MOVIA™ METRO

EPD®

Environmental Product Declaration in accordance with ISO 14025

EPD registration number: S-P-00520
Publication date: 2022-01-16
Revision date: 2022-03-08
Valid until: 2026-11-08

ALSTOM
• mobility by nature •

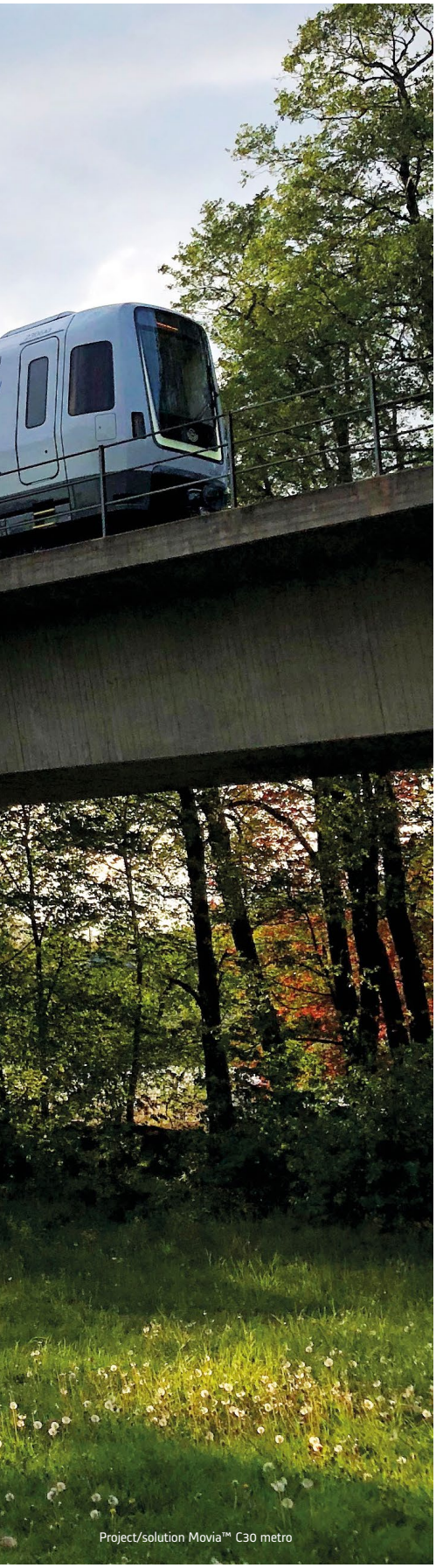
CONTENTS

ALSTOM, AT THE FOREFRONT OF SUSTAINABILITY

Alstom develops and offers a range of systems, equipment and services for the rail sector and considers its mission to support the transition towards global sustainable transport systems that are inclusive, environmentally-friendly, safe and efficient.

As a promoter of sustainable mobility, Alstom places environmental issues at the heart of its R&D strategy, constantly designing solutions and products which are less energy-consuming, quicker to install, cheaper to maintain, and with higher lifespan and reduced carbon footprint.

For more than 25 years, the company has worked systematically by introducing Ecodesign in its engineering procedures.
Today, Alstom can rely on a team of Ecodesign engineers to ensure the environmental performance of its portfolio and its ability to develop innovative solutions tackling key environmental challenges.



Project/solution Movia™ C30 metro

SUSTAINABLE MOBILITY

ENVIRONMENTAL MANAGEMENT

Alstom has an environmental management system fully in place and targets 100 % of manufacturing sites and regional centers with over 200 employees to be certified according ISO 14001:2015 Standard for Environmental management.

In the environmental management system, Alstom is including the life cycle perspective of products, from concept to recycling including maintenance and energy consumption. Alstom offers innovative solutions that respect the environment and meet the mobility needs according to a socially responsible model.

To continuously improve Alstom products and ways of working, environmental targets for sites and products are implemented and regularly evolved following return of experience and best practice.

COMMUNICATING ENVIRONMENTAL PERFORMANCE

ISO 14025

Alstom communicate the environmental performance of products through Environmental Product Declarations (EPDs) following the International EPD® System. EPDs are developed in line with the Product Category Rules for Rolling Stock (PCR 2009:05) as well as the principles and procedures of ISO 14025:2006. They are based on Life Cycle Assessment methodology and function as an externally validated communication tool, providing complete transparency to the benefit of customers and other stakeholders. The external validation is carried out by independent verifiers approved by the technical committee of the International EPD® System.

