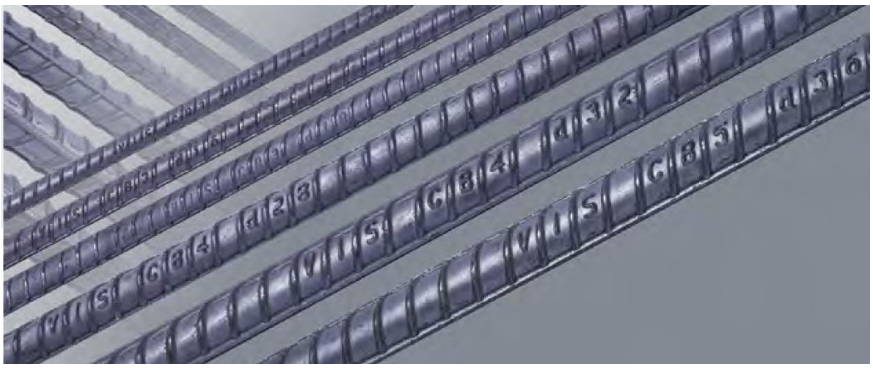
Environmental Product Declaration

Rebar

CONSTRUCTION STELL PRODUCT FROM HUNG YEN PLANT



Rebar is primarily used to reinforce concrete structures in buildings, bridges, and various civil and infrastructure projects.

Vietnam Italy Steel Joint Stock Company (VISCO), established in 2002, specializes in manufacturing and trading high-quality construction steel.

Using modern EAF processes and recycled materials, VISCO produces steel that reduces the consumption of virgin resources and minimizes the environmental burden associated with raw material extraction.

Since beginning production in 2002, VISCO has supplied rebar, wire rod, drawing wire rod, and steel billets that meet leading international standards, including British, American, and Japanese standards.

The company is certified to ISO 9001:2015 for quality management and ISO 14001:2015 for environmental management.

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ENVIRONMENTAL PRODUCT DECLARATION
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ENVIRONMENTAL PRODUCT DECLARATION

Rebar - Hung Yen Plant

According to ISO 14025,
and EN 15804+A2,

EPD PROGRAM AND PROGRAM OPERATOR NAME, ADDRESS, LOGO, AND WEBSITE	UL ENVIRONMENT 333 PFINGSTEN ROAD HTTPS://WWW.UL.COM/ NORTHBROOK, IL 60611 HTTPS://SPOT.UL.COM/
GENERAL PROGRAM INSTRUCTIONS AND VERSION NUMBER	PROGRAM OPERATOR RULES V2.7 2022
MANUFACTURER NAME AND ADDRESS	Vietnam Italy Steel Joint Stock Company – Hung Yen Plant Pho Noi A Industrial Park, Nguyen Van Linh Commune, Hung Yen Province, Vietnam
DECLARATION NUMBER	4792003266.101.1
DECLARED PRODUCT & FUNCTIONAL UNIT OR DECLARED UNIT	1 metric ton of Rebar
REFERENCE PCR AND VERSION NUMBER	PCR 2019:14 Construction Products (EN 15804+A2) v.2.0.1
DESCRIPTION OF PRODUCT APPLICATION/USE	Primarily used to reinforce concrete structures in buildings, bridges, and various civil and infrastructure projects
PRODUCT RSL DESCRIPTION (IF APPL.)	N/A
MARKETS OF APPLICABILITY	Global
DATE OF ISSUE	February 12, 2026
PERIOD OF VALIDITY	February 12, 2031
EPD TYPE	Product-specific
RANGE OF DATASET VARIABILITY	Mean
EPD SCOPE	Cradle-to-gate with modules C1-C4 and module D
YEAR(S) OF REPORTED PRIMARY DATA	October 2024 – September 2025
LCA SOFTWARE & VERSION NUMBER	Simapro Craft v10.2.0.3
LCI DATABASE(S) & VERSION NUMBER	Ecoinvent 3.11 (EN15804)
LCIA METHODOLOGY & VERSION NUMBER	EF 3.1, EN 15804

The PCR review was conducted by:	The International EPD System LCA-lab srl, SAPI srl info@environdec.com
This declaration was independently verified in accordance with ISO 14025: 2006. ☐ INTERNAL ☒ EXTERNAL	Skye Tang, UL Solutions
This life cycle assessment was conducted in accordance with ISO 14044 and the reference PCR by:	Jess Chen, UL Solutions
This life cycle assessment was independently verified in accordance with ISO 14044 and the reference PCR by:	YeonSung Mo, H.I.Pathway Co., LTD.

LIMITATIONS

Exclusions: EPDs do not indicate that any environmental or social performance benchmarks are met, and there may be impacts that they do not encompass. LCAs do not typically address the site-specific environmental impacts of raw material extraction, nor are they meant to assess human health toxicity. EPDs can complement but cannot replace tools and certifications that are designed to address these impacts and/or set performance thresholds – e.g. Type 1 certifications, health assessments and declarations, environmental impact assessments, etc.

Accuracy of Results: EPDs regularly rely on estimations of impacts; the level of accuracy in estimation of effect differs for any particular product line and reported impact.

Comparability: EPDs from different programs may not be comparable. Full conformance with a PCR allows EPD comparability only when all stages of a life cycle have been considered. However, variations and deviations are possible". Example of variations: Different LCA software and background LCI datasets may lead to differences results for upstream or downstream of the life cycle stages declared.

1. Product Definition and Information

1.1. Description of Company/Organization

Vietnam Italy Steel Joint Stock Company (VISCO) was established in 2002 with the main business of manufacturing and trading of construction steel.

