

ENVIRONMENTAL PRODUCT DECLARATION

In accordance with ISO 14025:2006 and EN15804+A2 for

Hot-rolled Carbon Steel Wire Rod

Manufactured by **Aço Verde Brasil S.A.**

Programme
The Internacional EPD® System
www.environdec.com

Programme Operator
EPD International AB

Local Operator
EPD® Brasil

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EPD INTERNATIONAL EPD SYSTEM

BRASIL EPD®

GENERAL INFORMATION

Programme Information

	The International EPD® System	EPD® Brasil
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Accountabilities PCR, LCA and independent third-party verification

Product Category Rules (PCR)

This declaration is based on the product category rules: **PCR 2023:01 – Fabricated Metal Products, Except Construction Products**, version 1.0.3., 2025-07-29. PCR review was conducted by The Technical Committee of the International EPD® System. A full list of members is available on www.environdec.com. The review panel may be contacted via info@environdec.com. Review chair: Hudai Kara. The review process took place on 16 May 2022 until 16 November 2022.

Life Cycle Assessment (LCA)

The LCA study was conducted by the consultancy Fundação ECO+, through specialists Rebeca Venâncio (rebeca.venancio@basf.com), Ana Carolina Godoy Albino (carolina.godoy@basf.com) and Eduardo Toshio Sugawara (eduardo.toshio-sugawara@basf.com). For more information, visit www.fundacaoecomais.org.br. To contact us, via ecomais@basf.com.

Third-party Verification

The independent, external (third-party) verification process for the Life Cycle Assessment (LCA) and Environmental Product Declaration (EPD) in accordance with ISO 14025:2006 was performed by verifying the individual EPD without a pre-verified LCA/EPD tool. The third-party verifier is accredited by the International EPD System and is Diogo Aparecido Lopes Silva, from the Federal University of São Carlos.

The EPD owner has the sole ownership, liability, and responsibility for the EPD. EPDs within the same product category but published in different programmes, may not be comparable. The following statement from ISO 14020 and 14025 is incomplete on the EPD. For two EPDs to be comparable, they shall be based on the same PCR (including the same first-digit 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 identical scope in terms of included life-cycle stages (unless the excluded life-cycle stage is demonstrated to be insignificant); apply identical impact assessment methods (including the same version of characterisation factors); and be valid at the time of comparison.

ABOUT AÇO VERDE DO BRASIL

Ferroeste Group

The history of the Ferroeste Group began on October 24, 1968, with the Rural Mechanization Company, providing agricultural services, forestry, and internal shipping to steel mills. In 1978, Ferroeste Steel Mill was acquired, rebuilt, and modernized, enabling it to achieve cutting-edge operations in the industry. In the city of Açailândia, Maranhão, we began operations in 1993, producing 60,000 tons annually with Gusa Nordeste S.A., which was the seed for this steel project called AVB – Green Steel of Brazil, the only company in the world to produce green steel, free from fossil fuels.

Providing renewable products with superior quality, customer satisfaction, and respect for the environment. These are the three main pillars that support our corporate commitment and position the Ferroeste brand as one of the most respected in Brazilian industry.

The Ferroeste Group has industrial complexes located in three Brazilian states, located in the Southeast and Northeast regions of the country. It is focused on acting with social and environmental responsibility, safety, quality, and productivity in order to achieve excellent results for our stakeholders. The company delivers high-quality renewable products, guarantees delivery times, provides excellent customer service, and minimizes the environmental impacts inherent in any production activity.





Aço Verde do Brasil

Aço Verde do Brasil S.A. (AVB), a member of the Ferroeste Group, was founded in 2015 with the purpose of transforming the steel industry through sustainability and innovation. It established itself as the first steelmaker in the world to produce long steel without the use of fossil fuels, promoting a pioneering and responsible approach to steel production with a lower environmental impact.

AVB is a publicly-held corporation, registered in category "B" with the Brazilian Securities and Exchange Commission (CVM), and operates with a 100% integrated, modern, and efficient industrial structure. The company's plant is located in the municipality of Açailândia, in the southern state of Maranhão, from where it serves the entire national territory with high-performance, low-impurity products, free of emissions from fossil fuels.

AVB's production model is based on the use of biocarbon, the main input used in its blast furnaces, sourced from sustainably cultivated forest areas. This strategy allows the company to operate with a low carbon footprint, internationally recognized through certification granted by the Société Générale de Surveillance (SGS), based on the guidelines of the Brazilian GHG Protocol Program and methodologies validated by World Steel Association (WorldSteel).

AVB currently has over 3,300 employees distributed across its industrial unit, planted and preserved forest areas in the states of Maranhão and Piauí, and its corporate office located in Minas Gerais. Its commitment to sustainability, innovation, and operational efficiency positions the company as a relevant player in the transition to a low-carbon economy.

