HENGTONG OPTIC ELECTRIC CO., LTD

ENVIRONMENTAL PRODUCT DECLARATION

Product: name:

Underground high voltage cables:

A1/XLPE/CWS/APL/HDPE 80/138kV 1C1200mm2;

A1/XLPE/CWS/APL/PE 80/138kV 1C2000mm2+2C2G.651A1a;

Cu/XLPE/CWS/APL/PE 80/138kV C2500mm2+2C2G.651A1a

Site Plant:

Hengtong avenue 88, Oidu, 215200, Suzhou City (China)

Program Operator	EPDItaly
Publisher	EPDItaly
Declaration Number	HENGTONG001
Registration Number	EPDITALY0367
Issue date	18/01/2023
Valid to	18/01/2028

in compliance with ISO 14025 and EN 50693

General information

EPD OWNER	Hengtong Optic-Electric co., LTD
SITE	Hengtong avenue 88, Oidu, 215200, Suzhou City (China)
FIELD OF APPLICATION OF THE PRODUCT	This document refers to the study of three underground cables suitable for the transport of high voltage electricity: Al/XLPE/CWS/APL/HDPE 80/138kV 1C1200mm2 and Al/XLPE/CWS/APL/PE 80/138kV 1C2000mm2+2C2G .651A1a) with an aluminum conductive body and (Cu/XLPE/CWS/APL/PE 80/138kV C2500mm2+2C2G.651A1a) with a copper conductive body.
PROGRAM OPERATOR	EPDItaly – info@epditaly.it
VERIFICATION INFORMATION	The PCR EPDITALY007 review was performed by Ing. Massimo De Pieri, Arch. Michele Paleari, Ing. Sara Toniolo. - info@epditaly.it. Independent verification of the declaration and data, carried out according to ISO 14025: 2010. ☐ Internal ☑ External Third party verification carried out by: ICMQ S.p.A., via Gaetano De Castillia n ° 10 - 20124 Milan, Italy. Accredited by Accredia.
CPC CODE	463 – family “Insulated wire and cable; optical fibre cables” and sub-sequent clusters
CONTACTS for information on the EPD	Peter Bian - bianhao <bianhao@htgd.com.cn>
PROJECT REPORT LCA	Via Cacciatori delle Alpi 1/a, 22070 CapiagoIntimiano (CO) web: www.reteclima.it | email: info@reteclima.it
COMPARABILITY STATEMENT	Environmental statements published within the same product category, but from different programs, may not be comparable.
LIABILITY STATEMENT	Hengtong Optic-Electric co., LTD releases EPDItaly non-compliance with environmental legislation. The holder of the declaration will be responsible for the information and supporting evidence. from any disclaims any responsibility for the information, data and results provided by the EPD Owner for life cycle assessment.
PRODUCT CATEGORY RULES – PCR	Core-PCR: EPDITALY007 " Electronic and electrical product and systems" Rev. 2 – 21/10/2020 Sub-PCR: EPDITALY016 "Electronic and electrical product and systems – Cables and wires" Rev. 2 del 25/09/2020

In this study, 3 different underground cables for transporting high-voltage electricity were analyzed. Two of them have an aluminum conductor body (Al/XLPE/CWS/APL/HDPE 80/138kV 1C1200mm2 and Al/XLPE/CWS/APL/PE 80/138kV 1C2000mm2+2C2G.651A1a) while the third is made of copper (Cu/XLPE/CWS/APL/PE 80/138kV C2500mm2+2C2G.651A1a). The coating of the conducting elements is made up of various materials such as cross-linked polyethylene and insulating copper or aluminum tapes that give thermal insulation and impermeability to the cable, produced by Hengtong Group. The assessment followed the EPDItaly Program in accordance with standards (ISO 14040 and 14044) and other reference documents already cited in the introduction (PCR EPDItaly016 - Cables and wires). The PCR identifies and records: the objective and scope of LCA-based information for the product category; the rules for producing additional environmental information; the life cycle stages to be included; the parameters to consider and how the data should be collected and communicated in a report.

Table 1 shows components and total weight of the three cables.

Table 1 Components and total weight

	Unit	Al 138 kV 1200 mm²	Al 138 kV 2000 mm²	Cu 138 kV 2500 mm²
Copper	kg/km	1.183,5	1.864,61	24.095,90
Aluminium	kg/km	3.462,38	5.683,25	294,08
Insulation material	kg/km	3.886,70	4.458,82	3.861,30
PE flame retardant	kg/km	1.204,50	2.023,08	2.394,9
Other	kg/km	565,42	649,74	1.693,62
Cable total weight	kg/km	10.302,5	14.679,5	32.339,8

Hengtong Optic-Electric CO., LTD

Hengtong Group is a company based in China engaged in research and development, design, production, and sale of products for fiber optic communication networks and for energy transport; it ranks seventh in Integer's Top 100 Electric Cable Manufacturers ranking. The company owns multiple management systems certified according to 7S, ISO9001, ISO14001, OHSASI8001, IEC, AMD standards; this means that the quality control mode, the whole process, the full performance, have been implemented in a comprehensive way.

