Steel-Hot Rolled Coil

Environmental Product Declaration

ISO 14020:2000, IS0 14025:2006, ISO 14040:2006, ISO 14044:2006, EN 15804:2012

EPD registration number:	S-P-01413
Publication date:	2019-07-12
Validity date:	2024-07-11
Geographical scope:	India

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1. Introduction

Founded in 1982, JSW Group is one of India's largest business conglomerates. It is a part of the US $15 billion O. P. Jindal Group. The group has strong footprints across various sectors namely, Steel, Energy, Minerals, Port & Infrastructure and Cement in multiple locations across India, US, South America and Africa. JSW Steel Ltd, JSW Energy, JSW Infrastructure are subsidiaries of JSW Group.

JSW Steel, the flagship company of JSW group, is India's leading primary and integrated steel producer with a capacity of 18 MTPA. It is one of the fastest growing companies in India with a footprint in over 140 countries. JSW Steel has one of the largest blast furnaces with a capacity of 3.3 MTPA, taking JSW's overall capacity to 12 MTPA at Vijayanagar, Karnataka. With its plants located across 6 strategic locations in South and West India, JSW Steel will continue to raise the bar with its high quality & diverse product range.

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 Limited, a subsidiary of thinkstep AG, Germany has been entrusted to conduct Life Cycle Assessment for JSW'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 thinkstep AG.

2. General Information

2.1 EPD, PCR, LCA Information

Table 1. EPD Information

Programme	The International EPD® System, www.environdec.com
Program operator	EPD International AB Box 210 60, SE-100 31 Stockholm, Sweden.
Declaration holder	JSW Steel Limited Vijayanagar Works, Vidyanagar P.O, Ballari, Dist., Karnataka-583275
Product	Hot Rolled Coil
CPC Code	41211 Flat-rolled products of non-alloy steel, not further worked than hot-rolled, of a width of 600 mm or more
EPD registration number	S-P-01413
Publication date	2019-07-12
Validity date	2024-07-11
Geographical scope	India
Reference standards	IS0 14020:2001, ISO 14025:2006, EN 15804:2012

Table 2. PCR Information

Reference PCR	'Construction Products and Construction Services' Version 2.2, 2012
Date of Issue	2017-05-30 (Version 2.2)

Table 3. Verification Information

Demonstration of verification	External, independent verification
Third party verifier	Dr Hüdai Kara, Metsims Sustainability Consulting, 4 Clear Water Place, Oxford OX2 7NL, UK Email: hudai.kara@metsims.com

Table 4. LCA Information

Title	Environmental Product Declaration of Hot Rolled Coil
Preparer	Dr. Rajesh Kumar Singh Thinkstep Sustainability Solutions Pvt. Ltd. 421, MIDAS, Sahar Plaza, Andheri Kurla Road, Andheri East, Mumbai, India - 400059 Email: rajesh.singh@thinkstep.com
Reference standards	ISO 14040/44 standard

2.2 Reference Period of EPD Data

The reference period for the data used within this EPD is the April 2016 to March 2017

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 Hot Rolled Coil manufactured at JSW Steel Limited's Vijayanagar Plant (India). The EPD is in accordance with ISO 14025 and EN 15804. EPD of construction products may not be comparable if they do not comply with EN 15804. 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 for JSW Steel Limited.

Product Category Rules (PCR) for the assessment of the environmental performance of Hot Rolled Coil is PCR for 'Construction Products and Construction Services' Version 2.2. This PCR is applicable to the product "Hot Rolled Coil "complying with the standard EN 15804.

The target audience includes JSW 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

JSW Steel Limited manufactures superlative Hot Rolled (HR) coils at its Hot Strip Mills (HSM), situated at Vijayanagar, Karnataka (India). The production of these coils involves the use of state-of-the-art equipment and manufacturing processes that ensure products of the highest quality. Steel is produced predominantly by two process routes; the blast furnace/basic oxygen furnace route (BOF) and the electric arc furnace route (EAF). JSW also applies corex technology for steel production which is modelled similar to blast furnace system. Primary data is used for all gate to gate processes.

Table 5. Specifications of Hot Rolled Coils

Parameter	Range
Thickness	1.2 - 25.4 mm
Width	900-2100 mm
Grades	• Re-rolling/ Drawing Grades • Tube and Pipe/ Forming Grades • Structural/ Medium Tensile Tube/ Forming Grades • LPG/ Low Pressure Vessel Grades • HSLA Grades • Medium Carbon Grades • Weather Resistance Grades • Line Pipe Grades • Chequered Plated

Hot Rolled Coils are used in a variety of applications like Automobiles, Boiler and Pressure Vessels, Ship Building, Railways, Transmission Towers, Oil and Petrochemicals, Coal and Mining, General and Heavy Engineering.

