TATA STEEL
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TATA

ENVIRONMENTAL PRODUCT DECLARATION

In accordance with ISO 14025 and EN 15804:2012+A2:2019 for Steel Rebar from Tata Steel Limited

Programme:	The International EPD® System, www.environdec.com
Programme operator:	EPD International AB
EPD registration number:	S-P-05018
Publication date:	2022-07-08
Valid until:	2027-07-07

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INDIA EPD®
THE INTERNATIONAL EPD SYSTEM

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1. Introduction

Tata Steel Limited, a flagship company of Tata Group is a multinational steel-making company headquartered in Mumbai (Maharashtra, India). The company is one of the world's most geographically diversified steel producing company. It was established in India as Asia's first integrated private steel company in 1907 and today the company, together with its subsidiaries, associates and joint ventures, has its presence across five continents with key operations in India, Netherlands and The United Kingdom. Tata Steel is among the top steel producing companies in the world with an annual crude steel capacity of 34 million tonnes per annum globally. The company is the second largest steel company in India and its largest steel plant is located in Jamshedpur, Jharkhand (India). The company's operations in India are fully integrated from mining to finished steel production and it also has captive iron ore and coking coal mines in India. Tata Steel group recorded a consolidated turnover of INR 1,56,294 crore in the financial year ending 31 March, 2021.

Thinkstep Sustainability Solutions Pvt. Ltd, a Sphera Company (formerly thinkstep AG) has been entrusted to review the life cycle assessment study carried out by Tata Steel and to develop an Environmental Product Declaration document based on the Life Cycle Assessment study carried out by Tata Steel Limited as per ISO 14040/44. The LCA model was created using the GaBi ts Software system for life cycle engineering, developed by Sphera (formerly thinkstep AG).

2. General Information

Table 1. EPD Information

Programme	The International EPD System, Indian Regional Hub www.environdec.com, www.environdecindia.com
Program operator	EPD International AB Box 210 60, SE-100 31 Stockholm, Sweden
Declaration holder	Tata Steel Limited, 15th Floor, Tata Centre, 43, Jawaharlal Nehru Road, Kolkata - 700071
Product	Steel Rebar
CPC code	412 products of iron or steel
EPD registration number	S-P-05018
Publication date	2022-07-08
Validity date	2027-07-07
Geographical scope	India
Reference standards	IS0 14020:2001, ISO 14025:2006, EN 15804:2012+A2:2019

Table 2. PCR Information

Reference PCR	'Construction Products and Construction Services' 2019:14, Version 1.11
Date of Issue	2021-02-05 (Version 1.11) (VALID UNTIL: 2024-12-20)

Table 3. Verifier Information

Demonstration of verification	External, independent verification
Third party verifier	Mr. Sunil Kumar CS, Founder and Principal Consultant, Chakra4 Sustainability Consulting Services, Ivory 501, HM World City, 9th Phase, J P Nagar, Bengaluru 560 108, Email: sunilkumar@chakra4.in

Table 4. LCA Information

Title	Environmental Product Declaration of Steel Rebar
Author	Dr. Rajesh Kumar Singh Thinkstep Sustainability Solutions Pvt. Ltd., a Sphera Company 707, Meadows, Sahar Plaza, Andheri Kurla Road, Andheri East, Mumbai, India - 400059 Email: rsingh@sphera.com
Reference standards	ISO 14040/44 standard

2.2 Reference Period of EPD Data

The reference period for the primary data (foreground data) used within this EPD ranges between Financial Year 2018 (April 2017 to March 2018) to Financial Year 2021 (April 2020 to March 2021) based on the availability of data from various participating sites in this EPD. Sites with primary data of Financial Year 2021 represents around 60% of the total product mentioned in this EPD. The final results mentioned in this study, represents the production tonnage manufactured during the year April 2020 to March 2021

2.3 Geographical Scope of EPD Application

The geographical scope of this EPD is India.

2.4 Additional Information about EPD

This EPD provides information for the Steel Rebar Product manufactured by Tata Steel Limited at its Jamshedpur facility as well as from its subsidiaries and external steel processing centres in India. The EPD is in accordance with ISO 14025 and EN 15804+A2. EPD of construction products may not be comparable if they do not comply with EN 15804+A2. The Life Cycle Assessment (LCA) study carried out for developing this EPD for steel products is done as per ISO 14040 and ISO 14044 requirements.

Product Category Rules (PCR) for the assessment of the environmental performance of steel products is PCR for 'Construction Products and Construction Services' 2019:14, Version 1.11.