Goal and scope of the study

In this study, 3 different underground cables for transporting high-voltage electricity were analyzed. Two of them have an aluminum conductor body (Al/XLPE/CWS/APL/HDPE 80/138kV 1C1200mm2 and Al/XLPE/CWS/APL/PE 80/138kV 1C2000mm2+2C2G.651A1a) while the third is made of copper (Cu/XLPE/CWS/APL/PE 80/138kV C2500mm2+2C2G.651A1a). The coating of the conducting elements is made up of various materials such as cross-linked polyethylene and insulating copper or aluminum tapes that give thermal insulation and impermeability to the cable. Here in after the three cables will be named respectively: Al 138 KV 1200, Al 138 KV 2000 and Cu 138 KV 2500.

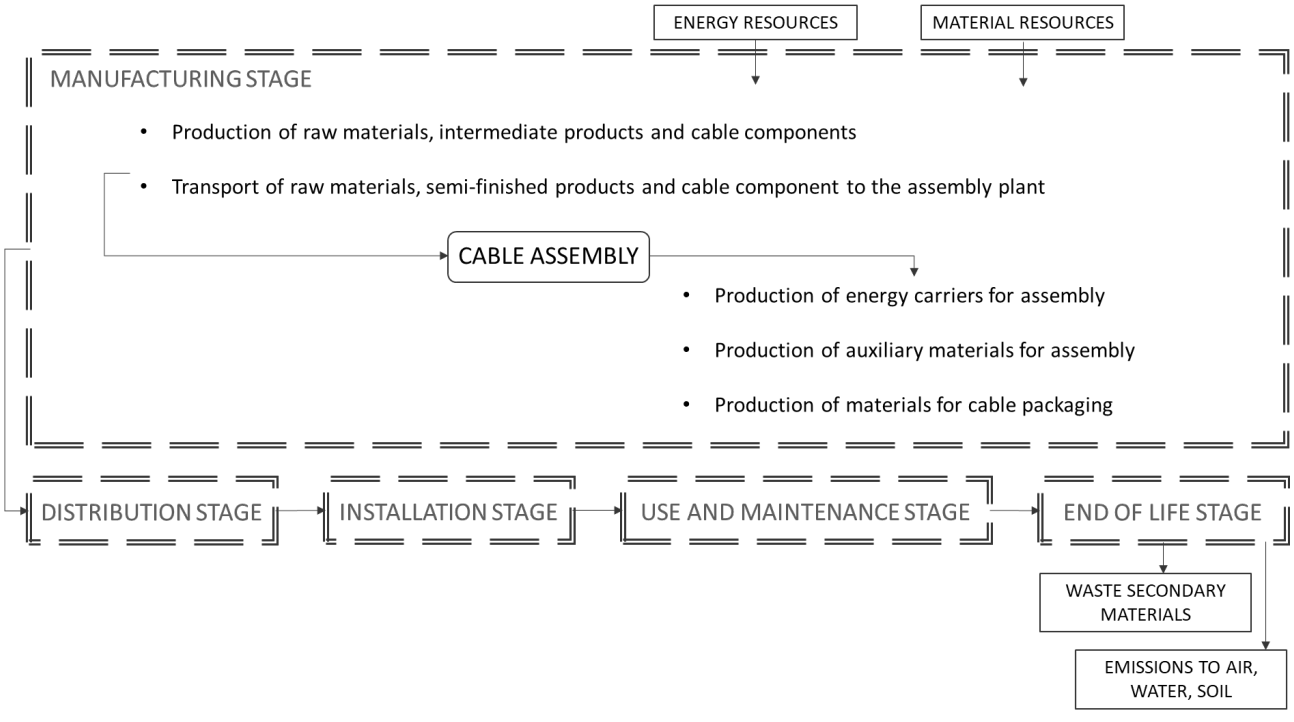
After production, the cables are rolled up on steel coils and covered with wood; the coils are coated with plastic film, and they are then loaded on wooden pallets and transported first by truck and then by ship to the

installation site (Brazil). The cable is laid underground within a high-density polyethylene pipe; the end-of-life scenario includes landfill, incineration, and recycling with varying percentages for the different types of materials. This study considers the life cycle of the product, from the extraction of raw materials to disposal and disposal at the end of its life, according to the cradle to grave approach - "from cradle to grave". The modules included in the evaluation, in accordance with the PCR and the reference technical regulations.

Table 2: Modules considered in the evaluation, according to the approach "*from cradle to grave*"

<table>
<tr><th colspan="2">MANUFACTURING STAGE</th><th>DISTRIBUTION STAGE</th><th>INSTALLATION STAGE</th><th>USE & Maintenance STAGE</th><th>END-OF-LIFE STAGE De-installation</th></tr>
<tr><th>UPTREAM MODULE</th><th>CORE MODULE</th><th colspan="4">DOWNSTREAM MODULE</th></tr>
<tr><td>extraction of raw materials, including waste recycling processes and the production of semi-finished and ancillary products</td><td>manufacturing of the product constituents, including all the stages</td><td colspan="4" rowspan="4">In accordance with EN 50693</td></tr>
<tr><td>transportation of raw materials to the manufacturing company</td><td>product assembly</td></tr>
<tr><td></td><td>packaging</td></tr>
<tr><td></td><td>waste recycling processes</td></tr>
</table>

Figure 1: System boundaries flowchart



EPD TYPE	The EPD followed a cradle to grave approach.
Geographical validity	The assessment was carried out in relation to the production site in Suzhou City (China). The main reference market is located in Brazil.
Database	Ecoinvent 3.8
Software	SimaPro 9.4

Product features and components

The construction, dimensions and technical parameters of the cables are detailed below (all data provided by Hengtong Group CO).

