Environmental Product Declaration

In accordance with ISO 14025:2006 for:

e-ATA 10 meter Electric Bus

from

Karsan Otomotiv Sanayi ve Ticaret A.Ş.

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Programme Information

Programme:	The International EPD® System	**Licensee:** EPD Türkiye
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Accountabilities for PCR, LCA and independent, third-party verification
Product Category Rules (PCR)
PCR: Public and Private Busses and Coaches, 2016:04, version: 2.0.3, Date: 2024-10-30, UN CPC code: 49112
PCR review was conducted by: *The Technical Committee of the International EPD® System. Review chair: Claudia A. Peña, University of Concepción, Chile*
Life Cycle Assessment (LCA)
LCA accountability: Ceren Naz Güleçyüz, Greenlife Danışmanlık
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: Callum Hill, JCH Industrial Ecology Ltd Approved by: The International EPD® System
Procedure for follow-up of data during EPD validity involves third-party verifier: ☐ Yes ☒ No

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Company Information

Owner of the EPD: Karsan Otomotiv Sanayi ve Ticaret A.Ş.

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About Karsan

Having left behind 58 years in the Turkish automotive industry, Karsan has been manufacturing in the commercial vehicle segment since its establishment, producing both its own brand and for some of the world's leading brands in its modern facilities. Since 1981, commercial vehicle production has been carried out at Karsan's Hasanağa factory in Bursa, which has an annual production capacity of approximately 20,000 vehicles in a single shift. The Hasanağa Factory, capable of producing all types of vehicles from passenger cars to heavy trucks, and from minibuses to buses, is located 30 km from the city center of Bursa, covering a total area of 203,000 m², of which 99,000 m² is indoors.

As the only independent multi-brand vehicle manufacturer in the Turkish automotive industry, Karsan aims to develop derivatives of new and existing products in collaboration with its partners and licensors, in line with its vision of staying one step ahead in the future of mobility.

At Karsan, the entire automotive value chain is managed, from R&D to production, and from marketing to sales and after-sales activities. Karsan manufactures its own environmentally friendly models, Jest and Atak, under its own brand.

In 2018, Karsan launched the e-JEST, followed by the e-ATAK in 2019, the Autonomous e-ATAK in 2021, and in the same year the 10 m, 12 m, and 18 m models of the e-ATA family. In 2022, the e-ATA HYDROGEN was also launched. With these achievements, Karsan became the first and only company in Europe to offer a fully electric product range from 6 meters to 18 meters. Karsan also manufactures 10 m, 12 m, and 18 m buses for Menarinibus, and as of 2022, it has been producing Megane Sedan cars for the Renault brand. In addition to vehicle production, Karsan also provides industrial services at its factory located in the Organized Industrial Zone.

Name and location of production site/Address of EPD Owner: Organize Sanayi Bölgesi Mavi Cad. No:13 16159 Nilüfer/Bursa

Figure 1. Karsan Production Facility

Product Information

Product name: e-ATA 10 meter Electric Bus

Product identification: 10M City Bus – Electric Articulated Bus

Product description: The 10-meter e-ATA provides 250 kW of power and offers superior traction with its electric hub motor. The e-ATA, equipped with seven different battery packs compatible with proven reliable plug-in charging and pantograph charging options, provides flexible solutions to meet the mobility needs of the cities of the future. With DC charging capability of up to 150 kW, the e-ATA can be charged in a short time.

