INNEO

B23 for Docklands Light Railway

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An EPD should provide current information, and may be updated if conditions change. The stated validity is therefore subject to the continued registration and publication at www.environdec.com

EPD®

Environmental Product Declaration
in accordance with ISO 14025

www.caf.net

CAF is a multinational group with over 100 years of experience offering integrated transport solutions at the forefront of technology that provide its customers with high value-added sustainable alternatives for mobility.

In this quest for a more sustainable future, CAF has developed the Inneo family of metros which constitute an innovative, adaptative and low emissions light rail system in many cities around the world.

ENVIRONMENTAL PRODUCT DECLARATIONS PROGRAMME
The international EPD® System
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PRODUCT CATEGORY RULES (PCR)
Rolling stock and parts thereof, Product Category Classi cation: UN CPC 495, 2009:05, version 4.0.2

PCR REVIEW WAS CONDUCTED BY
The Technical Committee of the International EPD® System
Chair of the PCR review: Claudia A. Peña

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

THIRD PARTY VERIFIER
Marcel Gómez Consultoría Ambiental SL / www.marcelgomez.com / info@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 ACCOUNTABILITY
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Name and location of production site: CAF S.A., Beasain Plant
Geographical scope: UK
EPDs within the same product category but from different programmes may not be comparable. For two EPDs to be comparable, they must be based on the same PCR (including the same version number) or be based on fully aligned PCRs or versions of PCRs; cover products with identical functions, technical performances and use (e.g. identical declared/functional units); have equivalent system boundaries and descriptions of data; apply equivalent data quality requirements, methods of data collection, and allocation methods; apply identical cut-off rules and impact assessment methods (including the same version of characterisation factors); have equivalent content declarations; and be valid at the time of comparison.
The EPD owner has the sole ownership, liability and responsibility of the EPD.
Differences Versus Previous Versions
2023.12.04 Version 1.0

CAF
COMMITMENT

Railways and the environment.
On track to efficiency.

CAF is one of the recognised international leaders 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.
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 being concious that the development of our industrial activity causes impacts on the environment, the organization includes Environmental protection as one of its primary objectives. CAF is committed to develop strategies against the climate change reducing its carbon footprint, promoting the use of renewable energy in its factories, as well as developing low emissions products.

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 such as photovoltaic panels in CAF's factories and its own hydro-electric plants to meet the energy requirements.

The implemented environmental management system has been certified in accordance with ISO 14001 since 2001 (approval number 0036012).

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 life 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.

INNEO

B23 FOR DOCKLANDS LIGHT RAILWAY

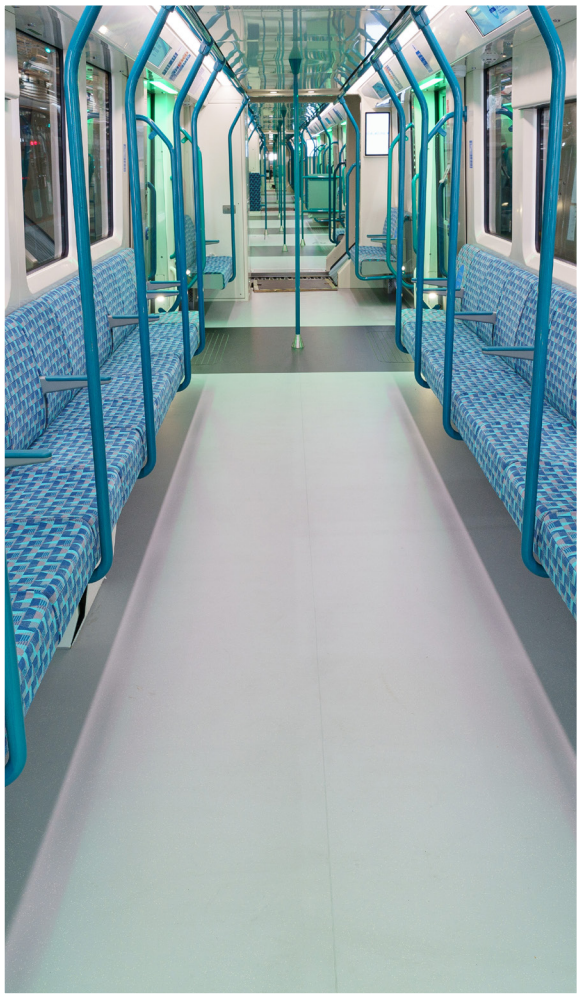
The train is an electric metro unit designed to run on the entire track network of Docklands Light Railway. It is formed by five cars, two end motor cars, one central motor car and two intermediate trailer cars.