Life cycle assessment (LCA) is a technique assessing the environmental impacts associated with all stages of a product's life cycle from cradle to grave (i.e. from raw material extraction through materials processing, manufacturing, distribution, use, repair and maintenance, and disposal or recycling).

MOVIA™ C30 METRO

The Movia™ product platform sets a high standard for environmentally sustainable metro transportation. This Environmental Product Declaration provides a detailed insight into the environmental impact of the Movia™ C30 metro for Storstockholms Lokaltrafik (SL) throughout its complete life cycle.

The four-car vehicles are fitted with a driver's cab at each end and are prepared for GoA 4 level driverless functionality.

The new vehicles features a four-by-four seating configuration with additional seats along the vehicle's sides to optimize comfort, capacity, and passenger flow, together with direct and indirect light sources a spacious passenger saloon is created.

MAIN FACTS

The Movia™ C30 metro for Storstockholms Lokaltrafik is designed to support the Stockholm´s Red Line transport network upgrade. The vehicle will operate at up to 90 km/h with space for 140 seated passengers and 720 standees.

KEY BENEFITS OF MOVIA™ C30 METRO

A SAFER ENVIRONMENT

The vehicle is developed with a strong emphasis on commitment to eliminate hazardous substances in the product as well as during production and maintenance providing a safer environment for our customers, passengers and employees.

A SATISFACTORY WORKING ENVIRONMENT

The cab is optimized and studied to provide a satisfactory working environment for the driver, including separate air conditioning control.

ENERGY EFFICIENCY

The energy-efficient Flexx™ Eco bogies and the well-proven Mitrac™ propulsion system will reduce maintenance costs and increase energy efficiency while further enhancing passenger comfort by minimizing noise.

A VEHICLE DESIGNED FOR ALL

The vehicle is offering inclusive accessibility thanks to a floor without height differences throughout the train, and with no difference in height between the platform and the vehicle. Priority seats clearly distinguished by a specific colour of seat fabric for instant identification. Flexible multipurpose areas for wheelchair users, parents with pushchairs, bulky luggage or standees, bicycles, strollers or powered mobility devices users.

DESCRIPTION OF THE PRODUCT

MAIN CHARACTERISTICS

	Vehicle data
Type of vehicle	Movia™ metro
Configuration	4-cars; multiple unit
Length over coupler covers	70 m
Width	2.915 m
Weight (empty)	115 metric tonne
Wheel diameter (new wheels)	825 mm
Doors per side	12 doors
Door width	1 400 mm
Seats	140 seats
Standees	720 standees
Voltage	750 V DC
Energy consumption (100% receptivity in the system)	4.09 kWh/km
Energy consumption (60% receptivity in the system)	5.52 kWh/km
Maximum operation speed	90 km/h
Maximum acceleration	1.1 m/s²
Maximum deceleration	1.1 m/s²

Carbody:
Aluminium alloy structure

Comfort:
Efficient heating, ventilation, and air conditioning system in both passenger saloons and driver cabs

Propulsion and electrical equipment:
Energy recovery through braking

Material selection:
Materials selected to be recoverable at end-of-life

NOISE EMISSIONS

The noise levels for Movia™ C30 metro were measured in accordance to the ISO 3095:2013.

	Unit	dB(A)
Standstill noise	LpAFmax	≤ 60
Pass-by noise 80 km/h	LpAeq, Tp (80 km/h)	≤ 77
Acceleration & Braking noise 0-40 / 40-0 km/h	LpAFmax	≤ 74

LIFE CYCLE DESCRIPTION

Environmental impacts of Movia™ C30 metro have been characterized through the realization of an LCA in accordance with ISO 14040:2006 and ISO 14044:2006 methodology, and the requirements of the PCR for Rolling stock, UN CPC 495, 2009:05, version 3.04.

The GaBi Software-System and Databases for Life Cycle Engineering (Sphera Solutions GmbH, 2021) were used to perform this life cycle impact assessment. The used Gabi databases have reference year between 2017-2020 and are valid to 2023.