This PCR is applicable to the Steel Rebar Product complying with the standard EN 15804+A2 (Sustainability of construction works - Environmental product declarations - Core rules for the product category of construction products).

3. Product Description and System Boundaries

3.1 Product Identification and Usage

1. Product Description:

Steel bars are commonly used as reinforcement to impart tensile and shear strength to the structure since concrete is weak in tension/shear. Steel is widely used as reinforcement because its coefficient of linear expansion is close to concrete. Steel reinforcing bars (Rebar) are manufactured through a hot rolling process with subsequent treatment (controlled cooling and tempering). Rebars produced by Tata Steel Limited are in sizes from 6mm to 40mm. Primary application of rebar is to strengthen concrete in end-use applications like buildings, bridges, metros, dams, thermal power plants, liquid retaining structures etc.

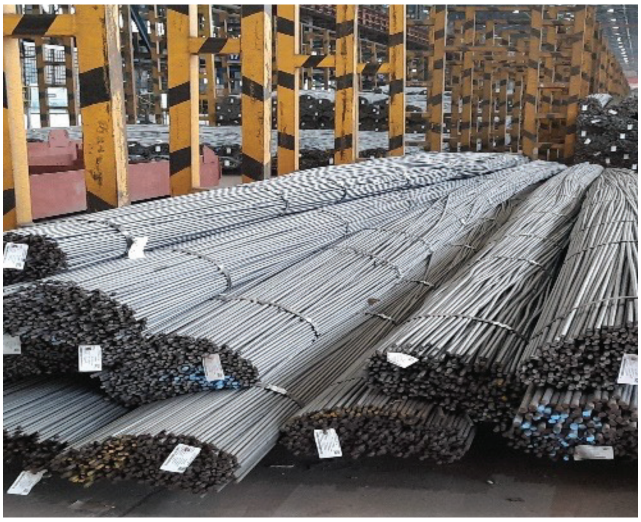


Figure 1: Steel Rebar Product from Tata Steel Ltd.

2. Participating Facilities

Steel Rebars produced in the following facilities are covered as part of this EPD. These facilities represent 92% of rebars produced during the year April 2020 to March 2021 in India by the company.

S. No.	Manufacturing Units	Facility
1	New Bar Mill, Tata Steel Jamshedpur (TSJ) Steel Works	Tata Steel Limited
2	Merchant Mill, Tata Steel Jamshedpur (TSJ) Steel Works	
3	Wire Rod Mill, Tata Steel Jamshedpur (TSJ) Steel Works	
4	Wire Rod Mill, Global Wires Business, Tarapur	
5	Wire Rod Mill, The Indian Steel and Wire Products Limited	A subsidiary of Tata Steel Limtied
6	Beekay Steel Industries Limited	Steel Processing Centres*
7	BMW Industries Limited	
8	Brand Alloys Private Limited	
9	Modern India Steel Rolling Mills Private Limited	

**Steel Processing centres are third-party contract manufacturers who produces the product on behalf of Tata Steel Limited*

3. Diameter range of Tata Steel Rebar:

6 – 40 mm

4. Rebar grades produced by Tata Steel:

Fe500, Fe500D, Fe550D, Fe500SD, Fe500CRSD, Fe600

5. Chemical composition of Tata Steel Rebar:

Grade	Specification, wt%							
	Cmax	Mn max	S max	P max	S+P max	N, max	Cu. Min	CE
Fe500	0.3	1.8	0.055	0.055	0.105	0.012	-	-
Fe500D	0.25	1.8	0.04	0.04	0.075	0.012	-	0.5
Fe500SD	0.25	1.8	0.04	0.04	0.075	0.012	-	0.5
Fe500 CRSD	0.25	1.8	0.04	0.04	0.075	0.012	0.4	0.5
Fe550D	0.25	1.8	0.04	0.04	0.075	0.012	-	0.61
Fe600	0.3	1.8	0.04	0.04	0.075	0.012	-	-

Above product do not contain any substances that can be included in "Candidate List of Substances of Very High Concern for Authorization".

