ENVIRONMENTAL PRODUCT DECLARATION

FLEXITY Outlook

The *BOMBARDIER* FLEXITY** Outlook tram reflects our dedication to developing products and services for sustainable mobility.

BOMBARDIER
the evolution of mobility

FLEXITY Outlook

Designed for Sustainable Mobility

Valencia

The *FLEXITY* Outlook tram sets a high standard for environmentally sustainable rail transportation. This Environmental Product Declaration provides a detailed insight into the environmental impact of the Valencia/ Alicante *FLEXITY* Outlook tram 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 Rail Vehicles (PCR 2009:05) as well as the principles and procedures of ISO 14025:2006. EPDs are part of the *BOMBARDIER* ECO4** product portfolio. They 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 Valencia and Alicante configuration of the *FLEXITY* Outlook tram forms the basis of the specific environmental information of this EPD.

FLEXITY Outlook Valencia/Alicante - Highlighted facts and figures

Number of cars	5
Weight (empty)	41 230 kg
Capacity	50 seats / 150 standing
Max speed	71 km/h
Energy consumption	3,7 kWh/km
Recoverability / Recyclability	98% / 92%

Alicante

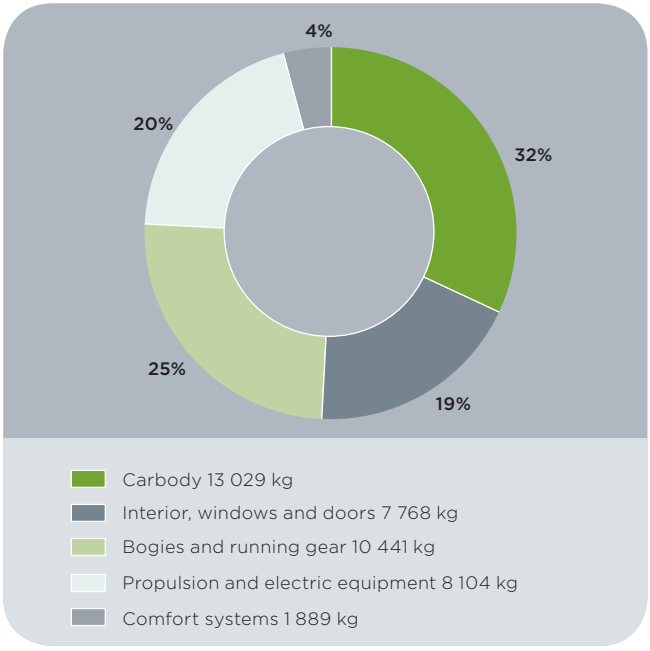
Material Content

The *FLEXITY* Outlook tram 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 Bombardier Controlled Substances list enables product designers to screen out such substances by identifying them throughout our supply chain and actively working towards eliminating them from our vehicles.

Material [kg]	Manufacturing	Maintenance	Total
Metals	33 928	17 054	50 982
Polymers	1 614	460	2 073
Elastomers	610	532	1 142
Glass	2 517		2 517
Fluids	169	521	690
MONM*	822		822
Others	1 569		1 569
Total (kg)	**41 230**	**18 567**	**59 795**

The *FLEXITY* Outlook tram material composition and all material required for maintenance during a 30 year operation. Materials are classified according to ISO 22628:2002. *Modified organic natural materials

