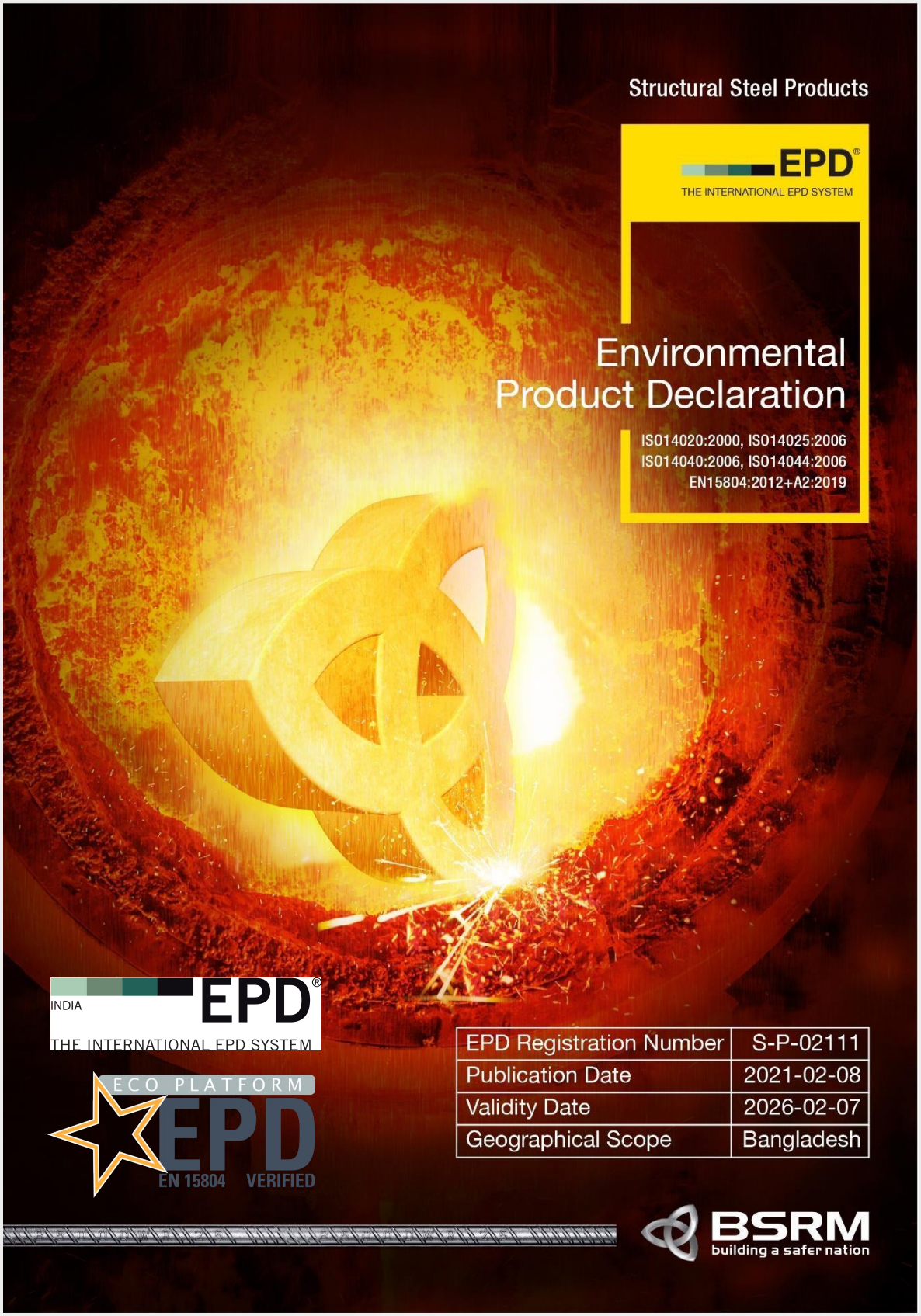
BSRM
building a safer nation



1. Introduction

The Bangladesh Steel Re-Rolling Mills Ltd. (BSRM) is a steel manufacturing company with 1.8 million tonnes of installed billet-making capacity based in Chittagong, Bangladesh. BSRM steel products are known for building major National landmarks and infrastructures. BSRM has embedded sustainability in their business strategy which has helped in maintaining their leadership positions in the steel industry by producing the best quality steel products while continuously enhancing customer satisfaction.

LEED, green building certification by USGBC, is one of the world's leading green building project and performance management system, delivering a comprehensive framework for green building design, construction, operations and performance.

To accelerate market transformation and buildings that go from net zero environmental impacts to generating positive environmental outcomes, LEED v4/4.1 introduced a series of system goals designed to raise the bar for achieving different levels of green building certification. The Materials and Resources (MR) credit category focuses on minimizing the embodied energy and other impacts associated with the extraction, processing, transport, maintenance and disposal of building materials using a life cycle approach. The MR credit category offers the building materials industry the greatest opportunities to earn points within LEED v4. Within MRc Building product disclosure & optimisation, specific credits apply for having EPDs.

The reason for carrying out the study is to assess the environmental profile of the structural steel products (Rebar, Angle, Channel, Square bar, Ribbed wire, Epoxy coated bar and Cut & Bends) and use the study to develop EPD for customer communication.

Among the tools available to evaluate environmental performance, life cycle assessment (LCA) provides a holistic approach by considering the potential impacts from all stages of manufacture, product use and end-of-life stages.

Thinkstep Sustainability Solutions Pvt. Ltd, a Sphera Company (formerly thinkstep AG). has been entrusted to conduct Life Cycle Assessment for BSRM's products as per the 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

2.1 EPD, PCR, LCA Information

Table 1. EPD Information

Programme	The International EPD® System, Indian Regional Hub www.environdec.com and www. environdecindia.com
Program operator	EPD International AB Box 210 60, SE-100 31 Stockholm, Sweden.
Declaration holder	BSRM Steel Ltd. Ali Mansion, 1207 /1099, Sadarghat Road, Chittagong, 4000 Bangladesh
Product	Structural Steel Product (Rebar, Angle, Channel, Square bar, Ribbed wire, Epoxy coated bar, Cut & Bends)
CPC Code	412 Products of Iron or steel
EPD registration number	S-P-02111
Publication date	2021-02-08
Validity date	2026-02-07
Geographical scope	Bangladesh
Reference standards	IS0 14020:2001, ISO 14025:2006, EN 15804:2012+A2:2019

Table 2. PCR Information

Reference PCR	PCR 2019:14- 'Construction Products', Version 1.0
Date of Issue	2019-12-20 (Version 1.0)

Table 3. Verification 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: cssunil67@gmail.com

Table 4. LCA Information

Title	Environmental Product Declaration of Structural Steel Products
Preparer	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 is the July 2019 to June 2020. The background data used in the study has been applied through GaBi datasets which is less than 5 years old.

2.3 Geographical Scope of EPD Application

The geographical scope of this EPD is Bangladesh.

2.4 Additional Information about EPD

This EPD provides information for the Structural Steel product (Rebar, Angle, Channel, Square bar, Ribbed wire, Epoxy coated bar, Cut & Bends) at BSRM Steel Limited's Chittagong Plant (Bangladesh). 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 structural steel products is done as per ISO 14040 and ISO 14044 requirements for BSRM Steel Limited.

Product Category Rules (PCR) for the assessment of the environmental performance of Structural steel products is PCR 2019:14- Construction Products, Version 1.0.

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

The target audience includes BSRM management, operational and marketing departments. Furthermore, it will be made available for many different external applications of the data, for technical and non-technical people, including customers of the steel industry, policy makers, LCA practitioners and academia as per company's decision to share information as they seem appropriate.

3. Product Description and System Boundaries

3.1 Product Identification and Usage

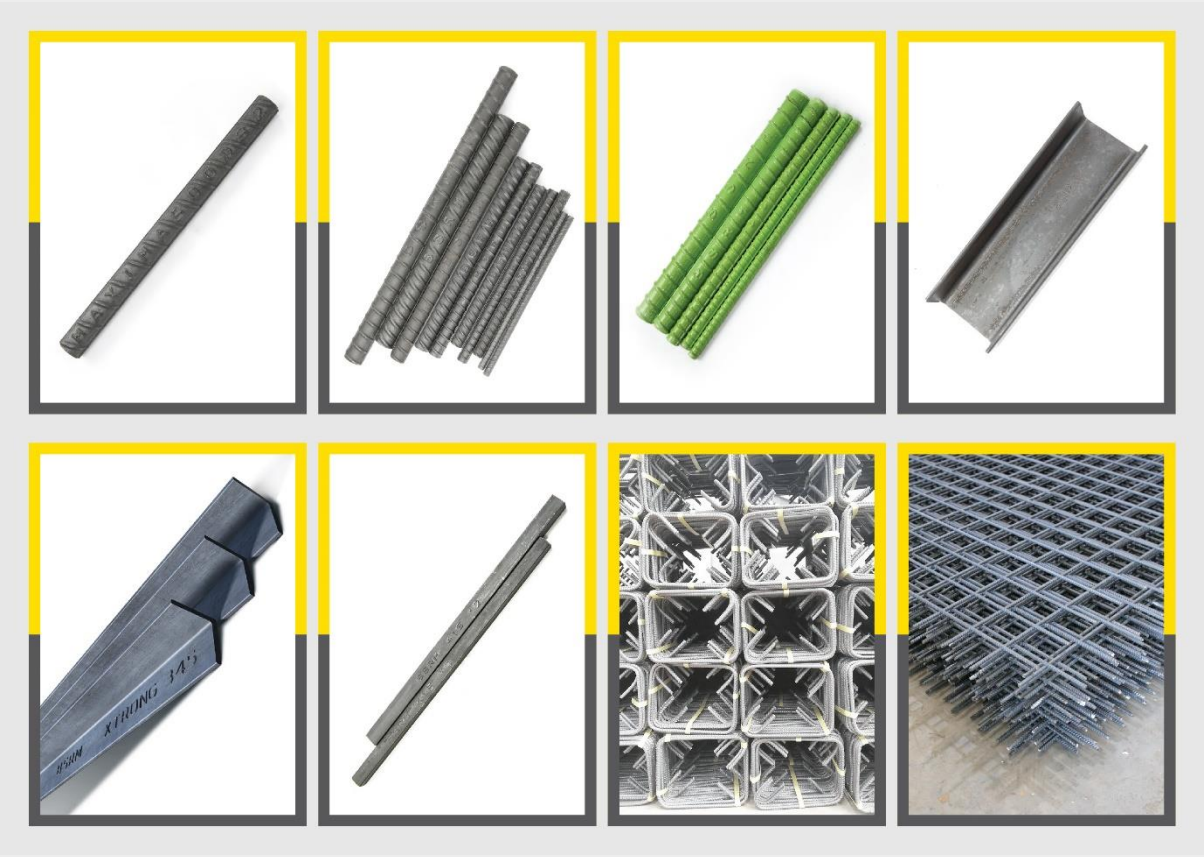
BSRM Steel Limited manufactures structural steel products (Rebar, Angle, Channel, Square bar, Ribbed wire, Epoxy coated bar and Cut & Bends) at Chittagong plant in Bangladesh region. The production of these structural steel products involves the use of state-of-the-art equipment and manufacturing processes that ensure products of the highest quality. Steel is produced predominantly by Induction Furnace process route. Primary data is used for all gate-to-gate processes.