1. Cable *Al/XLPE/CWS/APL/HDPE 80/138kV 1C1200mm2* (AL 138KV 1200)

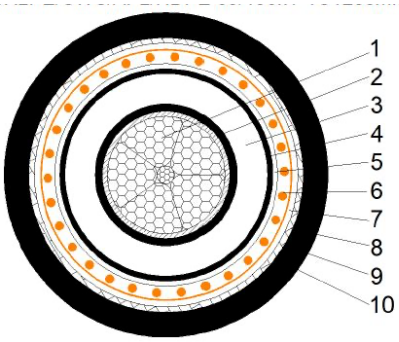


Table 3 shows all the cable components with description, nominal thickness, and diameter (expressed in mm).

Table 3 Cable features Al/XLPE/CWS/APL/HDPE 80/138kV 1C1200mm2

No.	Construction	Description	Nominal Thickness (mm)	Diameter (mm) (Approx.)
1	Conductor	Milliken circular aluminium conductor (class 2) with water blocking tape	/	44.0
2	Conductor screen	Semi-conducting tape and extruded semi-conducting thermosetting compound	0.3+0.2+1.8	83.9
3	Insulation	XLPE	16.0	
4	Insulation screen	Extruded semi-conducting thermosetting compound	1.5	
5	Water blocking	Semi-conducting water swelling tape	1×1.5	91.1
6	Metallic screen	Copper wires with copper tape counter open-helix wrapped	78/Φ1.4+0.1	
7	Water blocking	Semi-conducting water blocking tape	2×0.3	
8	Metal foil laminate	Al-PE laminate foil	0.25	99.9
9	Over sheath	HDPE with graphite coating	4.0	
10	Outer conductive layer			

Table 4 shows the cable technical parameters and specifically the mechanical and electrical parameter.

Tabella 4 Cable mechanical e technical parameter Al/XLPE/CWS/APL/HDPE 80/138kV 1C1200mm2

No.	Description	unit	Parameters
Mechanical Parameters			
1	Min. bending radius during installation	mm	1998
2	Min. bending radius installed	mm	11499
3	Max. allowable pulling tension of conductor	kN	48
4	Total weight of completed cable (Approx.)	kg/m	6.3*

Electrical Parameters			
1	Rated Frequency	Hz	50
2	Rated voltage of cable, U0/U(Um)	kV	80/138(145)
3	Impulse lightning voltage of cable	kV	650
4	Maximum DC resistance of conductor at 20℃	Ohm/km	0.0247
5	Maximum AC resistance of conductor at 90℃	Ohm/km	0.0318
6	Conductor to screen capacitance	μF/km	0.276
7	Nominal electrical stress at conductor screen @U0	kV/mm	6.5
8	Nominal electrical stress at insulation screen @U0	kV/mm	3.9
9	Charge current @U0	A/km	6.9
10	Inductance per unit length of flat formation	mH/km	0.353
11	Short circuit current for screen, 0.5s	kA	23.0
12	Short circuit current for conductor, 1s	kA	113.4
13	Max. continuous operation temperature for conductor	℃	90
14	Max. temperature at short circuit (≤5s) for conductor	℃	250

* wrong data deriving from the technical sheet, value used for the calculation is 10.4 t/km.

Table 5 shows standards and certifications followed for cable design.

Table 5 Standards and certifications Al/XLPE/CWS/APL/HDPE 80/138kV 1C1200mm2

ISO 9001	Quality Management Systems-Requirements
ISO 45001	Occupational health and safety management system
ISO 14001	Environment Management System
IEC 60183-2015	Guidance for selection of high voltage A.C. cable systems
IEC 60228-2004	Conductors of insulated cables
IEC 60840-2020	Power cables with extruded insulation and their accessories for rated voltages above 30kV(Um=36kV)up to 150kV(Um=170kV) – Test methods and requirements
IEC 60287-1-1-2014	Electric cables-Calculation of the current rating- Part 1-1: Current rating equations (100% load factor) and calculation of losses-General
IEC 60287-2-1-2015	Electric cables-Calculation of the current rating- Part 2-1: Thermal resistance - Calculation of thermal resistance
IEC 60949-2008	Calculations of thermally permissible short circuit currents, taking into account non-adiabatic heating effects

2. Cable *Al/XLPE/CWS/APL/PE 80/138kV 1C2000mm2+2C2G.651A1a* (AL 138KV 2000)

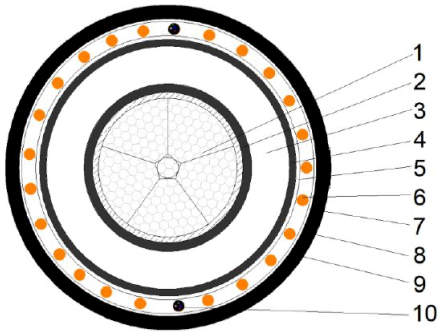


Table 6 shows all the cable components with description, nominal thickness and diameter (expressed in mm).

