HENGTONG OPTIC ELECTRIC CO., LTD

ENVIRONMENTAL PRODUCT DECLARATION

Product: name:

Underground medium voltage cables:

Cu/HEPR/CWS/PO 12/20 (24)kV 1x630mm2,

Al/XLPE/AL-PET/PE 12/20 (24)kV 3x1x185mm2

Aerial medium voltage cable:

Al/XLPE/AL-PET/PE+20SA 12/20 (24)kV 3x1x50+50Y mm2

Underground low voltage cables:

Al/XLPE/PO 0,6-1kV 3x150mm$^{2.}$ + 1x95mm^{2}

Site Plant:

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

Program Operator	EPDItaly
Publisher	EPDItaly
Declaration Number	HENGTONG003
Registration Number	EPDItaly0619
Issue date	17/04/2024
Valid to	17/04/2029

in compliance with ISO 14025 and EN 50693

General information

EPD OWNER	Hengtong Optic-Electric co., LTD
SITE	Hengtong avenue 88, Qidu, 215200, Suzhou City (China)
FIELD OF APPLICATION OF THE PRODUCT	This document refers to the study of: - two underground cables and one aerial cable suitable for the transport of medium voltage electricity: CU/HEPR/CWS/PO 12/20 (24)kV 1x630mm^2, Al/XLPE/AL-PET/PE 12/20 (24)kV 3x1x185mm^2 and Al/XLPE/AL-PET/PE+20SA 12/20 (24)kV 3x1x50+50Y mm^2. - One cable suitable for the transport of low voltage electricity: Al/XLPE/PO 0,6-1kV 3x150mm^2 + 1x95mm^2
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.
EPD type	Product specific EPD
CPC CODE	463 – family “Insulated wire and cable; optical fibre cables” and sub-sequent clusters
CONTACTS for information on the EPD	Elena Xu < xuyinong@htgd.com.cn >
PROJECT REPORT LCA	Via Cacciatori delle Alpi 1/a, 22070 Capiago Intimiano (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. 3 – 13/01/2023 Sub-PCR: EPDITALY016 "Electronic and electrical product and systems – Cables and wires" Rev. 2 del 25/09/2020

In this study were analyzed:

- 2 underground cables (CU/HEPR/CWS/PO 12/20 (24)kV 1x630mm^2 and Al/XLPE/AL-PET/PE 12/20 (24)kV 3x1x185mm^2) for transporting medium-voltage electricity. The conductor body is made of copper for the first cable and aluminum for the second one. 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. These two cables have similar features and weight but the first will be installed in Chile and the second in Italy. Here in after the two cables will be named respectively: Cu underground 20kV Chile and Al underground 20kV Italy;
- 1 aerial cable (Al/XLPE/AL-PET/PE+20SA 12/20 (24)kV 3x1x50+50Y mm^2) for transporting medium voltage electricity. The conductor body is made of aluminum and the coating of the conducting element is made up of various materials such as cross-linked polyethylene and insulating aluminum tapes that give thermal insulation and impermeability to the cable. This cable will be installed in Italy. Here in after the cable will be named: Al aerial 20kV Italy;
- 1 underground cable (Al/XLPE/PO 0,6-1kV 3x150mm$^{2.}$ + 1x95mm^2) for transporting low voltage electricity. The conductor body is made of aluminum and the coating of the conducting element is made up of cross-linked polyethylene and insulating polyolefin sheath that give thermal insulation and impermeability to the cable. This cable will be installed in Italy. Here in after the cable will be named: Al underground 1kV Italy.

The assessment of the four cables 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 cables.

Table 1 Components and total weight

Materials	Unit	Cu underground 20kV Chile	Al underground 20kV Italy	Al aerial 20kV Italy	Al underground 1kV Italy
Copper conductor	kg/km	5.829	-		-
Aluminum conductor	kg/km	-	1.488	394	1.428
Insulation material	kg/km	1.026	1.060	712	251
Outer Sheath	kg/km	552	863	506	468
Other	kg/km	350	812	927	-
Cable total weight	kg/km	7.759	4.224	2.539	2.148

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 was analyzed two medium voltage underground cables, one medium voltage aerial cable and one underground low voltage cable. Three cables have an aluminum conductor body for the transport and distribution of electrical energy while one cable have copper conductor. 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 cables.