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PRODUCT INFORMATION

Table 1 presents technical information on wire rod. Wire rod is a semi-finished long steel product manufactured by hot rolling steel billets into continuous coils with a round cross-section, followed by controlled cooling. At Aço Verde Brasil (AVB), wire rod is produced from iron ore combined with biocarbon from its own production, sourced from sustainably managed forest plantations.



Table 1 - Product Information.

Product Information	Description
Product name	Hot-rolled carbon steel wire rod
Product identification	Wire rod from Aço Verde do Brasil, produced by the Biocarbon BF/ BOF route and followed by hot rolling.
Product description	The wire rod is produced through the integrated steel production route and is widely used in the construction sector as well as in industry. Its applications include the manufacturing of wire for agricultural use, welding wire, nails, fasteners, cables, among other industrial uses.
Product characteristics	Diameter: from 0,90 to 1,25m Weight: from 1,700kg to 2,450 kg Gauges: from 5,5 mm to 16,0mm
Code Identification	UN CPC Group: 412 (for finished products of iron or steel) , Class: 4124 (bars and rods of iron or steel, hot-rolled), and subclass: 41241 (Bars and rods, hot-rolled, in irregularly wound coils, of iron or non-alloy steel)
Geographic scope	Açailândia, Maranhão, Brazil
Applications	*Civil construction*: used for the production of CA60 and, consequently, for the manufacture of trusses, welded mesh, columns, and spacers. *Industry*: used in agriculture, electrification, cables, white goods for home appliances, mechanical construction rods, automotive shock absorber rods, spring wires, ball bearings, among others.

CONTENT DECLARATION

PRODUCT

Below is a summary table with the product contents and the breakdown of the identification of the contained chemical substances and their hazardousness. The raw material for the carbon steel hot-rolled wire rod is the billet; therefore, the **Table 2** presented below shows the substance content of this input.

Product Components	%	Environmental/Hazardous Properties
Pig Iron	71%	No known hazardous properties.
Scrap	25%	No known hazardous properties.
Limestone	3%	No known hazardous properties.
Ferroalloy	1%	No known hazardous properties.
TOTAL	100%	

RECYCLED MATERIAL

Provenience of recycled materials (pre-consumer or post-consumer) in the product: Recycled materials come from scrap and derivatives used in the manufacturing process.

PACKAGING

Distribution packaging: The wire rod is packaged and shipped with a wooden cradle and rollers to ensure greater stability and safety in the distribution of the product. **Table 3** presents in detail the compositon of distribution packaging and their hazards.

Packaging Materials	Weight, kg	Weight, % (versus the product)	Environmental/Hazardous Properties
Wood cradle	15.16	2%	No known hazardous properties.
Rollers (polypropylene)	3.62	0.36%	No known hazardous properties.
Steel nails	0.35	0.04%	No known hazardous properties.
Solvent-based vanish	0.05	0.01%	No known hazardous properties.

Costumer packaging: The wire rod is packaged and shipped with a steel clip and identification tag. The consumer packaging is very low in relation to the product's weight. As the steel clip is made from the wire rod itself, it does not represent an additional material and is not accounted separately in the Content Declaration (**Table 4**).

Packaging Materials	Weight, g	Weight, % (versus the product)	Environmental/Hazardous Properties
Paper (cardboard/offset)	1.5	0.2%	No known hazardous properties.
Adhesive (hot-melt)	0.2	0.02%	No known hazardous properties.
Printing ink	0.05	0.01%	No known hazardous properties.

It is important to mention that in the final result presented, only consumer packaging was considered, due to the cradle-to-gate approach adopted in the study.



LCA INFORMATION

Declared Unit

The **declared unit** (FU) is equal to **1 (one) tonne (t) of the hot-rolled carbon steel wire rod**.

Time representativeness

AVB's primary operational data refer to the estimated average baseline conditions for wire rod production over a period of less than five years. The data comes from technical information provided by AVB experts, covering a three-year production period (2021, 2022 and 2023). Reference data is no older than five years.



Database(s) and LCA software used

MLC Sphera Database (CUP 2024.2) and software Sphera LCA for Experts version 10.6.2.9. MLC Sphera Database provides the life cycle inventory data for several of the raw materials and process materials obtained from upstream system. In the absence of datasets from this database, available ones from the Ecoinvent V3.4 database were used.

Data Quality Assessment

Data Quality was assessed using quantitative measures based on the quality and classification indicators recommended by the International EPD System. The criteria of temporality, location and technological representativeness were assessed using a simple average scale ranging from 1 to 5, where 1 is the best grade. The consolidated results of the analyses of the quality of the primary and secondary data for the present study are shown in Table 5.



Table 5 - Data Quality Analysis for primary and secondary data.

Representativeness	Primary data from AVB Expert Team	Secondary data from Sphera MLC database and literature
Technological	1.86	2.00
Temporal	3.00	3.13
Geographical	1.00	2.75
Precision	2.00	Not applicable

In general, AVB's operations data for the hot-rolled wire rod processing (representing scope 1) is **very good quality**, presenting and **average for primary data of 1.96**. To the inter-site transports data, this is based on the AVB's information, considering the transport mode and distance; transport emissions are calculated using the Sphera MLC Database. The DQR value calculated for the **secondary data used in the wire rod LCA is 2.63**, generally classified as **'Good quality'**. It should be noted that the quality of the study data is good, with the vast majority of the primary data collected from AVB's technical departments.

