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# Train HTR 412 Blues



Environmental Product Declaration in Accordance with ISO 14025  
Programme: The International EPD® System, [www.environdec.com](http://www.environdec.com),  
Programme operator: EPD International AB, Box 210 60, SE-100 31 Stockholm, Sweden

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## Verification informations

E-mail: [info@environdec.com](mailto:info@environdec.com).

EPD within the same product category, but from different programs, may not be comparable.

The owner of the EPD has the exclusive property and responsibility of the EPD.

Product Category Rules (PCR) reviewed and conducted by: The Technical Committee of the International EPD® System. Chair: Adriana Del Borghi Contact trough <a href="mailto:info@environdec.com">info@environdec.com</a>
Independent verification of the declaration and data, according to ISO 14025: 2006: <input type="checkbox"/> Certification process EPD <input checked="" type="checkbox"/> EPD verification
Third party verifier: Ing. Adriana Del Borghi ( <a href="mailto:delborghi@tetisinstitute.it">delborghi@tetisinstitute.it</a> , Tetis Institute Srl <a href="http://www.tetisinstitute.it">www.tetisinstitute.it</a> )  Approved by: International EPD System Technical Committee, supported by the Secretariat
Valid until: 2027/01/17
Procedure for follow-up of data during EPD validity involves third party verifier: <input checked="" type="checkbox"/> SI <input type="checkbox"/> NO

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Geographical Scope: Italy

# Company

Hitachi Rail is a fully integrated, global provider of rail solutions across rolling stock, signaling, service & maintenance, digital technology and turnkey solutions. With a presence in 38 countries across six continents and over 12,000

employees, our mission is to contribute to society through the continuous development of superior rail transport solutions. Drawing on the wider Hitachi Group's market-leading technology and research-and-development capabilities, we strive for

industry leading innovations and solutions that can deliver value for customers and sustainable railway systems that benefit wider society. For more information about Hitachi Rail, visit [www.hitachirail.com](http://www.hitachirail.com)

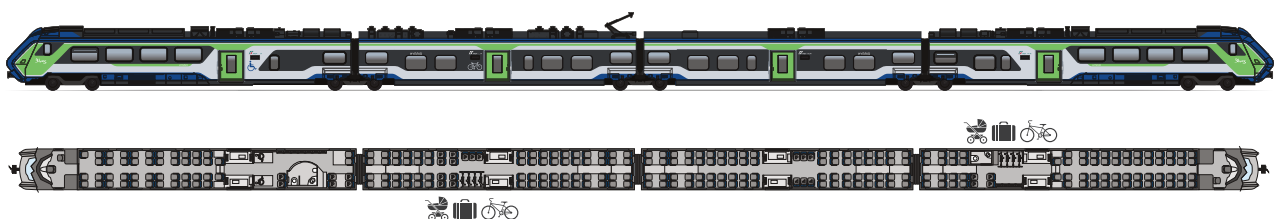
# Product

The vehicle features an innovative architecture that offers 4 operating modes:

- Electric (EMU) - Power supply from catenary 3kVdc (with provision for other supply voltages 25kVac 50Hz // 15kVac 16<sup>2</sup>/<sub>3</sub>Hz)
- Diesel-Electric (DEMU) - Powered by on-board Diesel Engine
- Hybrid (HMU) - Powered by on-board diesel engine and traction batteries
- Battery (BEMU) - Power supply from Traction Batteries (the simulation is not present in this document)

The HTR 412 Blues hybrid train, belonging to the Masaccio platform, is a rolling stock made by four passenger carriages coupled by three articulations. The rolling stock is approved in accordance with the current interoperability specifications (TSI) and classified as "Regional" - "Medium to long distance between stations" - "Electric / diesel locomotives with single and double deck passenger coaches".

There are two independent hybrid systems on board and each of them is composed of one LTO battery pack of 66 kWh (flexible and scalable capacity) installed on the roof of the TP towed box near the air conditioning system of the storage cells battery, and of one diesel power pack installed in the underbody of each motor body. In particular, the diesel power pack includes the 1000 HP diesel endothermic engine, the cooling system and the exhaust gas treatment system which minimizes and limits the emission values of atmospheric pollutants in accordance with the requirements issued by European bodies for the latest generation engines classified as "Stage V". The following figure shows the train configuration.



