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ENVIRONMENTAL PRODUCT DECLARATION

In accordance with ISO 14025:2006 for

Ebusco 3.0 12-meter

From:

Ebusco B.V.

Programme:	The International EPD® System, www.environdec.com
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EPD®
THE INTERNATIONAL EPD® SYSTEM

PROGRAMME INFORMATION

Programme

The International EPD® System

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Accountabilities for PCR, LCA and independent, third-party verification

Product Category Rules (PCR)

PCR2016:04 – UN CPC 49112, Public buses and coaches. V2.0.2.

PCR review was conducted by: n/a.

Life Cycle Assessment (LCA)
LCA accountability:
TNO
Web: www.tno.nl
Post: Anna van Buerenplein 1 2595 DA The Hague, Netherlands

Third-party verification
Independent third-party verification of the declaration and data, according to ISO 14025:2006, via:

☒ EPD verification by individual verifier.

Third-party verification: Leo Breedveld, 2B.

Approved by: The International EPD® System, Technical Committee, supported by the Secretariat.

Procedure for follow-up of data during EPD validity involves third-party verifier:

☒ Yes ☐ No

The EPD owner has the sole ownership, liability and responsibility of the EPD. EPD's within the same product category but from different programmes may not be comparable.

COMPANY INFORMATION

Owner of the EPD

Ebusco B.V.
Vuurijzer 23
5753 SV, Deurne
Netherlands

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Description of the organisation

Ebusco is dedicated to the development, production and distribution of fully electric city and regional buses and the associated ecosystem. Our goal is to contribute to a better and healthier living environment by making sustainable, emission-free transport of people the standard. Ebusco is originally a Dutch company, with its head office in Deurne. Together we work on creating clean cities.

Product-related or management system-related certifications

ISO 9001 and 14001 certificates, with intentions to supplement these with ISO 45001 in May 2024.

Name and location of production site

Deurne, Netherlands and Rouen, France.

PRODUCT INFORMATION

Product name

Ebusco 3.0 (12M).

Product identification

With a changing playing field, and the worldwide shift towards EV, Ebusco saw the need to revolutionize the industry standard. With a multifunctional team of key experts in the field of aerospace, automotive, and electronics, a completely new approach was taken in the development of electric buses, focusing on lightweight. The result of this approach: A lightweight bus with the lowest TCO in the market. By using composite materials in the main structure, Ebusco has developed a lightweight bus that has an effect on multiple aspects. Not only does the Ebusco 3.0 have the most efficient energy consumption, in addition, the bus is equipped with single tires and features insulated walls for optimal climate control. A design focused on drivers, passengers and all involved with the operation of the bus.

- Composite body of the bus; substantially lighter
- Expected service life time of 10 years
- Revolutionary design with a fully flat floor
- Floor-mounted batteries free up roof space for customisations like solar panels
- Reduced Total Cost of Ownership
- Innovative Camera System
- Range up to 700 km
- Passenger experience; spacious, luxurious, much daylight, comfortable, almost no noise and an increased freedom of movement
- Only overnight charging needed
- Much lower maintenance costs due to composite body

Product description

The analysed vehicle is the Ebusco 3.0 bus – a 12 m regional and city bus with 2 doors and a maximum capacity for a total of 110 passengers. The electricity consumption during use phase of the vehicle is 0.65 per kilometer, based on research as conducted by TüV.

UN CPC code

<49112>

Other codes for product classification

< N/A >

Geographical scope

The bus is manufactured in the Netherlands and operates throughout Europe. Consequently, the performance calculations for the use phase are based on the residual electricity mix in Europe. (For further details, see chapter 2.6.2 of the LCA report).

