CONSTRUCCIONES Y AUXILIAR DE FERROCARRILES S.A.

URBOS AXL
for Stockholm Lokaltrafik A35 Tram Units
Environmental Product Declaration according to ISO 14025

CAF provides a sustainable development testimony with a remaining in time vocation, capitalizing on their knowledge to continue to **lead and innovate** in the development of their own, state-of-the-art technology which promotes **efficiency, safety and comfort** in our products.

A new tram generation that guarantees maximum power-efficiency and full passenger ride comfort. **Versatile, with Personality and Environmentally Friendly.**

PCR review was conducted by:
Technical Committee of the International EPD® System
Joakim Thornéus (chair)
Swedish Environmental Management Council

Independent verification of the declaration and data,
according to ISO 14025:
□Internal ■External

Third Party Verifier:
Marcel Gómez Ferrer
Calle Vallmora 24, El Masnou
(Barcelona, Spain)
Tel: +34 630643593
www.marcelgomez.com

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UN CPC 495

EPDs within the same product category but from different
programmes may not be comparable.

CONSTRUCCIONES Y AUXILIAR DE FERROCARRILES S.A.

CAF'S COMMITMENT

**Railways and the environment.
On track for efficiency.**

CAF, CONSTRUCCIONES Y AUXILIAR DE FERROCARRILES, S.A. is one of the international leaders in the design, manufacture, maintenance and supply of equipment and components for railroad systems. Founded at the beginning of the XX century, based on the tradition of old foundries, CAF's headquarters are still based at the original site, and they have become an international group, made up of over 7,000 qualified professionals, with almost a quarter of these made up of university degree holders.

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 our products and of the sector itself. this technology includes the ACR system (Rapid Charge Accumulator) for catenary free trains, the EDRIS energy consumption controller, the SIBI active tilt system, or systems for the actual control of fleets and their maintenance such as AURA and MAP-TRAIN, etc.

CAF integrates Corporate Social Responsibility in the company's general policy, and is aware that their industrial activities can have an effect on the environment. For this reason the organisation includes Environmental protection as one of its priority objectives. CAF's environmental management is aimed at controlling and minimizing the significant environmental aspects such as emissions into the atmosphere, residues and energy consumption, with the principle of preserving natural resources. To this regard, the sustainability function has been implemented in the production processes for quite some time, 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 hydroelectric plant, including photovoltaic plates at their plants to meet the energy requirements: The implemented environmental management system has been certified according to standard ISO 14.001 since 2001.

In order to provide more efficient and more environmentally friendly means of transport, CAF is current implementing the “Product Sustainability Function”, introducing ecodesign methods in the engineering processes to optimise and control, from their very conception, the environmental impact of the products throughout their entire operating cycle.

As a result, CAF developed this verified EPD® of **Urbos AXL for SL A35 Tram Units.**

URBOS AXL
For Stockholm Lokaltrafik A35 Tram Units

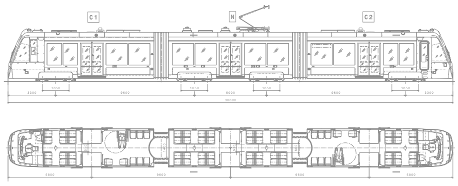
A35 Urbos AXL are international gauge tram units, with two ways 2-driving cabs, comprising 3 articulated body sections with the end bodies supported on a motor bogie and the central body on two motor bogies.

The A35 tram is fitted with an 80% low floor of the passenger area. It has an accessible and transitable design by means of the removal of the barriers to circulate along the vehicle, as the facilitation of passenger boarding and alighting from platforms. The vehicle is prepared for disabled persons accessibility and 2 wheelchair areas with dedicated stop request.

Both the inside and the cab have been designed and validated from an ergonomic point of view with the purpose of achieving the best possible comfort level for both users and operator's workers.

