URBOS

for the city of OSLO

Programme	The International EPD® System, www.environdec.com
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EPD®

Environmental Product Declaration
in accordance with ISO 14025

www.caf.net

Technological innovation in support of the environment to reach further with less power consumption. Urbos 100 conforms to the strictest environmental requirements, for perfect integration in architectural environments while maintaining high running performance. A new generation of trams that guarantees maximum power-efficiency and full passenger ride comfort. Versatile, with personality and environmentally friendly.

ENVIRONMENTAL PRODUCT DECLARATIONS PROGRAMME
The international EPD® System
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PRODUCT CATEGORY RULES (PCR)
Rolling stock, Product Category Classi cation: UN CPC 495, 2009:05, version 3.04

PCR REVIEW WAS CONDUCTED BY
The Technical Committee of the International EPD® System
Chair of the PCR review: Adriana Del Borghi

INDEPENDENT THIRD PARTY VERIFICATION OF THE DECLARATION AND DATA, ACCORDING TO ISO 14025:2006
☐ EPD process certification ☒ EPD Verification

THIRD PARTY VERIFIER
Marcel Gómez Ferrer / www.marcelgomez.com
Approved by: The International EPD® System Technical committee, supported by the Secretariat

PROCEDURE FOR FOLLOW UP OF DATA DURING EPD VALIDITY INVOLVES THIRD PARTY VERIFIER
☒Yes ☐No

LCA STUDY
Instituto tecnológico de Aragón / www.itainnova.es
Owner of the EPD: CAF S.A.
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Name and location of production site: CAF S.A., Zaragoza Plant
Geographical scope: Norway
EPDs within the same product category but from different programmes may not be comparable.
The EPD owner has the sole ownership, liability and responsibility of the EPD.
Differences Versus Previous Versions
2022.12.19 Version 1.0
2023.05.02 Version 2.0 - New verification: Operation mix updated

CAF **COMMITMENT**

Railways and the environment.
On track to efficiency.

CAF is an international leader in the design, manufacture, maintenance and supply of equipment and components for railway systems across the globe. The company was founded at the beginning of the 20th century and initially served primary industries in Northern Spain. Since then, the company has grown into the international company it is today with over 13,000 qualified professionals, over 30% of whom are degree qualified.

The company holds onto its roots with the company headquarters still being in the original site at Beasain. This education level combined with a commitment to R+D+I and the know-how built up from over 100 years of experience has meant that CAF has continued to lead and innovate their own state-of-the-art technology, which has significantly improved efficiency, safety and comfort of its products and of the sector itself. This technology includes solutions such as the Greentech energy efficient family with the Evodrive kinetic energy recovery system and the Freedrive for catenary-free running. Also solutions for the control of fleets and their maintenance such as AURA, NAOS for traffic and energy control, together with AURIGA the ERTMS wayside and onboard system of the CAFs group.

CAF integrates Corporate Social Responsibility into the company's general policy and is fully aware of the potential impact of industrial activities on the environment. For this reason the organisation includes Environmental protection as one of its primary objectives. CAF's environmental management is aimed at controlling and minimizing environmental impact from emissions into the atmosphere, residues and energy consumption, with the principle aim of preserving natural resources.

To achieve this CAF has implemented a sustainability function into the production processes, making the most of natural resources and generating energy via renewable methods.
The CAF Group operates photovoltaic solar, small scale wind and sustainable mobility business; with a hydro-electric plant and photovoltaic panels at their facilities to meet the energy requirements.

The implemented environmental management system has been certified in accordance with ISO 14001 since 2001.
In order to provide more efficient and more environmentally friendly means of transport, CAF is currently implementing the "Product Sustainability Function", introducing Eco design methods in the engineering processes to optimise and control the environmental impact of products throughout their entire operating cycle.

NEW INITIATIVES FOR SUSTAINABLE MOBILITY

The European Green Deal sets out the key elements that should structure climate action so that the European Union can become a carbon-neutral and competitive economy by 2050. Rail transport is the mode of public transport with the lowest emissions per passenger and therefore has a decisive role to play in the fight against climate change. The Fuel Cells and Hydrogen Joint Undertaking (FCH JU) of the European Commission has selected the project FCH2RAIL.

