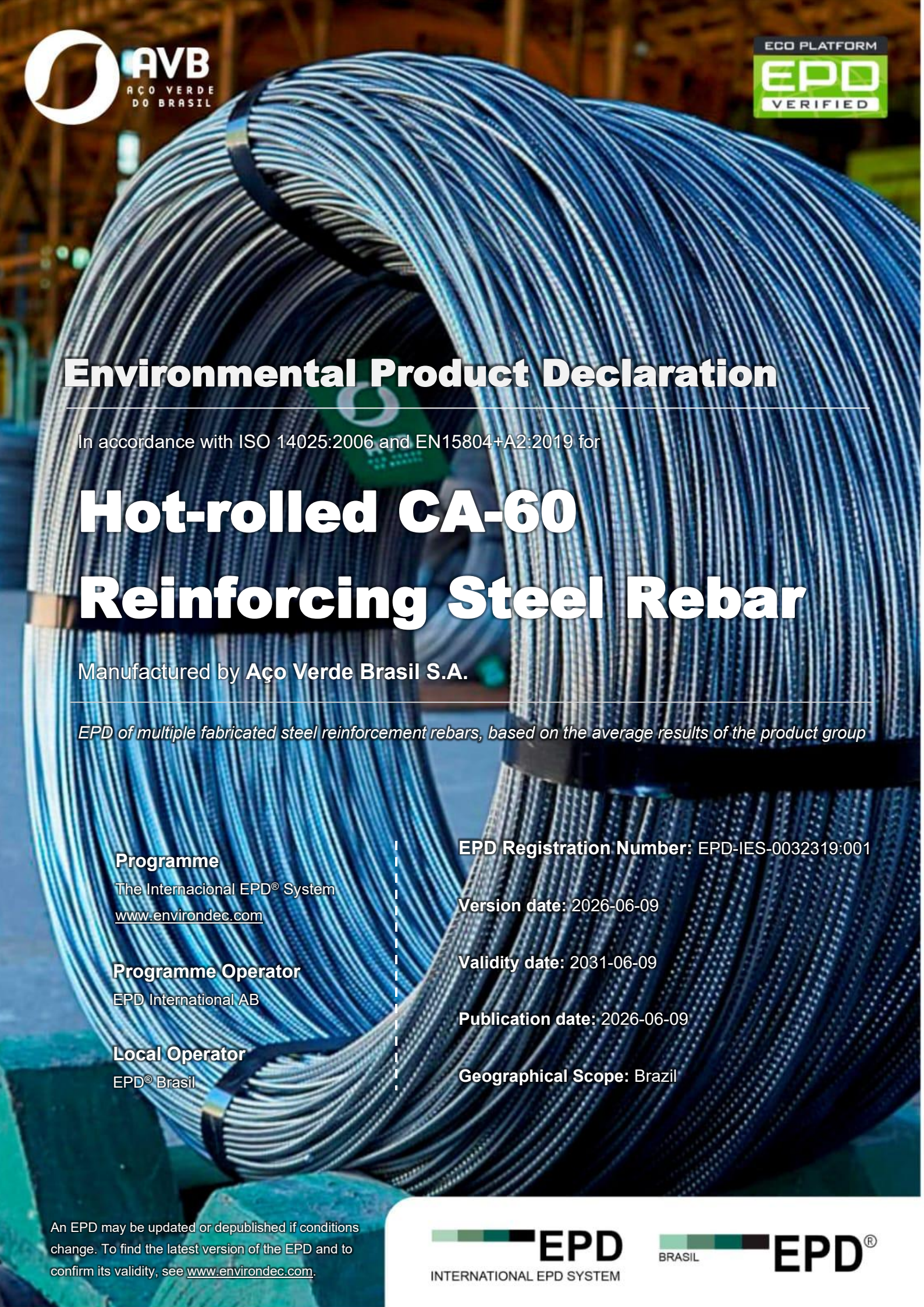


Environmental Product Declaration

In accordance with ISO 14025:2006 and EN15804+A2:2019 for

Hot-rolled CA-60 Reinforcing Steel Rebar

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

EPD of multiple fabricated steel reinforcement rebars, based on the average results of the product group

Programme
The Internacional EPD® System
www.environdec.com

Programme Operator
EPD International AB

Local Operator
EPD® Brasil

EPD Registration Number: EPD-IES-0032319:001

Version date: 2026-06-09

Validity date: 2031-06-09

Publication date: 2026-06-09

Geographical Scope: Brazil

An EPD may be updated or depublished if conditions change. To find the latest version of the EPD and to confirm its validity, see www.environdec.com.

GENERAL INFORMATION

Programme Information

	The International EPD® System	EPD® Brasil
Programme Operator	EPD International AB Box 210 60 SE – 100 31 Stockholm Sweden www.environdec.com support@environdec.com	Camburiú Street, 255 Alto da Lapa 05058-020, São Paulo, Brazil www.epdbrasil.com.br epdbrasil@vanzolini.com.br

Accountabilities PCR, LCA and independent third-party verification

Product Category Rules (PCR)

This declaration is based on the product category rules: **PCR 2019:14 – Construction Products**, version 2.0.1, 2025-06-05. Based on CEN standard EN 15804. CEN standard EN 15804 serve as the core PCR. PCR review was conducted by The Technical Committee of the International EPD® System. See www.environdec.com for a list member. The review panel may be contacted via the Secretariat www.environdec.com/contact. Review chair: Rob Rouwette (chair), Noa Meron (co-chair).

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. 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. For further information about comparability, see EN 15804 and ISO 14025.

COMPANY INFORMATION



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.

Company Information
Aço Verde do Brasil
Rod. BR 222 – 14, s.n.
Pequiá/Açailândia, Maranhão
Brazil

Communication Channels
www.avb.com.br
+ 55 99 3592 -1600
Jaime Filipe Justino Lacerda, jaime.lacerda@ferroeste.com.br

AVB AÇO VERDE DO BRASIL EPD INTERNATIONAL EPD SYSTEM

CERTIFICATIONS AND STANDARDS

Additional Environmental Information

The work carried out by Aço Verde do Brasil over the years has led to the **achievement** of **several certifications**, including ISO, NBR, and I-REC standards, as well as **recognition for best sustainability practices**. These accomplishments are the result of the strong commitment of AVB's Executive Management and its entire team of employees.

Environment

The AVB facilities involved in the manufacturing process operate under an Environmental Management System certified according to ISO 14001:2015 and a Quality Management System certified according to ISO 9001:2015. In addition, the electricity consumed at the plant is covered by I-REC certificates.



Sustainability

AVB is committed to sustainable through an Environmental Policy that guides its operations and stakeholder engagement, supported by integrated management systems with defined procedures and controls. The company has adopted the Carbon Disclosure (CDP) requirements and has been awarded the **Gold Seal** of the Brazilian GHG Protocol Program, with its GHG inventory verified in accordance with ISO 14064-3:2018 and third-party assurance by SGS. AVB also maintains certification of its Social Responsibility Management System under ABNT NBR 16001:2012, ensures independent verification of its Sustainability Report in line with GRI principles by Bureau Veritas Certification.

To view the full list, visit: https://avb.com.br/certificacoes/

Active Participation

In addition, the company participates in several national and international associations and initiatives related to environmental, social, and governance issues.

At the international level, AVB is member of the **WorldSteel Association** (WSA) and **Responsible Steel**, contributing to global discussion on sustainability and responsible steel production. In Brazil, AVB participates through the **Aço Brasil Institute**, engaging in commissions related to environmental and energy topics, and is also a signatory of **InPACTO**, reinforcing its commitment to the promotion of decent work practices and the eradication of slave and labor-analogous practices.



