Environmental Product Declaration

In accordance with ISO 14025:2006 for:

[*B15E01 eBus*]

from

[*BYD Auto Industry Co., Ltd.*]

Programme:	The International EPD® System, www.environdec.com
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Programme information

Programme:	The International EPD® System EPD International AB Box 210 60 SE-100 31 Stockholm Sweden www.environdec.com info@environdec.com

Accountabilities for PCR, LCA and independent, third-party verification
Product Category Rules (PCR)
PCR2016:04 – UN CPC 49112 & 49113, Public and private buses and coaches. VERSION 2.0.2
PCR review was conducted by: *The Technical Committee of the International EPD® System. A full list of members available on www.environdec.com/TC. The PCR review panel may be contacted via info@environdec.com. Review chair: Maurizio Feschi.*
Life Cycle Assessment (LCA)
LCA study conducted by BYD Auto Industry Co., Ltd. LCA of the vehicle is carried out by modelling in GaBi software.
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 verifier: <*Susanne Jorre, TÜV Rheinland Energy GmbH*> Approved by: The International EPD® System
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 for the EPD. EPDs within the same product category but from different programmes may not be comparable.

Company information

Owner of the EPD:

BYD Auto Industry Co., Ltd.
No. 3001, 3007, Hengping Road, Pingshan District, Shenzhen City, Guangdong Province 518118, P. R. China
00-86-0755-89888888

Description of the organisation:

BYD is a high-tech company devoted to technological innovations for a better life. BYD was founded in February 1995, and after more than 20 years of fast growth, the company has played a significant role in industries related to electronics, automobiles, new energy and rail transit. From energy generation and storage to its applications, BYD is dedicated to providing zero-emission energy solutions. Since its 1st all-electric concept car the ET unveiled in 2004, BYD has become one of the 1st NEV OEMs globally to produce one million electric passenger vehicles.

Product-related or management system-related certifications:

ISO 9001 – Quality management systems
ISO 14001 – Environmental management systems

Name and location of production site:

BYD Auto Industry Company Limited Changsha Branch
No.88, 2 Segment, South Wanjiali Road, Yuhua District, Changsha City, Hu'nan Province 410116, P. R. China

BYD Auto Industry Company Limited Hangzhou Branch
No. 99, Qi'hang Road, Renhe Street, Yuhang District, Hangzhou City, Zhejiang Province 311107, P. R. China

Product information

Product name: B15E01 eBus

Product identification:

WVTA Certificate No. – e9*2018/ 858*11109

Product description:

BYD B15E01 is a new 15m pure electric city vehicle developed by BYD Auto Industry Co., Ltd., and it offers a ride which is safe, comfortable and intelligent (see Table 1).

Safety
The vehicle is designed with a dual-line system, electric leakage alert system, and 360° electric shock protector for connectors. The vehicle is equipped with automatic fire extinguishers for the rear compartment and the power battery, interior and exterior emergency exit valves, emergency stop switch, front and rear anti-collision beams, window breakers, etc. The vehicle features steering time delay function. In case of vehicle abnormality and sudden disconnection of high voltage system, this function allows the driver to park the vehicle in a safe roadside area. The vehicle is equipped with an electronic stability control system (ESC) which is used to prevent the vehicle from getting out of control in extreme state, improving the safety and maneuverability of the vehicle.

Technical highlights
The vehicle is designed with the wheel-hub drive technology and equipped with a Fe battery system which incorporates high energy density and high power density as well as high safety, all of which are independently developed by BYD. Regenerative braking: Once braking has been initiated, a generator

regenerates and transforms kinetic energy into electrical energy, which is stored in the power battery to increase the driving range and enhance the driving safety by reducing wear in the brake disc and therefore avoiding thermally-induced failure. The application of front double-plug DC charging mode on the right side brings faster and more convenient charging. CAN bus communication system controls the vehicle and achieves intelligent management and maintenance of the vehicle.

Comfort

The independent front axle provides passengers with more comfortable experience. The air suspension system allows the vehicle height adjustment and kneeling. The rear view camera and in-vehicle monitoring system make the driver's job easier.

