ENVIRONMENTAL PRODUCT DECLARATION

IN ACCORDANCE WITH ISO 14025:2006 FOR

EPD®

TRAM FORCITY SMART ARTIC X54 JOKERI

ŠKODA GROUP

Programme	The International EPD® System, www.environdec.com
Programme operator	EPD International AB
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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**.

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Company information

Owner of the EPD: Škoda Transtech Oy (member of Škoda Group), +358 88 706 900, info@transtech.fi, Tutkijantie 8, 90570 Oulu, Finland
Description of the organisation: Škoda Transtech Oy, member of Škoda Group, is a Nordic rolling stock manufacturer specialized in production of vehicles for demanding weather conditions. The production facilities together with its outdoor test track are located in Otanmäki, Finland.
Product-related or management system-related certifications: ISO/TS 22163, ISO 9001 and ISO 14001
Name and location of production site: Otanmäki production site, Kokkolantie 1791, 88200 Otanmäki, Finland

Product information

Product name
TRAM FORCITY

Product identification
SMART ARTIC X54

Product description
8-axle, 4-bogie, 5-module, multi-articulated tram with all fully pivoting bogies at a low floor passenger compartment. The tram is designed for operations in harsh Nordic conditions. Expected service life time is 40 years.

UN CPC code
UN CPC 495, 2009:05, version 4.04

Geographical scope
The geographical range is global with priority use of Finnish and European processes for the production site located in Otanmäki. Operation and the end of life treatment are based on Finnish conditions in the City of Helsinki.

LCA information

Potential environmental impacts of Jokeri rolling stock have been evaluated using the life cycle assessment method according to ISO 14040:2006 and ISO 14044:2006 standards and with requirements of the PCR Rolling stock 2009:05, UN CPC 495, ver. 4.0.1. LCA serves as a valuable tool in environmental sustainability, offering a systematic and science-based approach to quantify and assess the environmental consequences associated with various scenarios and actions. Reference year is based on 01-09/2023 production data (due to new assembly line) and 2022 waste data of the Jokeri tram for the City of Helsinki and was carried out using the OpenLCA software ver. 2.0.2 with the Ecoinvent ver. 3.9.1, cut-off LCI database. Characterization methods used to assign environmental impacts are Environmental Footprint ver. 3.1 and EN 15804 for specific requirements. All processes responsible for more than 99% of the environmental impacts have been included in the LCA study.

Functional unit
The functional unit chosen is the transport of 1 passenger over 1 kilometre using the Jokeri tram in the City of Helsinki.

Reference service life
The operating lifetime of Jokeri has been set for 40 years with an average running distance of 80 000 km per year.

Time representativeness
The data set will be considered valid until there are significant changes to data in the production, technology, supply chain or operational and end of life scenarios.

Description of system boundaries
The system boundary is defined according to the chosen "cradle to grave" approach and therefore covers the whole life cycle within the scope proposed in the PCR.

More information
For vehicle production, the environmental implications of material procurement and component assembly, transportation of materials to the assembly plant, the assembly process itself, transportation of vehicles to the City of Helsinki, operational and maintenance phases, as well as waste management resulting from both the assembly and vehicle dismantling, have been evaluated. The data related to materials and production has been sourced from Skoda Transtech Oy's internal ERP database, based on measurements, calculations, and supply chain information. The mass of data obtained from the manufacturer include a 10% deviation and are expected to be lower, which suggests that the final environmental impact calculations may be overestimated.

When assessing the environmental impact related to energy consumption during the assembly phase, the energy production processes have been modelled using data for Finnish power sources, in accordance with the company's 2022 Guarantee of Origin energy certificate. Total energy consumption from 01-09/2023 was allocated based on the project working hours and number of trams finished.

During the operational phase, normal vehicle occupancy capacity (MNO) of 171 passengers has been considered, with 80% of passengers seated and an 80% of additional 4 passengers per square meter standing, following the EN 15663 standard for operational load. The environmental impact of energy consumption during the operational phase (0,0306 kWh/pass. km) has been evaluated based on the Finnish residual mix (0,398 kg CO_2 eq./kWh), as per the PCR (Source: AIB 2022). Data related to maintenance materials usage are based on planned preventive maintenance activities throughout the vehicle's entire lifespan, encompassing the majority of materials and spare parts.