Additionally, the share of primary data was calculated as 47% and it is based on GWP-GHG results. It is worth to note that it is a simplified indicator for data quality that does

not capture all relevant aspects of data quality. The calculated

Finally, a process of validation and review of secondary and primary data was conducted with the company throughout the study process, through virtual meetings, to reduce potential uncertainties and make the data as consistent and accurate as possible, within its limitations, also described throughout this document.

Assumptions and Limitations

Following the principle of transparency, all the assumptions and limitations adopted in the modeling of the product system are listed as follows:

- The environmental aspects associated with the production and maintenance of capital goods and the use of labor were not included, machinery, infrastructure, packaging, facilities and other equipment used in production processes. Regarding transportation, environmental aspects related to the construction and maintenance of road pavements, manufacture of vehicles (trucks) were also not considered, due to the fact that these objects have a significantly long useful lifespan in relation to the scope adopted in this study. In relation to the use of labor, the disregard of the respective aspects was due to the fact that the social aspects linked to the services performed throughout the defined product system were not the object of the present study. On the other hand, the production of fuels and atmospheric emissions resulting from the burning of fuels during the displacement of logistics modes were accounted for.
- For road transport, EURO 5 efficiency was considered for trucks, and emissions were calculated in the GaBi ts software, which uses the reference HBEFA 3.3 [Umweltbundesamt Berlin; BUWAL / OFEFP Bern; Umweltbundesamt Wien: Handbuch Emis-sionsfaktoren des Straßenverkehrs, version 3.3, http://www.hbefa.net/, Berlin, Bern, Vienna / Germany, Switzerland, Austria, 2017] for the emission factor calculations. For the combustion of fuel, an adjustment was made regarding the accounting of the percentage of 14% referring to the presence of biodiesel in diesel.
- For the transportation distances related to the freight of raw materials, a simple average distance was adopted, calculated based on data from the analyzed years and the various suppliers involved. The distance values were sourced from internal records maintained by AVB. This approach allows for a representative estimation of transportation distances across different time periods and supplier locations, ensuring consistency in the inventory data for the life cycle assessment;
- For unit conversion, technical data on density and weight of the materials were used, the values adopted are expressed in Table 6;
- Adoption of the average values for the inputs and outputs of the wire rod production process, considering the total annual production volume by Aço Verde Brasil

(AVB), encompassing the different compositions and wire rod diameters and gauges.



Table 6 - Technical data on density and weight of materials for unit conversion.

Parameter	Value	Unit	Reference
Blast Furnace Gas	1,25	kg/Nm^3	Ullmann's Encyclopedia of Industrial Chemistry, 2012
Basic Oxygen Furnace Gas	0,865	kg/Nm^3	Ullmann's Encyclopedia of Industrial Chemistry, 2012
Oxygen Liquid	1,33	kg/m^3	AVB Internal Data
Nitrogen Liquid	1,16	kg/m^3	AVB Internal Data
Argon Liquid	1,66	kg/m^3	AVB Internal Data
Charcoal (internal and external)	277	kg/m^3	AVB Internal Data
Firewood	530	kg/m^3	AVB Internal Data
Diesel	0.840	kg/L	ANP (National Petroleum Agency of Brazil)

- The differences identified between the total calculated inputs and outputs are attributed to the quantities allocated to inventory. These inventories correspond to raw materials, utilities, or other inputs that may not have been fully consumed within the analysed production year. Instead, they may be carried over and utilized in subsequent production periods, depending on operational demand and stock management practices.
- Adoption of secondary data from scientific studies conducted by different researchers, in order to define the input and output flows associated with the production of the raw materials consumed, including raw laterite, anti-scaling agents, defoamers, biocides, dispersants, flocculants, and inhibitors.
- For the extraction of laterite from the soil, a mechanical excavation approach was employed using loaders and trucks, with minimal preparatory treatment, including sieving, air drying, and, in some cases, simple crushing (IPAAM, 2023; Governo de Minas Gerais, 2023). For diesel combustion in mobile equipment, the GHG Protocol emission factors were applied, corresponding to 2.675 kg CO_2/L, 0.0001 kg CH_4/L, and 0.0001 kg N_2O/L. Regarding the management of coarse waste, it was assumed that disposal occurs in an internal sterile pile, with a maximum transport distance of 1 km.
- It was not possible to access all inventory data related to raw materials consumed in the wire rod production process within the adopted database - specifically for crude laterite, anti-crust agents, antifoaming agents, biocides, dispersants, flocculants, and inhibitors. Adoption of life cycle inventories corresponding to a generic compound within each category of input consumed in the process, for products such as anti-scaling agents, defoamers, biocides, dispersants, flocculants, and inhibitors.
- In the specific datasets, a regionalization process was conducted, involving the adjustment of the energy matrix according to the most recent BEN 2024 report. This regionalization was necessary due to the unavailability of specific national data for

certain inputs and processes, which required adapting the life cycle inventory to better reflect regional energy conditions and ensure greater accuracy in the environmental assessment.