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 Process Description

Products are manufactured using the Blast Furnace with Basic Oxygen Furnace (BF+BOF) route. Iron ore (typical mix based on Ferro-oxides Fe_2O_3) and other additives are mixed and sintered for being fed into the blast furnace together with coking coke, which is used as the reducing agent. (For corex the reducing agent is non-coking coal). Also pellets and / or lump may be used.

The pig iron produced in the blast furnace & corex is transferred into the basic oxygen furnace. In this vessel, the iron is converted into steel by lowering the carbon content of the iron by blowing oxygen into the melt (exothermic reaction). For temperature control, scrap (up to 10%) is added to the melt. Refining (lowering of sulphur, phosphorous and other tramp elements) and alloying with micro-alloying elements is applied according to steel grade to give the requested characteristics for the steel.

Depending on the special requirement for internal soundness, few steel products are processed through the RH Degassing unit.

The production also includes the electric arc furnace (EAF) route. The raw material input consists of shredded steel scrap, high melting steel scrap, pig iron, ferro alloys along with allied materials. This raw material is charged to the electric arc furnace. Initially melting takes place by the addition of oxygen and/or fuels. In the oxidation phase, the slag is formed for removal of undesired materials by the addition of lime and coke. In the reduction phase, the slag is reduced for oxygen and sulphur removal.

At the end of the steelmaking process, the liquid steel is transformed into a semi-finished product in a continuously casted steel slab. The semi-finished slab is then hot-rolled into the coils in HSM or further sent to CRM for making cold rolled coil. The liquid steel is also sent to wire rod mills and bar rod mills for productions of wire rods and bar rods, respectively. 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 explained in Figure 1.

Water is used in continuous casting machines for direct cooling of the slabs and billets. A contaminated process water flow is therefore generated. In many cases, this waste water is treated together with waste water streams from the hot rolling mills. After treatment, the water is recirculated.