The company has identified the market segment that is aimed at high quality construction steel products. Therefore, the company has invested in a steel rolling factory with a capacity of 350,000 tons / year, 100% synchronous import equipment, Danieli Morgardshammar technology provided by the world's leading steel corporation Daniel - Italy and a steel billet factory with the capacity of 552,000 tons / year by Consteel technology - steel refining technology with electric arc furnace feeding continuously across the body of the furnace.

With electric arc furnace production technology, the most modern technology in the world today, and using recycled materials, VIS steel reduces the consumption of virgin resources and minimizes the environmental burden associated with raw material extraction.

Start production since 2002, Vietnam Italy Steel is supplying products: rebar, wire rod, drawing wire rod and steel billet which meet the world's top-quality standards: British standards, American standards, Japanese standards….Vietnam Italy Steel has received the certificate of quality management ISO 9001: 2015 and environmental management certificate ISO 14001: 2015 and many awards for prestigious products - quality.

1.2. Product Description

Product Identification

- Product name: Rebar
- Product category: Construction steel
- Manufacturer: Vietnam Italy Steel Joint Stock Company – Hung Yen Plant
- Production site: Hung Yen Province, Vietnam

Product Specification

- Product size: From D10 mm ÷ D40 mm
- Length: From 6m ÷ 14m
- Weight of steel bundle: W - 3 tons
- Surface: Glossy, non crack, with embossed brand "VIS" and diameter of steel bar. Exp: VIS CB5 d36
- Color: Featured steel color
- Cross – Section: Circularity
- Unit mass: Stability
- Standard: Ability to meet the standard requirement of ASTM A615 / A615M (America), JIS G 3112: 2020 (Japan), TCVN 1651-2: 2018 (Vietnam), BS 4449 : 2005 (Britain)

Flow Diagram

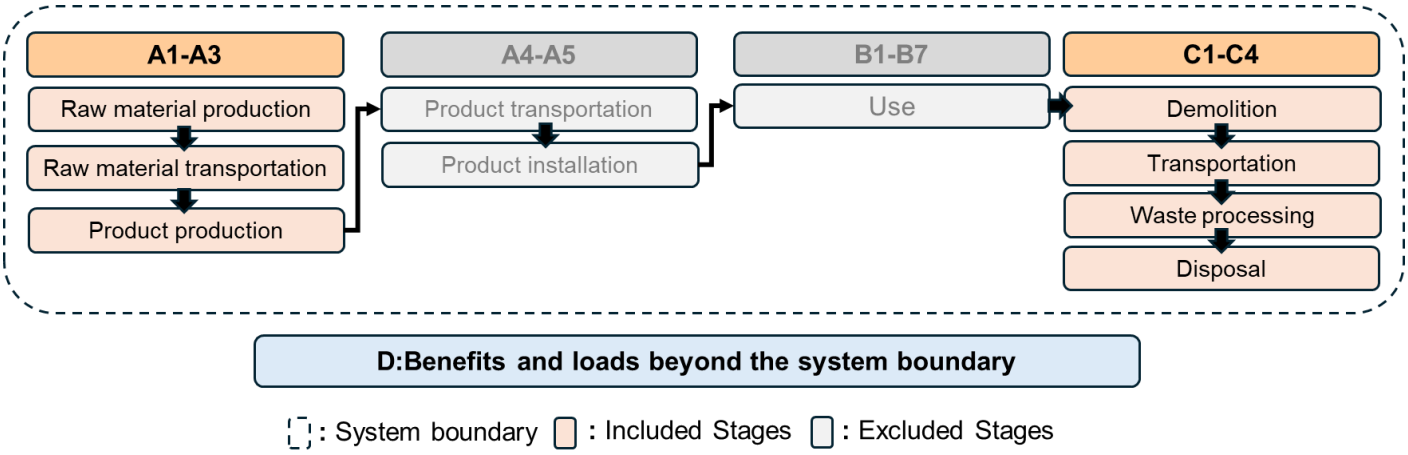


Figure 1: System boundary

Product Average

This EPD is a product-specific EPD. The declaration is for the steel product nominated as the product manufactured by Vietnam Italy Steel Joint Stock Company (VISCO).

1.3. Application

Rebar is primarily used to reinforce concrete structures in buildings, bridges, and various civil and infrastructure projects.

1.4. Declaration of Methodological Framework

- Referenced PCR: PCR 2019:14 Construction Products (EN 15804+A2) v.2.0.1.
- Declared unit: 1 metric ton of Rebar.
- System boundaries: Cradle-to-gate with modules C1-C4 and module D. (A1–A3, C1–C4, and D).
- Cut-off: Please refer to the 2.4 section.
- Data quality: Please refer to the 2.6 section.
- Allocation: Please refer to the 2.8 section.

1.5. Technical Requirements

Technical requirements can be found in the link below:

- https://vis.com.vn/brochure-cataloge
- Rebar - VIS

1.6. Properties of Declared Product as Delivered

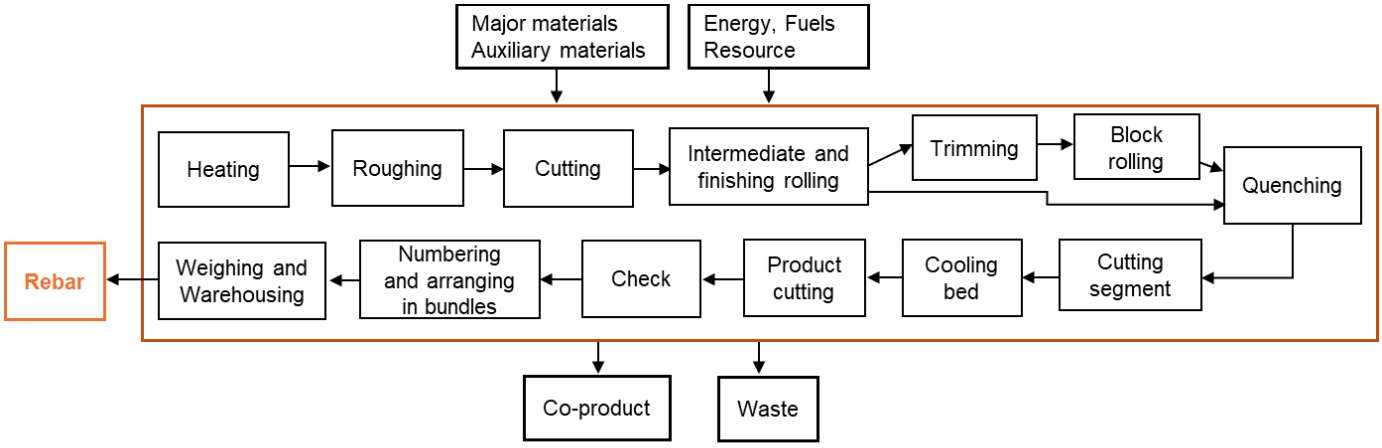
Please refer to “Product Specification” under section 1.2 Product Description.

1.7. Material Composition

Table 1. Chemical composition of the rebar

Standard	Grade	Chemical Composition					
		C	Mn	Si	P	S	N
TCVN1651 -2:2018 (Vietnam)	CB 300-V	-	-	-	0.05 MAX	0.05 MAX	-
	CB 400-V	0.29 MAX	1.80 MAX	0.55 MAX	0.04 MAX	0.04 MAX	-
	CB 500-V	0.32 MAX	1.80 MAX	0.55 MAX	0.04 MAX	0.04 MAX	-
	CB 600-V	-	-	-	0.04 MAX	0.04 MAX	-
ASTM A615 A615M-20 (America)	Grade 40	-	-	-	0.06 MAX	-	-
	Grade 60	-	-	-	0.060 MAX	-	-
JIS G3112: 2020 (Japan)	SR 235	-	-	-	0.050 MAX	0.050 MAX	-
	SR 295	-	-	-	0.050 MAX	0.050 MAX	-
	SD 295	0.27 MAX	1.50 MAX	0.55 MAX	0.050 MAX	0.050 MAX	-
	SD 345	0.27 MAX	1.60 MAX	0.55 MAX	0.040 MAX	0.040 MAX	-
	SD 390	0.29 MAX	1.80 MAX	0.55 MAX	0.040 MAX	0.040 MAX	-
	SD 490	0.32 MAX	1.80 MAX	0.55 MAX	0.040 MAX	0.040 MAX	-
BS 4449 – 2005 (Britain)	B 500B	0.25 MAX	-	-	0.050 MAX	0.050 MAX	0.012 MAX

1.8. Manufacturing



Rebar production at Hung Yen Plant

Figure 2: Rebar production process

Steel billets serve as the primary raw material. They first enter the heating furnace, followed by roughing and initial cutting as part of the primary forming operations. Afterward, the billets undergo the rolling process, which consists of intermediate rolling and finishing rolling. Depending on customer requirements, the rolled billets are then either transferred to trimming, block rolling, and quenching, or proceed directly to the quenching stage. Following quenching, the products pass through the cutting segment, cooling bed, final cutting, and other downstream processing steps to meet various market specifications.

1.9. Packaging

No packaging materials are used.

1.10. Transportation

Including raw material transportation and End-of-life stage waste transportation.

1.11. Product Installation

N/A (The use stage is not not declared in this study.)

1.12. Use

N/A (The use stage is not not declared in this study.)

1.13. Reference Service Life and Estimated Building Service Life

N/A (Since the product used declared unit, reference service life is not applicable.)

1.14. Reuse, Recycling, and Energy Recovery

Steel products can be 100% recycled as steel scrap and remelted circularly back to steel production.

In this study, 85% of the steel waste is assumed to be recovered as secondary material, based on the World Steel Association.

1.15. Disposal

In this study, it is assumed that 15% of the steel waste is landfilled.

2. Life Cycle Assessment Background Information

2.1. Functional or Declared Unit

Based on the PCR, the study uses a declared unit. The declared unit is one metric ton (tonne) of Rebar.

This EPD encompasses all types and grades of Rebar product groups produced by VISCO - Hung Yen Plant.

2.2. System Boundary

Table 2. Description of the system boundary modules

	PRODUCT STAGE			CONSTRUCT-ION PROCESS STAGE		USE STAGE							END OF LIFE STAGE				BENEFITS AND LOADS BEYOND THE SYSTEM BOUNDARY
	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
	Raw material supply	Transport	Manufacturing	Transport from gate to site	Assembly/Install	Use	Maintenance	Repair	Replacement	Refurbishment	Building Operational Energy Use During Product Use	Building Operational Water Use During Product Use	Deconstruction	Transport	Waste processing	Disposal	Reuse, Recovery, Recycling Potential
EPD Type	X	X	X	ND	ND	ND	ND	ND	ND	ND	ND	ND	X	X	X	X	X

The system boundary of this EPD follows a cradle-to-gate with modules C1-C4 and module D.

In accordance with the PCR, the following processes and goods are excluded from the system boundaries:

- Personnel-related processes: Activities such as business travel, commuting of personnel, and research and development activities not directly associated with the production of the target product are excluded.
- Infrastructure and capital goods: The production and end-of-life stages of infrastructure and capital goods used within the product system are excluded, as these items are not consumed during production and retain their function for more than three years.