## Technical informations

### Dimensions

- Length	86.08 m
- Width	2.80 m
- Height from the Pdf	4.286 m
Net weight	162,231 kg
Full speed	160 km/h
Number of Passengers Use test	498
Maximum acceleration	1.08 m/s <sup>2</sup> (EMU) 0.78 m/s <sup>2</sup> (HMU-DEMU)
Maximum power	1,330 kW (HMU)
Load Factor	94%
Specific Consumption Use Test	4.23 kWh/km (EMU) 1.94 l/km (HMU) 1.74 l/km (DEMU)

Use Test is the configuration used for the assessment of environmental impacts.

The following table shows the distribution of the materials that compose the train.

Product Group	Materials (kg) per vehicle								Total
	Metals	Polymers	Elastomers	Glass	Tec. Fluids	MONM	EEE	Others	
1 - Carbody	39,769	5	117	-	1	-	160	2,133	42,184
2 - Interior, window and doors	19,972	2,097	1,548	3,044	0	2,400	369	1,977	31,409
3 - Bogies / running gears	44,571	25	668	-	183	0	13	278	45,737
4 - Propulsion and electric equipment	27,275	4,058	1,054	16	130	0	2,963	816	36,311
5 - Comfort system	6,098	184	244	-	51	-	-	13	6,590
<b>Total</b>	<b>137,684</b>	<b>6,369</b>	<b>3,631</b>	<b>3,061</b>	<b>365</b>	<b>2,400</b>	<b>3,505</b>	<b>5,216</b>	<b>162,231</b>
	<b>84.9%</b>	<b>3.9%</b>	<b>2.2%</b>	<b>1.9%</b>	<b>0.2%</b>	<b>1.5%</b>	<b>2.2%</b>	<b>3.2%</b>	<b>100.0%</b>

MONM = Modified Organic Natural Materials (es.: leather, wood, cardboard, etc.)

EEE = Electric and Electronic Equipment

The following table shows the distribution of the materials that compose the HTR 412 Train in reference to the functional unit.

Product group	Materials (mg) per F.U.								
	Metals	Polymers	Elastomers	Glass	Tec. Fluids	MONM	EEE	Others	Total
1 - Carbody	24.571	0.003	0.072	-	0.001	-	0.099	1.318	26.064
2 - Interior, windows and doors	12.340	1.296	0.956	1.881	0.000	1.483	0.228	1.222	19.406
3 - Bogies / Running gears	27.538	0.015	0.413	-	0.113	0.000	0.008	0.172	28.259
4 - Propulsion and electric equipment	16.852	2.507	0.651	0.010	0.080	0.000	1.831	0.504	22.435
5 - Comfort system	3.767	0.114	0.151	-	0.031	-	-	0.008	4.071
<b>Total</b>	<b>85.069</b>	<b>3.935</b>	<b>2.243</b>	<b>1.891</b>	<b>0.226</b>	<b>1.483</b>	<b>2.166</b>	<b>3.223</b>	<b>100.235</b>
	<b>84.9%</b>	<b>3.9%</b>	<b>2.2%</b>	<b>1.9%</b>	<b>0.2%</b>	<b>1.5%</b>	<b>2.2%</b>	<b>3.2%</b>	<b>100.0%</b>

MONM = Modified Organic Natural Materials (es.: pelle, legno, cartone, etc.)    EEE = Electric and Electronic Equipment

The following dangerous substances are contained within the products that compose the train.

Dangerous substances	kg	Where
Lubricants/Oils/Gases	300	Propulsion and electrical equipment
Nickel cadmium batteries	700	Propulsion and electrical equipment







# Environmental Performance Declaration

## Methodology

The environmental performance of the product was measured through the Life Cycle Assessment (LCA), according to the ISO 14040 and ISO 14044 standards.

