Environmental Product Declaration

In accordance with ISO 14025:2006 for:

Volvo 7900 Electric

from

AB Volvo, Business Area Buses

VOLVO

Programme:	The International EPD® System, www.environdec.com
Programme operator:	EPD International AB
EPD registration number:	S-P-11237
Publication date:	2023-11-02
Valid until:	2028-11-02

An EPD should provide current information and may be updated if conditions change. The stated validity is therefore subject to the continued registration and publication at www.environdec.com.

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)
PCR: *PCR 2016:04 – UN CPC 49112 & 49113, Public and private buses and coaches. Version 2.0.2 (2023-02-01)*
PCR review was conducted by: *The Technical Committee of the International EPD® System* *Chair: Maurizio Fieschi* *Contact via: info@environdec.com*
Life Cycle Assessment (LCA)
LCA accountability: *Julia Lindholm, Anna Liljenroth, IVL Swedish Environmental Research Institute*
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: *Mats Zackrisson, RISE Research Institutes of Sweden* 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:
Volvo Bussar AB, 418 78 Göteborg, Sweden

Description of the organisation:
AB Volvo was founded in 1927 and is a global supplier of trucks, buses, coaches, construction equipment, marine and industrial engines.
Volvo Buses is a business unit within the Volvo group. The first bus was made in 1928. Today, the range includes buses between 10,5 and 30 metres, single and double deck, premium coaches and a range of chassis for third-party bodybuilders. Volvo Buses has R&D centres and manufacturing sites in Asia, Europe and the Americas. See volvo.com and volvobuses.com for further corporate information

Following the priorities of countries and cities around the world, Volvo focuses on the main and principal causes of negative environmental impact. That is the reason behind Volvo's decision to discontinue the production of diesel low-floor single deck city buses for the European market already in 2013, in favour of electrified vehicles, which Volvo introduced already in 2008 with the Volvo Hybrid. In our environmental management process, we continuously seek to identify and eliminate or replace harmful factors. International and national regulations are meticulously followed.

On a corporate level, the Volvo Group is taking the next step in adjusting and future-proofing the company in line with the ambitions of the Paris Climate Agreement. The ambition is that Volvo Group will be a net-zero emissions company by 2050, at the very latest. To be transparent on its progress, the company is now committing to the Science Based Targets initiative. More information is found here: https://www.volvogroup.com/en-en/news/2020/nov/news-3820494.html

To reduce the lifecycle environmental impact of electrified Volvo vehicles, Volvo is in the process of building its own battery production facility in Sweden, powered by renewable and fossil-free energy. This will significantly reduce the carbon footprint of Volvo's products. The battery plant is planned to reach full production volumes in 2030.

Product-related or management system-related certifications:

- **ISO9001:2015** certificate number 10000475106-MSC-SWEDAC-SWE
  The certificate is valid until March 31, 2024. The certificate includes Volvo Bussar Uddevalla AB, Volvo Bussar AB in Borås and Volvo Polska Sp.Z. o. o.
- **ISO9001:2015** certificate number C524495
  The certificate is valid until March 31, 2024. The certificate includes Volvo Group Trucks Operations, Köping.
- **ISO 14001:2015** certificate number 10000475107-MSC-SWEDAC-SWE
  Initial certification date June 25, 1995. Current certificate valid until March 31, 2024. The certificate includes Volvo Bussar Uddevalla AB, Volvo Bussar AB in Borås and Volvo Polska Sp.Z. o. o.
- **ISO 14001:2015** certificate number C524494
  The certificate is valid until March 31, 2024. The certificate includes Volvo Group Trucks Operations, Köping.
- **ISO 45001** certificate number 10000475108-MSC-SWEDAC-SWE
  The certificate is valid until March 31, 2024. The certificate includes Volvo Bussar Uddevalla AB, Volvo Bussar AB in Borås and Volvo Polska Sp.Z. o. o.