Table Technical description of the 3.0 12m bus

Group	Concept	Value
General	Denomination	Ebusco 3.0 12-meter
	Length	12 000 mm
	Width	2 550 mm
	Height	3 190 mm
	Floor to ceiling	2 350 mm
	Entry height	340 mm
	Capacity	110
	Driver cabin position	Front
	Door configuration	2/3 doors
	Calculated empty weight in running order without driver	9 950 kg
	Permissible gross vehicle weight	19 665 kg
Electric motor	Denomination	ZF AVE 130 High-speed asynchronous motor
	Maximum power	2x 125 kW
	Maximum torque	22 000 Nm
	Engine position	Integrated into the axle wheel hub
Axles	Axles	2
	Wheels	4
	Front axle load (max)	8 165 kg
	Middle axle load (max)	-
	Rear axle load (max)	11 500 kg
	Distance between axles	5 900 mm
	Front overhang	2 805 mm
	Rear overhang	3 285 mm
Steering control	Denomination	IGP Steering pump from Concentric
	Maximum wheel lock	56° / 46°
	Turning circle/minimum turning circle	21 400 mm
Electrical system/ Energy Storage System/ Battery	Denomination	Gotion
	Technology	LFP
Brake system	Denomination	Knorr Bremse Air Operated Disc Brake SN 7 / SB 7
Suspension	Denomination	ZF RL 82 EC / AVE 130
	Type	Air suspension
Air conditioning	Denomination	Thermo King (ATHENIA MKII)
Sound level	Moving vehicle	72.6 dB(A)
	Compressed air, service brake	66 dB(A)
	Compressed air, parking brake	59 dB(A)
	Compressed air, during the pressure regulator actuation	56 dB(A)

LCA INFORMATION

Functional unit / declared unit

The functional unit in the LCA study was 'transport of one passenger along 1 km in the Ebusco 3.0 12m bus'. According to the PCR guidelines, a travelled distance of 800,000 km may be assumed as stated in Directive 2009/33/EC.

Table 1 Functional unit of Ebusco 12m 3.0 bus.

Passenger capacity	km/year	Service life (year)	Passenger*km
110	80.000	10	88.000.000

Expected service life time

10 years.

Time representativeness

The inventory data was collected for the year 2022 and will be representative for the time period for which the EPD is valid (maximum five years).

Database(s) and LCA software used

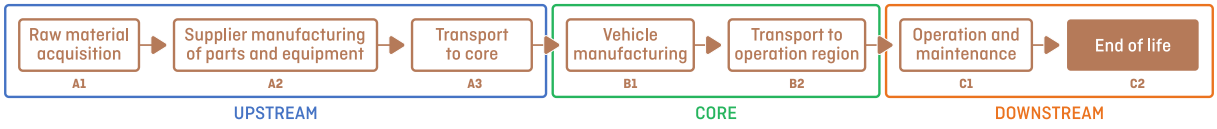
The following databases were used and are in line with the PCR's requirements: Ecoinvent 3.7 database and electricity mixes from AIB 2023 reports (for further details see chapter 2.7 of the LCA report). The LCA model has been made using the Simapro 9.2.0.1 software. (For further details see chapter 2.8.3 of the LCA report).

The characterization factors used for environmental impact calculations, have been derived from the EDIP 2003 V1.07, EN 15804 +A2 Method V1.0, from the LOTOS-EUROS methodology as applied in the ReCiPe LCIA 2008 method and from the AWARE method on water deprivation (WULCA recommendations on characterization model for water deprivation 2015, 2017). These factors are in line with the recommended databases used in the PCR (Env. Perf. Indicators | EPD International, n.d.).

System diagram

LCA stages are: Upstream, Core, Downstream. (For further details on how the lifecycle stages are divided, see figure 2.3 of the LCA report) LCA stages are: Upstream, Core, Downstream.

Figure 1 System diagram illustrating the life cycle of buses and coaches covered by the PCR referred in the text.



Description of system boundaries

A ***cradle-to-grave*** approach was used for the LCA study. (For further details, see chapter 2.5 of the LCA report).