Dimensions

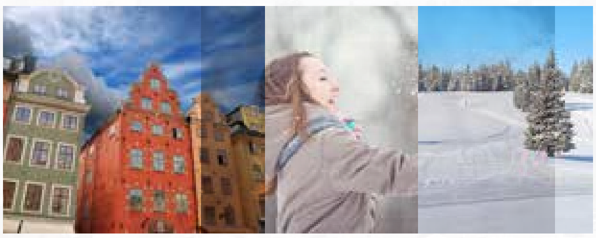
- Track gauge:	1,435 mm
- Length:	30,800 mm
- Exterior width:	2,650 mm
- Exterior height (pantograph down):	3,633 mm
- Distance between bogies (maximum):	9,600 mm
- Wheels radius:	315/275 mm



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 **Ecodesign 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.

This considered, CAF offers a vehicle adjustable for all types of urban environments, different track gauges and the capacity to adapt unit consists based on passenger demand.

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

In addition, each saloon is fitted with four priority seat places and four places for wheelchairs, bicycles and pushchairs.

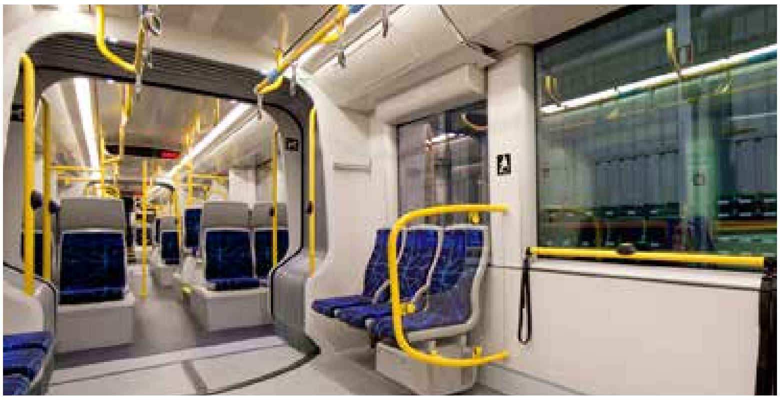
A35 units have been specially designed for the city of Stockholm, considering its strong personality and integrating theirselfs into the environment.

Welcome on Board

A35 trams are specifically design to meet extreme temperature conditions. Extra insulation panels and double glazing windows allow highest degree of comfort with low energy consumption.

Passenger capacity:

Seated	72
Standing (7 pax/m^2)	203
Total	275



Performance

Supply voltage:	750 VDC
Maximum service speed:	90 km/h
Rated traction power:	560 kW
Maximum acceleration:	1.2 m/s^2
Service brake deceleration rate:	1.3 m/s^2
Emergency brake maximum deceleration rate:	2.8 m/s^2

LED technology is used for lighting the tram therefore electric consumption and maintenance is reduced compared to previous designs. Light temperature color has been carefully selected to provide a warm and welcoming atmosphere to the interior of the tram.

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 demanded, the energy not needed by the own vehicle is sent to the main line so other vehicles can use it.

Carbodies

Structure

The structure supporting the modules is a mixed structure consisting of various materials:

- Aluminium extruded sections welded to each other to build the roofs and sidewalls.
- Steel frame.

Doors

Three double leaf doors on each side with a clearance of 1.300 mm.

The doors are sliding-plug type and are electrically operated.

Inside

Continuous passenger saloon all through the LRV. The interior lining is made up of HPL panels and polyester linings.

Main Equipment

Traction System

Overhead line current collection via an electrically driven pantograph.

Double traction inverters, one for each vehicle end car, air cooled by means of forced convection.

IGBT power electronics.

Electrodynamic brake, rheostatic with natural convection brake resistor and regenerative with current return to the OHL.

3-phase, asynchronous type motors with squirrel cage short-circuited rotor.

Auxiliary Electrical System

Two auxiliary converters provide steady 50 kVA (each), 3-phase, 400 Vac, power to supply the alternating current equipment.

Two battery chargers with 5.5 kW of power each to supply the direct current loads and the battery charging.