FUNCTIONAL UNIT

The functional unit for the performed LCA is transport of 1 passenger over 1 km using a 4 car metro vehicle in service for 33 years operating on the Stockholm's Red Line between Norsborg and Ropsten, with an average running distance of 150 000 km per year.

All assumptions on vehicle auxiliary systems load are following the methodology and operational profiles used for the energy consumption simulation. The simulated operational scenarios features energy recovery from regenerative braking with two scenarios maximum (100%) receptivity in the receiving system of the regenerated energy and based on customer data 60% receptivity. This is also the base for calculating the impacts for all maintenance activities during the vehicle's service life.

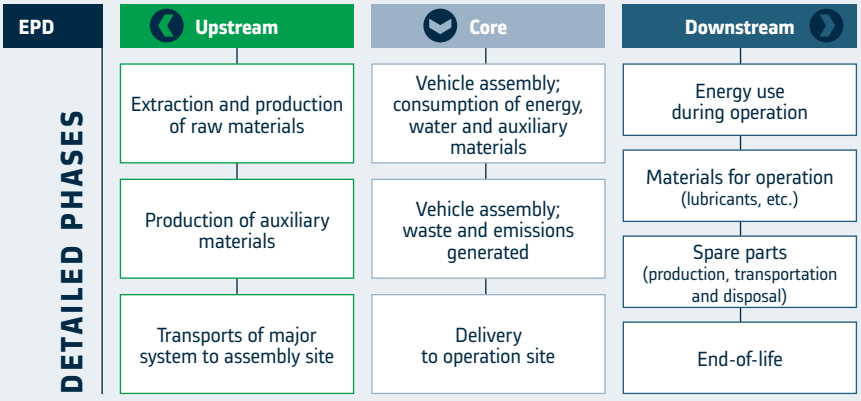
LIFE CYCLE BOUNDARIES

Material and energy production used upstream is country specific based on data from the supply chain. Site-specific data covering the production in 2019 for the assembly of bogies in Siegen (Germany) and the converter scope in Västerås (Sweden) have been included. Transportation of vehicle sub-systems is also included in the calculation of the different impact categories.

The core module includes site specific data covering the final vehicle assembly in Hennigsdorf (Germany). Included is also the impact from final transportation of the vehicle to the Customer site. Data related to the production in 2019 was considered.

The power supply for the vehicle operation is the Swedish national production grid mix. Data for used maintenance materials is based on the planned preventive maintenance of the vehicle over its entire service life.

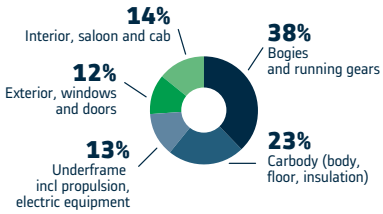
The end-of-life phase of the life cycle is modelled according to technology available today applying the ISO 22628:2002 methodology. It is assumed that the vehicle will be dismantled and disposed of in Sweden (Europe). The potential benefit from material recycling and energy recovery is not included in the environmental impact.



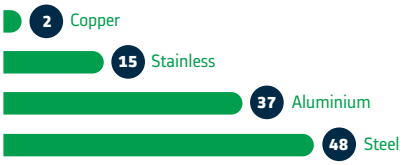
BILL OF MATERIALS

(mass in kg)	Upstream (vehicle)	Downstream (spare parts)	TOTAL
Metals	101 959	13 767	**115 725**
Electric and Electronic Equipment (EEE)	3 268	2 076	**5 343**
Polymers - filled and unfilled	3 452	1 382	**4 834**
Elastomers	2 049	1 998	**4 047**
Composites	652	20	**672**
Glass / Safety Glass	2 531	4	**2 535**
Oil, grease, etc.	104	25	**129**
Acids, Cooling agents, etc.	48	0	**48**
Mineral wool	22	0	**22**
Modified Organic Natural Materials (MONM)	276	979	**1 255**
Other	1 039	257	**1 297**
TOTAL	**115 399**	**20 508**	**135 907**

Rolling stock manufacturing: Share of mass by PCR categories

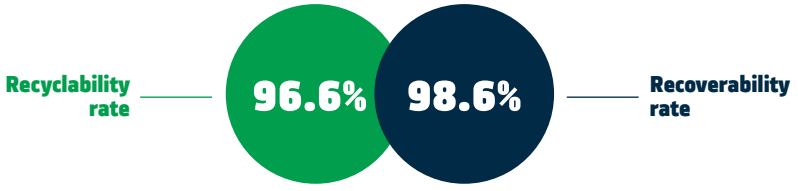


Rolling stock: Top four metals for manufacturing
(metric tonne)



A RECYCLABLE SOLUTION

Using materials featuring high recyclability and considering disassembly early in the design phase maximise the overall recoverability of the Movia™ C30 metro. Material recycling and energy recovery aggregate to a 98.6% recoverability rate by applying the ISO 22628:2002 methodology.



