ENVIRONMENTAL PRODUCT DECLARATION

Prima II

ALSTOM

OUR RESPONSIBILITY FOR THE ENVIRONMENT

ALSTOM'S ECO-DESIGN POLICY

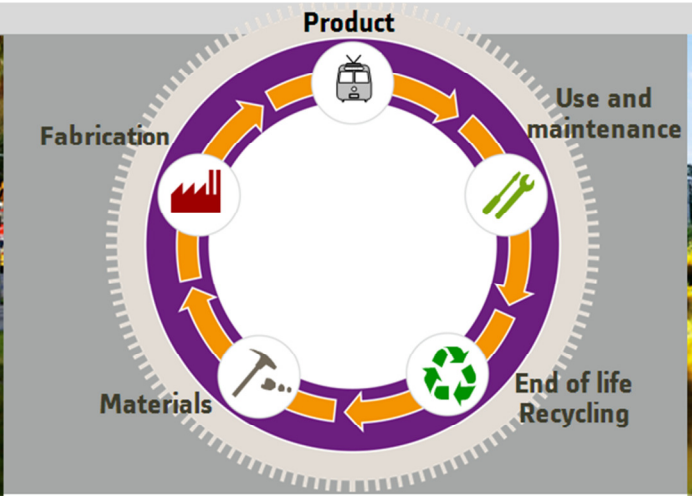
OUR COMMITMENT FOR ENVIRONMENT-FRIENDLY PRODUCTS

- Promote the manufacturing of its products in ISO 14001 certified sites, internally, at suppliers' and sub-contractors'.
- Design and manufacture all products with a view to controlling and reducing their impact on the environment all along their life cycle.
- Reduce our contribution to environmental impacts & global warming.
- Inform our customers of the application of this Eco-Design Policy.
- Manage environmental aspects in a pro-active way, cooperating with all stakeholders.
- Respect and anticipate all legal and regulatory requirements.

OBJECTIVES OF OUR EPD

The major objective of this Environmental Product Declaration is the publication of the environmental impacts of our rail vehicle. This EPD includes all relevant data on the environmental impacts of the Prima II vehicle range during its entire life cycle. During the development of new products, Alstom takes into account the EPD criteria at the earliest stage of the project to improve its know-how in terms of a sustainable product design.

This Environmental Product declaration has been prepared in compliance with ISO 14021. The Life Cycle Assessment defined accordingly meets ISO 14040.



PRIMA II RANGE

DESCRIPTION

This new generation of Prima electric freight locomotives is designed for cross-border itineraries in Europe and to give freight train operators and their customers the performance, flexibility and reliability they expect. Prima locomotives are also designed to give drivers the most modern comfort, innovative technology as well as an environmentally friendly use of resources.

KEY FIGURES

TRACK GAUGE: **1,435 MM**

SPEED: **140 KPH**

TRACTION POWER: **6,400 KW**

STARTING EFFORT: **320 KN**

AXLE LOAD: **22 T**

POWER SUPPLY:
25 KV, 15 KV,3 KV, 1.5 KV

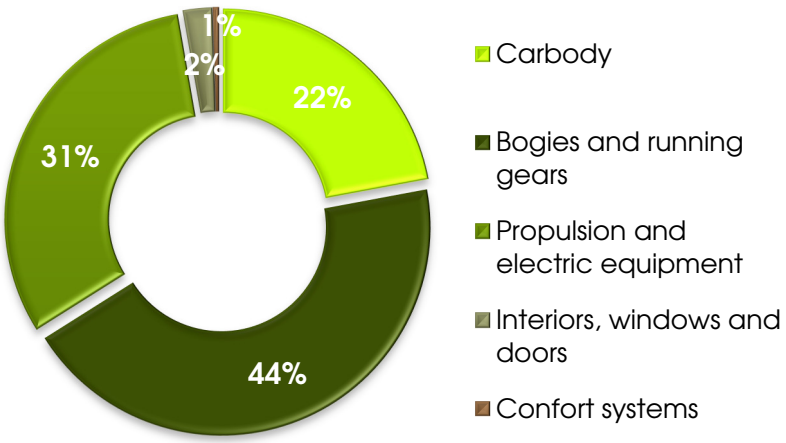
The Prima development took into account the major environmental impacts. The vehicle is of a consistent lightweight design and allows energy recovery from braking, with the energy consumption being reduced substantially. Due to a large number of recyclable materials, the Prima meets the highest environmental requirements.