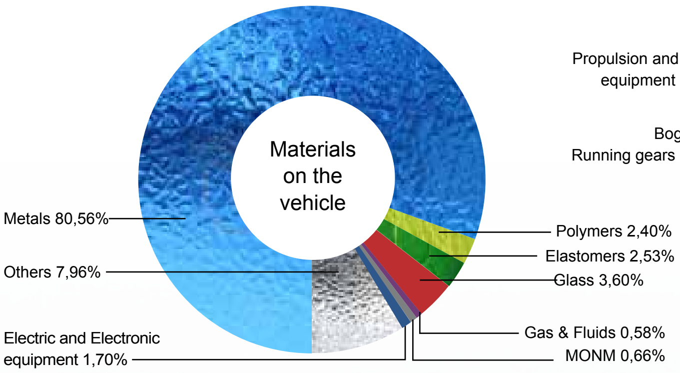
Two Ni-Cd batteries are installed, each with 20 cells providing a capacity of 260 Ah.

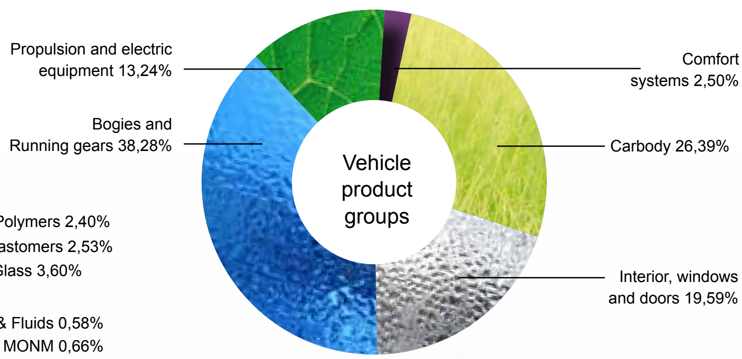
LIST OF MATERIALS

For the design of the A35 tram units, the materials have been selected, according to the functional, technical and regulatory requirements, as well as considering their recyclability and ease for dismantling at the end of their operating life. The following table shows the summarised inventory of the train materials.

Materials Used	Vehicle Materials (UPSTREAM)					
	Carbody	Interior, windows and doors	Bogies and running gears	Propulsion and electric equipment	Comfort systems	Total
Metals	21,09%	10,33%	37,51%	9,27%	2,37%	**80,56%**
Polymers	0,05%	0,77%	0,05%	1,48%	0,05%	**2,40%**
Elastomers	0,85%	1,13%	0,43%	0,10%	0,03%	**2,53%**
Glass	0,00%	3,53%	0,00%	0,07%	0,00%	**3,60%**
Gas & Fluids	0,01%	0,00%	0,18%	0,35%	0,04%	**0,58%**
MONM*	0,00%	0,66%	0,00%	0,00%	0,00%	**0,66%**
Electric and Electronic equipment	0,00%	0,14%	0,01%	1,55%	0,01%	**1,70%**
Others	4,40%	3,03%	0,10%	0,43%	0,00%	**7,96%**
TOTAL	**26,39%**	**19,59%**	**38,28%**	**13,24%**	**2,50%**	**100,00%**

* Modified natural organic materials



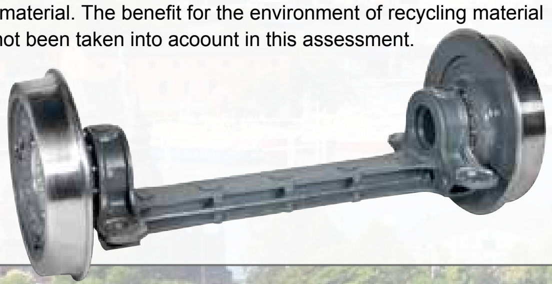


In accordance with their policy, CAF meets the environmental requirements right from the very first stages of their projects. When designing the A35 tram units, CAF has observed and demanded that their suppliers apply the "Railway Industry Substance List" (www.unife-database.org) to reject the content of regulated materials that could affect the environment or people's health. In addition, CAF has also taken into account specific material and chemical products restriction demanded by the customer.