AVB AÇO VERDE DO BRASIL

EPD INTERNATIONAL EPD SYSTEM

PRODUCT INFORMATION

Table 1 presents technical information about CA-60 rebar. CA-60 Rebar is a product manufactured by hot rolling steel billets into bars with a round cross-section, followed by thermal treatment using high-pressure water jets to obtain the required mechanical properties. At Aço Verde Brasil (AVB), CA-60 can be manufactured as coils or straight lengths. It 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 CA-60 reinforcing steel rebar
Product identification	CA-60 rebar from Aço Verde do Brasil, produced by the Biocarbon BF/ BOF route and followed by hot rolling.
Product description	Steel reinforcing bar used to reinforce concrete in the construction industry. The surface of the rebar is corrugated to limit the relative longitudinal movement between the steel and the surrounding concrete. 60 is a strength degree that indicates how much pressure the rebar can withstand (600 MPa)
Product characteristics	Carbon steel rebar in coils or straight lengths: Diameter from 4.2 mm to 10 mm Weight from 0.071 to 0.617 kg/m
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: 41242 (Other bars and rods of iron or non-alloy steel, not further worked than forged, hot-rolled, hot-drawn or extruded, but including those twisted after rolling)
Geographic scope	Açailândia, Maranhão, Brazil
Applications	*Civil construction*: used for supporting reinforced concrete structures.

PRODUCT INFORMATION

Additional Environmental Information

Product certifications and recognitions

In addition, AVB holds product-level certifications and recognitions for its reinforcing steel products **CA-50** and **CA-60**, demonstrating compliance with applicable technical and quality requirements and reinforcing the reliability and market acceptance of these products.



BUREAU VERITAS Certification

Certificado de Conformidade

BR36707006

FORNECEDOR SOLICITANTE

AÇO VERDE DO BRASIL S.A

ROD. BR 222, Nº69 – GLEBA TINGA, KM 14,5

CEP: 65.930-000 – AÇAILÂNDIA – MA – BRASIL

CNPJ: 07.636.657/0002-70

FABRICANTE

AÇO VERDE DO BRASIL S.A

ROD. BR 222, Nº69 – GLEBA TINGA, KM 14,5

CEP: 65.930-000 – AÇAILÂNDIA – MA – BRASIL

CNPJ: 07.636.657/0002-70

O Bureau Veritas Certification certifica que o Produto constante no item escopo de fornecimento abaixo especificado, foi avaliado e encontrado em conformidade com os requisitos dos documentos de referência.

Documento de Referência

PORTARIA INMETRO Nº 139 DE 19/03/21, ABNT NBR 7480:2007, ABNT NBR 7477:1982

Escopo de fornecimento

BARRAS E FIOS DE AÇO DESTINADOS A ARMADURAS PARA ESTRUTURAS DE CONCRETO ARMADO

FAMÍLIA DE FIOS DE AÇO – CATEGORIA CA-60 – SÉRIE FINA

Data de início da certificação: 06 DE MARÇO DE 2023.

Data da validade da certificação: 05 DE MARÇO DE 2026.

Este Certificado de Conformidade foi emitido segundo modelo de certificação 5 e é válido somente acompanhado das páginas de 1 a 02. A validade deste Certificado de Conformidade está atrelada à realização das avaliações de manutenção e tratamento de possíveis não conformidades de acordo com as orientações do Bureau Veritas Certification e previstas no RAC específico.

Para verificação da condição atualizada de regularidade deste Certificado de Conformidade deve ser consultado o banco de dados de produtos e serviços certificados do Inmetro.

Número(s) do(s) contrato(s): BR-4017907.

Certificado desde: 06 DE MARÇO DE 2020

Bruno Bomtorim Moreira

Gerente Técnico de Certificação de Produtos

Bureau Veritas Certifications

Rua Piauí, 438, Santa Paula

Cep: 09541-150, São Caetano do Sul, SP, Brasil

www.bureauveritas.com.br

Página 1 de 2

OCP 0018

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BUREAU VERITAS Certification

Certificado de Conformidade

BR36707007

FORNECEDOR SOLICITANTE

AÇO VERDE DO BRASIL S.A

ROD. BR 222, Nº69 – GLEBA TINGA, KM 14,5

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FABRICANTE

AÇO VERDE DO BRASIL S.A

ROD. BR 222, Nº69 – GLEBA TINGA, KM 14,5

CEP: 65.930-000 – AÇAILÂNDIA – MA – BRASIL

CNPJ: 07.636.657/0002-70

O Bureau Veritas Certification certifica que o Produto constante no item escopo de fornecimento abaixo especificado, foi avaliado e encontrado em conformidade com os requisitos dos documentos de referência.

Documento de Referência

PORTARIA INMETRO Nº 139 DE 19/03/21, ABNT NBR 7480:2007, ABNT NBR 7477:1982

Escopo de fornecimento

BARRAS E FIOS DE AÇO DESTINADOS A ARMADURAS PARA ESTRUTURAS DE CONCRETO ARMADO

FAMÍLIA DE FIOS DE AÇO - CA-60 – SÉRIE MEDIA

Data de Início da certificação: 06 DE MARÇO DE 2023.

Data da validade da certificação: 05 DE MARÇO DE 2026.

Este Certificado de Conformidade foi emitido segundo modelo de certificação 5 e é válido somente acompanhado das páginas de 1 a 02. A validade deste Certificado de Conformidade está atrelada à realização das avaliações de manutenção e tratamento de possíveis não conformidades de acordo com as orientações do Bureau Veritas Certification e previstas no RAC específico.

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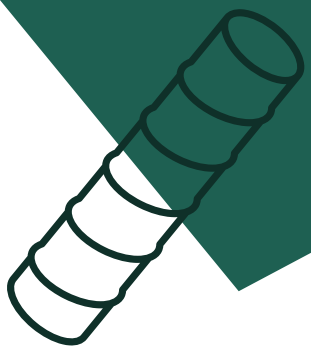
Para confirmar a autenticidade desse documento acesse https://bureauveritas.3ds.digitalcheck/1090913098741033125



AVB AÇO VERDE DO BRASIL

EPD INTERNATIONAL EPD SYSTEM

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 hot-rolled steel rebar is the billet; therefore, the **Table 2** presented below shows the substance content of this input. Steel rebar product does not contain hazardous substances. **None** of the substances can be included in 'Candidate List of Substances of Very High Concern' (SVHCs) and raw materials used are not part of the **European legislations** – EU REACH (EC 1907/2006).

Table 2 - Product Content Declaration.

Product content	Mass, %	Post-consumer recycled material, mass-% of product	Biogenic material, mass-% of product	Biogenic material, kg C/product or declared unit	Environmental and Hazardous substances on the SVHC List*
Pig Iron	71%	0%	0%	0 kg C	No known hazardous properties
Steel Scrap	25%	25%	0%	0 kg C	No known hazardous properties
Limestone	3%	0%	0%	0 kg C	No known hazardous properties
Ferroalloys	1%	0%	0%	0 kg C	No known hazardous properties
TOTAL	**100%**	**25%**	**0%**	**0 kg C**	

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.

BIOGENIC CARBON CONTENT

In accordance with the requirements of PCR 2019:14 v2.0.1 and EN 15804+A2, the biogenic material content and corresponding biogenic carbon content of the declared product were assessed. Steel rebar does not contain biogenic carbon. The packaging contains material that includes biogenic carbon. The respective values, calculated according to PCR 2019:14, v2.0.1, "Annex 2: Guidelines for the calculation of biogenic GWP", are presented in this document (Tables 3 and 4).