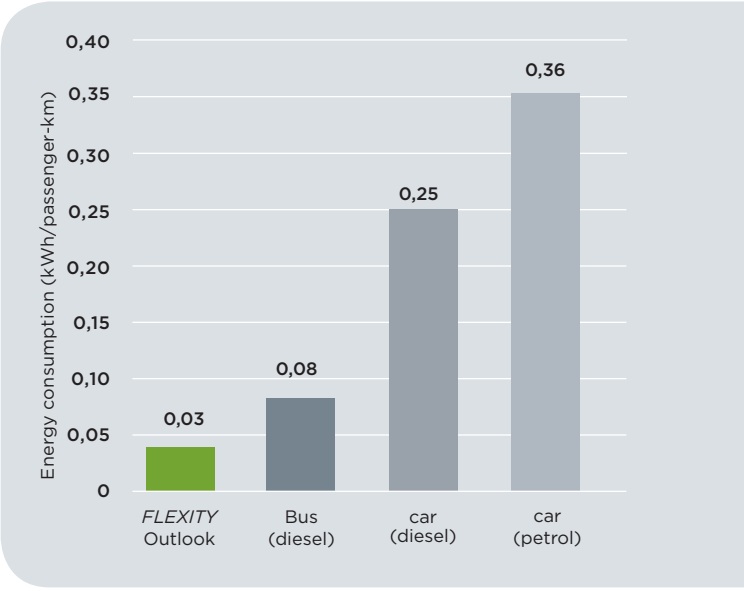
The following chart shows an allocation of the *FLEXITY* Outlook tram total vehicle mass to the five main product groups identified in PCR 2009:05, version 1.1[1].



The Valencia *FLEXITY* Outlook tram modular structure according to PCR 2009:05, version 1.1.

Energy Efficiency

The projected energy consumption of 3,7 kWh/km is based on a simulation run of the Valencia Linea 4 operational profile. In order to consider stops between the stations due to traffic lights and allow for varied driving styles the simulation has been carried out in minimum driving time +20%. Assumptions on vehicle comfort systems load is based on TecRec 100:001: Specification and verification of energy consumption for railway rolling stock. The passenger load was considered as 155 passengers, corresponding to an 80 % seated occupancy with 3 passengers/m² standing according to DIN 15663.



When compared to travelling by car or by bus the *FLEXITY* Outlook provides a far more energy efficient transportation solution.

Noise

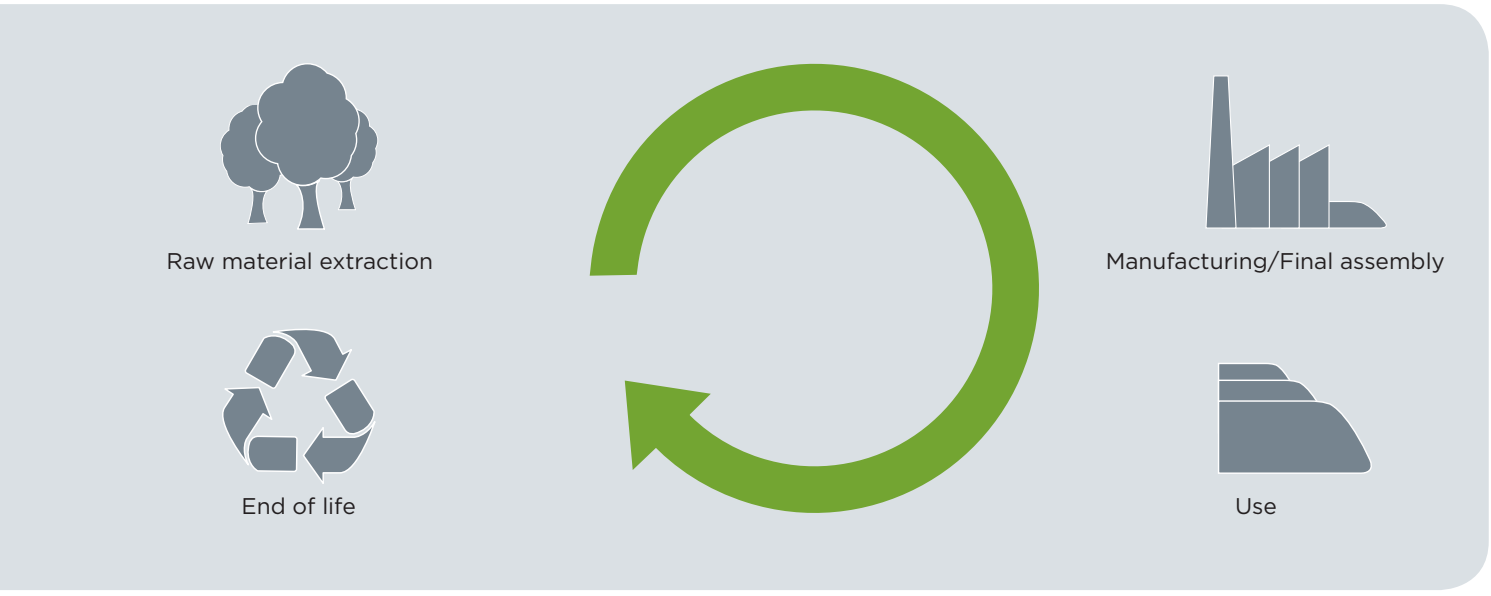
The *FLEXITY* Outlook tram is homologated according to ISO 3095, see limits shown in the table below. The limits for noise are defined at a distance of 7,5 m from the center of the track and 1,2 m above the top of the rail.