Table 5. Specifications of structural steel products

Product	Size (mm)	Brand Name	Grade (MPa/Ksi)	Conforming Standards
Rebar	8 - 50	BSRM XTREME 500W	500 MPa	ISO 6935-2:2016, IS:1786, ASTM A615, BS 4449:2008
		BSRM XTREME B500DWR	500 MPa	ISO 6935-2:2016, IS 1786
		BSRM ULTIMA 420DWR	420 MPa	ASTM A615, ISO 6935-2:2016
		BSRM MAXIMA 80G	80 Ksi	ASTM A706, ASTM A615, ISO 6935-2:2016
Angle	3 -12 (25X25, 35X35, 50X50, 65X65, 75X75, 90X90 & 100X100)	BSRM XTRONG 345	345 MPa	ISO 630-3, ISO 657-1
Channel	75X40X5, 100X50X5, 125X65X6	BSRM Channel	345 MPa	ISO 630-3, ISO 657-11
Square Bar	10 & 12	BSRM Square Bar	415 MPa	ISO 630-3, ISO 1035-2, ISO 1035-4
Ribbed Wire	4.5, 6 & 7	BSRM Wires B500AWR	500 MPa	ISO 6935-2, ASTM A1064
Epoxy Coated Bar	8 - 50	BSRM CENTURA	420 MPa, 500 MPa, 80 Ksi	ISO 14654, ASTM A775, IS:13620
Cut & Bends	As per Drawing	BSRM FastBuild Service	420 MPa, 500 MPa, 80 Ksi	ACI 315:99, ACI 117, ACI 318, BNBC

Structural steel products are used in a variety of applications like constructions and infrastructure.

Rebar is high strength reinforcing steel for general purpose construction. Homogeneous and repeatable mechanical properties of steel through appropriate chemistry and process control ensure excellent performance in any type of construction and the rebar properties are suitable for high seismic regions.



Cut & bend products (as per construction drawing) in downstream service are cost effective and convenient to install. After completing the life of any construction, the steel can be 100% recovered & recycled into the same grade or superior grade of steel.

Epoxy coated rebar introduced for coastal belt areas where extra humidity and salty water causes rapid corrosion of normal steel rebar. It prevents corrosion of the steel and ensures better life of the structures.

Product do not contain any substance that can be included in “Candidate List of Substances of Very High Concern for Authorization” and raw materials used are not part of EU REACH regulations.

3.2 System boundary

Figure 1 given below represents system boundary diagram of the study.

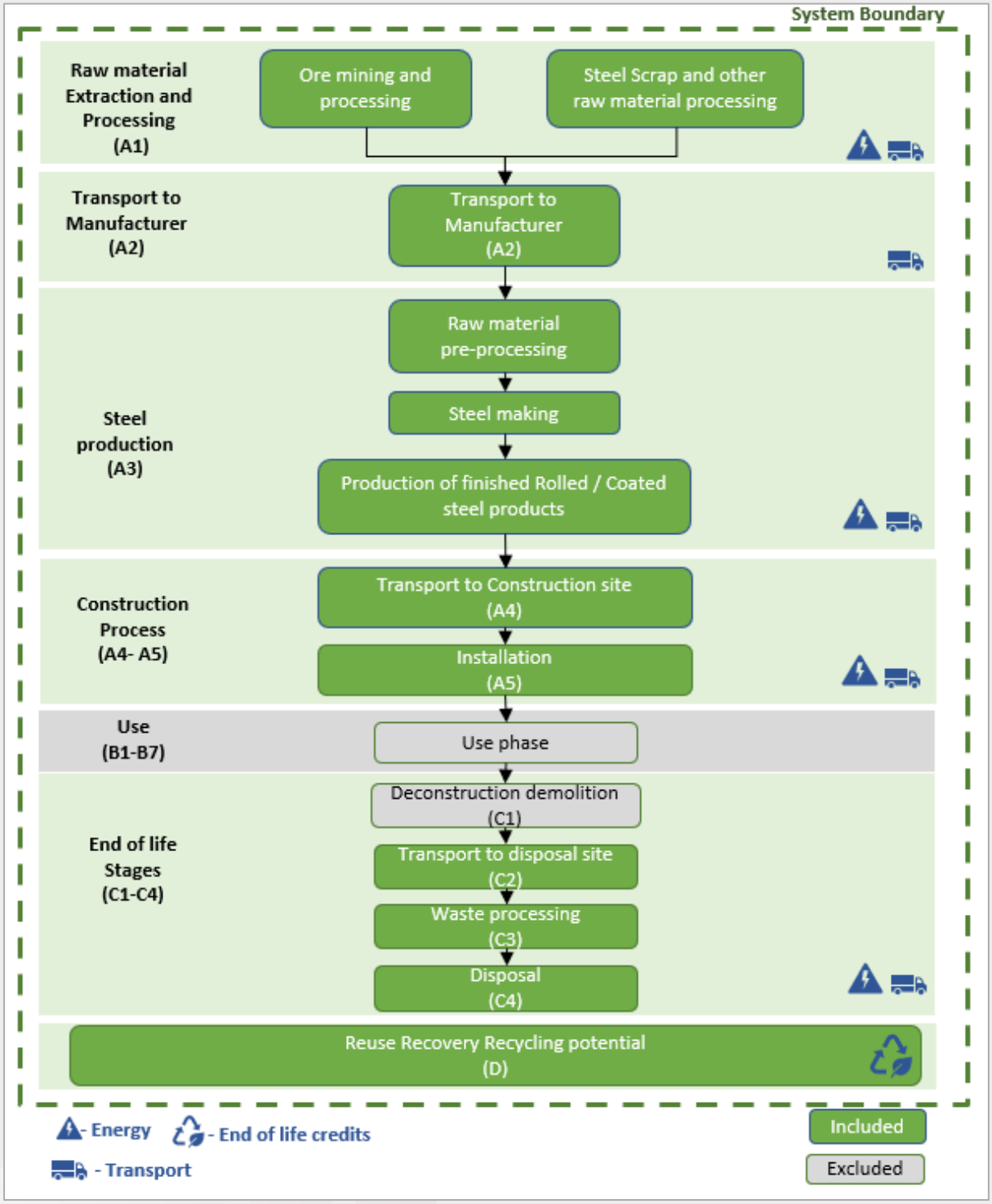


Figure 1 System boundary diagram (Cradle to gate with options)

3.3 Process Description

Steel products are manufactured using the induction furnace (IF) route. The raw material input consists of scrap (imported from different countries), direct reduced iron (DRI), Ferro alloys along with allied materials. Induction furnace melts scrap into liquid steel. Small quantity of coal-based Sponge Iron is used as additive to adjust carbon content of liquid steel. The slag generated during melting is mainly

from contaminants present in scrap and erosion of refractory lining. Compared to electric arc process of melting, the consumption of refractory, generation of dust, smoke and waste slag is considerably lower.

Liquid steel from induction furnace is refined and the chemical composition adjusted in ladle refining furnace. Flux such as lime and calcium carbide are used along with inert gas rinsing during refining. Once the chemistry and temperature are achieved, the liquid steel is transferred to continuous billet casting machine. Billets are hot rolled into various dimensions of Re- bar/Angle /Channel/Square bars. As per requirement of customers fusion bonded epoxy coated rebars are also manufactured. Similarly, automatic cutting and bending is done as per the requirements of the customers. Ribbed bars are produced by cold rolling/ribbing of wire rods.

The subsequent process involves finishing and inspection of the final product. The product is then dispatched and sent for shipping. The process chains are schematically presented in Figure 2.

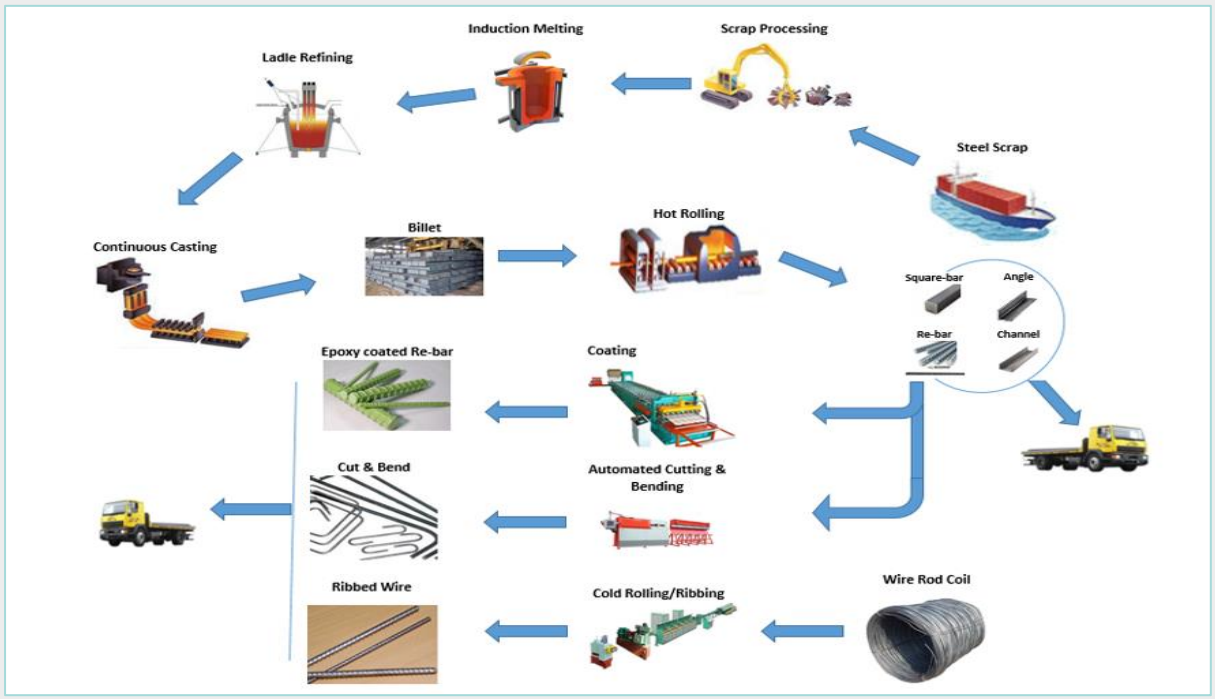


Figure 2 Steel making process at BSRM Steel

Water is used in continuous casting machines for direct cooling of the billets. A contaminated process water flow is therefore generated. This wastewater is sent to lagoons and treated and discharge outside the premise is avoided. The IF slag is of excellent quality, so it is utilised as aggregate in the road making. It is used as co-product, so the allocation has been applied according to the co-product allocation rules.

Exclusions:

The technical system shall not include:

- Manufacturing of production equipment, buildings and other capital goods
- Internal transportation of materials
- Human labour
- Business travel of personnel
- Travel to and from work by personnel
- Research and development activities

4. 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 professional database 2020 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. This is important in the case of the blast furnace route and EAF/IF route, which generates important quantities of valuable co-products (also known as by- products). Several methods are documented in ISO 14040:2006 and ISO Technical Report 14049. The main coproducts for IF-LF is listed in table 6, together with the allocation method as per World Steel and Eurofer's Co-product allocation methodology.

Table 6. Products in IF-LF steel plant where allocation is applied

Production Unit	Main Co-Products
IF-LF plant	Billet, IF-LF slag

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. This study has considered both the scraps viz, the external scrap used as input in the IF as well as the End-of-Life scrap generation. Accounting for all these, the End-of -life credit for recycling is applied over 85% of steel (850 kg in 1 tonne of structural steel products).[1] The landfill is considered as 15% of steel (150 kg in 1 tonne of structural steel products). Net scrap approach is applied for credit calculation. So, the credit is taken only for 4% as the recycled content in the input scrap is 96%. This scenario is the most probable alternative which has been considered based on the World steel LCA study.

[1] http://www.worldsteel.org/en/dam/jcr:6a222ba2-e35a-4126-83ab-5ae5a79e6e46/LCA+Methodology+Report.pdf

4.2.3 Declared unit

The declared unit for the EPD is 1 tonne of Structural steel product (Rebar, Angle, Channel, Square bar, Ribbed wire, Epoxy coated bar, Cut & Bends) manufactured at BSRM Steel Limited. The conversion factor used for the EPD is 1000 kg (from tonne to kg) for the structural steel product.

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 with EN15804+A2:2019 (Table 7), and divided into core, upstream (and downstream, if included) module.