Name and location of production site:
The Volvo Group in-house manufacturing steps of electric buses take place at the following sites:

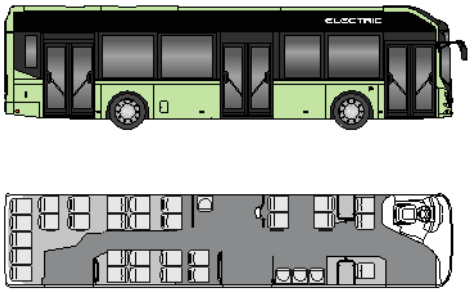
- Volvo Bussar Uddevalla AB, Sweden, production of chassi frames

- Volvo Bussar AB in Borås, Sweden, production of chassis
- Volvo Group Trucks Operations, Köping, Sweden, production of electric powertrains
- Volvo Polska Sp. Z o.o. in Wrocław, Poland, production of the complete electric bus

Product information

Product name:
Volvo 7900 Electric

Product description:
The Volvo 7900 Electric is a 12 m low-floor, single deck city bus with a capacity of up to 95 passengers, powered by a single electric motor. It features multiple charging interfaces and a modular energy storage system.



UN CPC code:
49112 & 49113

Geographical scope: Europe

Table 1. Technical description of the vehicle.

Group	Concept	Value
General	Description	Volvo 7900 Electric
	Model year	2022
	Door configuration	3 doors
	Permissible gross vehicle weight	19.5 tonnes
	Calculated empty weight in running order without driver	12 tonnes
Chassis	Length	12.0 m
	Width	2.55 m
	Capacity (total/seating/standing)	88/39/49 passengers
	Driver cabin position	Front left
Electric powertrain	Denomination/Engine type	Electric powertrain (EPT402)
	Nominal power	200 kW
	Nominal torque	19 000 Nm (wheel)

Group	Concept	Value
	Engine position	Rear
Gearbox	Type	Automatic gearbox
Axles	Axles	2
	Axle configuration	4 x 2 (Front axle with independent wheel steering)
	Wheels	6 x 275/70 on steel wheel R22.5
	First axle load (max)	7 500 kg
	Second axle load (max)	12 000 kg
	Distance between axles	6000 mm
	Front overhang	2700 mm
	Rear overhang	3300 mm
Steering control	Denomination	VDS (Volvo Dynamic Steering)
	Turn diameter	11
Battery	Technology	NCA (Lithium Nickel Cobalt Aluminium oxides)
Brake system	Denomination	Volvo disc brakes Electronic Braking System (EBS5) Anti-lock Braking System (ABS)
Suspension	Denomination	Electronic Stability Program (ESP)
	Type	Air bellow
Security	Systems	Acoustic Vehicle Alerting System (AVAS), Pedestrian and Cyclist Detection System (PCDS), LKS (Lane Keeping Support), Flammability R118.02, R29/93, R58, Side detection, Tire Pressure Monitoring (TPMS) and Speed zones.
Air conditioning	Denomination	CO2 HVAC (600 V) with heatpump (Carbon dioxide Heating, Ventilation and Air Conditioning), cooling 29 kW, heating 26 kW. AUX heater electric 24 kW/HVO (Hydrotreated vegetable oil) 16 kW
ECE Regulation N˚51	Moving sound level	67 dB (A)

Group	Concept	Value
	Stationary sound level	57 dB (A)

LCA information

Functional unit / declared unit: Transport of 1 passenger for 1 kilometre.

The bus capacity is calculated according to available seats and space for standing at 100 % load factor (88 passengers: 39 seats and 49 standing). The lifetime of the bus is assumed with a travelled distance of 80 000 km/year for 10 years.

