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Technical newsletter
Environmental footprint assessment method for FTTH cable

Life Cycle Assessment and Product Specific Rules: a language for environmental footprint assessment

May 2024

Environment and global warming are a real concern for citizens as well as for FttH roll out stakeholders such as operators, installers, and manufacturers.

FTTH stakeholders must comply with the “Green Deal” and associated European directives and regulations.

Europacable members are already highly involved in environmental footprint assessments of their products and solutions and have undertaken major work to anticipate:

- ESPR: Ecodesign for Sustainable Product Regulation,
- CPR: Construction Product Regulation,
- Green Procurement European initiative,
- and many other positive work to reach the climate objectives of the European commission.

Europacable members share the objective to deliver relevant and complete environmental performance of their products and solutions.

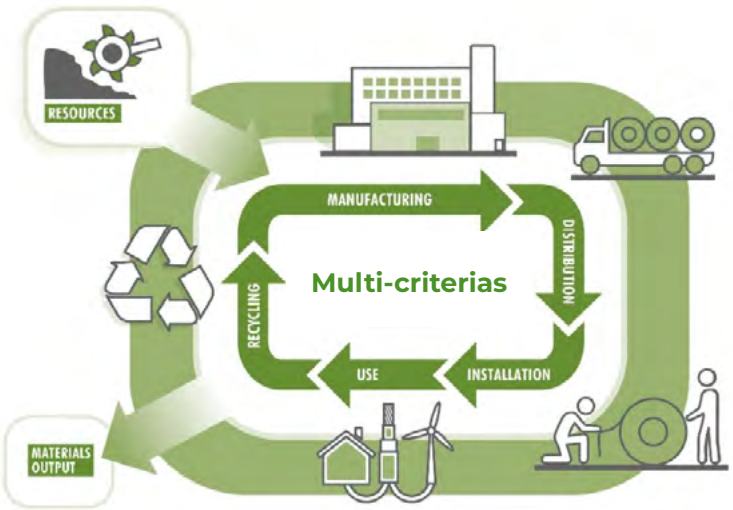
If the impact on Greenhouse Gases (GHG) emissions is an indicator that speaks to many people, because it is responsible for global warming, a list of quite 30 environmental indicators can be calculated, including the energy and water consumption, the mineral resource depletion, or water and human toxicity.

This document will present the Europacable view for a **multistep and multicriteria approach**, based on a specific method: the Life Cycle Assessment (LCA).

1. Life Cycle Assessment process

Through this method, a set of different environmental impacts can be evaluated during each life phase of the product:

- Manufacturing stage: from the extraction of natural resources to product and packaging manufacturing and their delivery to the manufacturer's last logistics platform,
- Distribution stage: transportation from the last manufacturer's logistics platform to the arrival of the product at the place of use,
- Installation stage: installation of the product at the place of use,
- Use stage: use of the product and maintenance necessary to ensure the ability for use,
- End-of-life stage: removal, dismantle and transportation of the end-of-life product to a treatment center or landfill site, and the end-of-life treatment.



The recommended environmental impact categories and indicators according to EN50693 are listed below.

Impact category	Indicator	Unit
Climate change	Radiative forcing as global warming potential (GWP100)	kg CO2 eq.
Ozone depletion	Ozone depletion potential	kg CFC-11 eq.
Human toxicity cancer effects	Comparative toxic unit for humans (CTUh)	CTUh
Human toxicity, non-cancer effects	Comparative toxic unit for humans (CTUh)	CTUh
Particulate matter/respiratory organics	Impact on human health	Incidence of diseases in Deaths/ kgPM2.5 emitted
Ionizing radiation, effects on human health	Human exposure efficiency relative to U235	kBq U235
Photochemical Ozone formation	Tropospheric ozone concentration increase	kg NMVOC eq.
Acidification	Accumulated exceedance	mol H+ eq.
Eutrophication, terrestrial	Accumulated exceedance	mol N eq.
Freshwater eutrophication	Nutrients reaching the end compartment (P)	freshwater: kg P eq.
Marine eutrophication	Nutrients reaching the end compartment (N)	seawater: kg N eq.
Freshwater ecotoxicity	Comparative toxic unit for ecosystems	(CTUe)
Land use	Soil quality index	Adimensional
Water resource depletion	Potential deprivation (water use related to scarcity)	m3 global saving eq.
Resource use - mineral	Abiotic resource depletion (ADP ultimate reserves)	Kg Sb-eq
Resource use - fossil	Abiotic resource depletion – fossil fuels (ADP-fossil)	MJ