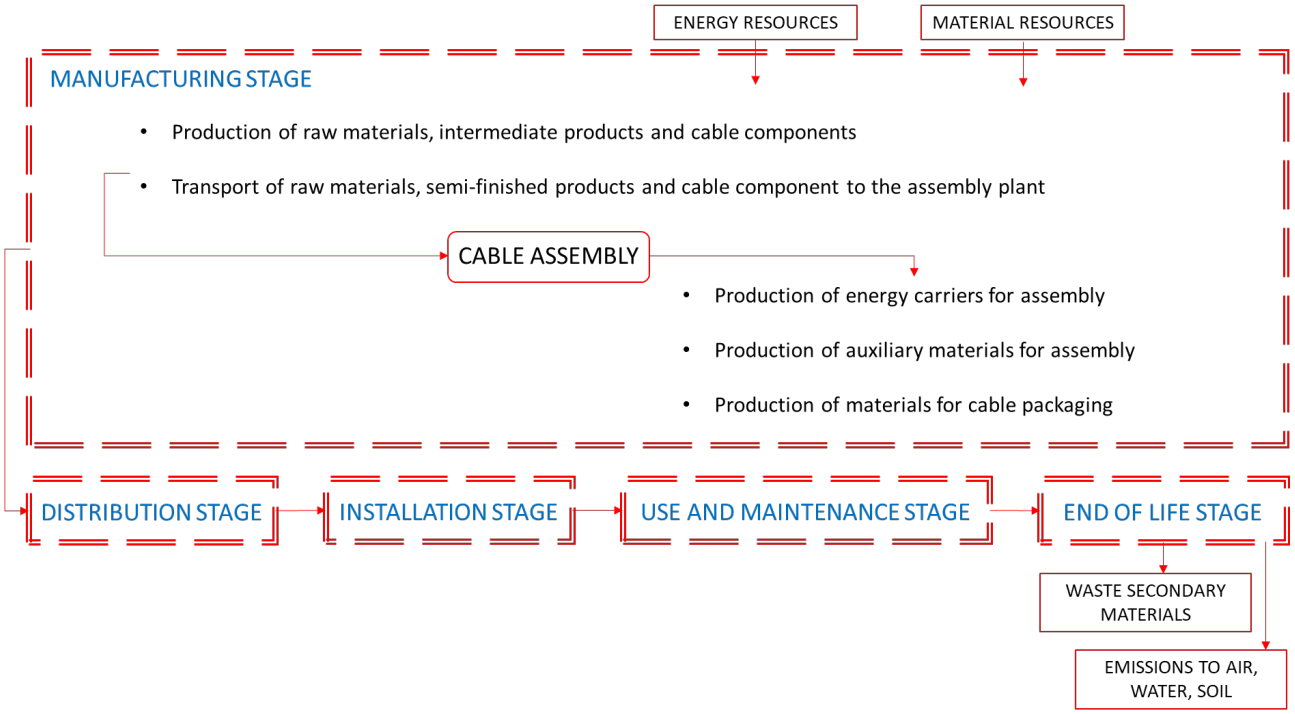
After production, the cables are rolled up on wood drum and covered with wood; they are then transported first by truck and then by ship to the installation site (Chile and Italy). The medium voltage underground cables are laid underground within a high-density polyethylene pipe; aerial medium voltage cable is positioned using concrete posts and a steel cable as support. 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 STAGE</th><th>END-OF-LIFE STAGE</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 Italy for Al underground 20KV Italy, Al aerial 20kV Italy and Al underground 1kV Italy cable and Chile for Cu underground 20kV Chile cable.
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 Cu underground 20kV Chile