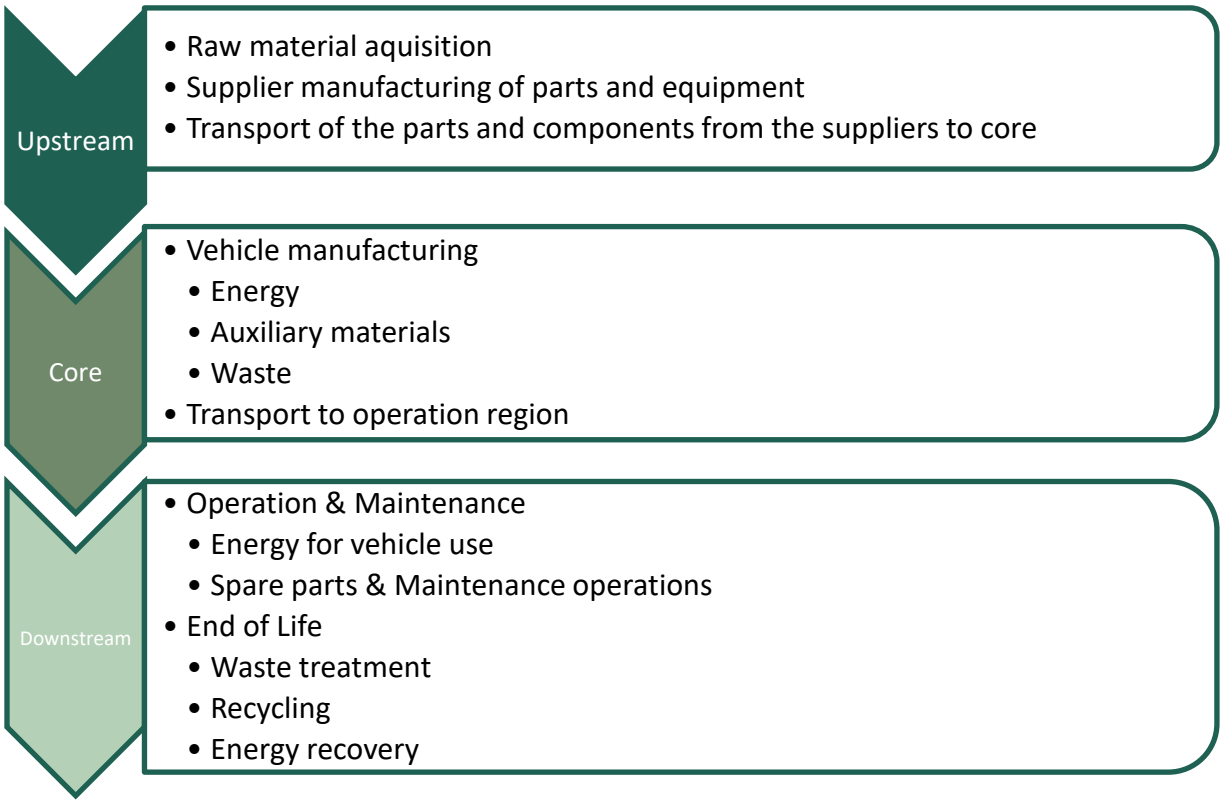
Table 2. Functional unit

Passenger capacity	Lifetime distance (km)	Passenger * km (pkm)	Battery weight (kg)	Battery energy (kWh)	Number of batteries
88	800 000	70 400 000	610	94	5

Time representativeness:
2021-2022 The data for production sites are based on the most recent full year data which was 2021. However, some data for components are from 2022.

Database(s) and LCA software used:
The life cycle assessment of the vehicle is carried out by modelling in Sphera's GaBi software (now renamed to LCA for experts) and the database version 2022.2, ecoinvent 3.8 was also used as a complement when data was missing.

System diagram:



Description of system boundaries:
This EPD considers the impacts of 1 pkm using a cradle to grave perspective. This means that it considers the environmental impact associated with the processes occurring all the way from extraction of resources from nature to the point where the bus reaches End of Life.

Details about the life cycle assessment:
Volvo Bussar AB collected information on material composition of the Volvo 7900 Electric bus during the years 2021 and 2022. Technical datasheets on certain components were also acquired from suppliers. In the cases where it was not possible to get actual data, proxies and literature sources were used to fill in the data gaps. To account for raw material production and external manufacturing/processing of parts, GaBi database and partly ecoinvent was used.