Excluded lifecycle stages

Manufacturing of production equipment, buildings and other capital goods, business travel of personnel, travel to and from work by personnel are all excluded. The lifecycle ends at the scrapyard.

Figure 2: Recyclability rate of 3.0 12m bus.

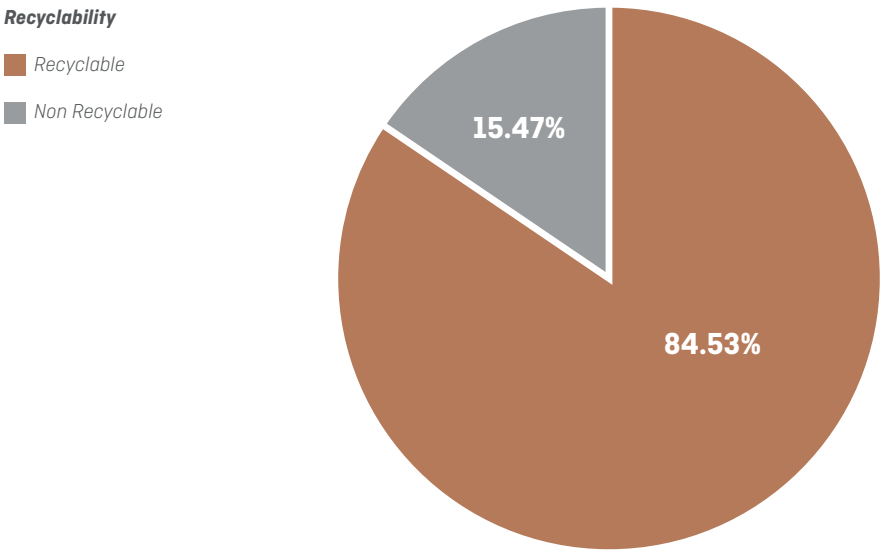
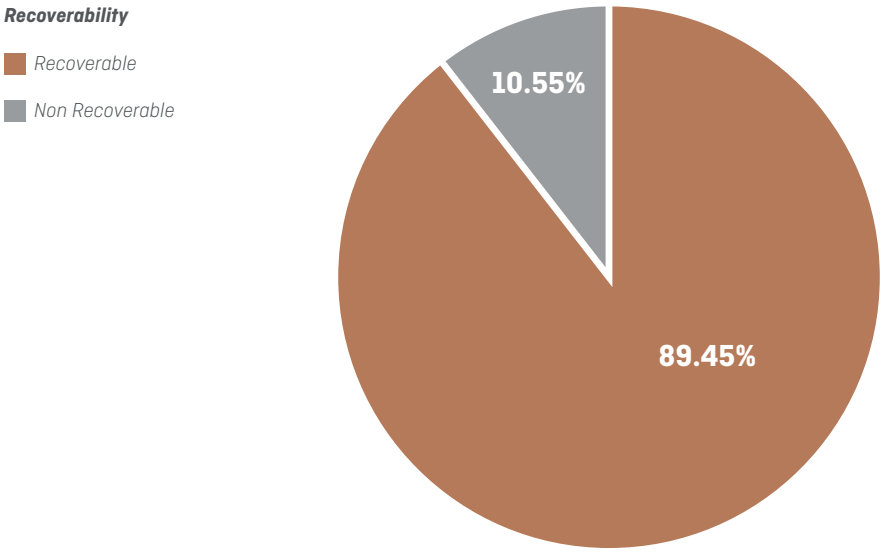


Figure 3: Recoverability rate of 3.0 12m bus.



More information

For further information and/or explanatory material, see: Chapter 1, Introduction of the LCA report. For information about the EPD, click here.

CONTENT DECLARATION

Table 2.1 shows that the percentage of materials included of materials included in the LCA is 99.29% of the total theoretical weight of the product. The remaining portion has not been considered in the study because the material was unknown.