- In addition to the mapped gases, it is known that other emissions also occur. Therefore, calculations were performed for greenhouse gas emissions — CO_2, CH_4, and N_2O — as well as water consumption, based on the following sources: (a) biomass combustion (rice straw, charcoal, and chipped wood); (b) fossil fuel combustion (diesel and LPG); and (c) calcination reaction. The calculations were carried out using absolute values of input consumption and product generation, combined with emission factors obtained from scientific and technical literature.
- Regarding CO_2 emissions from biomass combustion, these were considered equivalent to the CO_2 captured during biomass growth, thus cancelling each other out. This is because carbon removals should be accounted for as negative values, reflecting a positive environmental effect. Consequently, only biogenic CH_4 and N_2O emissions were effectively included in the final balance.
- The carbon content of the product was considered to calculate emissions and removals. For rice straw, it was 40%, charcoal 80% and firewood 50%. These values were obtained in 2006 IPCC Guidelines – volume 4, Agriculture, Forestry and Other Land Use (AFOLU).
- To calculate greenhouse gas emissions (GHG) from biomass burning, the following equation was adopted $Emissions\ (kg\ GHG) = generated\ energy\ (TJ) \times emissions\ factor\ (\frac{kg}{TJ})$. The generated energy (TJ) was obtained from $E = \frac{(consumed\ mass\ (kg) \times LHV)}{1{,}000{,}000}$. In this context, the values of 15 MJ/kg and 27,03 MJ/kg, respectively, were adopted for the lower calorific value (LHV) of rice straw and charcoal. Furthermore, the emission factors for rice straw and charcoal, were obtained for "biomass solid fuels" present in Table 2.5 p.2.41 of the IPCC Guidelines 2006. The values are presented in Table 3.
- The equation mentioned above for calculating GHG emissions was adopted for emissions from the burning of calcined petroleum coke, liquified petroleum gas and firewood. The LHV value and emissions factors adopted for coke were obtained from Table 2.5 of the 2006 IPCC Guidelines ("petrol coke") and LHV value and emissions factors adopted for LPG were obtained also from 2006 IPCC Guidelines Volume 2, Chapter 2 (stationary combustion) - Table 3.
- For diesel fuel, the GHG Protocol value was adopted based on the IPCC for stationary combustion, as indicated in Table 7.



Table 7 - Lower Heating Value and Emissions factor for different fuels.

Product	LHV (MJ/kg)	EF for CO_2 (kg/TJ)	EF for CH_4 (kg/TJ)	EF for N_2O (kg/TJ)
Rice Straw	15.00	-	30.00	4.00
Charcoal	27.03	-	200.00	1.00
Coke	33.00	97,500	0.60	3.00

LPG	46.44	63,000	0.80	3.00
Firewood	15.00	-	30.00	4.00
Diesel	43.0	72,600	0.50	0.10

- The blast furnace gas produced by AVB in the pig iron production process and other by-products has the following composition: 22% carbon monoxide (CO), 21% carbon dioxide (CO_2), 51.4% nitrogen (N_2), 4.20% hydrogen (H_2), 0.7% oxygen (O_2), and 0.7% methane (CH_4). Among the gases composing the blast furnace gas, only carbon monoxide and methane are consumed during the reactions in the process and can generate CO_2. The CO_2 already present in the gas acts as an inert gas, not consumed in the reactions and emitted in its original form. However, since blast furnace gas is a product of the iron ore reactions, the emissions from burning this gas were not accounted for, in order to avoid double counting of emissions.
- The same process was used to produce charcoal for both AVB subsidiaries and commercially purchased. The production process consists of drying the wood in the open air at room temperature.
- The moisture content of firewood and charcoal for both internal and external processing is, respectively, 29.68% and 5.14% for 2021; 29.68% and 5.65% for 2022; and 29.68% and 5.47% for 2023. The difference is the release of water vapor during drying, and the values are 24.54% (2021), 24.03% (2022) and 24.21% (2023).
- The Sphera GaBi software presents in its databases some black box datasets, which means the total flows of inputs and outputs of the life cycle of the material and/or process are displayed as elementary flows, making it impossible to investigate how the modeling of the stages of the life cycle of the evaluated pre-chain was carried out.
- It was not possible to obtain input and output data specific to individual SKUs of wire rod (i.e., differentiated by diameter, weight, or gauge), as such data are not monitored or recorded at this level of detail. Instead, process data are collected and managed in aggregate form for the total wire rod production, without segregation by product variant.
- The mass and energy balance of consumed raw materials, utilities, and ancillary products presented some discrepancies. These variances are primarily attributed to the existence of inventories of inputs and finished products accumulated throughout the assessed timeframes, which impact the reconciliation between reported inputs and outputs.
- In Life Cycle Assessment (LCA) databases, production data specific to the national context are not always available. In such cases, it is often necessary to use data from international or regional datasets, which may be adapted or adjusted to approximate the technological, geographical, and temporal representativeness of the national production. This limitation can influence the accuracy of the results, and should therefore be transparently reported as part of the data quality assessment.
- In the hot-rolled carbon steel wide rod's AVB process, only SOx, NOx, and particulate

matter emissions to the atmosphere from production processes are monitored and recorded (primary data).