3.2 System boundary

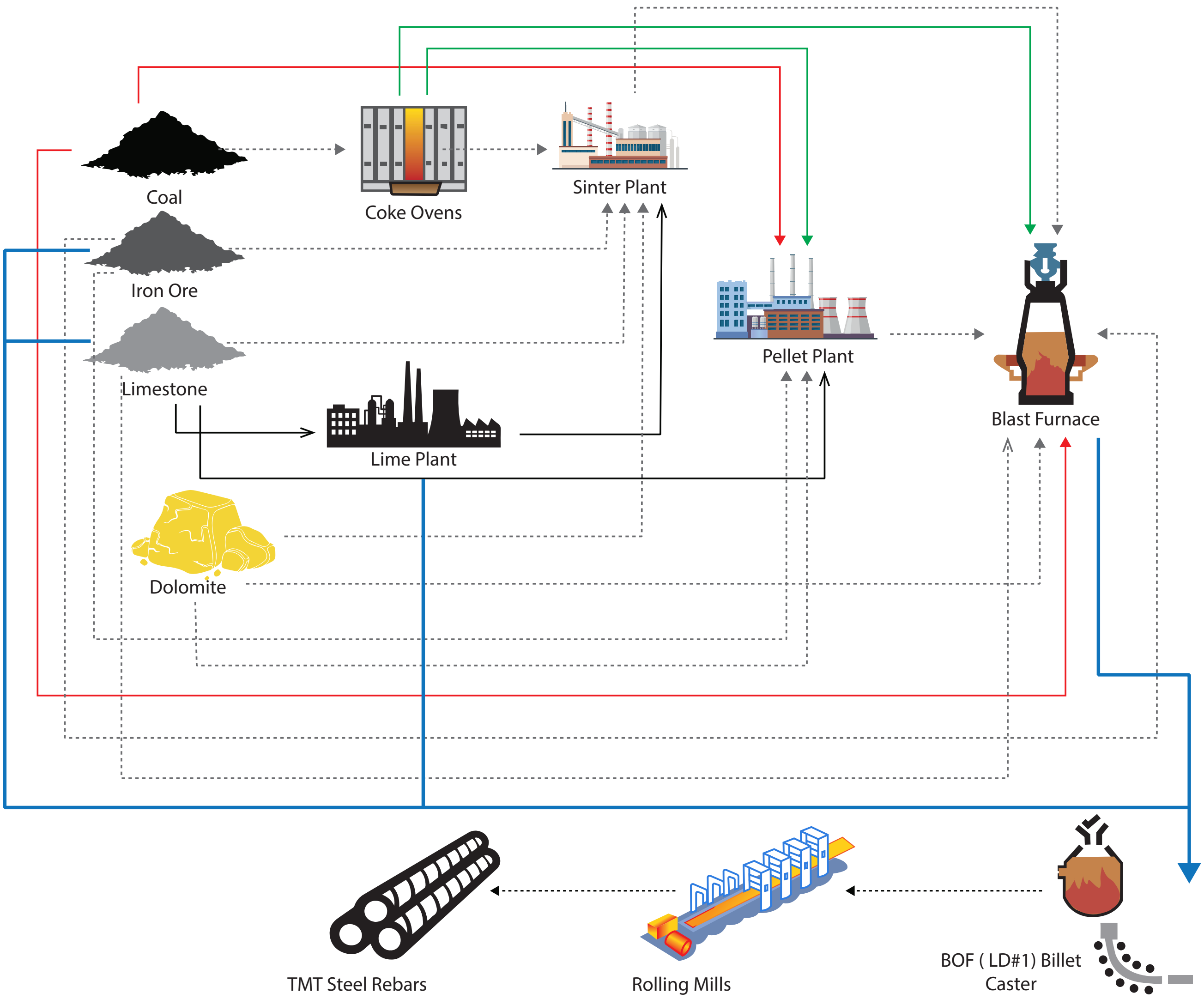
Figure 2 given below represents system boundary diagram of the study.

Figure 2: System boundary diagram (Cradle to gate with options)

3.3 Process Description

Tata Steel was established in India as Asia's first integrated private steel company in 1907 and has started its operation at Jamshedpur steel works facility in 1911. The technology used for producing steel rebars at Tata Steel Limited represents 100% Blast Furnace (BF) with Basic Oxygen Furnace (BOF) route comprising older to modern blast furnaces. In this BF-BOF technology, iron ore in the form of hematite is reduced in blast furnace through the addition of carbon source which is of internally produced Coke and some purchased quantities of metallurgical Coke and pulverized Coal. Gangue or impurities in the form of alumina and silica present in the Iron Ore is removed as blast furnace slag by the addition of Limestone, Pyroxenite and Quartz. 100% of Iron Ore used in the processes are from Tata Steel's captive Iron Ore mines and 39% of Coking Coal are from captive mines while fluxes (Limestone, Dolomite, etc.,) are purchased 100% from outside. The company has in-house processing units for the production of Coke, Sinter and Pellet which are the key raw materials for hot metal production in Blast Furnaces. Hot metal is the primary output of the blast furnace operation along with the generation of blast furnace gas and blast furnace slag. While BF slag is processed further externally to produce Ground Granulated Blast Furnace Slag (GGBS) that gets used in concrete production or gets directly used in slag cement production, BF gas generated is predominantly used within the steel works for heating and power generation applications. Hot metal produced from blast furnace is collected in torpedo ladles and sent to steel melting shops (SMS / LD shops) where steel billets are produced in caster. Steel Billets (also known as Crude Steel) are the intermediate steel product and a key raw material for the manufacturing of Steel Rebars.

