ENVIRONMENTAL PRODUCT DECLARATION

AZUR

The *AZUR* train reflects our dedication to developing products and services for sustainable mobility.

AZUR

Designed for Sustainable Mobility

The *AZUR* train sets a high standard for environmentally sustainable rail transportation. This Environmental Product Declaration provides a detailed insight into the environmental impact of the *AZUR* train throughout its complete life cycle.

Communicating Environmental Performance - ISO 14025

We communicate the environmental performance of our products through Environmental Product Declarations (EPDs) following the International EPD® System. Our EPDs are developed in line with the UNIFE Product Category Rules for Rolling Stock (PCR 2009 : 05 Rolling Stock, version 2.11) as well as the principles and procedures of ISO 14025:2006.

***AZUR* - Highlighted facts and figures for a train**	
Number of cars	9
Weight*	238 t
Capacity	272 seats / 1539 total
Maximum service speed	72.4 km/h
Energy consumption	26 kWh/km
Recoverability / Recyclability	97 % / 96 %

*Mass based on an empty train

EPDs are based on Life Cycle Assessment methodology and function as an externally validated communication tool, providing complete transparency to the benefit of our customers and other stakeholders.

The external validation is carried out by independent verifiers approved by the technical committee of the International EPD® System and/or the EU Eco-management and Audit Scheme (EMAS). The functional unit is transport of one passenger for 1 km.

This EPD is based on a 9 cars configuration of the *AZUR* train, manufactured by the Bombardier-Alstom Consortium (CBA) for the Société de transport de Montréal (STM).

Material Content

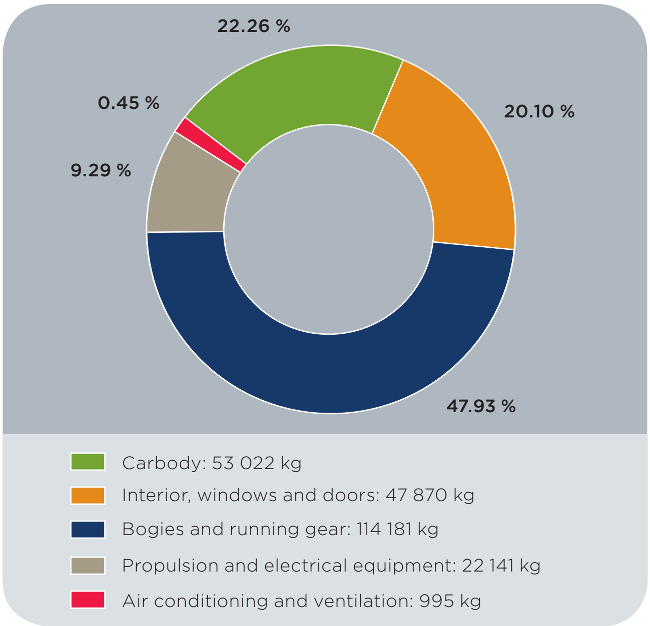
The *AZUR* train is developed with a strong emphasis on our commitment to eliminating hazardous substances and related toxic emissions, providing a safer environment for our customers, passengers and employees. The Railway Industry Substance List[1] enables product designers to screen out such substances by identifying them throughout our supply chain and actively working towards eliminating them from our products.

Materials[kg]	Manufacturing	Maintenance	Total
Metals	207 725	11 942	219 667
Polymers	5 003	1 806	6 809
Elastomers	7 429	80 668	88 097
Glass	6 815	0	6 815
Fluids	1 019	17 207	18 226
MONM*	123	6 564	6 687
Others	10 096	13 832	23 927
Total (kg)	**238 209****	**132 020**	**370 228**

The AZUR train material composition and all material required for maintenance during a 40 year operation. Materials are classified according to ISO 22628:2002 standard.

*Modified organic natural materials.
** Mass weighted for this study.