TECHNICAL DATA

Locomotive characteristics	
Length (m)	19,1
Width (m)	2,86
Mass (t)	88
Maximum axle load (t)	22
Axle configuration	BoBo
Protection against pressure waves	Yes
Electrical characteristics	
Power supply	25kV 50Hz, 15kV $16^{2/3}$Hz, 1,5kV DC, 3kV DC
Traction equipment type	Asynchronous
Type of semi-conductor	IGTB
Semi-conductor cooling	Water-cooled
Number of motors per traction inverter	1
Maximum number of pantographs	4
Type of electrical braking	Rheostat and Regenerative

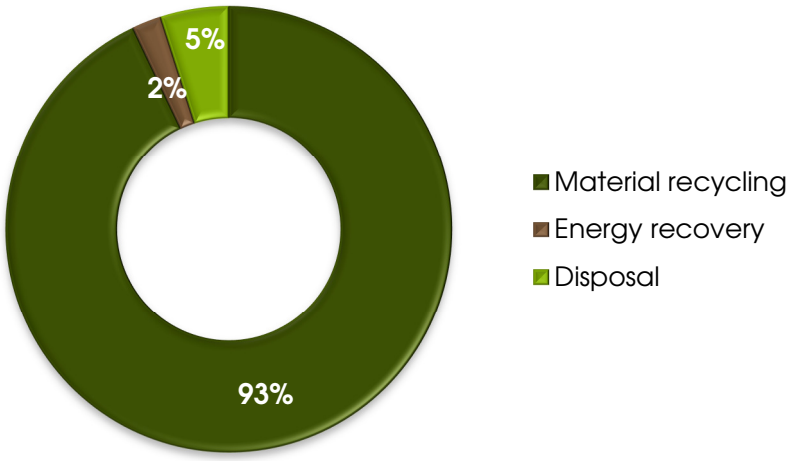
MODULAR STRUCTURE

The PRIMA II is a Freight Service Vehicle. Its modular structure has been determined in compliance with EN 15380-2. Find hereafter the mass ratio for each category:



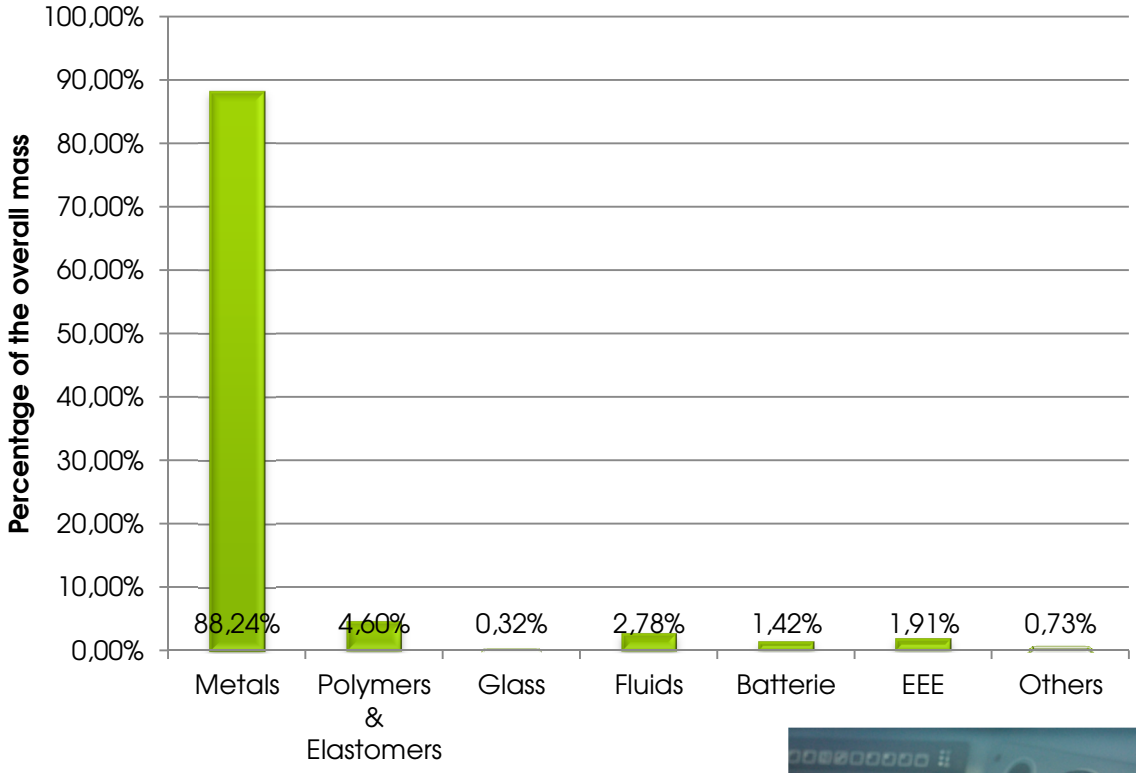
POTENTIAL RECYCLABILITY AND RECOVERABILITY