Allocation Rules

The wire rod production process is a multi-output process, specifically the blast furnace and steel mill stages, in addition to the auxiliary gas plant process (process of obtaining oxygen, nitrogen and argon); therefore, to correctly distribute the impact, following the International EPD System (2025) and PCR 2023:01 (2023), an allocation procedure was carried out based on physical criteria, that is, **mass allocation** was selected as the default criterion.

Cut-off criteria

Although the PCR 2023:01 allows the application of a cut-off rule of 1%, it also recommends to avoid performing cut-offs on inventory data, which means using all available inventory data. Following the latter approach, all flows of fuel, energy, materials and supplies necessary to produce the steel wire rod have been considered; materials that could be used in preventive or corrective maintenance of machinery and equipment were disregarded, as well as the use of uniforms and personal protective equipament or other auxiliary materials.

Packaging

The product doesn't have distribution packaging.



SYSTEM BOUNDARIES

Cradle-to-gate is selected for the Life Cycle Assessment (LCA) study according to EN 15804 Section 5.2. and PCR 2023:01 (modules A1 to A3), version 1.0.3. The AVB wire rod life cycle encompasses the **blast furnace**, **steelmaking**, and **hot rolling** processes and is classified into two life cycle substages: the ***upstream process*** (from cradle to gate) and the ***core process*** (from gate to gate). Detailed information on the upstream and core processes is available in modules A1 through A3, as described in Table 8. The production of all major inputs (e.g., raw materials, electricity, fuel, water) and waste considered in product stages A1, A2 and A3 are included in the study, as described in Figure 1.

Table 8 - Manufacturing Process of Wire Rod.

Life Cycle Stage	Module	Module Information	Description
Upstream	A1	Purchase of raw materials *(extraction and production of raw materials)*	- Extraction and processing of raw materials (e.g. mining processes, oxygen, argon, nitrogen, etc) and biomass production and processing (e.g. agricultural and forestry operations; - Reuse of products or materials from a previous product system; - Processing of secondary materials used as input for manufacturing the product from a previous product system; - Generation of electricity, steam and heat from primary energy resources, also including their extraction, refining and transport;
		Purchase of packaging	- Manufacturing of primary packaging - Transport up to the factory gate
	A2	Transportation of raw materials to the production plant	- Transportation up to the factory gate and internal transport; - Production of fuel consumed during transportation from the supplier to the company gate.
Core Process	A3	Purchase of auxiliary materials	- Production and transportation of auxiliary materials to the production plant; - Consumption and production of water; - Impacts due to the production of the energy consumed.
		Steel wire manufacturing process	- Manufacturing products and co-products; - Emissions into air and water during the manufacturing process.
		Production of plant waste	- Waste generated during the manufacturing process and their transport and treatment.