HAZARDOUS SUBSTANCES

Alstom's standard for hazardous substances management considers European regulation (REACh) and railway sector principles through the RISL (Railway Industry Substances List), which has been considered during the design of the vehicle as well as for chemicals used during maintenance.

For the Movia™ C30 metro the Region Stockholm's Phase-out lists for chemicals hazardous to the environment and the human health in products and chemicals have also been considered.
In some areas, use of hazardous substances according to RISL has not been avoidable due to functional and safety requirements, including lead in electronics and brass details as well the refrigerant gas mix used for the HVAC. However, no hazardous substances are used in any prohibited application at the time of production of the Movia™ C30 metro.

ENERGY CONSUMPTION DURING OPERATION

The energy consumption of the Movia™ C30 metro is 4.09 kWh/km for 100% energy receptivity of the receiving system of regenerated energy from braking, for 60% receptivity the corresponding number is 5.52 kWh/km. Energy consumption data is based on a simulation run on the Stockholm's Red Line on the route Ropsten-Norsborg-Ropsten including all intermediate stops, the simulation has been verified through actual test runs.

The energy consumption is based on a fully equipped vehicle, occupied with 125 passengers per 4-car trainset, and all auxiliary and passenger comfort systems operating. This corresponds to an daily average load factor of 15%

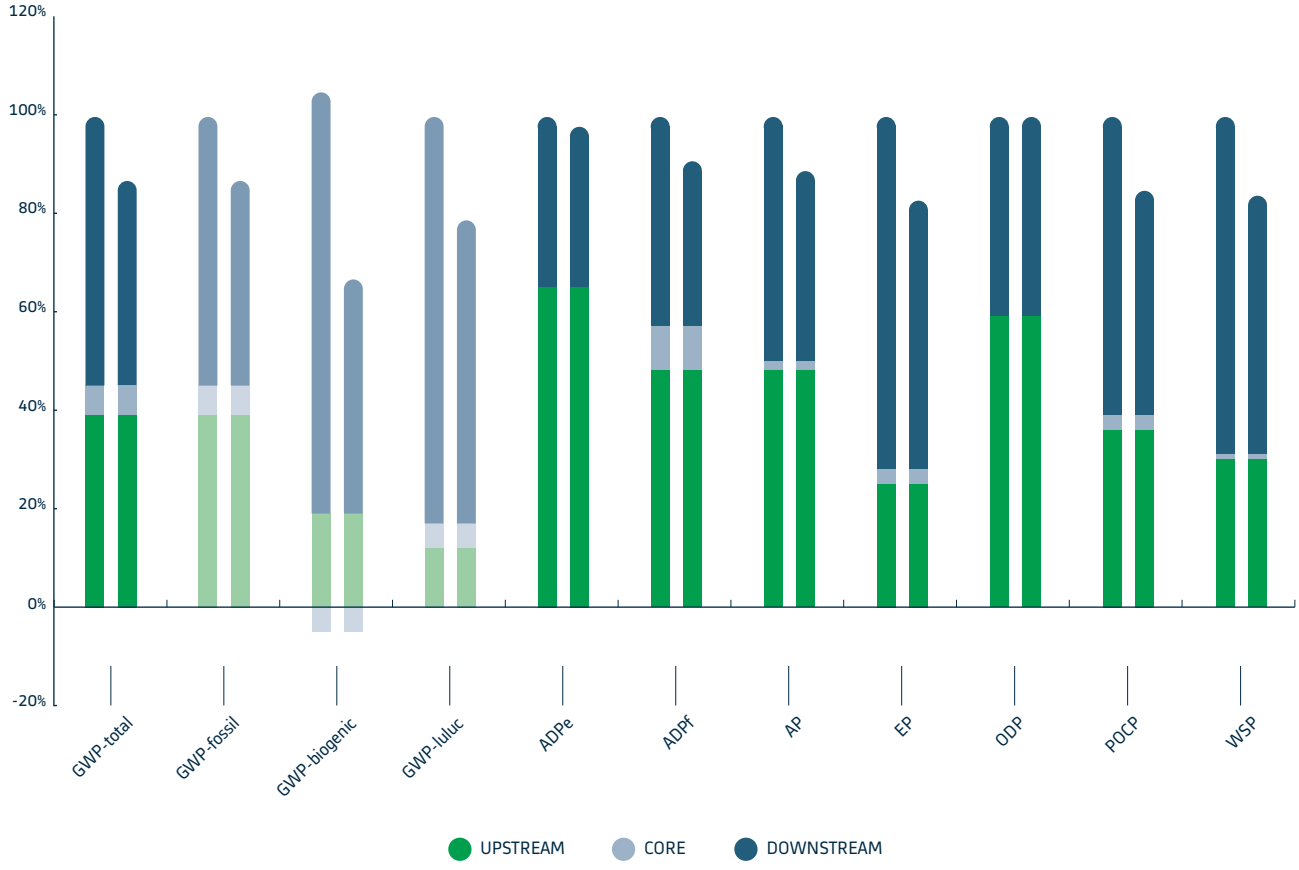
The Swedish national production electricity grid mix for transferring 1-60 kV supplied by GaBi Sphera Solution GmbH was used for modelling the environmental impact from the energy consumption during operation.