Table 6 Caratteristiche del cavo Al/XLPE/CWS/APL/PE 80/138kV 1C2000mm2+2C2G.651A1a

No.	Construction	Description	Nominal Thickness (mm)	Diameter (mm) (Approx.)
1	Conductor	Circular milliken aluminium conductor (class 2) with water blocking tape	/	55.8
2	Conductor screen	Semi-conducting tape and extruded semi-conducting thermosetting compound	0.15+0.2+1.8	59.9
3	Insulation	XLPE	16.0	91.9
4	Insulation screen	Extruded semi-conducting thermosetting compound	1.5	94.9
5	Water blocking	Semi-conducting water swelling tape	1.5	97.9
6	Metallic screen	Copper wires with copper tape counter open-helix wrapped	58/Φ2.04+0.1	102.2
7	Water blocking	Semi-conducting water blocking tape	0.5	104.7

8	Metal foil laminate	Al-PE laminate foil	0.3	105.6
9	Over sheath	PE (Black, anti-termite, halogen free, flame retardant) coated with graphite	4.5	114.6
10	OFC	Two tubes with two multi-mode optical fibres	/	/

Table 7 shows the cable technical parameters and specifically the mechanical and electrical parameter.

Table 7 Cable mechanical e technical parameter Al/XLPE/CWS/APL/PE 80/138kV 1C2000mm2+2C2G.651A1a

No.	Description	unit	Parameters
Mechanical Parameters			
1	Min. bending radius during installation	mm	2292
2	Min. bending radius installed	mm	1719
3	Max. allowable pulling tension of conductor	kN	80
4	Total weight of completed cable (Approx.)	kg/m	14.5
Electrical Parameters			
1	Rated Frequency	Hz	60
2	Rated voltage of cable, U0/U(Um)	kV	80/138(145)
3	Impulse lightning voltage of cable	kV	650
4	Maximum DC resistance of conductor @ 20℃	Ohm/km	0.0149
5	Maximum AC resistance of conductor @ 90℃	Ohm/km	0.0190
6	Conductor to screen capacitance	μF/km	0.325
7	Nominal electrical stress at conductor screen @U0	kV/mm	6.2
8	Nominal electrical stress at insulation screen @U0	kV/mm	4.1
9	Charge current @U0	A/km	8.2
10	Inductance per unit length of flat formation	mH/km	0.344
11	Short circuit current for screen, 1s	kA	21
12	Short circuit current for conductor, 1s	kA	189
13	Max. continuous operation temperature for conductor	℃	90
14	Max. temperature at short circuit (≤5s) for conductor	℃	250

Table 8 shows standards and certifications followed for cable design.

Table 8 Standards and certifications Al/XLPE/CWS/APL/PE 80/138kV 1C2000mm2+2C2G.651A1a

ISO 9001	Quality Management Systems-Requirements
OHSAS 18001	Occupational health and safety management system
ISO 14001	Environment Management System
IEC 60183-2015	Guidance for selection of high voltage A.C. cable systems
IEC 60228-2004	Conductors of insulated cables
IEC 60840-2011	Power cables with extruded insulation and their accessories for rated voltages above 30kV (Um=36kV) up to 150kV (Um=170kV) – Test methods and requirements
IEC 60287-1-1-2014	Electric cables-Calculation of the current rating- Part 1-1: Current rating equations (100% load factor) and calculation of losses-General
IEC 60287-2-1-2015	Electric cables-Calculation of the current rating- Part 2-1: Thermal resistance - Calculation of thermal resistance
IEC 60949-2008	Calculations of thermally permissible short circuit currents, taking into account non-adiabatic heating effects

3. Cable *Cu/XLPE/CWS/APL/PE 80/138kV C2500mm2+2C2G.651A1a* (CU 138KV 2500)

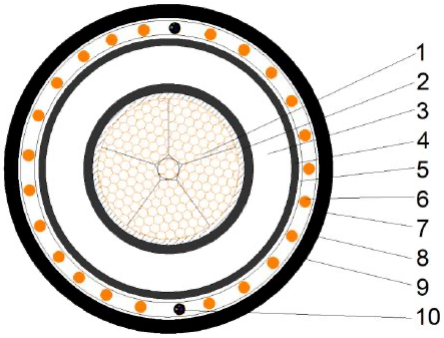


Table 9 shows all the cable components with description, nominal thickness, and diameter (expressed in mm).

Table 9 Cable features Cu/XLPE/CWS/APL/PE 80/138kV C2500mm2+2C2G.651A1a

No.	Construction	Description	Nominal Thickness (mm)	Diameter (mm) (Approx.)
1	Conductor	Circular milliken copper conductor (class 2) with water blocking tape	/	62.5
2	Conductor screen	Semi-conducting tape and extruded semi-conducting thermosetting compound	0.15+0.2+1.8	66.6
3	Insulation	XLPE	16.0	98.6
4	Insulation screen	Extruded semi-conducting thermosetting compound	1.5	101.6
5	Water blocking	Semi-conducting water swelling tape	1.5	104.6
6	Metallic screen	Copper wires with copper tape counter open-helix wrapped	58/Φ2.04+0.1	108.9
7	Water blocking	Semi-conducting water blocking tape	0.5	111.4
8	Metal foil laminate	Al-PE laminate foil	0.3	112.3
9	Over sheath	PE (Black, anti-termite, halogen free, flame retardant) coated with graphite	5.0	122.3
10	OFC	Two tubes with two multi-mode optical fibres	/	122.3

Table 10 shows the cable technical parameters and specifically the mechanical and electrical parameter.