CONTENT DECLARATION

PACKAGING

Distribution packaging: The CA-60 rebar in coils is transported using a wooden cradle; and in straight lengths, wooden spacers may be used in specific cases. **Table 3** presents in detail the compositon of distribution packaging and their hazards. Wood cradle and spacers were considered biogenic materials and assumed to contain approximately 50% of biogenic carbon by dry mass, corresponding to 0.50 kg C per kg wood (CEN, 2014; DORAISAMI, DOMKE & MARTIN, 2024). Steel nails and protective coating were considered non-biogenic materials. No substances listed in the REACH SVHC Candidate List above 0.1% by mass are intentionally added to the packaging materials.

Table 3 - Distribution Packaging Content Declaration

Product content	Weight, kg per declare unit	Weight, % (versus the product)	Post-consumer recycled material, weight-%	Biogenic material, weight-%	Biogenic material, kg C/kg	Environmental and Hazardous substances on the SVHC List*
Wood cradle and spacers	18.00	1.80%	0%	0%	0.5 kg C	No known hazardous properties
Steel nails	0.20	0.02%	0%	0%	0 kg C	No known hazardous properties
Protective coating for wood	0.05	0.01%	0%	0%	0 kg C	No known hazardous properties
TOTAL	**18.25**	**1.83%**	**0%**	**0%**	**9.00 kg C**	



AVB AÇO VERDE DO BRASIL

EPD INTERNATIONAL EPD SYSTEM

CONTENT DECLARATION

Costumer packaging: The CA-50 rebar is packaged and shipped with a steel strapping and ab identification tag. The consumer packaging is very low in relation to the product's weight. As the steel strapping is made of steel, it does not represent an additional material and is not accounted separately in the Content Declaration (**Table 4**).

Table 4 - Consumer Packaging Content Declaration.

Product content	Weight, g per declare unit	Weight, % (versus the product)	Post-consumer recycled material, weight-%	Biogenic material, weight-%	Biogenic material, kg C/kg	Environmental and Hazardous substances on the SVHC List*
Paper (cardboard/offset)	1.5	0.2%	0%	100%	0.44 kg C	No known hazardous properties
Adhesive (hot-melt)	0.20	0.02%	0%	0%	0 kg C	No known hazardous properties
Printing ink	0.05	0.01%	0%	0%	0 kg C	No known hazardous properties under normal handling conditions.
TOTAL	**1.75**	**0.2%**	**0%**	**0%**	**0.00066 kg C**	

Paper-based packaging materials were considered biogenic materials. A biogenic carbon content factor of **0.44 kg C per kg dry paper** was adopted based on typical cellulose carbon content reported (CEN, 2014; O'Sullivan et al., 2016). Adhesive and printing ink were considered non-biogenic materials. No substance listed in the REACH SVHC Candidate List above 0.1% by mass are intentionally added to the consumer packaging materials.

It is important to mention that, in the final result presented, only consumer packaging was considered, due to the study follows the system boundaries defined as *cradle-to-gate-with-options approach* (A1-A3 + C1-C4 + D) as permitted by the applicable PCR 2019:14 version 2.0.1.



AVB AÇO VERDE DO BRASIL

EPD INTERNATIONAL EPD SYSTEM

LIFE CYCLE ASSESSMENT (LCA) INFORMATION



Goal and Scope

The goal of the study is the evaluation of the potential environmental impacts of hot-rolled CA-60 reinforcing steel rebar. The communication of the EPD will be business-to-business (B2B). For a comprenhise assessment, it is essential to consider the results of module C and D, and not only those of modules A1-A3.

Declared Unit

The **declared unit** (DU) is equal to **1 (one) tonne (t) of the hot-rolled CA-60 reinforcing steel rebar**.

Geographical Scope

A1: Global

A2: Brazil

A3: Brazil

C1-C4: Global, adapted for Brazil context when possible (diesel composition and recovery rate)

D: Global

Time representativeness

AVB's primary operational data refer to the estimated average baseline conditions for CA-60 rebar 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 2025.2) 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. Some background datasets adopted in this study are based on Ecoinvent v3.4 (2017) due to the absence of technically equivalent and more recent datasets within the adopted database environment (MLC Sphera Database CUP2025.2). An assessment of potential substitute datasets was conducted, and no representative alternatives were identified for the relevant flows. Although these datasets exceed the preferred temporal representativeness defined by PCR 2019:14, they were retained as proxies because the associated flows are environmentally relevant and could not be excluded under the applicable cut-off criteria. This aspect is recognized as a limitation of the study and will be addressed in future EPD updates as newer datasets become available.

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
Product Stage		
Technological	1.75	3.07
Temporal	3.00	3.42
Geographical	1.13	2.78
Precision	2.00	Not applicable
End-of-Life		
Technological	-	3.00
Temporal	-	3.17
Geographical	-	2.17
Precision	-	Not applicable
Beyond system boundary		
Technological	3.00	3.00
Temporal	4.00	4.00
Geographical	4.00	3.33
Precision	2.00	Not applicable

In general, AVB's operations data for the hot-rolled CA-60 rebar processing (representing scope 1) is **good quality**, presenting an **average for primary data of 2.11**. 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. However, the calculation considers not only the primary data collected for the product stage but also the replacement data included in module D. Consequently, the **average value for the primary data becomes 3.33**. The DQR value calculated for the **secondary data used in the steel rebar LCA is 2.36**, generally classified as **'Good quality'**. When including the database, the **average data quality found is 3.88** (*fair 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 48% 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 calculation is limited to modules A1-A3 (product stage), in accordance with the requirements of the PCR 2019:14 and General Guideline. 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.

Environmental indicators and methods

The applied environmental indicators and characterization models are described in EN15804+A2 (as indicated in PCR 2019:14), which have already been compiled in a method known as EN 15804+A2 LCIA & LCI indicators v1.00 in Sphera Software. The applied characterization factors are associated with the EF 3.1 method (for more information, please access Environdec website)

Relevant aspects regarding electricity:

The electricity consumption reported by the company is annual and is related to the ammount of product production, the necessary calculation was made to take the energy consumption according to the determined declared unit.

For the year of study, the electricity consumed in the production process was based on a mixed production consumption plan, which consists of internally generated electricity and electricity purchased from the market. Specifically for end-of-life stages, the electricity consumed corresponds to the electricity supplied by the Brazilian national grid (grid mix) as documented in the BEN 2024 sabe on the reference year of 2023.

Table 5 describes the electricity modelling used in the life cycle assessment and details the data sources, selected electricity mixes, and modelling choices applied to different modules. To determine the impacts associated with electricity consumption in steel rebar, the datasets of the MLC Sphera Database CUP 2025.2 were used to model the different component of Brazilian energy matrix for the year 2023. The impacts of the electricity generated on the Brazilian energy matrix come from the modeling carried out based on electricity generation information during 2023. With the exception of the energy generated internally by AVB, the dataset was constructed according to the inputs and outputs of the process carried out by the EPD owners.

Table 5 - Overview of electricity modelling.

Electricity Modelling	
Selection for the electricity purchased by AVB	Brazilian electricity from hydro power
LCI dataset for the generation of electricity used in module A3	BR - Electricity from hydro power
Specific electricity* (e.g. Guarantees of Origin, GO) shall be valid for at least the upcoming year and the manufacturer shall make a commitment to buy GO for the full validity period of the EPD.	Contractual supply of 100% renewable electricity – hydro power through a Power Purchased Agreement (PPA) with TRADENER LTDA. The current contract is valid until December 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.
Selection for the electricity to other activities	Brazilian electricity grid mix
LCI dataset for the generation of electricity used in module C1-C4	BR Electricity grid mix (production mix), adapted to BEN 2024
Specific electricity* (e.g. Guarantees of Origin, GO) shall be valid for at least the upcoming year and the manufacturer shall make a commitment to buy GO for the full validity period of the EPD.	Not Applicable.