2.3. Estimates and Assumptions

The general assumptions applied throughout this study are as follows:

– Unit conversion: Since some material usage records or purchase quantities are not expressed in weight units,

and the emission factors for coal and lump coal combustion are provided in energy units (MJ), unit conversion is required to complete the LCI calculation.

- Road transportation: Domestic road transport is assumed to utilize Euro 4–equivalent diesel vehicles, in accordance with Vietnam's transportation policy.
- Transport distance data sources: Marine transport distances are obtained from MarineTraffic, while road transport distances are derived from Google Maps.

2.4. Cut-off Criteria

All the flows are included and there is no cut-off used in this study.

2.5. Data Sources

The data is based on company-specific primary data derived from consumption records, electricity bill and water bill.

Secondary data for upstream processes—including raw materials, auxiliary materials, packaging, energy, and resource inputs—were sourced from the Ecoinvent database.

2.6. Data Quality

Temporal Coverage

The primary data covers the period from October 2024 to September 2025. This data collection period meets the data quality requirements specified in the PCR and is therefore considered to have very good time representativeness.

Geographical Coverage

The geographical scope of product manufacturing is in Hung Yen, Vietnam. All primary production data were collected directly from the manufacturer, and the geographical representativeness of these data is considered very good.

Since primary geographical data for raw materials were not available, proxy datasets were used in this study. The selected datasets were chosen based on the closest geographical match available in the database to ensure appropriate regional representativeness.

Technological Coverage

Data used for the processes and products under study reflect the same technological conditions defined in the goal and scope, meaning that identical or equivalent technology has been applied throughout the assessment.

Dataset

Background data for materials, production processes, transportation, and end-of-life (EoL) stages were sourced from the ecoinvent v3.11 LCI database. The ecoinvent database is one of the most comprehensive and widely recognized LCI libraries available, providing detailed information on data quality and representativeness.

2.7. Period under Review

The period of the study covers from October 2024 to September 2025.

2.8. Allocation

Economic allocation has been applied in this study. The economic values used in the calculation represent a three-year average market prices of the product and co-product.

3. Life Cycle Assessment Scenarios

Table 3. End of life (C1-C4)

NAME		VALUE	UNIT
Assumptions for scenario development	At the end-of-life stage of construction steel products, the assumed scenario includes dismantling of the product, transportation to an end-of-life treatment facility, processing of secondary (recyclable) materials, and the final disposal of any non-recoverable steel fractions.		
Collection process (specified by type)	Collected separately	0	tonne
	Collected with mixed construction waste	1	tonne
Recovery (specified by type)	Reuse	0	tonne
	Recycling	0.85	tonne
	Landfill	0	tonne
	Incineration	0	tonne
	Incineration with energy recovery	0	tonne
	Energy conversion efficiency rate	-	-
Disposal (specified by type)	Product or material for final deposition	0.15	tonne
Removals of biogenic carbon (excluding packaging)		-	kg CO2

Scenario in Module D

Steel is fully recyclable, and an 85% recovery rate—based on World Steel data—is applied to calculate the end-of-life (EoL) recycling credit. This credit reflects both the burdens associated with recycling processes and the environmental benefits arising from the substitution of primary (virgin) steel production. Declared benefits and loads associated with the net flow of secondary material are included in Module D, while co-product allocation is excluded in accordance with PCR requirements.

Metals are assumed to reach the end-of-waste state after sorting and shredding processes. Module D therefore captures the treatment of recovered scrap, the net benefits associated with its recycling potential, and the avoided impacts resulting from the replacement of virgin steel production. The calculation of Module D is based on the average production data of the facility.

4. Life Cycle Assessment Results

4.1. Life Cycle Impact Assessment Results

Table 4. Environmental Impact Results according to EN 15804

EF3.1 (EN 15804+A2)	UNIT	A1-A3	C1	C2	C3	C4	D
GWP-total	kg CO2 eq.	1.58E+03	3.99E-01	1.62E+01	4.11E+00	8.70E-02	-4.13E+01
GWP-fossil	kg CO2 eq.	1.58E+03	3.99E-01	1.62E+01	4.10E+00	8.70E-02	-4.27E+01

GWP-biogenic	kg CO2 eq.	-6.50E+00	8.00E-05	4.98E-03	8.24E-03	1.75E-05	1.29E+00
GWP-LULUC	kg CO2 eq.	4.32E-01	4.08E-05	7.26E-03	2.97E-03	8.90E-06	4.51E-02
ODP	kg CFC11 eq.	7.22E-06	5.92E-09	2.05E-07	5.00E-08	1.29E-09	1.38E-07
AP	mol H^+ eq.	1.29E+01	3.56E-03	5.52E-02	3.16E-02	7.77E-04	-6.60E-02
EP-freshwater	kg P eq.	6.95E-01	1.28E-05	1.77E-03	7.02E-04	2.80E-06	-6.93E-03
EP-marine	kg N eq.	2.17E+00	1.66E-03	1.75E-02	1.31E-02	3.62E-04	1.57E-04
EP-terrestrial	mol N eq.	2.28E+01	1.82E-02	1.90E-01	1.42E-01	3.96E-03	-3.25E-01
POCP	kg NMVOC eq.	6.73E+00	5.43E-03	7.48E-02	4.24E-02	1.19E-03	-9.08E-02
ADP-M&M	kg Sb eq.	1.13E-03	1.39E-07	5.29E-05	2.22E-06	3.03E-08	2.05E-04
ADP-fossil	MJ	1.89E+04	5.19E+00	2.24E+02	5.39E+01	1.13E+00	-2.80E+02
WDP	m^3	1.72E+02	1.50E-02	1.27E+00	3.82E-01	3.28E-03	3.20E+01