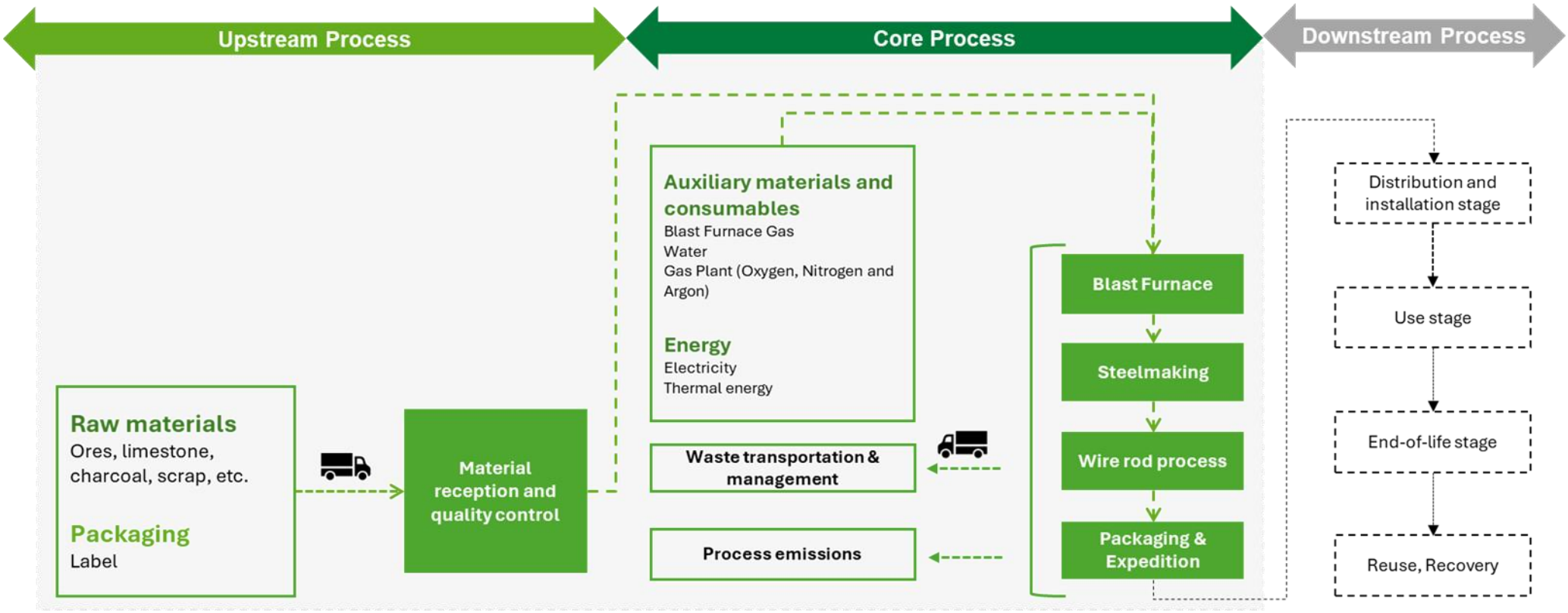


Figure 1 - System product considered for the study.

Table 9 describes the modules declared, geographical scope, share of specific data.

Table 9 – Reporting of modules declared and geographical scope.

	Product Stage			Distribution/ installation Phase		Use Stage							End-of-life Stage				Beyond product life cycle
	Raw material supply	Transport	Manufacturing	Transport	Distribution/ installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	De-construction demolition	Transport	Waste Processing	Disposal	Resue/recovery/ Recycling potential
Module	**A1**	**A2**	**A3**	**A4**	**A5**	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**C1**	**C2**	**C3**	**C4**	**D**
Modules declared	X	X	X	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Geography	GLO	BR	BR	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Specific Data	50%	50%	44%	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Product variation	0%					-	-	-	-	-	-	-	-	-	-	-	-
Site Variation	0%					-	-	-	-	-	-	-	-	-	-	-	-

X = Declared module; ND = no declared module; BR = Brazil; GLO = Global

Note: Infrastructure and capital goods are excluded for this evaluation, in upstream and core process. Data collection was carried out directly from AVB's Internal System.

ENVIRONMENTAL PERFORMANCE

Electricity Impact

In accordance with Section A.6.2 of the General Programme Instructions (GPI) and the PCR 2023:01, version 1.0.3, the EPD owner is required to ensure that the electricity supply is guaranteed for the duration of the EPD's validity. The current contractual power purchase agreement with TRADENER LTDA is valid until 2026, and AVB has expressed its intention and commitment to renew the agreement thereafter; the renewal process is already underway but could not be concluded before finalization of this study.

The electricity used in the wire rod production process at the Açailândia plant is sourced 100% from hydroelectric power. The environmental impact profile of electricity generated from a hydroelectric source was obtained from the MLC Sphera Database (2024.2) of dataset "Brazilian Electricity from hydro power" developed by Sphera.

Electricity has impacts associated with its generation and distribution in Brazil. These activities generate different effects that directly impact different categories of environmental impact. As part of the requirements of PCR 2023:01, the impact of the electricity from hydro power used in manufacturing process of hot-rolled carbon steel wire rod. The results is presented per kWh of electricity.

Environmental Performance

Electricity impact per kWh

Environmental Impact Category	Impact	Unit
Climate Change, Total	1.66E-1	kg CO_2 eq/kWh
Climate Change, fossil	1.66E-1	kg CO_2 eq/kWh
Climate Change, biogenic	2.46E-7	kg CO_2 eq/kWh
Climate Change, land use and land use change	3.23E-6	kg CO_2 eq/kWh
Ozone Depletion	5.13E-15	kg CFC-11 eq/kWh
Acidification	3.23E-6	Mole of H+ eq/kWh
Eutrophication, freshwater	1.91E-9	kg P eq/kWh
Eutrophication, marine	7.56E-7	kg N eq/kWh
Eutrophication, terrestrial	8.27E-6	Mole of N eq/kWh
Photochemical ozone formation	2.18E-6	kg NMVOC eq/kWh
Resource use, mineral and metals	1.48E-8	kg Sb eq/kWh
Resource use, fossils	1.62E-2	MJ/kWh
Water use	5.95E-2	m^3 world eq/kWh

Potential Environmental Impact

The Life Cycle Impact Assessment (LCIA) results for 1 (one) tonne of hot-rolled carbon steel wire rod are given. Both Upstream (raw materials and transportation) and Core (primary emissions and auxiliary process) process have been considered the environmental impacts. The environmental performance results are relative expressions and do not predict impacts on category endpoints, the exceeding of thresholds, safety margins or risks.