UN CPC code: 49112

Geographical scope:
Production: China (see Company information)
Assumed market: Europe
EOL: Europe

Table 1 Technical description of the vehicle

Group	Concept	Value
Layout	Denomination	B15E01 eBus
	Length	14 775 mm
	Width	2 550 mm
	Height	3 270 mm
	Capacity	90 Passengers, 47 seats and 43 standing
	Driver cabin position	Front
Electric Motor	Denomination	Permanent magnet synchronous motor
	Nominal power	110 kW
	Maximum torque	550 Nm
	Engine position	Middle Axle
Axles	Axles	3
	Wheels	8
	Front axle load [max]	7 300 kg
	Middle axle load [max]	7 300 kg
	Rear axle load [max]	12 600 kg
	Distance between axles	7 100 mm + 1 500 mm
	Front overhang	2 725 mm
	Rear overhang	3 450 mm
Steering control	Denomination	EHPS
	Maximum front axle turning angle, inside/outside wheel	56° / 46°
	Minimum turning cycle	25 m

Energy Storage System	Denomination	REESS
	Technology	Lithium iron phosphate (LiFePo4)
Brake system	Denomination	EBS
Suspension	Denomination	ECAS
Security	Systems	ABS/ ESC/ ASR/ TPMS
Air conditioner	Denomination	REVO-E Global (heat pump + PTC)
Sound level	Moving vehicle	77 dB
	Stationary vehicle	/
	Compressed air, service brake	70.3 dB
	Compressed air, parking brake	70.4 dB
	Compressed air, during the pressure regulator actuation	67.3 dB

LCA information

Functional unit:

The functional unit is the "transport of 1 passenger for 1 kilometre" (see Table 2).

The vehicle capacity is calculated according to available seats and space for standing at 100% load factor (90 passengers: 47 seats and 43 standing). The lifetime of the bus is assumed with a travelled distance of 1 200 000 km as stated by eBus.

Table 2 Functional Unit

Passenger Capacity	Expected/ Design service lifetime (year)	Lifetime distance (km)	Passenger * km (pkm)
90	12	1 200 000	108 000 000

Time representativeness:

The inventory period of the target products is from Jan. 1, 2022 to Jun. 30, 2022. During the production period of the covered products, the collection of relevant materials is the scope of investigation. All secondary data come either from Sphera's GaBi 10.6.2.9 databases.

Database(s) and LCA software used:

To carry out the life cycle impact assessment of the B15E01 eBus, an LCA model using Sphera's GaBi software and the therein available databases was created. The life cycle impact indicators are calculated based on the Version 2.0 of the default list of indicators defined by EPD International which is valid from 29/03/2022.

Description of system boundaries:

This EPD considers the impacts of 1 pkm using a cradle-to-grave perspective. This means, that it considers impacts associated with the extraction of resources from nature (through mining) through to the point at which the vehicle reaches its end of life (see Figure 1).

The benefit, the load from waste treatment for recycling purposes such as de-pollution and crushing, etc., is allocated in the next life cycle of substituted products, but not the primary producers, hence no burden or benefit will be allocated to the primary producer of the bus (cut-off approach). Therefore, the reuse, recovery and/ or recycling potentials are reported separately in module D.

Lifecycle stages:

The LCA calculations procedure is separated into three different life cycle stages following the Product Category Rule:

- Upstream processes: represent the input to the core processes (i.e. raw material acquisition and refinement, and production of intermediate components).
- Core processes: include processes managed by the organisation owning the EPD, in this case eBus.
- Downstream processes: cover the use stage of the vehicle and end of life scenarios and treatments.

For the processes within the system boundary, all available energy and material flow data have been included in the model.

Following the PCR, no credit is given for produced energy and recyclable materials within the system boundaries.

Data quality:

Data collection is performed according to the guidelines provided in ISO 14044:2006, 4.3.2.

The raw and basic materials like aluminium, stainless steel, polyethylene, etc. is coming from secondary data. The energy and water consumption and emission from the process of production are collected from primary data.

For production of components and auxiliary materials for vehicle assembly/ manufacturing, the data referring to processes and activities upstream in a supply chain under BYD's direct management control has been collected on site.

