RER NG

Environmental Product Declaration in accordance with ISO 14025

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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.

Sustainable mobility

Alstom's mission is to support the transition to sustainable transport systems by delivering mobility solutions that are safe, environmentally friendly, reliable and inclusive everywhere in the world.

ISO 14001

Environmental Management

Alstom has an environmental management system fully in place and targets 100 % of manufacturing sites and regional centres with over 200 employees to be certified according to 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

Alstom communicates 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).

RER NG

The X'trapolis™ product platform sets a high standard for environmentally sustainable commuter transportation. This Environmental Product Declaration provides a detailed insight into the environmental impact of the RER New Generation (RER NG) trains through their complete life cycle.

The RER NG is part of the "transport revolution" initiated by Ile de France Region. Designed for dense areas, the train benefits from a completely open design on two levels, focusing on fluidity, comfort and security.

As 6 & 7 cars trains with single deck head cars and double deck intermediate cars are delivered, this Environmental Product Declaration focuses on the 6 cars trains.

Product information

The RER NG is the new generation of RER rolling stock, dedicated to lines E and D of the Parisian network for SNCF Voyageurs and Ile de France Mobilités. RER NG rolling stock is designed and built by Alstom. This product belongs to the Rolling Stock product category (UN CPC 495).

Key benefits

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, maintenance and end of life. In addition, emissions of the train have been controlled to ensure the safety of passenger, operators and environment. Globally these actions have permitted to provide a safer environment for our customers, passengers, employees and natural environments.

High capacity

Designed for dense areas, the train benefits from a **completely open design on two levels**, focusing on fluidity, comfort and security.

With 1145 passengers per 6-car trainset when all seats are occupied and 4 passenger standing per m^2, the RER NG allows **up to 30% more passengers than a single deck** commuter train.

A vehicle designed for all

Single deck head cars facilitate access and movement aboard the train to persons **with disabilities, luggage or strollers.**

The colorful seats throughout the train take up the spirit of the Ile de France seats. **Five spaces are distributed throughout the train** and allow passengers to easily find their place (reception, low room, high room, wheelchair area, end car room).

The lighting has been designed for each space and simplifies the movement inside the train and improves travel comfort.

Main characteristics	Vehicle data
Type of vehicle	X'Trapolis CityDuplex RER NG
Configuration	6 cars; multiple unit
Expected service lifetime	40 years
Production	Head cars are assembled on Alstom site in Valenciennes - Petite-Forêt (France), intermediate cars are assembled on Alstom site in Crespin (France)
Length	112 m
Weight (empty)	298 835kg
Bogies	8 motor bogies and 4 trailer bogies
Doors	2 doors per side per car
Seats	501 including 69 folding
Capacity	501 with all seats occupied 1145 with all seats occupied and 4 passenger standing per m^2 1563 with all seats occupied and 6 passenger standing per m^2
Features	CCTV Cameras Air conditioning USB charging sockets
Voltage	1,5kV DC and 25kV AC 50 Hz
Passenger information	Hand free microphone Outdoor speaker Front display Displays on platform

Carbody

Head car: carbon steel structure
Intermediate car: aluminium 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.

Environment impacts of RER NG trains have been characterized through the realization of a cradle-to-grave 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 EIME® Software (version 5.9.3) and the CODDE database (version 2022-01) were used to perform this life cycle impact assessment.

Functional unit

The functional unit for the performed LCA is the transport of 1 passenger over 1 km, using a 6 car RER NG train in service for 40 years operation between Rosa Parks and Mantes stations, with an average running distance 5 766 000km.