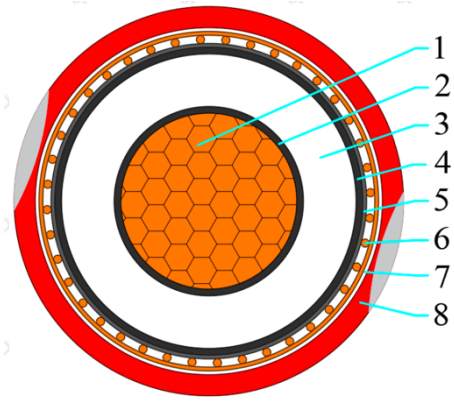


Table 3 shows all the cable components with description

Table 3 Cable features of Cu underground 20kV Chile

No.	Construction	Description
1	Conductor	Class 2, plain annealed circular compact copper conductor
2	Conductor screen	Extruded Semi-conductive compound
3	Insulation	EPR
4	Insulation screen	Extruded Semi-conductive compound
5	Separation layer	Semi-conducting water blocking tape
6	Metallic screen	Plain annealed copper wires with open helix copper tape
7	Binder tape	Non-conducting water blocking tape
8	Outer sheath	PO

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

Tabella 4 Cable mechanical e technical parameter of Cu underground 20kV Chile

No.	Description	unit	Parameters
Mechanical Parameters			
1	Approx. diameter of conductor	mm	29,8
2	Nominal thickness of insulation	mm	5,5
3	Nominnal thickness of outer sheath	mm	2,75
4	Max. diameter of cable	mm	56,7
5	Total weight of completed cable (Approx.)	kg/km	7.759
Electrical Parameters			
1	Rated voltage of cable, U0/U(Um)	kV	12/20(24)
3	Maximum DC resistance of conductor at 20°C	Ohm/km	0,0283
4	Maximum AC resistance of conductor at 90°C	Ohm/km	0,0422
5	Fault current carryng of conductor, 1s	kA	84,9
6	Fault current carryng of screen, 1s	kA	1,9
7	Conductor to screen capacitance	µF/km	0,560

2. Cable Al underground 20kV Italy

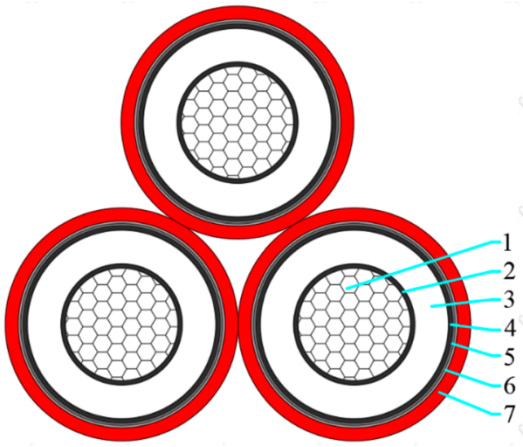


Table 5 shows all the cable components with description of Al underground 20kV Italy.

Table 5 Cable features of Al underground 20kV Italy

No.	Construction	Description
1	Conductor	Class 2, hard-drawn circular compacted aluminium conductor
2	Conductor screen	Semi-conductive compound
3	Insulation	XLPE
4	Insulation screen	Semi-conductive compound
5	Bedding layer	Semi-conducting water blocking tape
6	Metallic screen	Longitudinal Poly-laminated aluminum foil overlap
7	Outer sheath	PE/Red/UV-resistant

Table 6 shows the cable technical parameters and specifically the mechanical and electrical parameter.

Tabella 6 Cable mechanical e technical parameter of Al underground 20kV Italy

No.	Description	unit	Parameters
Mechanical Parameters			
1	Approx. diameter of conductor	mm	16,0
2	Nominal thickness of insulation	mm	4,9
3	Nominnal thickness of outer sheath	mm	2,8
4	Max. diameter of cable	mm	84,0
5	Total weight of completed cable (Approx.)	kg/km	4.225
Electrical Parameters			
1	Rated voltage of cable, U0/U(Um)	kV	12/20(24)
3	Maximum DC resistance of conductor at 20℃	Ohm/km	0,164
4	Maximum AC resistance of conductor at 90℃	Ohm/km	0,211
5	Fault current carryng of conductor, 1s	kA	17,5
6	Fault current carryng of screen, 1s	kA	2,0
7	Conductor to screen capacitance	μF/km	0,294