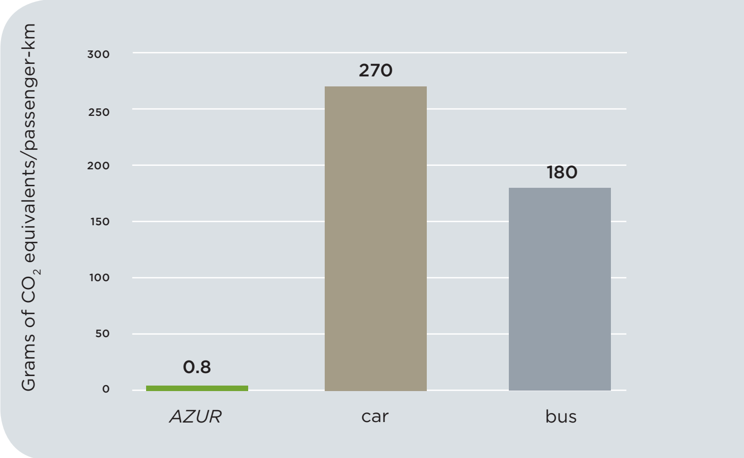
The *AZUR* is an Urban Passenger service vehicle. The following chart shows an allocation of the *AZUR* train total vehicle mass to the five main product groups identified in PCR 2009 : 05 Rolling Stock, version 2.11.[2]



The AZUR train modular structure according to PCR 2009 : 05 Rolling Stock, version 2.11.

Energy Efficiency

Regenerative braking, an energy saving and recovery concept, helps to maximize the energy efficiency of the *AZUR* train to 26 kWh/km. The *AZUR* train auxiliary systems energy consumption was calculated according to the methodology described in Railenergy Contract No. FP6-031458[3]. Data on energy consumption for traction as outlined in this methodology are based on actual measurements with a passenger load.[4]



Transporting one passenger over one kilometer with an AZUR train generates 99% less CO_2 than travelling the same distance in a car[5].

Noise

AZUR trains are certified according to ISO 3095: 2005 and ISO 3381: 2005. Noise measurement points are located at 1.5 m above the station platform and 3 m from the center of the longitudinal axis of the track that is closest to train users.

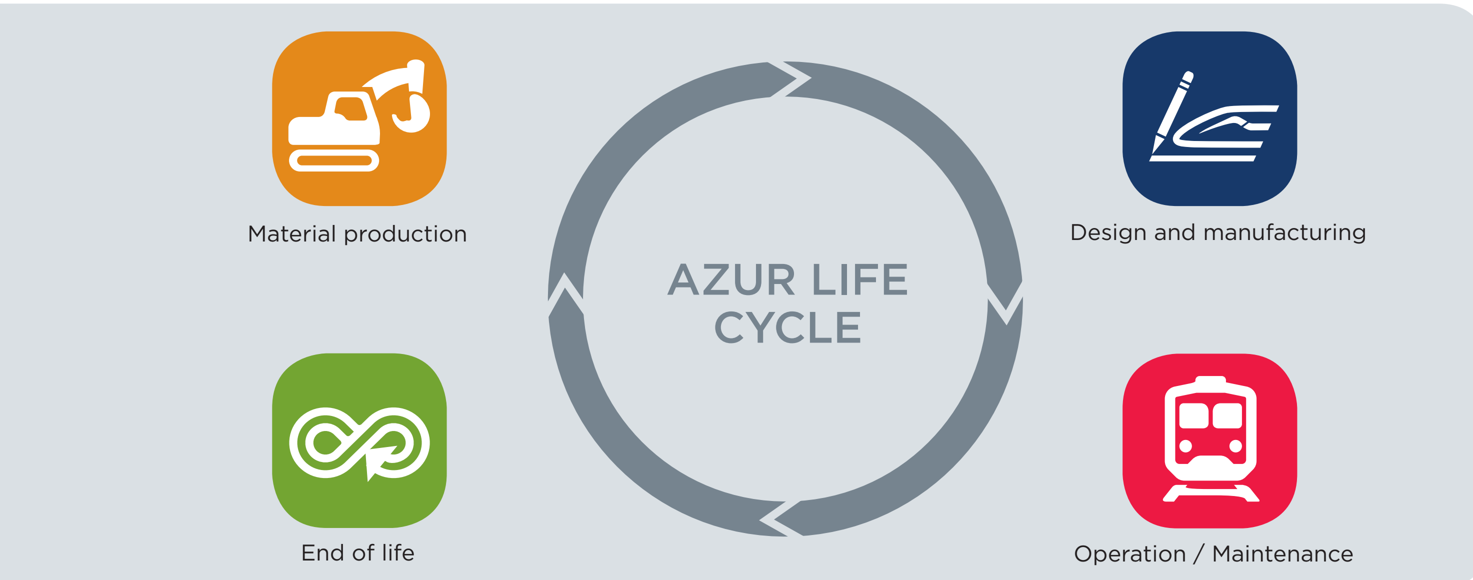
Standstill	**dB(A)**
Adjacent platform, trailer	<74
Adjacent platform, motor car	<73
Acceleration (when leaving the station)	
Adjacent platform, center	<92
Speed (when arriving to the station)	
Adjacent platform, center	<86