Table 7. 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 use	Water (user) deprivation potential, deprivation-weighted water consumption (WDP)	m^3 world equiv.

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 8.

Table 8. 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)	m^3

Table 9. 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 10. 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 heating fuels, electricity, steam and compressed air.

2. The sum of the excluded material flows must not exceed 5% of mass, energy or environmental relevance. However, in reality at least 99.9% of material inputs to each process stage were included.

3. Wastes representing less than 1% of total waste tonnage for given process stages were not recorded unless treated outside of the site.

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 the ecological information to be divided into raw material production (A1), inbound transportation (A2), Manufacturing (A3), outbound transportation (A4), installation (A5), transport of dismantled product to EoL site (C2), waste processing (C3), disposal (C4)as well as the end of life stage recycling (D) considerations.

Raw materials, fuels and energy are used for manufacturing process. After manufacturing the finished product is sent to the construction site. The product after its useful life goes to end of life phase. The packaging material (Wire rod) has been considered for recycling in the installation phase (module A5) and the credit has been taken in module D.

Table 11. Details of system boundary included in the study

EPD Module	Life Cycle Stages	Life Cycle Sub-Stages	Definitions
A1	Materials	Primary raw materials Production	Extraction, production of the raw materials.
A2	Upstream Transport	-	Transport of the scrap and other raw materials to the manufacturing unit.
A3	Manufacturing	steel shops, mills and utilities	Manufacturing of various grades of steel products at BSRM across the various shops i.e. Ladle furnace, Induction Furnace, CCM, Bar rod mill, Wire rod mill, Service centre etc. Manufacturing of packaging material has been considered.
A4	Downstream Transport	-	Transport of the finished product to the site.
A5	Installation	-	85% recycling for the packaging material has been considered. The credit for the packaging material has been taken in Module D.
C2	Transport to EoL site	-	Transport of the dismantled product to the EoL site
C3	Waste Processing	-	Waste processing of the dismantled product
C4	Disposal	-	Disposal of the dismantled products (i.e. 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. The credit is estimated using the recycling burden and credit

			of replacing virgin route steel. Net scrap approach has been applied for credit.

4.4.1 Geographic System Boundaries

The geographical coverage of this study covers the production of various structural steel products at BSRM, Chittagong plant in Bangladesh region. Indian specific datasets wherever possible have been adapted and others dataset were chosen from EU if no Bangladesh or Indian datasets were available. In addition, imported raw materials are considered along with transport. All the primary data has been collected from BSRM in cooperation 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 from the period July 2019 to June 2020. It is believed to be representative of steel production during this time frame.

4.4.3 Technology coverage

In the present study, IF-LF route is considered with major raw materials input of scrap (86%) and DRI (11%). Billets are used to produce the rebar, angle, channel and square bar. Further, rebar is used to produce the ribbed wire, epoxy coated bar and Cut & Bends.

4.5 Software and database

The LCA model was created using the GaBi 9 Software system for life cycle engineering, developed by thinkstep sphera. 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 http://www.gabi-software.com/international/support/gabi/gabi-database-2020-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 12.

Table 12. Modules of the production life cycle included (X = declared module; MNA = module not Assessed)

Production			Installation		Use stage							End-of-Life				Next product system
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	X	X	ND	ND	ND	ND	ND	ND	ND	ND	X	X	X	X

4.7.1 Overall Cradle to gate with Option LCIA results for 1- tonne Rebar

The LCIA result for 1 tonne of Rebar manufactured at BSRM Chittagong plant with the system boundary of Cradle-to-Gate with options have been as given in Table 13 to Table 16.

Table 13. Environmental impacts for 1-tonne Rebar

Parameter	Unit	A1	A2	A3	A4	A5	C2	C3	C4	D
GWP - total	kg CO_2 eq.	7.36E+02	6.00E+00	9.76E+01	1.79E+01	4.00E-01	3.57E+00	0.00E+00	8.95E+00	-3.26E+01
GWP - fossil	kg CO_2 eq.	7.36E+02	5.76E+00	9.74E+01	1.71E+01	3.99E-01	3.42E+00	0.00E+00	2.38E+00	-3.26E+01
GWP - biogenic	kg CO_2 eq.	8.97E-02	2.31E-01	1.60E-01	7.31E-01	9.82E-04	1.46E-01	0.00E+00	6.58E+00	-4.54E-02
GWP - luluc	kg CO_2 eq.	-6.89E-02	3.28E-04	2.78E-03	9.23E-04	3.91E-04	1.85E-04	0.00E+00	1.11E-03	-4.49E-04
ODP	kg CFC-11 eq.	1.11E-08	3.17E-16	1.20E-14	8.85E-16	5.68E-15	1.77E-16	0.00E+00	8.51E-15	6.23E-14
AP	Mole of H+ eq.	1.87E+00	4.70E-02	5.00E+00	1.48E-01	1.35E-03	2.97E-02	0.00E+00	1.78E-02	-7.41E-02
EP - freshwater	kg P eq.	9.44E-05	1.24E-06	5.46E-06	3.76E-06	7.30E-07	7.52E-07	0.00E+00	1.14E-05	-2.00E-05
EP - marine	kg N eq.	5.51E-01	1.79E-02	7.86E-01	6.91E-02	2.72E-04	1.38E-02	0.00E+00	4.65E-03	-1.37E-02
EP - terrestrial	Mole of N eq.	6.02E+00	1.97E-01	8.61E+00	7.58E-01	2.92E-03	1.52E-01	0.00E+00	5.09E-02	-1.40E-01
POCP	kg NMVOC eq.	1.60E+00	3.83E-02	2.26E+00	1.31E-01	1.09E-03	2.63E-02	0.00E+00	1.61E-02	-5.56E-02
ADPE	kg Sb eq.	2.47E-05	6.23E-08	4.15E-05	1.85E-07	1.00E-07	3.69E-08	0.00E+00	1.66E-07	-4.81E-04
ADPF	MJ	1.27E+04	7.95E+01	1.39E+03	2.37E+02	5.93E+00	4.75E+01	0.00E+00	3.00E+01	-2.79E+02
WDP	m^3 world equiv.	8.67E+01	1.94E-02	2.58E-01	5.50E-02	7.64E-02	1.10E-02	0.00E+00	2.37E-01	-2.18E+00
Caption	GWP - total = global warming potential; GWP - fossil = global warming potential (fossil fuel only); GWP - biogenic = global warming potential (biogenic); GWP - luluc = global warming potential (land use only); ODP = ozone depletion; AP = acidification terrestrial and freshwater; EP - freshwater = eutrophication potential (freshwater); EP - marine = eutrophication potential (marine); EP- terrestric = eutrophication potential (terrestrial); POCP = photochemical ozone formation; ADPE = abiotic depletion potential (element), ADPF = abiotic depletion potential (fossil) WDP = water scarcity.									

Table 14. Parameters describing resource use for 1-tonne Rebar

Parameter	Unit	A1	A2	A3	A4	A5	C2	C3	C4	D
PERE	MJ	-1.85E+00	2.96E-01	2.90E+00	8.48E-01	2.03E+00	1.70E-01	0.00E+00	3.45E+00	1.86E+01
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	0.00E+00
PERT	MJ	-1.85E+00	2.96E-01	2.90E+00	8.48E-01	2.03E+00	1.70E-01	0.00E+00	3.45E+00	1.86E+01

PENRE	MJ	1.27E+04	7.95E+01	1.39E+03	2.37E+02	5.94E+00	4.75E+01	0.00E+00	3.00E+01	-2.79E+02
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	0.00E+00
PENRT	MJ	1.27E+04	7.95E+01	1.39E+03	2.37E+02	5.94E+00	4.75E+01	0.00E+00	3.00E+01	-2.79E+02
SM	kg	9.80E+02	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	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	0.00E+00
FW	m^3	2.90E+00	6.65E-04	9.95E-03	1.89E-03	2.81E-03	3.77E-04	0.00E+00	7.03E-03	-5.70E-02
Caption	PERE = Use of renewable primary energy excluding the renewable primary energy resource 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 the non-renewable primary energy resources used as raw materials; PENRM = Use of non-renewable primary energy used 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 15: Output flows and waste categories for 1-tonne Rebar

Parameter	Unit	A1	A2	A3	A4	A5	C2	C3	C4	D
HWD	kg	4.20E-06	4.31E-09	2.93E-06	1.27E-08	2.56E-09	2.53E-09	0.00E+00	3.28E-08	-3.26E-05
NHWD	kg	5.49E+01	1.03E-03	-3.11E-02	2.96E-03	-1.20E-04	5.92E-04	0.00E+00	1.49E+02	2.99E+00
RWD	kg	-2.46E-03	1.76E-05	6.43E-04	4.93E-05	6.93E-04	9.86E-06	0.00E+00	2.98E-04	-2.26E-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	0.00E+00
MFR	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.23E+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	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	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	0.00E+00
Caption	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 16: Additional Environmental parameters for 1-tonne Rebar

Parameter	Unit	A1	A2	A3	A4	A5	C2	C3	C4	D
PM	Disease incidences	1.06E-05	3.57E-07	2.62E-05	9.63E-07	1.69E-08	1.93E-07	0.00E+00	2.18E-07	-1.10E-06
IR	kBq U235 eq.	-2.88E-01	1.67E-03	1.78E-02	4.69E-03	1.13E-01	9.38E-04	0.00E+00	2.68E-02	5.28E-01
ETF-fw	CTUe	9.78E+02	2.74E+01	2.59E+01	8.19E+01	2.10E+00	1.64E+01	0.00E+00	4.94E+01	-7.58E+00
HTP-c	CTUh	1.21E-07	4.64E-10	1.59E-08	1.40E-09	1.46E-10	2.81E-10	0.00E+00	2.48E-09	8.35E-09
HTP-nc	CTUh	8.38E-07	1.94E-08	1.40E-07	6.87E-08	1.86E-08	1.37E-08	0.00E+00	2.83E-07	-4.52E-07
SQP	Pt	-4.49E+01	3.65E-01	4.17E+00	1.02E+00	1.59E+00	2.05E-01	0.00E+00	3.88E+00	5.20E+00
Caption	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									

4.7.2 Overall Cradle to gate with Option LCIA results for 1- tonne Angle

The LCIA result for 1 tonne of Angle manufactured at BSRM Chittagong plant with the system boundary of Cradle-to-Gate with options have been as given in Table 17 to Table 20.