With the development of the Prima II locomotive, Alstom sets standards for a sustainable product development. A recycling rate of 93% has been calculated according to ISO 22628. The recovery rate amounts to 95 %.



MATERIAL COMPOSITION

The materials used in the Prima II have been selected in consideration of high energy and resource savings. The distribution of materials is detailed below:



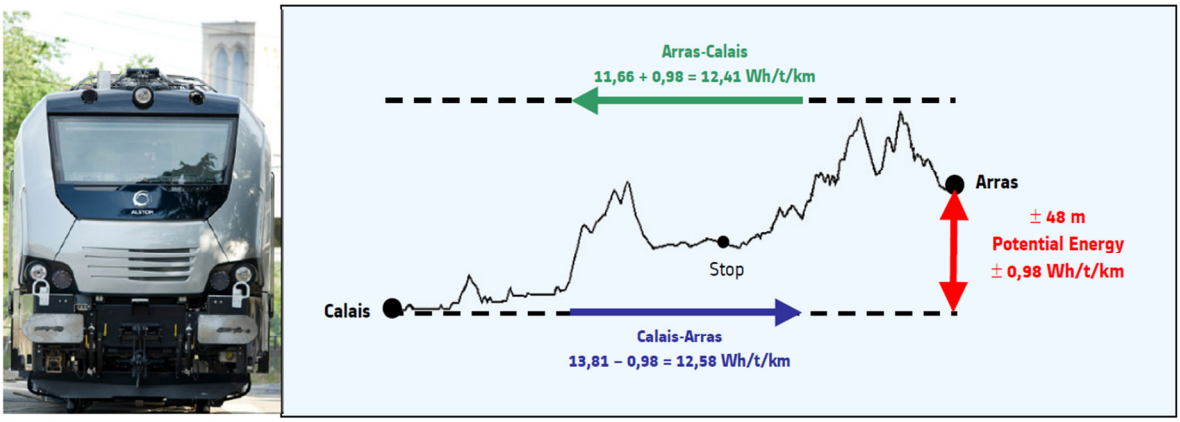
TECHNICAL PERFORMANCE

Electricity consumption

Mission profile

This calculation of energy consumption has been done in France, between Calais and Arras.
It is a 133km line for which the maximum ramp is 12‰ during few kilometers. The assumptions for the simulation reflects the profile lines of major European corridors. The catenary voltage chosen for these simulations is the 25kV - 50 Hz. This is a catenary voltage representative for today most European routes.
The results below are derived from a simulation. Each module of the drivetrain simulated accurately represents the subsystems of the real locomotive.