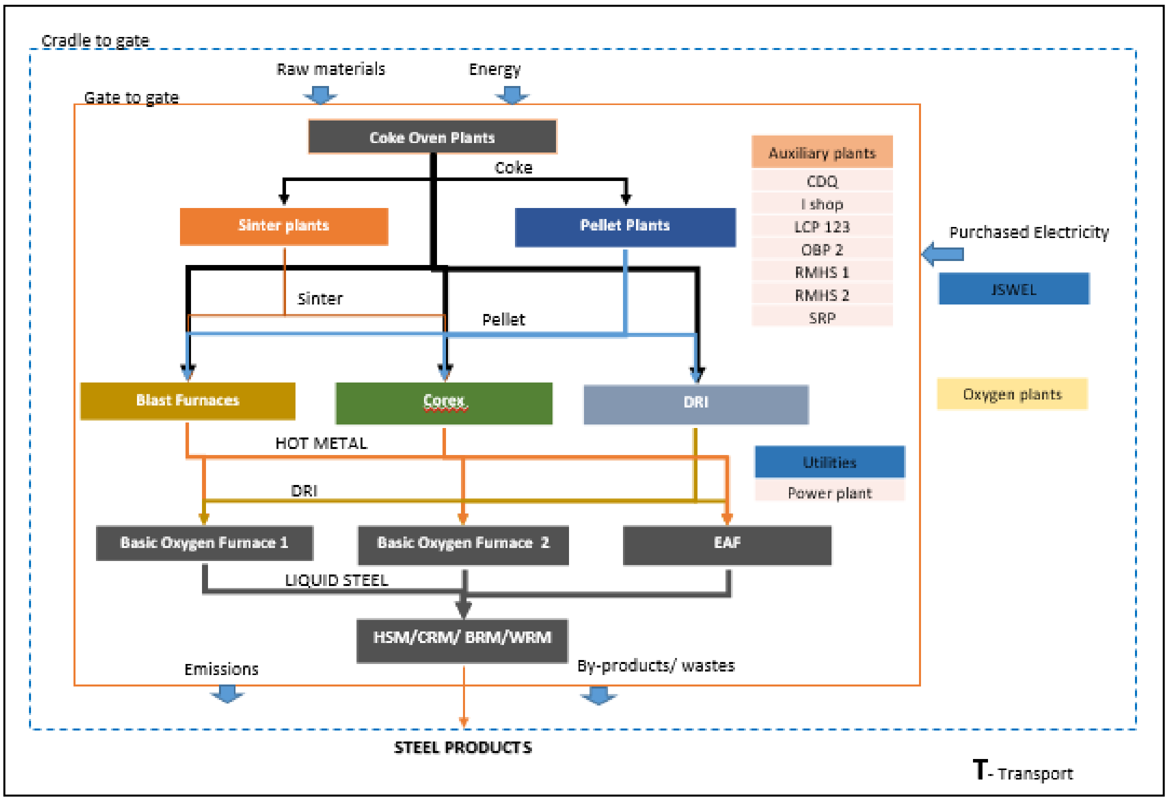

Figure 1. Steel making process at JSW Steel

4. LCA

4.1 Information Sources and Data Quality

To ensure that JSW can provide the most accurate and representative data for steel products, the quality of the data used in the models must be very high. The quality of the LCI data for modelling the life cycle stages have been assessed according to ISO 14044 (ISO, 2006b). 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). To achieve this, industry data collected directly from the producers were used wherever possible. For all other data, primary data were used where possible, e.g. ferro alloy compounds, and finally upstream LCA data from the GaBi 8 professional database. For this latter case, GaBi data were adapted for the data collection part.

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 particularly important in the case of the blast furnace 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 Blast furnace, Corex plants, Coke ovens, BOF and EAF are listed in table 6, together with the allocation method chosen.

Table 6. Products in various steel plants where allocation is applied

Production Unit	Main Co Products
Blast Furnace	Hot metal, BF slag
Corex Plant	Hot metal, Corex slag
Coke Oven Plant	Coke, Tar, Coke oven gas
EAF plant	Liquid steel, EAF slag
Basic Oxygen Furnace	Hot metal, BOF 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 EAF as well as the End of Life scrap generation.

4.2.3 Declared unit

The declared unit for the EPD is 1 ton of Hot Rolled Coil manufactured at Vijayanagar plant of JSW Steel Limited.

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. CML 2001 (January 2016) method developed by Institute of Environmental Sciences, Leiden University, Netherlands have been selected for evaluation of environmental impacts. These indicators are scientifically and technically valid.

The environmental impact per declared unit for the following environmental impact categories were reported in the EPD according with EN15804 (Table 7), and divided into core, upstream (and downstream, if included) module.

Table 7. Environmental impacts indicators

Impact Indicator	LCIA Method	Unit
Acidification Potential	CML	kg SO_2 equivalent
Eutrophication Potential	CML	kg PO_4^{3-} equivalent
Global Warming Potential	CML	kg CO_2 equivalent
Ozone Depletion Potential	CML	kg CFC-11 equivalent
Photochemical Ozone Creation Potential	CML	kg Ethene equivalent
Human Toxicity Potential	CML	kg DCB equivalent
Abiotic Depletion Potential - Elements	CML	kg Sb- equivalent
Abiotic Depletion Potential - Fossil resources		MJ, net calorific value

The consumption of natural resources per declared or function unit is reported in the EPD. Input parameters, according with EN15804, describing resource use are shown in Table 8.

Table 8. Natural resources use parameters

Parameter	Unit
Renewable primary energy as energy carrier	MJ, net calorific value
Renewable primary energy resources as material utilization	MJ, net calorific value
Total use of renewable primary energy resources	MJ, net calorific value
Non-renewable primary energy as energy carrier	MJ, net calorific value
Non-renewable primary energy as material utilization	MJ, net calorific value
Total use of non-renewable primary energy resources	MJ, net calorific value

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.

Criterion 2 was attainable because site input tonnages are weighed by relatively few inputs such as limestone, scrap, metallic additions, refractories, DRI, hot metal, and intermediate steel products which account for >99% of material inputs to each process stage.

4.4 System Boundaries

The study is a Cradle-to-Gate LCA study with the End-of-Life recycling of the steel. That is, it covers all of the production steps from raw materials in the earth (i.e. cradle) to production of the Hot Rolled Coil (i.e. Gate) with the End of Life Credit. The Cradle-to-Gate with end-of-life recycling, includes net credits associated with recycling the steel from the final products at the end-of-life (end-of-life scrap). It does not include the manufacture of the downstream final products or their use.

Table 9. Details of system boundary included in the study

Life Cycle Stages	Life Cycle Sub-Stages	Definitions	EPD Module
Materials	Primary raw materials production	Extraction, production of the raw materials to the primary packaging producer	A1
Upstream Transport	-	Transport of the raw materials for primary production of the assembly	A2
Manufacturing	Iron shops, steel shops and utilities	Manufacturing of various grades of steel products at JSW across the various shops i.e. Blast furnaces, Corex furnaces, EAF, BOF, DRI, Sinter plants, pellet plants, OBP, WRM, BRM, HSM, etc.	A3
EoL Credit	-	After its useful life, steel is considered to be a 100% recyclable material and as per World Steel Data 85% recoverability is observed. Thus 85% is considered for EoL credit.	D

4.4.1 Geographic System Boundaries

The geographical coverage of this study covers the production of various grades of steel in India. Indian boundaries wherever possible have been adapted and others dataset were chosen from EU if no Indian datasets were available. In addition, raw materials imported from other geographies are also applied in this study. All the primary data has been collected from JSW in cooperation with experts from thinkstep.