Table 17: Environmental impacts for 1-tonne Angle

Parameter	Unit	A1	A2	A3	A4	A5	C2	C3	C4	D
GWP - total	kg CO_2 eq.	7.59E+02	6.00E+00	9.45E+01	1.79E+01	4.00E-01	3.57E+00	0.00E+00	8.95E+00	-3.26E+01
GWP - fossil	kg CO_2 eq.	7.59E+02	5.77E+00	9.44E+01	1.71E+01	3.99E-01	3.42E+00	0.00E+00	2.38E+00	-3.26E+01
GWP - biogenic	kg CO_2 eq.	9.00E-02	2.32E-01	1.58E-01	7.31E-01	9.82E-04	1.46E-01	0.00E+00	6.58E+00	-4.54E-02
GWP - luluc	kg CO_2 eq.	-6.83E-02	3.28E-04	2.72E-03	9.23E-04	3.91E-04	1.85E-04	0.00E+00	1.11E-03	-4.48E-04
ODP	kg CFC-11 eq.	1.12E-08	3.17E-16	1.19E-14	8.85E-16	5.68E-15	1.77E-16	0.00E+00	8.51E-15	6.23E-14
AP	Mole of H+ eq.	1.97E+00	4.70E-02	4.99E+00	1.48E-01	1.35E-03	2.97E-02	0.00E+00	1.78E-02	-7.41E-02

EP - freshwater	kg P eq.	9.53E-05	1.25E-06	5.41E-06	3.76E-06	7.30E-07	7.52E-07	0.00E+00	1.14E-05	-2.00E-05
EP - marine	kg N eq.	5.75E-01	1.79E-02	7.83E-01	6.91E-02	2.72E-04	1.38E-02	0.00E+00	4.65E-03	-1.37E-02
EP - terrestrial	Mole of N eq.	6.28E+00	1.97E-01	8.58E+00	7.58E-01	2.92E-03	1.52E-01	0.00E+00	5.09E-02	-1.40E-01
POCP	kg NMVOC eq.	1.67E+00	3.83E-02	2.25E+00	1.31E-01	1.09E-03	2.63E-02	0.00E+00	1.61E-02	-5.56E-02
ADPE	kg Sb eq.	2.55E-05	6.23E-08	4.14E-05	1.85E-07	1.00E-07	3.69E-08	0.00E+00	1.66E-07	-4.81E-04
ADPF	MJ	1.30E+04	7.95E+01	1.33E+03	2.37E+02	5.93E+00	4.75E+01	0.00E+00	3.00E+01	-2.79E+02
WDP	m^3 world equiv.	8.87E+01	1.94E-02	2.55E-01	5.50E-02	7.64E-02	1.10E-02	0.00E+00	2.37E-01	-2.18E+00
Caption	GWP - total = global warming potential; GWP - fossil = global warming potential (fossil fuel only); GWP - biogenic = global warming potential (biogenic); GWP - luluc = global warming potential (land use only); ODP = ozone depletion; AP = acidification terrestrial and freshwater; EP - freshwater = eutrophication potential (freshwater); EP - marine = eutrophication potential (marine); EP- terrestric = eutrophication potential (terrestrial); POCP = photochemical ozone formation; ADPE = abiotic depletion potential (element), ADPF = abiotic depletion potential (fossil) WDP = water scarcity.									

Table 18: Parameters describing resource use for 1-tonne Angle

Parameter	Unit	A1	A2	A3	A4	A5	C2	C3	C4	D
PERE	MJ	1.22E+00	2.97E-01	2.87E+00	8.48E-01	2.03E+00	1.70E-01	0.00E+00	3.45E+00	1.86E+01
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	0.00E+00
PERT	MJ	1.22E+00	2.97E-01	2.87E+00	8.48E-01	2.03E+00	1.70E-01	0.00E+00	3.45E+00	1.86E+01
PENRE	MJ	1.30E+04	7.95E+01	1.33E+03	2.37E+02	5.94E+00	4.75E+01	0.00E+00	3.00E+01	-2.79E+02
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	0.00E+00
PENRT	MJ	1.30E+04	7.95E+01	1.33E+03	2.37E+02	5.94E+00	4.75E+01	0.00E+00	3.00E+01	-2.79E+02
SM	kg	9.80E+02	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	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	0.00E+00
FW	m^3	2.96E+00	6.66E-04	9.89E-03	1.89E-03	2.81E-03	3.77E-04	0.00E+00	7.03E-03	-5.70E-02
Caption	PERE = Use of renewable primary energy excluding the renewable primary energy resource 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 the non-renewable primary energy resources used as raw materials; PENRM = Use of non-renewable primary energy used 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 19: output flows and waste categories for 1-tonne Angle

Parameter	Unit	A1	A2	A3	A4	A5	C2	C3	C4	D
HWD	kg	4.28E-06	4.31E-09	2.92E-06	1.27E-08	2.56E-09	2.53E-09	0.00E+00	3.28E-08	-3.26E-05
NHWD	kg	5.50E+01	1.03E-03	-3.89E-02	2.96E-03	-1.20E-04	5.92E-04	0.00E+00	1.49E+02	2.99E+00
RWD	kg	-2.43E-03	1.76E-05	6.39E-04	4.93E-05	6.93E-04	9.86E-06	0.00E+00	2.98E-04	-2.26E-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	0.00E+00
MFR	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.23E+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	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	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	0.00E+00
Caption	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 20: Additional Environmental parameters for 1-tonne Angle

Para-meter	Unit	A1	A2	A3	A4	A5	C2	C3	C4	D
PM	Disease incidences	1.15E-05	3.57E-07	2.62E-05	9.63E-07	1.69E-08	1.93E-07	0.00E+00	2.18E-07	-1.10E-06
IR	kBq U235 eq.	-2.84E-01	1.67E-03	1.73E-02	4.69E-03	1.13E-01	9.38E-04	0.00E+00	2.68E-02	5.28E-01
ETF-fw	CTUe	1.00E+03	2.74E+01	2.53E+01	8.19E+01	2.10E+00	1.64E+01	0.00E+00	4.94E+01	-7.58E+00
HTP-c	CTUh	1.26E-07	4.65E-10	1.53E-08	1.40E-09	1.46E-10	2.81E-10	0.00E+00	2.48E-09	8.35E-09
HTP-nc	CTUh	8.78E-07	1.94E-08	1.37E-07	6.87E-08	1.86E-08	1.37E-08	0.00E+00	2.83E-07	-4.52E-07
SQP	Pt	-4.44E+01	3.65E-01	4.12E+00	1.02E+00	1.59E+00	2.05E-01	0.00E+00	3.88E+00	5.20E+00
Caption	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									

4.7.3 Overall Cradle to gate with Option LCIA results for 1- tonne Channel

The LCIA result for 1 tonne of Channel manufactured at BSRM Chittagong plant with the system boundary of Cradle-to-Gate with options have been as given in Table 21 to Table 24 .

Table 21: Environmental impacts for 1-tonne Channel

Parameter	Unit	A1	A2	A3	A4	A5	C2	C3	C4	D
GWP - total	kg CO_2 eq.	7.49E+02	6.04E+00	1.07E+02	1.79E+01	4.00E-01	3.57E+00	0.00E+00	8.95E+00	-3.26E+01
GWP - fossil	kg CO_2 eq.	7.49E+02	5.81E+00	1.07E+02	1.71E+01	3.99E-01	3.42E+00	0.00E+00	2.38E+00	-3.26E+01
GWP - biogenic	kg CO_2 eq.	9.03E-02	2.33E-01	1.60E-01	7.31E-01	9.82E-04	1.46E-01	0.00E+00	6.58E+00	-4.54E-02
GWP - luluc	kg CO_2 eq.	-6.92E-02	3.30E-04	2.94E-03	9.23E-04	3.91E-04	1.85E-04	0.00E+00	1.11E-03	-4.48E-04
ODP	kg CFC-11 eq.	1.12E-08	3.19E-16	1.21E-14	8.85E-16	5.68E-15	1.77E-16	0.00E+00	8.51E-15	6.23E-14
AP	Mole of H+ eq.	1.92E+00	4.73E-02	5.05E+00	1.48E-01	1.35E-03	2.97E-02	0.00E+00	1.78E-02	-7.41E-02
EP - freshwater	kg P eq.	9.52E-05	1.25E-06	5.60E-06	3.76E-06	7.30E-07	7.52E-07	0.00E+00	1.14E-05	-2.00E-05
EP - marine	kg N eq.	5.63E-01	1.81E-02	8.00E-01	6.91E-02	2.72E-04	1.38E-02	0.00E+00	4.65E-03	-1.37E-02
EP - terrestrial	Mole of N eq.	6.15E+00	1.98E-01	8.76E+00	7.58E-01	2.92E-03	1.52E-01	0.00E+00	5.09E-02	-1.40E-01
POCP	kg NMVOC eq.	1.63E+00	3.85E-02	2.30E+00	1.31E-01	1.09E-03	2.63E-02	0.00E+00	1.61E-02	-5.56E-02
ADPE	kg Sb eq.	2.51E-05	6.27E-08	4.19E-05	1.85E-07	1.00E-07	3.69E-08	0.00E+00	1.66E-07	-4.81E-04
ADPF	MJ	1.29E+04	8.01E+01	1.54E+03	2.37E+02	5.93E+00	4.75E+01	0.00E+00	3.00E+01	-2.79E+02
WDP	m^3 world equiv.	8.79E+01	1.95E-02	2.65E-01	5.50E-02	7.64E-02	1.10E-02	0.00E+00	2.37E-01	-2.18E+00
Caption	GWP - total = global warming potential; GWP - fossil = global warming potential (fossil fuel only); GWP - biogenic = global warming potential (biogenic); GWP - luluc = global warming potential (land use only); ODP = ozone depletion; AP = acidification terrestrial and freshwater; EP - freshwater = eutrophication potential (freshwater); EP - marine = eutrophication potential (marine); EP- terrestric = eutrophication potential (terrestrial); POCP = photochemical ozone formation; ADPE = abiotic depletion potential (element), ADPF = abiotic depletion potential (fossil) WDP = water scarcity.									

Table 22: Parameters describing resource use for 1-tonne Channel

Parameter	Unit	A1	A2	A3	A4	A5	C2	C3	C4	D
PERE	MJ	-8.86E-01	2.99E-01	2.98E+00	8.48E-01	2.03E+00	1.70E-01	0.00E+00	3.45E+00	1.86E+01
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	0.00E+00
PERT	MJ	-8.86E-01	2.99E-01	2.98E+00	8.48E-01	2.03E+00	1.70E-01	0.00E+00	3.45E+00	1.86E+01
PENRE	MJ	1.29E+04	8.01E+01	1.54E+03	2.37E+02	5.94E+00	4.75E+01	0.00E+00	3.00E+01	-2.79E+02
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	0.00E+00
PENRT	MJ	1.29E+04	8.01E+01	1.54E+03	2.37E+02	5.94E+00	4.75E+01	0.00E+00	3.00E+01	-2.79E+02
SM	kg	9.87E+02	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	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	0.00E+00
FW	m^3	2.94E+00	6.70E-04	1.02E-02	1.89E-03	2.81E-03	3.77E-04	0.00E+00	7.03E-03	-5.70E-02
Caption	PERE = Use of renewable primary energy excluding the renewable primary energy resource 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 the non-renewable primary energy resources used as raw materials; PENRM = Use of non-renewable primary energy used 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 23: Output flows and waste categories for 1-tonne Channel

Parameter	Unit	A1	A2	A3	A4	A5	C2	C3	C4	D
HWD	kg	4.25E-06	4.34E-09	2.97E-06	1.27E-08	2.56E-09	2.53E-09	0.00E+00	3.28E-08	-3.26E-05
NHWD	kg	5.53E+01	1.03E-03	-7.39E-03	2.96E-03	-1.20E-04	5.92E-04	0.00E+00	1.49E+02	2.99E+00
RWD	kg	-2.47E-03	1.77E-05	6.53E-04	4.93E-05	6.93E-04	9.86E-06	0.00E+00	2.98E-04	-2.25E-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	0.00E+00
MFR	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.23E+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	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	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	0.00E+00
Caption	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 24: Additional Environmental parameters for 1-tonne Channel

Parameter	Unit	A1	A2	A3	A4	A5	C2	C3	C4	D
PM	Disease incidences	1.09E-05	3.59E-07	2.66E-05	9.63E-07	1.69E-08	1.93E-07	0.00E+00	2.18E-07	-1.10E-06
IR	kBq U235 eq.	-2.89E-01	1.68E-03	1.91E-02	4.69E-03	1.13E-01	9.38E-04	0.00E+00	2.68E-02	5.28E-01
ETF-fw	CTUe	9.93E+02	2.76E+01	2.78E+01	8.19E+01	2.10E+00	1.64E+01	0.00E+00	4.94E+01	-7.58E+00
HTP-c	CTUh	1.23E-07	4.68E-10	1.77E-08	1.40E-09	1.46E-10	2.81E-10	0.00E+00	2.48E-09	8.35E-09
HTP-nc	CTUh	8.57E-07	1.96E-08	1.48E-07	6.87E-08	1.86E-08	1.37E-08	0.00E+00	2.83E-07	-4.52E-07
SQP	Pt	-4.51E+01	3.68E-01	4.31E+00	1.02E+00	1.59E+00	2.05E-01	0.00E+00	3.88E+00	5.20E+00
Caption	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									

4.7.4 Overall Cradle to gate with Option LCIA results for 1- tonne Square bar

The LCIA result for 1 tonne of Square bar manufactured at BSRM Chittagong plant with the system boundary of Cradle-to-Gate with options have been as given in Table 25 to Table 28 .