The profile mission is very important, therefore, the potential energy of 0,98 Wh/t/km due to the difference in elevation between the start and finish (48 meters) will correct the result.



Simulation conditions

Parameters:
- Maximum speed: 80 km / h
- Air temperature: 20 ° C
- Acceleration: 0.03 m / s ²
- Deceleration: 0.01 m / s ²
- Recuperation to catenary: yes
- Auxiliary power: 75 kW

The train consists of a locomotive ALSTOM PRIMA EL2 BoBo hauling wagons of transport combined type. The total mass of the train is 1590 tons. The configuration of the simulated train, due to its weight, represents a classic freight train.

No "smart" driving to reduce the consumption of energy is implemented in these simulations.
A 2 minutes stop will be made on the course Calais-Arras. This stop can be closer to the real conditions of transport of goods.

Results & Conclusion

The average score of 12.5 Wh/t/km, give us an idea of the energy performance of the locomotive PRIMA II. This value is highly dependent on the locomotive's terms of uses, for example
- A driving style more or less flexible
- A high maximum speed, dependent on the travel time
- The option of regenerative braking energy

It can change the results in one way or the other. The 12.5 Wh/t/km value is therefore a representation of the energy consumption for consistent configuration settings.

Noise emissions

The noise emissions of the Prima II have been measured according to Noise TSI 2011/229/EU. The external noise level has been measured at a distance of 7.5 m from the track centre and 1.2 m above the top of the rail and the internal noise at the centre of the cab, and at the train driver's ear height (1,60m).
The table below shows further result:

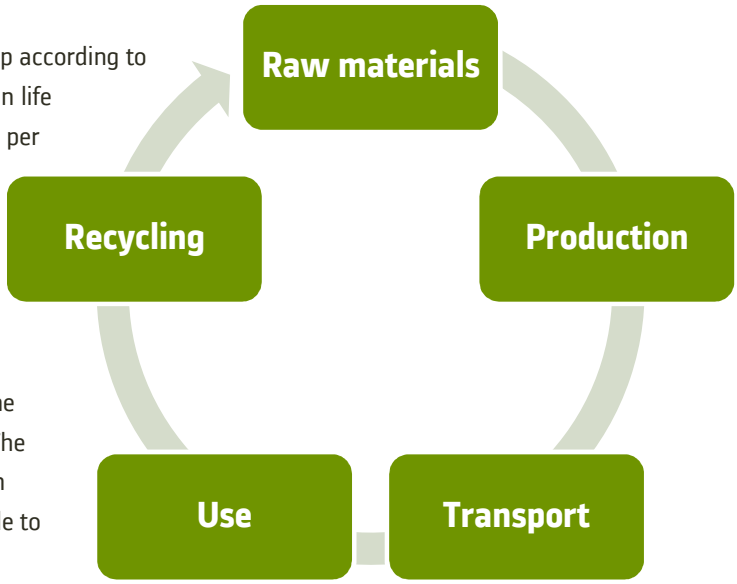
External Noise	***dB(A)***
Stationary sound pressure level	*62*
Acceleration sound pressure level	*84*
Constant speed sound pressure level *(measured at 140km/h and normalized at 80km/h)*	*85*