**Guarantees of Origin (or similar) shall include information on: the electricity provider; the purchaser; the electricity mix; the amount of electricity (in kWh) covered; and the time periods for issue and validity of the contract.*

Table 7 presents the breakdown of energy sources behind the electricity module used in end-of-life stages, along their respective share and the calculated enviromental impact expressed per kWh.

Table 6 - Country-specific grid mix for Brazil used for end-of-life stages electricity consumption.

Electricity Modelling	%	Value (MJ/kWh)
From nuclear	3%	0.111
From lignite	1%	0.0568
From hard coal	2%	0.0755
From coal gases	1%	0.0598
From natural gas	13%	0.583
From heavy fuel oil (HFO)	6%	0.255
From biomass (solid)	8%	0.327
From biogas	0%	0.00382
From hydro power	62%	2.68
From wind power	2%	0.0878
From photovoltaic	2%	0.0734
From waste	0%	0.0155

Table 8 presents the impact of electricity per kWh generated, considering the Brazilian national grid mix and the energy purchased from the market by AVB, which consists of 100% hydro power.

Table 7 - Electricity environmental performance per kWh generated.

Environmental Impact Category	Electricity from Hydro Power	Electricity Grid Mix	Unit
Climate Change, total	9.66E-02	3.24E-01	kg CO_2 eq/kWh
Climate Change, fossil	1.59E-03	2.51E-01	kg CO_2 eq/kWh
Climate Change, biogenic	8.95E-02	6.70E-02	kg CO_2 eq/kWh
Climate Change, land use change	5.45E-03	6.24E-03	kg CO_2 eq/kWh
Ozone Depletion	5.40E-15	1.94E-10	kg CFC-11 eq/kWh
Acidification	3.28E-06	3.23E-03	Mole of H+eq/kWh
Eutrophication, freshwater	1.68E-09	1.75E-06	kg P eq/kWh
Eutrophication, marine	7.59E-07	3.78E-04	kg N eq/kWh
Eutrophication, terrestrial	8.28E-06	4.15E-03	Mole of N eq/kWh
Photochemical Ozone Formation	3.56E-05	1.07E-03	kg NMVOC eq/kWh
Resource use, mineral and metals	1.48E-08	3.48E-08	kg Sb eq/kWh
Resource use, fossils	1.05E-02	3.68E+00	MJ/kWh
Water Use	6.01E-02	4.94E-02	m^3 world eq/kWh

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 following activities are excluded from the system boundary of this study: business travel of employees, employee commuting (transport between home and workplace), and research and development (R&D) activities. These processes are considered outside the scope of the product system and are assumed to have negligible influence on the overall environmental impacts of the assessed product.
- The environmental aspects associated with the production and maintenance of capital goods and the use of labor were not included – Example: 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.
- The environmental aspects of production, maintenance, and end-of-life of infrastructure and capital goods (e.g., buildings, machinery, and equipment) used within the product system are excluded from the system boundaries. This exclusion is consistent with EN 15804 and PCR requirements and is considered a methodological limitation, as potential environmental impacts associated with these elements are not accounted for in the results
- For road transport, EURO 5 efficiency was considered for trucks, and emissions were calculated in the LCA for Experts 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 9**;
- 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 8 - 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.
- In Life Cycle Assessment (LCA) databases, production data specific to the national context are not always available. In such cases, it is common to adopt data originating from other regions and, in some situations, as applied in the present study, to use *proxy*

datasets from databases with temporal coverage outside the requirements defined by the PCR, in order to ensure the completeness of the information for the analysed product system.

▪ 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.

▪ It was not possible to access all inventory data related to raw materials consumed in the hot-rolled steel rebar 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 10.

- 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 10**.

Table 9 - 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 LCA for Expert's 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 steel rebar's AVB process, only SOx, NOx, and particulate matter emissions to the atmosphere from production processes are monitored and recorded (primary data).
- It is assumed that the recovery rate of reinforcing steel and the associated end-of-life processing reflect typical practices in the Brazil context. However, the inputs related to raw materials and auxiliary processes used in the recovery and treatment stages are based on reference values from the applicable PCR, which may not fully represent national conditions. These values were applied due to the lack of more representative data sources.

Allocation Rules

The CA-60 steel rebar 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 2019:14 (2025), an allocation procedure was carried out based on economic criteria. The economic allocation was developed by taking the stable average AVB's marketing prices of the products and the co-product (pig iron, blast furnace slag, coal dust and steel billets); and for some products and co-products (hot metal, blast furnace gas, basic oxygen furnace gas, oxygen, argon and nitrogen), secondary data based also on market values were applied, to calculate the corresponding contribution percentages. It is important to note that, due to the absence of market value for the gases generated in the blast furnace and steelmaking processes, a substitution approach was applied, considering the

avoided consumption of natural gas through the internal use of process gases. Although natural gas has a significantly higher calorific value, these process gases are routinely used in combination with coke and charcoal to replace external fossil fuels in furnaces, ensuring adequate operational efficiency while reducing operating costs and associated environmental impacts. Based on published literature and prevailing industry practices (WorldSteel Association, 2021a; WorldSteel Association, 2021b; Musial et al., 2022; Arroyo, Pérez & Cuervo-Piñera, 2023; Fricker, 2003), further validated by AVB's technical team, it was deemed appropriate to apply this proxy approach, assigning the financial value of natural gas to both blast furnace gas and steelmaking gas for allocation purposes.

For the **blast furnace process**, the contribution percentages corresponding to the allocation of charges are 74% for hot metal, 9% for pig iron, 0.21% for blast furnace slag, 0.11% for coal dust, and 17% for blast furnace gas, according to the average marketing costs.

For the **steelmaking process**, the contribution percentages corresponding to the allocation of charges are 98% for steel billet and 2% for basic oyxgen furnace gas. For the **gas plant process**, the contribution percentages corresponding to the allocation of charges are 76% for oxygen, 23% for nitrogen and 1% for argon.

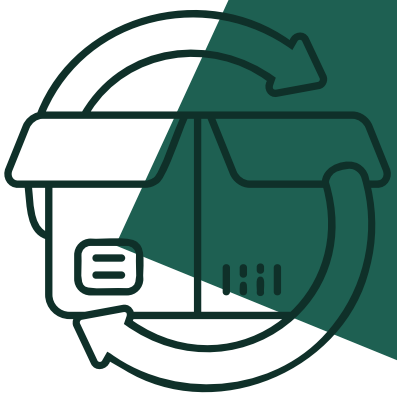
Cut-off criteria

Although the PCR 2019:14 version 2.0.1 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 rebar 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.

PRODUCT SYSTEM BOUNDARIES



Cradle-to-gate with **end-of-life** modules (C1-C4) and **beyond system boundary** (module D) are selected for the Life Cycle Assessment (LCA) study according to EN 15804 Section 5.2. and PCR 2019:14 (modules A1-A3 + C1-C4 + D). The AVB CA-60 rebar life cycle is divided into three stages: (i) the **product stage**, referred to as cradle-to-gate (modules A1-A3); (ii) the **end-of-life** stage (C1-C4); and (iii) the processes occurring **beyond the system boundary** (benefits and loads beyond the system boundary, module D). The product stage includes the **blast furnace**, **steelmaking**, **hot rolling** and **wire drawing** processes. The production of all major inputs (e.g., raw materials, electricity, fuel, water), as well as the waste flows included in product stages, as described in **Figure 1**.

Description of system boundaries

Module A1 to A3, product stage

The primary raw materials used in the production of steel rebar include steel scrap, calcined petroleum coke, calcined dolomite, lime, and ferroalloys (such as ferrosilicon, ferromanganese, and silicomanganese). Module A1 encompasses all environmental impacts associated with the extraction, processing, and production of these raw materials. In accordance with EPD guidelines, steel scrap used as input in modules A1–A3 is considered “burden-free,” with the exception of purchased scrap, for which upstream impacts are accounted.