Disassembling is foreseen right from the design stage to enhance material separation and recycling of the vehicle when its end of life is reached. Recycling instructions are provided to facilitate environmental friendly disposal.

Regulated materias on the Vehicle	% Weight	Location
Nickel	0,07%	**Electrical Components and Batteries**
Cadmium	0,07%	**Batteries**
Oils & Lubricants	0,12%	**Mechanical Components**
Coolant Gas	0,02%	**HVAC**

Parts for bogie, wheels and axels made of steel are manufactured by CAF in its own foundry where recycled scrap is employed as core material. The benefit for the environment of recycling material has not been taken into acoount in this assessment.



PRODUCT ENVIRONMENTAL IMPACT

Noise

Noise level meassured according to ISO 3095

Outside noise emited	dB(A)
Stationary noise	≤ 60
Starting noise	≤ 71
Pass-by noise (30/50/80 km/h)	≤ 68 ≤ 76 ≤ 81

Energy Consumption

Energy consumption during the use stage takes into account the route and timetables of the line the vehicle has been designed for (Alvik - Sickla - Udde route) and it has been calculated based on a simulation coherent with the reference document TecRec 100:001 - Specification and verification of energy consumption for railway rolling stock. A vehicle occupation capacity of 215 passengers (all seated and 5 passengers per sqr-meter standing) has been considered in accordance with the Operational Mass in standard EN 15663. Operational modeling is based on a 100% catenary reception scenario where the required energy during braking not used in auxiliary systems is regenerated on the catenary.

A35 trams are equipped with a stand-by mode to reduce electrical consumption when the vehicle is not operative due to parking or cleaning / maintenance works.

Electric Consumption	
Manufacturing [kWh/pass.km]	0.0006
Use Stage 100% reception [kWh/km]	3.8
Stand-by [kWh/km]	0.4

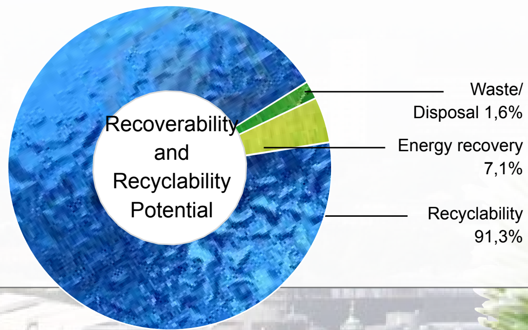
Data valid according to established simulation criteria. On real operation, depending on operational conditions, these values may vary.

The electric consumption for a passenger travelling 10 km is equivalent to approximately 10 minutes of clothes ironing or 25 minutes playing videogames.

Potential recoverability and recyclability profile

The recyclability potential has been assessed according to the methodology of standard ISO 22628. Material recycling and energy recovery results on more than 98% recoverability rate.

Recoverability and Recyclability Potential according to ISO 22628	
Recyclability Rate	91,3%
Recoverability Rate	98,4%