UN CPC code: 49112

Geographical scope: Europe

Figure 2. e-ATA 12 meter Electric Bus

Table 1. Technical Properties of the Vehicle

Group	Activity	Value
Vehicle Type	Vehicle Category & Class	Full Low Floor Electric Bus M3 Category Class I, LHD
Powertrain System	Drive Type	Electric Portal Axle (Hub Motor)
	Maximum Power (kWh)	250
	Torque (Nm)	22,000
	Engine Position	Electric Drive Portal Axle
Performance & Electric System	Range (km)	350
	Max speed (km/h)	80
	High Voltage Battery (Type-Capacity)	LFP – Up to 396 kWh
	Charging Type	Plug in DC Charger Pantograph (Optional)
	Charging Time	Up to 2 h 45 min with Plug in DC Charger
Axles	Axle Count	2
	Wheel Count	6
	Front Axle Load (max)	8,150
	Rear Axle Load (max)	12,850
	Distance Between Axles	4530
	Front Overhang (mm)	2,870
	Rear Overhang (mm)	3,350
Steering Control	Steering System Type	Electro-Hydraulic Pump
	Maximum Front Axle Turning Angle, (Inside/Outside Wheel)	56°/46°
	Minimum Turning Cycle (mm)	17,850
Body & Suspension System	Body Type	Carbon Steel: Space Frame Steel Tube Structure
	Corrosion Resistance	Cataphoresis & Underbody Coating
	Front Axle	ZFR RL 82 EC - Independent
	Central Axle	-
	Rear Axle	ZF AVE 130 – Electric Portal Axle
	Door Arrangement	2 or 3 Door Options
	Tires	275/70 R22.5
	Suspension	Air Suspension, Electronic Levelling, Kneeling Function
	Brake System	ABS, ASR, EBS, Regenerative Braking System
Capacity	Total / Seating / Standing	79/32/47
Weight & Dimensions	Gross Vehicle Weight (kg)	19,000 (19,500 Optional)
	Overall Length (mm)	10,750
	Overall Width (mm)	2,550
	Overall Height (mm)	3,350
Air Conditioning	Denomination	Songz LMD VI-T, R407C, 37 kW cooling / 30 kW heating – base (Songz EMB VI-T, R1234yf, 37 kW cooling / 28 kW heating – optional)
Noise	Sound Level (Driving Noise)	75 dB(A)

LCA information

Functional unit: Transport of 1 passenger for 1 km

Table 2. Functional unit for 10 meter Electric Bus

Passenger Capacity, passenger	Lifetime Milliage, km	Passenger.km
79 (27 Seated + 56 Standing)	1.000.000	79.000.000

Reference service life: Service life is highly dependent on the use cases. According to performed analysis the service lifetime milage is 1 million km.

Time representativeness: Data is representative for 2024 production year. Primary production data for the year 2024 was used in the LCA.

Database(s) and LCA software used: Ecoinvent 3.10 database and SimaPro software 9.6.0.1

Characterisation factor: EN 15804 method based on EF 3.1 normalization and weight values, published in July 2022.

Allocation: Energy consumption was allocated according to 2024 production figures. There is no co-product allocation.

Cut-off Criteria: The life cycle assessment (LCA) modelling excludes the following data: employee commuting to the workplace, the manufacturing of infrastructure and capital goods (machinery), environmental impacts associated with machinery maintenance, and waste generated during the production process. These exclusions are justified on the basis that their contributions to the overall environmental impacts are considered negligible. A cut-off criterion of 1% has been applied, whereby data representing at least 99% of the total estimated environmental impacts associated with elementary flows entering and leaving the product system have been included in the assessment.

System diagram:

Figure 3. System Boundry

Description of system boundaries: This EPD evaluates the impacts of 1 pkm from a cradle-to-grave perspective. This means it accounts for the environmental impacts of all processes, starting from the extraction of natural resources up to the End-of-Life stage of the bus.

Upstream Module

The upstream processes considered in this study include the extraction and production of raw and basic materials such as aluminium, steel, and other materials. This encompasses all associated activities, including mining, transportation, and the use of electricity, and fuel. Also, environmental impacts due to transportation of the raw materials considered in this module.

Core Moule:

The core processes considered in this study include production processes and transportation of the product to the customer. The production process begins with the welding stage, where the vehicle skeleton is formed. The shaped metal sheets are joined to the vehicle skeleton by welding and sent to the paint station. After painting, the vehicle is transferred to the assembly line for the installation of components such as the engine, front and rear parts, interior panels, seats, tires, and other equipment. After leaving the assembly line, the vehicle undergoes quality control and is made ready for dispatch. For the electricity Karsan obtains 83% of its electricity from renewable sources and the rest 17 % is from the national grid Additionally, the use of water is included. Transportation of the road vehicle from the assembly facility to the customer's location is considered within the system boundaries.

Details of electricity data used in LCA model

Country: Türkiye
Source Type: 17% Grid
Energy Sources: Coal: 62.7%
Oil: 0.7%
Natural gas: 36.6%

Electricity Data: Residual mix is calculated from "Electricity, medium voltage {TR}| market for electricity, medium voltage | Cut-off, S" by excluding renewable energy generation

Electricity Emission Factor (GWP-GHG result): 0.904 kg CO2eq/kWh

Downstream Module:

The downstream processes included in this study consist of two main stages: vehicle operation and vehicle maintenance during the use phase. The operation stage covers the electricity required for the operation of the road vehicle. In this study, the electricity consumption for vehicle operation is calculated as 0.002771605 kWh/pkm. While modelling the environmental impacts related to electricity consumption during vehicle use, the geographical region is considered as Europe according to the clients' countries.

