Cable and jumper Product Carbon Footprint Verification Report

Client: Zhongtian Radio Frequency Cable Co., Ltd

Verification Body: TÜV SÜD Certification and Testing (China) Co., Ltd.

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Abstract of product carbon footprint verification

Name of the client	Zhongtian Radio Frequency Cable Co., Ltd		
Name of responsible party	Zhongtian Radio Frequency Cable Co., Ltd		
Address of responsible party	No 105 Qixin Road Economic & Technological Development Zone 226010 NanTong, Jiangsu Province		
Actual production address	No 105 Qixin Road Economic & Technological Development Zone 226010 NanTong, Jiangsu Province		
Name of the verified product	Cable Jumper		
Verified product series	**Product category**	**Product model**	
	Cable	HCAAY-50-12	
		HCAAYZ-50-12	
		HRCAYZ-50-9	
		HRCAY-50-9	
		HCTAYZ-50-23	
		HCTAY-50-22	
		HCTAY-50-32	
		HHTAY-50-42	
		HLRWUCYZ-50-22T	
		HLRHTCYZ-50-32T	
	Jumper	4310M-4310M-9*2	
		4310M-4310M-9*15	
		NM-NM-9*2	
		4310M-4310MA-9*5	
		4310M-DM-9*3	
		4310M-NM-9*3	
		4310M-DMA-9*3	
		DM-DMA-9*3	
		NM-NM-12*3	
		DM-DM-12*2	
Time period	**Product category**	**Product model**	**Time period**
	Cable	HCAAY-50-12	2023-01-01~2023-12-31
		HCAAYZ-50-12	2023-01-01~2023-12-31
		HRCAYZ-50-9	2023-01-01~2023-12-31
		HRCAY-50-9	2023-01-01~2023-12-31

		HCTAYZ-50-23	2023-11-01~2023-11-30
		HCTAY-50-22	2023-07-01~2023-12-31
		HCTAY-50-32	2023-12-01~2023-12-31
		HHTAY-50-42	2023-12-01~2023-12-31
		HLRWUCYZ-50-22T	2023-06-01~2023-12-31
		HLRHTCYZ-50-32T	2023-01-01~2023-12-31
	Jumper	4310M-4310M-9*2	2023-08-01~2023-08-31
		4310M-4310M-9*15	2023-01-01~2023-03-31
		NM-NM-9*2	2023-01-01~2023-03-31
		4310M-4310MA-9*5	2023-02-01~2023-02-28
		4310M-DM-9*3	2023-01-01~2023-06-30
		4310M-NM-9*3	2023-09-01~2023-10-31
		4310M-DMA-9*3	2023-02-01~2023-02-28
		DM-DMA-9*3	2023-02-01~2023-02-28
		NM-NM-12*3	2023-01-01~2023-04-30
		DM-DM-12*2	2023-09-01~2023-09-30

System boundary	From Cradle to Gate: from acquisition of raw materials stage to manufacturing stage		
Declared unit	1 kilometer of cable 1 kilometer of jumper		
Verification criteria	☒ ISO 14067:2018 Greenhouse gases – Carbon footprint of products – Requirements and guidelines for quantification ☐ PAS 2050:2011 Specification for the assessment of the life cycle greenhouse gas emissions of goods and services ☒ ISO 14064-3:2019 Greenhouse gases – Part 3: Specification with guidance for the verification and validation of greenhouse gas statements ☐ Others: e.g. systems related to GHG quantification and reporting developed by the client		
Verification Purpose	☒ To confirm the correctness and conformity of the claim from the responsible party according to verification criteria ☒ To provide an independent evaluation of relevant information through objective evidence, including: whether the information in the GHG report meets the principles of relevance, completeness, consistency, accuracy and transparency; whether there are material errors and omissions in the reported data results; and whether the level of assurance provided is met ☐ Others:		
Operation rule	CCB_GHG_GR_001CS Version 02		
Product carbon	**Product category**	**Product model**	**Carbon emission**

footprint claim			（$kgCO_2eq/km$）
	Cable	HCAAY-50-12	2.40E+03
		HCAAYZ-50-12	2.41E+03
		HRCAYZ-50-9	1.79E+03
		HRCAY-50-9	1.77E+03
		HCTAYZ-50-23	2.72E+03
		HCTAY-50-22	2.71E+03
		HCTAY-50-32	4.80E+03
		HHTAY-50-42	5.81E+03
		HLRWUCYZ-50-22T	1.62E+03
		HLRHTCYZ-50-32T	2.87E+03
	Jumper	4310M-4310M-9*2	1.88E+03
		4310M-4310M-9*15	1.50E+03
		NM-NM-9*2	1.74E+03
		4310M-4310MA-9*5	1.62E+03
		4310M-DM-9*3	1.72E+03
		4310M-NM-9*3	1.68E+03
		4310M-DMA-9*3	1.77E+03
		DM-DMA-9*3	1.82E+03
		NM-NM-12*3	2.13E+03
		DM-DM-12*2	2.61E+03
Product carbon footprint statement	**Product category**	**Product model**	**Carbon emission （$kgCO_2eq/km$）**
	Cable	HCAAY-50-12	2.40E+03
		HCAAYZ-50-12	2.41E+03
		HRCAYZ-50-9	1.79E+03
		HRCAY-50-9	1.77E+03
		HCTAYZ-50-23	2.72E+03
		HCTAY-50-22	2.71E+03
		HCTAY-50-32	4.80E+03
		HHTAY-50-42	5.81E+03
		HLRWUCYZ-50-22T	1.62E+03
		HLRHTCYZ-50-32T	2.87E+03
	Jumper	4310M-4310M-9*2	1.88E+03
		4310M-4310M-9*15	1.50E+03
		NM-NM-9*2	1.74E+03
		4310M-4310MA-9*5	1.62E+03
		4310M-DM-9*3	1.72E+03

		4310M-NM-9*3	1.68E+03
		4310M-DMA-9*3	1.77E+03
		DM-DMA-9*3	1.82E+03
		NM-NM-12*3	2.13E+03
		DM-DM-12*2	2.61E+03
Analysis of the difference between product carbon footprint claim and statement	The product carbon footprint statement is consistent with the product carbon footprint claim.		
Category and name of field of specialization	B14 Power distribution and control equipment and its parts; insulated wires and cables; fiber optic cables		
Materiality	Less than 5% of total carbon emissions in the system boundary		
Level of assurance	☒ Reasonable assurance level ☐ Limited assurance level		
Date of document review	2024-02-07		
Date of on-site verification	2024-02-16		
Verification team leader	Kerry Yan		
Verification team member	-		
Other personnel (observers, interns/trainees, external auditors, etc.)	Tony Sun ; Abby Qin ; Solomon J. Zhou ; Aryn Yang Seph Lin ; Fiona Wang		
Address of the verification body	TÜV SÜD Certification and Testing (China) Co., Ltd. Guangzhou Branch 5F, Communication Building, 163 Pingyun Rd, Huangpu Ave. West, Guangzhou 510656 P.R. China		