In this process, first, functional unit and reference flow description are defined to quantify the performance of the service delivered by a product to the user. This includes the product name, the performance requirements, the reference lifetime of the product. Reference flow considerations add to the process the knowledges of:

- all the materials entering in the product constitution, including the waste and the discarded material generated by each product life phase,
- all the packaging used during the reference lifetime,
- all the elements, flows and processes required to distribute, install, use, remove, dismantle, and treat the reference product.

At this stage, generic standard ISO14040/44 concerns all products and it is too general to be applied as it is to FTTH optical cables. Since 2009, cable manufacturers have undertaken major works to establish a framework and reference documents to perform a life cycle assessment.

2. Product category rules and product specific rules

Thus, ISO14040/44 standardized approach is supplemented by an application domain segmentation and, at a second level, a product segmentation, which defined specific additional calculation rules.

These rules are detailed in 2 reference documents:

- Product Category Rules (PCR),
- and Product Specific Rules (PSR).

These two sets of rules allow each manufacturer to perform a Cable LCA in a defined context with an aim to obtain comparable results and to be able to decide of environmental improvements.

EN 50693 is the standardized PCR[1], Product Category rules for life cycle assessments of electronic, electrical products and systems. It is also applicable to the entire cable industry.

Note that equivalent national documents exist, such as in France or the Netherlands. For example in the latter country, the PCR describes the families of products constituting buildings. PCR EN50693 has more appropriate product coverage and would therefore be considered by Europacable as the reference PCR.

This document indicates mainly how to describe the functional unit and the reference flow, the boundaries of the studied systems, rules to extrapolate the results to an homogeneous environmental range, all the assumptions needed to perform the calculations of the environmental impacts, including all the transportation scenarios, and the electricity consumption scenarios.
The PCR defines how to build up the LCA report and draw up the Environmental Product Declaration.

IEC TR 62839-1 provides the standardized PSR used, for communication cables (copper and optical). This document, under revision and based on the document named PSR-0001-ed4-EN-2022 11 16 - Wires Cables and Accessories, clearly defines **the functional unit** for each cable category and **the reference usetime**.

[1] This document has its origins in preliminary work carried out jointly by the electrical, electronics and communications industries.

This document explains the impact presented **for 1 meter of 1 optical fibre** and finally to complete the definition of the functional unit, the declared unit can integrate the total count of fibre and all the impact results will be divided by the fibre number.

As an example, for a FTTH cable, the declared unit is as followed:

« A cable composed of N fibres used to transmit a communication signal on 1 meter according to 10GBASE-LR protocol, at 1310nm, during 20 years and a 100% use rate in accordance with the standards in force. »

In particular, this document defines how to calculate the energy consumption during the use phase and all the assumption for installation and end of life phases. The duration and rate of use is defined in a table which presents various applications. In the previous example, for a FTTH distribution optical cable, it corresponds to the "INFRASTRUCTURES - Telecom Networks (fixed and mobile)" application as defined in the table below.

APPLICATION AREAS	Application	Lifetime (years)	Use rate	Used time (years)
POWER GENERATION	Solar photovoltaics	25	100%	25
	Railway networks	30	100%	30
	Telecom networks (fixed and mobile phones)	20	100%	20
INDUSTRIAL APPLICATIONS	Oil, gas and petrochemicals	30	100%	30
	Handling	10	50%	5
	Automation	5	100%	5
	Nuclear	40	100%	40
	Wind turbines	20	30%	6
	Photovoltaic power plants	10	50%	5
	Airports	20	100%	20
ONBOARD SYSTEMS	Civil aeronautics	15	80%	12
	Shipbuilding and marine	30	80%	24
	Rolling stock	30	50%	15
	Automotives (Cars and trucks)	10	10%	1
BUILDING	Residential/tertiary/industrial except LAN	30	70%	21
	Data centers	10	100%	10
	LAN: residential	10	17%	1,7
	LAN: tertiary	10	25%	2,5
	LAN: industrial (factories, warehouses)	10	100%	10