At Tata Steel's Jamshedpur steel works facility, steel billets are produced in LD #1 and gets used in ten different rolling mills in India to produce steel rebars. Scope of this EPD covers 9 rolling mills representing 92% of total steel rebar produced during the year April 2020 – March 2021.



4. Life Cycle Assessment (LCA)

4.1 Information Sources and Data Quality

It is important that data quality is in accordance with the requirements of the LCA's goal and scope. This is essential to the reliability of LCA and achievement of the intended application. The quality of the LCI data for modelling the life cycle stages have been assessed according to ISO 14040:2006. Data quality is judged by its precision (measured, calculated or estimated), completeness (e.g. are there unreported emissions?), consistency (degree of uniformity of the methodology applied on an LCA serving as a data source) and representativeness (geographical, time period, technology). Primary data collected using data collection questionnaires was used for the study and for upstream processes GaBi 9.2 professional database 2021 was used.

4.2 Methodological Details

4.2.1 Co-Product Allocation

With any multi-product system, allocation rules are defined to relate the system inputs and outputs to each of the products. Several methods are documented in ISO 14040:2006 and ISO Technical Report 14049.

4.2.2 End-of-life phase

Steel is completely recyclable. Therefore, it is important to consider recycling in LCA studies involving steel, namely the steel scrap that is recycled from a final product at the end of its life. In addition, steel is a vital input to the steelmaking process, and this input of steel scrap should also be considered in LCA studies. Accounting for all these, the End-of -life credit for recycling is applied over 85% of steel* (850 kg in 1 tonne of steel products) . The landfill is considered as 15% of steel (150 kg in 1 tonne of steel products).

4.2.3 Declared unit

The declared unit for the EPD is 1 tonne of average Steel Rebar manufactured by Tata Steel Ltd in its own facility as well as through external steel processing centres in India.

4.2.4 Selection of application of LCIA categories

A list of relevant impact categories and category indicators is defined and associated with the inventory data. The environmental impact per declared unit for the following environmental impact categories were reported in the EPD according to EN15804+A2:2019 (Table 5), and divided into core, upstream (and downstream, if included) module.

*World Steel Methodology Report, 2020

Table 5. Environmental impacts indicators for EN15804+A2:2019

Impact category	Indicator	Unit
Climate change – total	Global Warming Potential total (GWP-total)	kg CO_2 eq.
Climate change - fossil	Global Warming Potential fossil fuels (GWP-fossil)	kg CO_2 eq.
Climate change – biogenic	Global Warming Potential biogenic (GWP-biogenic)	kg CO_2 eq.
Climate change – luluc	Global Warming Potential land use and land use change (GWP-luluc)	kg CO_2 eq.
Ozone Depletion	Depletion potential of the stratospheric ozone layer (ODP)	kg CFC-11 eq.
Acidification	Acidification potential, Accumulated Exceedance (AP)	Mole of H+ eq.
Eutrophication aquatic freshwater	Eutrophication potential, fraction of nutrients reaching freshwater end compartment (EP-freshwater)	kg PO_4 eq.
Eutrophication aquatic marine	Eutrophication potential, fraction of nutrients reaching marine end compartment (EP-marine)	kg N eq.
Eutrophication terrestrial	Eutrophication potential, Accumulated Exceedance (EP-terrestrial)	Mole of N eq.
Photochemical ozone formation	Formation potential of tropospheric ozone (POCP)	kg NMVOC eq.
Depletion of abiotic resources - minerals and metals	Abiotic depletion potential for non-fossil resources (ADP- minerals & metals)	kg Sb eq.
Depletion of abiotic resources - fossil fuels	Abiotic depletion for fossil resources potential (ADP-fossil)	MJ
Water Scarcity	Water (user) deprivation potential, deprivation -weighted water consumption (WDP)	m^3 world eq.