Cut-off rules

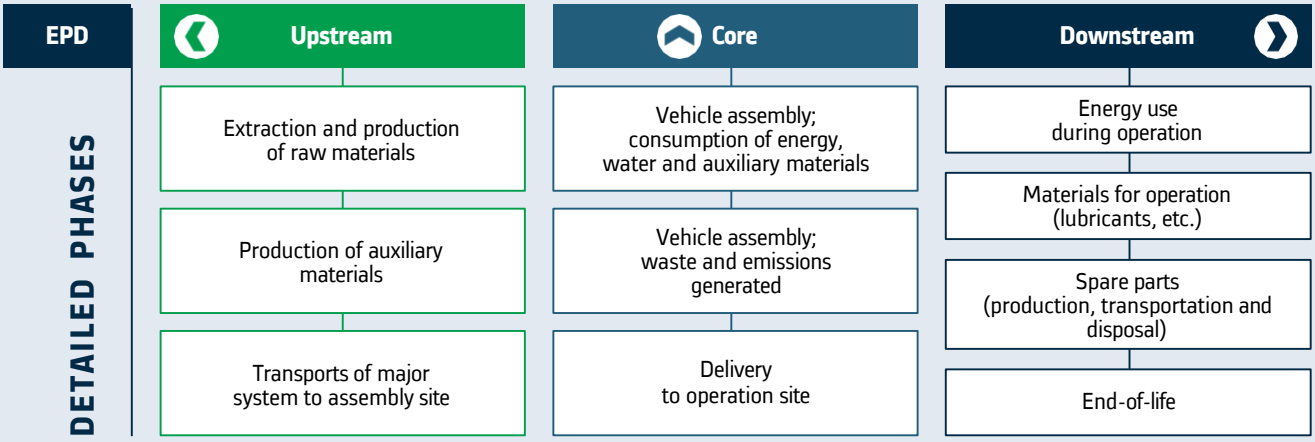
The exclusion rules applied are in line with the indications of the PCR for Rolling stock (PCR 2009:05).

Life Cycle Description

Material and energy production data used for **the upstream module** is based on data from the supply chain and consider the specific recycled content. The impact of the use of hazardous substances in the product has also been evaluated. Transportation of vehicle sub-systems is included in the calculation of the different impact categories.

The core module includes site specific data covering the external vehicles assembly in the site of Valenciennes – Petite-Forêt (France) and the intermediate vehicles assembly in the site of Crespin (France). The reference period for the site-specific data goes from 1st June 2020 to 31st May 2021. Included is also the impact from final transportation of the vehicle to the customer site.

The power supply for the vehicle operation **in the downstream module** is the French national production grid mix. Data used for maintenance materials is based on the planned preventive maintenance of the vehicle over its entire service life. Emissions of particles are estimated from the wear rate of friction parts. The end-of-life is modelled in line with the ISO 22628:2002 methodology. The recyclability and recoverability potential of each material is assessed based on its nature, its integration in the trainset, and the technology available today. As a result, all metals and most single material polymers are considered as recyclable whereas most composite polymers are considered as recoverable only. It is assumed that the vehicle will be dismantled and disposed of in France.



Allocations

In **the upstream module**, no allocation is required except the allocations built into the databases of the LCA software.

For the vehicle assembly **in the core module**, the impact of the production plant is allocated by number of car produced, all projects combined.

Impacts and benefits of the recycling of waste are excluded from the scope of the study. Burden linked to incineration are included, but impact and benefits linked to the use of the energy from incineration are also excluded.

Data quality

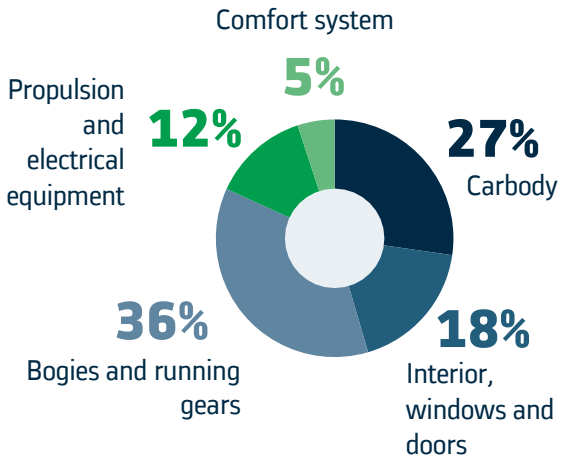
Whenever possible, specific data was used. In particular, 99,1% of the mass of the train and the spare parts were inventoried with specific data, the rest being modelled according to the PCR for Rolling stock (PCR 2009:05).

95% of the delivery of components was inventoried with specific data, the rest being modelled by a transport by truck on 500km, in line with the PCR for Rolling stock (PCR 2009:05).

