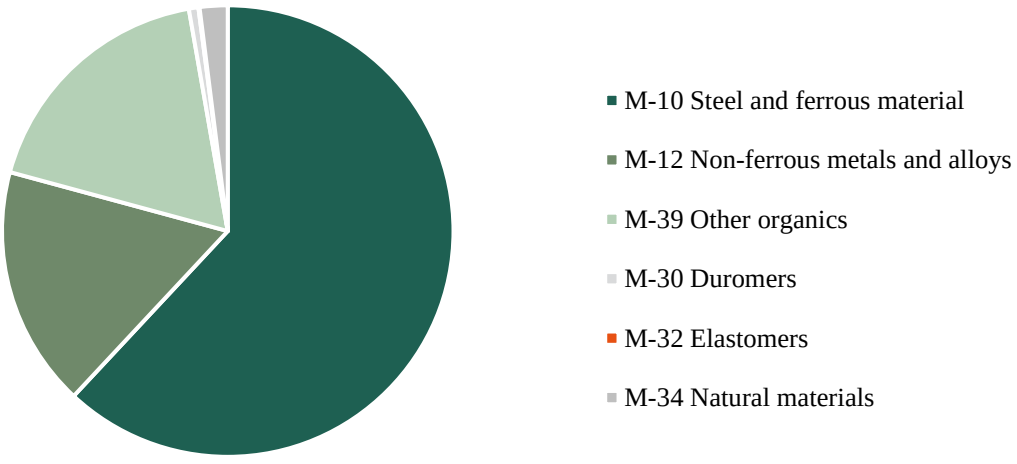
For the end-of-life, the distribution transformer's steel, aluminum and copper components are recycled and incinerated while the presspaper, wood and rubber are incinerated with energy recovery and without energy recovery according to the percentages defined in SIST EN 50693 (SIST EN 50693, 2020). The natural ester is assumed to be incinerated at the end-of-life of the transformer. The de-installation of the distribution transformer is assumed to take place using a crane that operates for 15 minutes.

Material	Amount (kg)	Waste Treatment	Percentage (%)
Steel	1.11E+03	Recycling	80
		Incineration	20
Aluminum	3.07E+02	Recycling	70
		Incineration	30
Copper	2.13E+00	Recycling	60
		Incineration	40
Natural ester	3.23E+02	Incineration	100
Presspaper/ pressboard	3.58E+01	Incineration with heat recovery	50
		Incineration	50
Rubber	1.52E+00	Incineration with heat recovery	50
		Incineration	50

Content declaration

Product

Material	Material classes	Main material classes	Mass (kg)	Percentage (%)
Steel and ferrous material	M-101, M-119	M-10	1107.81	61.54
Stainless Steel	M-100		2.15	0.12
Aluminum	M-120	M-12	306.93	17.05
Copper	M-121		2.13	0.12
Natural ester	M-399	M-39	323.00	17.94
Resins	M-302	M-30	12.18	0.68
Elastomers	M-320	M-32	1.52	0.08
Pressboard	M-341	M-34	16.35	0.91
Presspaper	M-341		19.50	1.08
Paint	-		4.00	0.22
Total	**-**		***1795.55***	***99.75***



Packaging

Material	Material classes	Mass (kg)	Percentage (%)
Wood	M-340	18.13	1.01

Substances of very high concern (SVHC)

The painting process involves the usage of powder paintings and coatings that contain the following hazardous substances:

Hazardous substances	CAS number	Hazardous substances	CAS number
Alkoxylated alkyl	174955-61-4	Potassium hydroxide	1310-58-3
Modified ethoxylated fatty alcohol	68154-99-4	Ethanol	64-17-5
Sodium nitrite	7632-00-0	Sodium orthophosphate	7601-54-9
Zinc nitrate	7779-88-6	Nitric acid	7697-37-2
Sodium hydroxide	1310-73-2	bis(2,3-epoxypropyl) terephthalate	7195-44-0
Zinc dihydrogen phosphate	13598-37-3	tris(oxiranylmethyl) benzene-1,2,4-tricarboxylate	7237-83-4
Orthophosphoric acid	7664-38-2	titanium dioxide	13463-67-7
Manganese dihydrogen phosphate	18718-07-5	2-ethyl-N,N-bis(2-ethylhexyl) hexylamine	1860-26-0
Zinc hexafluorosilicate	16871-71-9	2-Propenoic acid, 2-methyl-, methyl ester, polymer with butyl 2-propenoate, ethenylbenzene, 1,2-propanediol mono(2-methyl-2-propenoate) and 2-propenoic acid	37237-99-3
Nickel nitrate	13138-45-9	Solvent naphta (petroleum), light, aromatic	64742-95-6
Manganese nitrate	10377-66-9		

*** *None of the substances listed above are considered as substances of very high concern (SVHC) on the REACH Candidate List published by the European Chemicals Agency.*