The consumption of natural resources per declared or function unit is reported in the EPD. Input parameters, according with EN15804+A2, describing resource use are shown in Table 6.

Table 6. Natural resources use parameters

Parameter	Unit
Renewable primary energy as energy carrier (PERE)	MJ
Renewable primary energy resources as material utilization (PERM)	MJ
Total use of renewable primary energy resources (PERT)	MJ
Non-renewable primary energy as energy carrier (PENRE)	MJ
Non-renewable primary energy as material utilization (PENRM)	MJ
Total use of non-renewable primary energy resources (PENRT)	MJ
Use of secondary material (SM)	kg
Use of renewable secondary fuels (RSF)	MJ
Use of non-renewable secondary fuels (NRSF)	MJ
Net freshwater Use (FW)	m3

Table 7. Output flows and waste categories parameters

Parameter	Unit
Hazardous waste disposed (HWD)	kg
Non-hazardous waste disposed (NHWD)	kg
Radioactive waste disposed (RWD)	kg
Components for re-use (CRU)	kg
Materials for recycling (MFR)	kg
Materials for energy recovery (MER)	kg
Exported electrical energy (EEE)	MJ
Exported thermal energy (EET)	MJ

Table 8. Additional parameters

Impact category	Indicator	Unit
Particulate matter emissions	Potential incidence of disease due to PM emissions (PM)	Disease incidences
Ionising radiation	Potential Human exposure efficiency relative to U235 (IRP)	kBq U235 eq.
Eco-toxicity (freshwater)	Potential Comparative Toxic Unit for ecosystems (ETP - fw)	CTUe
Human toxicity, cancer effects	Potential Comparative Toxic Unit for humans (HTP - c)	CTUh
Human toxicity, non-cancer effects	Potential Comparative Toxic Unit for humans (HTP - nc)	CTUh
Land use related impacts / Soil quality potential	Potential soil quality index (SQP)	Pt

4.3 Cut-off Criteria

Criteria were set out in the original study for the recording of material flows and to avoid the need to pursue trivial inputs/outputs in the system. These are outlined below:

1. All energetic inputs to the process stages were recorded, including fuels, electricity, steam and compressed air
2. Each excluded material flow must not exceed 1% of mass, energy or environmental relevance, for each unit process. Accordingly, 99% of the material flow were accounted
3. The sum of the excluded material flows in the system must not exceed 5% of mass, energy or environmental relevance and it has been complied

4.4 System Boundaries

The study is a cradle-to-gate with additional modules LCA study. It covers the stages from production of raw materials to the End of Life of the product, excluding the use phase of the product. The scope covers raw material production (A1), inbound transportation (A2), manufacturing (A3), product dismantling (C1), transport of dismantled product to EoL site (C2), waste processing (C3), disposal (C4) as well as the end of life stage recycling (D) considerations. The scenarios included are currently in use and are representatives for one of the most likely scenario alternatives.

Table 9. Details of system boundary included in the study

EPD Module	Life Cycle Stages	Life Cycle Sub-Stages	Definitions
A1	Materials	Primary raw materials Production	This module covers extraction and production of the raw materials. In this study, Steel Billet (Crude Steel) is the raw material for the manufacturing of Steel Rebars and hence the production of billet and its upstream is included in this module
A2	Upstream Transport	-	Transportation of raw materials to the manufacturing unit
A3	Manufacturing	Utilities	Manufacturing of steel rebar products
C1	Product Dismantling	-	Dismantling of the steel rebar product
C2	Transport to EoL site	-	Transport of the dismantled product to the EoL site
C3	Waste Processing	-	Waste processing of the dismantled product (85% steel recycling)
C4	Disposal	-	Disposal of the dismantled products (i.e. landfill) 15% of steel product is send to landfill
D	EoL Credit	-	Steel is a 100% recyclable material and as per World Steel Data 85% recoverability is observed. Thus 85% is considered for EoL credit

4.4.1 Geographic System Boundaries

The geographical coverage of this study covers the production of steel rebar products by Tata Steel Ltd in its Jamshedpur steel works facility as well as by it subsidiaries and external steel processing centres in India. Indian specific datasets wherever possible have been adapted and others dataset were chosen from EU if no Indian datasets were available. In addition, imported raw materials are considered along with transport. All the primary data has been collected from Tata Steel Limited in co-operation with experts from Sphera (formerly Thinkstep AG)

4.4.2 Temporal System Boundaries

The data collection is related to one year of operation and the year of the data is indicated in the questionnaire for each data point. The data was derived between April 2017 to March 2021 (includes Financial Years 2018, 2019, 2020 and 2021 based on the availability of data from different participating sites). It is believed to be representative of steel production during this time frame.