For end-of-life treatment, the model adheres to available technology and follows the UNIFE UNI-LCA-001 method. It is assumed that the vehicle will be dismantled and disposed of in the City of Helsinki. The potential benefit from material recycling and energy recovery is not included in the calculation of the environmental impacts. Results are only relative statements which do not indicate the end points of the impact categories, exceeding threshold values, safety margins or risks.

Hazardous substances

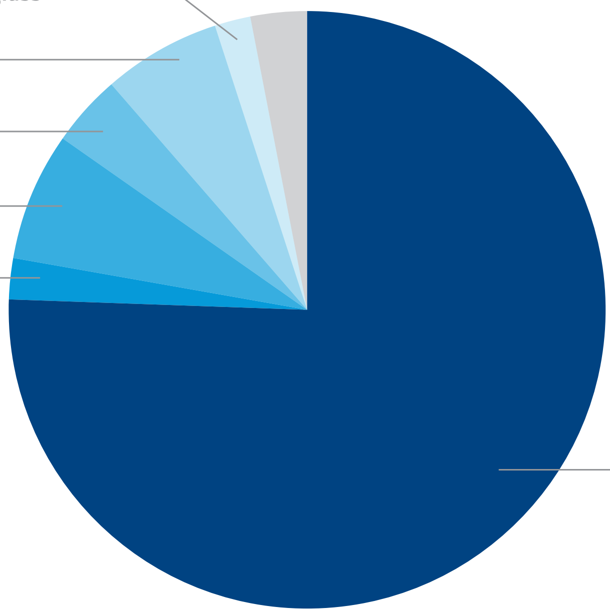
Skoda's approach to managing hazardous substances aligns with European regulations, including REACH, and adheres to the principles of the railway sector as outlined in the RISL (Railway Industry Substances List). These considerations are integral during the vehicle design phase and extend to the chemicals used for maintenance. Certain functional and safety requirements necessitate the use of hazardous substances, such as heavy metals in electronics, lubricants and the refrigerant used in the HVAC system. In any prohibited applications no hazardous substances are used during the manufacture of the Tram Forcity SMART ARTIC X54.

NOISE EMISSIONS
The noise levels for the tram were determined in accordance to the ISO 3095.

	UNIT	dB
Standstill noise (partial load)	$L_{pAeq,T}$	≤ 48
Acceleration noise	L_{AFmax}	≤ 75
Pass-by noise at 60 km/h	L_{Aeq}	≤ 78

Recyclablity rate
92.60%
Recoverability rate
98.00%

VEHICLE MATERIALS CONTENT

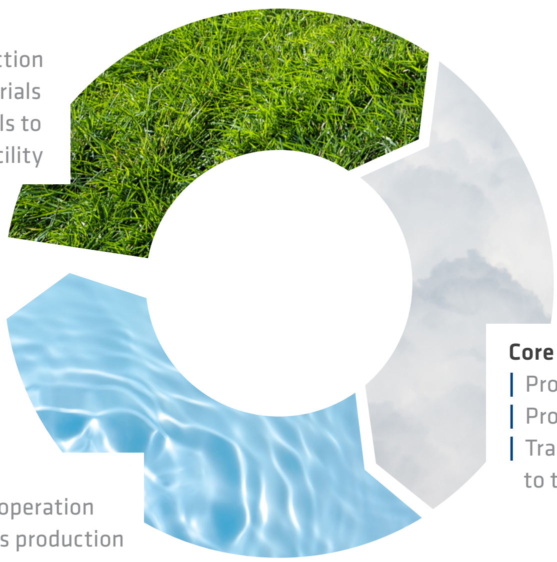


OPERATIONAL PHASE	MAIN SCENARIO – MNO	EL4	EL6
Distance travelled per year	80 000 km	80 000 km	80 000 km
Vehicle lifetime	40 years	40 years	40 years
Normal operational load	171 passengers	214 passengers	282 passengers
Energy consumption	0.0306 kWh/pass.km	0.0254 kWh/pass.km	0.0204 kWh/pass.km

“MNO” (80 % of seats occupied, 80% of 4 pass./m² standing) “EL4” (all seats occupied, 4 pass./m² standing)
“EL6” (all seats occupied, 6 pass./m² standing)

LIFECYCLE PHASES

Upstream
- Extraction and production of raw and basic materials
- Transports of materials to the manufacturing facility



Core
- Production and assembly of rolling stock
- Production of auxiliary materials
- Transportation of the rail vehicle to the operation location

Downstream
- Energy consumption during operation
- Major maintenance materials production
- End of life treatment