Table 25: Environmental impacts for 1-tonne Square bar

Parameter	Unit	A1	A2	A3	A4	A5	C2	C3	C4	D
GWP - total	kg CO_2 eq.	7.44E+02	5.98E+00	1.03E+02	1.79E+01	4.00E-01	3.57E+00	0.00E+00	8.95E+00	-3.26E+01
GWP - fossil	kg CO_2 eq.	7.44E+02	5.75E+00	1.03E+02	1.71E+01	3.99E-01	3.42E+00	0.00E+00	2.38E+00	-3.26E+01
GWP - biogenic	kg CO_2 eq.	8.96E-02	2.31E-01	1.58E-01	7.31E-01	9.82E-04	1.46E-01	0.00E+00	6.58E+00	-4.54E-02

GWP - luluc	kg CO_2 eq.	-6.84E-02	3.27E-04	2.87E-03	9.23E-04	3.91E-04	1.85E-04	0.00E+00	1.11E-03	-4.48E-04
ODP	kg CFC-11 eq.	1.11E-08	3.16E-16	1.21E-14	8.85E-16	5.68E-15	1.77E-16	0.00E+00	8.51E-15	6.23E-14
AP	Mole of H+ eq.	1.91E+00	4.68E-02	5.00E+00	1.48E-01	1.35E-03	2.97E-02	0.00E+00	1.78E-02	-7.41E-02
EP - freshwater	kg P eq.	9.46E-05	1.24E-06	5.54E-06	3.76E-06	7.30E-07	7.52E-07	0.00E+00	1.14E-05	-2.00E-05
EP - marine	kg N eq.	5.60E-01	1.79E-02	7.89E-01	6.91E-02	2.72E-04	1.38E-02	0.00E+00	4.65E-03	-1.37E-02
EP - terrestrial	Mole of N eq.	6.12E+00	1.96E-01	8.64E+00	7.58E-01	2.92E-03	1.52E-01	0.00E+00	5.09E-02	-1.40E-01
POCP	kg NMVOC eq.	1.62E+00	3.82E-02	2.27E+00	1.31E-01	1.09E-03	2.63E-02	0.00E+00	1.61E-02	-5.56E-02
ADPE	kg Sb eq.	2.50E-05	6.21E-08	4.17E-05	1.85E-07	1.00E-07	3.69E-08	0.00E+00	1.66E-07	-4.81E-04
ADPF	MJ	1.28E+04	7.93E+01	1.47E+03	2.37E+02	5.93E+00	4.75E+01	0.00E+00	3.00E+01	-2.79E+02
WDP	m^3 world equiv.	8.74E+01	1.93E-02	2.62E-01	5.50E-02	7.64E-02	1.10E-02	0.00E+00	2.37E-01	-2.18E+00
Caption	GWP - total = global warming potential; GWP - fossil = global warming potential (fossil fuel only); GWP - biogenic = global warming potential (biogenic); GWP - luluc = global warming potential (land use only); ODP = ozone depletion; AP = acidification terrestrial and freshwater; EP - freshwater = eutrophication potential (freshwater); EP - marine = eutrophication potential (marine); EP- terrestric = eutrophication potential (terrestrial); POCP = photochemical ozone formation; ADPE = abiotic depletion potential (element), ADPF = abiotic depletion potential (fossil) WDP = water scarcity.									

Table 26: Parameters describing resource use for 1-tonne Square bar

Parameter	Unit	A1	A2	A3	A4	A5	C2	C3	C4	D
PERE	MJ	-4.89E-01	2.96E-01	2.95E+00	8.48E-01	2.03E+00	1.70E-01	0.00E+00	3.45E+00	1.86E+01
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	0.00E+00
PERT	MJ	-4.89E-01	2.96E-01	2.95E+00	8.48E-01	2.03E+00	1.70E-01	0.00E+00	3.45E+00	1.86E+01
PENRE	MJ	1.28E+04	7.93E+01	1.47E+03	2.37E+02	5.94E+00	4.75E+01	0.00E+00	3.00E+01	-2.79E+02
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	0.00E+00
PENRT	MJ	1.28E+04	7.93E+01	1.47E+03	2.37E+02	5.94E+00	4.75E+01	0.00E+00	3.00E+01	-2.79E+02
SM	kg	9.77E+02	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	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	0.00E+00
FW	m^3	2.92E+00	8.58E-04	1.01E-02	1.89E-03	2.81E-03	3.77E-04	0.00E+00	7.03E-03	-5.70E-02
Caption	PERE = Use of renewable primary energy excluding the renewable primary energy resource 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 the non-renewable primary energy resources used as raw materials; PENRM = Use of non-renewable primary energy used 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 27: Output flows and waste categories for 1-tonne Square bar

Parameter	Unit	A1	A2	A3	A4	A5	C2	C3	C4	D
HWD	kg	4.22E-06	4.29E-09	2.95E-06	1.27E-08	2.56E-09	2.53E-09	0.00E+00	3.28E-08	-3.26E-05
NHWD	kg	5.48E+01	1.02E-03	-1.76E-02	2.96E-03	-1.20E-04	5.92E-04	0.00E+00	1.49E+02	2.99E+00
RWD	kg	-2.44E-03	1.76E-05	6.49E-04	4.93E-05	6.93E-04	9.86E-06	0.00E+00	2.98E-04	-2.26E-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	0.00E+00
MFR	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.23E+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	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	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	0.00E+00
Caption	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 28: Additional Environmental parameters for 1-tonne Square bar

Para-meter	Unit	A1	A2	A3	A4	A5	C2	C3	C4	D
PM	Disease incidences	1.09E-05	3.56E-07	2.62E-05	9.63E-07	1.69E-08	1.93E-07	0.00E+00	2.18E-07	-1.10E-06
IR	kBq U235 eq.	-2.86E-01	1.67E-03	1.85E-02	4.69E-03	1.13E-01	9.38E-04	0.00E+00	2.68E-02	5.28E-01
ETF-fw	CTUe	9.86E+02	2.73E+01	2.69E+01	8.19E+01	2.10E+00	1.64E+01	0.00E+00	4.94E+01	-7.58E+00

HTP-c	CTUh	1.23E-07	4.63E-10	1.70E-08	1.40E-09	1.46E-10	2.81E-10	0.00E+00	2.48E-09	8.35E-09
HTP-nc	CTUh	8.53E-07	1.94E-08	1.45E-07	6.87E-08	1.86E-08	1.37E-08	0.00E+00	2.83E-07	-4.52E-07
SQP	Pt	-4.46E+01	3.64E-01	4.25E+00	1.02E+00	1.59E+00	2.05E-01	0.00E+00	3.88E+00	5.20E+00
Caption	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									

4.7.5 Overall Cradle to gate with Option LCIA results for 1- tonne Ribbed wire

The LCIA result for 1 tonne of Ribbed wire manufactured at BSRM Chittagong plant with the system boundary of Cradle-to-Gate with options have been as given in Table 29 to Table 32 .

Table 29: Environmental impacts for 1-tonne Ribbed wire

Parameter	Unit	A1	A2	A3	A4	A5	C2	C3	C4	D
GWP - total	kg CO_2 eq.	7.70E+02	6.07E+00	9.87E+01	1.79E+01	4.05E-01	3.57E+00	0.00E+00	8.95E+00	-3.27E+01
GWP - fossil	kg CO_2 eq.	7.70E+02	5.83E+00	9.86E+01	1.71E+01	4.04E-01	3.42E+00	0.00E+00	2.38E+00	-3.26E+01
GWP - biogenic	kg CO_2 eq.	9.11E-02	2.34E-01	1.62E-01	7.31E-01	9.94E-04	1.46E-01	0.00E+00	6.58E+00	-4.54E-02
GWP - luluc	kg CO_2 eq.	-6.90E-02	3.32E-04	2.81E-03	9.23E-04	3.95E-04	1.85E-04	0.00E+00	1.11E-03	-4.64E-04
ODP	kg CFC-11 eq.	1.13E-08	3.21E-16	1.21E-14	8.85E-16	5.75E-15	1.77E-16	0.00E+00	8.51E-15	6.22E-14
AP	Mole of H+ eq.	2.01E+00	4.75E-02	5.06E+00	1.48E-01	1.36E-03	2.97E-02	0.00E+00	1.78E-02	-7.42E-02
EP - freshwater	kg P eq.	9.65E-05	1.26E-06	5.52E-06	3.76E-06	7.39E-07	7.52E-07	0.00E+00	1.14E-05	-2.00E-05
EP - marine	kg N eq.	5.83E-01	1.81E-02	7.95E-01	6.91E-02	2.75E-04	1.38E-02	0.00E+00	4.65E-03	-1.37E-02
EP - terrestrial	Mole of N eq.	6.38E+00	1.99E-01	8.71E+00	7.58E-01	2.95E-03	1.52E-01	0.00E+00	5.09E-02	-1.40E-01

POCP	kg NMVOC eq.	1.69E+00	3.87E-02	2.29E+00	1.31E-01	1.11E-03	2.63E-02	0.00E+00	1.61E-02	-5.56E-02
ADPE	kg Sb eq.	2.59E-05	6.30E-08	4.20E-05	1.85E-07	1.02E-07	3.69E-08	0.00E+00	1.66E-07	-4.81E-04
ADPF	MJ	1.32E+04	8.04E+01	1.40E+03	2.37E+02	6.00E+00	4.75E+01	0.00E+00	3.00E+01	-2.80E+02
WDP	m^3 world equiv.	8.99E+01	1.96E-02	2.61E-01	5.50E-02	7.73E-02	1.10E-02	0.00E+00	2.37E-01	-2.18E+00
Caption	GWP - total = global warming potential; GWP - fossil = global warming potential (fossil fuel only); GWP - biogenic = global warming potential (biogenic); GWP - luluc = global warming potential (land use only); ODP = ozone depletion; AP = acidification terrestrial and freshwater; EP - freshwater = eutrophication potential (freshwater); EP - marine = eutrophication potential (marine); EP- terrestric = eutrophication potential (terrestrial); POCP = photochemical ozone formation; ADPE = abiotic depletion potential (element), ADPF = abiotic depletion potential (fossil) WDP = water scarcity.									