3. Cable Al aerial 20kV Italy

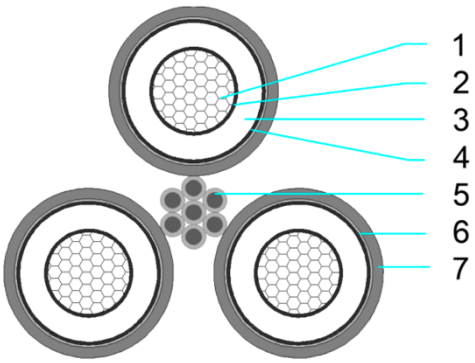


Table 7 shows all the cable components with description of Al aerial 20kV Italy

Table 7 Cable features of Al aerial 20kV Italy

No.	Construction	Description
1	Conductor	Class 2, circular compact aluminum conductor
2	Conductor screen	Extruded Semi-conductive compound
3	Insulation	XLPE
4	Insulation screen	Extruded Semi-conductive compound
5	Messenger	Aluminum clad steel wires (Type 20SA)
6	Metallic screen	Longitudinal Poly-laminated aluminum foil overlap
7	Outer sheath	PE/Grey/UV-resistant

Table 8 shows the cable technical parameters and specifically the mechanical and electrical parameter.

Tabella 8 Cable mechanical e technical parameter of Al aerial 20kV Italy

No.	Description	unit	Parameters
Mechanical Parameters			
1	Approx. diameter of conductor	mm	8,3
2	Nominal thickness of insulation	mm	4,9
3	Nominnal thickness of outer sheath	mm	1,9
4	Max. diameter of cable	mm	72,6
5	Total weight of completed cable (Approx.)	kg/km	2.539
Electrical Parameters			
1	Rated voltage of cable, U0/U(Um)	kV	12/20(24)
3	Maximum DC resistance of conductor at 20℃	Ohm/km	0,641
4	Maximum AC resistance of conductor at 90℃	Ohm/km	0,822
5	Fault current carryng of conductor, 1s	kA	4,7
6	Fault current carryng of screen, 1s	kA	1,57
7	Conductor to screen capacitance	μF/km	0,190

4. Cable Al underground 1kV Italy

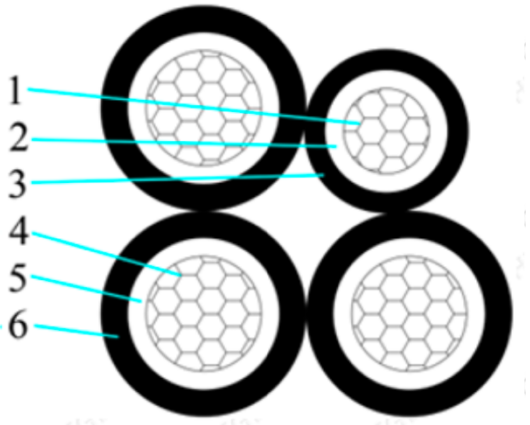


Table 9 shows all the cable components with description of Al underground 1kV Italy.

Table 9 Cable features of Al underground 1kV Italy

No.	Construction	Description
1	Neutral core conductor	Class 2, hard-draw circular compacted aluminium conductor
2	Neutral core insulation	XLPE
3	Neutral core sheath	PO
4	Phase core conductor	Class 2, hard-draw circular compacted aluminium conductor
5	Phase core insulation	XLPE
6	Phase core sheath	PO

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

Tabella 10 Cable mechanical e technical parameter of Al underground 1kV Italy

No.	Description	unit	Parameters
Mechanical Parameters			
1	Approx. diameter of phase conductor	mm	14,4
2	Approx. diameter of neutral conductor	mm	11,4
3	Nominal thickness of insulation of phase conductor	mm	1,4
4	Nominal thickness of insulation of neutral conductor	mm	1,1
5	Nominnal thickness of outer sheath	mm	1,4
6	Max. diameter of cable	mm	52,3
7	Total weight of completed cable (Approx.)	kg/km	2.148
Electrical Parameters			
1	Rated voltage of cable, U0/U(Um)	kV	0,6/1
3	Maximum DC resistance of phase conductor at 20°C	Ohm/km	0,206
4	Maximum DC resistance of earth conductor at 20°C	Ohm/km	0,320
5	Maximum AC resistance of conductor at 90°C	Ohm/km	0,265
6	Fault current carryng of conductor, 1s	kA	14,2