The data used for the study are the 2020 environmental results of the Pistoia and Naples plants multiplied by the hours / production budget of 2021 used as an allocation factor. Both generic and specific data meet the criteria for the preparation of the EPD contained in the General Program Instructions, as well as in the Product Category Rules for railway vehicles. The contribution provided by proxy data is less than 10% of the total. The use phase was modelled using data obtained from a simulation carried out by "HR" in compliance with the CEI CLC / TS\_50591: 2014-05 and TECREC\_100\_001\_ENERGY\_STANDARD\_VER\_1\_2\_final

standards.

In calculating the impacts of the use phase as consumption, the one related to the convoy in 4-car configuration was considered, while the section of 70 km was taken as the reference section and for the profile, the attachment B.3 Regional Passenger Traffic was respected in relation to CEI CLC / TS\_50591: 2014-05 standard.

The simulation results were obtained for different operating conditions:

- EMU, fully electric with catenary power supply
- HMU, hybrid mode
- DEMU, hybrid mode with battery support

Since the vehicle, depending on the different routes, will be able to operate in the three different modes, the results are proposed for the three operating scenarios. For the simulations, the

following hypotheses were assumed:

For the simulations, the following hypotheses were assumed:

- Total kilometers traveled on average per year: 130,000 km
- Life cycle train: 25 years
- Number of passengers (in accordance with EN 15663): 498

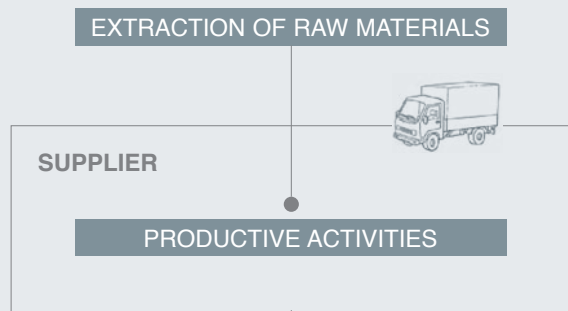
The Italian energy mix taken from the European Residual Mixes 2020 document prepared by the AIB (Association of Issuing), was used as the electricity mix for the use phase. The Ecoinvent 3.6 database was considered for the processes for the production of basic materials, for the processes of waste treatment and for the production of electronic parts. The default factors available on the website [www.environdec.com](http://www.environdec.com) were used as characterization factors.

# Functional unit

In accordance with the relevant PCR, the functional unit is represented by the transport of 1 passenger for 1 km