In addition to the energy consumption during the operation stage, maintenance activities throughout the vehicle lifetime are also included within the downstream system boundary. This comprises the environmental impacts associated with the replacement of maintenance parts, as well as the consumption of components, sensors and mechanical elements used during regular and corrective servicing operations. The components accounted for in the model include, among others, the fuel filling sensor cap, water pump components, oil and air filters, braking system parts, steering arm, suspension bushings, level sensors, converter, cooling fan module, radio unit, control switches, high-voltage cables, battery control unit, pantograph controller and related connectors. All maintenance-related components are modelled according to their material compositions and replacement frequencies.

Finally, end-of-life processes of the vehicle after its use phase are accounted for, including recycling and disposal operations. For the end-of-life scenario, a rate of 90% recycling and 10% disposal has been considered.

Content Declaration

The total weight of the vehicle is 18 tonne. The material distribution (%) is shared in the Figure 4 below.

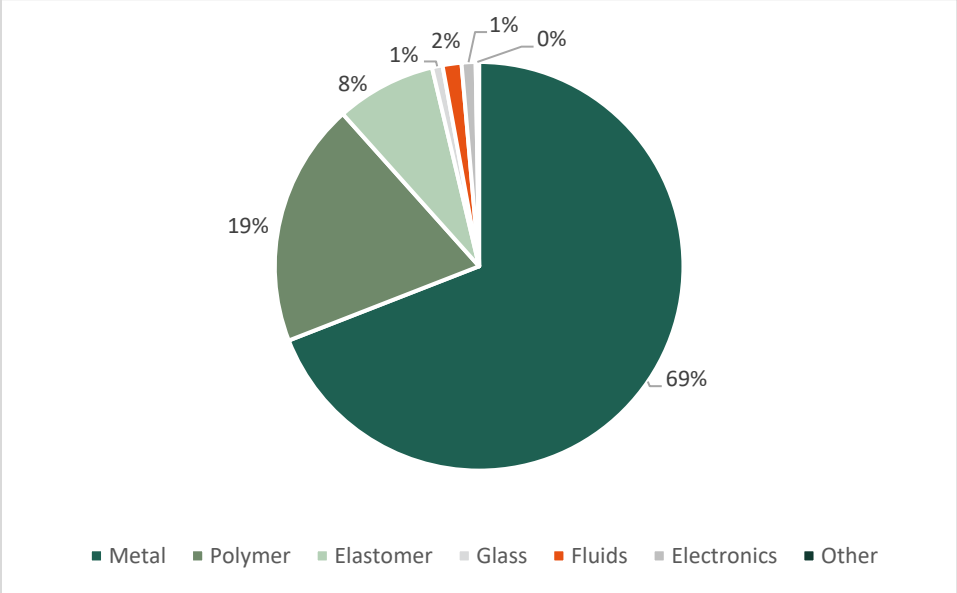

Figure 4. Content declaration according to ISO22826

*Packaging is not applied.

Rates for recycling and recoverability is calculated according to ISO 22628 and is presented in Figure 5.

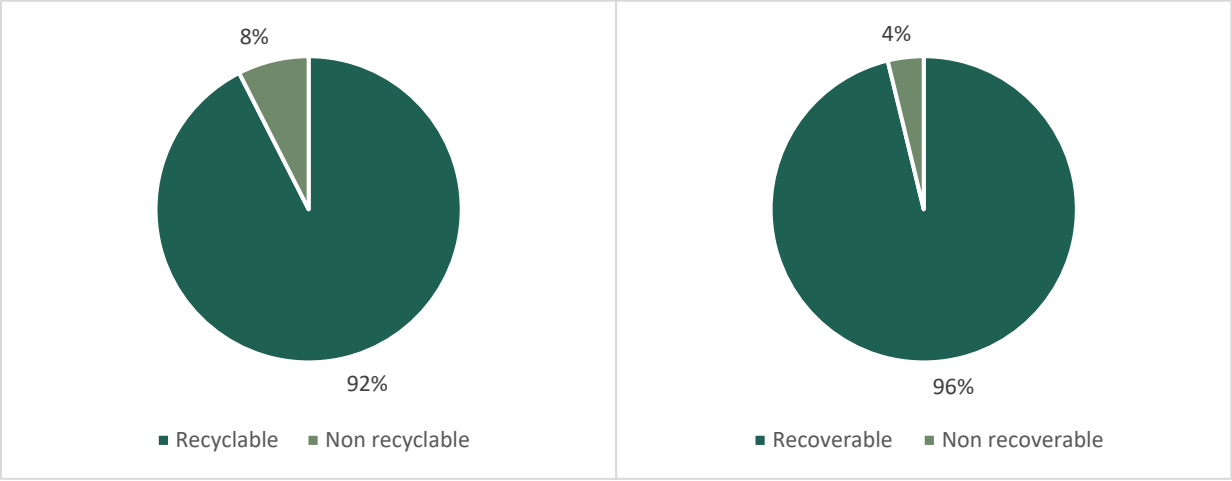

Figure 5. Recycling and recoverability rates according to ISO 22628.