Source: PEPECOPASSPORT PSR-0001-ed4-EN-2022 11 16 - Wires Cables and Accessories - AppendicesNetwork scalability

This functional unit definition ruled by PCR and PSR documents allows to produce comparable environmental results and to measure the environmental performances of the cable designs.
Performing an LCA using the relevant PCR and PSR alllows to produce comparable indicators and initiate a fair environmental comparison of Product environmental footprint (PEF).

Better still, multi-criteria LCA is a tool allowing the virtuous approach of eco-design, further to a first eco-profile, seeking to reduce the overall environmental footprint by reducing each individual environmental impact.

3. Environmental outputs

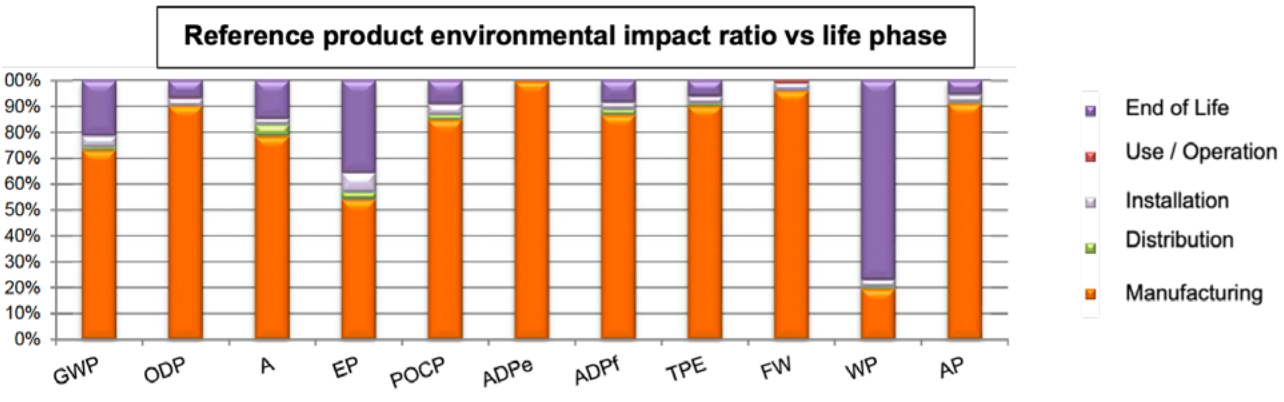
The results of a product Life cycle assessment are communicated via an Environmental Product Declaration (EPD), which also follows precise rules. If, and only if, they are derived from the same PSR (and therefore from the same PCR), EPDs make it possible to compare different technical solutions or products from a given or different manufacturers for the same service provided.

PCR and PSR rules define the required information on the Environmental Product declaration, the product ID, the raw materials used and its mass, the different assumptions of the calculation, the transportation, use and end of life scenarios. The declaration shall mention the software used to make the calculation and finally the environmental impact results in the form of table expressing the score for each product life phase. Some elements are mandatory, others are optional. These criteria are presented below with an example of a table of results for one metre of a given FTTH cable, taking into account all the environmental impacts.