FCH2RAIL is technically led by CAF and would benefit from the European funding under the H2020 Program to work on the development of a railway vehicle prototype powered by hydrogen.

SPORVEIEN'S SL18

SL18 is an international gauge, bidirectional tram with two driver cabs, made up of 5 articulated modules resting on two motor bogies and one trailer bogie under the central module.

TECHNICAL DATASHEET

Composition	Mc-S-T-S-Mc
Power supply voltage	750 Vdc
Track gauge	1.435 mm
Max. speed	70 km/h
Length	34.16 m
Exterior width	2.65 m
Vestibule area floor height	330-360 mm
Total capacity	220
Places for wheelchairs	2

EQUIPMENT

Saloon and cab air conditioning
Passenger Audio and Visual Information: public address system, TFT displays for passenger information, video-advertising system, external colour route displays, passenger/driver intercommunication
LED indicators, TFT displays, intercoms
Event recorder and driver surveillance system
Interior video surveillance (CCTV)
Sanders and Flange lubrication
Train control and diagnostic system using programmed logic
People Counting System (APC)
Radio communication system
Signalling system
Operation assistance system
Traffic light priorization system
Driver Advisory System & Energy Management for efficient driving
Head-up display

URBOS

VERSATILE, WITH PERSONALITY AND ENVIRONMENTALLY FRIENDLY

Technological Innovation in support of the environment to reach further with less power consumption. Urbos conforms to the strictest Design for Environment requirements, for perfect integration in architectural environments while maintaining high running performance. A new train generation that guarantees maximum power-efficiency and full passenger ride comfort.

EACH CITY HAS UNIQUE CHARACTERISTICS THAT CALL FOR BESPOKE SOLUTIONS

SL18 units have been particularly conceived for the city of Oslo, considering its strong personality and integrating themselves into the environment.

This integration is seconded by a commitment for maximum accessibility, riding comfort and user friendliness.

SL 18 trams are specifically designed to meet extreme temperature conditions. Specific insulation panels and double glazing windows allow the highest degree of comfort with low energy consumption.

INFORMATION ABOUT THE **ENVIRONMENTAL DECLARATION**

This environmental declaration was made following the requirements of the reference document "PCR 2009:05 v.3.04 - UN CPC 495 Rolling Stock" published by Environdec (www.environdec.com) and is based on the data of the URBOS 100 tram units for the City of Oslo, for all the stages of the product's life cycle (production of raw materials and components, assembly of the vehicle, distribution, use and end of life).

The Urbos 100 environmental impact study has been quantified by means of a Life Cycle Analysis in accordance with standards ISO 14040 and ISO 14044. The LCA study uses a "cradle to grave" approach where the impacts are allocated to the corresponding modules. The methods of the characterization of the environmental impact of the compiled operating life inventory are CML-IA and for some specific cases EDIP 2003, Midpoint+ and CED. The LCA scope is defined according to the polluter-pays principle proposed in the PCR. All known processes within a contribution of 99% of the environmental impacts have been included in the LCA. Information regarding the materials and production of the vehicle has been obtained directly from the Management Systems of CAF and the information provided by the suppliers themselves. Data from the Ecoinvent database (version 3.6) has been used for the environmental definition of the processes and materials. Those processes not available in Ecoinvent database were generated using first hand data.

FUNCTIONAL UNIT

The functional unit in this study is the transport of 1 passenger over 1km and the operating life of the vehicle analysed has been set at 30 years.