Volvo Bussar AB has determined transport distances from the suppliers to their manufacturing facilities (core) based on the supplier country of the parts and its weight. A macro was used to group the weight of the parts per country. Furthermore, the distances between Volvo's own manufacturing facilities were added.

The manufacturing of the bus includes all Volvo's manufacturing and assembly sites. The chassi frames are produced in Uddevalla (Sweden), the chassis are produced in Borås (Sweden), the electric powertrains are produced in Köping (Sweden) and the complete electric bus is assembled in Wrocław, (Poland). To account for the manufacturing of parts and components occurring at the suppliers' sites, some general processes were used to represent the processing of materials into components, for the cases where the processing was not already included in the material dataset.

Regarding the transport to the operating region, the distance used was 1 000 km.

The use phase is based on the electricity consumption (with charging losses) from the driving cycle 18 km/h with maximum number of passengers in city environment. The electricity mix presented in the main results is the residual mix for Europe as suggested by the PCR. To increase the understanding of the importance of choice of electricity mix, other electricity mixes are provided in the interpretation section.

Preventive maintenance includes material production of spare parts and fluids used during operation and end of life treatment of the parts.

The end-of-life phase has been based on the ISO 22628:2002 and Annex B. This standard is also used to calculate the recoverability and recyclability rate.

Content declaration

The total weight of the analysed vehicle is 13.2 tonne. The material content is presented in Figure 1. The material content is retrieved from the Bill of Material (BOM) and when material information is missing, it has been approximated with the most used steel in the vehicle. Therefore, all weights are included in the calculations.

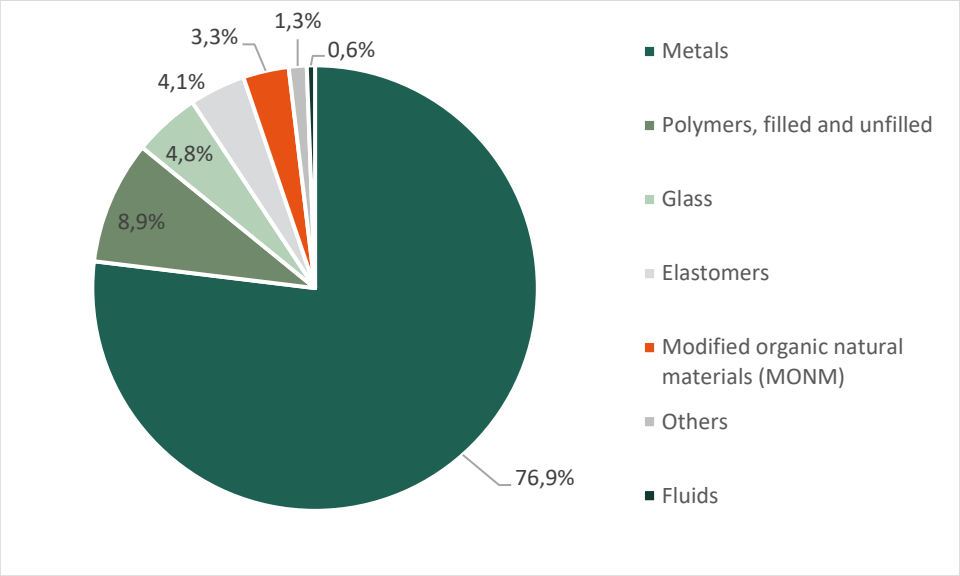


Figure 1. Content declaration according to ISO 22628.

Rates for recycling and recoverability is calculated according to ISO 22628 and is presented in Figure 2.