## System Boundaries

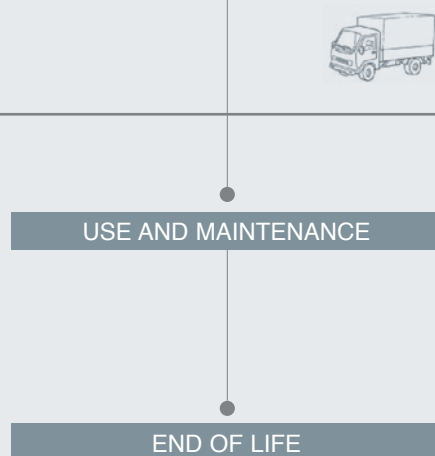
### MODULE UPSTREAM



### MODULE CORE



### MODULE DOWNSTREAM



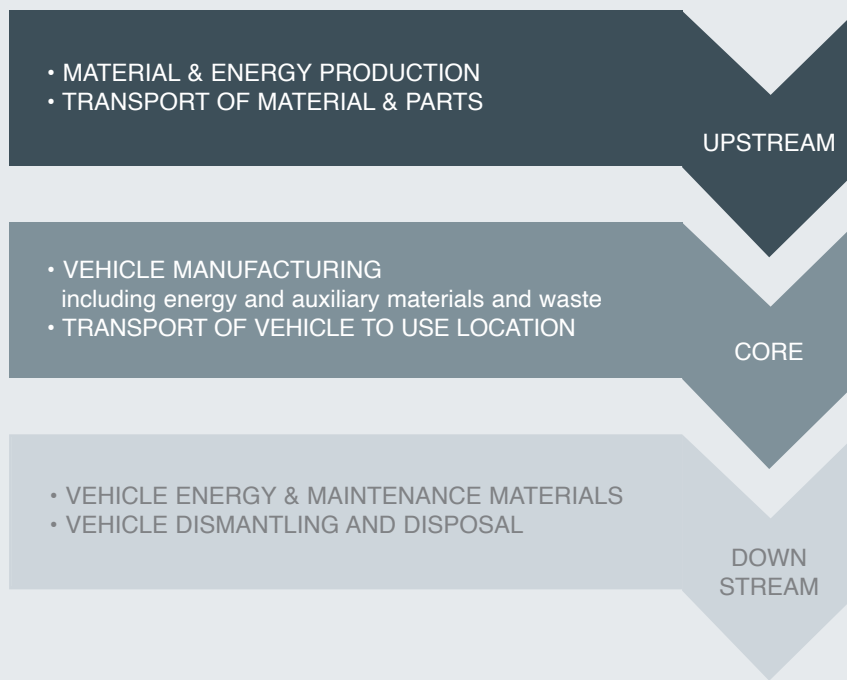
EPD

Figure 1 - System boundaries. All modules from the extraction of raw materials to the end of life are included





The chosen system is divided into three phases based on the following hypotheses:



### **Exclusion (Cut off)**

The exclusion rules applied are in line with the indications of the relative PCR.  
Transport to the end customer was overlooked

# Environmental Results

## Environmental Impacts

Parameters	U.M.	Upstream	Core	Downstream				Total		
				Use Phase EMU	Use Phase HMU	Use Phase DEMU	End of life	Use Phase EMU	Use Phase HMU	Use Phase DEMU
GWP	kg CO <sub>2</sub> eq.	6.8228E-04	5.5618E-04	5.0373E-03	1.3237E-02	1.1889E-02	4.3705E-06	6.2801E-03	3.1402E-02	3.1407E-02
ODP	kg CFC-11 eq.	2.6632E-09	6.2064E-11	3.2974E-10	2.3226E-09	2.0890E-09	2.4980E-13	3.0553E-09	0	0
AP	kg SO <sub>2</sub> eq.	5.9140E-06	1.0426E-06	2.0991E-05	1.3047E-04	1.1738E-04	4.7238E-09	2.7952E-05	2.7580E-04	2.7580E-04
EP	kg PO <sub>4</sub> <sup>3-</sup> eq.	2.2910E-06	2.5141E-07	5.6382E-06	2.3989E-05	2.1617E-05	1.3172E-09	8.1819E-06	5.3787E-05	5.3789E-05
POCP o POFP	kg C <sub>2</sub> H <sub>4</sub> eq.	3.2670E-07	5.9317E-08	9.5545E-07	2.3582E-06	2.1321E-06	1.8050E-10	1.3416E-06	5.8318E-06	5.8319E-06
ADPe	kg Sb eq.	1.7404E-07	2.5702E-09	2.0041E-07	2.0804E-07	2.0595E-07	3.1528E-11	3.7705E-07	7.9100E-07	7.9104E-07
ADPf	MJ, potere calorifico netto	9.5400E-03	8.6402E-03	7.8182E-02	1.8302E-01	1.6440E-01	2.0849E-05	9.6383E-02	4.4378E-01	4.4380E-01