Table 10 Cable mechanical e technical parameter Cu/XLPE/CWS/APL/PE 80/138kV C2500mm2+2C2G.651A1a

No.	Description	unit	Parameters
Mechanical Parameters			
1	Min. bending radius during installation	mm	2446
2	Min. bending radius installed	mm	1835
3	Max. allowable pulling tension of conductor	kN	175
4	Total weight of completed cable (Approx.)	kg/m	32.1
Electrical Parameters			
1	Rated Frequency	Hz	60
2	Rated voltage of cable, U0/U(Um)	kV	80/138(145)
3	Impulse lightning voltage of cable	kV	650
4	Maximum DC resistance of conductor @ 20℃	Ohm/km	0.0072
5	Maximum AC resistance of conductor @ 90℃	Ohm/km	0.0130
6	Conductor to screen capacitance	μF/km	0.354
7	Nominal electrical stress at conductor screen @U0	kV/mm	6.1
8	Nominal electrical stress at insulation screen @U0	kV/mm	4.1
9	Charge current @U0	A/km	8.9
10	Inductance per unit length of flat formation	mH/km	0.332
11	Short circuit current for screen, 1s	kA	21
12	Short circuit current for conductor, 1s	kA	357
13	Max. continuous operation temperature for conductor	℃	90
14	Max. temperature at short circuit (≤5s) for conductor	℃	250

Table 11 shows standards and certifications followed for cable design.

Table 11 Standards and certifications Cu/XLPE/CWS/APL/PE 80/138kV C2500mm2+2C2G.651A1a

9001	Quality Management Systems-Requirements
OHSAS 18001	Occupational health and safety management system
ISO 14001	Environment Management System
IEC 60183-2015	Guidance for selection of high voltage A.C. cable systems
IEC 60228-2004	Conductors of insulated cables
IEC 60840-2011	Power cables with extruded insulation and their accessories for rated voltages above 30kV (Um=36kV) up to 150kV (Um=170kV) – Test methods and requirements
IEC 60287-1-1-2014	Electric cables-Calculation of the current rating- Part 1-1: Current rating equations (100% load factor) and calculation of losses-General
IEC 60287-2-1-2015	Electric cables-Calculation of the current rating- Part 2-1: Thermal resistance - Calculation of thermal resistance
IEC 60949-2008	Calculations of thermally permissible short circuit currents, taking into account non-adiabatic heating effects

Impact Assessment

1. Impact assessment of Al 138 KV 1200:

Table 12: Impact assessment of Al 138 KV 1200

IMPACT ASSESSMENT AL 138 KV 1200								
			1. Manufacturing Stage		2. Distribution Stage	3. Installation Stage	4. Use and Maintenance Stage	5. End of Life Stage
INDICATOR	**UM**	**TOTAL**	**UPSTREAM**	**CORE**	**DOWNSTREAM**			
GWP – total	kg CO_2eq	1,67E+05	1,23E+05	2,83E+03	2,64E+03	3,32E+04	2,73E+00	6,14E+03
GWP – fossil	kg CO_2eq	1,60E+05	1,23E+05	2,83E+03	2,64E+03	3,02E+04	1,64E+00	1,35E+03
GWP – biogenic	kg CO_2eq	6,78E+03	-3,32E+02	-1,59E+00	6,50E-01	2,61E+03	8,81E-01	4,51E+03
GWP – luluc	kg CO_2eq	2,48E+02	3,88E+01	2,57E-01	4,34E-02	2,09E+02	1,72E-01	1,30E-01
ODP	kg CFC-11eq	1,43E-02	9,47E-03	2,03E-05	5,54E-04	4,05E-03	1,53E-07	1,96E-04
POCP	kg NMVOC eq	7,32E+02	5,03E+02	8,18E+00	5,94E+01	1,52E+02	5,05E-03	9,17E+00
AP	mol H^+eq	1,62E+03	1,36E+03	1,38E+01	8,49E+01	1,47E+02	1,36E-02	6,95E+00
EP- freshw	kg P eq	8,12E+01	7,80E+01	4,75E-01	1,47E-02	2,65E+00	2,12E-04	1,11E-01
WDP	M3 depriv.	3,56E+04	2,88E+04	2,74E+02	-4,55E+00	6,52E+03	6,01E-01	2,74E+01
ADP – fossil	kg Sb eq	1,68E+01	1,68E+01	8,50E-05	4,39E-05	3,96E-03	1,54E-07	7,80E-05
ADP- min&met	MJ	2,05E+06	1,39E+06	2,38E+04	3,44E+04	5,90E+05	2,48E+01	1,29E+04

GWP-total = Global Warming Potential; 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, 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 deprivation potential, deprivation weighted water consumption

Table 13: Use of resources of Al 138KV 1200

USE OF RESOURCES: AL 138 KV 1200								
			1. Manufacturing Stage		2. Distribution Stage	3. Installation Stage	4. Use and Maintenance Stage	5. End of Life Stage
INDICATOR	**UM**	**TOTAL**	**UPSTREAM**	**CORE**	**DOWNSTREAM**			
PENRE	MJ	2,06E+06	1,39E+06	2,38E+04	3,44E+04	5,91E+05	2,49E+01	1,29E+04
PERE	MJ	1,17E+05	1,03E+05	2,14E+03	4,55E+01	1,13E+04	3,78E+01	1,12E+02
PENRM	MJ	8,47E+00	8,12E+00	1,37E-01	9,69E-04	2,13E-01	3,67E-06	3,00E-03
PERM	MJ	3,44E+02	2,19E+02	2,03E-01	8,62E-02	1,24E+02	3,01E-04	3,07E-01
PENRT	MJ	2,06E+06	1,39E+06	2,38E+04	3,44E+04	5,91E+05	2,49E+01	1,29E+04