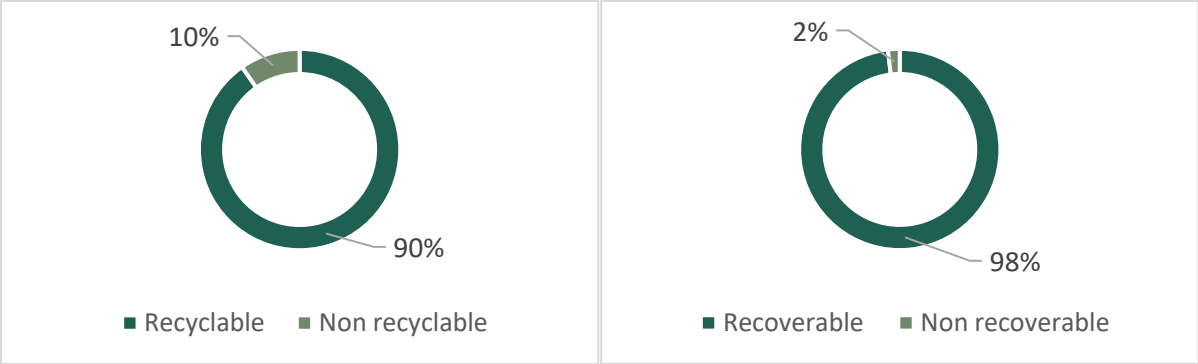


Figure 2. Recycling and recoverability rates according to ISO 22628.

Volvo Buses has a Masterlist where all substances of very high concern (SVHC) as defined and listed in the European Chemicals Agency (ECHA) Candidate List of substances of very high concern for Authorization, that are present in their vehicles during the last half year in concentrations above 0.1% by weight is presented. These files are found via the link below and by typing in the following parameters:

- Brand: Volvo Buses
- Language: EN
- Document type: Model
- Model list: Volvo 7900 Electric

https://plcp.srv.volvo.com/scip/article

Results of the environmental performance indicators

Impact category indicators

Table 3. Impact category results per pkm.

PARAMETER		UNIT	Upstream	Core	Downstream		TOTAL
					Operation	Maintenance & EoL	
Global warming potential (GWP)	TOTAL	kg CO_2 eq.	1.57E-03	9.23E-05	6.61E-03	2.59E-04	8.53E-03
	Fossil	kg CO_2 eq.	1.56E-03	9.19E-05	6.59E-03	2.53E-04	8.49E-03
	Biogenic	kg CO_2 eq.	1.41E-05	3.73E-07	3.89E-06	6.17E-06	2.46E-05
	Land use and land transformation	kg CO_2 eq.	2.52E-06	4.71E-08	4.29E-07	2.55E-07	3.25E-06
Ozone depletion potential (ODP)		kg CFC 11 eq.	8.21E-11	8.50E-17	6.51E-14	1.07E-10	1.89E-10
Acidification potential (AP)		kg mol H^+ eq.	1.38E-05	1.26E-07	9.70E-06	1.06E-06	2.47E-05
Eutrophication potential (EP)	Aquatic freshwater	kg P eq.	6.98E-07	3.88E-10	2.96E-09	3.27E-08	7.34E-07
	Aquatic marine	kg N eq.	1.73E-06	4.95E-08	2.66E-06	1.09E-07	4.55E-06
	Terrestrial	mol N eq.	1.82E-05	5.08E-07	2.83E-05	3.06E-06	5.01E-05
Photochemical ozone creation potential (POCP)		kg NMVOC eq.	5.11E-06	1.32E-07	7.48E-06	6.02E-07	1.33E-05
Abiotic depletion potential (ADP)*	Metals and minerals	kg Sb eq.	2.10E-07	7.91E-12	7.85E-10	7.56E-11	2.10E-07
	Fossil resources	MJ, net calorific value	2.27E-02	1.23E-03	1.40E-01	4.43E-03	1.68E-01
Water deprivation potential (WDP)*		m^3 world eq.	1.96E-03	1.06E-05	4.93E-04	1.99E-04	2.66E-03

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

Resource use indicators

Table 4. Resource use results per pkm.