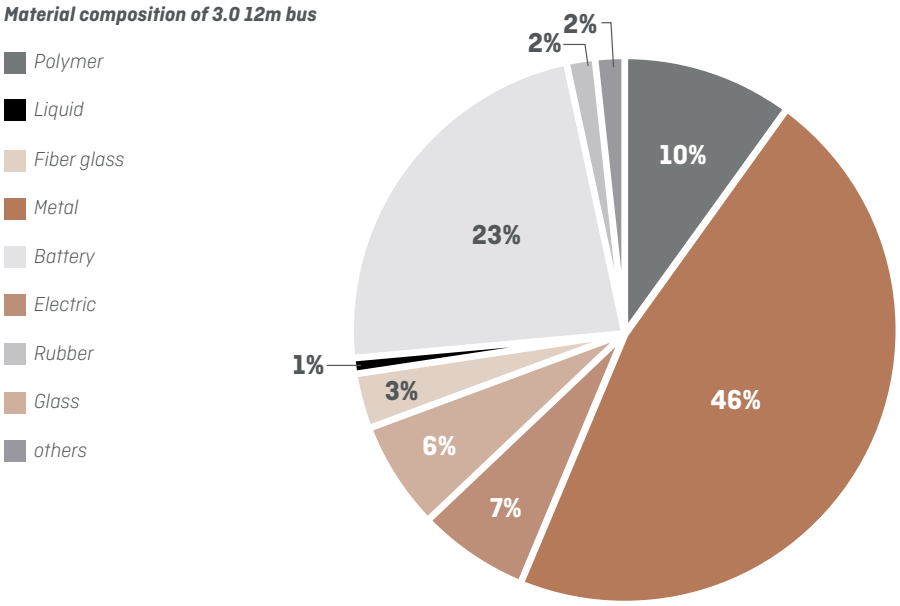
Table 2.1 analysed weight (based on the BOM – Bill of Materials) of the bus for LCA.

Group	Analused weight (kg)	Theoretical weight (kg)
Body	3,623.32	
Front axle	941.54	
Driven axle	1,649.84	
Steering	204.74	
Door systems	211.00	
Exterior lights	11.74	
Exterior glass	580.68	
Brake system	36.18	
Drive cooling	52.82	
Energy storage	2,795.90	11,523.00
Driver's workplace	71.40	
Climate control	183.12	
Compressed air system	187.76	
Windscreen wipers	105.00	
Exterior information	0.58	
Interior information	1.10	
Harnesses	743.93	
Electrical components	27.19	
Total	11,427.84	% analysed -> 99.2%

Table 2.2 Content declaration per material group.

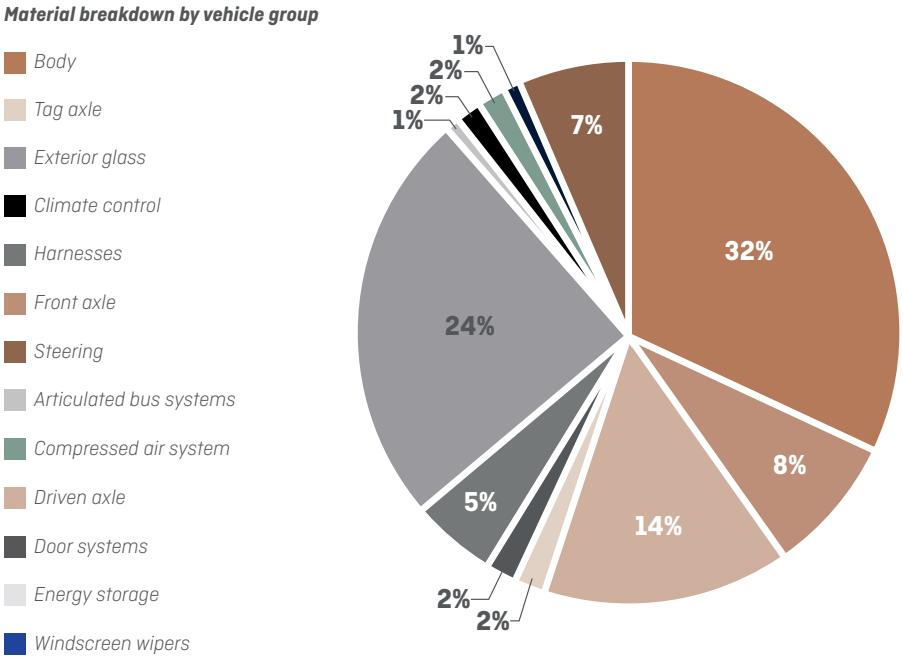
Material	Weight in kg	Weight in %
Polymer	1,143.96	10%
Metal	5,268.22	46%
Electric	744.13	7%
Fabric	34.00	0%
Glass	730.07	6%
Fiber Glass	382.00	3%
Liquid	57.50	1%
Battery	2,681.00	23%
Rubber	186.96	2%
others	200.00	2%