Impact Assessment

1. Impact assessment of Cu underground 20kV Chile:

Table 9: Impact assessment of Cu underground 20kV Chile

IMPACT ASSESSMENT								
			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	2,95E+04	1,61E+04	1,30E+03	1,89E+03	5,68E+03	8,38E+00	4,48E+03
GWP – fossil	kg CO_2eq	2,90E+04	1,89E+04	1,30E+03	1,89E+03	5,72E+03	8,37E+00	1,12E+03
GWP – biogenic	kg CO_2eq	4,84E+02	-2,83E+03	6,47E+00	4,91E-01	-4,84E+01	4,35E-03	3,36E+03
GWP – luluc	kg CO_2eq	2,87E+01	2,53E+01	8,10E-01	3,16E-02	2,52E+00	4,50E-04	5,96E-02
ODP	kg CFC-11eq	3,17E-03	2,44E-03	2,01E-06	4,01E-04	2,45E-04	1,91E-07	8,02E-05
POCP	kg NMVOC eq	2,03E+02	1,36E+02	4,01E+00	3,80E+01	2,24E+01	4,11E-02	2,85E+00
AP	mol H^+eq	7,22E+02	6,33E+02	7,12E+00	5,37E+01	2,54E+01	6,77E-02	2,25E+00
EP- freshw	kg P eq	3,03E+01	2,90E+01	2,17E-01	1,40E-02	9,89E-01	6,29E-03	9,30E-02
WDP	m^3 depriv.	1,49E+04	1,16E+04	8,54E+02	-1,38E+00	2,41E+03	3,06E-01	4,76E+01
ADP – fossil	MJ	4,66E+05	2,70E+05	1,53E+04	2,49E+04	1,51E+05	9,72E+01	5,31E+03
ADP - min&met	kg Sb eq	1,41E+01	1,41E+01	8,98E-05	4,87E-05	1,09E-03	4,60E-08	5,83E-05

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 10: Use of resources of Cu underground 20kV Chile

USE OF RESOURCES								
			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	4,71E+05	2,73E+05	1,53E+04	2,57E+04	1,51E+05	1,00E+02	5,45E+03
PERE	MJ	5,38E+04	4,25E+04	3,82E+03	4,17E+01	3,69E+03	2,33E+01	4,91E+01
PENRM	MJ	6,18E+00	5,71E+00	2,70E-02	1,68E-03	5,32E-02	5,46E-05	9,05E-04
PERM	MJ	3,84E+04	4,21E+04	4,22E-04	1,02E-01	5,51E+01	1,81E-04	3,10E-01
PENRT	MJ	4,71E+05	2,73E+05	1,53E+04	2,57E+04	1,51E+05	1,00E+02	5,45E+03
PERT	MJ	9,22E+04	8,46E+04	3,82E+03	4,18E+01	3,75E+03	2,33E+01	4,94E+01
FW	m^3	3,62E+02	2,96E+02	2,42E-03	2,14E-01	6,37E+01	9,67E-02	1,64E+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 11: Waste production and output flows of Cu underground 20kV Chile

WASTE PRODUCTION AND OUTPUT FLOWS								
			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	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
NHWD	kg	3,96E+03	0,00E+00	9,21E+00	0,00E+00	0,00E+00	0,00E+00	3,95E+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	5,20E+03	0,00E+00	1,28E+02	0,00E+00	1,25E+03	0,00E+00	3,81E+03
CRU	kg	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	9,00E+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 underground 20kV Italy:

Table 12: Impact assessment of Al underground 20kV Italy

IMPACT ASSESSMENT								
			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	5,68E+04	4,71E+04	7,22E+02	1,22E+03	5,20E+03	3,13E+01	2,57E+03
GWP – fossil	kg CO_2eq	5,97E+04	5,13E+04	7,12E+02	1,22E+03	5,24E+03	2,86E+01	1,15E+03
GWP – biogenic	kg CO_2eq	-2,87E+03	-4,26E+03	8,70E+00	3,38E-01	-3,50E+01	2,72E+00	1,42E+03
GWP – luluc	kg CO_2eq	1,31E+01	1,05E+01	4,51E-01	1,68E-02	2,07E+00	2,20E-03	1,15E-02
ODP	kg CFC-11eq	2,59E-03	2,01E-03	1,21E-06	2,66E-04	2,61E-04	4,00E-06	4,86E-05
POCP	kg NMVOC eq	2,20E+02	1,74E+02	2,20E+00	2,21E+01	2,09E+01	5,93E-02	1,52E+00
AP	mol H^+eq	3,98E+02	3,40E+02	3,91E+00	3,09E+01	2,13E+01	1,28E-01	1,38E+00
EP- freshw	kg P eq	1,40E+01	1,29E+01	1,21E-01	5,30E-03	9,20E-01	6,34E-03	7,01E-02
WDP	m^3 depriv.	1,19E+04	6,88E+03	7,86E+02	-2,87E+00	4,17E+03	1,96E+01	8,12E+01
ADP – fossil	MJ	7,54E+05	5,59E+05	8,39E+03	1,63E+04	1,67E+05	4,43E+02	3,03E+03
ADP - min&met	kg Sb eq	8,13E-01	8,13E-01	7,30E-05	2,58E-05	3,78E-04	3,49E-07	2,74E-05
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 underground 20kV Italy

USE OF RESOURCES								
			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	7,54E+05	5,61E+05	8,39E+03	1,63E+04	1,67E+05	4,43E+02	3,03E+03
PERE	MJ	5,90E+04	4,48E+04	2,08E+03	2,27E+01	5,04E+03	1,16E+02	5,97E+01
PENRM	MJ	1,56E+00	1,48E+00	5,14E-03	7,27E-04	5,31E-02	1,27E-04	5,09E-04
PERM	MJ	4,42E+04	5,13E+04	9,30E-05	4,84E-02	7,54E+01	8,97E-04	1,01E+00
PENRT	MJ	7,54E+05	5,61E+05	8,39E+03	1,63E+04	1,67E+05	4,43E+02	3,03E+03
PERT	MJ	1,03E+05	9,61E+04	2,08E+03	2,28E+01	5,12E+03	1,16E+02	6,07E+01
FW	m^3	5,57E+03	5,10E+03	9,02E-01	7,24E-02	7,43E+01	4,83E-01	2,16E+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 14: Waste production and output flows of Al underground 20kV Italy

WASTE PRODUCTION AND OUTPUT FLOWS								
			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	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
NHWD	kg	2,72E+03	0,00E+00	1,18E+01	0,00E+00	0,00E+00	0,00E+00	2,71E+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	3,37E+03	0,00E+00	5,72E+01	0,00E+00	1,80E+03	0,00E+00	1,51E+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 Al aerial 20kV Italy:

Table 12: Impact assessment of Al aerial 20kV Italy

IMPACT ASSESSMENT								
			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	2,74E+04	2,36E+04	5,11E+02	7,02E+02	4,18E+02	1,22E+02	2,12E+03
GWP – fossil	kg CO_2eq	2,82E+04	2,58E+04	5,05E+02	7,01E+02	4,15E+02	1,11E+02	7,48E+02
GWP – biogenic	kg CO_2eq	-7,94E+02	-2,19E+03	5,58E+00	1,94E-01	2,48E+00	1,06E+01	1,37E+03
GWP – luluc	kg CO_2eq	9,06E+00	8,08E+00	3,24E-01	9,65E-03	6,31E-01	8,56E-03	6,78E-03
ODP	kg CFC-11eq	1,42E-03	1,18E-03	9,20E-07	1,53E-04	4,26E-05	1,56E-05	2,92E-05
POCP	kg NMVOC eq	1,03E+02	8,60E+01	1,56E+00	1,27E+01	1,71E+00	2,31E-01	1,04E+00
AP	mol H^+eq	1,84E+02	1,61E+02	2,77E+00	1,77E+01	1,62E+00	5,00E-01	8,66E-01
EP- freshw	kg P eq	6,13E+00	5,88E+00	8,67E-02	3,04E-03	8,61E-02	2,47E-02	5,03E-02
WDP	m^3 depriv.	4,77E+03	3,81E+03	7,62E+02	-1,65E+00	7,05E+01	7,64E+01	5,19E+01
ADP – fossil	MJ	3,21E+05	2,98E+05	5,95E+03	9,35E+03	4,17E+03	1,72E+03	1,82E+03
ADP - min&met	kg Sb eq	2,20E-01	2,20E-01	6,71E-05	1,48E-05	7,28E-04	1,36E-06	1,72E-05