GWP-fossil: Global Warming Potential fossil fuels
GWP-biogenic: Global Warming Potential biogenic
GWP-LULUC: Global Warming Potential land use and land use change
GWP-total: Global Warming Potential
ODP: Depletion potential of the stratospheric ozone layer
AP: Acidification potential, Accumulated Exceedance
EP-freshwater: Eutrophication potential, fraction of nutrients reaching freshwater end compartment.
EP-marine: Eutrophication potential, fraction of nutrients reaching freshwater end compartment.
EP-terrestrial: Eutrophication potential, Accumulated Exceedance
POCP: Formation potential of tropospheric ozone
ADP-M&M: Abiotic depletion potential for non-fossil resources (minerals and metals)
ADP-fossil: Abiotic depletion potential for fossil resources
WDP: Water deprivation potential, deprivation weighted water consumption

Table 5. Environmental Impact Results – GWP-GHG indicator according to EN 15804

EF3.1 (EN 15804+A2)	Unit	A1-A3	C1	C2	C3	C4	D
GWP-total	kg CO2 eq.	1.58E+03	3.99E-01	1.62E+01	4.10E+00	8.70E-02	-4.26E+01

4.2. Life Cycle Inventory Results

Table 6. Resource Use

Parameter	Unit	A1-A3	C1	C2	C3	C4	D
RPR_E	MJ	1.26E+03	3.26E-02	3.11E+00	2.50E+00	7.10E-03	1.20E+02
RPR_M	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RPR_T	MJ	1.26E+03	3.26E-02	3.11E+00	2.50E+00	7.10E-03	1.20E+02
$NRPR_E$	MJ	1.89E+04	5.19E+00	2.24E+02	5.39E+01	1.13E+00	-7.17E+02
$NRPR_M$	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$NRPR_T$	MJ	1.89E+04	5.19E+00	2.24E+02	5.39E+01	1.13E+00	-7.17E+02
SM	Kg	1.30E+02	2.15E-03	9.85E-02	1.70E-02	4.69E-04	1.45E+02
RSF	MJ	4.07E-02	5.63E-06	1.27E-03	4.87E-05	1.23E-06	1.51E-02
NRSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	m3	5.24E+00	3.67E-04	3.10E-02	1.02E-02	8.00E-05	1.98E+00

PERE: Use of renewable primary energy excluding renewable primary energy resources used as raw materials
PERM: Use of renewable primary energy resources used as raw materials
PERT: Total use of renewable primary energy resources (primary energy and primary energy resources used as materials)
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 resources (primary energy and primary energy resources used as materials)
SM: Use of secondary material
RSF: Use of renewable secondary fuels
NRSF: Use of non-renewable secondary fuels
FW: Net use of fresh water

Table 7. Output Flows and Waste Categories

PARAMETER	UNIT	A1-A3	C1	C2	C3	C4	D
HWD	Kg	2.71E+02	5.82E-03	5.12E-01	1.61E-01	1.27E-03	1.48E+01
NHWD	Kg	4.28E+03	8.48E-02	9.86E+00	3.56E+00	1.85E-02	3.67E+03
RWD	Kg	4.01E-03	5.42E-07	4.42E-05	4.73E-05	1.18E-07	1.95E-03
CRU	Kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MFR	Kg	1.41E+00	2.31E-05	2.52E-03	1.29E-03	5.04E-06	5.36E-03
MER	Kg	7.48E-04	7.37E-08	1.49E-05	2.02E-06	1.61E-08	1.09E-04
EEE	MJ	1.47E+00	2.45E-04	1.87E-02	2.15E-02	5.36E-05	7.14E-01
ETE	MJ	1.24E+00	1.15E-04	3.33E-02	1.51E-03	2.51E-05	3.41E-01

HWD: Hazardous waste disposed
NHWD: Non-hazardous waste disposed
RWD: Radioactive waste disposed
*The characteristics that render waste hazardous are described in existing applicable legislation, e.g. in the European Waste Framework Directive.

CRU: Components for re-use
MFR: Materials for recycling
MER: Materials for energy recovery
EEE: Exported electric energy
ETE: Exported thermal energy
*The estimated impact results are only relative statements which do not indicate the end points of the impact categories, exceeding threshold values, safety margins or risks.

4.3. Additional LCA results-100% Recycling scenario

Table 8. Environmental Impact Results according to EN 15804

EF3.1 (EN 15804+A2)	UNIT	A1-A3	C1	C2	C3	C4	D
GWP-total	kg CO2 eq.	1.58E+03	3.99E-01	1.62E+01	4.84E+00	0.00E+00	-1.06E+02
GWP-fossil	kg CO2 eq.	1.58E+03	3.99E-01	1.62E+01	4.82E+00	0.00E+00	-1.09E+02
GWP-biogenic	kg CO2 eq.	-6.50E+00	8.00E-05	4.98E-03	9.69E-03	0.00E+00	3.31E+00
GWP-LULUC	kg CO2 eq.	4.32E-01	4.08E-05	7.26E-03	3.49E-03	0.00E+00	1.16E-01
ODP	kg CFC11 eq.	7.22E-06	5.92E-09	2.05E-07	5.89E-08	0.00E+00	3.54E-07
AP	mol H^+ eq.	1.29E+01	3.56E-03	5.52E-02	3.72E-02	0.00E+00	-1.69E-01
EP-freshwater	kg P eq.	6.95E-01	1.28E-05	1.77E-03	8.26E-04	0.00E+00	-1.78E-02
EP-marine	kg N eq.	2.17E+00	1.66E-03	1.75E-02	1.54E-02	0.00E+00	4.03E-04
EP-terrestrial	mol N eq.	2.28E+01	1.82E-02	1.90E-01	1.67E-01	0.00E+00	-8.32E-01