Content declaration

Material content in 1 vehicle (%)	Carbody	Interior, windows and doors	Bogies and running gears	Propulsion and electric	Comfort systems	Non-classified	Total
Metals	24.90%	10.12%	19.35%	14.46%	3.10%	3.89%	75.81%
Elastomers	0.42%	0.83%	0.00%	0.61%	0.09%	0.25%	2.20%
Polymers	0.69%	2.98%	0.21%	1.56%	0.00%	1.49%	6.93%
Composites	0.00%	3.70%	0.00%	0.08%	0.03%	0.09%	3.90%
Electric and Electronic Equipment	0.00%	0.15%	0.66%	4.28%	0.39%	0.75%	6.23%
Glass	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Safety glass	0.00%	2.01%	0.00%	0.00%	0.00%	0.00%	2.01%
Oil, grease and similar	0.03%	0.11%	0.00%	0.00%	0.00%	0.13%	0.28%
Acids, cooling agents or similar	0.00%	0.00%	0.00%	0.66%	0.00%	0.03%	0.69%
Other inorganic materials	0.00%	0.07%	0.03%	0.00%	0.00%	1.79%	1.89%
Mineral wool	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
MONM, including wood	0.00%	0.07%	0.00%	0.00%	0.00%	0.00%	0.07%
TOTAL	26.04%	20.04%	20.25%	21.64%	3.61%	8.42%	100.00%

Results of the environmental performance indicators

IMPACT CATEGORY INDICATORS

PARAMETER		Unit	Upstream	Core	Downstream	Total
Global warming potential (GWP)	Fossil	kg CO_2 eq.	6,11E-04	3,90E-04	1,28E-02	1,38E-02
	Biogenic	kg CO_2 eq.	3,07E-06	2,55E-07	1,00E-05	1,34E-05
	Land use and land transformation	kg CO_2 eq.	4,72E-06	1,79E-07	1,23E-05	1,71E-05
	TOTAL	kg CO_2 eq.	6,19E-04	3,90E-04	1,28E-02	1,38E-02
Ozone layer depletion (ODP)		kg CFC ^{11} eq.	5,99E-11	5,78E-12	2,58E-10	3,24E-10
Acidification potential (AP)		mol H^+ eq.	5,85E-06	1,89E-06	4,08E-05	4,85E-05
Eutrophication potential (EP)	Aquatic freshwater	kg P eq.	4,42E-07	6,66E-08	4,10E-06	4,61E-06
	Aquatic marine	kg N eq.	7,62E-07	3,04E-07	9,18E-06	1,03E-05
	Aquatic terrestrial	mol N eq.	7,89E-06	3,16E-06	8,94E-05	1,00E-04
Photochemical oxidant creation potential (POCP)		kg NMVOC eq.	2,98E-06	1,18E-06	3,15E-05	3,57E-05
Abiotic depletion potential (ADP)*	Metals and minerals	kg Sb eq.	4,25E-08	3,32E-10	1,20E-08	5,48E-08
	Fossil resources	MJ, net calorific value	8,03E-03	6,46E-03	3,71E-01	3,85E-01
Water deprivation potential (WDP)*		m^3 world eq. deprived	2,63E-04	5,83E-05	3,33E-03	3,65E-03
Particulate matter emissions*		disease incidence	4,80E-11	3,56E-11	2,20E-10	3,04E-10

** 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

PARAMETER		Unit	Upstream	Core	Downstream	Total
Primary energy resources – Renewable	Use as energy carrier	MJ, net calorific value	3,78E-06	1,07E-03	1,51E-02	1,62E-02
	Used as raw materials	MJ, net calorific value	1,03E-03	6,89E-06	1,66E-04	1,20E-03
	TOTAL	MJ, net calorific value	1,03E-03	1,08E-03	1,53E-02	1,74E-02
Primary energy resources – Non-renewable	Use as energy carrier	MJ, net calorific value	2,40E-04	6,35E-03	3,68E-01	3,68E-01
	Used as raw materials	MJ, net calorific value	7,80E-03	1,10E-04	2,66E-03	1,69E-02
	TOTAL	MJ, net calorific value	8,04E-03	6,46E-03	3,71E-01	3,85E-01
Secondary material (optional)		kg	ND	ND	ND	ND
Renewable secondary fuels (optional)		MJ, net calorific value	ND	ND	ND	ND
Non-renewable secondary fuels (optional)		MJ, net calorific value	ND	ND	ND	ND
Net use of fresh water (optional)		m3	9,27E-06	1,48E-06	2,86E-04	2,97E-04

Acidification (AP)
Acidification is the process of increasing the acidity of soils, air, or water caused by an elevated concentration of hydrogen ions. An indicator of the impact category of acidification is accumulated exceedance (AE). The result is expressed in mol H+ eq.