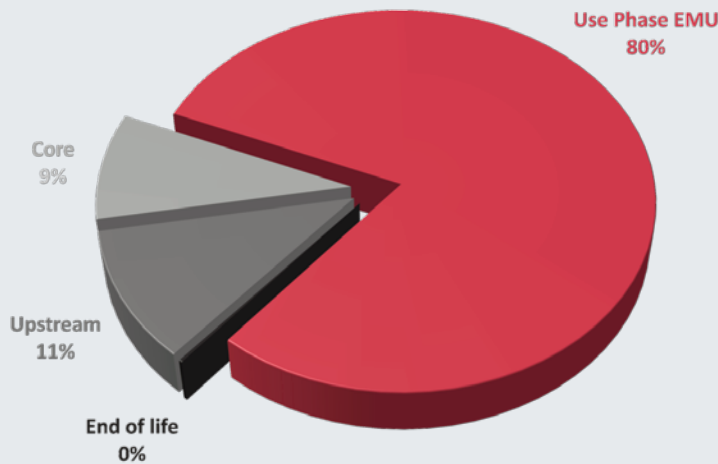
## Use of Resources

Parameters	U.M.	Upstream	Core	Downstream				Total		
				Use Phase EMU	Use Phase HMU	Use Phase DEMU	End of life	Use Phase EMU	Use Phase HMU	Use Phase DEMU
Renewable										
Use as energy carriers	MJ	9.0926E-04	3.7528E-03	4.5035E-03	1.1368E-03	1.0353E-03	2.9282E-07	9.1658E-03	1.1338E-02	1.1338E-02
Used as raw materials	MJ	2.9229E-05	0	2.7516E-06	2.7516E-06	2.7516E-06	0	3.1980E-05	3.7484E-05	3.7484E-05
<b>Total</b>	<b>MJ</b>	<b>9.3849E-04</b>	<b>3.7528E-03</b>	<b>4.5062E-03</b>	<b>1.1396E-03</b>	<b>1.0381E-03</b>	<b>2.9282E-07</b>	<b>9.1978E-03</b>	<b>1.1375E-02</b>	<b>1.1375E-02</b>
Non Renewable										
Use as energy carriers	MJ	7.4058E-03	7.6366E-03	7.7516E-02	1.8371E-01	1.6494E-01	2.0796E-05	9.2579E-02	4.4121E-01	4.4123E-01
Used as raw materials	MJ	2.4590E-04	3.7397E-05	4.7572E-04	4.7572E-04	4.7572E-04	0	7.5902E-04	1.7105E-03	1.7105E-03
<b>Total</b>	<b>MJ</b>	<b>7.6517E-03</b>	<b>7.6740E-03</b>	<b>7.7991E-02</b>	<b>1.8419E-01</b>	<b>1.6542E-01</b>	<b>2.0796E-05</b>	<b>9.3338E-02</b>	<b>4.4292E-01</b>	<b>4.4294E-01</b>
Secondary material	kg	0	0	0	0	0	0	0	0	0
Renewable secondary fuels	MJ	0	0	0	0	0	0	0	0	0
Non-renewable secondary fuels	MJ	0	0	0	0	0	0	0	0	0
Use of fresh water	m <sup>3</sup>	6.0399E-06	6.8492E-06	4.6808E-05	1.0733E-05	9.7668E-06	6.8206E-09	5.9703E-05	8.0196E-05	8.0203E-05

## Waste Productions and Output Flows

Parameters	U.M.	Upstream	Core	Downstream				End of life	Total		
				Use Phase EMU	Use Phase HMU	Use Phase DEMU	Use Phase EMU		Use Phase HMU	Use Phase DEMU	
WASTE											
Hazardous waste disposed	kg	0	1.3938E-06	0	0	0	0	1.3938E-06	1.3938E-06	1.3938E-06	
Non-hazardous waste disposed	kg	0	1.9778E-05	8.6006E-07	8.6006E-07	8.6006E-07	4.7723E-06	2.5411E-05	2.2358E-05	2.7131E-05	
Radioactive waste disposed	kg	2.0883E-08	7.3473E-09	2.3954E-07	1.2731E-06	1.1428E-06	1.3945E-10	2.6791E-07	2.6836E-06	2.6837E-06	
ENERGY (MJ)											
Component for reuse	kg	0	0	0	0	0	0	0	0	0	
Material for recycling	kg	0	3.0064E-04	1.9999E-05	2.3406E-05	2.3406E-05	9.3491E-05	4.1413E-04	3.6745E-04	4.6094E-04	
Material for energy recovery	kg	0	0	1.1237E-05	1.1237E-05	1.1237E-05	1.9722E-06	1.3209E-05	3.3711E-05	3.5683E-05	
Exported energy, electricity	MJ	0	0	0	0	0	0	0	0	0	
Exported energy, thermal	MJ	0	3.0064E-04	3.1236E-05	0	0	9.5463E-05	4.2734E-04	4.0116E-04	4.9662E-04	

## GWP



Around 80% of the GWP is related to the "Use phase - DownStream" of the train and is due to emissions caused by the energy consumption necessary for the vehicle to function throughout its life.