4.4.3 Technology coverage

100% of this study is a representative of Blast Furnace with Basic Oxygen Furnace route for which the key raw materials are iron ore and coal.

4.5 Software and database

The LCA model was created using the GaBi 9.2 Software system for life cycle engineering, developed by Sphera Solutions Inc. The GaBi database provides the life cycle inventory data for several of the raw and process materials obtained from the upstream system. Detailed database documentation for GaBi datasets can be accessed at: https://gabi.sphera.com/international/support/gabi/gabi-database-2021-lci-documentation%20/.

4.6 Comparability

According to the standards, EPDs do not compare the environmental performance of products in the sector. Any comparison of the declared environmental performance of products lies outside the scope of these standards and is suggested to be feasible only if all compared declarations follow equal standard provisions.

4.7 Results

Modules of the life cycle included as per PCR is given in Table 10.

Table 10. Modules of the production life cycle included (X = declared module; MNA = module not applicable)

Production			Installation		Use stage							End-of-Life				Credits & charges outside system boundary
Raw material supply	Transport to manufacturer	Manufacturing	Transport to building site	Installation into building	Use / application	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	Deconstruction / demolition	Transport to EoL	Waste processing for reuse, recovery, recycle	Disposal	Reuse, recovery, or recycling potential
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
X	X	X	MNA	MNA	MNA	MNA	MNA	MNA	MNA	MNA	MNA	X	X	X	X	X

4.7.1 LCIA results for 1 tonne of Steel Rebar

The LCIA results for 1 tonne of Steel Rebar is given in Table 11 to Table 15. The estimated results are only relative statements which do not indicate the end points of the impact categories, exceeding threshold values, safety margins or risks.

Table 11. Environmental impacts for 1 tonne of Steel Rebar

Parameter	Unit	A1	A2	A3	C1	C2	C3	C4	D
Climate Change	kg CO2 eq.	2.52E+03	2.16E+00	2.05E+02	6.10E+00	4.08E+00	0.00E+00	7.18E+00	-1.48E+03
Climate Change (fossil)	kg CO2 eq.	2.52E+03	2.16E+00	2.05E+02	6.11E+00	4.08E+00	0.00E+00	7.40E+00	-1.48E+03
Climate Change (biogenic)	kg CO2 eq.	-4.88E-01	-6.56E-04	-3.04E-02	-3.80E-03	-8.38E-04	0.00E+00	-2.20E-01	-2.12E+00
Climate Change (land use change)	kg CO2 eq.	4.34E-01	3.99E-03	1.94E-01	3.16E-04	2.11E-04	0.00E+00	7.20E-03	4.22E-02
Ozone depletion	kg CFC-11 eq.	4.46E-09	4.33E-15	4.53E-13	3.03E-16	2.02E-16	0.00E+00	1.64E-14	3.23E-12
Acidification	Mole of H+ eq.	5.89E+00	2.68E-02	1.98E+00	7.26E-03	3.47E-02	0.00E+00	2.38E-02	-3.30E+00
Eutrophication freshwater	kg P eq.	2.04E-04	1.71E-06	8.54E-05	1.29E-06	8.59E-07	0.00E+00	5.67E-06	-8.38E-04
Eutrophication marine	kg N eq.	1.05E+00	3.70E-03	2.20E-01	8.39E-04	1.57E-02	0.00E+00	5.78E-03	-6.01E-01
Eutrophication terrestrial	Mole of N eq.	1.15E+01	3.70E-03	2.45E+00	9.27E-03	1.72E-01	0.00E+00	6.34E-02	-6.09E+00
Photochemical ozone formation - human health	kg NMVOC eq.	2.86E+00	1.02E-02	9.12E-01	3.84E-03	2.99E-02	0.00E+00	1.83E-02	-2.48E+00
Resource use, mineral and metals	kg Sb eq.	1.65E-04	1.16E-07	5.87E-06	6.33E-08	4.22E-08	0.00E+00	5.00E-07	-2.40E-02
Resource use, energy carriers	MJ	2.48E+04	2.31E+01	1.68E+03	8.14E+01	5.43E+01	0.00E+00	1.06E+02	-1.27E+04
Water scarcity	m^3 world equiv.	1.12E+02	2.13E-01	2.55E+01	1.88E-02	1.26E-02	0.00E+00	-7.97E-02	-1.12E+02