Climate change (GWP)
Climate change is divided into three parts: biogenic, fossil, land use and land use transformation. Indicator called global warming potential (GWP100) is used to measure the amount of greenhouse gases contributing to global warming. The results are quantified in kilograms of CO2 eq.

Resource use, minerals and metals (ADP)
Resource scarcity and limitations for current and future generations includes depletion of abiotic resources – elements (ADPe), quantified in kg Sb eq. and depletion of abiotic resources – fossil fuels (ADPf), quantified in MJ.

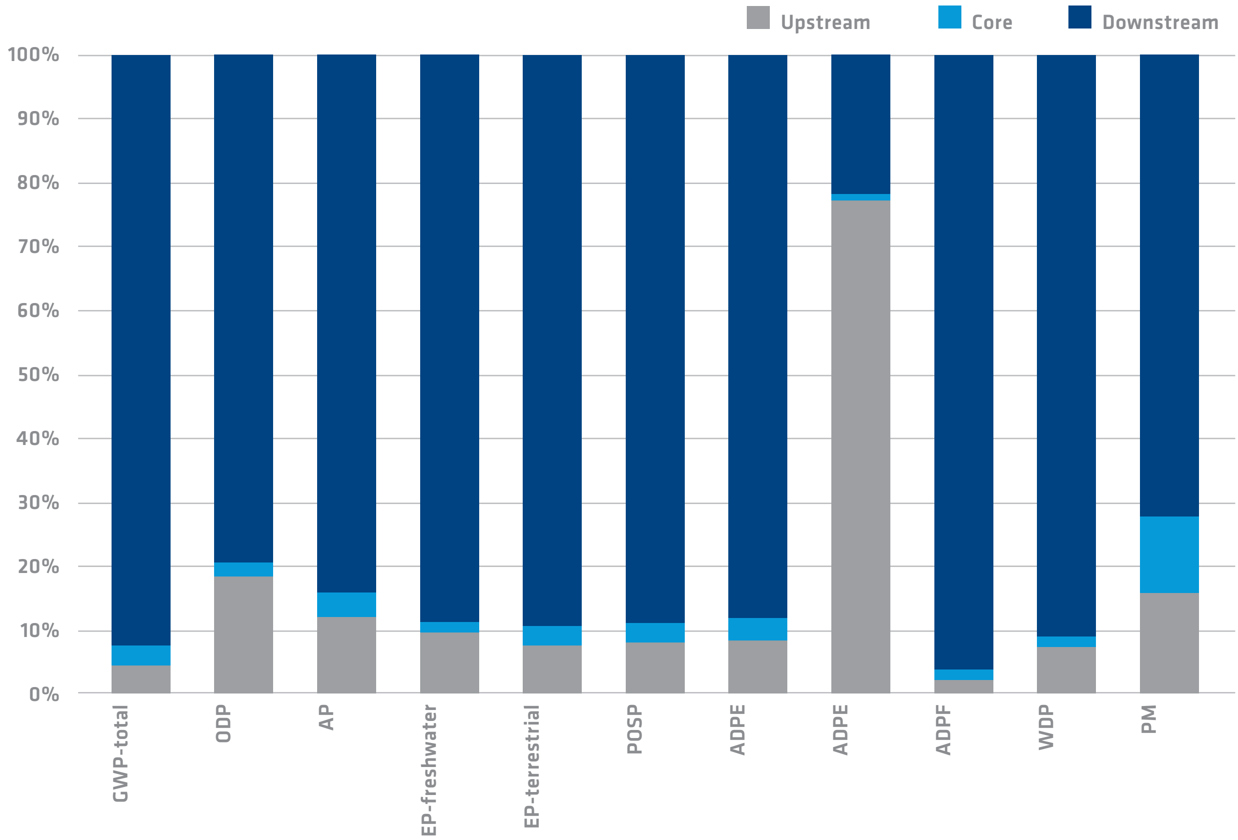
Eutrophication (EP)
Eutrophication enriches the environment with nutrients, impacting land, water, and seas leading to excess plankton and algae growth, harming the water quality. It is categorised into terrestrial (accumulated exceedance expressed in mol N eq.), freshwater (nutrient fraction reaching freshwater end expressed in kg P eq.), and marine impacts (nutrient fraction reaching marine end expressed in kg N eq.