CUT OFF AND ALLOCATIONS

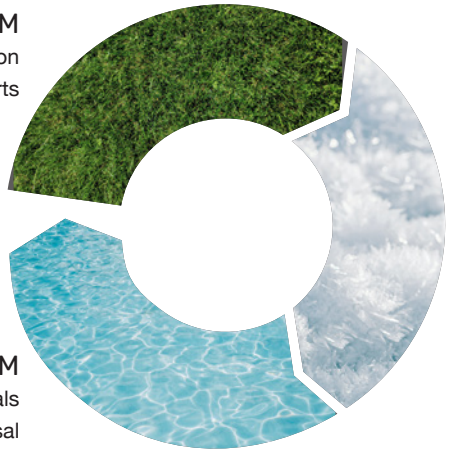
For vehicle assembly, the effect of the procurement of materials and components making it up have been considered, as well as the transport of materials (over 68,9% of the tram weight) to the assembly plant, the assembly itself, handling of the waste from both the assembly and dismantling of the vehicle and the transport of the vehicle from CAF's Zaragoza plant to Oslo in Norway. For the environmental impact of the energy consumption during assembly, the Spanish 2020 electricity production mix has been taken into account. For the environmental impact characterization of the energy consumption during use phase an average of 70.000 km per year and 100% renewable hydroelectric power has been considered.

During the downstream phase, the materials used to operate the vehicle – such as brake pads, flange and top of the rail lubrication or sand – as well as the maintenance materials and spare parts (based on the maintenance program) are considered.

A vehicle occupation capacity of 138 passengers (all seated and 2 passengers per square-meter standing) has been considered in accordance with the operational mass defined in standard EN 15663.

At the end of life, and vehicle dismantling stage, has been modelled according to ISO 21106. The potential advantage of recycling and recovery of the energy from incineration processes has not been accounted for in the study. Excluded processes are according to chapter 4.3.1 of the Product Category Rules 2009:05.

ROLLING STOCK SYSTEM BOUNDARIES



UPSTREAM
- Material & Energy Production
- Transport of Material & Parts

CORE
- Vehicle Manufacturing (including energy and auxiliary materials and waste)
- Transport of Vehicle to Use Location

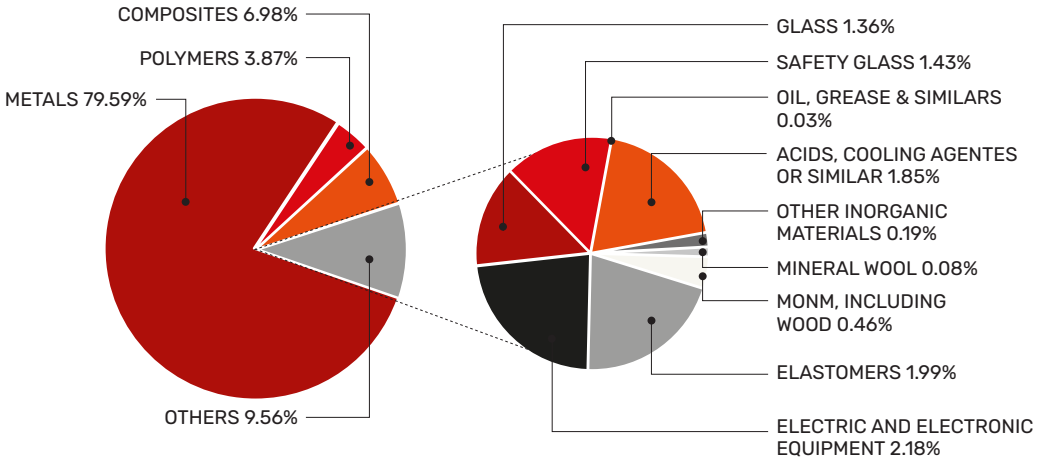
DOWNSTREAM
- Vehicle Energy & Maintenance Materials
- Vehicle Dismantling and Disposal

LIST OF **MATERIALS**

In the design of the SL18 materials have been selected according to the functional, technical and regulatory requirements, as well as considering their recyclability and ease of dismantling at the end of their operating life.

In accordance with their policy, CAF meets the environmental requirements right from the very first stages of their projects. When designing the SL18, CAF has observed and demanded that their suppliers apply the “Railway Industry Substance List” (www.unifedatabase.org) to reject the content of regulated materials that could affect the environment or people’s health.