PARAMETER		UNIT	Upstream	Core	Downstream		TOTAL
					Operation	Maintenance & EoL	
Primary energy resources – Renewable	Use as energy carrier	MJ, net calorific value	8.20E-03	9.16E-04	2.02E-02	9.05E-04	3.02E-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	8.20E-03	9.16E-04	2.02E-02	9.05E-04	3.02E-02
Primary energy resources – Non-renewable	Use as energy carrier	MJ, net calorific value	2.35E-02	1.23E-03	1.40E-01	4.43E-03	1.69E-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	2.35E-02	1.23E-03	1.40E-01	4.43E-03	1.69E-01
Secondary material (optional)		kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Renewable secondary fuels (optional)		MJ, net calorific value	1.51E-30	0.00E+00	0.00E+00	0.00E+00	1.51E-30
Non-renewable secondary fuels (optional)		MJ, net calorific value	1.77E-29	0.00E+00	0.00E+00	0.00E+00	1.77E-29
Net use of fresh water (optional)		m^3	5.12E-05	2.64E-06	3.06E-05	2.28E-05	1.07E-04

Waste indicators

Table 5. Waste results per pkm.

PARAMETER	UNIT	Upstream	Core	Downstream		TOTAL
				Operation	Maintenance & EoL	
Hazardous waste disposed	kg	3.88E-09	3.07E-13	1.00E-11	2.22E-12	3.89E-09
Non-hazardous waste disposed	kg	1.28E-04	1.44E-06	2.97E-05	7.77E-06	1.67E-04
Radioactive waste disposed	kg	3.54E-07	2.99E-08	2.33E-05	1.04E-07	2.37E-05

Output flow indicators

Table 6. Output results per pkm.

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	5.56E-05	1.66E-05	0.00E+00	3.08E-04	3.80E-04
Materials for energy recovery	kg	1.70E-06	6.71E-06	0.00E+00	1.54E-05	2.38E-05
Exported energy, electricity	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, thermal	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Results interpretation

In addition to the results provided in the results section above, an interpretation section is added to the EPD. This section aims at giving a deeper understanding of the results and explain the impact of certain parameters.

Firstly, a contribution analysis regarding fossil climate change is made. The contribution analysis is presented in Figure 3. The result shows that the main impact considering fossil climate change originates from the operation, meaning the use of the bus. This is due to the use of electricity and specifically that the European residual mix is used for operating the bus. The upstream phase is also connected to a large share of fossil climate impact, however significantly lower than the operation.