Noise	dB(A)
Standstill noise	< 59
Pass by noise	< 82

[1] Product Category Rules (PCR) for preparing an Environmental Product Declaration (EPD) for Rail Vehicles, UNCPC CODE: 495, PCR 2009:05, version 1.1, International EPD Consortium (IEC).

A Life Cycle Perspective

Environmental Profile of the FLEXITY Outlook



At Bombardier 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.

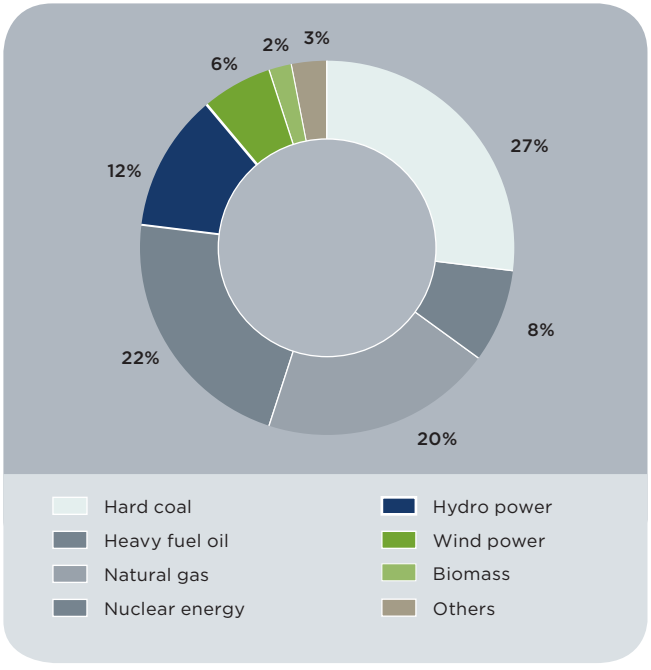
Life Cycle Assessment

Resource efficiency, waste generation and overall environmental impact are estimated throughout all life cycle phases of the Valencia *FLEXITY* Outlook tram, following ISO 14040:2006 methodology.[3] The study has been carried out in cooperation with the Vienna University of Technology. The results are based on the Valencia *FLEXITY* Outlook tram in service for 30 years, with an average running distance of 60 000 km per year. All assumptions on vehicle comfort systems load are based on TecRec 100:001: Specification and verification of energy consumption for railway rolling stock, following the methodology and operational profiles used for the energy consumption simulation. The simulated operational scenario features 50% energy recovery from regenerative braking. 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 tables.