Results of the environmental performance indicators

Impact category indicators

PARAMETER		UNIT	Upstream	Core	Downstream	TOTAL
Global warming potential (GWP)	Fossil	kg CO_2 eq.	631.72	239.07	NA	**870.79**
	Biogenic	kg CO_2 eq.	0.26	38.17	NA	**38.43**
	Land use and land transformation	kg CO_2 eq.	3.22	3.46	NA	**6.68**
	TOTAL	**kg CO_2 eq.**	**635.19**	**280.70**	NA	**915.90**
Ozone layer depletion (ODP)		kg CFC 11 eq.	5.57E-6	1.36E-5	NA	**1.92E-5**
Acidification potential (AP)		mol H^+ eq.	3.52	2.15	NA	**5.66**
Eutrophication potential (EP)	Aquatic freshwater	kg P eq.	**0.05**	**0.03**	NA	**0.07**
	Aquatic marine	kg N eq.	**0.56**	**0.39**	NA	**0.96**
	Aquatic terrestrial	mol N eq.	**6.11**	**4.24**	NA	**10.35**
Photochemical oxidant creation potential (POCP)		kg NMVOC eq.	2.26	1.36	NA	**3.65**
Abiotic depletion potential (ADP)*	Metals and minerals	kg Sb eq.	1.33E-2	5.91E-4	NA	**1.39E-2**
	Fossil resources	MJ, net calorific value	6,342.89	3,382.87	NA	**9,725.76**
Water deprivation potential (WDP)*		m^3 world eq. deprived	61.75	59.76	NA	**121.52**

** 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.*

All information modules are reported and valued separately. However, the present EPD presents itself the total impact across all stage.

The environmental performance results are relative expressions and do not predict impacts on category endpoints, the exceeding of thresholds, safety margins or risks.



Figure 2 - Upstream and Core process basic impact categories results.



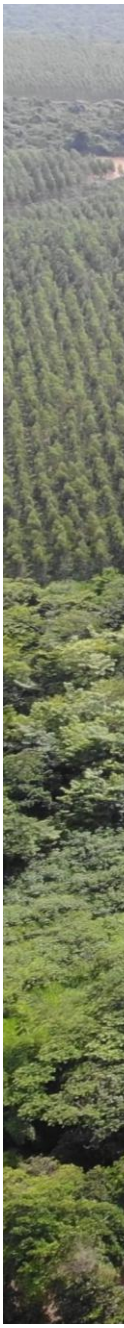
As can be seen in the Figure 2, the greatest environmental impacts are generated by Upstream process that is related for obtaining raw materials and transportation, except for climate change biogenic and ozone depletion environmental indicators. In these environmental impacts, the greatest impact is generated by Core process that refers to the manufacturing operations within the factory, covering the transformation of raw materials into the final product, including energy use, auxiliary materials, emissions, and waste generation.

In the **Climate Change**, fossil emissions category, the total impact was **870.79 kgCO_2e per tonne of wire rod**, with 69% attributed to the Upstream and 31% to the Core. The predominance of Upstream is mainly due to coke, iron ore beneficiation, and raw material transportation. In the Core, emissions are associated with direct combustion and process reactions in the blast furnace and BOF, as well as thermal energy use in rolling. Including biogenic emissions (38.43 kgCO_2e per tonne of wire rod, concentrated in the Core) and land use change emissions (6.68 kgCO_2e, distributed between modules) highlights the influence of renewable-based inputs and energy in the production system.

Photochemical ozone formation (3.65 kg NMVOCeq per tonne of wire rod) is mainly influenced by the Upstream process, due to NMVOC emissions from the production and transport of fossil fuels and chemical inputs. In the Core process, contributions come from fugitive emissions in internal process gas systems. In the **Ozone Depletion** environmental indicator (1.92×10^{-5} kg CFC-11e per tonne of wire rod), the Core Process is predominant, reflecting potential emissions from the utility systems.

For **Acidification** (5.66 mol H^+e per tonne of wire rod), the Upstream accounts for 62% due to SO_2 and NO_x emissions from power generation, mining, and external coke production, while the Core (38%) is associated with combustion in furnaces and rolling processes. In **Eutrophication**, both in freshwater (0.07 kg P eq per tonne wire rod), marine (0.96 kg N eq per tonne wire rod), and terrestrial (10.35 mol N eq per tonne wire rod) environments, the Upstream is dominant due to NO_x and NH_3 emissions from transportation and electricity generation, while the Core contributes through atmospheric emissions and treated effluents containing nutrients.

Abiotic depletion of minerals and metals (1.39×10^{-2} kg Sb eq per tonne wire rod) is almost entirely attributed to the Upstream, associated with the extraction and beneficiation of iron ore and alloying elements, while **abiotic depletion of fossil resources** (9,725.76 MJ per tonne wire rod) shows major impact in the Upstream process (energy embedded in coke, LPG and transport) and for Core process



(thermal energy, partially supplied by recovered process gases).

