REGINA Intercity X55

Environmental Product Declaration

The *BOMBARDIER* REGINA Intercity X55 train reflects our dedication to developing products and services for sustainable mobility. With Environmental Product Declarations we provide an in depth analysis of the environmental impact our products have throughout their 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** EcoEfficient Optimised Environmental Performance 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).

This EPD gives a detailed insight into the environmental impact of the *REGINA* Intercity X55 train throughout all phases of the vehicle life cycle.

REGINA Intercity X55

Designed for Sustainable Mobility

Integrating Design for Environment to product development has a profound impact on Bombardier rail vehicles. The *REGINA* Intercity X55 train sets a high standard for environmentally sustainable rail transportation.

Eco-efficient Intercity Travel

The *REGINA* Intercity X55 provides passengers with a sustainable solution to intercity travel. It features a recoverability and recyclability rate of 98% and 93% respectively, high energy efficiency at 8,04 kWh per km and low standstill and pass-by noise levels. Overall environmental impact throughout the *REGINA* Intercity X55 train life cycle is inherently low with power supply at operation being sourced exclusively from renewable energy resources.

REGINA Intercity X55 - Highlighted facts and figures	
Number of cars	4
Weight	226 916 kg
Capacity	245 seats
Max speed	200 km/h
Energy consumption	8,04 kWh/km
Recoverability/ Recyclability	98% / 93%

The *REGINA* Intercity X55 train is designed in Västerås, Sweden to withstand the harsh conditions in Scandinavia. The consequent reliability reduces the environmental impact of maintenance and service throughout the *REGINA* Intercity X55 train life cycle.

Bombardier Transportation Sweden has been certified according to ISO 14001 since 1999.

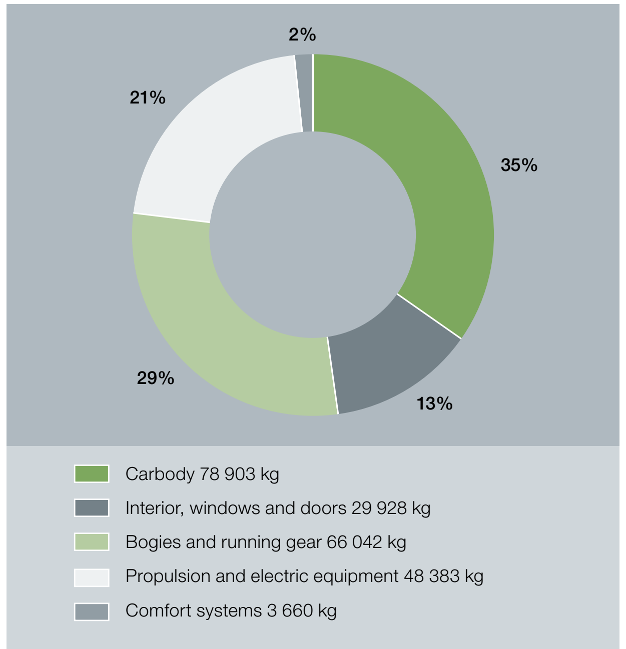
Material Content

The *REGINA* Intercity X55 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 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	179 981,3	94 101,3	274 082,6
Polymers	9 157,8	177,0	9 334,8
Elastomers	7 416,4	3 352,4	10 768,8
Glass	7 051,5	53,3	7 104,8
Fluids	1 849,8	387,7	2 237,5
MONM	6 217,4	473,6	6 691,0
Others	15 241,3	10 570,3	25 811,6
Total	**226 915,5**	**109 115,6**	**336 031,1**

The REGINA Intercity X55 material composition and all material required for maintenance during a 25 year operation. Materials are classified according to ISO 22628:2002.