TECHNICAL DATASHEET

Composition	A-B-C-D-E
Power supply voltage	750 Vdc
Track gauge	1.435 mm
Max. speed	80 km/h
Length	86.7 m
Exterior width	2.65 m
Total capacity	792
Places for wheelchairs	3

EQUIPMENT

Air conditioning
Passenger Audio and Visual Information: public address system, TFT displays for passenger information, video-advertising system, passenger/driver intercommunication
LED displays
Event recorder
Interior and exterior video surveillance (CCTV)
Flange lubrication system
Train control and diagnostic system (TCMS) using programmed logic
Derailment detection system
Radio communication system
Door Control Panels (DCP) for PSA
Communication Based Train Control (CBTC)
Fire Detection System
WiFi for Staff



INNEO

SAFETY AND COMFORT FOR THE CITIES OF THE FUTURE

CAF INNEO family of metros provides an innovative, quality and efficient solution with a clear orientation to the customer comfort. In keeping with this philosophy, some key design features are low noise levels, a bright functional space, live passenger information and easy access. INNEO is equipped with the latest technological advances in terms of safety, performance and comfort.

Today light rails systems are becoming ever more important in cities around the globe, as they represent a mobility solution that helps reduce traffic congestion problems, offering passengers a fast, punctual and more sustainable means of transport in comparison to others such as particular vehicle.

EACH CITY HAS UNIQUE CHARACTERISTICS THAT CALL FOR BESPOKE SOLUTIONS

B23 units have been specially designed for the Docklands Light Railway system which serves the redeveloped Docklands area of London. B23 units support GoA3 operation and they feature an emergency manual mode as a back-up. The service is automated providing the system with a strong optimization in terms of energy consumption and an enhanced passenger service.

This integration is seconded by a commitment for maximum accessibility, riding comfort and user friendliness. To this regards, B23 vehicles meet RVAR 2010 (Rail Vehicle Accessibility Regulations).

B23 vehicles are specifically design to circulate through the DLR infrastructure.

The fully walk-through trains allow to increase the capacity of transport of passengers keeping the highest degree of comfort and enhancing safety.

INFORMATION ABOUT THE **ENVIRONMENTAL DECLARATION**

This environmental declaration was made following the requirements of the reference document “PCR 2009:05 v.4.0.2 - UN CPC 495 Rolling Stock and parts thereof” published by Environdec (www. environdec.com) and is based on the data of the B23 vehicle for Docklands Light Railway, 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 INNEO environmental impact study has been quantified by means of a Life Cycle Analysis in accordance with standards ISO 14040, ISO 14044 and ISO 14025. The LCA study uses a “cradle to grave” approach where the impacts are allocated to the corresponding modules. The method of the characterization of the environmental impact of the compiled operating life inventory follows the EF Reference Package 3.1 (EF 3.1). The LCA scope is defined according to the polluter-pays and the modularity principles proposed in the PCR. All known processes within a contribution of 99% of the environmental impacts have been included in the LCA.

According to ISO 14044:2006, published data should come from reliable and quality sources of information in order to accomplish the aim and the scope of the LCA study. In this line of action, information related to manufacturing processes has been verified according to ISO 14001 and EMAS regulation. Other information such as material inventory or maintenance phase information has been checked by CAF Technical Engineers or by direct measuring during production. 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 3.9.1) has been used for the environmental definition of the processes and materials. All this information has been treated using Simapro 9.5.0 software. 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 35 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 82.30% of the metro 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 Beasain plant to London in UK. For the environmental impact of the energy consumption during assembly, 100% renewerable wind power electricity has been taken into account.

The input data for the core phase of the vehicle has been allocated in proportion to the yearly man hours cost.

For the environmental impact characterization of the energy consumption during use phase an average of 110.000 km per year and 2022 residual UK electricity mix (0.4475 kg CO2e/kWh) has been considered.

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

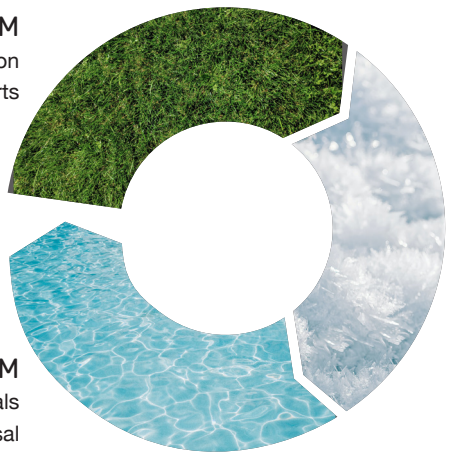
A vehicle occupation capacity of 792 passengers (all seated and 5 passengers per square-meter standing) has been considered in accordance with the operational mass defined in standard EN 15663.