Module A2 covers the environmental impacts related to the transportation of raw materials from suppliers to the manufacturing facility, including all upstream logistics. Module A3 includes the impacts generated during the manufacturing processes occurring on site, from the receipt of raw materials to the final production of the steel rebar.

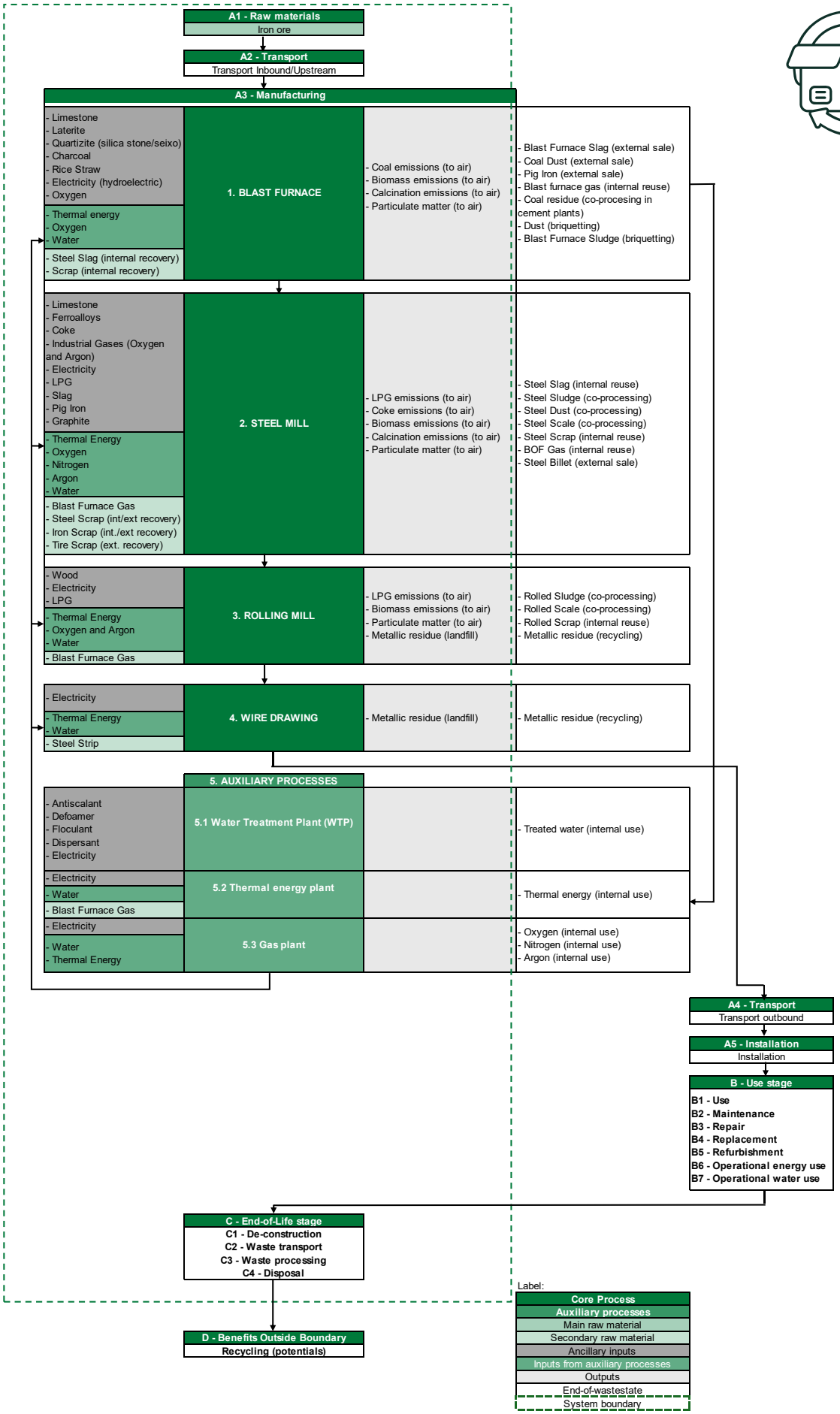


Figure 1 - System product considered for the study.

Module C1 to C4, end-of-life

Representative scenarios for the final disposition of the product were defined based on typical waste management practices applicable to the geographical context of the study (Brazil). Allocation to different waste treatment routes (recycling, recovery, and final disposal) was based on representative secondary data and/or technical literature, ensuring consistency with the geographical and technological scope of the assessment. In the absence of specific primary data, conservative assumptions were applied in accordance with PCR 2019:14 (Table 4. Default data for modelling modules C1, C2, C3 and C4. References: Erlandsson et al., (2015), OVAM (2017), page 40) – **Table 8**. The **Module C1** (Deconstruction/Demolition) considers the environmental impact during the dismantling of the product at the installation site. The energy demand corresponding to the demolition/deconstruction of reinforced concrete was adopted as a proxy described in Table 4 of PCR 2019:14. Additionally, under Brazilian conditions, **Paulino et al. (2023) report that approximately 45% of post-demolition waste is recovered**; this value was used as the baseline scenario in this study. The fraction of post-demolition material not recovered was assumed to be directed to landfill disposal. **Module C2** (transport to waste processing and/or disposal) includes the transportation of waste to treatment or final disposal facilities, based on representative transport distances and modes. In accordance with PCR 2019:14 (version 2.0.1), a transport distance of 80 km was assumed, as the waste is not directed to incineration processes. The selected transport vehicle corresponds to *'GLO Truck diesel driven, Euro 5, cargo consumptio 20 - 26t gross weight / 17,3t payload'* consistent with the specifications provided in the applicable PCR. **Module C3** (waste processing for reuse, recovery, and recycling) includes the processes required to prepare waste for subsequent treatment, such as sorting, separation, and mechanical processing. A 5% process loss rate was assumed, in accordance with the internal best practices of the Eco+ Foundation, which conducted the study. **Module C4** (final disposal) comprises the waste flows directed to landfill, in accordance with the defined EoL scenarios. For this stage, only diesel consumption associated with waste compaction and landfill operation (e.g., trench excavation) was considered, along with the corresponding emissions from fuel combustion.

Table 8 – Considerations of end-of-life aspects.

Module	Process	Quantity	Energy Carrier
C1	Demolition/deconstruction concrete/reinforced concrete	10 kWh/tonne	Diesel
C2	Transport	80 km	16-32 tonne lorry

			(EURO 5)
C3	Loading and unloading at sorting facility	1.8 kWh/tonne	Diesel
	Mechanical sorting	2.2 kWh/tonne	Electricity
	Fragging of steel	7.4 kWh/tonne	Diesel
C4	Compacting of inert construction waste, including backfilling	1.6 kWh/tonne	Diesel

End-of-Life (EoL) scenarios for 100% recycling and 100% landfill are further stated in the results section.

Module D, beyond boundary system

Module D ("benefits and loads beyond the system boundary") represents the environmental impacts avoided or incurred when materials recovered at the end-of-life of a product are used in subsequent product systems. **Secondary data** were used to characterize both the environmental profile of the substituted material and the impacts associated with post-End-of-Waste (post-EoW) processes. The substitution point was defined in accordance with the requirements of the PCR 2019:14 v2.0.1, ensuring consistency between the substituted product and the recovered material.

In this study, **the substitution point corresponds to the material at the stage at which it enters the steelmaking process**, i.e., prepared and classified scrap (average market scrap quality) ready to be charged into the Basic Oxygen Furnace (BOF). This definition ensures that the comparison between secondary and primary material is performed at an equivalent functional stage.