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
			Energy consumption	Maintenance and Consumables	End of Life	
RENEWABLE RESOURCES CONSUMPTION						
Materials [kg/ pass.km]	1,09.10^{-05}	2,50.10^{-05}	4,02.10^{-06}	4,32.10^{-06}	5,51.10^{-09}	4,43.10^{-05}
Wood	3,64.10^{-06}	8,58.10^{-06}	1,46.10^{-06}	9,89.10^{-07}	1,78.10^{-09}	1,47.10^{-05}
Carbon Dioxide	7,16.10^{-06}	1,59.10^{-05}	2,57.10^{-06}	3,32.10^{-06}	3,73.10^{-09}	2,90.10^{-05}
Peat	7,70.10^{-08}	5,61.10^{-07}	6,43.10^{-10}	1,20.10^{-08}	1,11.10^{-11}	6,51.10^{-07}
Water use (*) ([l/pass.km]	1,19.10^{-02}	3,27.10^{-03}	2,35.10^{-03}	3,20.10^{-03}	1,10.10^{-05}	2,08.10^{-02}
Energy [MJ/ pass.km]	9,01.10^{-05}	1,82.10^{-04}	7,02.10^{-02}	3,51.10^{-05}	4,45.10^{-07}	7,06.10^{-02}
Hydroelectric	3,33.10^{-05}	6,73.10^{-05}	6,67.10^{-02}	1,30.10^{-05}	4,22.10^{-07}	6,68.10^{-02}
Wind	4,25.10^{-05}	8,60.10^{-05}	3,51.10^{-03}	1,66.10^{-05}	1,91.10^{-08}	3,66.10^{-03}
Biomass	5,32.10^{-06}	1,07.10^{-05}	0,00.10^{-00}	2,07.10^{-06}	3,07.10^{-09}	1,81.10^{-05}
Solar	8,95.10^{-06}	1,81.10^{-05}	0,00.10^{-00}	3,49.10^{-06}	0,00.10^{-00}	3,05.10^{-05}
NON RENEWABLE RESOURCES CONSUMPTION						
Materials [kg/ pass.km]	4,31.10^{-04}	1,31.10^{-04}	5,75.10^{-04}	2,43.10^{-04}	2,48.10^{-06}	1,38.10^{-03}
Iron	4,66.10^{-05}	2,96.10^{-06}	1,44.10^{-05}	4,48.10^{-05}	4,57.10^{-08}	1,09.10^{-04}
Coal	8,37.10^{-05}	2,13.10^{-05}	1,95.10^{-05}	4,46.10^{-05}	5,14.10^{-08}	1,69.10^{-04}
Gravel	8,43.10^{-05}	1,73.10^{-05}	4,42.10^{-04}	7,40.10^{-05}	1,85.10^{-06}	6,19.10^{-04}
Others	2,16.10^{-04}	8,89.10^{-05}	9,95.10^{-05}	8,00.10^{-05}	5,36.10^{-07}	4,85.10^{-04}
Energy [MJ/ pass.km]	1,90.10^{-04}	3,83.10^{-04}	0,00.10^{-00}	7,39.10^{-05}	7,68.10^{-07}	6,48.10^{-04}
Coal	3,75.10^{-05}	7,58.10^{-05}	0,00.10^{-00}	1,46.10^{-05}	9,57.10^{-08}	1,28.10^{-04}
Nuclear	5,85.10^{-05}	1,18.10^{-04}	0,00.10^{-00}	2,28.10^{-05}	4,91.10^{-07}	2,00.10^{-04}
Lignite	3,92.10^{-06}	7,92.10^{-06}	0,00.10^{-00}	1,53.10^{-06}	7,36.10^{-08}	1,34.10^{-05}
Fuel Oil	4,48.10^{-06}	9,05.10^{-06}	0,00.10^{-00}	1,74.10^{-06}	2,18.10^{-08}	1,53.10^{-05}
Natural Gas	8,53.10^{-05}	1,72.10^{-04}	0,00.10^{-00}	3,32.10^{-05}	8,57.10^{-08}	2,91.10^{-04}
WASTE [kg/ pass.km]	1,51.10^{-07}	1,27.10^{-05}	5,77.10^{-08}	5,55.10^{-05}	3,54.10^{-06}	7,19.10^{-05}
Hazardous	1,07.10^{-07}	3,36.10^{-06}	3,88.10^{-08}	0,00.10^{-00}	1,07.10^{-06}	4,58.10^{-06}
Non Hazardous	4,39.10^{-08}	9,29.10^{-06}	1,89.10^{-08}	5,55.10^{-05}	2,46.10^{-06}	6,73.10^{-05}
ENVIRONMENTAL IMPACT [/pass.km]						
Global Warming Potential (kg CO2-Eq)	4,80.10^{-04}	1,60.10^{-04}	1,76.10^{-04}	1,45.10^{-04}	2,34.10^{-06}	9,63.10^{-04}
Acidifiying Potential (kg SO_2-Eq)	3,49.10^{-06}	7,51.10^{-07}	5,81.10^{-07}	8,75.10^{-07}	8,52.10^{-09}	5,70.10^{-06}
Eutrophication Potential (kg $PO4^{-3}$-Eq)	3,11.10^{-06}	1,75.10^{-07}	3,00.10^{-07}	7,34.10^{-07}	1,82.10^{-09}	4,32.10^{-06}
Photochemical Ozone Creation Potential (kg C_2H_4-Eq)	2,06.10^{-07}	3,48.10^{-08}	4,03.10^{-08}	7,37.10^{-08}	3,34.10^{-10}	3,55.10^{-07}
Ozone Depletion Potential (kg CFC-11-Eq)	1,06.10^{-10}	3,47.10^{-11}	6,13.10^{-12}	1,45.10^{-11}	2,86.10^{-13}	1,62.10^{-10}