Water use (WDP)
Water deprivation potential quantifies the potential of water deprivation to humans or ecosystems. It is quantified in m^3 world eq. and helps evaluate the risks associated with water scarcity.

Ozone depletion (ODP)
Ozone layer depletion is the result of emissions of ozone-depleting substances, such as long-lived chlorine and bromine-containing gases (e.g., CFCs, HCFCs, Halons). It is quantified in kg CFC-11 eq., with the ozone depletion potential as its indicator.

Photochemical oxidant formation (POCP)
The impact category photochemical oxidation formation aggregates substances that contribute to the formation of tropospheric ozone. Category indicator is tropospheric ozone concentration increase expressed in kg NMVOC eq.

CONTRIBUTION OF LIFE CYCLE PHASES ON THE ENVIRONMENTAL IMPACTS



WASTE INDICATORS

PARAMETER	UNIT	Upstream	Core	Downstream	TOTAL
Hazardous waste disposed	kg	1,26E-09	3,67E-11	3,58E-09	4,88E-09
Non-hazardous waste disposed	kg	2,73E-06	1,52E-07	9,71E-06	1,26E-05
Radioactive waste disposed	kg	9,55E-10	1,44E-09	1,71E-07	1,74E-07

OUTPUT FLOW INDICATORS

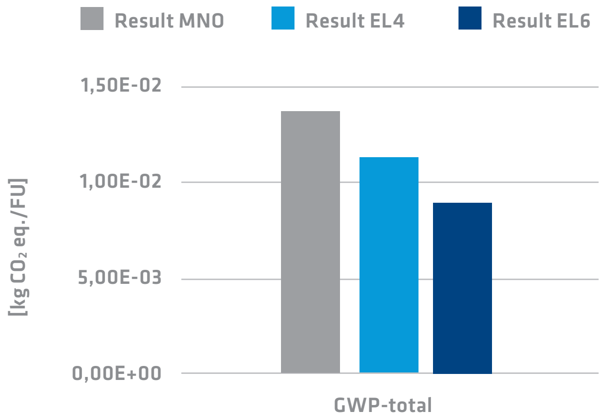
PARAMETER	UNIT	Upstream	Core	Downstream	TOTAL
Components for reuse	kg	ND	ND	ND	ND
Material for recycling	kg	ND	1,29E-05	1,05E-04	1,18E-04
Materials for energy recovery	kg	ND	8,57E-07	6,19E-06	7,05E-06
Exported energy, electricity	MJ per energy carrier	ND	ND	ND	ND
Exported energy, thermal	MJ per energy carrier	ND	ND	ND	ND

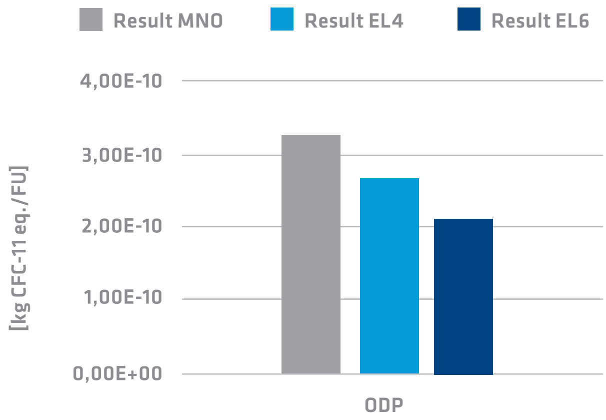
"INA" (Indicator Not Assesed)