Outside noise levels, standstill train: doors closed, all auxiliaries running, middle-speed ventilation.

[1] UNIFE. (2011). *Railway Industry Substance List*. Retrieved from www.unife-database.org
[2] Product Category Rules (PCR) for preparing an Environmental Product Declaration (EPD) for Rolling Stock, UNCPC CODE: 495, PCR 2009 : 05 Rolling Stock, version 2.11, International EPD Consortium (IEC).
[3] Based on *Specification and verification of energy consumption for railway rolling stock (Railenergy WP 2.2: input to future UIC/UNIFE Techinical Recommendation)*, equivalent to TS 50591 version 2013
[4] Considering a car in running condition, all fixed seats occupied and four standing passengers per m² of useable floor: *Fourniture de matériel roulant MR 08 pour le Métro de Montréal: Spécification techniques Division II, Contract No. 3909 -10-10-38.*
[5] WWF. (2012). *Report Canada 2012: Road Transportation Emissions Reduction Strategies: Climate Change Program - World Wide Fund for Nature.*

A life Cycle Perspective

Environmental Profile of the *AZUR*



Life cycle thinking is integrated to the design process, highlighting the significance of different design choices and the true overall environmental impact these choices have.

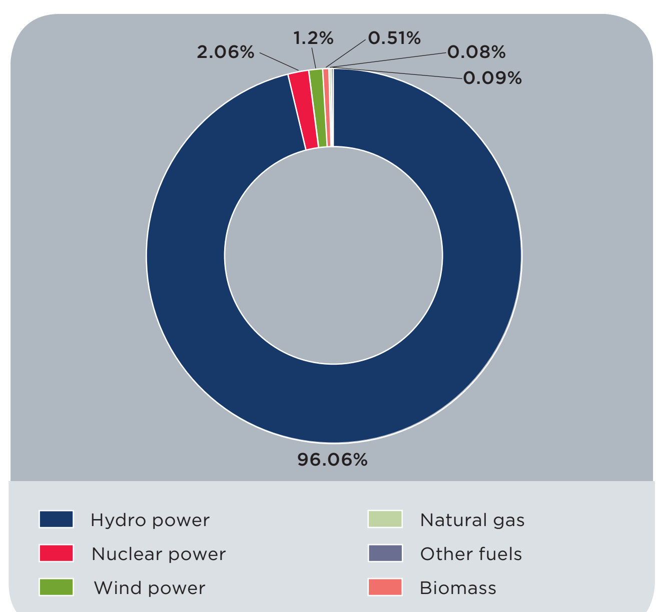
Life Cycle Assessment

Resource efficiency, waste generation and overall environmental impact are estimated throughout all life cycle phases of the *AZUR* train (reference period: 2012-2013), following ISO 14040:2006[6]. The results are based on a 9-car configuration of the *AZUR* train in service for 40 years, with an average running distance of 120 000 km per year and regenerative braking at 50%. All assumptions on vehicle comfort systems load are based on Railenergy Contract No. FP6-031458. The passenger load is all seats occupied + 4 standing passengers/m^2, resulting in a total of 1106 passengers per 9-car train (72% passenger load). The end of life phase of the life cycle is modeled according to technology available today. The potential benefit from material recycling and energy recovery is not included in the environmental impact charts and tables.

[6] Life Cycle Assessment Report FR-M8-MPP-GP-GE-QA-GN-9999-280, rev4 for AZUR trains.