Table 30: Parameters describing resource use for 1-tonne Ribbed wire

Parameter	Unit	A1	A2	A3	A4	A5	C2	C3	C4	D
PERE	MJ	1.53E+00	3.00E-01	2.93E+00	8.48E-01	2.06E+00	1.70E-01	0.00E+00	3.45E+00	1.86E+01
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	0.00E+00
PERT	MJ	1.53E+00	3.00E-01	2.93E+00	8.48E-01	2.06E+00	1.70E-01	0.00E+00	3.45E+00	1.86E+01
PENRE	MJ	1.32E+04	8.04E+01	1.40E+03	2.37E+02	6.01E+00	4.75E+01	0.00E+00	3.00E+01	-2.80E+02
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	0.00E+00
PENRT	MJ	1.32E+04	8.04E+01	1.40E+03	2.37E+02	6.01E+00	4.75E+01	0.00E+00	3.00E+01	-2.80E+02
SM	kg	9.91E+02	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	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	0.00E+00
FW	m^3	3.00E+00	6.73E-04	1.01E-02	1.89E-03	2.85E-03	3.77E-04	0.00E+00	7.03E-03	-5.70E-02
Caption	PERE = Use of renewable primary energy excluding the renewable primary energy resource 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 the non-renewable primary energy resources used as raw materials; PENRM = Use of non-renewable primary energy used 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 31: Output flows and waste categories for 1-tonne Ribbed wire

Parameter	Unit	A1	A2	A3	A4	A5	C2	C3	C4	D
HWD	kg	4.33E-06	4.36E-09	2.97E-06	1.27E-08	2.59E-09	2.53E-09	0.00E+00	3.28E-08	-3.26E-05
NHWD	kg	5.56E+01	1.04E-03	-3.14E-02	2.96E-03	-1.22E-04	5.92E-04	0.00E+00	1.49E+02	2.98E+00
RWD	kg	-2.46E-03	1.78E-05	6.50E-04	4.93E-05	7.02E-04	9.86E-06	0.00E+00	2.98E-04	-2.28E-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	0.00E+00
MFR	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.24E+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	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	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	0.00E+00
Caption	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 32: Additional Environmental parameters for 1-tonne Ribbed wire

Parameter	Unit	A1	A2	A3	A4	A5	C2	C3	C4	D
PM	Disease incidences	1.17E-05	3.61E-07	2.66E-05	9.63E-07	1.71E-08	1.93E-07	0.00E+00	2.18E-07	-1.10E-06
IR	kBq U235 eq.	-2.87E-01	1.69E-03	1.80E-02	4.69E-03	1.14E-01	9.38E-04	0.00E+00	2.68E-02	5.28E-01
ETF-fw	CTUe	1.02E+03	2.77E+01	2.62E+01	8.19E+01	2.13E+00	1.64E+01	0.00E+00	4.94E+01	-7.65E+00
HTP-c	CTUh	1.28E-07	4.70E-10	1.61E-08	1.40E-09	1.48E-10	2.81E-10	0.00E+00	2.48E-09	8.34E-09
HTP-nc	CTUh	8.92E-07	1.96E-08	1.42E-07	6.87E-08	1.88E-08	1.37E-08	0.00E+00	2.83E-07	-4.54E-07
SQP	Pt	-4.48E+01	3.70E-01	4.22E+00	1.02E+00	1.61E+00	2.05E-01	0.00E+00	3.88E+00	5.18E+00
Caption	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									

4.7.6 Overall Cradle to gate with Option LCIA results for 1- tonne Epoxy coated bar

The LCIA result for 1 tonne of Epoxy coated bar manufactured at BSRM Chittagong plant with the system boundary of Cradle-to-Gate with options have been as given in Table 33 to Table 36.

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Table 33: Environmental impacts for 1-tonne Epoxy coated bar

Parameter	Unit	A1	A2	A3	A4	A5	C2	C3	C4	D
GWP - total	kg CO_2 eq.	1.21E+03	5.97E+00	9.71E+01	1.79E+01	3.98E-01	3.57E+00	0.00E+00	8.95E+00	-3.26E+01
GWP - fossil	kg CO_2 eq.	1.21E+03	5.74E+00	9.69E+01	1.71E+01	3.97E-01	3.42E+00	0.00E+00	2.38E+00	-3.26E+01
GWP - biogenic	kg CO_2 eq.	2.52E+00	2.30E-01	1.60E-01	7.31E-01	9.78E-04	1.46E-01	0.00E+00	6.58E+00	-4.54E-02
GWP - luluc	kg CO_2 eq.	2.68E-02	3.26E-04	2.76E-03	9.23E-04	3.89E-04	1.85E-04	0.00E+00	1.11E-03	-4.42E-04
ODP	kg CFC-11 eq.	1.11E-08	3.15E-16	1.19E-14	8.85E-16	5.65E-15	1.77E-16	0.00E+00	8.51E-15	6.23E-14
AP	Mole of H+ eq.	3.78E+00	4.67E-02	4.97E+00	1.48E-01	1.34E-03	2.97E-02	0.00E+00	1.78E-02	-7.41E-02
EP - freshwater	kg P eq.	6.48E-04	1.24E-06	5.43E-06	3.76E-06	7.26E-07	7.52E-07	0.00E+00	1.14E-05	-2.00E-05
EP - marine	kg N eq.	9.81E-01	1.78E-02	7.82E-01	6.91E-02	2.71E-04	1.38E-02	0.00E+00	4.65E-03	-1.37E-02
EP - terrestrial	Mole of N eq.	1.07E+01	1.96E-01	8.56E+00	7.58E-01	2.91E-03	1.52E-01	0.00E+00	5.09E-02	-1.40E-01
POCP	kg NMVOC eq.	2.88E+00	3.81E-02	2.25E+00	1.31E-01	1.09E-03	2.63E-02	0.00E+00	1.61E-02	-5.55E-02
ADPE	kg Sb eq.	4.90E-05	6.20E-08	4.13E-05	1.85E-07	9.99E-08	3.69E-08	0.00E+00	1.66E-07	-4.81E-04
ADPF	MJ	2.04E+04	7.91E+01	1.38E+03	2.37E+02	5.91E+00	4.75E+01	0.00E+00	3.00E+01	-2.79E+02
WDP	m^3 world equiv.	1.23E+02	1.93E-02	2.56E-01	5.50E-02	7.60E-02	1.10E-02	0.00E+00	2.37E-01	-2.18E+00
Caption	GWP - total = global warming potential; GWP - fossil = global warming potential (fossil fuel only); GWP - biogenic = global warming potential (biogenic); GWP - luluc = global warming potential (land use only); ODP = ozone depletion; AP = acidification terrestrial and freshwater; EP - freshwater = eutrophication potential (freshwater); EP - marine = eutrophication potential (marine); EP- terrestric = eutrophication potential (terrestrial); POCP = photochemical ozone formation; ADPE = abiotic depletion potential (element), ADPF = abiotic depletion potential (fossil) WDP = water scarcity.									

Table 34: Parameters describing resource use for 1-tonne Epoxy coated bar

Parameter	Unit	A1	A2	A3	A4	A5	C2	C3	C4	D
PERE	MJ	2.01E+02	2.95E-01	2.88E+00	8.48E-01	2.02E+00	1.70E-01	0.00E+00	3.45E+00	1.86E+01
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	0.00E+00
PERT	MJ	2.01E+02	2.95E-01	2.88E+00	8.48E-01	2.02E+00	1.70E-01	0.00E+00	3.45E+00	1.86E+01
PENRE	MJ	2.04E+04	7.91E+01	1.38E+03	2.37E+02	5.91E+00	4.75E+01	0.00E+00	3.00E+01	-2.79E+02
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	0.00E+00
PENRT	MJ	2.04E+04	7.91E+01	1.38E+03	2.37E+02	5.91E+00	4.75E+01	0.00E+00	3.00E+01	-2.79E+02
SM	kg	9.75E+02	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	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	0.00E+00
FW	m^3	4.20E+00	6.62E-04	9.90E-03	1.89E-03	2.80E-03	3.77E-04	0.00E+00	7.03E-03	-5.70E-02
Caption	PERE = Use of renewable primary energy excluding the renewable primary energy resource 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 the non-renewable primary energy resources used as raw materials; PENRM = Use of non-renewable primary energy used 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 35: Output flows and waste categories for 1-tonne Epoxy coated bar

Parameter	Unit	A1	A2	A3	A4	A5	C2	C3	C4	D
HWD	kg	6.90E-06	4.28E-09	2.92E-06	1.27E-08	2.54E-09	2.53E-09	0.00E+00	3.28E-08	-3.26E-05
NHWD	kg	5.65E+01	1.02E-03	-3.09E-02	2.96E-03	-1.20E-04	5.92E-04	0.00E+00	1.49E+02	2.99E+00
RWD	kg	2.20E-02	1.75E-05	6.40E-04	4.93E-05	6.90E-04	9.86E-06	0.00E+00	2.98E-04	-2.24E-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	0.00E+00
MFR	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.22E+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	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	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	0.00E+00
Caption	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 36: Additional Environmental parameters for 1-tonne Epoxy coated bar

Parameter	Unit	A1	A2	A3	A4	A5	C2	C3	C4	D
PM	Disease incidences	2.91E-05	3.55E-07	2.61E-05	9.63E-07	1.68E-08	1.93E-07	0.00E+00	2.18E-07	-1.10E-06
IR	kBq U235 eq.	2.31E+00	1.66E-03	1.77E-02	4.69E-03	1.13E-01	9.38E-04	0.00E+00	2.68E-02	5.28E-01
ETF-fw	CTUe	2.36E+03	2.72E+01	2.58E+01	8.19E+01	2.09E+00	1.64E+01	0.00E+00	4.94E+01	-7.55E+00
HTP-c	CTUh	2.46E-07	4.62E-10	1.58E-08	1.40E-09	1.46E-10	2.81E-10	0.00E+00	2.48E-09	8.36E-09
HTP-nc	CTUh	5.92E-06	1.93E-08	1.40E-07	6.87E-08	1.85E-08	1.37E-08	0.00E+00	2.83E-07	-4.51E-07
SQP	Pt	1.28E+02	3.63E-01	4.15E+00	1.02E+00	1.58E+00	2.05E-01	0.00E+00	3.88E+00	5.21E+00
Caption	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									

4.7.7 Overall Cradle to gate with Option LCIA results for 1- tonne Cut & Bends

The LCIA result for 1 tonne of Cut & Bends manufactured at BSRM Chittagong plant with the system boundary of Cradle-to-Gate with options have been as given in Table 37 to Table 40 .

Table 37: Environmental impacts for 1-tonne Cut & Bends

Parameter	Unit	A1	A2	A3	A4	A5	C2	C3	C4	D
GWP - total	kg CO_2 eq.	9.64E+02	7.33E+00	1.19E+02	1.79E+01	4.89E-01	3.57E+00	0.00E+00	8.95E+00	-3.33E+01
GWP - fossil	kg CO_2 eq.	9.63E+02	7.05E+00	1.19E+02	1.71E+01	4.88E-01	3.42E+00	0.00E+00	2.38E+00	-3.33E+01
GWP - biogenic	kg CO_2 eq.	1.14E-01	2.83E-01	1.96E-01	7.31E-01	1.20E-03	1.46E-01	0.00E+00	6.58E+00	-4.61E-02
GWP - luluc	kg CO_2 eq.	-8.04E-02	4.01E-04	3.39E-03	9.23E-04	4.78E-04	1.85E-04	0.00E+00	1.11E-03	-7.37E-04

ODP	kg CFC-11 eq.	1.36E-08	3.88E-16	1.47E-14	8.85E-16	6.95E-15	1.77E-16	0.00E+00	8.51E-15	6.17E-14
AP	Mole of H+ eq.	2.57E+00	5.74E-02	6.11E+00	1.48E-01	1.65E-03	2.97E-02	0.00E+00	1.78E-02	-7.60E-02
EP - freshwater	kg P eq.	1.21E-04	1.52E-06	6.67E-06	3.76E-06	8.93E-07	7.52E-07	0.00E+00	1.14E-05	-2.07E-05
EP - marine	kg N eq.	7.39E-01	2.19E-02	9.61E-01	6.91E-02	3.33E-04	1.38E-02	0.00E+00	4.65E-03	-1.41E-02
EP - terrestrial	Mole of N eq.	8.07E+00	2.40E-01	1.05E+01	7.58E-01	3.57E-03	1.52E-01	0.00E+00	5.09E-02	-1.44E-01
POCP	kg NMVOC eq.	2.14E+00	4.68E-02	2.76E+00	1.31E-01	1.34E-03	2.63E-02	0.00E+00	1.61E-02	-5.69E-02
ADPE	kg Sb eq.	3.25E-05	7.62E-08	5.08E-05	1.85E-07	1.23E-07	3.69E-08	0.00E+00	1.66E-07	-4.81E-04
ADPF	MJ	1.66E+04	9.72E+01	1.69E+03	2.37E+02	7.26E+00	4.75E+01	0.00E+00	3.00E+01	-2.85E+02
WDP	m^3 world equiv.	1.12E+02	2.37E-02	3.15E-01	5.50E-02	9.34E-02	1.10E-02	0.00E+00	2.37E-01	-2.17E+00
Caption	GWP - total = global warming potential; GWP - fossil = global warming potential (fossil fuel only); GWP - biogenic = global warming potential (biogenic); GWP - luluc = global warming potential (land use only); ODP = ozone depletion; AP = acidification terrestrial and freshwater; EP - freshwater = eutrophication potential (freshwater); EP - marine = eutrophication potential (marine); EP- terrestric = eutrophication potential (terrestrial); POCP = photochemical ozone formation; ADPE = abiotic depletion potential (element), ADPF = abiotic depletion potential (fossil) WDP = water scarcity.									