Figure 4.1: Material composition of the 3.0 12m bus.



The material composition of the whole bus and the material breakdown of the bus by vehicle group are shown in Figure 4.1 and Figure 4.2, respectively. The unknown fraction (1%) is reported in the category "Others.

Figure 4.2: Part breakdown in weight % of the bus (details on materials can be found in chapter 2). *Vehicle group is a compartment of a bus.*



Detailed information about the SVHC (Substances of Very High Concern) in Ebusco buses is listed in the REACH declaration, which is available upon request.

Functional unit / declared unit

Table 3.1 shows the environmental performance indicators for different categories per functional unit (pkm). It is estimated that 74% of the carbon footprint originates from the downstream process (use phase and maintenance, up to the end of life of the bus).

Table 3.1 Indicators of impact assessment per functional unit (pkm).

	Parameter	Unit	Upstream	Core	Downstream	Total
Global warming potential (GWP)	**Fossil**	kg CO2 eq.	1.03E-03	1.41E-04	3.23E-03	4.41E-03
	Biogenic	kg CO2 eq.	6.86E-06	1.69E-05	1.05E-04	1.29E-04
	Land use and land transformation	kg CO2 eq.	3.16E-06	2.41E-07	4.01E-06	7.42E-06
	TOTAL	kg CO2 eq.	1.04E-03	1.58E-04	3.34E-03	4.54E-03
	Ozone depletion potential (ODP)	kg CFC 11 eq.	2.22E-10	7.28E-12	1.08E-10	3.38E-10
	Acidification potential (AP)	kg SO2 eq.	7.58E-06	5.70E-07	1.84E-05	2.66E-05
	Eutrophication potential (EP)	kg PO43- eq.	3.49E-06	3.52E-07	6.08E-06	9.96E-06
	Photochemical ozone creation potential (POCP)	kg NMVOC eq.	4.33E-06	3.30E-07	9.21E-06	1.39E-05
	Abiotic depletion potential (ADP) for minerals and metals (non-fossil resources)	kg Sb eq.	1.38E-07	2.58E-09	2.66E-08	1.74E-07
	Abiotic depletion potential (ADP) for fossil resources	MJ. net calorific value	1.33E-02	1.59E-03	4.08E-02	5.59E-02
	Water deprivation potential (WDP)	m3 eq.	4.40E-04	2.92E-05	1.02E-03	1.48E-03
	Eutrophication, freshwater	kg P eq.	9.39E-07	1.00E-07	1.32E-06	2.36E-06
	Eutrophication, marine	kg N eq.	1.42E-06	1.22E-07	4.13E-06	5.67E-06
	Eutrophication, terrestrial	mol N eq.	1.50E-05	1.15E-06	3.47E-05	5.08E-05

Table 3.2 Indicators describing the use of resources per functional unit (pkm).