## Additional information

### Energy consumption

As energy consumption of Train HTR 412 in use phase, the one obtained by the "HR" Engineering function through a simulation was considered. This was consistent with the CEI CLC / TS\_50591: 2014-05 standards (as required by the reference PCR) and TECREC\_100\_001\_ENERGY\_STANDARD\_VER\_1\_2\_final calculated on a stretch of 70 km. It resulted that the vehicle's average energy consumption was equal to:

- EMU mode: 4.15 kWh/km;
- HMU mode: 1.94 l/km;
- DEMU mode: 1.74 l/km.

The estimated number of passengers considered for the calculation of the functional unit was 498.

### Noise

In addition to the wheels, the main sources of noise and vibration among the systems installed on board the trains are: HVAC, the compressed air circuit, the traction motor, the reducer, the auxiliary converter, the traction converters, the compressed air system and trumpets.

The following table represents the internal and external noise levels in different operating conditions of the train.

	U.M.	stationary noise	acceleration noise from 0 to 30 km/h	transit noise at 80 km/h	transit noise at 160 km/h
EMU	dB	63	80	78	83
HMU	dB	71	83	81	86

The noise analysis was conducted on the vehicle according to ISO 3095 and ISO 3381





### Recyclability and recoverability potential

The recycling and recovery percentages are shown in the following table.

Railway product Recycling Rate Calculation End of Life					
Total Product Mass, MV	162,231 kg	Mass Reused	- kg	Mass Processed	162,231 kg
Mass Recycled	151,315 kg	Mass Recovered as Energy	3,192 kg	Mass for Disposal	7,724 kg
Mass Material Recovered (Reuse+Recyc)	151,315 kg	Industrial Batteries	2,285 kg	Mass Dismantled	67.0%
Reusability	- %	Recyclability Rate	93.3 %	Recovery Rate	95.2%

	Recyclability	Recoverability
End of Life	93.3%	95.2%
Maintenance	65.9%	97.6%
Life Cycle	86.1%	95.9%

### Other environmental informations

Hitachi Rail has developed and certified a Worker Health and Safety Management System in accordance with ISO 45001 and an Environmental Management System in accordance with

ISO 14001. Hitachi Rail recognizes as its strategic objectives:

- the satisfaction of the customer's needs, both from the point of view of the product and the service;
- the health and safety of its employees;

- the safety, reliability and quality of its products.

The use of materials that can cause allergic reactions was completely avoided.

# Glossary

## **Acidification Potential (AP).**

Phenomenon for which rain has an acidity factor (pH) lower than the average values. This can cause damage to forests and crops, aquatic ecosystems and objects in general. This phenomenon is caused by emissions of SO<sub>2</sub>, NOX, and NH<sub>3</sub>, substances included in the Acidification Potential (AP) list and expressed in quantities of equivalent SO<sub>2</sub> produced.

## **Eutrophication Potential (EP).**

Enrichment of surface water bodies by adding nutrients. This causes an imbalance in aquatic ecosystems due to the abnormal development of certain plant species, encouraged by the excessive presence of nutrients. In particular, the Eutrophication Potential (EP) includes salts of phosphorus and nitrogen and is expressed in grams of oxygen (kg O<sub>2</sub>).

## **Global Warming Potential (GWP).**

Phenomenon in which the infrared rays re-emitted from the earth's surface are absorbed by the molecules of certain substances present in the atmosphere, causing a process of global warming of the atmosphere. The indicator used to measure the intensity of the phenomenon is the GWP (Global Warming Potential), which includes CO<sub>2</sub> emissions, the main greenhouse gas, and emissions

of other gases such as methane (CH<sub>4</sub>), nitrogen oxide (N<sub>2</sub>O), chlorofluorocarbons (CFCs), which are expressed in terms of CO<sub>2</sub> equivalent (kg CO<sub>2</sub>eq).