PERT	MJ	1,17E+05	1,03E+05	2,14E+03	4,56E+01	1,14E+04	3,78E+01	1,13E+02
FW	m3	9,34E+02	7,14E+02	8,01E+00	2,35E+01	9,98E+01	8,06E-03	8,73E-01
MS	kg	0,00E+00	0,00E+00	0,00E+00	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 materials; PERE = Use of renewable primary energy excluding renewable primary energy resources used as raw materials; PENRM = Use of nonrenewable primary energy resources used as raw materials; PERM = Use of renewable primary energy resources used as raw materials; PENRT = Total use of non-renewable primary energy resources; PERT = Total use of renewable primary energy resources; FW = Use of net fresh water; MS = Use of secondary material; RSF = Use of renewable secondary fuels; NRSF = Use of non-renewable secondary fuels.

Table 14: Waste production and output flows of Al 138KV 1200

WASTE PRODUCTION AND OUTPUT FLOWS AL 138 KV 1200								
			1. Manufacturing Stage		2. Distribution Stage	3. Installation Stage	4. Use and Maintenance Stage	5. End of Life Stage
INDICATOR	UM	TOTAL	UPSTREAM	CORE	DOWNSTREAM			
HWD	kg	1,40E+01	0,00E+00	1,40E+01	0,00E+00	0,00E+00	0,00E+00	0,00E+00
NHWD	kg	1,01E+04	0,00E+00	3,16E+01	0,00E+00	3,18E+03	0,00E+00	6,92E+03
RWD	kg	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
MER	kg	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
MFR	kg	3,99E+03	0,00E+00	4,10E+02	0,00E+00	2,45E+02	0,00E+00	3,33E+03
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	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
EEE	MJ	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00

HWD = Hazardous waste disposed; NHWD = Non-hazardous waste disposed; RWD = Radioactive waste disposed; MER = Materials for energy recovery; MFR = Materials for recycling; CRU = Components for reuse; ETE= Exported thermal energy; EEE= Exported electricity energy.

2. Impact assessment of Al 138 KV 2000:

Table 15: Impact assessment of Al 138 KV 2000

IMPACT ASSESSMENT AL 138 KV 2000								
			1. Manufacturing Stage		2. Distribution Stage	3. Installation Stage	4. Use and Maintenance Stage	5. End of Life Stage
INDICATOR	**UM**	**TOTAL**	**UPSTREAM**	**CORE**	**DOWNSTREAM**			
GWP – total	kg CO_2eq	2,86E+05	2,30E+05	2,86E+03	4,82E+03	4,11E+04	1,63E+00	7,78E+03
GWP – fossil	kg CO_2eq	2,71E+05	2,31E+05	2,86E+03	4,82E+03	3,14E+04	9,81E-01	1,73E+03
GWP – biogenic	kg CO_2eq	1,36E+04	-1,07E+03	-1,58E+00	1,18E+00	8,94E+03	5,26E-01	5,69E+03
GWP – luluc	kg CO_2eq	3,21E+02	1,11E+02	2,58E-01	7,86E-02	2,09E+02	1,03E-01	1,77E-01
ODP	kg CFC-11eq	1,95E-02	1,41E-02	2,14E-05	1,01E-03	4,17E-03	9,11E-08	2,48E-04
POCP	kg NMVOC eq	1,04E+03	7,49E+02	8,24E+00	1,12E+02	1,57E+02	3,02E-03	1,08E+01
AP	mol H^+eq	1,71E+03	1,38E+03	1,38E+01	1,60E+02	1,51E+02	8,10E-03	8,33E+00
EP- freshw	kg P eq	5,83E+01	5,49E+01	4,75E-01	2,42E-02	2,78E+00	1,27E-04	1,46E-01
WDP	M3 depriv.	4,62E+04	3,93E+04	2,76E+02	-9,65E+00	6,55E+03	3,59E-01	3,65E+01
ADP – fossil	kg Sb eq	1,19E+00	1,18E+00	8,63E-05	4,82E+03	4,11E+04	1,63E+00	7,78E+03
ADP- min&met	MJ	3,16E+06	2,46E+06	2,39E+04	4,82E+03	3,14E+04	9,81E-01	1,73E+03

GWP-total = Global Warming Potential; 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, 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 deprivation potential, deprivation weighted water consumption

Table 16: Use of resources of Al 138KV 2000

USE OF RESOURCES AL 138 KV 1200								
			1. Manufacturing Stage		2. Distribution Stage	3. Installation Stage	4. Use and Maintenance Stage	5. End of Life Stage
INDICATOR	**UM**	**TOTAL**	**UPSTREAM**	**CORE**	**DOWNSTREAM**			
PENRE	MJ	3,16E+06	2,46E+06	2,39E+04	6,24E+04	5,99E+05	1,49E+01	1,65E+04
PERE	MJ	2,34E+05	2,20E+05	2,14E+03	8,27E+01	1,14E+04	2,26E+01	1,52E+02
PENRM	MJ	1,36E+01	1,33E+01	1,37E-01	1,68E-03	2,16E-01	2,20E-06	4,12E-03
PERM	MJ	4,78E+02	3,53E+02	2,17E-01	1,43E-01	1,24E+02	1,80E-04	3,98E-01
PENRT	MJ	3,16E+06	2,46E+06	2,39E+04	6,24E+04	5,99E+05	1,49E+01	1,65E+04
PERT	MJ	2,35E+05	2,21E+05	2,14E+03	8,29E+01	1,15E+04	2,26E+01	1,53E+02