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

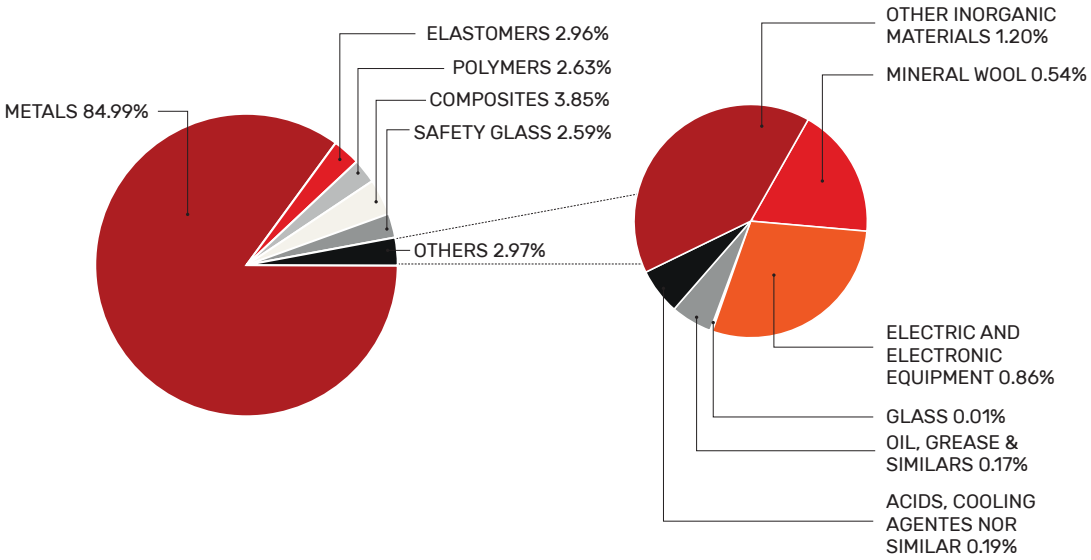
DOWNSTREAM
- Vehicle Energy & Maintenance Materials
- Vehicle Dismantling and Disposal

LIST OF **MATERIALS**

In the design of the B23 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.

When designing the B23, 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	22.07%	8.99%	42.32%	8.06%	3.55%	84.99%
Elastomers	0.82%	1.19%	0.80%	0.080%	0.076%	2.96%
Polymers	0.768%	0.45%	0.10%	1.14%	0.16%	2.63%
Composites	0.11%	3.57%	0.081%	0.093%	0%	3.85%
Electric and Electronic Equipment	0.00012%	0.09%	0.40%	0.33%	0.045%	0.86%
Glass	0%	0.00040%	0.00%	0.0055%	0%	0.006%
Safety glass	0%	2.59%	0.00%	0%	0%	2.59%
Oil, grease & similars	0.057%	0.021%	0.084%	0%	0.0070%	0.17%
Acids, cooling agentes or similar	0%	0%	0%	0.164%	0.030%	0.19%
Other inorganic materials	0.46%	0%	0.54%	0.092%	0.11%	1.20%
Mineral wool	0%	0.31%	0%	0.0039%	0.225%	0.54%
TOTAL	24.28%	17.22%	44.32%	9.97%	4.20%	112,674 Kg

PRODUCT
ENVIRONMENTAL IMPACT

ENERGY CONSUMPTION

B23 vehicles are equipped with different operating modes which allows to manage energy consumption scenarios such us remote switch-on of the vehicles or stabling mode as an energy efficient parking mode.

When braking energy generated by the vehicle is available, it is used for feeding its own auxiliary systems such air conditioning or lighting, reducing the external demand of energy. In case this braking energy exceeds the internal auxiliary power demanded, the energy not needed by the own vehicle is sent to the main line so other vehicles can use it.

kW.h/pass.km

	100% receptivity
Average use: service	0.00507
Average use: service + standby	0.00520

Metro energy consumption values measured during testing operations.