Content declaration

Rolling stock manufacturing

Share of mass by PCR categories



Rolling stock

Top four metals for manufacturing (metric tonne)

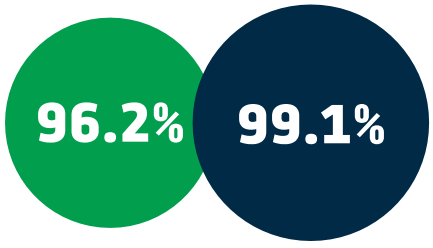
of recycled (pre-consumer or postconsumer) content included in the train, helping to reduce the environmental impact linked to the production of raw materials

Bill of materials (mass in kg)	Upstream (vehicle)	Downstream (spare parts)	TOTAL
Metals	253 599	130 336	383 935
Electric and Electronic Equipment (EEE)	20 970	4 504	25 474
Polymers – filled and unfilled	7 420	22 633	30 053
Glass / Safety Glass	4 858	0	4 858
Elastomers	4 366	8 590	12 956
Composites	2 253	291	2 544
Modified Organic Natural Materials (MONM)	2 076	8	2 084
Oil, grease, etc.	1 398	6 151	7 549
Mineral wool	263	0	263
Acis, cooling agents, etc.	147	211	358
Other	1 485	20 359	21 844
TOTAL	**298 835**	**193 083**	**491 918**

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.

In some areas, use of hazardous substances according to RISL has not been avoidable due to functional and safety requirements, including lead in electronics as well the refrigerant gas mix used for the air conditioning system. However, **no hazardous substances are used in any prohibited application at the time of production of the RER NG train.**



Recyclability rate **Recoverability rate**

A recyclable solution

using materials featuring high recyclability and considering disassembly early in the design phase maximise the overall recoverability of the RER NG. Material recycling and energy recovery aggregate to a 99.1% recoverability rate by applying **ISO22628:2002** methodology.

Additional information

Energy consumption during operation

Energy consumption data is based on a simulation run on the route **from Rosa Parks station to Mantes station**, including all intermediate stops, in **hourly mode**. The power tension of the line is **1,5kV**.

The energy consumption is based on a **fully equipped vehicle, occupied with 500 passengers per 6-car trainset (all seats occupied)**, and all auxiliary and passenger comfort systems operating. This corresponds to a daily average **load factor of 32%.** 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**.

	Operation
Energy consumption while running	9,1kWh/km
Power consumption in standby mode	151kW
Distance travelled per year	5 766 000km
Roundtrip distance (for energy calculation)	123km
Operation time	310 days/year, 7 h/day in standby mode, over 40 years
Number of passenger (for energy calculation)	500

The **PCR for Rolling Stock (PCR 2009:05)** stipulates that for the electricity consumed during the downstream module, the impacts of the production of electricity must calculated **first** using the **specific data of the electricity as produced or purchased**, then at the **using the residual national electricity mix**, and finally, if the first two models are not possible, using **the national electricity mix**.

However, no residual electricity mix data was available in EIME® software when the calculation was performed. Thus, the choice was made for the entire scope, to use the **French national production electricity grid mix for transferring 1-60kV** supplied by EIME® software. This approach appears to be conservative.

Noise emissions

	Unit	dB(A)
Stationery noise	LpAeq	66
Noise in preconditioning	LpAeq	62
Constant speed noise 80km/h	LpAeq, Tp (80km/h)	79
Acceleration	LpAfmax	79