Statement of responsibility
1）The responsible party is responsible for the compliance of the Product Carbon Footprint claim with

the ISO 14067:2018 standard, and the Responsible Party is responsible for the preparation and fair presentation of the Product Carbon Footprint Report in accordance with the standard; 2）The verifier is responsible for issuing a verification statement based on the verification of the product's carbon footprint claim, and the verification process and results are in accordance with ISO 14064-3:2019; 3）The procedure for collecting verification evidence for the assessment of GHG declarations is: CCB_GHG_P_09ECS Procedures for the Implementation of the Greenhouse Gas Validation and Verification Process.
Verification conclusion：
The product carbon footprint verification statement is based on ISO 14064-3:2019 to verify the claim of the responsible party that “The cradle-to-gate carbon footprint associated with cable model HCAAY-50-12 (10 models in total, see product series) and jumper model 4310M-4310M-9*2 (10 models in total, see product series) produced by the responsible party within the manufacturing geographical boundary and time boundary is 2.40E+03 kgCO_2eq/kg (for the remaining 9 cable model, see product carbon footprint claim) and 1.88E+03 kgCO_2eq/kg (for the remaining 9 jumper model, see product carbon footprint claim)". It was verified regarding compliance with the requirements of ISO 14067:2018. The product carbon footprint claim is consistent with the product carbon footprint verification statement.

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Abbreviations

PCR	Product Category Rule
IPCC	The Intergovernmental Panel on Climate Change
GWP	Global Warming Potentials
LCA	Life Cycle Assessment
GLO	Global average
RoW	Rest of World
tkm	tonne kilometre (unit for transportation services)
PTFE	Polytetrafluorethylene
CN	China
HDPE	High-density polyethylene
LDPE	Low-density polyethylene
PE	Polyethylene
LSZH	Low smoke zero halogen
EVA	Ethyl vinyl acetate
POE	Polyolefin elastomer
ECGC	East China grid
JS	Jiangsu
DQR	Data Quality Rating
CV	Control Value

1 General description of verification

1.1 Verification purposes

TÜV SÜD Certification and Testing (China) Co., Ltd. (hereinafter referred to as TÜV SÜD) was commissioned by Zhongtian Radio Frequency Cable Co., Ltd to carry out product carbon footprint verification on cable and jumper of Zhongtian Radio Frequency Cable Co., Ltd (hereinafter referred to as the responsible party).

The purposes of this verification include: 1) to confirm the correctness and conformity of the claim from the responsible party according to verification criteria; 2) to provide an independent evaluation of relevant information through objective evidence, including: whether the information in the GHG report meets the principles of relevance, completeness, consistency, accuracy and transparency; whether there are material errors and omissions in the reported data results; and whether the level of assurance provided is met.

1.2 Verification criteria

This verification was mainly conducted based on ISO 14067:2018 *Greenhouse gases – Carbon footprint of products – Requirements and guidelines for quantification* and ISO 14064-3:2019 *Greenhouse gases – Part 3: Specification with guidance for the verification and validation of greenhouse gas statements*. The verification also referred to parts of the *Suggestions for Updating the Product Environmental Footprint Methodology* (hereinafter referred to as PEF) and the *Product Environmental Footprint Category Rules Guidance* (version 6.3, hereinafter referred to as PEFCR Guidelines). As of this verification, EN 15804:2012+A2:2019 *Sustainability of construction works – Environmental product declarations – Core rules for the product category of construction products* was being referred. Other relevant standards and literature that also referred to are listed in the *References* section of this verification report.

1.3 Verification evidence-gathering procedures

TÜV SÜD conducted document review and on-site verification of the responsible party on 2024-02-07 and 2024-02-16 respectively. The objects and contents include basic information of the enterprise, inventory of emission facilities, inventory of emission sources, inventory of monitoring equipment, information related to activity level and emission factors, etc. Through the strategic analysis of verification activities and risk assessment to identify the risks of verification activities in advance, a reasonable evidence-gathering plan was developed for:

1) Accounting boundaries, emission facilities and emission sources identification of the responsible party, etc.

2) Information management for the acquisition, recording, transmission and aggregation of activity level data and parameters related to emissions within the system boundary of responsible party.

3) Accounting methods and emission data calculation process.

4) Calibration and maintenance of measuring instruments and monitoring equipment.

5) Verification of quality assurance and documentation archiving.

The responsible party provided relevant supporting materials and evidentiary materials according to the evidence-gathering plan formulated by the verification team. Verification activity performed 100% of collection for data sources and all sampling for data source for cross check.

1.4 Statement of responsibility

1）The responsible party is responsible for the compliance of the Product Carbon Footprint claim with the ISO 14067:2018 standard, and the Responsible Party is

responsible for the preparation and fair presentation of the Product Carbon Footprint Report in accordance with the standard;

2）The verifier is responsible for issuing a verification statement based on the verification of the product's carbon footprint claim, and the verification process and results are in accordance with ISO 14064-3:2019;

3）The procedure for collecting verification evidence for the assessment of GHG declarations is: CCB_GHG_P_09ECS Procedures for the Implementation of the Greenhouse Gas Validation and Verification Process.

1.5 General information of responsible party and verified product

Founded in December 2004, Zhongtian RF Cable Co., Ltd. covers an area of 70,500 square meters, building area of 40,000 square meters, with a registered capital of 500 million yuan.

The company's main products include high temperature coaxial cable, RF coaxial cable, leaky coaxial cable, railway signal cable, hybrid cable, communication cable for railway transportation equipment, data cable, RF coaxial connector, RF coaxial jumper, arrester, feeder clamp, leaky cable clamp, and trunking assemblies. Mainly used in various types of mobile communications, microwave communications, radio broadcasting systems, railway tunnels, railroad locomotives and ships and other fields. It has an annual production capacity of 10,000km communication cable for rail transportation equipment, 50,000km data cable, 5,000km high temperature cable, 15,000km leaky cable, 80,000km high-quality RF cable, 13,000km rail signal cable, and related supporting accessories.

The company has imported a full set of critical production equipment, with internationally advanced imported physical foaming and welding rolling production lines, equipped with domestic advanced twisting and cable forming machines, and

adopting domestic advanced CNC machine tools to produce a variety of supporting accessories products. The company has set up the most modern and complete CNAS-certified communication product testing center and combustion laboratory to monitor the stability and reliability of product quality, as well as cable flame retardant, fire-resistant and other safety performance tests.