Parameter		Unit	Upstream	Core	Downstream	Total
Primary energy resources Renewable	**Use as energy carrier**	MJ, net calorific value	1.49E-03	4.01E-04	4.37E-03	6.26E-03
	Used as raw materials	MJ, net calorific value	5.87E-06	0	6.55E-07	6.53E-06
	TOTAL	MJ, net calorific value	1.50E-03	4.01E-04	4.37E-03	6.27E-03
Primary energy resources Non-renewable	**Use as energy carrier**	MJ, net calorific value	1.43E-02	2.45E-03	6.80E-02	8.48E-02
	Used as raw materials	MJ, net calorific value	2.01E-04	0	5.75E-04	7.76E-04
	TOTAL	MJ, net calorific value	1.45E-02	2.45E-03	6.86E-02	8.56E-02
	Secondary material	kg	2.91E-05	0.00E+00	0.00E+00	2.91E-05
	Renewable secondary fuels[A]	MJ, net calorific value	0	0	0	0
	Non-renewable secondary fu els[A]	MJ, net calorific value	0	0	0	0
	Net use of freshwater	m3	1.33E-05	1.77E-06	4.10E-05	5.60E-05

Table 3.3 Waste categories indicators per functional unit (pkm).

Parameter	Unit	Upstream	Core	Downstream	Total
Hazardous waste disposed	kg	1.73E-07	4.83E-09	6.25E-08	2.40E-07
Non-hazardous waste disposed	kg	4.47E-04	1.17E-05	2.06E-04	6.65E-04
Radioactive waste disposed	kg	4.08E-08	1.36E-08	3.87E-07	4.41E-07

Table 3.4 Output flows per functional unit (pkm).

Parameter	Unit	Upstream	Core	Downstream	Total
Components for reuse	kg	0.00E+00	0.00E+00	8.36E-05	8.36E-05
Material for recycling	kg	9.66E-05	4.02E+02	2.61E-05	8.13E-05
Material for energy recovery	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, thermal	MJ	0	0	0	0

The result tables shall only contain values or the letters "INA" (Indicator Not Assessed). It is not possible to specify INA for mandatory indicators. INA shall only be used for voluntary parameters that are not quantified because no data is available.

RESULTS INTERPRETATION

The lifecycle assessment reveals that a significant portion (74%), see table 4, of the bus's carbon footprint is attributed to its downstream processes, including its use phase, ongoing maintenance, and eventual end-of-life scenarios. The total life cycle carbon emission stands at 399,916 kg CO2 eq., a figure primarily driven by the use phase across various impact categories, with notable exceptions in water deprivation and abiotic depletion for minerals and metals (non-fossil resources), where battery production and mineral extraction are predominant contributors (Figure 5).

A sensitivity analysis focusing on the carbon fiber production used in the bus construction indicates a minimal impact on the overall environmental performance, underscoring the efficiency of the material choices in this context. It is important to note that these results are specific to the Ebusco 3.0 model, reflecting its unique material composition, size, and design specifications. The findings offer vital insights for further improving environmental sustainability in electric bus design and operation, particularly highlighting the significant impact of the use phase and pointing towards potential areas for optimization.

This EPD serves as a valuable tool for understanding the environmental implications of the Ebusco 3.0 electric bus, providing a foundation for future developments in sustainable public transportation solutions.