Internal Noise	***dB(A)***
Constant speed sound pressure level at 140km/h	*74*

Environmental Impacts

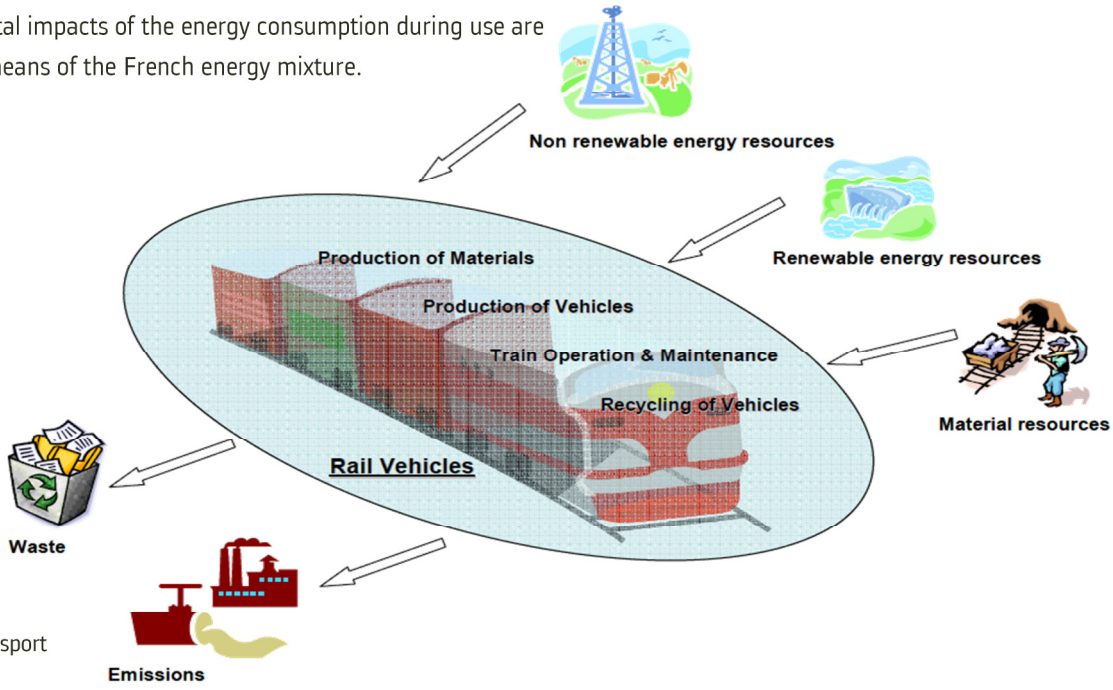
To be able to make a statement on the environmental compatibility of a rail vehicle, so-called Life Cycle Assessments (LCA) have to be drawn up, which analyse the environmental impacts of a rail vehicle during its entire life cycle, i.e. from its production via its use up to its disposal.

The Life Cycle Assessment of the Prima II has been drawn up according to ISO 14040. The analysed life cycle of the Prima II is based on life duration of 30 years, for a locomotive travelling 150000 km per year. The LCA results are thereby divided into 3 phases: Upstream Module, Core Module and Downstream Module.



The Upstream Module includes the extraction and production of raw materials, for example. The Core Module describes, inter alia, the production of the rail vehicle and the corresponding energy consumptions (power, water, gas). The Downstream Module demonstrates the energy consumption during the operation phase (use), the transport of the vehicle to the customer and the disposal of the product (End-of-Life)

The environmental impacts of the energy consumption during use are determined by means of the French energy mixture.



The following LCA results are reported in relation to a functional unit: **transport of 1 tons of for 100 km**.

Use of resources

Non-renewable resources	Upstream	Core	Downstream		Total
			Use	End-of-Life	
Material [kg/ton. 100 km]					
Inert rock	5,96E-05	6,45E-04	3,21E-01	2,38E-06	3,22E-01
Dolomite	1,87E-02	7,90E-12	1,81E-02	1,69E-12	3,68E-02
Natural aggregate	6,31E-07	4,32E-06	4,82E-03	1,38E-08	4,83E-03
Others	2,27E-03	8,39E-05	6,19E-03	1,13E-06	8,54E-03
Energy [MJ/ton. 100 km]					
Uranium	1,11E-02	1,23E-02	1,45E+01	2,34E-04	1,46E+01
Crude oil	1,08E-02	9,06E-04	2,19E-01	1,12E-03	2,32E-01
Hard coal	3,04E-02	1,00E-03	8,76E-01	1,64E-04	9,07E-01
Lignite (brown coal)	2,79E-03	2,98E-04	3,60E-02	6,62E-05	3,91E-02
Natural gas	1,13E-02	1,06E-03	6,99E-01	2,71E-04	7,12E-01
Others	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00