The company has been adhering to the sustainable development strategy, the environmental protection and scientific and technological innovation effectively combined, out of a green, high-tech development road. With the quality policy of "customer satisfaction, excellence, continuous improvement and innovation", we strive to build the company into a first-class enterprise, better fulfill our commitment to the society and employees' health, safety and environment, and adhere to the resource-saving and environment-friendly road.

The verified products of responsible party were 10 models of cable and 10 models of jumper. The cable is an electric cable and a signal transmitter and generally formed with four layers of material. The inner part is a conductor wire with an insulated PE layer enclosed. The insulated PE layer is surrounded by the web shape conductor. The outer part is the insulated material. The cable is used for system signal transmission. The jumper is used to link base station antenna to main feeder or tower amplifier, main feeder or antenna feeder arrester to base station transmitting equipment, and 50Ω radio frequency coaxial feeder interconnected between equipment. The jumper is composed by cable, connectors on both end by soldering and injection molding processes.

The information about yield within the time boundary for the different models of cable and jumper are shown in Table 1-1. The appearance of the products of cable is shown in Figure 1-1, and of the products of jumper is shown in Figure 1-2.

Table 1-1 Weight and yield information

Product Category	Product model	Product information	Yield within the time boundary
Cable	HCAAY-50-12	2.26E+02 kg/km	2.03E+03 km
	HCAAYZ-50-12	2.44E+02 kg/km	5.32E+04 km
	HRCAYZ-50-9	1.86E+02 kg/km	1.21E+03 km
	HRCAY-50-9	1.71E+02 kg/km	3.51E+03 km
	HCTAYZ-50-23	5.91E+02 kg/km	5.40E+00 km
	HCTAY-50-22	5.22E+02 kg/km	2.32E+02 km
	HCTAY-50-32	1.11E+03 kg/km	2.50E+00 km
	HHTAY-50-42	1.64E+03 kg/km	8.73E+00 km
	HLRWUCYZ-50-22T	3.77E+02 kg/km	1.86E+02 km
	HLRHTCYZ-50-32T	1.05E+03 kg/km	2.34E+03 km
Jumper	4310M-4310M-9*2	5.00E+02 pc/km	9.60E-02 km
	4310M-4310M-9*15	6.67E+01 pc/km	7.71E+01 km
	NM-NM-9*2	5.00E+02 pc/km	3.50E+00 km
	4310M-4310MA-9*5	2.00E+02 pc/km	3.69E+00 km
	4310M-DM-9*3	3.33E+02 pc/km	7.96E+01 km
	4310M-NM-9*3	3.33E+02 pc/km	4.31E+00 km
	4310M-DMA-9*3	3.33E+02 pc/km	2.00E+00 km
	DM-DMA-9*3	3.33E+02 pc/km	1.50E+00 km
	NM-NM-12*3	3.33E+02 pc/km	4.22E+00 km
	DM-DM-12*2	5.00E+02 pc/km	1.20E-02 km

Figure 1-1 Appearance of products of cable (from top to bottom and from left to right:

HRCAY-50-9, HRCAYZ-50-9, HCAAY-50-12, HCAAYZ-50-12, HHTAY-50-42,

HCTAY-50-32, HCTAYZ-50-23, HCTAY-50-22, HLRWUCYZ-50-22T,

HLRHTCYZ-50-32T)