Cut-off rules:

Environmental impacts relating to personnel, infrastructure, and production equipment not directly consumed in the process are excluded from the system boundary. All other reported data were incorporated and modelled using the best available life cycle inventory data.

The following procedure was followed for the exclusion of inputs and outputs:
1) All inputs and outputs to a (unit) process will be included in the calculation for which data is available. Data gaps may be filled by conservative assumptions with average or generic data. Any assumptions for such choices will be documented;
2) In case of insufficient input data or data gaps for a unit process, the cut-off criteria chosen is less than 1% of the mass of common auxiliary compare to total mass of product; less than 0.1% of the mass of auxiliary containing rare or high purity components; the total ignored does not exceed 5%.

Allocation

Allocation refers to the partitioning of input or output flows of a process or a product system between the product systems under study and one or more other product systems. In this study, the mass criterion is used. The following two types of allocation procedures considered:

Co-product allocation
In the production of the bus, the consumption of energy and water during manufacturing is equally allocated on each product, as the production line is designated for the specific type. No other by-products are produced from the same production line, hence there is no need to allocate the energy or water consumption with other products.

Reuse, recycling, and recovery allocation
For the allocation of reuse, recycling and recovery, the polluter pays principle (PPP) is followed in this report. This means that the waste transportation to the treatment site and the waste processing (mainly shredding) is considered in this report, while the benefit, the load from waste treatment for recycling purposes such as de-pollution and crushing, etc., is allocated to the next life cycle of substituted products, but not the primary producers, hence no burden or benefit will be

allocated to the primary producer of the bus (cut-off approach).

Detail information:

The production/ manufacture process can be divided into welding, coating, chassis and assembly.

The technological coverage reflects the physical reality for the declared products.

Used datasets are complete according to the system boundary within the limits set by the criteria for the exclusion of inputs and outputs.

The eBus collected the required data for the material composition of the B15E01 in 2022. To account for raw material acquisitions and external manufacturing of parts, the GaBi Software and databases developed by Sphera were used.

The eBus has determined the transport distances from the suppliers to core to a large extend. The transports of 100% of the bus weight were considered for the transport to core.

The manufacturing includes all eBus's manufacturing and assembly sites. Material, emission, and energy consumption data were gathered from Jan. 1, 2022 to Jun. 30, 2022. For the transport to operating region, the distance was calculated according to output allocation.

The modelling of the use phase was based on the power consumption data from the E-SORT Test Report. According to the energy consumption calculation under various kind of operating conditions, the average level of consumption is taken into account. For air condition and heating use, the weather situation has been analysed. The calculation of assumed scenario is shown in Table 3.

The electricity grid mix used for use phase is 'DK: Electricity grid mix Sphera, 2022'. Because the assumed market area is in Europe.

For maintenance all spare parts required over the life cycle, were included into the analysis. The recycling of the vehicle follows the requirements of the ISO 22628:2002, in order to calculate the vehicles' recyclability and recoverability (see Figure 2 and 3).

Environmental impacts relating to personnel, infrastructure, and production equipment not directly consumed in the process are excluded from the system boundary. All other reported data were incorporated and modelled using the best available life cycle inventory data.

For missing secondary data, substitution of missing data is using similar secondary data approach was taken to shorten the gap.

Disclaimer: The EPD includes module C, and this study discourages the use of the results of modules A1-A3 without considering the results of the module C.

Table 3 Energy use calculation in Downstream

Electricity use	**Amount**	**Unit**
Average electricity consumption/ km [SORT Report]	1.3	kWh/ km
Total energy consumption in life time	1560000	kWh
Biodiesel use	**Amount**	**Unit**
Fuel consumption/ h [Thermo S300]	3	kg/h
Lifetime service time	2265	h
Total fuel consumption in life time	81540	kg
Remark: The Biodiesel heating system usage scenario and time is automatically turned on below 0°C, and the use time range is from November to March (average daily operating time is 15 h), the total days is 151.		