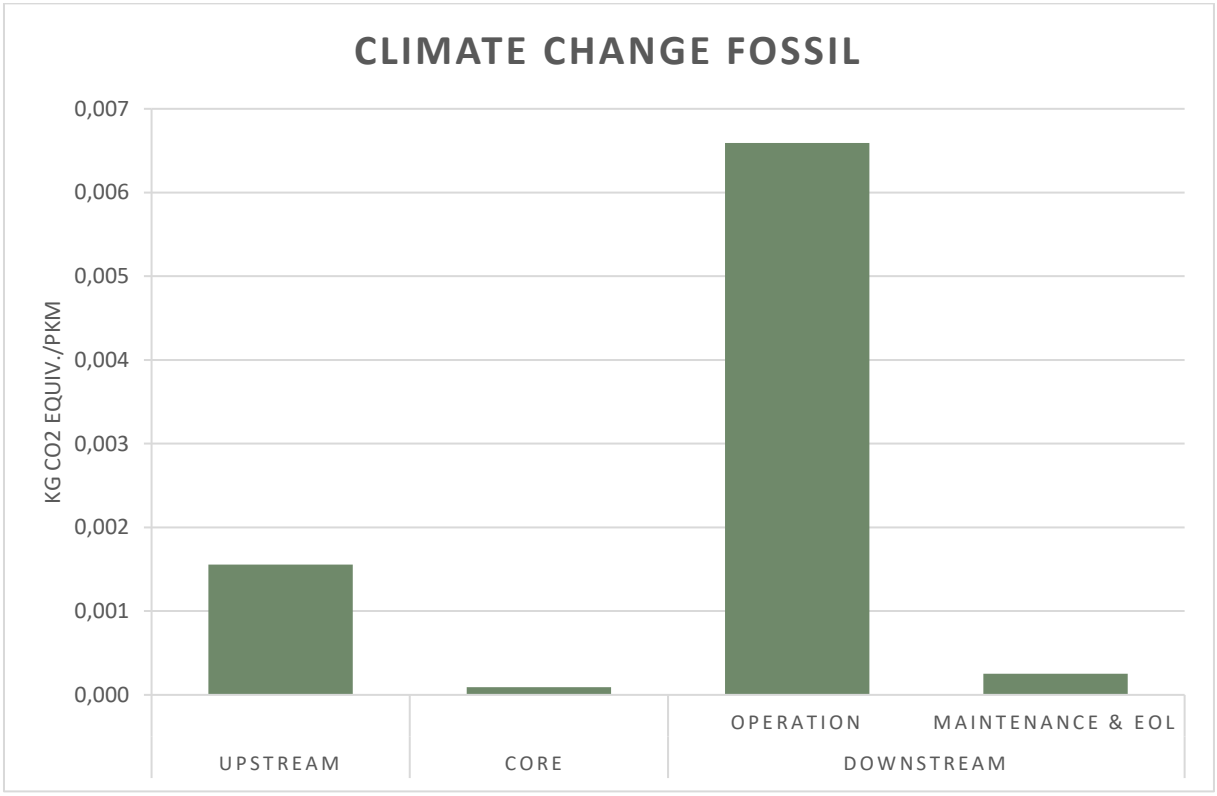


Figure 3. Results for the environmental impact category climate change fossil, divided into the categories: upstream, core, operation as well as maintenance & End of Life. The results are presented per the functional unit person kilometers (pkm).

There are many more environmental impact categories presented in the EPD and to give an understanding of where in the life cycle these impacts occur Figure 4 is made. In Figure 4 4, results from a selection of environmental impact categories are presented and divided into different activities along the value chain. When analysing the graph, it is evident that some categories are more relevant for the operation and some of the others are more relevant for raw material acquisition.

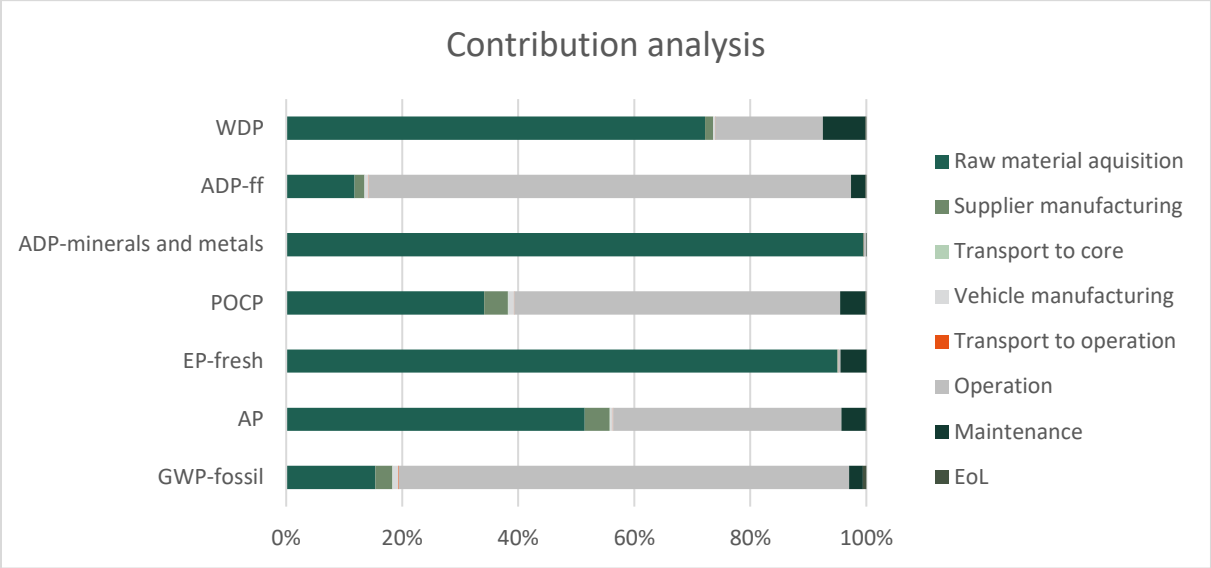


Figure 4. Results for a selection of investigated environmental impact categories. The results are presented per the functional unit person kilometer. The result is divided into different activities along the value chain.