Water use (121.52 m³ world-eq per tonne wire rod) is balanced between Upstream and Core, reflecting both mining/beneficiation and cooling/rolling operations. As the indicator is expressed in m³ world-eq, the results are sensitive to the water scarcity factor of the regions involved.

Overall, the analysis confirms that, in the BF associated to BOF route, the **supply chain is responsible for a substantial share of the environmental impacts**, especially in categories related to fossil emissions and the consumption of mineral and energy resources. The Core process, although less dominant in some categories, is **relevant in indicators linked to utilities**, **direct process emissions**, and **water consumption**.

Resource use indicators

Parameters describing resource use were evaluated according to the EN 15804+A2. The results of the environmental indicators evaluation describing resource use and others describing material and energy balance flows for Upstream and Core Process are presented in details as follows.

PARAMETER		UNIT	Upstream	Core	Downstream	TOTAL
Primary energy resources – Renewable	Use as energy carrier (PERE)	MJ, net calorific value	5.03	3.97	NA	**9.00**
	Used as raw materials (PERM)	MJ, net calorific value			**NA**	
	TOTAL (PERT)	**MJ, net calorific value**	**5.03**	**3.97**	NA	**9.00**
Primary energy resources – Non-renewable	Use as energy carrier (PENRE)	MJ, net calorific value	6.34	3.38	NA	**9.73**
	Used as raw materials (PENRM)	MJ, net calorific value			NA	
	TOTAL (PENRT)	**MJ, net calorific value**	**6.34**	**3.38**	NA	**9.73**
Secondary material (SM)		kg			NA	
Renewable secondary fuels (RSF)		MJ, net calorific value	NA	1.40E-34	NA	**1.40E-34**
Non-renewable secondary fuels (NRSF)		MJ, net calorific value	NA	1.64E-33	NA	**1.64E-33**
Net use of fresh water (FW)		m^3	9.89E-3	7.89E-3	NA	**1.78E-2**

VERSION HISTORY

This Environmental Product Declaration (EPD) is the original version developed in accordance with the General Programme Instructions (GPI) of the International EPD® System, version 5.0.1. It provides transparent and verified information about the environmental performance of the product throughout its life cycle. This version has been independently verified and

Version	**1.0**
Date	2025-10-20
Remark	Original version of EPD



ABBREVIATIONS

ADP Abiotic Depletion Potential

AFOLU Agriculture, Forestry and Other Land Use

AP Acidification Potential

AR6 IPCC's Sixth Assessment Report

AVB Aço Verde do Brasil

BEN Brazilian National Energy Balance

BF Blast Furnace

BFG Blast Furnace Gas

BOF Basic Oxygen Furnace

CA-60 Steel bar

CH_4 Methane

CO_2 Carbon Dioxide

CUP Customer-Unique Package

CVM Brazilian Securities and Exchange Commission

DQA Data Quality Assessment

DNM Data Needs Matrix

DQI Data Quality Indicators

DQL Data Quality Levels

DQR Data Quality Rating

EF Emission Factor

EPD Environmental Product Declaration

Eq Equivalent

EN 15804 European Standard 15804

EP Eutrophication Potential

EU-PEF European Union Product Environmental Footprint

EURO European Emission Standards

FU Functional Unit

FW Use of net fresh water

GeR Geographical Representativeness

GHG Greenhouse Gases

GWP Global Warming Potential

HBEFA Handbook Emission Factors for Road Transport

IPCC Intergovernmental Panel on Climate Change

ISO International Organization for Standardization

LCA Life Cycle Assessment

LCA FE Sphera's LCA for Experts Software

LCI Life Cycle Inventory

LCIA Life Cycle Impact Assessment

LPG Liquefied Petroleum Gas

LHV Low Heat Value

LUC Land Use Change

MJ Megajoule

MLC Managed LCA Content

N Nitrogen

NH_3 Ammonia

NM-VOC Non-Methane Volatile Organic Compounds

N_2O Nitrous oxide

NOx Nitrogen Oxides

NRSF Use of non-renewable secondary fuels

ODP Ozone Depletion Potential

P Precision

PCR Product Category Rules

PENRE Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials

PENRM Use of non-renewable primary energy resources used as raw materials

PENRT Total use of non-renewable primary energy

PERE Primary energy resources used as raw materials

PERM Renewable primary energy resources used as raw materials

PERT Total use of renewable primary energy

POCP Photochemical Ozone Creation Potential

RSF Use of renewable secondary fuels

Sb Antimony

SDS Safety Data Sheet for Chemicals

SGS Société Générale de Surveillance

SKU Stock Keeping Unit

SM Use of secondary materials

SOx Sulphur Oxides

TeR Technological Representativeness

TiR Temporal/Time Representativeness

UN CPC United Nations Central Product Classification

WDP Water Deprivation Potential

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