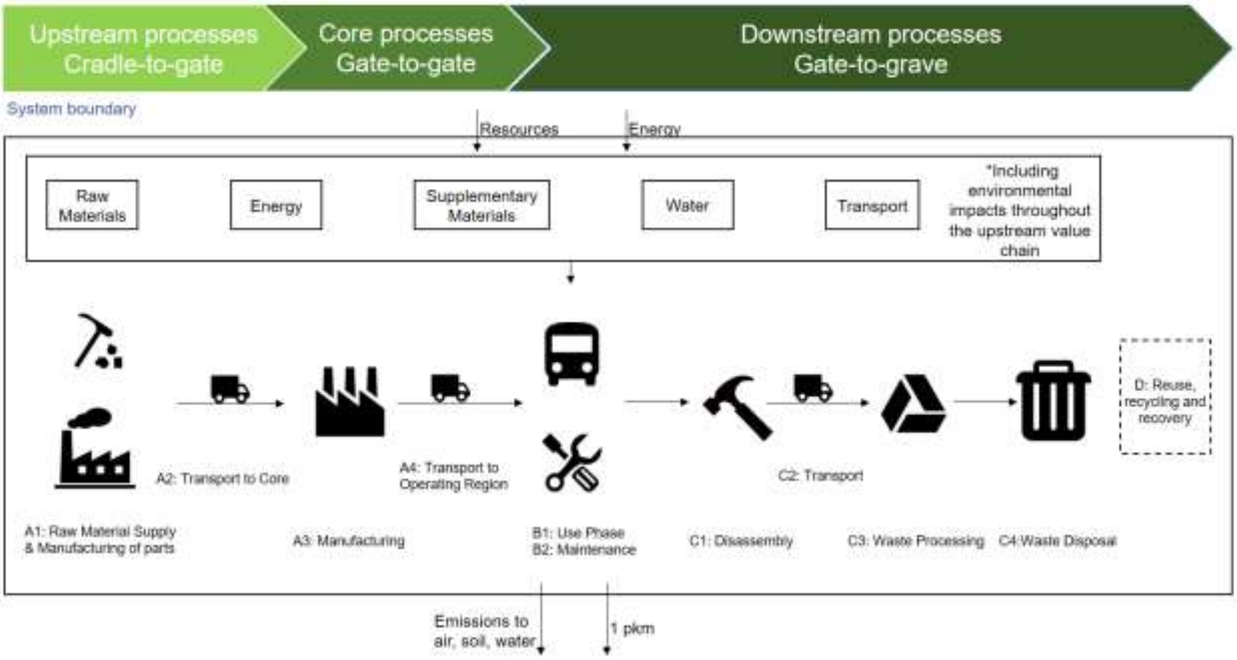

Figure 1 System boundary

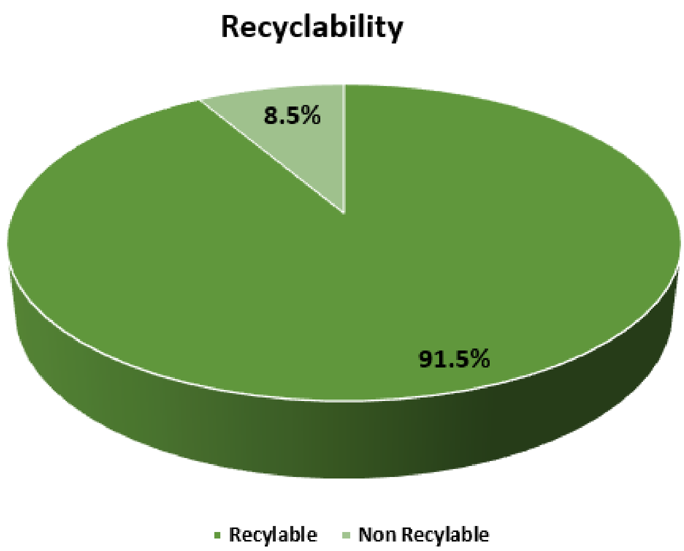

Figure 2 Recyclability rates of the vehicle

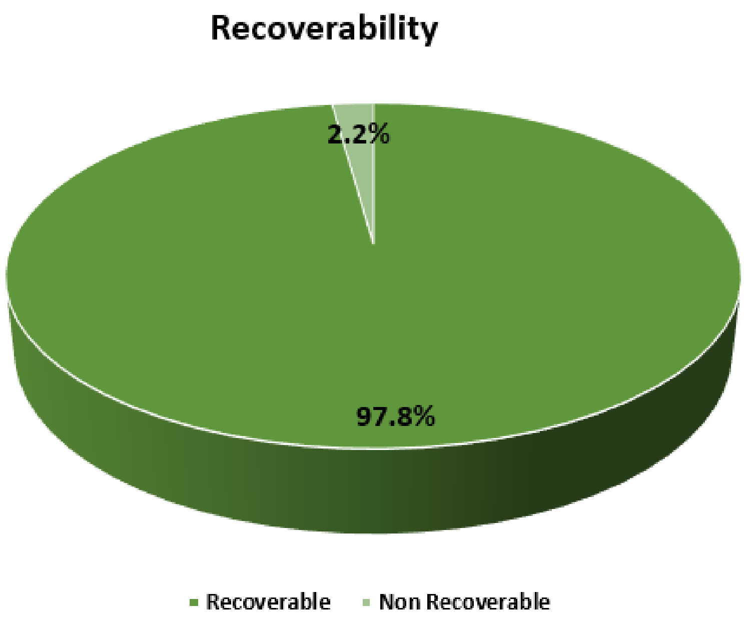

Figure 3 Recoverability rates of the vehicle

Content declaration

Product

The percentage of materials included in the LCA is 99.57% of the total theoretical weight of the product (see Table 4). The remaining portion has not been considered in the study because the material was unknown.

Figure 4 and Figure 5 depict the material composition of the whole vehicle and material breakdown of the vehicle by vehicle group, respectively.

Table 4 Analysed weight (based on the BOM-bill of materials) vs. theoretical

Vehicle Group	Analysed weight (kg)	Theoretical weight (kg)
Frame (incl.plating)	4754.17	17800
Powertrain	3216.98	
Seats	803.29	
Exterior components	1984.48	
Interior components	1923.85	
Electrical harnesses and systems	1559.86	
Heating system	809.17	
Doors and Windows	1893.87	
Vehicle wheels	777.74	
Total weight	17723.40	% analysed - 99.57%