The selection of electricity mix used in the operation phase of the vehicle has a large influence on the results of the LCA. To illustrate this, the results presented in the EPD are compared with the result of other electricity mixes. Figure 5 presents the results from fossil climate change impact for several electricity mixes in the operation phase. The impact is divided into upstream, core, operation as well as maintenance and end of life.

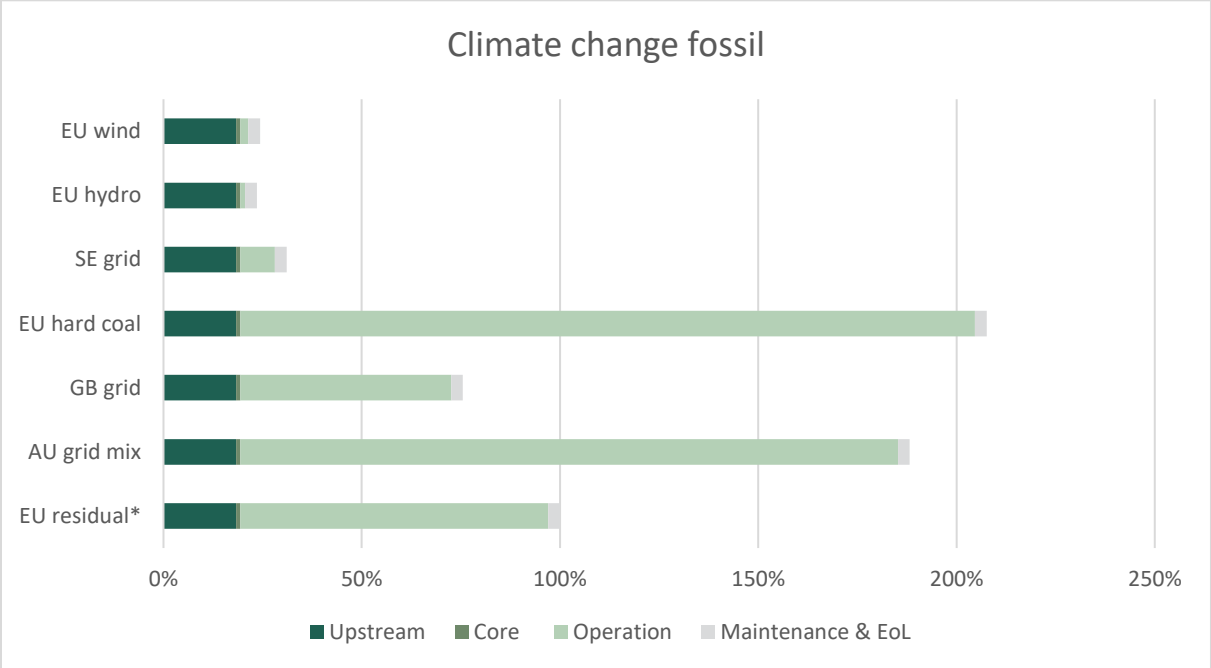


*Figure 5. Results for fossil climate impact for several electricity mixes, the electricity grid mix used in the study is marked with an *.*

Figure 5 clearly shows the impact of chosen electricity grid mix. Note that only the operation phase has been varied. A change from European residual electricity mix to Swedish grid mix would decrease the fossil climate impact with 69%, while a change to European hard coal would increase the fossil climate impact with roughly a factor of 2.

References

General Programme Instructions of the International EPD® System. Version 4.0.

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

Lindholm, J., Liljenroth, A. (2023). LCA methodology report for Volvo Buses and 7900e and 7900eA.

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