Calculation procedure

The net flow value was obtained from equation 1, and then the value of D was calculated using equation 2.

$$F = Y \times (M_{MR,out} - M_{MR,in}) \quad \textbf{(Eq. 1)}$$

$$D = (F \times Imp_{pEoW}) - (F \times Imp_{subt.}) \quad \textbf{(Eq. 2)}$$

For every ton of steel installed on a construction site in Brazil, at the end of its useful life, 450 kg of demolition waste are recovered after sorting and treatment, reaching their final destination (but, considering a 5% loss, 427 kg of demolition waste are recovered at the end). The remainder (550 kg) is lost due to adhesion to the concrete and is disposed of in landfills. In the product phase, the steel already presents a percentage of scrap, with a range of 14% to 25% being adopted. Thus, the M_MRin value is 143.5 kg and M_MRout is 427.5 kg, and the yield factor is 1. This assumption is justified by the absence of additional post-EoW processing steps beyond the transport of post-demolition material to the steelmaking facility; therefore, no material losses are considered at this stage. The net flow value is 284.0 kg.

Modules declared, geographical scope, share of specific data and data variation (in GWP-GHG results)

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							X	X	X	X	X
Geography	GLO	BR	BR	ND	ND	ND							GLO + BR				GLO
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.

Table 10 presents the data quality declaration and analysis for hot-rolled CA-50 reinforcing steel rebar production. **The total primary data share was calculated as 47%**.

Table 10 - Declaration of data sources, reference years, data categories, and share primary data.

Life Cycle Stage	Process	Description of Process	Source Type	Source	Reference year	Data Category	Share primary data of GWP-GHG results for A1-A3
Product Stage (A1-A3)	Purchased raw-materials	Consumption of purchased raw-materials	Collected data	EPD owner	Average of 2021-2023	50% generic data, 50% primary data	32%
		Production of purchased raw-materials	Database	Sphera Database (2025.2)	Mixed		
	Transport of raw-materials to manufacturing site	Distance between supplier and manufacturing site	Collected data	EPD owner	Average of 2021-2024	50% generic data, 50% primary data	3%
		Fuel consumption	Database	Sphera Database (2025.2)	2023		
		% of biofuel composition in fuel brazilian context	Literature	Brazilian Law n. 11,097/2005	2024		
		Transport Combustion Emissions	Database	Sphera Database (2025.2)	2023		
	Product Manufacturing (auxiliary and emissions process)	Consumption of raw materials and electricity	Collected data	EPD owner	Average of 2021-2023	60% generic data, 40% primary data	12%
		Production of raw-materials and electricity	Database	Sphera Database (2025.2)	Mixed		
		Product Manufacturing emissions	Collected data	EPD owner	Average of 2021-2023		
		Product Manufacturing emissions (calculation from primary and secondary data)	Estimated data	2006 IPCC Guidelines	2006		
				GHG Protocol	version 2025.0.1		
	Waste treatment and transport of waste to treatment site	Generation of industrial waste	Collected data	EPD owner	Average of 2021-2023	60% generic data, 40% primary data	1%
		Waste treatment	Database	Sphera Database (2025.2)	Mixed		
		Distance between manufacturing and treatment site	Collected data	EPD owner	Average of 2021-2023		
		Fuel consumption	Database	Sphera Database (2025.2)	2023		
		% of biofuel composition in fuel brazilian context	Literature	Brazilian Law n. 11,097/2005	2024		

End-of-life (C1-C4)	Demolition or Deconstruction (C1)	Fuel consumption in demolition or deconstruction processes	Literature	PCR 2019:14, v2.0.1	2025	100% generic data	0%
		Production of purchased fuel	Database	Sphera Database (2025.2)	Mixed		
		Emissions from fuel combustion in demolition machinery (calculation from secondary data)	Estimated data	2006 IPCC Guidelines	2006		
				CETESB	2019		
	Transport to waste processing and/or disposal (C2)	Distance between the demolition site and the sorting plant	Literature	PCR 2019:14, v2.0.1	2025	100% generic data	0%
		Fuel consumption	Database	Sphera Database (2025.2)	2023		
		% of biofuel composition in fuel brazilian context	Literature	Brazilian Law n. 11,097/2005	2024		
		Transport Combustion Emissions	Database	Sphera Database (2025.2)	2023		
	Waste processing for recovery, reuse and recycling (C3)	Consumption of fuel and electricity	Literature	PCR 2019:14, v2.0.1	2025	100% generic data	0%
		Production of electricity	Database	Sphera Database (2025.2)	Mixed		
		Production of purchased fuel	Database	Sphera Database (2025.2)	Mixed		
		Emissions from fuel combustion in machinery (calculation from secondary data)	Estimated data	2006 IPCC Guidelines	2006		
				CETESB	2019		
	Disposal (C4)	Consumption of fuel to waste compacting and backfilling	Literature	PCR 2019:14, v2.0.1	2025	100% generic data	0%
Beyond Boundary System (D)		Amount of material recovered at the end of a product's life that can be used for replacement in other production systems.	Literature	Paulino et al., 2023 and Thieves et al., 2022	2022-2023	100% generic data	0%
		Production of the material to be replaced	Database	Sphera Database (2025.2)	2014		
Total share of primary data, of GWP-GHG results for A1-A3							**48%**

ENVIRONMENTAL PERFORMANCE

The estimated impact results are only relative statements, which do not indicate the endpoints of the impact categories, exceeding threshold values, safety margins and/or risks.

Mandatory impact Category Indicators according to EN 15804

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

Environmental Performance Indicator		Unit	A1	A2	A3	Total (A1-A3)	C1	C2	C3	C4	D
Climate Change (GWP)	Fossil	$kgCO_2eq$	677.74	51.97	255.53	985.24	3.25	5.30	0.77	6.69E-02	-932.46
	Biogenic	$kgCO_2eq$	35.70	0.09	90.55	126.34	0.01	0.01	0.07	4.46E-04	-1.93
	Land Use Change	$kgCO_2eq$	3.14	4.69	2.71	10.54	0.25	0.48	0.11	2.24E-02	0.08
	Total	**$kgCO_2eq$**	**716.59**	**56.75**	**348.79**	**1122.13**	**3.51**	**5.80**	**0.95**	**8.98E-02**	**-934.30**
Photochemical Ozone Creation (POF)		kg NMVOCeq	3.44	3.44	0.18	1.59	5.21	0.04	0.01	4.55E-04	-3.26
Ozone Depletion (ODP)		kg CFC-11eq	6.01E-06	6.01E-06	1.63E-10	1.56E-05	2.16E-05	1.67E-11	1.95E-10	7.78E-13	7.09E-12
Acidification (AP)		mol H+ eq	4.09	4.09	0.19	2.81	7.09	0.02	0.01	4.11E-04	-8.09
Eutrophication (EP)	Freshwater	kg P eq	5.04E-02	7.48E-04	3.11E-02	8.23E-02	4.08E-05	7.70E-05	1.86E-05	3.59E-06	-7.82E-04
	Marine	kg N eq	0.73	0.09	0.50	1.32	0.01	0.01	2.16E-03	1.86E-04	-1.02
	Terrestrial	mol N eq	7.92	1.02	5.39	14.32	0.15	0.11	0.02	1.99E-03	-11.01
Abiotic Depletion Potential (ADP)*	Mineral and Metal	kg Sb eq	1.45E-02	3.96E-06	6.78E-04	1.51E-02	2.15E-07	4.06E-07	1.24E-07	1.89E-08	-4.43E-02
	Fossil	MJ	7681.89	710.88	3656.02	12048.79	38.67	73.05	19.67	3.40E+00	-9686.73
Water User (WU)		m^3 world eq	76.83	76.83	0.22	67.07	144.12	0.02	0.02	0.05	-39.90

** 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.*

*** The results of the end-of-life stage (modules C1-C4) should be considered when using the results of the product stage (modules A1-A3)" For services, "A1-A3" shall be replaced by "A1-A5".*

A1 – purchased raw material; A2 – raw material transportation; A3 – product manufacturing; A1-A3 – product stage; C1 – demolition/deconstruction; C2 – Transportation for waste processing and/or disposal; C3 – Waste Processing for recovery, reuse and/or recycling; C4 – Disposal; D – beyond system boundary

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Potential Environmental Impact

The Life Cycle Impact Assessment (LCIA) results for 1 (one) tonne of hot-rolled CA-60 reinforcing steel 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.