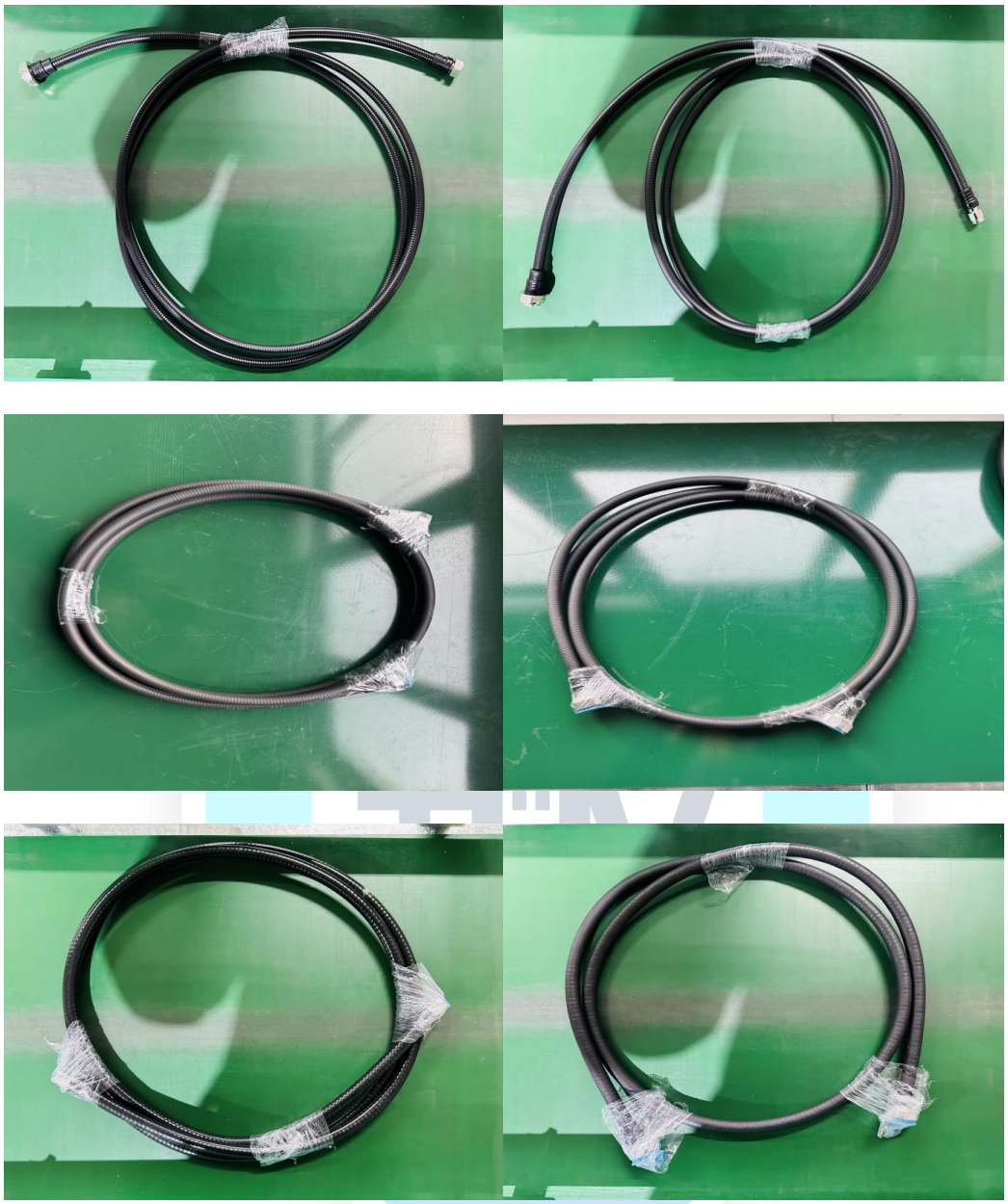

Figure 1-2 Appearance of products of jumper (from top to bottom and from left to right: 4310M-4310M-9*2, 4310M-4310M-9*15, NM-NM-9*2, 4310M-4310MA-9*5, 4310M-DM-9*3, 4310M-NM-9*3, 4310M-DMA-9*3, DM-DMA-9*3, NM-NM-12*3, DM-DM-12*2)

2 Scope of verification

2.1 Scope of greenhouse gases

The scope of greenhouse gases in this verification of PCF is consistent with the scope of the IPCC Sixth Assessment Report, including carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), sulfur hexafluoride (SF_6), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and nitrogen trifluoride (NF_3).

2.2 Time period and location of verification data

The time boundary of product carbon footprint data for the inspected products is shown in Table 2-1. The manufacturing address is No. 105 Qixin Road, Economic & Technological Development Zone, NanTong, Jiangsu Province. Figure 2-1 shows the production geographic boundaries.

Table 2-1 Time period of each product model

Product Category	Product model	Time period
Cable	HCAAY-50-12	2023-01-01~2023-12-31
	HCAAYZ-50-12	2023-01-01~2023-12-31
	HRCAYZ-50-9	2023-01-01~2023-12-31
	HRCAY-50-9	2023-01-01~2023-12-31
	HCTAYZ-50-23	2023-11-01~2023-11-30
	HCTAY-50-22	2023-07-01~2023-12-31
	HCTAY-50-32	2023-12-01~2023-12-31
	HHTAY-50-42	2023-12-01~2023-12-31
	HLRWUCYZ-50-22T	2023-06-01~2023-12-31
	HLRHTCYZ-50-32T	2023-01-01~2023-12-31
Jumper	4310M-4310M-9*2	2023-08-01~2023-08-31
	4310M-4310M-9*15	2023-01-01~2023-03-31
	NM-NM-9*2	2023-01-01~2023-03-31
	4310M-4310MA-9*5	2023-02-01~2023-02-28
	4310M-DM-9*3	2023-01-01~2023-06-30
	4310M-NM-9*3	2023-09-01~2023-10-31
	4310M-DMA-9*3	2023-02-01~2023-02-28
	DM-DMA-9*3	2023-02-01~2023-02-28
	NM-NM-12*3	2023-01-01~2023-04-30
	DM-DM-12*2	2023-09-01~2023-09-30

Figure 2-1 The production geographical boundary of the product

2.3 Declared unit

The declared units of the product carbon footprint use SI units. The declared units of the product carbon footprint of the cable are 1 kilometer of cable. The declared units of the product carbon footprint of the jumper are 1 kilometer of jumper (the length is calculated by the length of its inner feeder).

2.4 System boundary

System boundary in this verification is cradle-to-gate, i.e., from the acquisition of raw materials stage to manufacturing stage, including 1 life cycle stages: A1-A3 – Product. A4-A5 – Construction process, B – Use, C – End of life and D – Benefits and loads beyond the system boundary are excluded from the system boundary of LCA for equipment products. The process flow of system boundary of product's life cycle is shown in Figure 2-2 and Figure 2-3.

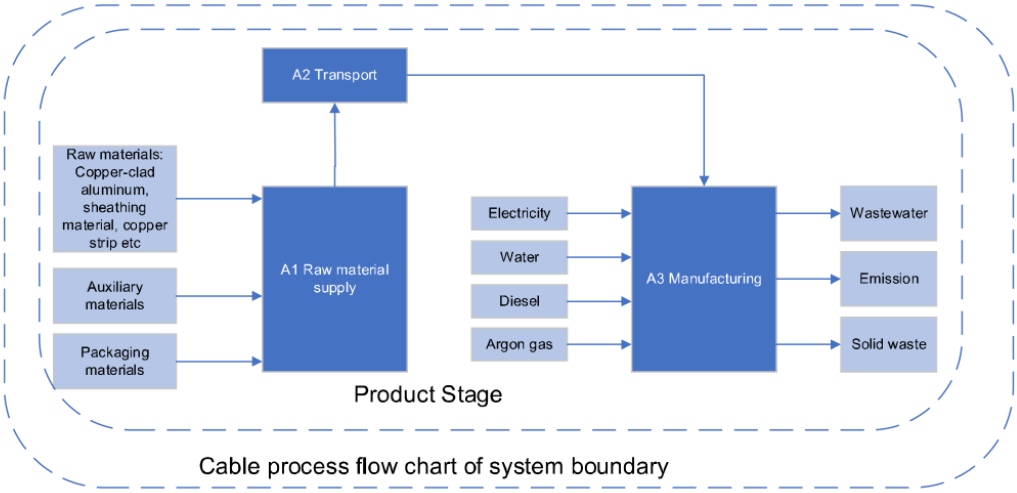

Figure 2-2 Cable process flow chart of product's system boundary

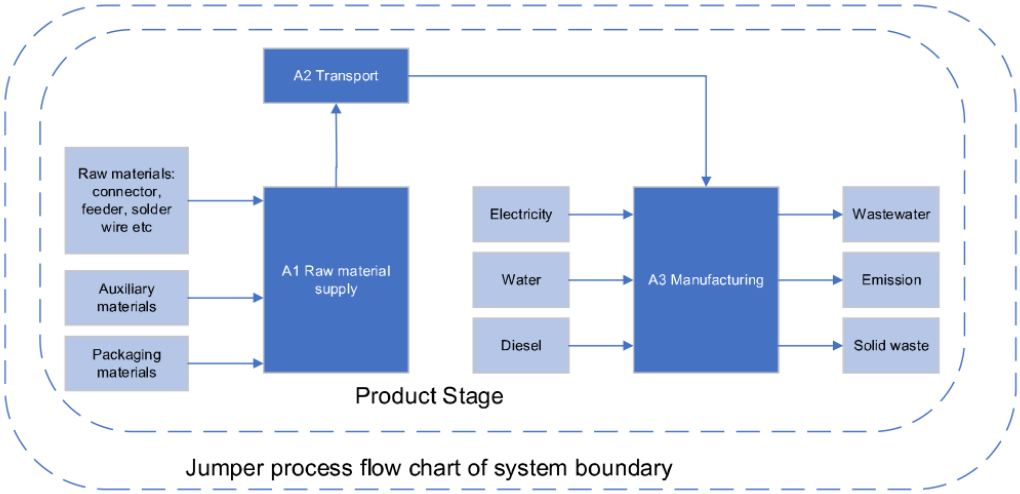

Figure 2-3 Jumper process flow chart of product's system boundary

2.5 Cut-off principles

According to ISO 14067:2018 and other verification standards (see *References* section), the complete scope of data for this verification has covered raw materials, production auxiliary materials, packaging materials, transportation of raw materials and auxiliary materials, manufacturing energy and resource consumption and waste emissions and disposals of manufacturing process.