Disassembling is foreseen right from the design stage to enhance material separation and recycling of the vehicle when its end of life is reached. The following figures show the summarised inventory of the tram materials.



VEHICLE MATERIALS						
MATERIAL CONTENT IN 1 VEHICLE (%)	CARBODY	INTERIOR, WINDOWS AND DOORS	BOGIES AND RUNNING GEARS	PROPULSION AND ELECTRIC EQUIPMENT	COMFORT SYSTEMS	TOTAL
Metals	26.51%	9.61%	31.33%	9.21%	2.93%	79.59%
Elastomers	0.68%	0.96%	0.22%	0.12%	0.02%	1.99%
Polymers	0.02%	0.89%	0.09%	2.73%	0.14%	3.87%
Composites	4.10%	2.45%	0.07%	0.21%	0.15%	6.98%
Electric and Electronic Equipment	0.00%	0.24%	0.69%	1.22%	0.02%	2.18%
Glass	0.00%	1.35%	0.00%	0.01%	0.00%	1.36%
Safety glass	0.00%	1.43%	0.00%	0.00%	0.00%	1.43%
Oil, grease & similars	0.00%	0.00%	0.01%	0.00%	0.02%	0.03%
Acids, cooling agentes or similar	1.62%	0.05%	0.05%	0.00%	0.13%	1.85%
Other inorganic materials	0.00%	0.01%	0.14%	0.04%	0.00%	0.19%
Mineral wool	0.00%	0.04%	0.00%	0.00%	0.03%	0.08%
MONM, including wood	0.00%	0.30%	0.15%	0.00%	0.01%	0.46%
TOTAL	32.93%	17.32%	32.75%	13.54%	3.47%	

HAZARDOUS SUBSTANCES	WEIGHT (%)	LOCATION
Nickel	0.0295%	Electronic components
Cadmium	0.0000139%	Mechanical components
Lubricant oil and grease	0.0300%	Mechanical components
Cooling agents	0.0376%	HVAC

PRODUCT
ENVIRONMENTAL IMPACT

NOISE EMISION

The main sources of noise emission involve the effects of the rolling gear, the HVAC unit and the vehicle's traction equipment. In accordance with standard ISO 3095, the unit's exterior contractual noise emission is as follows:

	dB(A)
Stationary sound pressure level	≤61
Acceleration sound pressure level	≤75
Constant speed sound pressure level	≤78

RECOVERABILITY AND RECYCLABILITY POTENTIAL PROFILE

As a result of the studied design and modularity used during assembly and dismounting, high recyclability and recoverability potential ratios are achieved at the end of the tram operating life.

Recyclability Rate	92.70%
Recoverability Rate	94.66%

Recoverability and recyclability potential according to ISO 21106

ENERGY CONSUMPTION

SL18 trams are equipped with a Sleep Mode to reduce noise and electrical consumption when the vehicle is not operative due to parking or cleaning / maintenance works.

Braking energy generated by the vehicle is used for feeding its own auxiliary systems such air conditioning or lighting. When the braking energy exceeds the auxiliary power demand, the energy not needed by the own vehicle is sent to the main line so other vehicles can use it.

kW.h/pass.km

Manufacturing	1,79 E-04	
	0% receptivity	100% receptivity
Average use: service	0.04626	0.02598
Average use: service + standby	0.04691	0.02663

Tram energy consumption values measured on track
(Ljabru- Oslo Hospital and Jernbanetorget- Rikshospitalet sections).

SUITABLE SANDING

SL18 is equipped with an efficient automatic sanding system with built-in flow meters. The wheel slide protection system commands the sand demand without manual intervention to apply the correct amount only when needed.