As shown, the highest environmental impacts are associated with the stages involving the extraction and production of raw materials, as well as their transportation to the manufacturing site. These stages dominate most of the indicators, except for climate change biogenic and ozone depletion. For these two indicators, the greatest contribution comes from the manufacturing stage, which comprises all operations carried out within the factory, including the transformation of raw materials into the final product, energy consumption, use of auxiliary materials, and the associated emissions and waste generation.

In the **Climate Change**, fossil category, the purchased raw materials (A1) represent approximately 65% of the impact, mainly driven by raw material extraction and processing activities. The product manufacturing (A3) accounts for 30%, associated with direct combustion and process emissions during steelmaking and rolling, while transportation (A2) contributes around 5%, reflecting fuel consumption in supply logistics. For Climate Change, biogenic, emissions are predominantly linked to the raw-materials manufacturing (72%), due to the use and handling of biomass-based inputs. Manufacturing processes represent 28. In the Climate Change, land use change category, impacts are divided between transportation (44%), raw materials (29%) and the manufacturing (27%), indicating that land-use change effects arise both from raw material sourcing and internal use of biomass-based energy, with no contribution from transportation.

Considering **Climate Change**, total, 65% of the impact arises from raw materials manufacturing activities, driven by input production and upstream energy consumption. The product manufacturing contributes 30%, linked to combustion and process reactions, and transportation accounts for 5%. **Photochemical Ozone Formation** is mainly influenced by raw materials manufacturing processes (64%), due to NMVOC emissions from the production and transport of fossil fuels and chemical inputs. The product manufacturing accounts for 32%, related to fugitive emissions from internal process-gas systems, while A2 contributes 3%. In the **Ozone Depletion** indicator, the manufacturing process (A3) dominates the impact with 79%, reflecting emissions

associated with utility systems and refrigerants. Raw materials contribute 21%.

For **Acidification Potential**, purchased raw materials represents 53% of the impact, mainly due to SO_2 and NO_x emissions from electricity generation, mining, and external raw material processing. The product manufacturing contributes 44%, arising from combustion in furnaces and rolling operations, while A2 accounts for 3%. **Freshwater eutrophication** is 52% related to raw materials processes, primarily due to emissions linked to electricity generation and raw material extraction, with the product manufacturing contributing 47%. **Marine eutrophication** is also dominated by raw materials processes (53%), largely related to NO_x emissions from logistics and energy generation. The product manufacturing contributes 40%, and transportation adds 7%. For **terrestrial eutrophication**, purchased raw materials accounts for 53%, followed by the product manufacturing with 40%, linked to atmospheric nutrient emissions, while A2 contributes 7%, mainly from NO_x generated by fuel combustion.

Abiotic depletion of minerals and metals is overwhelmingly associated with raw materials extraction activities (93%), reflecting the extraction and beneficiation of iron ore and alloying elements. The product manufacturing contributes 7%, and transport impacts are negligible. **Abiotic depletion of fossil** resources shows a 57% contribution from raw materials, driven by embedded energy in raw materials and fuels, while the product manufacturing accounts for 38% due to thermal energy demand, and A2 represents 6% from fuel consumption in transportation. **Water use** is more evenly distributed, with 45% associated with raw materials processes, mainly related to mining and beneficiation, and 55% linked to product manufacturing processes, particularly cooling and rolling operations.



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.

Resource use indicators	Unit	Purchased raw materials (A1)	Raw materials transport (A2)	Product manufacturing (A3)	Total (A1-A3)	Demolition (C1)	Waste transport (C2)	Waste processing (C3)	Disposal (C4)	Benefits beyond boundary (D)
Use of renewable primary energy (PERE)	[MJ]	16243.34	4.43	8.36	6.89	0.39	26.16	16243.34	4.43	8.36
Total use of renewable primary energy resources (PERT)	[MJ]	16243.34	4.43	8.36	6.89	0.39	26.16	16243.34	4.43	8.36
Use of non-renewable primary energy (PENRE)	[MJ]	12048.79	38.67	73.05	19.67	3.40	-9678.06	12048.79	38.67	73.05
Total use of non-renewable primary energy resources (PENRT)	[MJ]	12048.79	38.67	73.05	19.67	3.40	-9678.06	12048.79	38.67	73.05
Use of renewable secondary fuels (RSF)	[MJ]	0.00	0.00	0.00	0.00	0.00	-0.80	0.00	0.00	0.00
Use of non-renewable secondary fuels (NRSF)	[MJ]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Use of net fresh water (FW)	[m3 world equiv.]	20.95	0.00	0.00	0.02	0.00	-0.18	20.95	0.00	0.00

Output flows and waste indicators

Output flows and waste categories	Unit	Purchased raw materials (A1)	Raw materials transport (A2)	Product manufacturing (A3)	Total (A1-A3)	Demolition (C1)	Waste transport (C2)	Waste processing (C3)	Disposal (C4)	Benefits beyond boundary (D)
Hazardous waste disposed (HWD)	**kg**	5.68E-02	4.26E-08	4.53E-07	5.68E-02	2.31E-09	4.37E-09	2.21E-09	2.04E-10	-9.04E-02
Non-hazardous waste disposed (NHWD)	**kg**	-9.75E+00	3.82E-01	6.97E-01	-8.67E+00	2.08E-02	3.93E-02	1.18E-02	1.83E-03	0.00E+00
Radioactive waste disposed (RWD)	**kg**	1.29E-01	7.91E-04	1.71E-02	1.47E-01	4.30E-05	8.12E-05	1.44E-04	3.78E-06	0.00E+00

Additional environmental performance indicators

Optional indicators	Unit	Purchased raw materials (A1)	Raw materials transport (A2)	Product manufacturing (A3)	Total (A1-A3)	Demolition (C1)	Waste transport (C2)	Waste processing (C3)	Disposal (C4)	Benefits beyond boundary (D)
GWP-GHG	**kg CO_2 eq**	6.98E+02	4.98E+01	3.41E+02	1.09E+03	3.50E+00	5.08E+00	8.30E-01	8.86E-02	-9.32E+02
Particulate matter	**[Diesease incidences]**	1.30E-04	1.48E-06	2.27E-04	3.59E-04	2.31E-07	1.47E-07	6.26E-08	4.17E-09	-1.22E+03
Ionizing radiation, human health	**[kBq U235 eq]**	2.37E+01	6.58E-02	1.07E+01	3.45E+01	3.58E-03	6.76E-03	9.43E-03	3.15E-04	-3.90E-05
Ecotoxicity, freshwater	**[CTUe]**	2.25E+03	1.20E+03	1.65E+03	5.09E+03	6.51E+01	1.23E+02	3.05E+01	5.73E+00	-5.87E-06
Human toxicity, cancer	**[CTUh]**	1.22E-05	2.10E-08	7.11E-08	1.23E-05	1.14E-09	2.16E-09	6.44E-10	1.01E-10	3.92E+01
Human toxicity, non-cancer	**[CTUh]**	5.46E-06	5.89E-07	1.68E-06	7.73E-06	3.22E-08	6.05E-08	1.58E-08	2.82E-09	0.00E+00
Land Use	**[Pt]**	1.30E-04	1.48E-06	2.27E-04	3.59E-04	2.31E-07	1.47E-07	6.26E-08	4.17E-09	-1.22E+03