The input mass ratio of products within system boundaries in this report is 99.00%. Energy and resource consumption in the production stage and production

waste discharge and disposal were all taken into account. In addition, the consumption and emissions of roads and plants' infrastructure, equipment of each process, personnel and living facilities in the plants were ignored.

2.6 Allocation principles

The activity data collected by the responsible party is allocated according to the allocation procedures, principles, and properties in Table 2-2 and Table 2-3.

Table 2-2 Allocators, principles, and properties of activity data of cable

Process	Procedure	Principle	Property
Raw materials	Avoid allocation	\	\
Packaging materials	Avoid allocation	\	\
Manufacturing energy and resource consumption	Allocation between co-products	Physical allocation	Yield of factory (Total km of cable)
Manufacturing emissions and waste	Allocation between co-products	Physical allocation	Yield of factory (Total km of cable)
Transportation	Avoid allocation	\	\
Processes involving recovery	Allocation for recovery operations	Cut-off Model	\

Table 2-3 Allocators, principles, and properties of activity data of jumper

Process	Procedure	Principle	Property
Raw materials	Avoid allocation	\	\
Packaging materials	Avoid allocation	\	\
Manufacturing energy and resource consumption	Allocation between co-products	Physical allocation	Yield of factory (Total pc of jumper)
Manufacturing emissions and waste	Allocation between co-products	Physical allocation	Yield of factory (Total pc of jumper)
Transportation	Avoid allocation	\	\
Processes involving recovery	Allocation for recovery operations	Cut-off Model	\

2.7 Software and Database

The life-cycle assessment software used in this study is SimaPro 9.5.0.0, using the Ecoinvent 3.9.1 database. The GHG emission assessment method adopted is IPCC 2021 GWP100 V1.02.

3 Verification of product carbon footprint data inventory

3.1 Data sources

The product carbon footprint data for this verification was obtained from the evidence documents recorded and maintained by the responsible party within the time period and product system boundary (Table 3-1).

Table 3-1 PCF data sources

Data category	Data source	
Activities (primary) data	Data at raw material supply	BOM sheets
	Data at manufacturing	Electricity meters; notice of electricity and tap water bills; environmental impact assessment report; exhaust gas test report; hazardous waste inventory; waste transfer joint order
	Yield data of product	Monthly production reports; warehouse orders
	Transportation data	Transportation mode of raw materials and product; transportation distance of road
Background (secondary) data	Data at raw material supply	Ecoinvent 3.9.1 database (see Annex A)
	Data at manufacturing	Ecoinvent 3.9.1 database (see Annex A)
	Transportation data	Ecoinvent 3.9.1 database (see Annex A)

3.2 Assumptions

This verification does not involve scenario assumptions.

3.3 Activity data

All unit processes and corresponding activity data for each declared unit of product at each life cycle stage are identified by verifying the responsible party's evidence documentation, of which the unit processes contribution that are either 5% or more in its module or more than 1% in the product carbon footprint verification of cable model HCAAYZ-50-12 (as an example) are listed in Table 3-2 and of jumper model 4310M-DM-9*3 (as an example) are listed in Table 3-3. The complete list of all unit processes is shown in Annex A.

Table 3-2 Important unit processes and activity data of cable model HCAAYZ-50-12

Life cycle stage	Module	Unit process	Consumption/emission of product per declared unit
A1-A3 - Product	A1- Raw material supply	Wire drawing for copper-clad aluminum	6.00E+01 kg
		Copper-clad aluminum (red copper)	1.34E+01 kg
		Copper-clad aluminum (aluminum)	4.66E+01 kg
		HDPE	2.17E+01 kg
		Copper strip	7.80E+01 kg
		Copper strip working	7.80E+01 kg
		LSZH (aluminum hydroxide)	3.41E+01 kg
	A2 - Transport	Copper-clad aluminum transport (10T freight)	4.35E+00 tkm
		Copper-clad aluminum transport (32T freight)	9.81E+00 tkm
		PE material transport	2.48E+00 tkm
		LSZH transport (32T freight)	2.80E+00 tkm
		LSZH transport (30T freight-supplier 1)	4.06E+00 tkm
		LSZH transport (30T freight-supplier 2)	2.01E+00 tkm
	A3 - Manufacturing	Electricity - grid	6.23E+01 kWh
		Argon gas	1.36E+02 kg

Table 3-3 Important unit processes and activity data of jumper model 4310M-DM-9*3

Life cycle stage	Module	Unit process	Consumption/emission of product per declared unit
A1-A3 - Product	A1- Raw material supply	Connector (brass)	1.78E+01 kg
		Connector (PTFE)	7.40E-01 kg
		1/2'' Super flexible feeder	8.23E-01 km
		Solder wire	6.33E-01 kg
	A2 - Transport	Connector transport	3.70E+00 tkm
		Injection molding material transport	2.61E-01 tkm
	A3 - Manufacturing	Tap water	1.40E+03 kg
		Electricity - grid	2.32E+01 kWh
		Hazardous waste - saponified oil	1.14E+00 kg

3.4 Activity data

The secondary data reference sources for each unit process are shown in Annex A.

4 Product carbon footprint verification results and analysis

4.1 Product Carbon Footprint Verification Results

According to the verified carbon footprint data list of products, the carbon footprint of declared units within the life cycle system boundary of the products under verification is verified (Table 4-1), as well as the amount and proportion of carbon footprint at each stage of the life cycle (Table 4-2 and Table 4-3).