Table 12. Resource use for 1-tonne of Steel Rebar

Parameter	Unit	A1	A2	A3	C1	C2	C3	C4	D
PERE	MJ	3.23E+02	3.24E+00	1.56E+02	2.91E-01	1.94E-01	0.00E+00	7.41E+00	9.87E+02
PERM	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	MJ	3.23E+02	3.24E+00	1.56E+02	2.91E-01	1.94E-01	0.00E+00	7.41E+00	9.87E+02
PENRE	MJ	2.48E+04	2.31E+01	1.68E+03	8.14E+01	5.43E+01	0.00E+00	1.06E+02	-1.27E+04
PENRM	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT	MJ	2.48E+04	2.31E+01	1.68E+03	8.14E+01	5.43E+01	0.00E+00	1.06E+02	-1.27E+04
SM	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	m3	2.80E+00	7.39E-03	7.39E-01	6.46E-04	4.31E-04	0.00E+00	1.41E-03	-2.61E+00
Caption	PERE = Use of renewable primary energy excluding renewable primary energy resources used as raw materials; PERM = Use of renewable primary energy as raw materials; PERT = Total use of renewable primary energy resources; PENRE = Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials; PENRM = Use of non-renewable primary energy d as raw materials; PENRT = Total use of non-renewable primary energy resources; SM = Use of secondary material; RSF = Use of renewable secondary fuels; NRSF = Use of non-renewable secondary fuels; FW = Use of net fresh water								

Table 13. Output flows and waste categories for 1-tonne of Steel Rebar

Parameter	Unit	A1	A2	A3	C1	C2	C3	C4	D
HWD	kg	3.93E-05	1.46E-08	8.71E-07	4.34E-09	2.89E-09	0.00E+00	4.80E-07	-1.63E-03
NHWD	kg	1.19E+00	7.35E-03	6.05E-01	1.01E-03	6.77E-04	0.00E+00	1.50E+02	1.52E+02
RWD	kg	2.63E-02	2.32E-04	1.12E-02	1.69E-05	1.13E-05	0.00E+00	1.25E-03	4.53E-04
CRU	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MFR	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.50E+02	0.00E+00	0.00E+00
MER	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EEE	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EET	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	HWD = Hazardous waste disposed; NHWD = Non-hazardous waste disposed; RWD = Radioactive waste disposed; CRU = Components for re-use; MFR = Materials for recycling; MER = Materials for energy recovery; EEE = Exported electrical energy; EET = Exported thermal energy								

Table 14. Biogenic carbon content of product and packaging for 1-tonne of Steel Rebar

Parameter	A1	A2	A3	C1	C2	C3	C4	D
Biog. C in product [kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Biog. C in packaging [kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Caption	Biog. C in packaging = Biogenic carbon content in packaging; Biog. C in product = Biogenic carbon content in product							

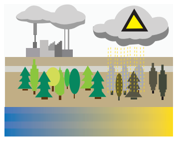
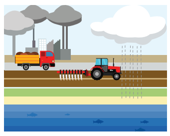
Table 15. Additional Environmental parameters for 1-tonne of Steel Rebar

Parameter	Unit	A1	A2	A3	C1	C2	C3	C4	D
PM	Disease incidences	6.95E-05	4.35E-07	3.03E-05	6.14E-08	2.23E-07	0.00E+00	2.56E-07	-4.96E-05
IR	kBq U235 eq.	2.39E+00	1.08E-02	1.06E+00	1.61E-03	1.07E-03	0.00E+00	1.78E-01	2.74E+01
ETF-fw	CTUe	2.13E+03	2.55E+00	3.60E+02	2.80E+01	1.87E+01	0.00E+00	3.15E+01	-7.55E+01
HTP-c	CTUh	4.21E-08	2.78E-10	2.51E-08	4.74E-10	3.21E-10	0.00E+00	3.62E-09	4.54E-07
HTP-nc	CTUh	3.87E-06	1.75E-08	1.16E-06	1.52E-08	1.55E-08	0.00E+00	3.64E-07	-1.53E-05
SQP	Pt	5.31E+02	2.38E+00	2.33E+02	3.51E-01	2.34E-01	0.00E+00	8.02E+00	3.43E+02
PM = Particulate matter emissions; IR = Ionising radiation, human health; ETF= Eco-toxicity (freshwater); HTP-c = Human toxicity, cancer effects; HTP-nc = Human toxicity, non-cancer effects; SQP = Soil quality potential/Land use related impacts									

4.8 Interpretation

The interpretation of the results for 1 tonne of Steel Rebar are presented in Table 16.