** This indicator accounts for all greenhouse gases except biogenic carbon dioxide uptake and emissions and biogenic carbon stored in the product. As such, the indicator is identical to GWP-total except that the CF for biogenic CO2 is set to zero.*

***Disclaimer 1: This impact category deals mainly with the eventual impact of low dose ionizing radiation on human health of the nuclear fuel cycle. It does not consider effects due to possible nuclear accidents, occupational exposure nor due to radioactive waste disposal in underground facilities. Potential ionizing radiation from the soil, from radon and from some construction materials is also not measured by this indicator.*

****Disclaimer 2: 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.*

Environmental Performance Results (scenario EoL 100% recycling)

Mandatory impact category indicators according to EN 15804 (scenario EoL 100% recycling)

In accordance with EN 15804+A2 (Sections 6.2.6, 6.3.9, 7.3.4, and Annex D) and the requirements of the General Programme Instructions (GPI) v5, Rule A.12.6, this EPD reports, in addition to the most likely end-of-life scenario, the environmental results for two hypothetical scenarios: 100% landfill and 100% recycling. These additional scenarios are provided to ensure transparency, enable contextual comparability, and illustrate the product's sensitivity to different end-of-life.

Environmental Performance Indicator		Unit	A1	A2	A3	Total (A1-A3)	C1	C2	C3	C4	D
Climate Change (GWP)	Fossil	$kgCO_2eq$	677.74	51.97	255.53	985.24	3.25	5.30	0.77	0.00E+00	-2648.02
	Biogenic	$kgCO_2eq$	35.70	0.09	90.55	126.34	0.01	0.01	0.07	0.00E+00	-5.47
	Land Use Change	$kgCO_2eq$	3.14	4.69	2.71	10.54	0.25	0.48	0.11	0.00E+00	0.24
	Total	**$kgCO_2eq$**	**716.59**	**56.75**	**348.79**	**1122.13**	**3.51**	**5.80**	**0.95**	0.00E+00	**-2653.25**
Photochemical Ozone Creation (POF)		kg NMVOCeq	3.44	3.44	0.18	1.59	5.21	0.04	0.01	0.00E+00	-9.26
Ozone Depletion (ODP)		kg CFC-11eq	6.01E-06	6.01E-06	1.63E-10	1.56E-05	2.16E-05	1.67E-11	1.95E-10	0.00E+00	2.01E-11
Acidification (AP)		mol H+ eq	4.09	4.09	0.19	2.81	7.09	0.02	0.01	0.00E+00	-22.96
Eutrophication (EP)	Freshwater	kg P eq	5.04E-02	7.48E-04	3.11E-02	8.23E-02	4.08E-05	7.70E-05	1.86E-05	0.00E+00	-2.22E-03
	Marine	kg N eq	0.73	0.09	0.50	1.32	0.01	0.01	2.16E-03	0.00E+00	-2.89
	Terrestrial	mol N eq	7.92	1.02	5.39	14.32	0.15	0.11	0.02	0.00E+00	-31.26
Abiotic Depletion Potential (ADP)*	Mineral and Metal	kg Sb eq	1.45E-02	3.96E-06	6.78E-04	1.51E-02	2.15E-07	4.06E-07	1.24E-07	0.00E+00	-0.13
	Fossil	MJ	7681.89	710.88	3656.02	12048.79	38.67	73.05	19.67	0.00E+00	-27,508.53
Water User (WU)		m^3 world eq	76.83	76.83	0.22	67.07	144.12	0.02	0.02	0.00E+00	-113.31

Environmental Performance Results (scenario EoL 100% landfill)

Mandatory impact category indicators according to EN 15804 (scenario EoL 100% landfill)

Environmental Performance Indicator		Unit	A1	A2	A3	Total (A1-A3)	C1	C2	C3	C4	D
Climate Change (GWP)	Fossil	$kgCO_2eq$	677.74	51.97	255.53	985.24	3.25	5.30	0.00E+00	1.21E-01	0.00E+00
	Biogenic	$kgCO_2eq$	35.70	0.09	90.55	126.34	0.01	0.01	0.00E+00	8.08E-04	0.00E+00
	Land Use Change	$kgCO_2eq$	3.14	4.69	2.71	10.54	0.25	0.48	0.00E+00	4.06E-02	0.00E+00
	Total	**$kgCO_2eq$**	**716.59**	**56.75**	**348.79**	**1122.13**	**3.51**	**5.80**	**0.00E+00**	**1.63E-01**	**0.00E+00**
Photochemical Ozone Creation (POF)		kg NMVOCeq	3.44	3.44	0.18	1.59	5.21	0.04	0.00E+00	8.27E-04	0.00E+00
Ozone Depletion (ODP)		kg CFC-11eq	6.01E-06	6.01E-06	1.63E-10	1.56E-05	2.16E-05	1.67E-11	0.00E+00	1.41E-12	0.00E+00
Acidification (AP)		mol H+ eq	4.09	4.09	0.19	2.81	7.09	0.02	0.00E+00	7.47E-04	0.00E+00
Eutrophication (EP)	Freshwater	kg P eq	5.04E-02	7.48E-04	3.11E-02	8.23E-02	4.08E-05	7.70E-05	0.00E+00	6.50E-06	0.00E+00
	Marine	kg N eq	0.73	0.09	0.50	1.32	0.01	0.01	0.00E+00	3.38E-04	0.00E+00
	Terrestrial	mol N eq	7.92	1.02	5.39	14.32	0.15	0.11	0.00E+00	3.62E-03	0.00E+00
Abiotic Depletion Potential (ADP)*	Mineral and Metal	kg Sb eq	1.45E-02	3.96E-06	6.78E-04	1.51E-02	2.15E-07	4.06E-07	0.00E+00	3.43E-08	0.00E+00
	Fossil	MJ	7681.89	710.88	3656.02	12048.79	38.67	73.05	0.00E+00	6.17E+00	0.00E+00
Water User (WU)		m^3 world eq	76.83	76.83	0.22	67.07	144.12	0.02	0.00E+00	**1.88E-03**	0.00E+00

ABBREVIATIONS

ADP Abiotic Depletion Potential

ADP-M Abiotic Depletion Potential, fossil

ADP-F Abiotic Depletion Potential, mineral & metals

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

BR Brazil

B2B Business-to-business

CA-60 Steel bar

CEN European Committee for Standardization

CDP Carbon Disclosure Program

CH_4 Methane

CO_2 Carbon Dioxide

cPCR Complementary Product Category Rule

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

DU Declared Unit

EF Emission Factor

EPD Environmental Product Declaration

Eq Equivalent

EN 15804 European Standard 15804

EP Eutrophication Potential

EP-F Eutrophication Potential Freshwater

EP-M Eutrophication Potential Marine

EP-T Eutrophication Potential Terrestrial

EoL End-of-life

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

GLO Global

GPI General Programme Instructions

GRI Global Reporting Institute

GWP Global Warming Potential

HBEFA Handbook Emission Factors for Road Transport

HFO Heavt Fuel Oil

IES International EPD System SA

IPCC Intergovernmental Panel on Climate Change

I-REC International Renewable Energy Certificate

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

LTDA Limited Liability Company

MJ Megajoule

MLC Managed LCA Content

N Nitrogen

ND Not Declared

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

PPA Power Purchase Agreement

R&D Research & Development

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

TJ Terajoules

UN CPC United Nations Central Product Classification

WDP Water Deprivation Potential

WSA WorldSteel Association

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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	2026-06-09
Remark	Original version of EPD



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