EF3.1 (EN 15804+A2)	Unit	A1-A3	C1	C2	C3	C4	D
POCP	kg NMVOC eq.	6.73E+00	5.43E-03	7.48E-02	4.99E-02	0.00E+00	-2.33E-01
ADP-M&M	kg Sb eq.	1.13E-03	1.39E-07	5.29E-05	2.62E-06	0.00E+00	5.25E-04
ADP-fossil	MJ	1.89E+04	5.19E+00	2.24E+02	6.34E+01	0.00E+00	-7.17E+02
WDP	m³	1.72E+02	1.50E-02	1.27E+00	4.50E-01	0.00E+00	8.22E+01

Table 9. Environmental Impact Results – GWP-GHG indicator according to EN 15804

EF3.1 (EN 15804+A2)	Unit	A1-A3	C1	C2	C3	C4	D
GWP-total	kg CO2 eq.	1.58E+03	3.99E-01	1.62E+01	4.83E+00	0.00E+00	-1.09E+02

Table 10. Resource Use

Parameter	Unit	A1-A3	C1	C2	C3	C4	D
RPR_E	MJ	1.26E+03	3.26E-02	3.11E+00	2.94E+00	0.00E+00	1.20E+02
RPR_M	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RPR_T	MJ	1.26E+03	3.26E-02	3.11E+00	2.94E+00	0.00E+00	1.20E+02
$NRPR_E$	MJ	1.89E+04	5.19E+00	2.24E+02	6.34E+01	0.00E+00	-7.17E+02
$NRPR_M$	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$NRPR_T$	MJ	1.89E+04	5.19E+00	2.24E+02	6.34E+01	0.00E+00	-7.17E+02
SM	Kg	1.30E+02	2.15E-03	9.85E-02	2.01E-02	0.00E+00	1.45E+02
RSF	MJ	4.07E-02	5.63E-06	1.27E-03	5.73E-05	0.00E+00	1.51E-02
NRSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	m3	5.24E+00	3.67E-04	3.10E-02	1.20E-02	0.00E+00	1.98E+00

Table 11. Output Flows and Waste Categories

Parameter	Unit	A1-A3	C1	C2	C3	C4	D
HWD	Kg	2.71E+02	5.82E-03	5.12E-01	1.90E-01	0.00E+00	1.48E+01
NHWD	Kg	4.28E+03	8.48E-02	9.86E+00	4.19E+00	0.00E+00	3.67E+03
RWD	Kg	4.01E-03	5.42E-07	4.42E-05	5.57E-05	0.00E+00	1.95E-03
CRU	Kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MFR	Kg	1.41E+00	2.31E-05	2.52E-03	1.51E-03	0.00E+00	5.36E-03
MER	Kg	7.48E-04	7.37E-08	1.49E-05	2.38E-06	0.00E+00	1.09E-04
EEE	MJ	1.47E+00	2.45E-04	1.87E-02	2.53E-02	0.00E+00	7.14E-01
ETE	MJ	1.24E+00	1.15E-04	3.33E-02	1.78E-03	0.00E+00	3.41E-01

4.4. Additional LCA results-100% Landfill scenario

Table 12. Environmental Impact Results according to EN 15804

EF3.1 (EN 15804+A2)	Unit	A1-A3	C1	C2	C3	C4	D
GWP-total	kg CO2 eq.	1.58E+03	3.99E-01	1.62E+01	0.00E+00	5.80E-01	0.00E+00
GWP-fossil	kg CO2 eq.	1.58E+03	3.99E-01	1.62E+01	0.00E+00	5.80E-01	0.00E+00

GWP-biogenic	kg CO2 eq.	-6.50E+00	8.00E-05	4.98E-03	0.00E+00	1.16E-04	0.00E+00
GWP-LULUC	kg CO2 eq.	4.32E-01	4.08E-05	7.26E-03	0.00E+00	5.93E-05	0.00E+00
ODP	kg CFC11 eq.	7.22E-06	5.92E-09	2.05E-07	0.00E+00	8.60E-09	0.00E+00
AP	mol H^+ eq.	1.29E+01	3.56E-03	5.52E-02	0.00E+00	5.18E-03	0.00E+00
EP-freshwater	kg P eq.	6.95E-01	1.28E-05	1.77E-03	0.00E+00	1.86E-05	0.00E+00
EP-marine	kg N eq.	2.17E+00	1.66E-03	1.75E-02	0.00E+00	2.41E-03	0.00E+00
EP-terrestrial	mol N eq.	2.28E+01	1.82E-02	1.90E-01	0.00E+00	2.64E-02	0.00E+00
POCP	kg NMVOC eq.	6.73E+00	5.43E-03	7.48E-02	0.00E+00	7.90E-03	0.00E+00
ADP-M&M	kg Sb eq.	1.13E-03	1.39E-07	5.29E-05	0.00E+00	2.02E-07	0.00E+00
ADP-fossil	MJ	1.89E+04	5.19E+00	2.24E+02	0.00E+00	7.55E+00	0.00E+00
WDP	m^3	1.72E+02	1.50E-02	1.27E+00	0.00E+00	2.19E-02	0.00E+00

Table 13. Environmental Impact Results – GWP-GHG indicator according to EN 15804

EF3.1 (EN 15804+A2)	UNIT	A1-A3	C1	C2	C3	C4	D
GWP-total	kg CO2 eq.	1.58E+03	3.99E-01	1.62E+01	0.00E+00	5.80E-01	0.00E+00