	Operation
Distance travelled per year	150 000 km
Number of passenger (for energy calculation)	125
Energy consumption (60% receptivity)	0.044 kWh/ pass. km
Energy consumption (100% receptivity)	0.033 kWh/ pass. km

ENVIRONMENTAL PERFORMANCE

CONTRIBUTION OF EACH PHASE TO THE ENVIRONMENTAL IMPACTS

The relative contribution from each phase of the life cycle of Movia™ C30 metro. For each environmental impact category the total impact for operation at 60% receptivity is set to 100%, the environmental impact during operation with 100% receptivity in relation to 60% is to the right. Impact categories according to the CML methodology and AWARE.



CONFIGURATION

Life cycle description information and environmental performance results published in this EPD corresponds to the reference design configuration developed by Alstom.

To know the performance associated to other possible configurations of the solution, please contact Alstom.

ENVIRONMENTAL IMPACTS

Indicator per functional unit	Unit	Upstream	Core	Downstream		TOTAL 60%	TOTAL 100%
				60%	100%		
Global warming potential (GWP) - Total	kg CO_2 eq. /pass. km	1.40E-03	2.30E-04	2.00E-03	1.54E-03	**3.63E-03**	**3.17E-03**
Global warming potential (GWP) - Fossil	kg CO_2 eq. /pass. km	1.40E-03	2.30E-04	1.99E-03	1.53E-03	**3.62E-03**	**3.16E-03**
Global warming potential (GWP) - Biogenic	kg CO_2 eq. /pass. km	6.83E-07	-1.74E-07	3.18E-06	1.76E-06	**3.69E-06**	**2.27E-06**
Global warming potential (GWP)- Land use and land transformation	kg CO_2 eq. /pass. km	7.42E-07	3.40E-07	5.15E-06	3.88E-06	**6.23E-06**	**4.96E-06**
Depletion of abiotic resources-elements (ADPe)	kg Sb eq. /pass. km	2.09E-08	6.19E-11	1.11E-08	1.05E-08	**3.20E-08**	**3.15E-08**
Depletion of abiotic resources-fossil fuels (ADPf)	MJ /pass. km	1.48E-02	2.72E-03	1.30E-02	1.03E-02	**3.06E-02**	**2.79E-02**
Acidification potential (AP)	kg SO_2 eq. /pass. km	7.16E-06	2.53E-07	7.38E-06	5.78E-06	**1.48E-05**	**1.32E-05**
Eutrophication potential (EP)	kg PO_4^{3-} eq. /pass. km	4.48E-07	4.71E-08	1.27E-06	9.63E-07	**1.77E-06**	**1.46E-06**
Emission of ozone-depleting gases (ODP)	kg CFC 11 eq. /pass. km	9.02E-15	5.38E-18	6.20E-15	6.18E-15	**1.52E-14**	**1.52E-14**
Photochemical ozone creation potential (POCP)	kg C_2H_4 eq. /pass. km	5.10E-07	4.13E-08	8.50E-07	6.48E-07	**1.40E-06**	**1.20E-06**
Water scarcity potential (WSP)	m^3 eq.	4.73E-04	1.10E-05	8.44E-04	1.10E-03	**1.58E-03**	**1.33E-03**