Power Supply

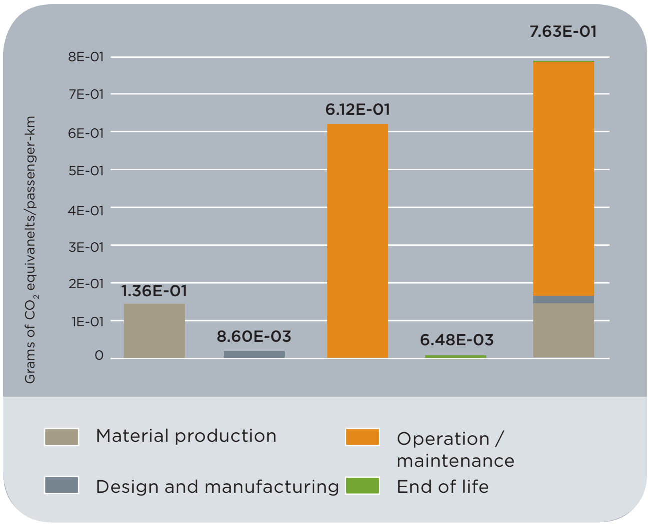
The Hydro-Québec grid power supply mix for 2012 was used to model the operational phase of the *AZUR* train life cycle.



Hydro-Québec grid power supply for the AZUR train resulting in emissions of 23.68 g of CO_2 equivalent per kWh.

Carbon Footprint

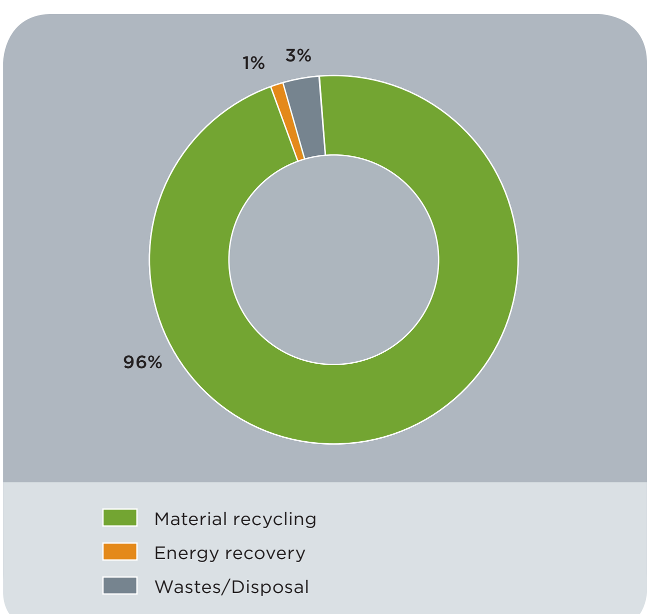
Greenhouse gas (GHG) emissions throughout the *AZUR* train life cycle are 0.8 g of CO_2 equivalents per passenger travelling one kilometer.



GHG emissions in g CO_2 equivalents/passenger-km

Recyclability and Recoverability

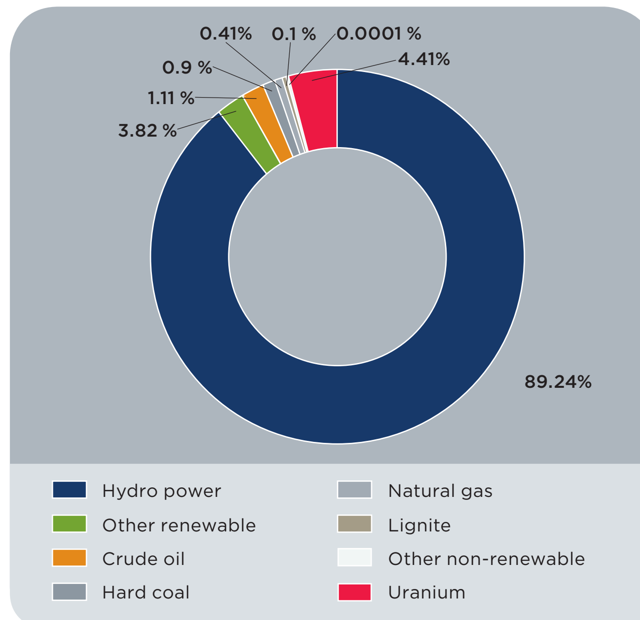
Using materials featuring high recyclability and considering disassembly early in the design phase maximise the overall recoverability of the *AZUR* train. Material recycling and energy recovery aggregate to a 97% recoverability rate.