Table 38: Parameters describing resource use for 1-tonne Cut & Bends

Parameter	Unit	A1	A2	A3	A4	A5	C2	C3	C4	D
PERE	MJ	7.45E+00	3.63E-01	3.54E+00	8.48E-01	2.48E+00	1.70E-01	0.00E+00	3.45E+00	1.83E+01
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	0.00E+00
PERT	MJ	7.45E+00	3.63E-01	3.54E+00	8.48E-01	2.48E+00	1.70E-01	0.00E+00	3.45E+00	1.83E+01
PENRE	MJ	1.66E+04	9.72E+01	1.69E+03	2.37E+02	7.26E+00	4.75E+01	0.00E+00	3.00E+01	-2.85E+02
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	0.00E+00
PENRT	MJ	1.66E+04	9.72E+01	1.69E+03	2.37E+02	7.26E+00	4.75E+01	0.00E+00	3.00E+01	-2.85E+02
SM	MJ	1.20E+03	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	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	0.00E+00
FW	m^3	3.73E+00	8.14E-04	1.22E-02	1.89E-03	3.44E-03	3.77E-04	0.00E+00	7.03E-03	-5.81E-02
Caption	PERE = Use of renewable primary energy excluding the renewable primary energy resource 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 the non-renewable primary energy resources used as raw materials; PENRM = Use of non-renewable primary energy used 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 39: Output flows and waste categories for 1-tonne Cut & Bends

Parameter	Unit	A1	A2	A3	A4	A5	C2	C3	C4	D
HWD	kg	5.36E-06	5.27E-09	3.59E-06	1.27E-08	3.13E-09	2.53E-09	0.00E+00	3.28E-08	-3.26E-05
NHWD	kg	6.73E+01	1.25E-03	-3.80E-02	2.96E-03	-1.47E-04	5.92E-04	0.00E+00	1.49E+02	2.97E+00
RWD	kg	-2.80E-03	2.15E-05	7.86E-04	4.93E-05	8.48E-04	9.86E-06	0.00E+00	2.98E-04	-2.78E-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	0.00E+00
MFR	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.50E+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	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	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	0.00E+00
Caption	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 40: Additional Environmental parameters for 1-tonne Cut & Bends

Parameter	Unit	A1	A2	A3	A4	A5	C2	C3	C4	D
PM	Disease incidences	1.56E-05	4.36E-07	3.21E-05	9.63E-07	2.07E-08	1.93E-07	0.00E+00	2.18E-07	-1.12E-06
IR	kBq U235 eq.	-3.29E-01	2.05E-03	2.17E-02	4.69E-03	1.38E-01	9.38E-04	0.00E+00	2.68E-02	5.23E-01
ETF-fw	CTUe	1.29E+03	3.35E+01	3.17E+01	8.19E+01	2.57E+00	1.64E+01	0.00E+00	4.94E+01	-8.93E+00
HTP-c	CTUh	1.62E-07	5.68E-10	1.94E-08	1.40E-09	1.79E-10	2.81E-10	0.00E+00	2.48E-09	8.19E-09

HTP-nc	CTUh	1.15E-06	2.38E-08	1.72E-07	6.87E-08	2.27E-08	1.37E-08	0.00E+00	2.83E-07	-4.84E-07
SQP	Pt	-5.08E+01	4.47E-01	5.10E+00	1.02E+00	1.94E+00	2.05E-01	0.00E+00	3.88E+00	4.83E+00
Caption	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 estimated impact results are only relative statements which do not indicate the end points of impact categories, exceeding threshold values, safety margins or risks. The interpretation of the results for 1-tonne Structural steel products (Rebar, Angle, Channel, Square bar, Ribbed wire, Epoxy coated bar and Cut & Bends have been presented in Table 41 to Table 47 .

Table 41. Interpretation of most significant contributors to life cycle parameters (Rebar)

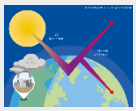
Parameter	Most significant contributor
Abiotic Depletion Potential (ADP) - Elements 	The total cradle to gate impact is 6.63E-05 kg Sb-eq. The highest contribution is from the module A3 (62.63%) followed by Module A1 (37.28%). In the module A3 the highest contribution is from the wire rod (packaging material) (93%). In module A1 the highest contribution is from Electricity (81%) followed by DRI (13%). There is a credit of 4.81E-04 kg Sb-eq. from the module D.
Acidification Potential (AP) 	The total cradle to gate impact is 6.92E+00 Mole of H+ eq. The highest contribution is from module A3 (72.29%) followed by module A1 (27.03%). In module A3 the highest contribution is from process emission from Induction furnace process (96%). There is a credit of 7.41E-02 Mole of H+ eq. from module D.
Eutrophication Potential (EP) 	The total cradle to gate impact is 1.01E-04 kg P eq. The highest contribution is from module A1 (93.37%) followed by module A3 (5.40%). In module A1 the highest contribution is from Deionised water (77%) followed by Electricity (22%). There is a credit of 2.00E-05 kg P eq. from module D.
Global Warming Potential (GWP 100 years) 	The total cradle to gate impact is 8.40E+02 kg CO_2 eq. The highest contribution is from module A1 (87.66%) followed by module A3 (11.62%). In module A1 the highest contribution is from Electricity (78%) followed by DRI (15%), Lime (3.53%) and Ferro silicon (2.46%). There is a credit of 3.26E+01 kg CO2eq. from module D.
Ozone Layer Depletion Potential (ODP, steady state) 	The total cradle to gate impact is 1.11E-08 kg CFC11-eq. with highest contribution is from module A1 (100%). In module A1 the highest contribution is from Electrodes (100%). There is an impact of 6.23E-14 kg CFC11-eq. from module D.
Photochemical Ozone Creation Potential (POCP) 	The total cradle to gate impact is 3.90 E+00 kg NMVOC eq. The highest contribution is from module A3 (57.97%) followed by module A1 (41.04%). In the module A3 the highest contribution from the process emission from Induction furnace process (88%). In the module A1 the highest contribution from the Electricity (105%) with a credit of 10 % from DRI. There is credit of 5.56E-02 kg NMVOC eq. from module D.
Abiotic depletion potential (ADP) - Fossil 	The total cradle to gate impact is 1.42E+04 MJ. The highest contribution is from the module A1 (89.63%) followed by Module A3 (9.81%). In module A1 the highest contribution is from Electricity (72%) followed by DRI (24%). There is a credit of 2.79E+02 from module D.

Table 42: Interpretation of most significant contributors to life cycle parameters (Angle)

Parameter	Most significant contributor
Abiotic Depletion Potential (ADP) - Elements 	The total cradle to gate impact is 6.70E-05 kg Sb-eq. The highest contribution is from the module A3 (61.83%) followed by Module A1 (38.08%). In the module A3 the highest contribution is from wire rod (packaging material) (93%). In module A1 the highest contribution is from Electricity (81%) followed by DRI (12%). There is a credit of 4.81E-04 kg Sb-eq. from the module D.
Acidification Potential (AP) 	The total cradle to gate impact is 7.01E+00 Mole of H+ eq. The highest contribution is from module A3 (71.21%) followed by module A1 (28.11%). In module A3 the highest contribution is from process emission from Induction furnace process (96%). There is a credit of 7.41E-02 Mole of H+ eq. from module D.
Eutrophication Potential (EP) 	The total cradle to gate impact is 1.02E-04 kg P eq. The highest contribution is from module A1 (93.47%). In module A1 the highest contribution is from Deionised water (76%) followed by Electricity (23%). There is a credit of 2.00E-05 kg P eq. from module D.
Global Warming Potential (GWP 100 years) 	The total cradle to gate impact is 8.60E+02 kg CO_2 eq. The highest contribution is from module A1 (88.31%) followed by module A3 (10.99%). In module A1 the highest contribution is from Electricity (78%) followed by DRI (15%), Lime (3.43%) and Ferro silicon (2.38%). There is a credit of 3.26E+01 kg CO2eq. from module D.
Ozone Layer Depletion Potential (ODP, steady state) 	The total cradle to gate impact is 1.12E-08 kg CFC11-eq. with highest contribution is from module A1 (100%). In module A1 the highest contribution is from Electrodes (100%). There is an impact of 6.23E-14 kg CFC11-eq. from module D.
Photochemical Ozone Creation Potential (POCP) 	The total cradle to gate impact is 3.96 E+00 kg NMVOC eq. The highest contribution is from module A3 (56.84%) followed by module A1 (42.19%). In the module A3 the highest contribution from the process emission from Induction furnace process (88%). In the module A1 the highest contribution from the Electricity (105%) with a credit of 10 % from DRI. There is credit of 5.56E-02 kg NMVOC eq. from module D.
Abiotic depletion potential (ADP) - Fossil 	The total cradle to gate impact is 1.44E+04 MJ. The highest contribution is from the module A1 (90.22%) followed by Module A3 (9.23%). In module A1 the highest contribution is from Electricity (73%) followed by DRI (24%). There is a credit of 2.79E+02 from module D.

Table 43: Interpretation of most significant contributors to life cycle parameters (Channel)

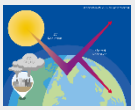
Parameter	Most significant contributor
Abiotic Depletion Potential (ADP) - Elements 	The total cradle to gate impact is 6.71E-05 kg Sb-eq. The highest contribution is from the module A3 (62.48%) followed by Module A1 (37.43%). In module A3 the highest contribution is from Wire rod (packaging material) (92%). In module A1 the highest contribution is from Electricity (81%) followed by DRI (12%). There is a credit of 4.81E-04 kg Sb-eq. from the module D.
Acidification Potential (AP) 	The total cradle to gate impact is 7.02E+00 Mole of H+ eq. The highest contribution is from module A3 (71.97%) followed by module A1 (27.36%). In module A3 the highest contribution is from process emission from Induction furnace process (95%). There is a credit of 7.41E-02 Mole of H+ eq. from module D.
Eutrophication Potential (EP) 	The total cradle to gate impact is 1.02E-04 kg P eq. The highest contribution is from module A1 (93.29%) followed by module A3 (5.49%). In module A1 the highest contribution is from Deionised water (77%) followed by Electricity (22%). There is a credit of 2.00E-05 kg P eq. from module D.
Global Warming Potential (GWP 100 years) 	The total cradle to gate impact is 8.62E+02 kg CO_2 eq. The highest contribution is from module A1 (86.89%) followed by module A3 (12.41%). In module A1 the highest contribution is from Electricity (78%) followed by DRI (15%), Lime (3.49%) and Ferro silicon (2.43%). There is a credit of 3.26E+01 kg CO2eq. from module D.
Ozone Layer Depletion Potential (ODP, steady state) 	The total cradle to gate impact is 1.12E-08 kg CFC11-eq. with highest contribution is from module A1 (100%). In module A1 the highest contribution is from Electrodes (100%). There is an impact of 6.23E-14 kg CFC11-eq. from module D.
Photochemical Ozone Creation Potential (POCP) 	The total cradle to gate impact is 3.97 E+00 kg NMVOC eq. The highest contribution is from module A3 (57.96%) followed by module A1 (41.07%). In the module A3 the highest contribution from the process emission from Induction furnace process (87%). In the module A1 the highest contribution from the Electricity (106%) with a credit of 10 % from DRI. There is credit of 5.56E-02 kg NMVOC eq. from module D.
Abiotic depletion potential (ADP) - Fossil 	The total cradle to gate impact is 1.45E+04 MJ. The highest contribution is from the module A1 (88.84%) followed by Module A3 (10.61%). In module A1 the highest contribution is from Electricity (72%) followed by DRI (24%). There is a credit of 2.79E+02 from module D.