**HVAC.** Heating, Ventilation, and Air Conditioning.

**MONM.** Modified Organic Natural Materials.

## **Ozone Depletion Potential (ODP).**

Degradation and reduction, caused by chlorofluorocarbons (CFC) or chlorofluoromethanes (CFM), of the ozone layer present in the stratosphere to filter the ultraviolet component of the sun's rays thanks to its particularly reactive compounds. The reference substance for evaluating ODP (Ozone Depletion Potential) is trichlorofluoromethane, or CFC-11.

## **Photochemical Ozone Creation Potential (POCP).**

Production of compounds which due to the effect of light, are able to cause oxidizing reactions which lead to the creation of ozone in the troposphere. The POCP (Photochemical Ozone Creation Potential) indicator mainly includes VOCs (volatile organic compounds) and is expressed in grams of ethylene (kg C<sub>2</sub>H<sub>4</sub>).



# References

- LCA Train HTR 412 “Blues” Rev 01 – Final report, Capgemini Engineering and Hitachi Rail, 27 December 2021
- Use phase – ED18P021851B – Convogli Diesel-Elettrici per Trenitalia – Masaccio Blues – Simulazioni di marcia – Rev. 03, 18.01.2021
- Technical Recommendation UIC and UNIFE – Specification and verification of energy consumption for railway rolling stock – TECREC\_100\_001\_ENERGY\_STANDARD\_VER\_1\_2\_final and CEI CLC/TS\_50591:2014-05
- Product Category Rules (PCR 2009:05) v. 3.04 for preparing an Environmental Product Declaration (EPD) for Rolling Stocks - UNCPC CODE: 495
- General Programme Instructions For Environmental Product Declarations, EPD, 2019-09-18 version 3.01
- ISO 22628:2002 - Veicoli stradali - Riciclabilità e recuperabilità - Metodo di calcolo
- EN 15380-2:2006 - Railway applications - Naming system for railway vehicles - Part 2 Product groups
- EN 12663:2009 - Railway applications. Structural requirements of railway vehicle bodies
- ISO 14040:2006/AMD 1:2020 - Environmental management -- Life cycle assessment -- Principles and framework
- ISO 14044:2006 / AMD 1:2017 / AMD 2:2020 - Environmental management -- Life cycle assessment -- Requirements and guidelines
- ISO 3095:2013 - Acoustics -- Railway applications -- Measurement of noise emitted by railbound vehicles
- EN ISO 3381:2011 - Railway applications - Acoustics - Measurement of noise inside railbound vehicles
- UNI EN ISO 45001:2018 - “Sistemi di gestione per la salute e sicurezza sul lavoro – Requisiti e guida per l’uso”
- UNI EN ISO 14001:2015 Sistemi di gestione ambientale - Requisiti e guida per l'uso
- Database Ecoinvent 3.6, software SimaPro 9.1 e dati dei fornitori utilizzati per il calcolo, inclusi i database richiesti dalle PCR
- (1) Reference legislation for dangerous substances
  - Regulation 1907/2006 “REACH” (Annex XVII)
  - Directive 94/62/EC on packaging and packaging waste and subsequent updates
  - Regulation (CE) 1005/2009 on ozone depleting substances
  - Directive 2002/95/CE RoHS
  - Regulation (CE) n. 648/2004
  - Directive 2002/72/CE
  - Directive 2001/41/CE
  - Directive 67/548/CE
- Methodology and versions used in the study for each impact category are the following:
  - Global Warming Potential GWP100, CML 2001 baseline Version: January 2016. IPCC 2013 - kg CO<sub>2</sub> eq
  - Ozone Depletion Potential ODP, Model WMO 1999 kg CFC-11
  - Acidification Potential AP, CML 2001 non-baseline (fate not included), Version: January 2016 - kg SO<sub>2</sub> eq
  - Eutrophication Potential EP, CML 2001 baseline (fate not included), Version: January 2016 - kg PO<sub>43</sub>-eq
  - Photochemical oxidants creation potential POCP, LOTOS-EUROS as applied in ReCiPe 2008 - kg C<sub>2</sub>H<sub>4</sub> eq.
  - Abiotic depletion potential – CML 2001 baseline - Elements - kg Sb eq.
  - Abiotic depletion potential – CML 2001 baseline - Fossil fuels - MJ, net calorific value

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