Table 4-1 Product carbon footprint information of cable and jumper

Product category	Product Model	Carbon footprint per declared unit（$kgCO_2eq/km$）
Cable	HCAAY-50-12	2.40E+03
	HCAAYZ-50-12	2.41E+03
	HRCAYZ-50-9	1.79E+03
	HRCAY-50-9	1.77E+03
	HCTAYZ-50-23	2.72E+03
	HCTAY-50-22	2.71E+03
	HCTAY-50-32	4.80E+03
	HHTAY-50-42	5.81E+03
	HLRWUCYZ-50-22T	1.62E+03
	HLRHTCYZ-50-32T	2.87E+03
Jumper	4310M-4310M-9*2	1.88E+03
	4310M-4310M-9*15	1.50E+03
	NM-NM-9*2	1.74E+03
	4310M-4310MA-9*5	1.62E+03
	4310M-DM-9*3	1.72E+03
	4310M-NM-9*3	1.68E+03
	4310M-DMA-9*3	1.77E+03
	DM-DMA-9*3	1.82E+03
	NM-NM-12*3	2.13E+03
	DM-DM-12*2	2.61E+03

Table 4-2 Values and ratios of PCF of cable at different life cycle stages

Product model	Life cycle stage	Module	Carbon footprint per declared unit ($kgCO_2eq/km$)	Ratio（%）
HCAAY-50-12	A1-A3-Product	A1-Raw material supply	2.00E+03	83.45
		A2-Transport	6.15E+00	0.26
		A3-Manufacturing	3.90E+02	16.30
HCAAYZ-50-12	A1-A3-Product	A1-Raw material supply	2.01E+03	83.53
		A2-Transport	5.95E+00	0.25
		A3-Manufacturing	3.90E+02	16.22
HRCAYZ-50-9	A1-A3-Product	A1-Raw material supply	1.39E+03	77.92
		A2-Transport	3.74E+00	0.21
		A3-Manufacturing	3.90E+02	21.87
HRCAY-50-9	A1-A3-Product	A1-Raw material supply	1.38E+03	77.74
		A2-Transport	3.72E+00	0.21
		A3-Manufacturing	3.90E+02	22.05
HCTAYZ-50-23	A1-A3-Product	A1-Raw material supply	2.29E+03	84.15
		A2-Transport	8.35E+00	0.31
		A3-Manufacturing	4.22E+02	15.54
HCTAY-50-22	A1-A3-Product	A1-Raw material supply	2.31E+03	85.48
		A2-Transport	7.14E+00	0.26
		A3-Manufacturing	3.86E+02	14.26
HCTAY-50-32	A1-A3-Product	A1-Raw material supply	4.39E+03	91.60
		A2-Transport	1.29E+01	0.27
		A3-Manufacturing	3.90E+02	8.13
HHTAY-50-42	A1-A3-Product	A1-Raw material supply	5.40E+03	92.97
		A2-Transport	1.81E+01	0.31
		A3-Manufacturing	3.90E+02	6.72
HLRWUCYZ-50-22T	A1-A3-Product	A1-Raw material supply	1.23E+03	75.90
		A2-Transport	4.60E+00	0.28
		A3-Manufacturing	3.86E+02	23.82
HLRHTCYZ-50-32T	A1-A3-Product	A1-Raw material supply	2.46E+03	85.79

		A2-Transport	1.73E+01	0.60
		A3-Manufacturing	3.90E+02	13.60

Table 4-3 Values and ratios of PCF of jumper at different life cycle stages

Product model	Life cycle stage	Module	Carbon footprint per declared unit ($kgCO_2eq/km$)	Ratio（%）
4310M-4310M-9*2	A1-A3-Product	A1-Raw material supply	1.76E+03	94.04
		A2-Transport	1.38E+00	0.07
		A3-Manufacturing	1.10E+02	5.88
4310M-4310M-9*15	A1-A3-Product	A1-Raw material supply	1.50E+03	99.55
		A2-Transport	2.07E-01	0.01
		A3-Manufacturing	6.62E+00	0.44
NM-NM-9*2	A1-A3-Product	A1-Raw material supply	1.69E+03	97.10
		A2-Transport	1.04E+00	0.06
		A3-Manufacturing	4.96E+01	2.85
4310M-4310MA-9*5	A1-A3-Product	A1-Raw material supply	1.60E+03	98.92
		A2-Transport	6.77E-01	0.04
		A3-Manufacturing	1.68E+01	1.04
4310M-DM-9*3	A1-A3-Product	A1-Raw material supply	1.69E+03	98.14
		A2-Transport	1.08E+00	0.06
		A3-Manufacturing	3.11E+01	1.80
4310M-NM-9*3	A1-A3-Product	A1-Raw material supply	1.64E+03	97.59
		A2-Transport	8.18E-01	0.05
		A3-Manufacturing	3.97E+01	2.36
4310M-DMA-9*3	A1-A3-Product	A1-Raw material supply	1.75E+03	98.35
		A2-Transport	1.26E+00	0.07
		A3-Manufacturing	2.81E+01	1.58
DM-DMA-9*3	A1-A3-Product	A1-Raw material supply	1.79E+03	98.38
		A2-Transport	1.41E+00	0.08
		A3-Manufacturing	2.81E+01	1.54
NM-NM-12*3	A1-A3-Product	A1-Raw material supply	2.10E+03	98.52
		A2-Transport	7.12E-01	0.03
		A3-Manufacturing	3.08E+01	1.45
DM-DM-12*2	A1-A3-Product	A1-Raw material supply	2.52E+03	96.69
		A2-Transport	2.33E+00	0.09

		A3-Manufacturing	8.40E+01	3.22

4.2 Contribution of each life cycle stage

Taking cable model HCAAYZ-50-12 and jumper model 4310M-DM-9*3 as examples, the unit processes and contribution amount that contributed more than 1% in the product carbon footprint verification are listed below (Table 4-4 and 4-5).

Table 4-4 Cable model HCAAYZ-50-12 Product Carbon Footprint Contribution of Unit Processes (above 1%)

Life cycle stage	Module	Unit process	Carbon footprint per declared unit ($kgCO_2eq/km$)	Ratio (%)
A1-A3 - Product	A1-Raw material supply	Wire drawing for copper-clad aluminum	4.66E+01	1.94
		Copper-clad aluminum (red copper)	9.19E+01	3.82
		Copper-clad aluminum (aluminum)	1.09E+03	45.43
		HDPE	5.03E+01	2.09
		Copper strip	5.35E+02	22.24
		Copper strip working	4.66E+01	1.94
		LSZH (aluminum hydroxide)	4.31E+01	1.79
	A3-Manufacturing	Electricity - grid	5.52E+01	2.29
		Argon gas	3.33E+02	13.84

Table 4-5 Jumper model 4310M-DM-9*3 Product Carbon Footprint Contribution of Unit Processes (above 1%)

Life cycle stage	Module	Unit process	Carbon footprint per declared unit ($kgCO_2eq/km$)	Ratio (%)
A1-A3 - Product	A1-Raw material supply	Connector (brass)	1.01E+02	5.87
		Connector (PTFE)	1.21E+02	7.00
		1/2'' Super flexible feeder	1.45E+03	84.15
		Solder wire	1.78E+01	1.03
	A3-Manufacturing	Electricity - grid	2.05E+01	1.19

4.3 Completeness and Consistency verification

The carbon footprint verification procedure for the verified product was based on the actual production activities of the company. The inventory data of each stage within the system boundary were obtained from evidential document from the responsible party. The data were not checked to have omissions, and the cut-off and allocation principles have been explained and described to meet the completeness requirement of the standard.