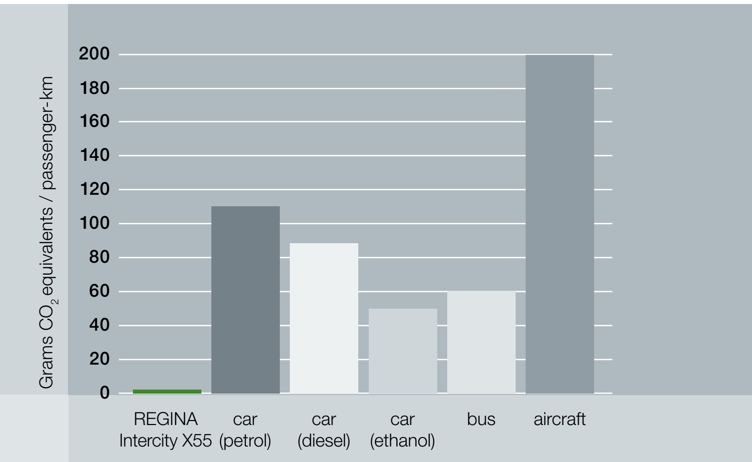
The following chart shows an allocation of the *REGINA* Intercity X55 total vehicle mass to the five main product groups identified in PCR 2009:05, version 1.1[1].



The REGINA Intercity X55 modular structure according to PCR 2009:05, version 1.1[1].

Energy Efficiency

Regenerative braking and ECO-driving, an energy saving electronic support for the driver, contribute to maximizing the energy efficiency of the *REGINA* Intercity X55 train at 8,04 kWh/km. Energy consumption data is based on a simulation run between Stockholm and Gothenburg including four stops with assumptions on vehicle auxiliary systems load based on EC Contract No. FP6-031458. The passenger load is set to 50% based on the estimated vehicle occupancy, giving 123 passengers per 4-car trainset. Regenerative braking is at approximately 10% due to the low number of stops and the fact that braking usually occurs at speeds over 150 km/h, requiring the extensive application of mechanical braking.



When compared to travelling with a car, bus or aircraft up to 95% of the resulting fossil CO_2 emissions per passenger/km could be avoided[2].

Noise

The *REGINA* Intercity X55 train is homologated according to TSI CR Noise (2006), 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	< 68
Starting noise	< 82
Pass-by noise at 80 km/h	< 81
Pass-by noise at 200 km/h	< 93

[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).

[2] Calculations and assumptions are carried out by Bombardier and are based on the Network for Transport and Environment methods and data.

A Life Cycle Perspective

Environmental Profile of the REGINA Intercity X55

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 have been analysed throughout all life cycle phases of the *REGINA* Intercity X55 train, following ISO 14040:2006 methodology.[3]

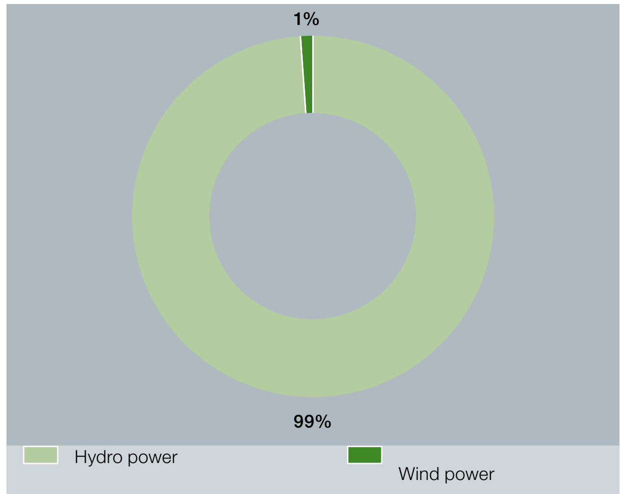
The results are based on a 25 year vehicle lifetime operating between the cities of Stockholm and Gothenburg, with an average running distance of 400 000 km per year and a 50% passenger load factor. Propulsion and auxiliary energy consumption over the *REGINA* Intercity X55 train life cycle is based on the methodology and operational profiles used for the energy consumption simulation. The end of life phase of the life cycle is modeled according to technology available today. The potential benefit that could be gained from material recycling and energy recovery at this phase of the vehicle life cycle has not been considered and is not shown in the results.