(*) except the use in hidroelectric power generation

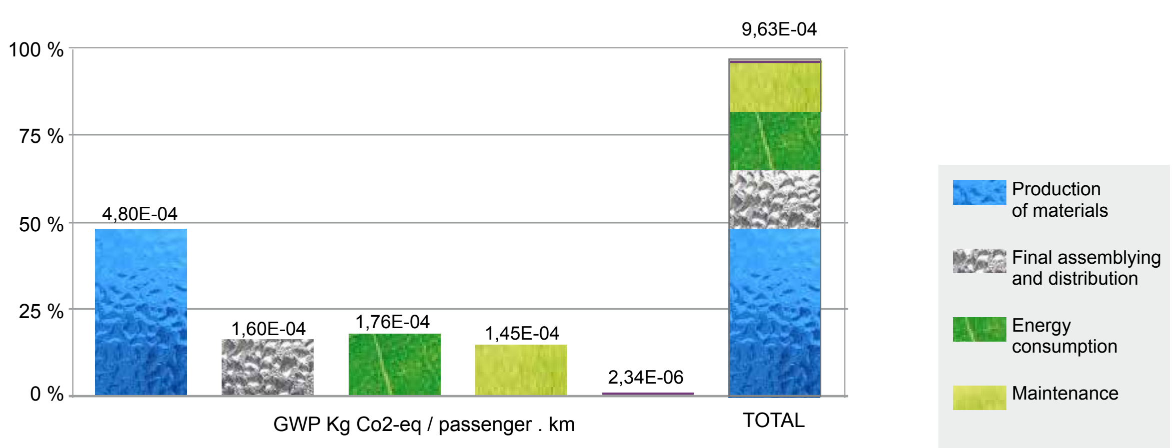
The quality of the compiled data has been analysed with a Pedigree Matrix analysis (Pedigree Matrix - Weidema and Suhr Wesnaes, 1996). It has been verified that the quality of the data is "extremely high" in the CAF train assembly process and in the Urbos AXL composition, and it is "high" quality for the environmental assessment basis data.

ENVIRONMENTAL PROFILE OF THE PRODUCT LIFE CYCLE

Under a Life Cycle approach, cost and environmental impacts reduction of the operation use have been core targets of the Urbos AXL design process. A low specific energy consumption per passenger has been achieved, thanks to the lightness and large capacity of the tram, together with a low consumption of maintenance materials, as a result of the reliability and durability of the components, and the modularity and standardisation of the solutions employed.

According to data supplied, 100% renewable energy is employed to run the rail vehicles and therefore greenhouse gas emissions are extremely low compared to other modes of transport although an extensive use during 30 years.

Total Global Warming Potential (kg CO2 eq.)