ENVIRONMENTAL PROFILE OF THE **PRODUCT LIFE CYCLE**

ENVIRONMENTAL PROFILE OF THE PRODUCT LIFE CYCLE									
ENVIRONMENTAL PROFILE FOR THE FUNCTIONAL UNIT [1 PASS. 1 KM]			Material and component production [UPSTREAM]	Transport and vehicle assembly [CORE]	Vehicle use [DOWNSTREAM]			TOTAL	
					Use energy consumption & consumables		Maintenance & End of Life	0% recept.	100% recept.
					0% recept.	100% recept.			
Primary energy resources – Renewable	Used as raw materials	MJ, net calorific value	1.37E-04	2.40E-04	1,81E-01	1,03E-01	1.22E-06	1,81E-01	1,03E-01
	Used as raw materials	MJ, net calorific value	2.28E-03	3.70E-05	2,10E-05	2,10E-05	7.00E-05	2,41E-03	2,41E-03
	TOTAL	MJ, net calorific value	2.42E-03	2.77E-04	1,81E-01	1,03E-01	7.13E-05	1,84E-01	1,05E-01
Primary energy resources – Non Renewable	Use as energy carrier	MJ, net calorific value	1.09E-03	2.46E-03	3,30E-03	1,87E-03	8.19E-05	6,94E-03	5,51E-03
	Used as raw materials	MJ, net calorific value	1.00E-02	4.93E-04	8,75E-04	8,75E-04	8.59E-04	1,22E-02	1,22E-02
	TOTAL	MJ, net calorific value	1.11E-02	2.96E-03	4,17E-03	2,75E-03	9.41E-04	1,92E-02	1,77E-02
Secondary material (*)		Kg	N/A	N/A	N/D	N/D	N/A	N/D	N/D
Renewable secondary fuels		MJ, net calorific value	0	0	0	0	0	0	0
Non-renewable secondary fuels		MJ, net calorific value	0	0	0	0	0	0	0
Net use of fresh water m^3		m^3	5.14E-07	7.71E-07	1,61E-06	9,47E-07	4.44E-07	3,34E-06	2,68E-06

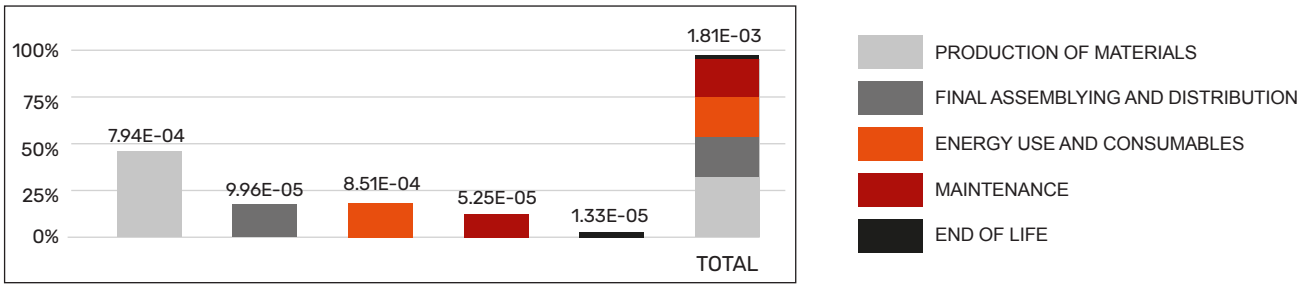
* Secondary material is known as used as a fraction of material inputs, but documented and consistent data from the supply chain are not available, so this indicator is not assessed.