Table 44: Interpretation of most significant contributors to life cycle parameters (Square bar)

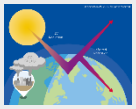
Parameter	Most significant contributor
Abiotic Depletion Potential (ADP) - Elements 	The total cradle to gate impact is 6.68E-05 kg Sb-eq. The highest contribution is from the module A3 (62.46%) followed by Module A1 (37.45%). In module A3 the highest contribution is from wire rod (packaging material) (93%). In module A1 the highest contribution is from Electricity (81%) followed by DRI (12%). There is a credit of 4.81E-04 kg Sb-eq. from the module D.
Acidification Potential (AP) 	The total cradle to gate impact is 6.96E+00 Mole of H+ eq. The highest contribution is from module A3 (71.87%) followed by module A1 (27.46%). In module A3 the highest contribution is from process emission from Induction furnace process (96%). There is a credit of 7.41E-02 Mole of H+ eq. from module D.
Eutrophication Potential (EP) 	The total cradle to gate impact is 1.01E-04 kg P eq. The highest contribution is from module A1 (93.31%) followed by module A3 (5.46%). In module A1 the highest contribution is from Deionised water (77%) followed by Electricity (23%). There is a credit of 2.00E-05 kg P eq. from module D.
Global Warming Potential (GWP 100 years) 	The total cradle to gate impact is 8.53E+02 kg CO_2 eq. The highest contribution is from module A1 (87.22%) followed by module A3 (12.08%). In module A1 the highest contribution is from Electricity (78%) followed by DRI (15%), Lime (3.48%) and Ferro silicon (2.42%). There is a credit of 3.26E+01 kg CO2eq. from module D.
Ozone Layer Depletion Potential (ODP, steady state) 	The total cradle to gate impact is 1.11E-08 kg CFC11-eq. with highest contribution is from module A1 (100%). In module A1 the highest contribution is from Electrodes (100%). There is an impact of 6.23E-14 kg CFC11-eq. from module D.
Photochemical Ozone Creation Potential (POCP) 	The total cradle to gate impact is 3.93 E+00 kg NMVOC eq. The highest contribution is from module A3 (57.79%) followed by module A1 (41.24%). In the module A3 the highest contribution from the process emission from Induction furnace process (87%). In the module A1 the highest contribution from the Electricity (106%) with a credit of 10 % from DRI. There is credit of 5.56E-02 kg NMVOC eq. from module D.
Abiotic depletion potential (ADP) - Fossil 	The total cradle to gate impact is 1.43E+04 MJ. The highest contribution is from the module A1 (89.20%) followed by Module A3 (10.24%). In module A1 the highest contribution is from Electricity (72%) followed by DRI (24%). There is a credit of 2.79E+02 from module D.

Table 45: Interpretation of most significant contributors to life cycle parameters (Ribbed wire)

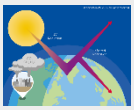
Parameter	Most significant contributor
Abiotic Depletion Potential (ADP) - Elements 	The total cradle to gate impact is 6.80E-05 kg Sb-eq. The highest contribution is from the module A3 (61.80%) followed by Module A1 (38.11%). In module A3 the highest contribution is from wire rod (packaging material) (93%). In module A1 the highest contribution is from Electricity (81%) followed by DRI (12%). There is a credit of 4.81E-04 kg Sb-eq. from the module D.
Acidification Potential (AP) 	The total cradle to gate impact is 7.12E+00 Mole of H+ eq. The highest contribution is from module A3 (71.09%) followed by module A1 (28.24%). In module A3 the highest contribution is from process emission from the Induction furnace process (96%). There is a credit of 7.42E-02 Mole of H+ eq. from module D.
Eutrophication Potential (EP) 	The total cradle to gate impact is 1.03E-04 kg P eq. The highest contribution is from module A1 (93.44%) followed by module A3 (5.34%). In module A1 the highest contribution is from Deionised water (76%) followed by Electricity (22%). There is a credit of 2.00E-05 kg P eq. from module D.
Global Warming Potential (GWP 100 years) 	The total cradle to gate impact is 8.75E+02 kg CO_2 eq. The highest contribution is from module A1 (88.02%) followed by module A3 (11.28%). In module A1 the highest contribution is from Electricity (78%) followed by DRI (15%), Lime (3.41%) and Ferro silicon (2.38%). There is a credit of 3.27E+01 kg CO2eq. from module D.
Ozone Layer Depletion Potential (ODP, steady state) 	The total cradle to gate impact is 1.13E-08 kg CFC11-eq. with highest contribution is from module A1 (100%). In module A1 the highest contribution is from Electrodes (100%). There is an impact of 6.22E-14 kg CFC11-eq. from module D.
Photochemical Ozone Creation Potential (POCP) 	The total cradle to gate impact is 4.02E+00 kg NMVOC eq. The highest contribution is from module A3 (56.98%) followed by module A1 (42.05%). In the module A3 the highest contribution from the process emission from Induction furnace process (88%). In the module A1 the highest contribution from the Electricity (105%) with a credit of 10 % from DRI. There is credit of 5.56E-02 kg NMVOC eq. from module D.
Abiotic depletion potential (ADP) - Fossil 	The total cradle to gate impact is 1.47E+04 MJ. The highest contribution is from the module A1 (89.92%) followed by Module A3 (9.54%). In module A1 the highest contribution is from Electricity (73%) followed by DRI (24%). There is a credit of 2.80E+02 from module D.

Table 46: Interpretation of most significant contributors to life cycle parameters (Epoxy coated bar)

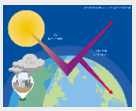
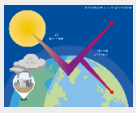
Parameter	Most significant contributor
Abiotic Depletion Potential (ADP) - Elements 	The total cradle to gate impact is 9.04E-05 kg Sb-eq. The highest contribution is from the module A1 (54.23%) followed by Module A3 (45.71%). In module A1 the highest contribution is from Electricity (65%) followed by Epoxy resin (22%) and DRI (6%). In module A3 the highest contribution is from wire rod (packaging material) (93%). There is a credit of 4.81E-04 kg Sb-eq. from the module D.
Acidification Potential (AP) 	The total cradle to gate impact is 8.80E+00 Mole of H+ eq. The highest contribution is from module A3 (56.50%) followed by module A1 (42.97%). In module A3 the highest contribution is from process emission from the Induction furnace process (96%). There is a credit of 7.41E-02 Mole of H+ eq. from module D.
Eutrophication Potential (EP) 	The total cradle to gate impact is 6.55E-04 kg P eq. The highest contribution is from module A1 (98.98%). In module A1 the highest contribution is from Epoxy resin (81%) followed by Deionised water (11%). There is a credit of 2.00E-05 kg P eq. from module D.
Global Warming Potential (GWP 100 years) 	The total cradle to gate impact is 1.31E+03 kg CO_2 eq. The highest contribution is from module A1 (92.15%) followed by module A3 (7.39%). In module A1 the highest contribution is from Electricity (76%) followed by DRI (9%) and Epoxy resin (8%). There is a credit of 3.26E+01 kg CO2eq. from module D.
Ozone Layer Depletion Potential (ODP, steady state) 	The total cradle to gate impact is 1.11E-08 kg CFC11-eq. with highest contribution is from module A1 (100%). In module A1 the highest contribution is from Electrodes (100%). There is an impact of 6.23E-14 kg CFC11-eq. from module D.
Photochemical Ozone Creation Potential (POCP) 	The total cradle to gate impact is 5.17 E+00 kg NMVOC eq. The highest contribution is from module A1 (55.73%) followed by module A3 (43.54%). In the module A1 the highest contribution from the Electricity (94%) with a credit of 6 % from DRI. In the module A3 the highest contribution from the process emission from the Induction furnace process (88%). There is credit of 5.55E-02 kg NMVOC eq. from module D.
Abiotic depletion potential (ADP) - Fossil 	The total cradle to gate impact is 2.19E+04 MJ. The highest contribution is from the module A1 (93.32%) followed by Module A3 (6.31%). In module A1 the highest contribution is from Electricity (72%) followed by DRI (15%) and Epoxy resin (9%). There is a credit of 2.79E+02 from module D.

Table 47: Interpretation of most significant contributors to life cycle parameters (Cut & Bends)

Parameter	Most significant contributor
Abiotic Depletion Potential (ADP) - Elements 	The total cradle to gate impact is 8.34E-05 kg Sb-eq. The highest contribution is from the module A3 (60.93%) followed by Module A1 (38.98%). In module A3 the highest contribution is from wire rod (packaging material) (93%). In module A1 the highest contribution is from Electricity (81%) followed by DRI (12%). There is a credit of 4.81E-04 kg Sb-eq. from the module D.
Acidification Potential (AP) 	The total cradle to gate impact is 8.74E+00 Mole of H+ eq. The highest contribution is from module A3 (69.93%) followed by module A1 (29.41%). In module A3 the highest contribution is from process emission from the Induction furnace process (96%). There is a credit of 7.60E-02 Mole of H+ eq. from module D.
Eutrophication Potential (EP) 	The total cradle to gate impact is 1.29E-04 kg P eq. The highest contribution is from module A1 (93.66%). In module A1 the highest contribution is from Deionised water (74%) followed by Electricity (21%). There is a credit of 2.07E-05 kg P eq. from module D.
Global Warming Potential (GWP 100 years) 	The total cradle to gate impact is 1.09E+03 kg CO_2 eq. The highest contribution is from module A1 (88.41%) followed by module A3 (10.91%). In module A1 the highest contribution is from Electricity (78%) followed by DRI (14%), Lime (3.29%) and Ferro silicon (2.29%). There is a credit of 3.33E+01 kg CO2eq. from module D.
Ozone Layer Depletion Potential (ODP, steady state) 	The total cradle to gate impact is 1.36E-08 kg CFC11-eq. with highest contribution is from module A1 (100%). In module A1 the highest contribution is from Electrodes (100%). There is an impact of 6.17E-14 kg CFC11-eq. from module D.
Photochemical Ozone Creation Potential (POCP) 	The total cradle to gate impact is 4.95 E+00 kg NMVOC eq. The highest contribution is from module A3 (55.79%) followed by module A1 (43.26%). In the module A3 the highest contribution from the process emission from the Induction furnace process (88%). In the module A1 the highest contribution from the Electricity (105%) with a credit of 9 % from DRI. There is credit of 5.69E-02 kg NMVOC eq. from module D.
Abiotic depletion potential (ADP) - Fossil 	The total cradle to gate impact is 1.84E+04 MJ. The highest contribution is from the module A1 (90.28%) followed by Module A3 (9.19%). In module A1 the highest contribution is from Electricity (73%) followed by DRI (23%). There is a credit of 2.85E+02 from module D.

Concluding, the study provides fair understanding of environmental impacts during the various life cycle stages of structural steel 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), outbound transportation (A4), installation (A5), transport of dismantled product to EoL site (C2), waste processing (C3), disposal (C4)as well as the end of life stage recycling (D) considerations. Major focus areas should be aligned to optimise electricity consumption in IF-LF and mills. Sourcing of electricity from green energy such as solar, wind, hydro etc. may be explored.

5. 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.

6. 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.

7. References

- EN 15804: 2012+A2:2019, Sustainability of construction works - Environmental product declarations - Core rules for the product category of construction products
- GaBi 9 2020: Dokumentation der GaBi-Datensätze der Datenbank zur Ganzheitlichen Bilanzierung. LBP, Universität Stuttgart und PE International, 2012
- GaBi 9 2020: 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 - CO_2 Data Collection User Guide, Version 9 (May 2019)