Table 16. Interpretation of most significant contributors to life cycle parameters (Steel Rebar)

Parameter		Most significant contributor
Resource use, minerals, and metals		The total cradle to gate impact is 1.71E-04 kg Sb eq. In A1 – A3 module around 96.5% impact is from steel billet. A total credit of -2.40E-02 kg Sb eq is taken in module D.
Acidification		The total cradle to gate impact is 7.90E+00 Mole of H+ eq. In A1 – A3, the steel billet (74.6%) followed by electricity (15%) and rebar rolling mill process (10%) has the highest impacts. A total credit of -3.30E+00 Mole of H+ eq is taken in module D.
Eutrophication Potential		The total cradle to gate impact is 2.91E-04 kg P eq. In A1 – A3, the steel billet (70.1%) followed by electricity (27%) has the highest impacts. A total credit of -8.38E-04 kg P eq is taken in module D.
Climate Change		The total cradle to gate impact is 2.73E+03 kg CO2 eq. In A1 – A3, the steel billet (92.4%) followed by electricity (4%) has the highest impacts. A total credit of -1.48E+03 kg CO2 eq is taken in the module D.
Ozone depletion		The total cradle to gate impact is 4.46E-09 kg CFC eq. In module A1 – A3, the impacts are due to the steel billet manufacturing. A total credit of 3.23E-12 kg CFC-11 eq is taken in module D.
Photochemical ozone formation - human health		The total cradle to gate impact is 3.78E+00 kg NMVOC eq In A1 – A3, the steel billet (75.6%) followed by electricity (10.84%) and rebar rolling mill process (7%) has the highest impacts. A total credit of -2.48E+00 kg NMVOC eq is taken in module D.
Resource use, energy carriers		The total cradle to gate impact is 2.65E+04 MJ. In A1 – A3, the steel billet (93.58%) has the highest impacts. A total credit of -1.27E+04 MJ is taken in module D.

Concluding, the study provides fair understanding of environmental impacts during the various life cycle stages of steel rebar production. It also identifies the hot spots in the value chain where improvement activities can be prioritised and accordingly investment can be planned. The scope covers the ecological information to be divided into raw material production (A1), transportation (A2), manufacturing (A3), product dismantling (C1), transport of dismantled product to EoL site (C2), waste processing (C3), waste disposal (C4) as well as the end of life stage recycling (D) considerations.

4.8.1 LCA Terminology

Cradle to Gate	Scope of study extends from mining of natural resources to the completed product ready for shipping from the manufacturing dispatch "gate", known as Modules A1-A3.
Cradle to Grave	Scope of study extends from mining of natural resources to manufacture, use and disposal of products at End of Life, including all Modules A-D.
End of life	Post-use phase life cycle stages involving collection and processing of materials (e.g. scrap) and recycling or disposal, known as Modules C and D.

5. Other Environmental Information

The constituent materials used within our products are responsibly sourced and we apply the principles of Sustainable Development and of Environmental Stewardship as a standard business practice in our operations. Protecting the environment by preserving non-renewable natural resources, increasing energy efficiency, reducing the environmental emissions, limiting the impact of materials transportation to and from our operations is part of our way in doing business.

6. References

- EN 15804: 2012+A2:2019, Sustainability of construction works - Environmental product declarations - Core rules for the product category of construction products
- GaBi 9.2 2021: Dokumentation der GaBi-Datensätze der Datenbank zur Ganzheitlichen Bilan zierung. LBP, Universität Stuttgart und PE International, 2012
- GaBi 9.2 2021: Software und Datenbank zur Ganzheitlichen Bilanzierung. LBP, Universität Stuttgart und PE International, 2012
- ISO 14020:2000 Environmental labels and declarations - General principles
- 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 Environmental management - Life cycle assessment - Requirements and guidelines.
- ISO/TR 14049:2012 Environmental management - Life cycle assessment - Illustrative examples on how to apply ISO 14044 to goal and scope definition and inventory analysis.
- WSI and Eurofer's Co-product Allocation Methodology 2014 - A methodology to determine the LCI of Steel industry Co-products.
- World Steel Association - CO2 Data Collection User Guide, Version 9 (May 2019)
- World Steel Association – Life Cycle Inventory Methodology Report for Steel Products 2017

END OF DOCUMENT