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 aerial 20kV Italy

USE OF RESOURCES								
			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	3,21E+05	2,99E+05	5,95E+03	9,35E+03	4,18E+03	1,72E+03	1,82E+03
PERE	MJ	2,63E+04	2,13E+04	1,47E+03	1,30E+01	1,37E+02	4,51E+02	2,74E+01
PENRM	MJ	1,88E+00	1,81E+00	7,20E-03	5,83E-04	1,77E-02	9,41E-04	5,24E-04
PERM	MJ	2,45E+04	2,75E+04	6,28E-05	2,75E-02	2,33E-01	3,46E-03	4,15E-01
PENRT	MJ	3,21E+05	2,99E+05	5,95E+03	9,35E+03	4,18E+03	1,72E+03	1,82E+03
PERT	MJ	5,08E+04	4,88E+04	1,47E+03	1,31E+01	1,37E+02	4,51E+02	2,78E+01
FW	m^3	2,29E+02	1,52E+02	5,79E-04	7,24E-02	7,43E+01	4,83E-01	2,16E+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 14: Waste production and output flows of Al aerial 20kV Italy

WASTE PRODUCTION AND OUTPUT FLOWS								
			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	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
NHWD	kg	1,73E+03	0,00E+00	7,57E+00	0,00E+00	0,00E+00	0,00E+00	1,73E+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	1,76E+03	0,00E+00	2,21E+01	0,00E+00	9,20E+02	0,00E+00	8,14E+02
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.

4. Impact assessment of Al underground 1kV Italy:

Table 12: Impact assessment of Al underground 1kV Italy

IMPACT ASSESSMENT								
			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	3,76E+04	3,55E+04	1,57E+02	6,14E+02	1,06E+02	3,64E+01	1,22E+03
GWP – fossil	kg CO_2eq	3,89E+04	3,76E+04	1,54E+02	6,14E+02	1,06E+02	3,32E+01	4,05E+02
GWP – biogenic	kg CO_2eq	-1,24E+03	-2,07E+03	2,76E+00	1,70E-01	3,52E-02	3,15E+00	8,17E+02
GWP – luluc	kg CO_2eq	6,80E+00	6,68E+00	1,08E-01	8,45E-03	8,66E-04	2,55E-03	3,70E-03
ODP	kg CFC-11eq	1,17E-03	9,80E-04	4,34E-07	1,34E-04	2,54E-05	4,64E-06	2,33E-05
POCP	kg NMVOC eq	1,41E+02	1,28E+02	4,77E-01	1,11E+01	5,17E-01	6,89E-02	7,41E-01
AP	mol H^+eq	2,81E+02	2,64E+02	8,43E-01	1,55E+01	4,91E-01	1,49E-01	6,11E-01
EP- freshw	kg P eq	1,03E+01	1,03E+01	2,88E-02	2,66E-03	4,38E-04	7,36E-03	2,63E-02
WDP	m^3 depriv.	5,21E+03	4,45E+03	7,20E+02	-1,44E+00	-2,54E-01	2,28E+01	2,48E+01
ADP – fossil	MJ	3,52E+05	3,38E+05	1,82E+03	8,19E+03	1,52E+03	5,14E+02	1,44E+03
ADP - min&met	kg Sb eq	7,78E-01	7,78E-01	5,70E-05	1,30E-05	4,65E-06	4,06E-07	9,97E-06