[2] Rainer Pamminger, Life Cycle Assessment Report - *FLEXITY* Outlook Valencia, Vienna University of Technology, 2011

Power supply

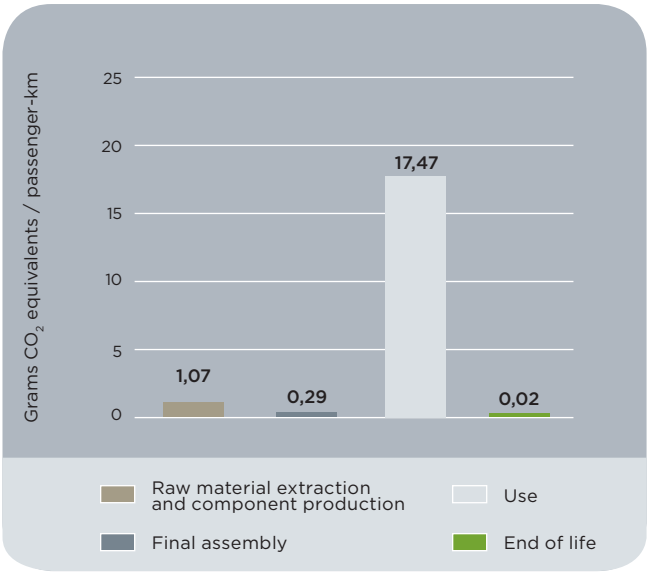
Electric power to Valencia *FLEXITY* Outlook tram is sourced primarily from hard coal and nuclear energy. The Spanish average power supply mix for 2011 was used to model the operation phase of the Valencia *FLEXITY* Outlook tram life cycle.



Power supply for the Valencia *FLEXITY* Outlook tram resulting in emissions of 593 g of CO_2 equivalents per kWh.

Carbon Footprint

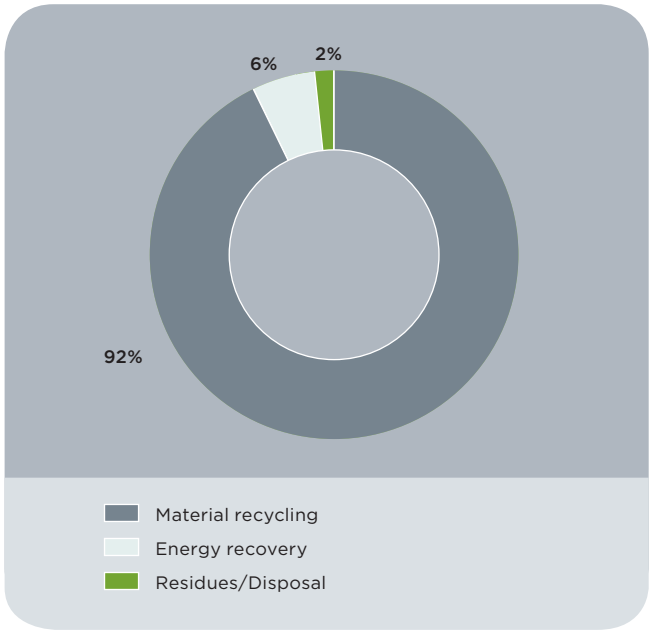
Greenhouse gas (GHG) emissions throughout the Valencia *FLEXITY* Outlook tram life cycle are 18,85 g of CO_2 equivalents per passenger travelling one km.