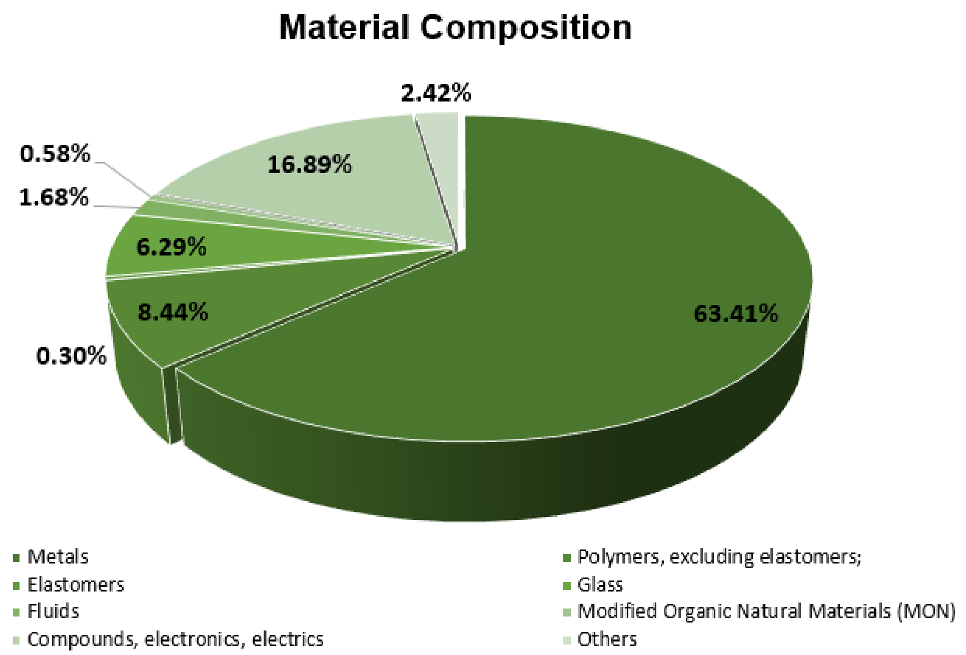

Figure 4 Material composition of the vehicle

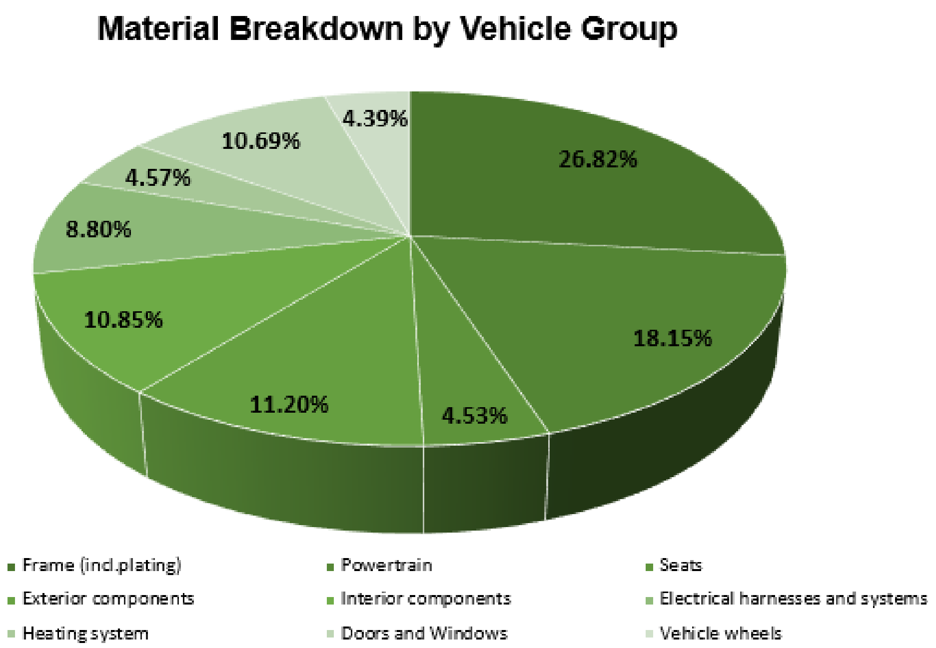

Figure 5 Material breakdown by vehicle group

*Vehicle group is a compartment of a vehicle

Environmental performance

Potential environmental impact

Table 5 depicts the environmental impacts of 1 pkm. Nearly all environmental impacts are predominantly influenced by the downstream processes. Impacts from downstream processes are driven by the bus operation.

The estimated impact result are only relative statements, which do not indicate the endpoints of the impact categories, exceeding threshold values, safety margins and/or risks.

Table 5 Environmental impacts

PARAMETER		UNIT	Upstream	Core	Downstream		TOTAL
					Operation	Maintenance & EoL	
Global warming potential (GWP)	Fossil	kg CO_2 eq.	1.01E-03	8.66E-05	5.28E-03	9.77E-06	6.39E-03
	Biogenic	kg CO_2 eq.	-4.95E-07	1.14E-06	-2.02E-03	3.87E-06	-2.02E-03