ENVIRONMENTAL PROFILE FOR THE FUNCTIONAL UNIT [1 PASS. 1 KM]		Material and Component Production [UPSTREAM]	Transport and vehicle assembly [CORE]	Vehicle use [DOWNSTREAM]				TOTAL	
WASTE* [kg/ pass.km]				Use energy consumption & consumables		Maintenance	& End of Life	0% recept.	100% recept.
				0% recept.	100% recept.				
Hazardous waste disposed	Kg	6.60E-07	2.63E-09	1,07E-08	6,69E-09	2.91E-09	1.38E-10	6,76E-07	6,72E-07
Non Hazardous disposed	Kg	1.94E-04	1.54E-05	1,02E-03	5,80E-04	1.27E-05	6.35E-06	1,25E-03	8,08E-04
Radioactive waste disposed	Kg	3.70E-08	1.02E-08	1,95E-08	1,27E-08	1.95E-09	3.23E-10	6,90E-08	6,22E-08
OUTPUT FLOWS [kg/ pass.km]									
Components for reuse	Kg	0	0	0	0	0	0	0	0
Material for recycling	Kg	0	1.33E-06	0	0	5.21E-06	1.38E-04	1.45E-04	1.45E-04
Materials for energy recovery	Kg	0	0	0	0	8.36E-06	2.93E-06	1.47E-05	1.47E-05
Exported energy, electricity	Kg	0	0	0	0	0	0	0	0
Exported energy, thermal	Kg	0	0	0	0	0	0	0	0

* (EDIP 2003 method)
Note: up-stream material waste is included in column “material and component production [Upstream]”

ENVIRONMENTAL PROFILE FOR THE FUNCTIONAL UNIT [1 PASS. 1 KM]		Material and Component Production [UPSTREAM]	Transport and vehicle assembly [CORE]	Vehicle use [DOWNSTREAM]				TOTAL	
ENVIRONMENTAL IMPACT [/pass.km]				Use energy consumption & consumables		Maintenance	End of Life	0% recept.	100% recept.
				0% recept.	100% recept.				
Global Warming potential	kg CO2-Eq	7.94E-04	9.96E-05	5,63E-04	3,27E-04	5.25E-05	1.33E-05	1,522E-03	1,286E-03
Ozone depletion potential	kg CFC-11-Eq	1.97E-10	2.45E-11	2,91E-11	1,93E-11	8.37E-12	6.04E-13	2,591E-10	2,494E-10
Acidification potential	kg SO2-Eq	5.44E-06	4.08E-07	2,21E-06	1,30E-06	2.09E-07	1.08E-08	8,286E-06	7,377E-06
Eutrophication potential	kg PO4-Eq	2.88E-06	1.03E-07	9,45E-07	5,47E-07	8.67E-08	1.18E-08	4,025E-06	3,628E-06
Photochemical oxidation potential (Tropospheric Ozone)	kg C2H4-Eq	3.72E-07	2.35E-08	1,13E-07	6,66E-08	2.06E-08	7.72E-10	5,298E-07	4,836E-07
Abiotic depletion	kg Sb-eq	2.73E-07	6.48E-10	2,26E-08	1,32E-08	4.95E-09	1.20E-10	3,015E-07	2,920E-07
Abiotic depletion (fossil fuels)	MJ	8.75E-03	2.21E-03	3,47E-03	2,33E-03	7.61E-04	5.20E-05	1,524E-02	1,410E-02

TOTAL GLOBAL WARMING POTENTIAL (kg CO2 eq.)



In 2019 Norwegian CO2 emissions were 6.72 metric tons per capita
Source: http://data.worldbank.org

WASTE

CAF has legal authorization for industrial waste generation, both hazardous and non-hazardous, issued by the Government of Aragon in accordance with current Spanish legislation. The final treatment of the 100% waste generated is carried out by companies also authorized by the Government of Aragon. Over the 90% (by weight) of the waste is recovered.

For suppliers of materials and services, CAF demand compliance with the legal regulations of each country of origin and, in addition, CAF makes its own waste management system available to the companies that carry out work at its facilities.

DEFINITIONS

Acidification (potential)
Acidification results from the emission of sulphur dioxide and nitrogen oxides. In the atmosphere, these oxides react with the existing steam, forming acids which fall back to the earth in the form of rain or snow, or as dry deposits. Its effect on the earth generally shows itself in the form of reduced forest development and in aquifer ecosystems, such as lakes, acidification is apparent in the disappearance of some living organisms. Other objects such as constructions, monuments and buildings may also be damaged as a result of the effects of acid rain. Acidification potential measures an emitting substance's contribution to acidification expressed in sulphur dioxide equivalents (SO2).