Environmental performance

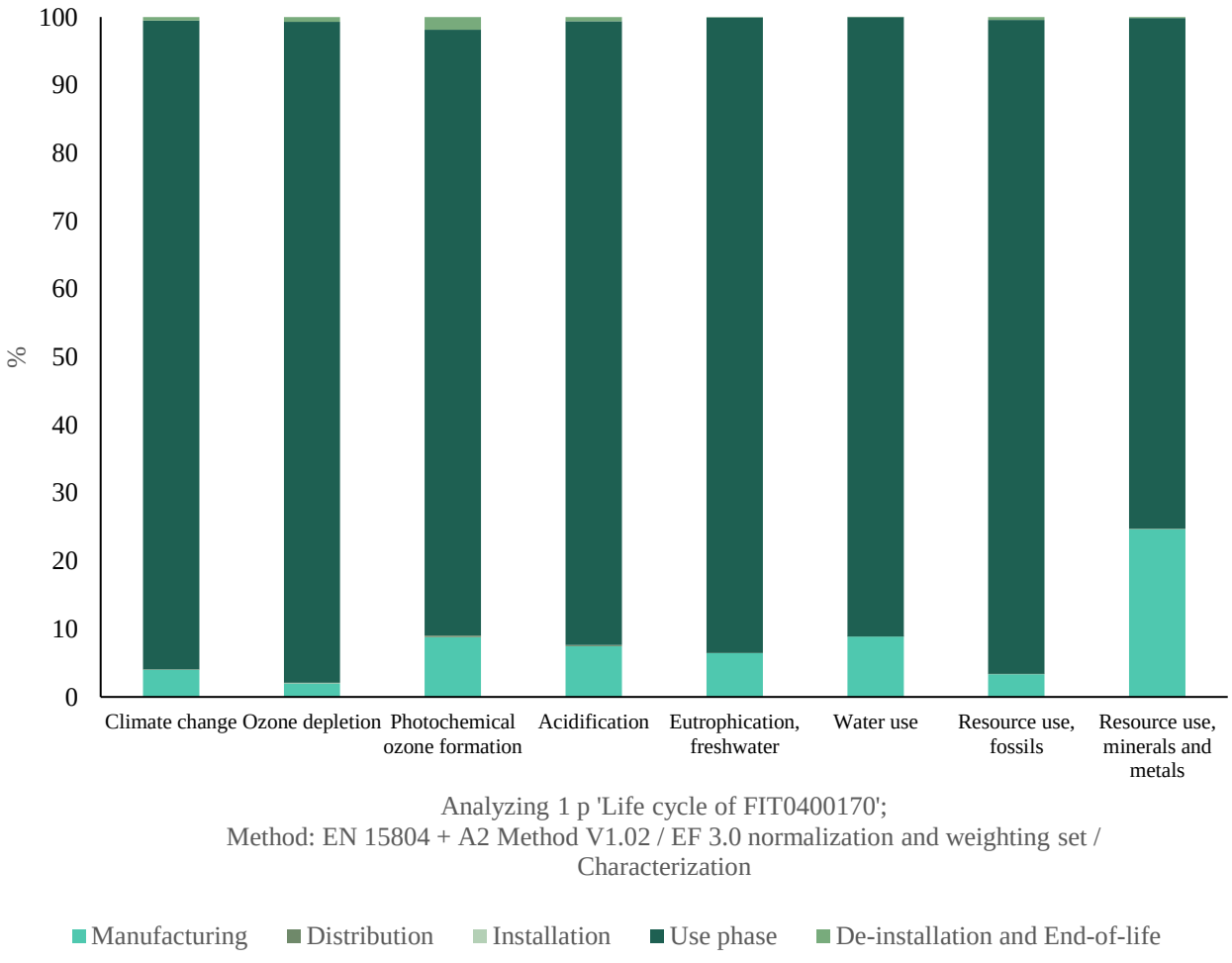
Potential environmental impacts

			Manufacturing		Distribution	Installation	Use	De-installation End-of-life	
Impact category		***Unit***	***Upstream***	***Core***	***Downstream***				***Total***
Climate change	*Total*	kg CO_2 eq	1.06E+04	5.43E+02	7.81E+01	3.92E+01	2.64E+05	1.38E+03	2.77E+05
	Fossil		1.16E+04	5.71E+02	7.80E+01	1.27E+01	2.42E+05	1.16E+03	2.56E+05
	Biogenic		-1.10E+03	-2.79E+01	1.90E-02	2.65E+01	2.17E+04	2.24E+02	2.08E+04
	Land use and land use change		2.03E+01	2.11E-01	4.63E-02	2.08E-03	3.14E+01	1.35E-01	5.21E+01
Ozone layer depletion		kg CFC-11 eq	5.78E-04	1.12E-04	1.65E-05	2.58E-06	3.34E-02	2.49E-04	3.44E-02
Acidification		mol H+ eq	8.34E+01	7.42E+00	1.69E+00	7.93E-02	1.12E+03	7.30E+00	1.22E+03
Eutrophication		kg P eq	3.84E+00	4.17E-02	3.64E-03	6.54E-04	5.59E+01	3.95E-02	5.99E+01
Photochemical ozone formation		kg NMVOC	4.33E+01	9.09E+00	1.26E+00	1.20E-01	5.31E+02	1.13E+01	5.97E+02
Resource use, minerals and metals		kg Sb eq	1.71E-01	3.76E-03	1.50E-04	1.50E-05	5.31E-01	1.04E-03	7.07E-01
Resource use, fossils		MJ	1.22E+05	7.54E+03	1.08E+03	1.70E+02	3.72E+06	1.56E+04	3.86E+06
Water use		m^3 depriv.	1.59E+04	4.38E+01	2.67E+00	1.65E-01	1.63E+05	1.68E+01	1.79E+05

*** *It is to be noted that the negative value of the biogenic carbon during the manufacturing stage is mainly due to the natural vegetable ester used in the drying, tanking and oil filling, in addition to i) the wood used in the active part assembly, more precisely the insulation process for which the use of pressboard is required, ii) the winding manufacturing, for which insulation presspaper is needed and iii) the wood plates required in the packaging stage. Also, the climate change biogenic values are not in perfect balance since such balance cannot be accurately performed by the LCA software.*

Potential environmental impacts (%)

	Manufacturing		Distribution	Installation	Use	De-installation and End of life	
Impact category	***Upstream***	***Core***	***Downstream***				***Total***
Climate change	3.82	0.20	0.03	0.01	95.44	0.50	100.00
Ozone depletion	1.68	0.32	0.05	0.01	97.21	0.72	100.00
Acidification	6.85	0.61	0.14	0.01	91.79	0.60	100.00
Eutrophication	6.41	0.07	0.01	0.00	93.45	0.07	100.00
Photochemical ozone formation	7.26	1.52	0.21	0.02	89.06	1.89	100.00
Resource use, minerals and metals	24.16	0.53	0.02	0.00	75.14	0.15	100.00
Resource use, fossils	3.17	0.20	0.03	0.00	96.20	0.41	100.00
Water use	8.89	0.02	0.00	0.00	91.08	0.01	100.00