	Land use and land transformation	kg CO_2 eq.	4.14E-07	3.82E-08	1.34E-04	1.10E-09	1.34E-04
	TOTAL	kg CO_2 eq.	1.01E-03	8.78E-05	3.39E-03	1.36E-05	4.50E-03
Acidification potential (AP)		kg mol H^+ eq.	5.27E-06	8.78E-07	1.61E-05	2.08E-08	2.22E-05
Eutrophication potential (EP)	Aquatic freshwater	kg P eq.	2.26E-09	2.63E-10	2.26E-07	1.72E-10	2.28E-07
	Aquatic marine	kg N eq.	8.05E-07	2.37E-07	4.02E-06	6.21E-09	5.07E-06
	Aquatic terrestrial	mol N eq.	8.69E-06	2.59E-06	6.48E-05	6.13E-08	7.61E-05
Photochemical oxidant creation potential (POCP)		kg NMVOC eq.	2.50E-06	6.67E-07	7.10E-06	2.35E-08	1.03E-05
Ozone layer depletion (ODP)		kg CFC 11 eq.	1.92E-13	2.11E-15	6.68E-14	3.06E-18	2.61E-13
Abiotic depletion potential (ADP)	Metals and minerals	kg Sb eq.	2.94E-08	-9.71E-11	3.12E-09	3.52E-13	3.24E-08
	Fossil resources	MJ, net calorific value	1.14E-02	1.29E-03	5.64E-02	3.10E-04	6.94E-02
Water deprivation potential (WDP)		m^3 world eq.	2.85E-04	3.10E-05	5.88E-04	6.96E-06	9.11E-04