[3] Bombardier document: 3EST7–3320 Life Cycle Assessment of the REGINA Intercity X55.

[4] Vattenfall AB: EPD of Electricity from Vattenfall's Nordic Hydropower.

Power supply

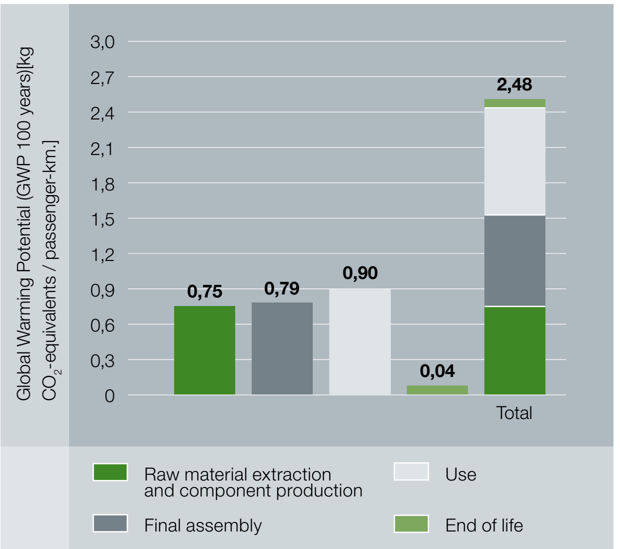
Electric power to SJ AB rail vehicles is sourced exclusively from hydro power and wind power. Data from Vattenfall AB[4] was used to model propulsion and auxiliary energy consumption throughout the 25 year operational lifetime of the *REGINA* Intercity X55 train.



Power supply for the REGINA Intercity X55 resulting in emissions of 9,94g of CO2 equivalents per kWh.

Carbon Footprint

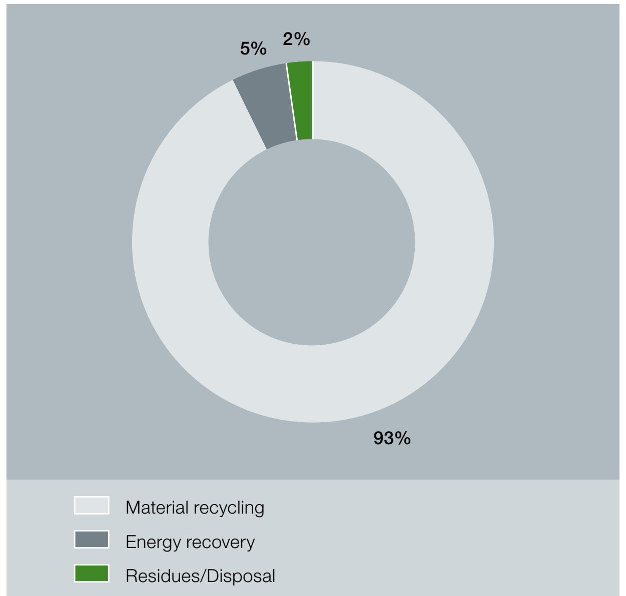
Greenhouse gas (GHG) emissions throughout the *REGINA* Intercity X55 train life cycle are as low as 2,48 g of CO_2 equivalents when allocated to one passenger travelling for one km.



Contribution of each life cycle phase to the total mass of CO_2 equivalents emitted.