GHG emissions in g CO_2 equ/passenger-km

Recyclability and Recoverability

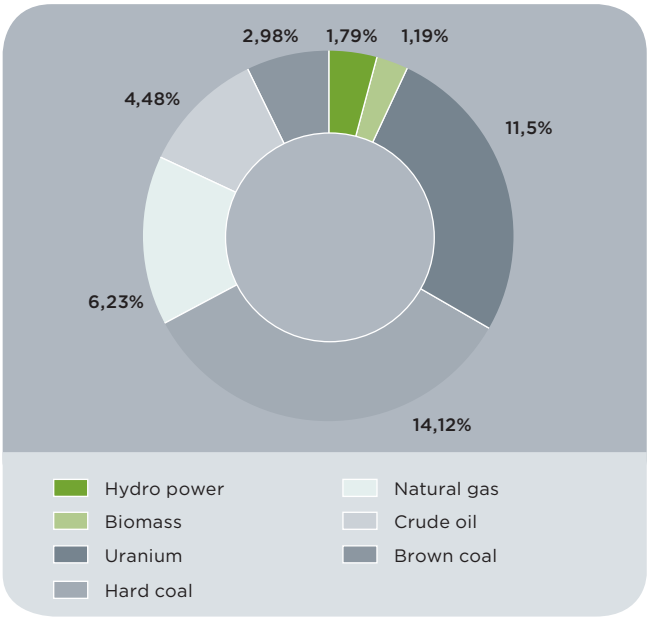
Using materials featuring high recyclability and considering disassembly early in the design phase maximise the overall recoverability of the Valencia *FLEXITY* Outlook tram. Material recycling and energy recovery aggregate to a 98% recoverability rate.



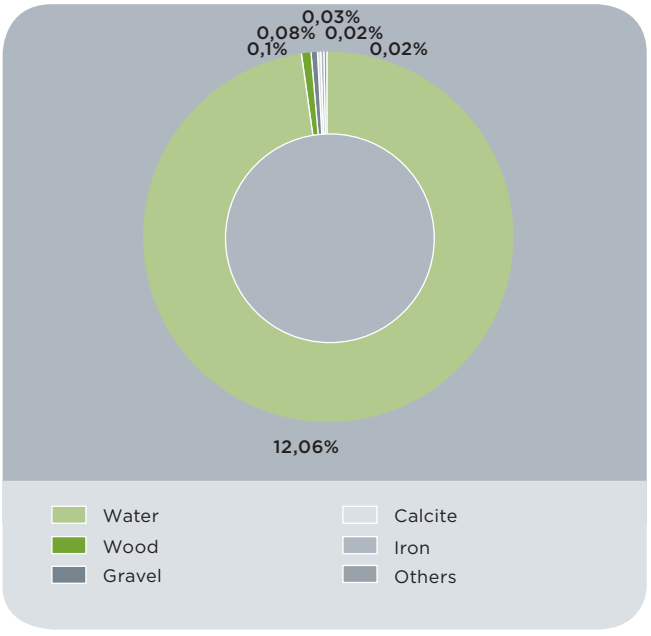
Projected recoverability at the end of life phase of the Valencia *FLEXITY* Outlook, following ISO 22628 methodology.

Energy and Material Resource Use

Renewable and non-renewable energy and material resource use throughout the Valencia *FLEXITY* Outlook tram 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 shades representing renewable resources and grey shades representing non-renewable resources.



Energy resource use throughout the Valencia *FLEXITY* Outlook life cycle shown as a percentage of the total calorific value.



Material resource use throughout the Valencia *FLEXITY* Outlook life cycle shown as a percentage of the total material resource mass.