Use of resources

		Manufacturing		Distribution	Installation	Use	De-installation and End of life	
Parameter	***Unit***	***Upstream***	***Core***	***Downstream***				***Total***
Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw material (PENRE)	MJ	1.09E+05	7.54E+03	1.08E+03	1.70E+02	3.72E+06	1.56E+04	3.85E+06
Use of renewable primary energy excluding renewable primary energy resources used as raw material (PERE)	MJ	3.33E+04	6.91E+02	9.88E+00	1.32E+00	9.64E+05	6.54E+01	9.98E+05
Use of non-renewable primary energy resources used as raw material (PENRM)	MJ	1.36E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.36E+04
Use of renewable primary energy resources used as raw material (PERM)	MJ	6.09E+02	3.76E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.85E+02
Total use of non-renewable primary energy resources (primary energy and primary energy resources used as raw materials) (PENRT)	MJ	1.22E+05	7.54E+03	1.08E+03	1.70E+02	3.72E+06	1.56E+04	3.86E+06
Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials) (PERT)	MJ	3.39E+04	1.07E+03	9.88E+00	1.32E+00	9.64E+05	6.54E+01	9.99E+05
Net use of fresh water (FW)	m^3	4.10E+02	1.35E+00	9.07E-02	9.04E-03	4.37E+03	7.36E-01	4.78E+03
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

Waste production and output flows

		Manufacturing		Distribution	Installation	Use	De-installation and End of life	
Parameter	***Unit***	***Upstream***	***Core***	***Downstream***				***Total***
Hazardous waste disposed (HWD)	kg	0.00E+00	1.61E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.61E+00
Non-hazardous waste disposed (NWHD)	kg	2.55E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.55E-01
Radioactive waste disposed (RWD)	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for energy recovery (MER)	kg	0.00E+00	0.00E+00	0.00E+00	9.06E+00	0.00E+00	1.87E+01	2.77E+01
Material for recycling (MFR)	kg	0.00E+00	1.67E+02	0.00E+00	0.00E+00	0.00E+00	1.10E+03	1.27E+03
Components for reuse (CRU)	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
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

- Boulay, A. M., Bare, J., Benini, L., Berger, M., Lathuillière, M. J., Manzardo, A., ... & Pfister, S. (2018). The WULCA consensus characterization model for water scarcity footprints: assessing impacts of water consumption based on available water remaining (AWARE). The International Journal of Life Cycle Assessment, 23(2), 368-378.
- Ecoinvent (2019). http://www.ecoinvent.org/
- EPDItaly (2022). Operating instructions IO-EPD-01 rev. 20/07/22.
- EPDItaly007 (2020). PCR for electronic and electrical products and systems rev.2. Retrieved from www.epditaly.it
- EPDItaly018 (2021). PCR for electronic and electrical products and systems-Power transformers v.3.5. Retrieved from www.epditaly.it
- EPDItaly Programme (2022). Regulations of the EPDItaly Programme rev 5.2. Retrieved from www.epditaly.it
- Goedkoop, M., Oele, M., Leijting, J., Ponsioen, T., Meijer, E. (2013). Introduction to LCA with SimaPro. http://www.pre-sustainability.com/download/SimaPro8IntroductionToLCA.pdf https://www.pre-sustainability.com/simapro (accessed September 2018).
- International Organization for Standardization (ISO), 14040:2006. Environmental management — Life cycle assessment — Principles and framework
- International Organization for Standardization (ISO), 14044:2006. Environmental management — Life cycle assessment — Requirements and guidelines
- LCA report - Life cycle assessment of 400 kVA KNAN distribution transformer FIT0400170 (110082)
- Matelec Group (2006). HV/LV three phase distribution transformers LEBANON - Reduced Losses. Accessed on June 19, 2020.
- NREL (n.d.). U.S. Life Cycle Inventory Database. Retrieved from https://www.nrel.gov/lci/
- PRé. (n.d.). Sustainability software for fact-based decision. Retrieved from https://pre-sustainability.com/solutions/tools/simapro
- SIST EN 50693 (2020). Product category rules for life cycle assessments of electronic and electrical products and systems.

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