Recyclability and Recoverability

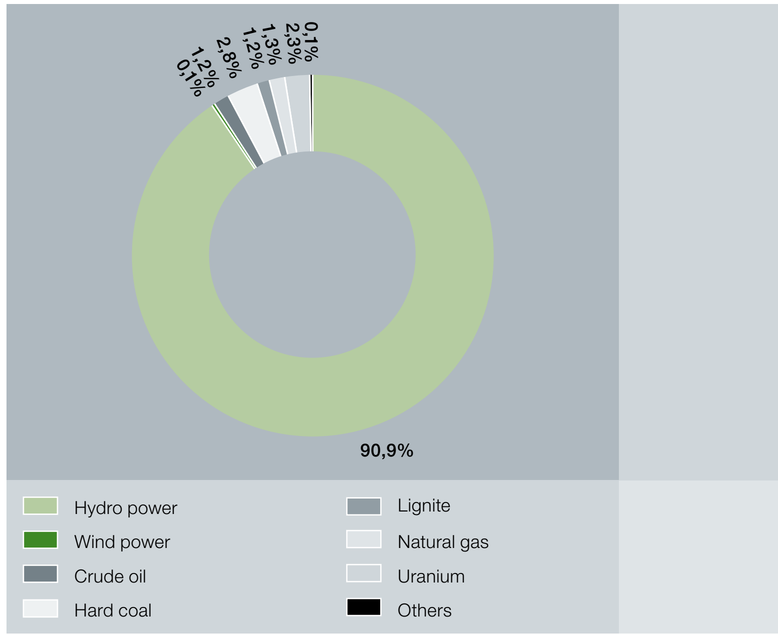
Using materials featuring high recyclability and considering disassembly early in the design phase maximise the overall recoverability of the *REGINA* Intercity X55 train. Material recycling and energy recovery aggregate to give a 98% recoverability rate.



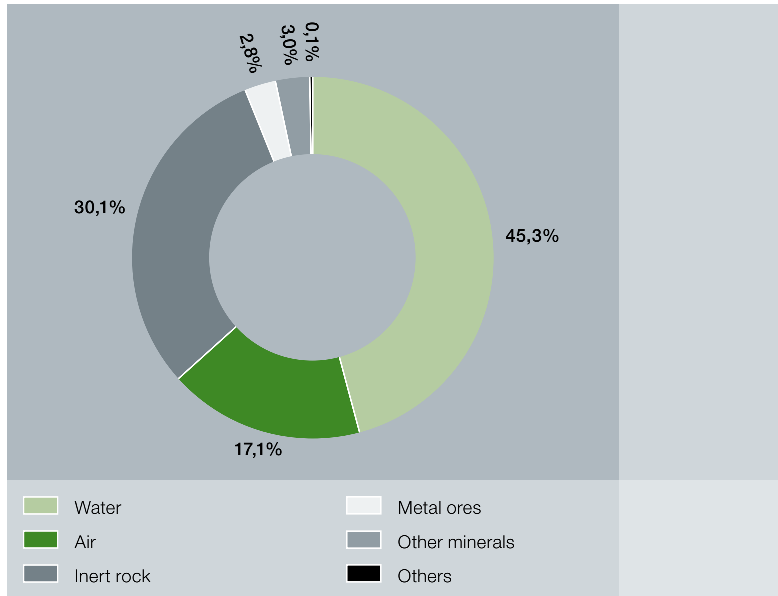
Projected recoverability at the end of life phase of the REGINA Intercity X55, following ISO 22628 methodology.

Energy and Material Resource Use

Renewable and non-renewable energy and material resource use throughout the *REGINA* Intercity X55 train life cycle is detailed in the following charts as a percentage of the total for the entire lifecycle 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 REGINA Intercity X55 lifecycle shown as a percentage of the total calorific value.



Material resource use throughout the REGINA Intercity X55 lifecycle shown as a percentage of the total material resource mass.