GLOBAL WARMING POTENTIAL

These indicators calculates the contribution to global warming of the planet by the emission of greenhouse gases. GWP is expressed as: GWP-fossil, GWP-biogenic, GWP-land use and land use change (luluc), and GWP-Total (the sum of the other three GWP indicators).

The result is expressed in kg CO_2 equivalents.

DEPLETION OF ABIOTIC RESOURCES-ELEMENTS

This indicator calculates the depletion of non-fossil resources.

The result is expressed in kg Sb equivalents.

DEPLETION OF ABIOTIC RESOURCES-FOSSIL FUELS

This indicator calculates the depletion of fossil resources.

The result is expressed in MJ.

ACIDIFICATION POTENTIAL

This indicator calculates the potential atmospheric acidification caused by the emission of gas with an acidifying effect.

The result is expressed in kg SO_2 equivalents.

EUTROPHICATION POTENTIAL

This indicator calculates the eutrophication potential of water caused by the emission of specific substances (discharge of phosphoric, nitrogenous and organic matter).

The result is expressed in kg phosphate equivalents.

EMISSION OF OZONE-DEPLETING GASES

This indicator calculates the contribution made by the discharge of specific gases responsible for ozone layer depletion.

The result is expressed in kg CFC-11 equivalents.

PHOTOCHEMICAL OZONE CREATION POTENTIAL

This indicator calculates the potential of certain gases (NOx, CO, VOCs, etc.) to create ozone in the troposphere under the effect of solar radiation.

The result is expressed in kg ethylene equivalents.

WATER SCARCITY POTENTIAL

The indicator represents the potential to deprive human or ecosystem when consuming water in a considered area, considering both availability and demand.

The result is expressed in m^3 equivalents.

USE OF RESOURCES

Parameter		Unit	Upstream	Core	Downstream		TOTAL 60%	TOTAL 100%
					60%	100%		
RENEWABLE RESOURCES								
Primary energy resources	Use as energy carrier	MJ, net calorific value /pass. km	1.03E-04	9.49E-04	1.52E-01	1.13E-01	**1.54E-01**	**1.14E-01**
	Used as raw materials	MJ, net calorific value /pass. km	2.49E-03	3.94E-05	7.42E-04	7.42E-04	**3.27E-03**	**3.27E-03**
	TOTAL	**MJ, net calorific value /pass. km**	**2.59E-03**	**9.88E-04**	**1.53E-01**	**1.14E-01**	**1.57E-01**	**1.17E-01**
NON-RENEWABLE RESOURCES								
Primary energy resources	Use as energy carrier	MJ, net calorific value /pass. km	1.52E-04	1.45E-03	1.71E-01	1.27E-01	**1.73E-01**	**1.28E-01**
	Used as raw materials	MJ, net calorific value /pass. km	1.54E-02	1.58E-03	2.88E-03	2.88E-03	**1.99E-02**	**1.99E-02**
	TOTAL	**MJ, net calorific value /pass. km**	**1.55E-02**	**3.04E-03**	**1.74E-01**	**1.30E-01**	**1.93E-01**	**1.48E-01**
Secondary material		kg /pass. km	N/A	N/A	N/A	N/A	**N/A**	**N/A**
Renewable secondary fuels		MJ, net calorific value /pass. km	N/A	N/A	N/A	N/A	**N/A**	**N/A**
Non-renewable secondary fuels		MJ, net calorific value /pass. km	N/A	N/A	N/A	N/A	**N/A**	**N/A**
Net use of fresh water*		m^3 /pass. km	3.45E-03	3.11E-04	1.64E-01	1.21E-01	**1.67E-01**	**1.25E-01**

*The net use of fresh water does not constitute a "water footprint" as potential environmental impacts due to the water use in different geographical locations is not captured.