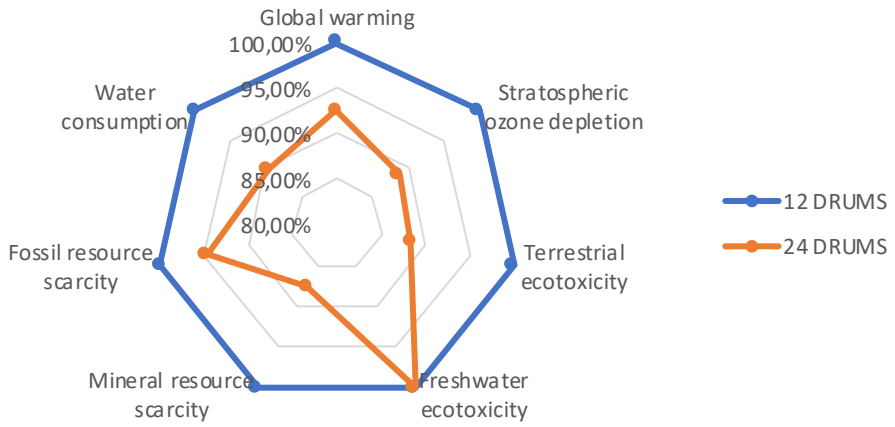
Mandatory Or Optional	Indicator	Unit	Total	Manufacturing	Distribution	Installation	Use	End of Life
M	Ozone depletion	kg.eq. CFC-11	1.14E-8	1.05E-8	2.5E-12	7.08E-10	1.55E-14	2.16E-10
M	Acidification (AP)	mole.eq.H+	6.55E-4	5.86E-4	1.03E-5	3.83E-5	6.1E-9	2.08E-5
M	Freshwater eutrophication	kg.eq.P	1.45E-6	9.78E-7	6.12E-10	1.21E-7	5.01E-11	3.53E-7
M	Marine aquatic eutrophication	kg.eq.N	9.21E-5	7.5E-5	4.84E-6	6.24E-6	8.39E-10	6.03E-6
M	Terrestrial eutrophication	mole.eq.N	1.02E-3	8.2E-4	5.31E-5	6.95E-5	1.21E-8	7.55E-5
M	Photochemical ozone formation	kg.eq. NMVOC	4.36E-4	3.78E-4	1.34E-5	2.64E-5	2.49E-9	1.82E-5
M	Depletion of abiotic resources - elements	kg.eq.Sb	1.26E-8	1.17E-8	6.42E-11	6.42E-10	4.98E-13	1.33E-10
M	Depletion of abiotic resources - fossil fuels	MJ	3.49E+0	3.23E+0	2.28E-2	1.83E-1	2.02E-4	5.43E-2
M	Climate change - total	kg.eq.CO2	1.34E-1	8.28E-2	1.63E-3	1.28E-2	1.05E-6	3.67E-2
M	Climate change - fossil fuels	kg.eq.CO2	1.33E-1	8.21E-2	1.63E-3	1.28E-2	1.05E-6	3.67E-2
M	Climate change - biogenics	kg.eq.CO2	7.97E-4	7.59E-4	00E+0	3.8E-5	2.71E-9	-9.49E-11
M	Water requirement	m^3.eq. deprivation worldwide	1.46E-1	1.35E-1	6.2E-6	7.64E-3	7.63E-8	3.11E-3
M	Use of renewable primary energy, excluding renewable primary energy resources used as raw materials	MJ	5.03E-2	4.58E-2	3.04E-5	3.87E-3	1.87E-5	5.35E-4
M	Use of renewable primary energy resources used as raw materials	MJ	2.03E-2	2.03E-2	00E+0	00E+0	00E+0	00E+0
M	Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials)	MJ	7.06E-2	6.61E-2	3.04E-5	3.87E-3	1.87E-5	5.35E-4
M	Use of non-renewable primary energy, excluding non-renewable primary energy resources used as raw materials	MJ	2.87E+0	2.61E+0	2.28E-2	1.83E-1	2.02E-4	5.43E-2
M	Use of non-renewable primary energy resources used as raw materials	MJ	6.22E-1	6.22E-1	00E+0	00E+0	00E+0	00E+0
M	Total use of non-renewable primary energy resources (primary energy and primary energy resources used as raw materials)	MJ	3.49E+0	3.23E+0	2.28E-2	1.83E-1	2.02E-4	5.43E-2
M	Use of secondary materials	kg	3.26E-3	3.26E-3	00E+0	00E+0	00E+0	00E+0
M	Use of renewable secondary fuels	MJ	6.52E-3	00E+0	00E+0	6.52E-3	00E+0	00E+0
M	Use of non-renewable secondary fuels	MJ	6.52E-3	00E+0	00E+0	6.52E-3	00E+0	00E+0
M	Net use of fresh water	m^3	3.4E-3	3.15E-3	1.44E-7	1.78E-4	1.78E-9	7.24E-5
M	Hazardous waste disposed of	kg	2.59E-2	3.68E-3	00E+0	1.24E-3	1.57E-8	2.1E-2
M	Non-hazardous waste disposed of	kg	3.34E-2	3.43E-3	5.73E-5	6.88E-3	1.01E-7	2.3E-2
M	Radioactive waste disposed of	kg	2.61E-6	5.16E-7	4.08E-8	1.15E-6	4.26E-11	9E-7
M	Materials for recycling	kg	7.06E-4	00E+0	00E+0	7.06E-4	00E+0	00E+0
M	Materials for energy recovery	kg	5.77E-4	00E+0	00E+0	5.61E-4	00E+0	1.63E-5