In terms of consistency verification, the assumptions, methodologies and scope of data for the carbon footprint of the products under verification were consistent with the system boundary. Background (secondary) data selection of the database emission factor parameters was consistent with the production process of each raw material. The selection of transportation emission factors was consistent with the mode of transportation. The emission factor data of energy and resource was close to the geographical area where the factory is located, and the data closest to the year of verification was selected.

4.4 Uncertainty analysis

The main databases used for this verification of the product carbon footprint were Ecoinvent 3.9.1. The uncertainty analysis was quantified by Monte Carlo analysis function using the IPCC 2021 GWP 100 V1.02 method in SimaPro 9.5.0.0. As examples, the results of uncertainty analysis for cable model HCAAYZ-50-12 and jumper model 4310M-DM-9*3 are shown in Table 4-6 and Table 4-7. The results show that the carbon footprint result of cable model HCAAYZ-50-12 has a very low uncertainty (CV<10%) and the carbon footprint result of jumper model 4310M-DM-9*3 has a low uncertainty (CV=10%~30%).

Table 4-6 Monte Carlo analysis table of product carbon footprint verification results of cable HCAAYZ-50-12

Impact category	Unit	Mean	Median	Standard deviation	CV (%)
Climate Change	$kgCO_2eq/km$	2.39E+03	2.35E+03	2.15E+02	8.96

Table 4-7 Monte Carlo analysis table of product carbon footprint verification results of jumper 4310M-DM-9*3

Impact category	Unit	Mean	Median	Standard deviation	CV (%)
Climate Change	$kgCO_2eq/km$	1.73E+03	1.70E+03	2.03E+02	11.69

4.5 Data quality analysis

The data quality analysis for this verification is based on PEF's Data Quality Rating (DQR) methodology (Table 4-8 and 4-9). Using cable model HCAAYZ-50-12 and jumper model 4310M-DM-9*3 as examples, unit processes that contribute more than 2% to a product's carbon footprint are included in the DQR analysis, which meets

the methodology's requirement of selecting the top 80% of the unit processes contributing to the Pareto analysis, and can be representative of the product's DQR. The ratings of completeness (C), methodological appropriateness and consistency (M), technical representativeness (Te_R), geographic representativeness (Ge_R), time-related representativeness (Ti_R), and precision (P) and weights of each unit process are shown in Table 4-8 and Table 4-9. Of these, C and M are qualitative and the other four are quantitative.

The DQR value of cable model HCAAYZ-50-12 is 1.97 and of jumper model 4310M-DM-9*3 is 1.58, which means a Very Good Quality level for both cable and jumper product.

Table 4-8 Cable HCAAYZ-50-12 carbon footprint DQR sheet

Life cycle stage	Module	Unit Process	C	M	Te_R	Ge_R	Ti_R	P	Weight
A1-A3 - Product	A1-Raw material supply	Wire drawing for copper-clad aluminum	√	√	2	2	2	2	2.07%
		Copper-clad aluminum (red copper)	√	√	2	3	2	2	4.08%
		Copper-clad aluminum (aluminum)	√	√	2	1	2	2	48.54%
		HDPE	√	√	2	2	2	2	2.23%
		Copper strip	√	√	2	3	2	2	23.76%
		Copper strip working	√	√	2	2	2	2	2.07%
	A3-Manufacturing	Electricity - grid	√	√	1	1	2	2	2.45%
		Argon gas	√	√	3	2	2	2	14.79%
Total			√	√	2.12	1.77	2	2	100%
DQR				1.97		Level		Very good quality	

Table 4-9 Jumper 4310M-DM-9*3 carbon footprint DQR sheet

Life cycle stage	Module	Unit Process	C	M	Te_R	Ge_R	Ti_R	P	Weight
A1-A3 - Product	A1-Raw material supply	Connector (brass)	√	√	2	2	2	2	6.05%
		Connector (PTFE)	√	√	3	2	2	2	7.22%
		1/2'' Super flexible feeder	√	√	1	1	2	2	86.73%
Total			√	√	1.20	1.13	2	2	100%
DQR				1.58		Level		Very good quality	

5 Recommendations for product carbon footprint work

According to the verification process and results, the raw material supply module is the largest contributor to the carbon footprint of the verified products for both cable and jumper product.

For the cable product, major contributors are aluminum in copper-clad aluminum and copper strip in raw material supply module. The manufacturing module also has certain contribution to the carbon footprint of the product, mainly by grid electricity and argon gas usage.

For the jumper product, major contributors are connector and 1/2'' super flexible feeder in raw material supply module. The manufacturing module has some contribution to the carbon footprint of the product, mostly by grid electricity usage.

It is recommended that the responsible party further improve its environmental management in the supply chain and look for greener and low-carbon alternative suppliers for raw materials, especially for copper-clad aluminum, copper strip and connector, to reduce the contribution of raw materials to the carbon footprint of the product.

6 References

1) ISO 14067:2018 Carbon footprint of products —Requirements and guidelines for quantification and communication
2) ISO 14064-3:2019 Greenhouse gases —Part 3: Specification with guidance for the verification and validation of greenhouse gas statements
3) ISO 14040:2006 Environmental management — Life cycle assessment —Principles and Framework
4) ISO 14044:2006 Environmental management — Life cycle assessment — Principles and guidelines
5) PAS 2050:2008 Specification for the assessment of the life cycle greenhouse gas emissions of goods and services
6) GHG protocol Product Life Cycle Accounting and Reporting Standard
7) Zampori, L. and Pant, R., Suggestions for updating the Product Environmental Footprint (PEF) method, EUR 29682 EN, Publications Office of the European Union, Luxembourg, 2019, ISBN 978-92-76- 00654-1, doi:10.2760/424613, JRC115959.
8) Product Environmental Footprint Category Rules Guidance, Version 6.3, May 2018.
9) EN 15804:2012+A2:2019 Sustainability of construction works – Environmental product declarations – Core rules for the product category of construction products.