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	93.91%
Recoverability Rate	95.85%

Recoverability and recyclability potential according to ISO 21106

ENVIRONMENTAL PROFILE OF THE **PRODUCT LIFE CYCLE**

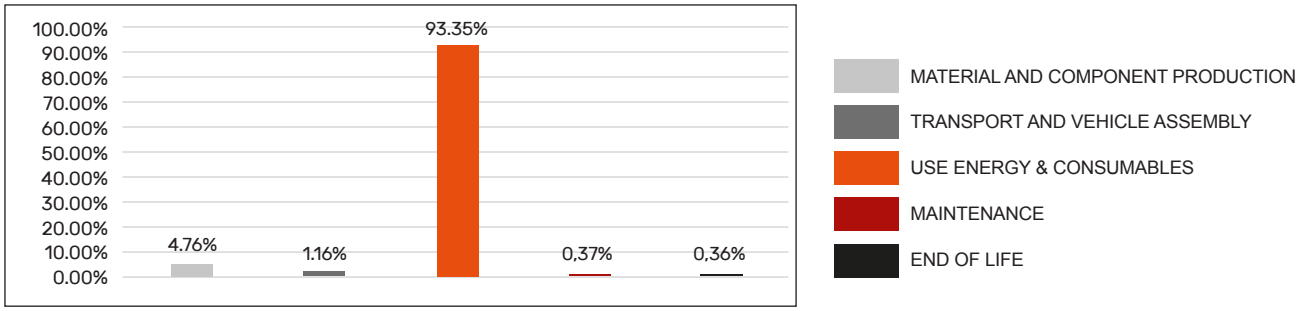
ENVIRONMENTAL PROFILE OF THE PRODUCT LIFE CYCLE							
ENVIRONMENTAL PROFILE FOR THE FUNCTIONAL UNIT [1 PASS. 1 KM]			Material and component production [UPSTREAM]	Transport and vehicle assembly [CORE]	Vehicle use		TOTAL
					Use energy consumption	Maintenance & End of Life	
					100% recept.		100% recept.
Primary energy resources – Renewable	Use as energy carrier	MJ, net calorific value	3.47E-074	1.66E-04	8.76E-04	2.61E-06	1.39E-03
	Used as raw materials	MJ, net calorific value	2.64E-05	1.15E-05	2.42E-06	4.84E-06	4.52E-05
	TOTAL	MJ, net calorific value	3.74E-04	1.77E-04	8.78E-0	7.45E-06	1.44E-03
Primary energy resources – Non Renewable	Use as energy carrier	MJ, net calorific value	1.35E-03	3.99E-04	5.38E-02	1.13E-04	5.56E-02
	Used as raw materials	MJ, net calorific value	3.64E-04	1.09E-05	5.15E-05	1.03E-04	5.30E-04
	TOTAL	MJ, net calorific value	1.71E-03	4.09E-04	5.38E-02	2.16E-04	5.62E-02

ENVIRONMENTAL PROFILE FOR THE FUNCTIONAL UNIT [1PASS. 1KM]		Material and Component Production [UPSTREAM]	Transport and vehicle assembly [CORE]	Vehicle use [DOWNSTREAM]			TOTAL
WASTE* [kg/ pass.km]				Use energy & consumption	Maintenance	End of Life	
				100% recept.			
Hazardous waste disposed	Kg	4.79E-08	1.91E-09	1.50E-07	4.91E-09	4.50E-10	2.05E-07
Non Hazardous disposed	Kg	4.06E-05	1.19E-05	9.94E-05	3.37E-06	8.55E-07	1.56E-04
Radioactive waste disposed	Kg	4.45E-09	5.25E-10	2.86E-07	1.34E-10	4.97E-12	2.91E-07