M	Exported energy	MJ by energy vector	5.22E-4	3.31E-5	00E+0	4.89E-4	00E+0	00E+0
O	Total use of primary energy during the life cycle	MJ	3.56E+0	3.3E+0	2.28E-2	1.87E-1	2.21E-4	5.48E-2
O	Emission of fine particles	incidence of diseases	4.49E-9	4E-9	8.4E-11	2.67E-10	2.36E-13	1.4E-10
O	Ionizing radiation, human health	kBq. eq.U235	5.75E-1	5.47E-1	3.97E-6	2.75E-2	2.73E-5	4.32E-4
O	Ecotoxicity (fresh water)	CTUe	6.8E-1	6.06E-1	1.1E-3	4.12E-2	7.44E-6	3.25E-2
O	Human toxicity, carcinogenic effects	CTUh	4.19E-10	3.93E-10	2.87E-14	2.44E-11	1.76E-16	1.7E-12
O	Human toxicity, non-carcinogenic effects	CTUh	8.41E-10	7.49E-10	3.1E-12	4.68E-11	7.61E-15	4.2E-11
O	Impacts related to land use/soil quality	-	6.4E-3	6.1E-3	00E+0	3.05E-4	3.36E-8	00E+0

The declaration may be completed by different charts which emphasize as in the example below the importance of the manufacturing phase.



The results of the environmental footprint calculations in the context of comparison or ecodesign can be also presented in radar form. Pictured below as an example, the result of a comparison between several packaging types and the environmental impact in this example have been grouped to ease the reading of the graph.



Carbon footprint, water consumption, energy consumption, resource depletion are the most famous environmental criteria, and often featured on the first pages of environmental declarations (PEF, EPD, PEP,...).

This type of presentation shows also the importance of the multicriteria approach, and the necessity to have a voluntary approach to reduce the environmental footprint impacting on the planetary boundaries, as materialised in the radar chart without increasing individual environmental footprint.
However, all cable manufacturers have also the possibility after having carried out a multi-phase multi-criteria life cycle assessment to make:

- type II self-declarations according to ISO14021 standard,
- and/or declarations of the carbon footprints of their products according ISO14067 standard.

Conclusion

LCA is thus a method to calculate the environmental impacts of the FTTH optical cables allowing for fair and comparable environmental declaration. The calculation's processes are indeed based on the use of standardized PCR (i.e. CENELEC EN 50-693 or PCR-ed4--2021 09 06) and PSR (i.e. IEC TR 62839-1 Ed 2 or PSR-0001-ed4-EN-2022 11 16) relating to the product categories.

4. Reference documents

ISO14040 Environmental management - Life cycle assessment – Principles and framework
ISO14044 Environmental management – Life cycle assessment – requirements and guidelines
ISO14025 Environmental labels and declarations – Type III environmental declarations
ISO14021 Environmental labels and declarations – Self-declared environmental claims
ISO14067 Greenhouse gases – carbon footprint of the product (under review)
EN 50 693 Product category rules for life cycle assessments of electronic and electrical products and systems
IEC TR 62839-1 Environmental declaration – Part 1 Ed2: Communication wires and cables - product specific rules, (Note: Ed2 was still in preparation and not yet published at the date of the publication of this Newsletter)

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