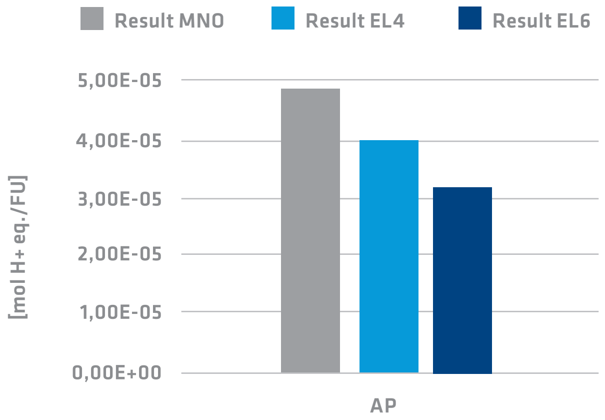
Additional environmental information

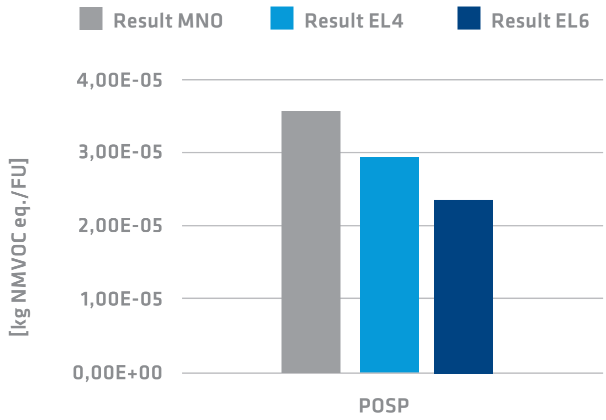
For higher representativeness of the results two more operational scenarios were evaluated. Subsequent assessment of the scenarios shows that increasing the number of passengers to 214 (EL4) or 272 (EL6) passengers would considerably reduce (by 17 % and 39 %) the final environmental impacts in all categories.

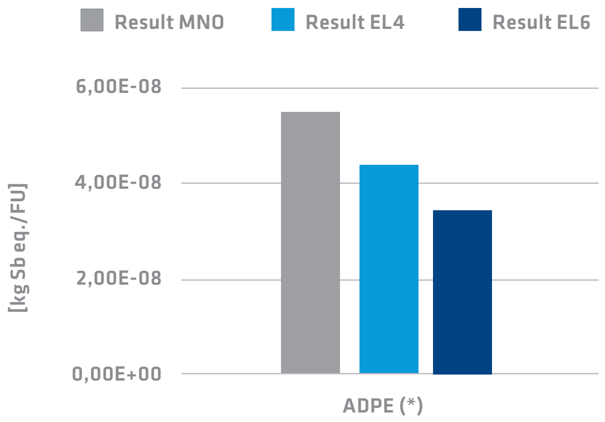
DIFFERENT SCENARIOS COMPARISON

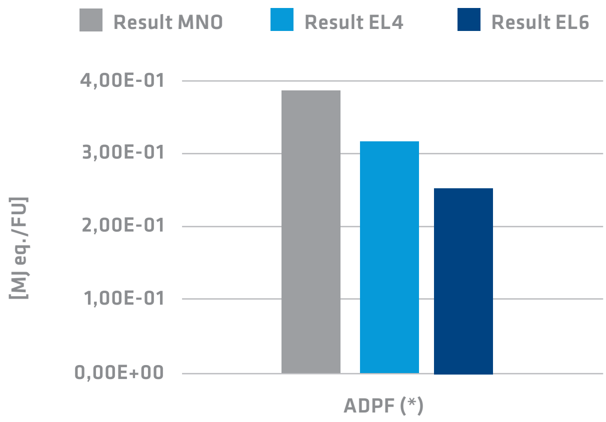












Programme information

Programme

The International EPD® System, EPD International AB, Box 210 60, SE-100 31 Stockholm, Sweden
www.environdec.com, info@environdec.com
EPD owner has the sole ownership, liability and responsibility of the EPD.

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

Product Category Rules (PCR)	
PCR	Rolling stock and parts thereof, 2009:05, Version 4.0.1, UN CPC 495
PCR review was conducted by	Claudia A. Peña, The Technical Committee of the International EPD® System. A full list of members is available at www.environdec.com. The review panel may be contacted via info@environdec.com.
Life Cycle Assessment (LCA)	
LCA accountability	Doc. Ing. Lukáš Ferkl, Ph.D., Ing. Eva-Žofie Hlinková, EnviTrail s.r.o.
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	Doc. Ing. Jan Weinzettel, Ph.D., Individual EPD verifier for EPD International
Approved by	The International EPD® System

*For EPD Process Certification, an accredited certification body certifies and reviews the management process and verifies EPDs published on a regular basis. For details about third-party verification procedure of the EPDs, see GPI.

Procedure for follow-up of data during EPD validity involves third-party verifier: ☐ Yes ☑ No

EPDs within the same product category but from different programmes may not be comparable. For two EPDs to be comparable, they must be based on the same PCR (including the same version number) or be based on fully aligned PCRs or versions of PCRs; cover products with identical functions, technical performances and use (e.g. identical declared/functional units); have equivalent system boundaries and descriptions of data; apply equivalent data quality requirements, methods of data collection, and allocation methods; apply identical cut-off rules and impact assessment methods (including the same version of characterisation factors); have equivalent content declarations; and be valid at the time of comparison.

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