Noise emissions

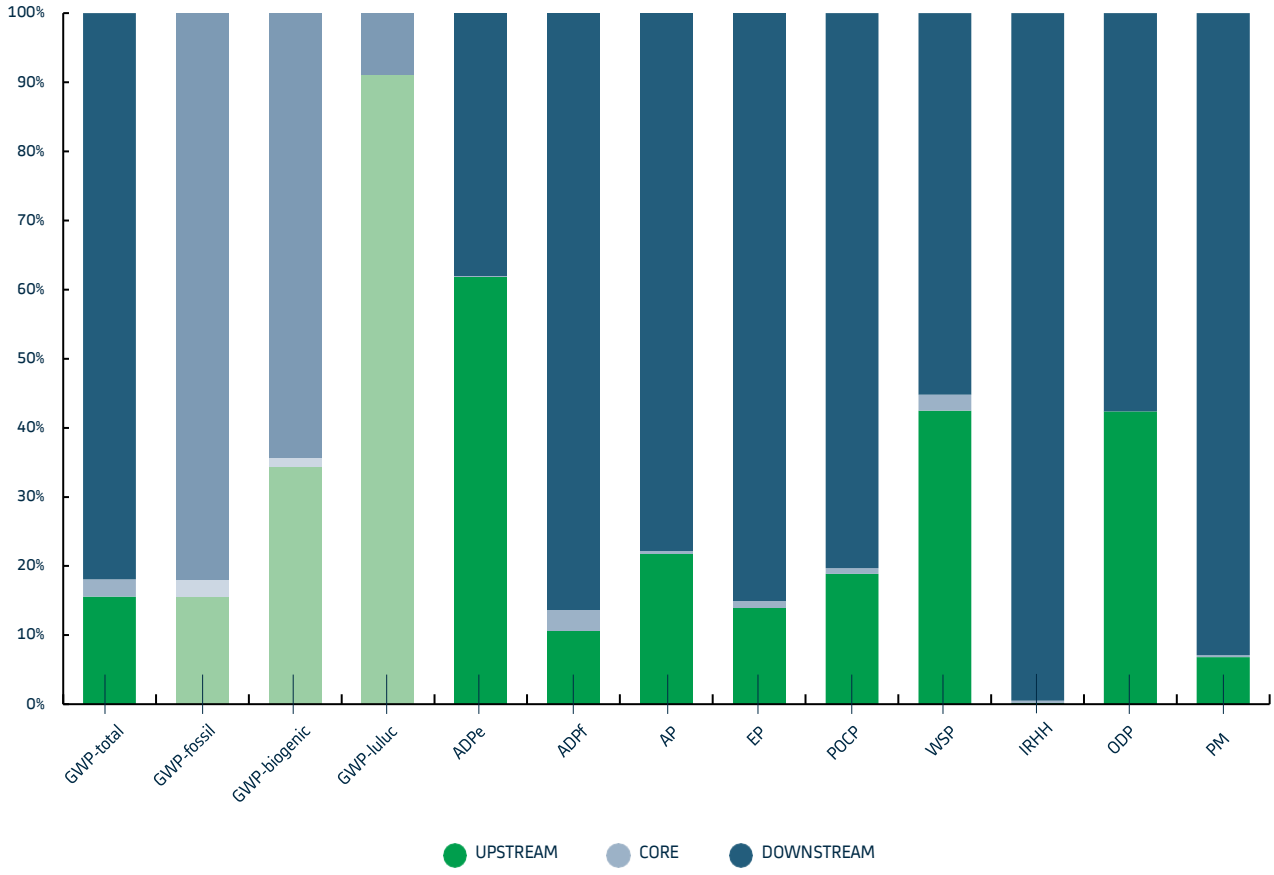
The noise levels for RER NG were measured **in accordance to the ISO 3095:2013.**

Environmental performance

Contribution of each phase to the environmental impacts

The relative contribution from each phase of the life cycle of RER NG train

For most indicators, the downstream phase is responsible for the most significant part of the environmental impacts. This is especially due to the electricity consumption during the use of the train for the 40 years of its expected lifetime.



Configuration

Life cycle description information and environmental performance results published in this EPD correspond to the one of the design configurations 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
Global warming potential (GWP) - Total	kg CO_2 eq. /pass.km	3,38E-04	5,52E-05	1,78E-03	**2,17E-03**
Global warming potential (GWP) - Fossil	kg CO_2 eq. /pass.km	3,34E-04	5,50E-05	1,77E-03	**2,16E-03**
Global warming potential (GWP) - Biogenic	kg CO_2 eq. /pass.km	3,81E-06	1,56E-07	7,14E-06	**1,11E-05**
Global warming potential (GWP) - Land use and land transformation	kg CO_2 eq. /pass.km	2,10E-12	0,00E+00	2,05E-13	**2,31E-12**
Depletion of abiotic resources - Elements (ADPe)	kg Sb eq. /pass.km	2,36E-08	3,05E-11	1,45E-08	**3,82E-08**
Depletion of abiotic resources - Fossil fuels (ADPf)	MJ /pass.km	2,98E-03	8,30E-04	2,41E-02	**2,79E-02**
Acidification potential (AP)	kg SO_2 eq. /pass.km	2,41E-06	6,45E-08	8,65E-06	**1,11E-05**
Eutrophication potential (EP)	kg PO_4^{3-} eq. /pass.km	1,48E-07	9,86E-09	9,00E-07	**1,06E-06**
Photochemical ozone creation potential (POCP)	kg NMVOC eq. /pass.km	1,03E-06	4,76E-08	4,39E-06	**5,47E-06**
Water scarcity potential (WSP)	m^3 eq. /pass.km	1,50E-04	8,23E-06	1,95E-04	**3,54E-04**
Ionising Radiation – Human Health	kgU235 eq. /pass.km	7,11E-05	1,39E-04	3,95E-02	**3,98E-02**
Emission of ozone-depleting gases (ODP)	kg CFC 11 eq. /pass.km	6,15E-10	4,53E-13	8,36E-10	**1,45E-09**
Particulate Matter	Disease Incidence /pass.km	3,50E-11	1,51E-12	4,77E-10	**5,14E-10**