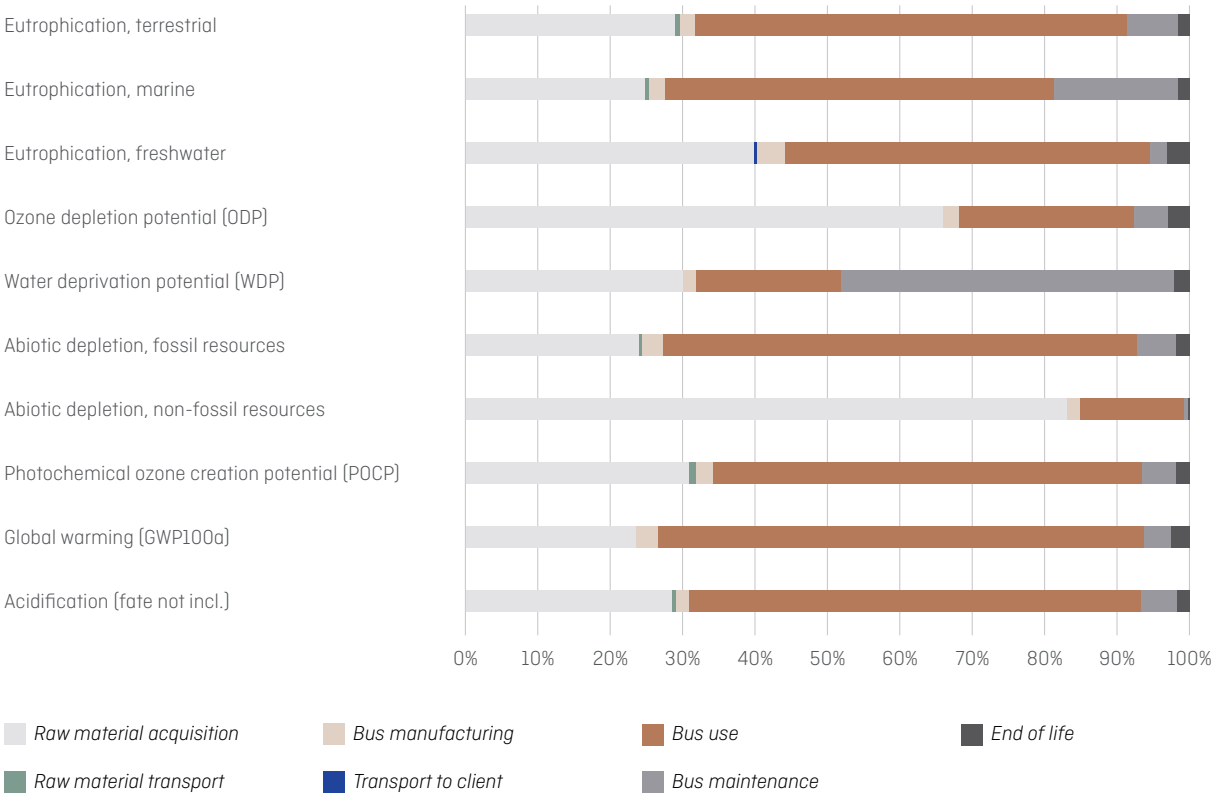
Table 4 Environmental impacts by life cycle stages.

LIFE CYCLE STAGE	GWP*	POCP	AP	ADP-NFR	ADP-FR	WDP	EP, freshwater	EP, marine	EP, terrestrial
Raw Material acquisition	23%	31%	28%	83%	24%	30%	39.8%	24.6%	28.9%
Raw material transport	0%	1%	0%	0%	0%	0%	0.0%	0.5%	0.6%
Bus manufacturing	3%	2%	2%	1%	3%	2%	4.2%	2.1%	2.2%
Transport to client	0%	0%	0%	0%	0%	0%	0.1%	0.1%	0.1%
Bus use	68%	60%	62%	14%	66%	20%	50.6%	53.7%	59.7%
Bus maintenance	4%	5%	5%	1%	5%	46%	2.3%	17.2%	6.8%
End of life	3%	2%	2%	0%	2%	3%	3.1%	1.8%	1.8%

**Global warming potential (100y) | Photochemical ozone creation potential (POCP) | Acidification potential | Eutrophication potential | Abiotic depletion potential (non-fossil resources) | Abiotic depletion potential (fossil resources) | Water deprivation potential.*

Figure 5 Eco profile of 12m bus.

12m bus - 1 p*km transported



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