Table 14. Resource Use

PARAMETER	UNIT	A1-A3	C1	C2	C3	C4	D
RPR_E	MJ	1.26E+03	3.26E-02	3.11E+00	0.00E+00	4.74E-02	0.00E+00
RPR_M	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RPR_T	MJ	1.26E+03	3.26E-02	3.11E+00	0.00E+00	4.74E-02	0.00E+00
$NRPR_E$	MJ	1.89E+04	5.19E+00	2.24E+02	0.00E+00	7.55E+00	0.00E+00
$NRPR_M$	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
$NRPR_T$	MJ	1.89E+04	5.19E+00	2.24E+02	0.00E+00	7.55E+00	0.00E+00
SM	Kg	1.30E+02	2.15E-03	9.85E-02	0.00E+00	3.12E-03	0.00E+00
RSF	MJ	4.07E-02	5.63E-06	1.27E-03	0.00E+00	8.18E-06	0.00E+00
NRSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	m3	5.24E+00	3.67E-04	3.10E-02	0.00E+00	5.33E-04	0.00E+00

Table 15. Output Flows and Waste Categories

PARAMETER	UNIT	A1-A3	C1	C2	C3	C4	D
HWD	Kg	2.71E+02	5.82E-03	5.12E-01	0.00E+00	8.46E-03	0.00E+00
NHWD	Kg	4.28E+03	8.48E-02	9.86E+00	0.00E+00	1.23E-01	0.00E+00
RWD	Kg	4.01E-03	5.42E-07	4.42E-05	0.00E+00	7.89E-07	0.00E+00
CRU	Kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MFR	Kg	1.41E+00	2.31E-05	2.52E-03	0.00E+00	3.36E-05	0.00E+00
MER	Kg	7.48E-04	7.37E-08	1.49E-05	0.00E+00	1.07E-07	0.00E+00
EEE	MJ	1.47E+00	2.45E-04	1.87E-02	0.00E+00	3.57E-04	0.00E+00
ETE	MJ	1.24E+00	1.15E-04	3.33E-02	0.00E+00	1.67E-04	0.00E+00

5. LCA Interpretation

Hot Spot Analysis

The A1 stage contributes the highest share of all mandatory environmental impacts, followed by A3. Using GWP-Total as an example, the A1 module accounts for more than 60% of the impacts, while A3 accounts for over 30%.

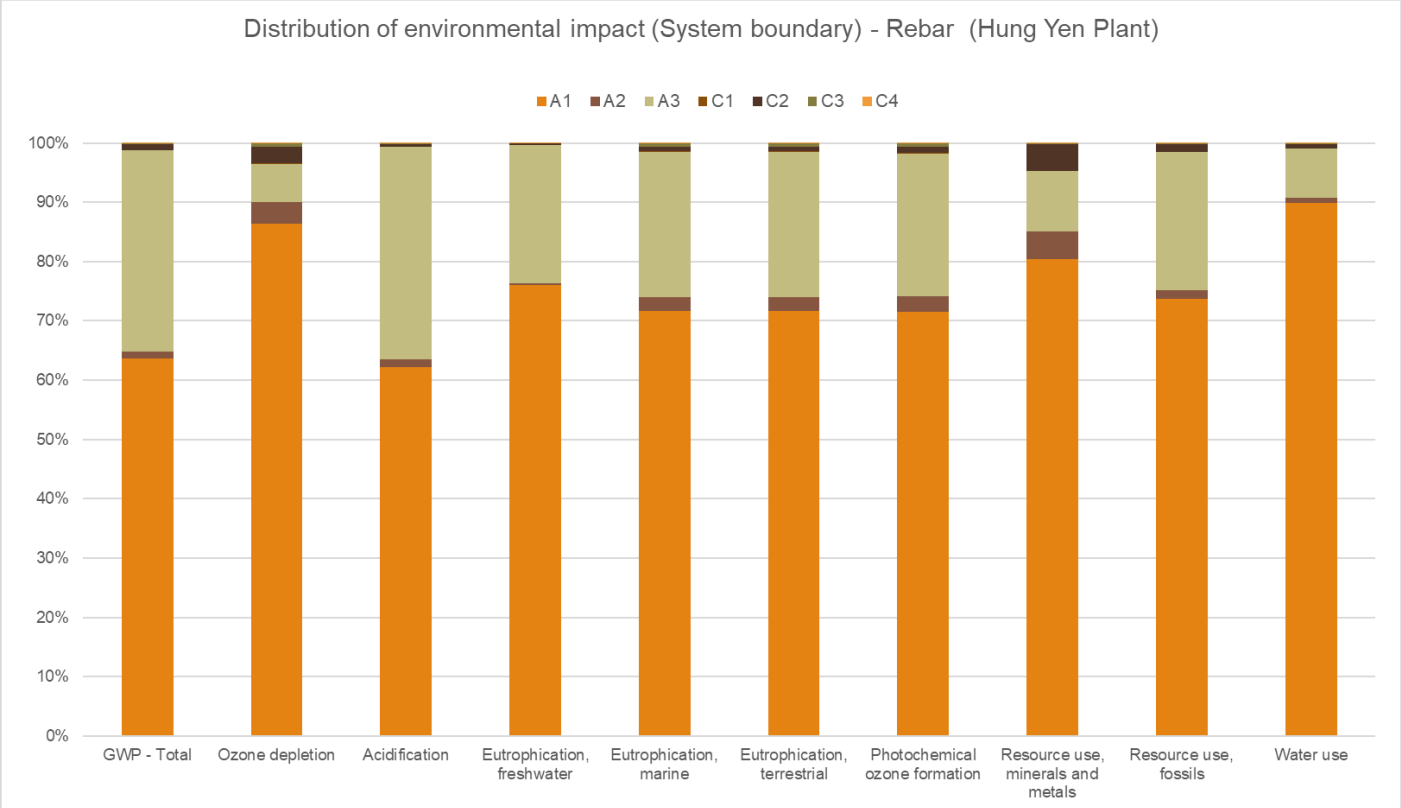


Figure 3: Rebar production process

Using GWP - Total as the representative indicator, the main environmental impact hotspots are as follows. Together, these items account for 88.9% of the impact:

- Billet (EAF): 33.7%.
- Billet (BOF): 24.9%.
- Coal (burned in industrial equipment): 15.3%.
- Lump coal (burned in industrial equipment): 15.0%.