FW	m3	1,27E+03	1,04E+03	8,05E+00	2,58E-01	2,12E+02	4,81E-03	1,39E+00
MS	kg	0,00E+00	0,00E+00	0,00E+00	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 materials; PERE = Use of renewable primary energy excluding renewable primary energy resources used as raw materials; PENRM = Use of nonrenewable primary energy resources used as raw materials; PERM = Use of renewable primary energy resources used as raw materials; PENRT = Total use of non-renewable primary energy resources; PERT = Total use of renewable primary energy resources; FW = Use of net fresh water; MS = Use of secondary material; RSF = Use of renewable secondary fuels; NRSF = Use of non-renewable secondary fuels.

Table 17: Waste production and output flows of per Al 138KV 2000

WASTE PRODUCTION AND OUTPUT FLOWS AL 138 KV 2000								
			1. Manufacturing Stage		2. Distribution Stage	3. Installation Stage	4. Use and Maintenance Stage	5. End of Life Stage
INDICATOR	UM	TOTAL	UPSTREAM	CORE	DOWNSTREAM			
HWD	kg	1,40E+01	0,00E+00	1,40E+01	0,00E+00	0,00E+00	0,00E+00	0,00E+00
NHWD	kg	2,02E+04	0,00E+00	1,82E+02	0,00E+00	1,08E+04	0,00E+00	9,28E+03
RWD	kg	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
MER	kg	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
MFR	kg	1,58E+04	0,00E+00	5,90E+02	0,00E+00	9,93E+03	0,00E+00	5,32E+03
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	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
EEE	MJ	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00

HWD = Hazardous waste disposed; NHWD = Non-hazardous waste disposed; RWD = Radioactive waste disposed; MER = Materials for energy recovery; MFR = Materials for recycling; CRU = Components for reuse; ETE= Exported thermal energy; EEE= Exported electricity energy.

3. Impact assessment of Cu 138 KV 2500:

Table 18: Impact assessment of Cu 138 KV 2500

IMPACT ASSESSMENT Cu 138 KV 2500								
			1. Manufacturing Stage		2. Distribution Stage	3. Installation Stage	4. Use and Maintenance Stage	5. End of Life Stage
INDICATOR	**UM**	**TOTAL**	**UPSTREAM**	**CORE**	**DOWNSTREAM**			
GWP – total	kg CO_2eq	3,89E+05	3,34E+05	3,78E+03	7,10E+03	3,56E+04	1,12E+00	8,69E+03
GWP – fossil	kg CO_2eq	3,76E+05	3,33E+05	3,78E+03	7,10E+03	3,06E+04	6,71E-01	1,92E+03
GWP – biogenic	kg CO_2eq	1,10E+04	2,10E+02	-2,10E+00	1,74E+00	4,44E+03	3,60E-01	6,31E+03
GWP – luluc	kg CO_2eq	1,04E+03	6,81E+02	3,35E-01	1,16E-01	2,86E+02	7,02E-02	6,80E+01
ODP	kg CFC-11eq	2,42E-02	1,86E-02	2,38E-05	1,48E-03	3,91E-03	6,24E-08	1,83E-04
POCP	kg NMVOC eq	1,40E+03	1,06E+03	1,11E+01	1,64E+02	1,52E+02	2,06E-03	1,22E+01
AP	mol H^+eq	2,47E+03	2,06E+03	1,84E+01	2,36E+02	1,48E+02	5,54E-03	8,80E+00
EP- freshw	kg P eq	1,15E+02	1,12E+02	6,21E-01	3,57E-02	2,81E+00	8,66E-05	1,64E-01
WDP	M3 depriv.	6,93E+04	6,29E+04	3,59E+02	-1,42E+01	6,00E+03	2,46E-01	4,69E+01
ADP – fossil	kg Sb eq	1,75E+00	1,75E+00	1,10E-04	9,91E-05	4,37E-03	6,30E-08	1,87E-04
ADP- min&met	MJ	4,47E+06	3,74E+06	3,11E+04	9,19E+04	5,90E+05	1,01E+01	1,82E+04

GWP-total = Global Warming Potential; 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, 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 deprivation potential, deprivation weighted water consumption

Table 19: Use of resources of Cu 138KV 2500

USE OF RESOURCES Cu 138 KV 2500								
			1. Manufacturing Stage		2. Distribution Stage	3. Installation Stage	4. Use and Maintenance Stage	5. End of Life Stage
INDICATOR	**UM**	**TOTAL**	**UPSTREAM**	**CORE**	**DOWNSTREAM**			
PENRE	MJ	4,47E+06	3,74E+06	3,11E+04	9,19E+04	5,92E+05	1,02E+01	1,87E+04
PERE	MJ	3,54E+05	3,38E+05	2,81E+03	1,22E+02	1,19E+04	1,55E+01	8,40E+02
PENRM	MJ	1,85E+01	1,81E+01	1,79E-01	2,47E-03	2,40E-01	1,50E-06	3,07E-03
PERM	MJ	6,46E+02	5,21E+02	2,41E-01	2,11E-01	1,24E+02	1,23E-04	4,01E-01
PENRT	MJ	4,47E+06	3,74E+06	3,11E+04	9,19E+04	5,92E+05	1,02E+01	1,87E+04
PERT	MJ	3,55E+05	3,39E+05	2,81E+03	1,22E+02	1,21E+04	1,55E+01	8,40E+02