Eutrophication (potential)
Eutrophication results in the enrichment of water ecosystems with organic compounds and nutrients, which give rise to an increased production of plankton, algae and other water plants with the resulting reduction in water quality. In this case the main sources related to this phenomenon are nitrogen and phosphorous.
A secondary effect is the decomposition of dead organic material, a process which consumes oxygen and may result in anaerobic environments. The eutrophication potential, expressing in equivalent PO-43, quantifies nutrient enrichment via the release of a substance in water or land.

Global Warming (potential)
Greenhouse effect emissions into the atmosphere absorb some of the infrared solar radiation reflected on the earth's surface resulting in a troposphere temperature increase. The global warming potential is an index, in equivalent kg of CO2, to measure the global warming contribution of a substance released into the atmosphere in a span of 100 years.

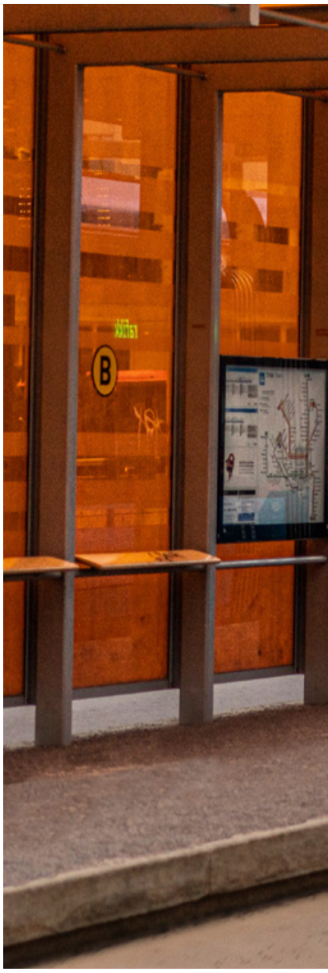
Ozone depletion (potential)
The ozone layer in the atmosphere protects the flora and fauna from harmful ultraviolet radiation from the sun. Some substances emitted into the atmosphere deplete this layer resulting in a higher level of UV radiation on the earth. The ozone layer depletion potential is the contribution of a substance compared with the impact caused by CFC-11.

Ozone photochemical formation/ Photochemical oxidation (potential)
The photo-chemical formation of the ozone in the troposphere is mainly provoked by the decomposition of volatile organic compounds (VOCs) in the presence of nitrogen oxides (Nox) and light. The formation of ozone by means of this process can be quantified by using the so-called ozone photochemical formation potentials (POCPs) expressed in equivalent kg of ethane (C 2H4).

Abiotic depletion (includding fossil fuels) (potential)
Characterization of the scarcity of resources and hence the limitations in its availability to current and future generations. The Abiotic Depletion Potential of a resource is defined as the ratio of the annual production and the square of the ultimate Earth reserve for the resource divided by the same ratio for a reference resource, antimony (Sb).

REFERENCE DOCUMENTATION

- ISO14040:2006. Environmental management. Life cycle assessment. Principles and framework.
- ISO14044:2006. Environmental management. Life cycle assessment. Requirements and guidelines.
- ISO 14025:2006 Environmental labels and declarations. Type III environmental declarations. Principles and procedures.
- Product Category Rules 2009:05 version 3.04 - UN CPC 495 Rolling Stock
- General Programme Instructions for environmental product declarations, EPD, version 3.0
- TecRec 100:001. Specification and verification of energy consumption for railway Rolling stock.
- EN 15663:2017. Railway applications. Definition of vehicle reference masses.
- ISO 3085. Railway applications - Acoustics - Measurement of noise emitted by railbound vehicles.
- Railway Industry Substance List, (www.unife-database.org).
- UNI-LCA-001:00 Railway Rolling Stock - Recyclability and Recoverability Calculation Method.
- ISO 21106:2019, Railway applications — Recyclability and recoverability calculation method for rolling stock.
- EN 50591:2019 Specification and verification of energy consumption for railway rolling stock.



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SCAN TO VISIT
OUR PROJECT