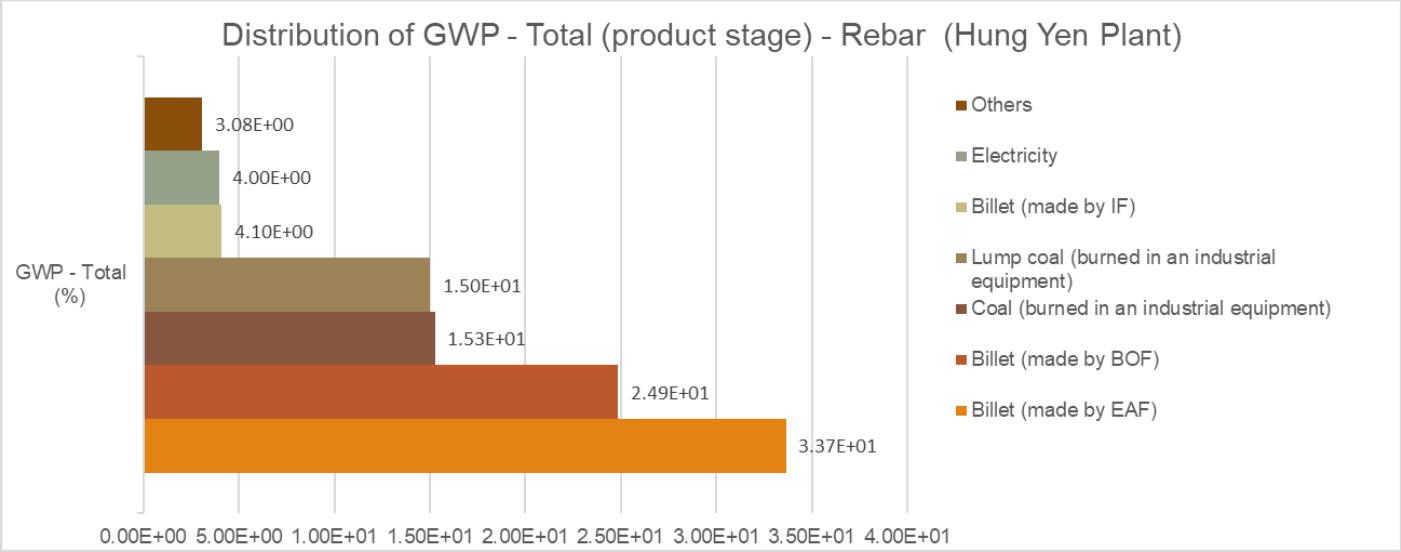


Figure 4: Rebar production process

As shown in the figure above, the primary emission source originates from the upstream steel billets. As illustrated in the figure above, approximately 60% of the GWP-GHG impacts are attributed to the billets.

In addition, the plant uses coal as the fuel for billet reheating. Compared to electric heating, coal-based heating results in higher emissions, thereby increasing the environmental impacts associated with the A3 manufacturing stage.

Sensitivity Analysis

REBAR (HUNG YEN) - GWP-TOTAL				
Item	**Unit**	**Economic allocation (Base line)**	**Mass allocation**	**Difference (%)**
Allocation factor for billet		99.8613%	97.1262%	-
Billet (made by BOF)	kg CO2 eq	3.92E+02	3.81E+02	-2.739%
Billet (made by EAF, from Hai Phong)	kg CO2 eq	5.30E+02	5.16E+02	-2.739%
Coal (burned in industrial equipment)	kg CO2 eq	2.41E+02	2.34E+02	-2.739%
Lump coal (burned in industrial equipment)	kg CO2 eq	2.37E+02	2.30E+02	-2.739%

Based on the assessment results, the production stage (A1–A3) is the dominant contributor to the overall climate impacts, accounting for approximately 90% of the total emissions.

Among all life cycle modules, the raw material stage (A1) shows the highest contribution, representing 60%–90% depending on the impact indicators. The manufacturing stage (A3) is the second-largest contributor, with a contribution range of 8–34%. In contrast, raw material transportation contributes only 0–2%, indicating a relatively minor influence compared to raw material production and manufacturing processes.

According to sensitivity analysis, when using economic allocation as the baseline, switching to mass allocation results in a -2.7% difference in environmental impacts, which is considered an acceptable minor deviation. For the analysis of the Hung Yen plant, although the choice of allocation principle has some influence on the numerical results, it does not materially affect the core findings or overall conclusions of this study.

6. References

- General Programme Instructions of the International EPD® System. Version GPI 5.0.1
- PCR 2019:14. Construction Product. Version 2.0.1
- Ecoinvent version 3.11 database
- SimaPro Craft version 10.2.0.3
- ISO 14025:2006, Environmental labels and declarations – Type III environmental declarations – Principles and procedures.
- ISO 14040:2006, Environmental management – Life cycle assessment – Principles and framework.
- ISO 14044:2006/Amd 2:2020 Environmental management - Life cycle assessment - Requirements and guidelines
- EN 15804+A2: EN 15804:2012+A2:2019: Sustainability of construction works – Environmental Product Declarations - Core rules for the product category of construction products.