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 underground 1kV Italy

USE OF RESOURCES								
			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	3,52E+05	3,39E+05	1,82E+03	8,19E+03	1,52E+03	5,14E+02	1,44E+03
PERE	MJ	2,32E+04	2,20E+04	4,27E+02	1,14E+01	2,32E+00	1,77E+02	1,98E+01
PENRM	MJ	2,49E+00	2,46E+00	2,51E-03	5,11E-04	7,46E-05	2,80E-04	3,37E-04
PERM	MJ	2,92E+04	3,00E+04	2,54E-05	2,43E-02	7,39E-03	1,37E-03	2,47E-01
PENRT	MJ	3,52E+05	3,39E+05	1,82E+03	8,19E+03	1,52E+03	5,14E+02	1,44E+03
PERT	MJ	5,24E+04	5,20E+04	4,27E+02	1,14E+01	2,33E+00	1,77E+02	2,00E+01
FW	m^3	9,71E+01	9,56E+01	1,44E-04	2,98E-02	4,17E-03	6,07E-01	8,33E-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 underground 1kV Italy

WASTE PRODUCTION AND OUTPUT FLOWS								
			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	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
NHWD	kg	1,01E+03	0,00E+00	3,62E+00	0,00E+00	0,00E+00	0,00E+00	1,00E+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	2,99E+03	0,00E+00	9,46E+02	0,00E+00	9,00E+02	0,00E+00	1,14E+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.

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: - electricity consumption for office; - 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.
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 2023.
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.

DOWNSTREAM

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 for underground medium voltage cables and production and processing of concrete posts and steel cable for aerial medium voltage cable.

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.

The disposal scenario of the three cable Al underground 20kV Italy, Cu underground 20kV Chile and Al aerial 20kV Italy is defined on the basis of the following assumptions: for aluminum: 30% landfill and 70% recycling; for plastic fractions 80% incineration and 20% recycling; for metal tape 100% landfill.

The disposal scenario of the cable Al underground 1kV Italy is defined on the basis of the following assumptions: for aluminum: 30% landfill and 70% recycling; incineration for plastic fractions.

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.

REFERENCES:

- ISO 14040:2006 Environmental management - Life cycle assessment - Principles and framework
- ISO 14044:2006 Environmental management - Life cycle assessment - Requirements and guidelines
- ISO 14020:2000 Environmental labels and declarations -- General principles
- UNI EN ISO 14025:2010, Etichette e dichiarazioni ambientali - Dichiarazioni ambientali di Tipo III - Principi e procedure
- EN 50693:2019 Product category rules for life cycle assessments of electronic and electrical products and systems
- UNI EN 15804:2012+A1:2013+A2:2019 Sustainability of construction works - Environmental product declarations - Core rules for the product category of construction products
- Regolamento EPDItaly rev. 6.0 del 30/10/2023
- PCR EPDItaly007 – PCR for electronic and electrical product and systems – Rev.3 13/01/2023
- PCR EPDItaly016 – PCR for electronic and electrical product and systems – Cables and wires – Rev.2 25/09/2020
- Report LCA, LCA of 3 medium voltage electric cables: Cu underground 20kV, Al underground 20kV, Al aerial 20kV and one low voltage electric cable: Al underground 1kV. Edition 1, April 2024
- Ecoinvent, 2021, The Swiss Centre for Life Cycle Inventories, Ecoinvent v3.8
- SimaPro, https://simapro,com/
- Chen et al. 2019. Life cycle assessment of end-of-life treatments of waste plastics in China
- GIOTTO. Tubazioni corrugate pieghevoli in PE per passaggio e protezione interrata di cavi eletrici, telefonici e sistemi di telecomunicazioni
- Power System Operation, 2020. Life Cycle Assessment of Underground Cables
- EPD – Prysmian Group: Low voltage 0,6/1 kV underground cables: ARE4EX 3x1x150+95N mm^2 ARE4EX 3x1x240+150N mm^2
- EPD – Prysmian Group: Medium voltage 12/20 kV underground cables: ARP1H5EX 3x1x185 mm^2 ARP1H5EX 3x1x240 mm^2