Environmental Impact in Detail

Renewable resources	Upstream module Raw material extraction and component production	Core module Final assembly	Downstream module Use	 End of life	Total life cycle
Material [kg/pass.km]	8,20E-03	1,23E-02	3,68E-03	3,40E-04	2,45E-02
Water	5,73E-03	8,78E-03	3,11E-03	1,44E-04	1,78E-02
Air	2,43E-03	3,51E-03	5,62E-04	1,96E-04	6,70E-03
Carbon dioxide	3,43E-05	1,75E-06	5,61E-06	3,83E-08	4,17E-05
Nitrogen	5,93E-07	7,96E-13	2,96E-09	2,38E-14	5,96E-07
Energy [MJ/pass.km]	1,41E-03	5,84E-04	2,87E-01	8,64E-06	2,89E-01
Biomass	1,50E-06	0,00E+00	1,80E-06	0,00E+00	3,30E-06
Primary energy from geothermics	4,59E-05	3,88E-07	7,63E-06	6,46E-09	5,39E-05
Primary energy from hydro power	1,00E-03	2,60E-04	2,87E-01	3,81E-06	2,88E-01
Primary energy from solar energy	3,21E-04	2,68E-05	5,68E-05	5,22E-07	4,05E-04
Primary energy from wind power	4,14E-05	2,96E-04	1,11E-05	4,29E-06	3,53E-04
Others	1,15E-06	1,01E-07	2,82E-08	3,13E-09	1,29E-06
Non-renewable resources					
Material [kg/pass.km]	5,18E-03	4,09E-03	5,34E-03	6,18E-05	1,47E-02
Inert rock	4,31E-03	4,06E-03	3,37E-03	5,93E-05	1,18E-02
Metal ores	7,20E-04	3,78E-07	3,77E-04	6,21E-09	1,10E-03
Non renewable elements	7,55E-06	3,29E-11	4,14E-09	1,86E-14	7,56E-06
Other minerals	1,41E-04	3,16E-05	1,59E-03	2,49E-06	1,77E-03
Energy [MJ/pass.km]	1,06E-02	1,17E-02	5,51E-03	1,84E-04	2,80E-02
Crude oil	2,47E-03	2,83E-04	9,63E-04	1,41E-05	3,73E-03
Hard coal	3,29E-03	2,69E-03	2,91E-03	3,98E-05	8,93E-03
Lignite	4,85E-04	3,05E-03	1,88E-04	4,45E-05	3,76E-03
Natural gas	2,29E-03	1,14E-03	7,45E-04	1,94E-05	4,19E-03
Uranium	2,08E-03	4,57E-03	6,98E-04	6,65E-05	7,42E-03
Waste [kg/pass.km]	6,61E-03	4,09E-03	3,37E-03	7,79E-05	1,42E-02
Hazardous waste	5,92E-06	1,93E-06	2,71E-06	3,14E-06	1,37E-05
Nonhazardous waste	6,61E-03	4,09E-03	3,37E-03	7,48E-05	1,41E-02
Environmental impact categories [pass.km]					
Acidification Potential (AP) [kg SO_2-Equiv.]	3,98E-06	1,36E-06	1,45E-06	2,89E-08	6,82E-06
Eutrophication Potential (EP) [kg Phosphate-Equiv.]	7,06E-07	1,76E-07	7,88E-06	3,79E-09	8,77E-06
Global Warming Potential (GWP 100 years) [kg CO_2-Equiv.]	7,54E-04	7,94E-04	8,95E-04	3,96E-05	2,48E-03
Ozone Layer Depletion Potential (ODP) [kg R11-Equiv.]	5,88E-11	1,31E-10	1,51E-11	1,91E-12	2,07E-10
Ozone Creation Potential (POCP) [kg Ethene-Equiv.]	3,48E-07	3,20E-07	2,35E-07	2,18E-09	9,05E-07

Definitions

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 (H^+ ion).

Carbon footprint
The 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 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.

Global warming potential
The aggregate measure of the contribution to the greenhouse effect of some gases through their conversion into carbon dioxide equivalents.

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).

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-approach.

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.
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Environmental Product Declarations within the same product category, but from different programs may not be comparable. This EPD is valid until 2015-01-10
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EPD®

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

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