For upstream processes, the biogenic GWP is negative, due to the natural rubber share of the tyres and the wooden part of the floor. For downstream processes, the biogenic GWP is negative due to the consumption of 100% biodiesel below 0°C by Oil-fired heating system.

Use of resources

Table 6 depicts resources that the elementary flows crossing the system boundary between nature and the studied product system.
The use of resources describes the amount of primary as well as secondary materials and fuels. Primary resources are resources that are extracted from the environment for the first time. Secondary materials and fuels consist of substances that have already been used before and are made available to the bus life cycle after recycling.

Table 6 Indicators describing use of primary and secondary resources

PARAMETER		UNIT	Upstream	Core	Downstream		TOTAL
					Operation	Mainten-ance&EoL	
Primary energy resources – Renewable	Use as energy carrier	MJ, net calorific value	1.50E-03	1.59E-04	1.26E-01	7.29E-06	1.28E-01
	Used as raw materials	MJ, net calorific value	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	TOTAL	MJ, net calorific value	1.50E-03	1.59E-04	1.26E-01	7.29E-06	1.28E-01
Primary energy resources – Non-renewable	Use as energy carrier	MJ, net calorific value	1.15E-02	1.29E-03	5.65E-02	3.10E-04	6.95E-02
	Used as raw materials	MJ, net calorific value	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	TOTAL	MJ, net calorific value	1.15E-02	1.29E-03	5.65E-02	3.12E-04	6.95E-02
Net use of fresh water (optional)		m^3	7.22E-06	8.38E-07	7.54E-05	1.63E-07	8.36E-05

Waste production and output flows

Waste production

Table 7 depicts the waste production over the whole life cycle.

Table 7 Indicators describing waste production

PARAMETER	UNIT	Upstream	Core	Downstream		TOTAL
				Operation	Maintenance &EoL	
Hazardous waste disposed	kg	1.64E-08	3.20E-10	1.26E-11	3.23E-15	1.67E-08
Non-hazardous waste disposed	kg	1.24E-04	2.31E-06	2.03E-04	6.90E-06	3.37E-04
Radioactive waste disposed	kg	1.37E-07	2.07E-08	4.00E-06	2.87E-10	4.16E-06

Output flows

Table 8 depicts the output flows. During the life cycle, no components for reuse accrue. The amount of materials for recycling outweighs the amount of materials for energy recovery.

In this EPD, it is assumed that “materials for energy recovery” consider materials that can be incinerated in waste incineration plants. These materials are produced by upstream, core and downstream processes.

Table 8 Indicators describing output flows

PARAMETER	UNIT	Upstream	Core	Downstream		TOTAL
				Operation	Maintenance & EoL	
Components for reuse	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Material for recycling	kg	1.04E-04	0.00E+00	0.00E+00	1.61E-04	2.65E-04
Materials for energy recovery	kg	9.46E-07	5.62E-07	0.00E+00	7.69E-06	9.20E-06

Results Interpretation

Table 9 depicts the environmental profile of B15E01 eBus over all stages of its lifecycle. The environmental impacts are the most significant in Bus Operation, originating from electricity consumption and biodiesel consumption (only for Oil-fired heating system below 0°C, 100% biodiesel is used). These impacts comprise from 63.9% to 85.1% in all categories, except Ozone layer depletion (ODP) and Abiotic depletion potential (ADP-EL). ODP and ADP-EL is mainly concerned with the consumption of materials, which contribution is consequently lower in this stage. The environmental profile of B15E01 eBus is shown in Figure 6.