Results of the environmental performance indicators

Impact category indicators

PARAMETER		UNIT	Upstream	Core	Downstream		TOTAL
					Operation	Maintenance - EoL	
Global warming potential (GWP)	Total	kg CO_2 eq.	4.91E-04	9.98E-04	1.49E-03	2.76E-04	3.26E-03
	Fossil	kg CO_2 eq.	4.90E-04	8.73E-04	1.43E-03	2.75E-04	3.07E-03
	Biogenic	kg CO_2 eq.	-1.37E-06	1.24E-04	5.43E-05	8.58E-07	1.77E-04
	Land use and land use change	kg CO_2 eq.	1.69E-06	1.33E-06	4.44E-06	2.97E-07	7.75E-06
Ozone layer depletion (ODP)		kg CFC 11 eq.	9.36E-11	3.79E-11	2.49E-11	9.90E-12	1.66E-10
Acidification potential (AP)		mol H^+ eq.	3.01E-06	2.94E-06	7.31E-06	3.17E-06	1.64E-05
Eutrophication potential (EP)	Aquatic freshwater	kg P eq.	3.05E-07	2.03E-07	1.28E-06	3.39E-07	2.13E-06
	Aquatic marine	kg N eq.	5.45E-07	6.32E-07	1.27E-06	3.76E-07	2.82E-06
	Aquatic terrestrial	mol N eq.	5.84E-06	6.63E-06	1.10E-05	4.28E-06	2.78E-05
Photochemical oxidant creation potential (POCP)		kg NMVOC eq.	2.17E-06	2.83E-06	3.65E-06	1.26E-06	9.92E-06
Abiotic depletion potential (ADP)*	Metals and minerals	kg Sb eq.	5.23E-08	1.88E-09	3.13E-09	6.84E-08	1.26E-07
	Fossil resources	MJ, net calorific value	6.67E-03	1.22E-02	3.39E-02	3.34E-03	5.62E-02
Water deprivation potential (WDP)*		m^3 world eq. deprived	1.44E-04	1.57E-02	3.83E-04	8.06E-05	1.63E-02

** Disclaimer: The results of this environmental impact indicator shall be used with care as the uncertainties of these results are high or as there is limited experience with the indicator.*

Resource use indicators

PARAMETER		UNIT	Upstream	Core	Downstream		TOTAL
					Operation	Maintenance - EoL	
Primary energy resources – Renewable	Use as energy carrier	MJ, net calorific value	5.23E-04	1.58E-03	7.76E-03	4.50E-04	1.03E-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	5.23E-04	1.58E-03	7.76E-03	4.50E-04	1.03E-02
Primary energy resources – Non-renewable	Use as energy carrier	MJ, net calorific value	6.67E-03	1.22E-02	3.39E-02	3.34E-03	5.62E-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	6.67E-03	1.22E-02	3.39E-02	3.34E-03	5.62E-02

Waste indicators

PARAMETER	UNIT	Upstream	Core	Downstream		TOTAL
				Operation	Maintenance - EoL	
Hazardous waste disposed	kg	7.17E-08	6.17E-08	5.02E-08	1.54E-08	1.99E-07
Non-hazardous waste disposed	kg	3.55E-05	4.76E-04	6.95E-05	2.68E-05	6.08E-04
Radioactive waste disposed	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Output flow indicators

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	0.00E+00	0.00E+00	0.00E+00	1.46E-04	1.46E-04
Materials for energy recovery	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, electricity	MJ per energy carrier	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, thermal	MJ per energy carrier	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

References

General Programme Instructions of the International EPD® System. Version 5.0.1

PCR 2024:10.30. Public and Private Buses and Coaches. Version 2.0.3

ISO 22628:2002 – Road vehicles - Recyclability and recoverability – Calculation method

Ecoinvent / Ecoinvent Centre, www.ecoinvent.org

SimaPro / SimaPro LCA Software, Pré Consultants, the Netherlands, www.pre-sustainability.com

INTERNATIONAL EPD SYSTEM

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