In 2009 Sweden CO2 emissions were 4.7 metric tons per capita
Source: http://data.worldbank.org

INFORMATION REGARDING THE ENVIRONMENTAL DECLARATION

This environmental declaration was made following the requirements of the reference document "PCR 2009:05 Version 2.0. Product category rules for preparing an environmental product declaration for Rail Vehicles. UNCPC CODE: 495" published by Environdec (www.environdec.com) and is based on the data of the URBOS AXL A35 tram units for Stockholm Lokaltrafik, 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 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.

The Urbos AXL environmental impact study has been quantified by means of an Life Cycle Analysis in accordance with standards ISO 14040 and ISO 14044. The method of the characterisation of the environmental impact of the compiled operating life inventory was CML 2001.

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 2.2) 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.

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 (60% 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 Saragossa plant to Stockholm.

For the environmental impact of the energy consumption during assembly, the Spanish electricity production Mix has been taken into account, with data provided by the Spanish Ministry for Industry for 2011 (the most up to date on publishing this declaration).
For environmental impact characterization of the energy consumption during use phase an average of 85000 km per year has been considered and specific customer electricity mix comprised of 95% hydro-power and 5% windpower has been used.

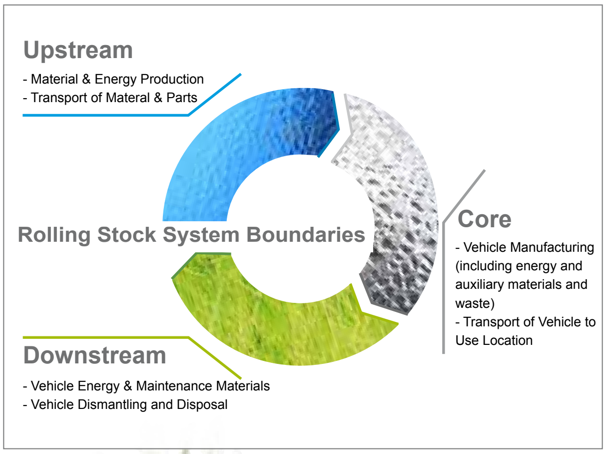
The production of materials used to operate the units as well as the materials and spare parts according to the preventive maintenance program has been considered.

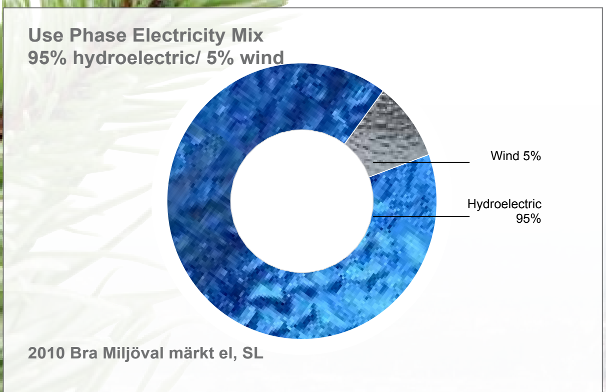
In the end of life, and vehicle dismantling stage, has been modelled according to UNI-LCA-001:00 Railway Rolling Stock - Recyclability and Recoverability Calculation Method. The potential advantage of recycling and recovery of the energy from incineration processes has not been accounted for in the study.

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.
- PCR 2009:05. Product category rules for preparing an environmental product declaration for Rail Vehicles.
- General Programme Instructions for environmental product declarations, EPD, version 1.0
- ISO 22628:2002. Road vehicles. Recyclability and recoverability. Calculation method.
- TecRec 100:001. Specification and verification of energy consumption for railway Rolling stock.
- EN 15663:2009. 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.

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 photo-chemical formation potentials (POCPs) expressed in equivalent kg of ethane (C 2H4).

Registered office

JM Iturrioz 26
20200 Beasain (Gipuzkoa)
Spain

CONSTRUCCIONES Y AUXILIAR DE FERROCARRILES S.A.

Administration offices

Padilla, 17
28006 Madrid
Spain

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