Environmental Impact in Detail

	Upstream module	Core module
Renewable resources	Raw material extraction and component production	Final assembly
Material (kg/passenger km)	8,20E-03	1,23E-02
Water	9,01E-03	1,33E-03
Wood	2,01E-05	3,25E-06
Energy (MJ/passenger km)	1,41E-03	5,84E-04
Hydro power	1,66E-03	5,77E-05
Biomass	4,40E-04	4,72E-05
Wind power	2,87E-05	4,10E-05
Solar energy	4,14E-07	8,53E-07
Non-renewable resources		
Material (kg/passenger km)	5,18E-03	4,09E-03
Gravel	3,02E-04	4,03E-05
Calcite	9,78E-05	4,32E-06
Iron	1,66E-04	1,68E-06
Others	1,38E-04	1,33E-06
Energy (MJ/passenger km)	1,06E-02	1,17E-02
Uranium	2,28E-03	8,68E-04
Hard coal	6,97E-03	9,44E-04
Natural gas	3,03E-03	2,02E-03
Crude oil	4,18E-03	4,34E-04
Brown coal	1,81E-03	1,51E-03
Waste		
Waste (kg/passenger km)	6,61E-03	4,09E-03
Hazardous waste	9,96E-05	9,12E-06
Non-hazardous waste	2,91E-02	4,19E-02
Environmental impact categories (pass.km)		
Acidification Potential (AP) [kg SO_2-Equiv.]	6,44E-06	4,56E-07
Eutrophication Potential (EP) [kg Phosphate-Equiv.]	2,87E-06	8,37E-08
Global Warming Potential (GWP 100 years) [kg CO_2-Equiv.]	1,07E-03	2,94E-04
Ozone Layer Depletion Potential (ODP, steady state) [kg R11-Equiv.]	1,06E-09	3,27E-11
Ozone Creation Potential (POCP) [kg Ethene-Equiv.]	4,36E-07	3,20E-07

Downstream module		Total
Use	End of life	
3,68E-03	3,40E-04	2,45E-02
1,10E-01	3,19E-05	1,21E-01
7,81E-04	4,62E-08	8,05E-04
2,87E-01	8,64E-06	2,89E-01
1,61E-02	1,59E-06	1,79E-02
1,14E-02	6,82E-07	1,19E-02
7,71E-03	3,98E-07	7,78E-03
4,94E-05	3,12E-09	5,07E-05
5,34E-03	6,18E-05	1,47E-02
6,20E-04	4,18E-06	9,66E-04
1,61E-04	2,11E-07	2,64E-04
7,09E-05	1,26E-07	2,38E-04
6,89E-05	2,13E-07	2,09E-04
5,51E-03	1,84E-04	2,80E-02
1,08E-01	9,72E-06	1,11E-01
1,33E-01	1,06E-05	1,41E-01
5,72E-02	8,13E-06	6,23E-02
4,02E-02	4,53E-05	4,48E-02
2,64E-02	3,72E-06	2,98E-02
3,37E-03	7,79E-05	1,42E-02
1,90E-04	1,15E-07	2,99E-04
7,76E+00	4,01E-04	7,83E+00
1,68E-04	2,43E-08	1,75E-04
1,16E-05	7,29E-09	1,45E-05
1,75E-02	2,39E-05	1,89E-02
1,11E-09	5,71E-13	2,20E-09
2,35E-07	2,18E-09	9,05E-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 warning potential

The Global warning potential 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 vehicle life cycle. The total mass of emitted GHGs is allocated to 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 contribute 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 new rail vehicle are expressed as a percentage by mass of the rail vehicle that can potentially be recycled, reused or both (recyclability rate), or recovered, reused or both (recoverability rate).

Design for Environment

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

Applying a complete life cycle perspective to vehicle design is central to our product responsibility strategy. Maximising energy and resource efficiency, eliminating hazardous substances and related toxic emissions as well as enhancing the overall product recyclability rate is the result of a high quality working process applied to product design and cascaded down our supply chain. The Bombardier Transportation Design for Environment (DfE) Centre of Competence, together with the DfE expert network, acts as a catalyst by providing the essential tools, expertise and central coordination in projects worldwide.

More information on Design for Environment and Environmental Product Declarations at Bombardier is available at:
www.csr.bombardier.com/en/products/our-product-reponsibility-strategy

PCR review was conducted by the technical committee of the international EPD® system:
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Independent verification of the declaration and data, in accordance to ISO 14025:2006
☐ **Internal** ☒ **External**
Manfred Mühlberger, Individual Verifier, ETA Umweltmanagement GmbH, Vienna, Austria

Environmental Product Declarations within the same product category, but from different programs may not be comparable. This EPD is valid until 2015-02-10.
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EPD®

More information on the international EPD® system is available at www.environdec.com.

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