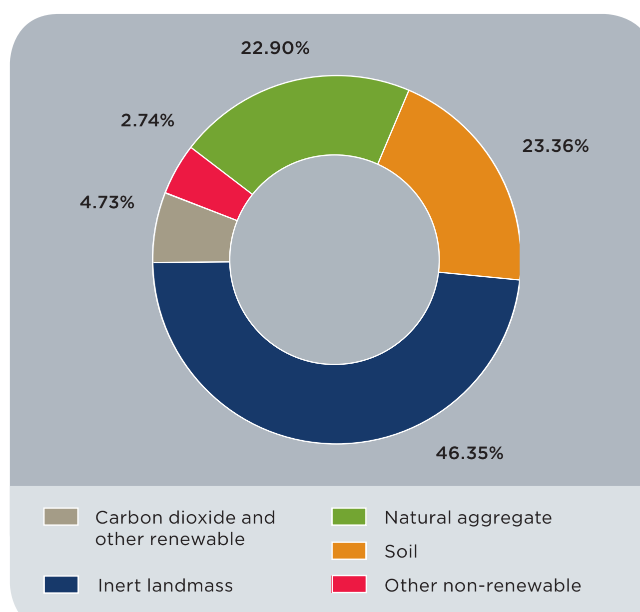
Projected recoverability at the end of life phase of the AZUR train, following ISO 22628 methodology.

Energy and Material Resource Use

Renewable and non-renewable energy and material resource use throughout the rail vehicle life cycle is detailed in the following charts as a percentage of the total for the entire life cycle of the vehicle. The distinction between renewable and non-renewable energy and material resources is shown with green/blue shades representing renewable resources and grey/brown/orange/red shades representing non-renewable resources.



Energy resource use throughout the AZUR train life cycle shown as a percentage of the total calorific value.



Material resource use throughout the AZUR train life cycle shown as a percentage of the total material resource mass.

Environmental Impact in Detail[7]

		Upstream module	Core module	
	Unit of measurement	Material production	Design and manufacturing	Operation / maintenance
Renewable material resources				
Carbon dioxide	kg/pass.km	3.71E-06	1.21E-06	1.88E-04
Others	kg/pass.km	2.39E+07	-2.74E-08	-3.59E-06
Renewable energy resources				
Hydro power	MJ/pass.km	2.88E-05	7.30E-04	1.02E-01
Biomass	MJ/pass.km	2.06E-07	2.61E-17	1.13E-05
	kg/pass.km	1.97E-08	1.78E-18	1.09E-06
Others (solar, wind, geothermal, and wave energy)	MJ/pass.km	3.69E-05	3.06E-05	4.31E-03
Non-renewable material resources				
Inert landmass	kg/pass.km	1.46E-03	8.54E-06	4.23E-04
Natural aggregates	kg/pass.km	-9.08E-06	7.09E-06	9.43E-04
Soil	kg/pass.km	5.96E-07	7.13E-06	9.50E-04
Others	kg/pass.km	5.30E-05	3.40E-06	5.60E-05
Non-renewable energy resources				
Crude oil	kg/pass.km	5.18E-06	5.53E-07	2.64E-05
Hard coal	kg/pass.km	3.04E-05	3.55E-07	8.65E-06
Lignite	kg/pass.km	2.78E-06	2.54E-07	6.34E-06
Natural gas	kg/pass.km	3.45E-06	2.23E-07	6.84E-06
Uranium[8]	MJ/pass.km	7,19E-03	5,56E-03	7,45E-01
	kg/pass.km	1,07E-10	8,27E-11	1,11E-08
Others	kg/pass.km	2.87E-09	1.11E-10	1.02E-08
Water				
Total use of water resources	kg/pass.km	7.54E-02	8.33E-01	1.16E+02
Direct amount of water used	kg/pass.km	-	5.49E-05	-
Waste				
Hazardous	kg/pass.km	1.72E-08	1.54E-08	2.06E-06
Non-hazardous	kg/pass.km	1.04E-03	3.05E-05	1.32-03
Total waste[9]	kg/pass.km	1.04E-03	3.05E-05	1.32-03
Radioactive[10]	kg/pass.km	1,71E-08	1,54E-08	2,06E-06
Environmental impact categories				
Acidification Potential (AP) [kg SO_2-Equiv.]	kg/pass.km	7.29E-07	1.28E-08	9.15E-07
Eutrophication Potential (EP) [kg Phosphate-Equiv.]	kg/pass.km	3.86E-08	2.37E-09	9.17E-08
Global Warming Potential (GWP 100 years) [kg CO_2-Equiv.]	kg/pass.km	1.36E-04	8.60E-06	6.12E-04
Ozone Layer Depletion Potential (ODP, steady state) [kg R11-Equiv.]	kg/pass.km	1.51E-14	4.73E-15	6.11E-13
Ozone Creation Potential (POCP) [kg Ethene-Equiv.]	kg/pass.km	6.27E-08	2.24E-08	8.30E-08