Table 9 Environmental Impacts by life cycle stage

Life cycle stage	GWP	AP	EP	POCP	ODP	ADP-EL	ADP-FF	WDP
Raw material	22.5%	23.7%	11.4%	29.9%	73.6%	90.7%	16.5%	31.2%
Bus manufacturing	1.3%	0.7%	0.6%	1.1%	0.8%	-0.3%	1.3%	3.4%
Transport to client	0.7%	3.2%	2.8%	4.9%	0.0%	0.0%	0.6%	0.0%
Bus Operation	75.3%	72.3%	85.1%	63.9%	25.6%	9.6%	81.2%	64.6%
Bus Maintenance	0.2%	0.1%	0.1%	0.2%	0.0%	0.0%	0.4%	0.8%
Bus EoL	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

*GWP: Global Warming Potential | AP: Acidification potential | EP: Eutrophication terrestrial | POCP: Photochemical oxidant creation potential | ODP: Ozone layer depletion | ADP-EL: Abiotic depletion potential elements | ADP-FF: Abiotic depletion potential fossil fuels | WDP: Water deprivation potential

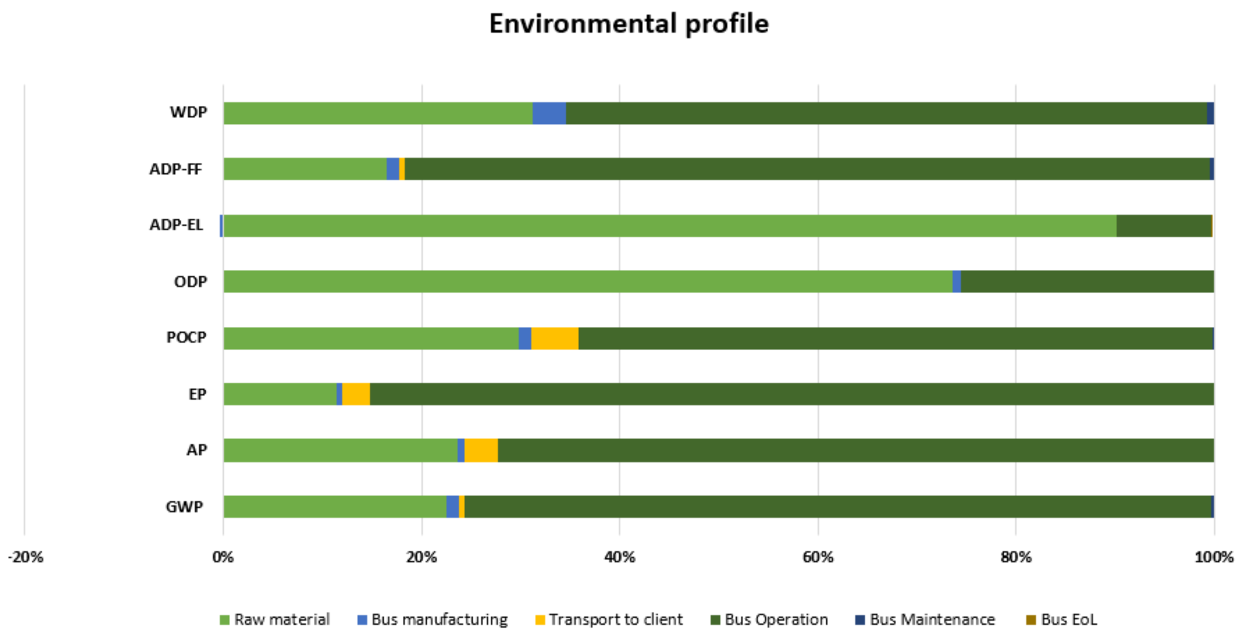

Figure 6 Environmental profile

References

[1] General Programme Instruction of the International EPD® System. Version 4.0, 2021-03-29

[2] EPD International, PCR 2016:04 – UN CPC 49112: Public and private buses and coaches. VERSION 2.0.2, Sweden: Environmental Product Declaration International AB, 2020

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