* (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 100% recept.	Maintenance	End of Life	
Climate change total	kg CO2 eq	1.19E-04	2.88E-05	2.33E-03	9.30E-06	8.98E-06	2.49E-03
Climate change - Biogenic	kg CO2 eq	3.27E-07	7.04E-07	3.38E-06	9.51E-09	7.21E-10	4.42E-06
Climate change - Fossil	kg CO2 eq	1.17E-04	2.81E-05	2.32E-03	9.28E-06	8.98E-06	2.49E-03
Climate change - Land use and LU change	kg CO2 eq	1.56E-06	2.60E-08	2.20E-07	1.25E-08	7.57E-10	1.82E-06
Acidification	mol H+ eq	1.37E-06	7.55E-08	4.97E-06	8.79E-08	3.00E-08	6.54E-06
Eutrophication, freshwater	kg P eq	1.14E-07	4.67E-09	1.44E-07	6.68E-09	1.34E-10	2.70E-07
Eutrophication, marine	kg N eq	1.14E-07	1.79E-08	1.27E-06	8.47E-09	1.28E-08	1.46E-06
Eutrophication, terrestrial	mol N eq	1.58E-06	1.75E-07	1.33E-05	9.77E-08	1.37E-07	1.53E-05
Photochemical ozone formation	kg NMVOC eq	6.08E-07	8.07E-08	4.60E-06	6.39E-08	5.39E-08	5.41E-06
Ozone depletion	kg CFC11 eq	3.01E-11	1.05E-12	1.20E-10	2.07E-13	1.01E-13	1.51E-10
ADP, minerals and metals	kg Sb eq	1.36E-08	2.05E-10	3.97E-09	8.89E-10	4.09E-12	1.87E-08
ADP, fossils	MJ	1.64E-03	4.13E-04	5.03E-02	1.43E-04	7.63E-05	5.26E-02
Water Deprivation Potential	m^3	4.27E-05	2.75E-04	5.08E-05	2.73E-06	2.33E-07	3.72E-04

TOTAL GLOBAL WARMING POTENTIAL (kg CO2 eq.)



In 2020 British CO2 emissions were 4.6 metric tons per capita and year
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.

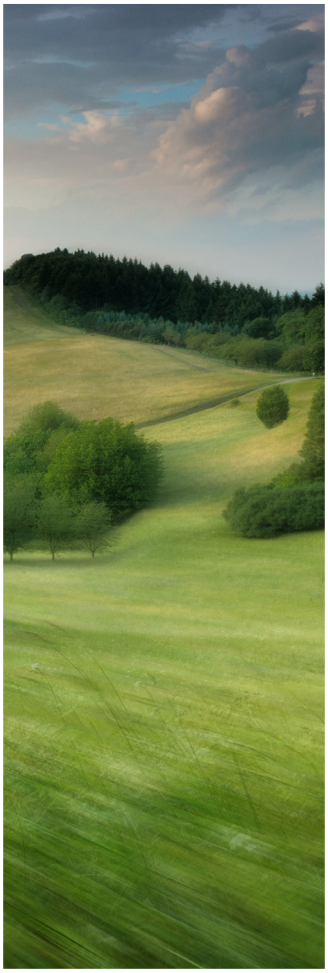
Ozone photochemical formation/ Photochemical oxidation (potential)
The photo-chemical formation of the ozone in the troposphere is mainly provoked by the decomposition of volatile organic compounds (VOCs) in the presence of nitrogen oxides (Nox) and light. The formation of ozone by means of this process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

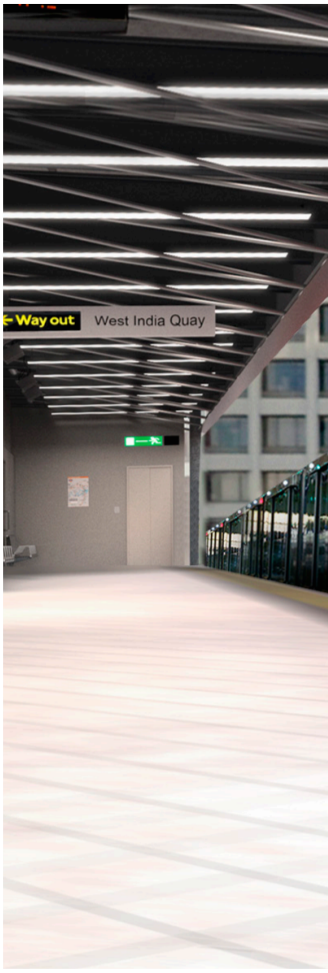
Abiotic depletion (includding fossil fuels) (potential)
Characterization of the scarcity of resources and hence the limitations in its availability to current and future generations. The Abiotic Depletion Potential of a resource is defined as the ratio of the annual production and the square of the ultimate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

Water Deprivation Potential (WDP)
The water footprint of a product is the amount of water that is consumed or polluted in all processing stages of its production. The Water Deprivation Potential of a resource is an index, in m3, to quantify how much pressure that product has put on freshwater resources. Notably the variables in the calculation of water footprint will vary depending on location, season but also on a yearly basis depending on the occurrence of extreme weather events such as drought.

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 4.0.2- UN CPC 495 Rolling Stock and parts thereof
- General Programme Instructions for environmental product declarations, EPD, version 4.0
- 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.
- ISO 14020:2000 Environmental labels and declarations
- The underlying LCA report





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SCAN TO VISIT
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