Downstream module	
End of life	Total
3.08E-07	1.93E-04
-1.21E-08	-3.39E-06
7.52E-07	1.03E-01
1.24E-16	1.15E-05
8.49E-18	1.11E-06
4.11E-06	4.38E-03
1.01E-05	1.90E-03
1.22E-07	9.41E-04
7.63E-08	9.58E-04
3.15E-07	1.13E-04
4.12E-08	3.22E-05
2.19E-07	3.96E-05
6.29E-07	1.00E-05
1.00E-07	1.06E-05
1,05E-03	7,59E-01
1,56E-11	1,13E-08
2,00E-10	1.34E-08
4.39E-03	1.17E+02
-	-
9.48E-11	2.10E-06
1.41E-05	2.41E-03
1.41E-05	2.41E-03
9.48E-11	2,10E-06
4.11E-09	1.66E-06
5.03E-10	1.33E-07
6.48E-06	7.63E-04
1.08E-15	6.32E-13
3.52E-10	1.69E-07

Definitions

Life Cycle Assessment

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

Acidification potential

The aggregate measure of the acidifying potential of some substances, calculated through the conversion factor of sulphur oxides and nitrogen and ammonia into acidification equivalents (SO_2).

Global warming potential and carbon footprint

The Global warming potential (Carbon footprint) of a passenger travelling for one km is the result of an allocation of the total amount of greenhouse gases (GHG) emitted over all phases of the product life cycle. The total mass of emitted GHGs is expressed in CO_2 equivalents.

Eutrophication potential

The aggregate measure of the inland water eutrophication potential of some substances, calculated through the conversion factor of phosphorous and nitrogen compounds (waste water discharges and air emissions of NO_x and NH_3) into phosphorous equivalents.

Ozone layer depletion potential

The aggregate measure of the ozone layer depleting potential of some substances, calculated through the conversion factor of halogenated hydrocarbons that contributes to the depletion of the ozone layer into CFC -11 equivalents.

Photochemical ozone creation potential

The aggregate measure of the ground level ozone creation potential of some substances, calculated through the conversion factor of ethylene equivalents that contribute to the formation of photochemical oxidants.

Recyclability and recoverability

The recyclability and the recoverability rate of a product are expressed as a percentage by mass of the product that can potentially be recycled, reused or both (recyclability rate), or recycled, recovered and reused (recoverability rate).

[7] Secondary resources are not considered in this study and therefore have values of 0.
Negative figures are the result of negative process inputs for selected processes.
[8] Based on the latest available data by Hydro-Québec at the time of this study.
These data do not exclude the closure of the nuclear plant Gentilly-2.
[9-10] Radioactive waste is included in the calculation of hazardous waste.

EcoDesign

The integration of environmental sustainability into product development is fundamental at Bombardier-Alstom Consortium, where it has a core function in designing state of the art rail transportation products.

Applying a complete life cycle perspective to vehicle design is central to the consortium’s product responsibility strategy. Maximising energy and resource efficiency, eliminating hazardous substances and related toxic emissions as well as enhancing the overall product recyclability rate are the result of a high quality working process applied to product design and cascaded down to our supply chain.

More information on EcoDesign and Environmental Product Declarations is available at :
www.bombardier.com/en/sustainability.html
www.alstom.com/microsites/group/sustainability/

Product Category Rules (PCR) review was conducted by The Technical Committee of the International EPD® System:
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Independent verification of the declaration and data, according to ISO 14025: 2006 :
☐ **EPD process certification** ☒ **EPD verification**

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Accredited or 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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For more information on the International EPD® System: www.environdec.com.

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