WASTE

Parameter	Unit	Upstream	Core	Downstream		TOTAL 60%	TOTAL 100%
				60%	100%		
Hazardous waste disposed	kg /pass. km	8.00E-09	5.62E-13	1.49E-09	1.48E-09	**9.49E-09**	**9.48E-09**
Non-hazardous waste disposed	kg /pass. km	2.43E-04	7.40E-06	2.94E-04	2.27E-04	**5.45E-04**	**4.77E-04**
Radioactive waste disposed	kg /pass. km	2.86E-07	1.24E-07	6.71E-05	4.97E-05	**6.75E-05**	**5.01E-05**

OUTPUT FLOWS

Parameter	Unit	Upstream	Core	Downstream	TOTAL
Components for reuse	kg /pass. km	N/A	N/A	N/A	**N/A**
Material for recycling	kg /pass. km	N/A	N/A	2.08E-04	**2.08E-04**
Materials for energy recovery	kg /pass. km	N/A	N/A	7.72E-06	**7.72E-06**
Exported energy, electricity	MJ /pass. km	N/A	N/A	N/A	**N/A**
Exported energy, thermal	MJ /pass. km	N/A	N/A	N/A	**N/A**

PROGRAMME RELATED INFORMATION AND VERIFICATION

This Environmental Product Declaration (EPD) is based on a product Life-Cycle Assessment according to ISO 14040:2006/ISO 14044:2006 and is compliant with the requirements set in ISO 14025:2006.

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**.

Product category rules (PCR):
Rolling stock, PCR 2009:05, version 3.04, UN CPC 495

PCR review was conducted by:
The Technical Committee of the International EPD® System. Chair: Gorka Benito Alonso.
The PCR review panel may be contacted via info@environdec.com.

Independent verification of the declaration and data, according to ISO 14025:2006:

☐ EPD Process Certification (internal)

■ EPD Verification (external)

Third party verifier:
Martin Erlandsson
IVL Swedish Environmental Research Institute
Box 210 60 - 100 31 Stockholm - Sweden
martin.erlandsson@ivl.se

Approved by:
The International EPD® System

EPD®s within the same product category but from different programs may not be comparable.

Programme:	The International EPD® System EPD International AB Box 210 60 SE-100 31 Stockholm Sweden www.environdec.com
EPD registration number:	S-P-00520
Published:	2022-01-13
Revised:	2022-03-08
Valid until:	2026-11-08

EPD owner:	Alstom 48, rue Albert Dhalenne 93482 Saint-Ouen, Cedex France
LCA producer:	Alstom 48, rue Albert Dhalenne 93482 Saint-Ouen, Cedex France

Revision
2022-01-13 First issue
2022-03-08 Editorial update including; adding reference to ISO 14025 on first page and spelling corrections.

REFERENCES

AWARE 1.2 c (2019), Water scarcity potential
CML 2001 (version 2016), CML-IA Characterisation Factors
Energy Declaration C30 Metro (internal report)
EPD International (2017), General Programme Instructions for the International EPD® System. Version 3.0, dated 2017-12-11.
GaBi Software System and Database for Life Cycle Engineering version 10.5.1.124 by Sphera Solution GmbH (2021)
ISO 14025:2006, Environmental labels and declarations — Type III environmental declarations — Principles and procedures
ISO 14040:2006, Environmental management — Life cycle assessment — Principles and framework
ISO 14044:2006, Environmental management — Life cycle assessment — Requirements and guidelines
ISO 22628:2002, Road vehicles — Recyclability and recoverability — Calculation method
ISO 3095:2013, Acoustics — Railway applications — Measurement of noise emitted by railbound vehicles
Life Cycle Assessment report Movia™ C30 metro (internal report)
PCR 2009:05, ver 3.04, Rolling stock Product Category Rules, UNCPC 495
Region Stockholm (2017), Phase out list for chemicals hazardous to the environment and human health / Phase out list for chemicals hazardous to the environment and human health in products
Type Test 10 Exterior Noise Standstill C30 Metro (internal report)
UNIFE, Railway Industry Substance List (RISL), Retrieved from **www.unife.org**

Alstom
48, rue Albert Dhalenne
93 482 Saint-Ouen-sur-Seine Cedex – France
Telephone: +33 1 57 06 90 00

www.alstom.com

ALSTOM
• mobility by nature •