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 CO2 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 SO2 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.

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 m3 equivalents.

Ionizing radiation – human health

This indicator represents the emissions of radionuclides with damage to human health and ecosystems (generally linked to use of nuclear power in an electricity mix)

The result is expressed in kg U235 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.

Particulate matter

Health impact of emissions of small particles and liquid droplets (e.g., organic chemicals, soil or dust particles)

The result is expressed in disease incidence.

* The results of this environmental impact indicator shall be used with care as the uncertainties of the results are high and as there is limited experience with the indicator.

Use of resources		Unit	Upstream	Core	Downstream	TOTAL
RENEWABLE RESOURCES						
Primary energy resources	Use as energy carrier	MJ, net calorific value /pass. km	1,35E-04	9,78E-05	2,72E-02	**2,74E-02**
	Used as raw materials	MJ, net calorific value /pass. km	1,01E-05	0,00E+00	8,95E-09	**1,01E-05**
	TOTAL	**MJ, net calorific value /pass. km**	**1,45E-04**	**9,78E-05**	**2,72E-02**	**2,74E-02**
NON-RENEWABLE RESOURCES						
Primary energy resources	Use as energy carrier	MJ, net calorific value /pass. km	8,57E-03	1,78E-03	2,96E-01	**3,07E-01**
	Used as raw materials	MJ, net calorific value /pass. km	2,86E-04	7,39E-06	5,69E-04	**8,60E-04**
	TOTAL	**MJ, net calorific value /pass. km**	**8,84E-03**	**1,79E-03**	**2,97E-01**	**3,08E-01**
Secondary material		kg /pass. km	1,53E-05	0,00E+00	8,71E-06	**2,40E-05**
Renewable secondary fuels		MJ, net calorific value /pass. km	0,00E+00	0,00E+00	0,00E+00	**0,00E+00**
Non-renewable secondary fuels		MJ, net calorific value /pass. km	0,00E+00	0,00E+00	0,00E+00	**0,00E+00**
Net use of fresh water*		m3 /pass. km	2,88E-06	1,61E-07	4,21E-06	**7,25E-06**

* 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	Unit	Upstream	Core	Downstream	TOTAL
Hazardous waste disposed	kg /pass. km	1,39E-03	1,03E-06	5,73E-04	**1,97E-03**
Non-hazardous waste disposed	kg /pass. km	2,91E-04	1,00E-05	3,43E-04	**6,42E-04**
Radioactive waste disposed	kg /pass. km	2,09E-07	4,85E-09	2,01E-07	**4,16E-07**

Output flows	Unit	Upstream	Core	Downstream	TOTAL
Components for reuse	kg /pass. km	N/A	0,00E+00	0,00E+00	**0,00E+00**
Material for recycling	kg /pass. km	6,87E-06	4,86E-09	1,62E-04	**1,68E-04**
Materials for energy recovery	kg /pass. km	3,16E-15	1,39E-07	6,07E-06	**6,21E-06**
Exported energy, electricity	MJ /pass. km	N/A	0,00E+00	0,00E+00	**0,00E+00**
Exported energy, thermal	MJ /pass. km	N/A	0,00E+00	0,00E+00	**0,00E+00**

Programme information

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. Alstom, owner of the EPD, has the sole ownership, liability and responsibility of the EPD.

Product category rules (PCR): PCR for 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)

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Approved by
The International EPD® System

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

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