Annex A List of verified secondary data sources

Table A-1 List of verified secondary data sources of each unit process

A1-Raw material supply	
Raw material	Raw material
Connector (brass)	Brass {RoW}| brass production | Cut-off, U
Connector (PTFE)	Tetrafluoroethylene {RoW}| tetrafluoroethylene production | Cut-off, U
Injection molding material	Polyethylene, linear low density, granulate {RoW}| polyethylene production, linear low density, granulate | Cut-off, U
Dust cap	Packaging film, low density polyethylene {RoW}| packaging film production, low density polyethylene | Cut-off, U
Bubble bag	Packaging film, low density polyethylene {RoW}| packaging film production, low density polyethylene | Cut-off, U
Solder wire	Solder, bar, Sn95.5Ag3.9Cu0.6, for electronics industry {GLO}| solder production, bar, Sn95.5Ag3.9Cu0.6, for electronics industry | Cut-off, U
Corrugated cardboard	Corrugated board box {RoW}| corrugated board box production | Cut-off, U
Pallet	Sawnwood, board, softwood, raw, dried (u=20%) {RoW}| board, softwood, raw, kiln drying to u=20% | Cut-off, U
Copper-clad aluminum processing	Wire drawing, copper {RoW}| wire drawing, copper | Cut-off, U
Copper-clad aluminum (red copper)	Copper, cathode {GLO}| market for copper, cathode | Cut-off, U
Copper-clad aluminum (aluminum)	Aluminium, primary, ingot {CN}| aluminium production, primary, ingot | Cut-off, U
HDPE	Polyethylene, high density, granulate {RoW}| polyethylene production, high density, granulate | Cut-off, U
LDPE	Polyethylene, low density, granulate {RoW}| polyethylene production, low density, granulate | Cut-off, U
Nucleating agent	Polyethylene, linear low density, granulate {RoW}| polyethylene production, linear low density, granulate | Cut-off,

	U
Copper strip	Copper, cathode {GLO}| market for copper, cathode | Cut-off, U
Copper strip processing	Sheet rolling, copper {RoW}| sheet rolling, copper | Cut-off, U
PE sheathing compound	Polyethylene, high density, granulate {RoW}| polyethylene production, high density, granulate | Cut-off, U
LSZH sheathing compound (EVA)	Ethylene vinyl acetate copolymer {RoW}| ethylene vinyl acetate copolymer production | Cut-off, U
LSZH sheathing compound (PE)	Polyethylene, high density, granulate {RoW}| polyethylene production, high density, granulate | Cut-off, U
LSZH sheathing compound (grafting material)	Maleic anhydride {RoW}| maleic anhydride production by catalytic oxidation of benzene | Cut-off, U
LSZH (aluminum hydroxide)	Aluminium hydroxide {CN}| aluminium hydroxide production | Cut-off, U
LSZH (POE)	N-olefins {RoW}| n-olefins production | Cut-off, U
LSZH (auxiliaries)	Tetraethyl orthosilicate {GLO}| tetraethyl orthosilicate production | Cut-off, U
Copper pipe	Copper, cathode {GLO}| market for copper, cathode | Cut-off, U
Copper pipe processing	Sheet rolling, copper {RoW}| sheet rolling, copper | Cut-off, U
A2-Transport	
Transport	**Secondary data source**
Transport of raw materials-Road transportation	Transport, freight, lorry 7.5-16 metric ton, EURO4 {RoW}| transport, freight, lorry 7.5-16 metric ton, EURO4 | Cut-off, U
	Transport, freight, lorry 16-32 metric ton, EURO4 {RoW}| transport, freight, lorry 16-32 metric ton, EURO4 | Cut-off, U
	Transport, freight, lorry >32 metric ton, EURO4 {RoW}| transport, freight, lorry >32 metric ton, EURO4 | Cut-off, U
A3-Manufacturing	
List of auxiliary materials	
Argon gas	Argon, liquid {RoW}| market for argon, liquid | Cut-off, U
Energy and resources	
Electricity - grid	Electricity, low voltage {CN-ECGC}| market for electricity, low voltage | Cut-off, U
Electricity – photovoltaic	Electricity, low voltage {CN-JS}| electricity production,

panel	photovoltaic, 3kWp slanted-roof installation, multi-Si, panel, mounted | Cut-off, U
Diesel	Diesel {RoW}| market for diesel | Cut-off, U
Water	Tap water {RoW}| market for tap water | Cut-off, U
Waste	
Waste water	Waste water
Hazardous waste	Hazardous waste, for incineration {RoW}| treatment of hazardous waste, hazardous waste incineration | Cut-off, U
Waste cable	Waste, electrical and electronic cables {RoW}| treatment of waste, electrical and electronic cables, open burning | Cut-off, U
Waste copper scrap	Scrap copper {RoW}| treatment of scrap copper, municipal incineration | Cut-off, U
Waste injection molding material	Waste polyethylene {RoW}| treatment of waste polyethylene, municipal incineration | Cut-off, U
Waste brass	Scrap copper {RoW}| treatment of scrap copper, municipal incineration | Cut-off, U
Waste connector	Scrap copper {RoW}| treatment of scrap copper, municipal incineration | Cut-off, U
Waste paperboard	Waste paperboard {GLO}| treatment of waste paperboard, open burning | Cut-off, U
Waste wood	Waste wood, untreated {RoW}| treatment of waste wood, untreated, municipal incineration | Cut-off, U
Waste plastic paper	Waste polyethylene {RoW}| treatment of waste polyethylene, municipal incineration | Cut-off, U
Waste foam materials	Waste polyethylene {RoW}| treatment of waste polyethylene, municipal incineration | Cut-off, U
Waste copper-clad aluminum (red copper)	Scrap copper {RoW}| treatment of scrap copper, municipal incineration | Cut-off, U
Waste copper-clad aluminum (aluminum)	Scrap aluminium {RoW}| treatment of scrap aluminium, municipal incineration | Cut-off, U
Waste copper pipe core wire	Scrap copper {RoW}| treatment of scrap copper, municipal incineration | Cut-off, U
Waste embossing process copper material	Scrap copper {RoW}| treatment of scrap copper, municipal incineration | Cut-off, U
Waste sheathing material	Waste polyethylene {RoW}| treatment of waste polyethylene, municipal incineration | Cut-off, U
Waste core wire (copper)	Scrap copper {RoW}| treatment of scrap copper, municipal

	incineration | Cut-off, U
Waste punch press copper strip	Scrap copper {RoW}| treatment of scrap copper, municipal incineration | Cut-off, U
Waste aluminum	Scrap aluminium {RoW}| treatment of scrap aluminium, municipal incineration | Cut-off, U