FW	m3	2,21E+03	1,99E+03	1,05E+01	3,81E-01	2,12E+02	3,29E-03	2,75E+00
MS	kg	0,00E+00	0,00E+00	0,00E+00	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 materials; PERE = Use of renewable primary energy excluding renewable primary energy resources used as raw materials; PENRM = Use of nonrenewable primary energy resources used as raw materials; PERM = Use of renewable primary energy resources used as raw materials; PENRT = Total use of non-renewable primary energy resources; PERT = Total use of renewable primary energy resources; FW = Use of net fresh water; MS = Use of secondary material; RSF = Use of renewable secondary fuels; NRSF = Use of non-renewable secondary fuels.

Table 20: Waste production and output flows of per Cu 138KV 2500

WASTE PRODUCTION AND OUTPUT FLOWS AL 138 KV 1200								
			1. Manufacturing Stage		2. Distribution Stage	3. Installation Stage	4. Use and Maintenance Stage	5. End of Life Stage
INDICATOR	UM	TOTAL	UPSTREAM	CORE	DOWNSTREAM			
HWD	kg	1,40E+01	0,00E+00	1,40E+01	0,00E+00	0,00E+00	0,00E+00	0,00E+00
NHWD	kg	1,78E+04	0,00E+00	1,92E+02	0,00E+00	4,54E+02	0,00E+00	1,72E+04
RWD	kg	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
MER	kg	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
MFR	kg	2,11E+04	0,00E+00	1,32E+03	0,00E+00	4,97E+03	0,00E+00	1,49E+04
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	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
EEE	MJ	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00

HWD = Hazardous waste disposed; NHWD = Non-hazardous waste disposed; RWD = Radioactive waste disposed; MER = Materials for energy recovery; MFR = Materials for recycling; CRU = Components for reuse; ETE= Exported thermal energy; EEE= Exported electricity energy.

METHODOLOGY

The methodology followed as a reference standard is that of the Life Cycle Assessment, which considers all environmental aspects and potential environmental impacts along the life cycle of the product, from the extraction and transport of raw materials through manufacture and use, up to at the end of life.

FUNCTIONAL UNIT	The functional unit of the study is 1km of cable with a charge conventionally set at 1A for 40 years and a 100% utilization rate, as determined by the PCR.
EXCLUSIONS AND CUT OFF	The impacts from these things are not considered in the present study: - production, transport and installation of capital goods (buildings, infrastructures, machinery); - production, use and disposal of packaging for individual components and intermediate products; - materials and energy flows of the installation and dismantling phases, if these are carried out manually; - devices external to the cable itself, necessary for installation; - emission in water; - cable components whose total mass does not exceed 0.88% of the total weight of the Cu 138 KV 2500 cable, 0,84% of the Al 138 KV 2000 cable and 0.4% of the Al 138 KV 1200 cable.
DATA QUALITY	In the context of this study, the activity data are mainly of “primary type”, i.e., collected with the support of the Company for the specific production site. Secondary data refer to specific databases or to the most updated technical reference literature, to ensure a good level of reliability. In this study the secondary data that were used concern the installation phase, the use phase, and the end of life of the product.
REFERENCE PERIOD	The primary data collected in the context of this study refer to the year 2021.
ALLOCATION	The allocation criteria adopted for the LCA model comply with the reference standards. Most of the primary data used were provided by the client directly referring to the U.F. Some data from the production stage has instead been allocated to the product on the basis of production volumes. In detail, the allocation procedures were applied to the following processes relating to the cable production phase: - Distribution of the cable to the place of destination; - Energy and resource consumption.

STAGE	The following life cycle stages considered in the study: ***UPSTREAM E CORE*** **Manufacturing stage:** - Extraction of raw materials and production of materials / semi-finished / accessory products; - Packaging production; - Transport of materials / semi-finished products / accessory products; - Manufacturing and assembling of the product; - Waste disposal and recycling. **Distribution stage:** transport of the finished product to the final customer. **Installation stage:** The activities included in this phase of the life cycle concern the transport of cables to the installation site, the actual installation and disposal of packaging. Includes excavation operations, production, and processing of the HDPE pipe, and covering the excavation with sand. **Use and maintenance stage:** the electrical energy losses of the cables encountered during operation, for the whole duration of their life cycle (40 years). **End of life stage:** the transport of the product to the treatment site and the final disposal of the product. In the cable disposal scenario, the recycling of metal parts was considered while, for the other materials, the disposal scenarios were considered with reference to the Brazilian statistics (40% landfill and 60% recycling for copper; 30% landfill and 70% recycling for aluminium and 91% landfill, 7,6% incineration and 1,4% recycling for other waste)
Reference Service Life (RSL)	In this LCA study, functional to obtaining the EPD certification, a useful life was considered 40 years, in accordance with the provisions of the reference PCR.

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