Renewable resources	Upstream	Core	Downstream		Total
			Use	End-of-Life	
Material [kg/ton. 100 km]					
Water	9,07E-02	2,87E-02	2,24E+00	3,11E-04	2,36E+00
Oxygen	1,50E-03	3,86E-03	8,34E-01	4,87E-06	8,40E-01
Carbon dioxide	4,47E-06	3,49E-06	4,99E-03	9,51E-09	5,00E-03
Others	1,45E-05	3,82E-07	5,80E-06	2,77E-08	2,07E-05
Energy [MJ/ton. 100 km]					
Hydropower	1,39E-04	6,43E-04	7,41E-01	1,01E-06	7,42E-01
Biomass	4,68E-04	7,54E-08	2,55E-04	4,62E-07	7,24E-04
Wind power	3,16E-06	4,38E-05	2,07E-02	9,87E-08	2,08E-02
Solar energy	1,48E-06	3,37E-05	4,70E-02	8,73E-08	4,70E-02
Geothermics	4,39E-07	2,14E-06	1,23E-03	2,25E-08	1,23E-03
Others	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00

Waste generation

Waste					
	Upstream	Core	Downstream		Total
			Use	End-of-Life	
Material [kg/ton. 100 km]					
Hazardous	1,21E-04	1,80E-07	1,79E-04	4,44E-07	3,01E-04
Non-hazardous	1,13E-02	6,33E-04	3,32E-01	1,25E-05	3,44E-01
Total	1,14E-02	6,33E-04	3,32E-01	1,29E-05	3,44E-01

Potential environmental impacts

The potential environmental impacts are quantified by so-called impact categories. The individual categories are calculated by means of the substances arising during the entire life cycle.

Environmental impact categories						
		Upstream	Core	Downstream		Total
				Use	End-of-Life	
[kg eq./ ton. 100 km]						
GWP	kg CO2 eq.	4,84E-03	3,87E-04	1,97E-01	2,81E-04	2,03E-01
ODP	kg CFC 11 eq.	6,21E-10	3,53E-10	4,18E-07	1,53E-11	4,19E-07
AP	kg SO2 eq.	2,98E-05	4,32E-07	2,09E-04	4,58E-07	2,40E-04
EP	kg PO4 3- eq.	1,19E-06	2,08E-07	6,41E-05	1,25E-07	6,57E-05
POCP	kg C2H4 eq.	2,30E-06	3,96E-08	2,10E-05	4,03E-08	2,34E-05

Environmental Glossary

Term	Explanation
EPD	An Environmental Product Declaration contains verifiable and comparative statements on the environmental impacts of a product. It is based on a Life Cycle Assessment (LCA).
LCA	A Life Cycle Assessment demonstrates the environmental impacts of a rail vehicle during its entire life cycle.
Impact categories	Impact categories are selected environmental topics, which reflect the consolidated values of emissions or resource consumption and represent the potential environmental impacts.
GWP	The Global Warming Potential describes the impacts of certain gases on the anthropogenic, i.e. man-made greenhouse effect. The relevant greenhouse gases are indicated in CO_2 equivalents, i.e. the emissions are set in relation to CO2 concerning their potential greenhouse effect.
ODP	The Ozone Depletion Potential describes the depletion of the stratospheric ozone layer caused by mankind. If the ozone concentration in the stratosphere is too low, this may cause photosynthesis failures, for example, and humans may suffer from skin cancer and eye diseases, for example.
POCP	The Photochemical Ozone Creation Potential quantifies the photochemical ozone-forming potentials of individual emissions. Excessive photochemical ozone creation leads to a high, particularly toxic ozone concentration near ground level.
AP	The Acidification Potential describes the acid deposition in plants, soils and surface waters caused by the conversion of air pollutants in acid.
EP	Eutrophication Potential is defined as the potential of nutrients to cause over-fertilisation of water and soil which in turn can result in increased growth of biomass
Recycling rate	The recycling rate describes the ratio of the quantity of material that can be reused, recycled or both to the whole mass of the vehicle.
Recovery rate	The recovery rate is composed of the material mass that can be recycled, reused or energetically recovered.