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 April 2016 to March 2017. It is believed to be representative of Indian steel production during this time frame.

4.4.3 Technology coverage

Steel is produced predominantly by two process routes; the blast furnace/basic oxygen furnace route and the electric arc furnace route (the BOF and EAF routes respectively). JSW also applies Corex technology for steel production which is modelled similar to Blast furnace system. Primary data is used for all gate to gate processes. The BOF route is primary ore-based which generally uses up to 35% scrap input. The steel-making stage of this route is carried out using the basic oxygen furnace. The EAF route is predominantly a 100% scrap-based steelmaking process. Both routes continuously cast products that feed into hot and cold rolling processes. In the present study, all different routes are considered as per the data collected for yearly production and further a route wise analysis is also covered in the study.

4.5 Software and database

The LCA model was created using the GaBi 8 Software system for life cycle engineering, developed by thinkstep AG. 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-2019-lci-documentation.

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 production life cycle included as per PCR is given in Table 10.

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

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	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	X

The LCIA result for 1 ton of Hot Rolled Coil manufactured at JSW Vijayanagar plant with the system boundary of Cradle-to-Gate with the end-of-life recycling of the steel have been as given in Table 11.

Table 11. Cradle to Gate with EoL Credit LCIA Result of 1-ton HRC

Impact Category	Unit	A1-A3	D
Abiotic Depletion Potential (ADP elements)	kg Sb-Equiv.	5.06E-04	-2.88E-03
Acidification Potential (AP)	kg SO_2-Equiv	2.08E+01	-3.07E+00
Eutrophication Potential (EP)	kg Phosphate-Equiv.	1.32E+00	-8.00E-02
Global Warming Potential (GWP 100 years)	kg CO_2-Equiv.	2.55E+03	-1.3E+03
Ozone Layer Depletion Potential (ODP, steady state)	kg CFC 11-Equiv.	2.29E-06	4.11E-05
Photochemical Ozone Creation Potential (POCP)	kg Ethene-Equiv.	1.01E+00	-6.60E-01
Human Toxicity Potential (HTP inf.)	kg DCB-Equiv.	8.93E+02	-8.50E+01
Abiotic Depletion Potential (ADP fossil)	MJ	2.94E+04	-1.35E+04

Table 12. Cradle to Gate with EoL Credit natural resource use result of 1-ton HRC

Parameter	Unit	A1-A3	D
Renewable primary energy as energy carrier	MJ	2.47E+02	7.00E+02
Renewable primary energy resources as material utilization	MJ	0.00E+00	0.00E+00
Total use of renewable primary energy resources	MJ	2.47E+02	7.00E+02
Non-renewable primary energy as energy carrier	MJ	2.95E+04	-1.20E+04
Non-renewable primary energy as material utilization	MJ	0.00E+00	0.00E+00
Total use of non-renewable primary energy resources	MJ	2.95E+04	-1.20E+04

4.8 Interpretation

The interpretation of the results for 1-ton HRC is given in Table 13.

Table 13. Interpretation of most significant contributors to life cycle parameters

Parameter	Most significant contributor
Abiotic Depletion Potential (ADP) - Elements	The Cradle to Gate ADP elements is 5.06E-04 kg Sb-equiv. with EoL credit of -2.88E-03 kg Sb-equiv. In Cradle to Gate impacts, BOF contributes the most with 74.31%.
Acidification Potential (AP)	The Cradle to Gate AP is 20.8 kg SO_2-equiv. with EoL credit of -3.07 kg SO_2-equiv. In Cradle to Gate impacts, coke oven contributes the maximum to AP with 52.43%.
Eutrophication Potential (EP)	The Cradle to Gate EP is 1.32 kg Phosphate-equiv. with EoL credit of -0.08 kg Phosphate-equiv. In Cradle to Gate impacts, coke oven contributes the maximum to EP with 52.27%.
Global Warming Potential (GWP 100 years)	The Cradle to Gate GWP is 2545.30 kg CO_2 equiv. with EoL credit -1295.9 kg CO_2 equiv. In Cradle to Gate impacts, BF contributes the highest with 30.38% and Coke oven contributes 18.67% to GWP.
Ozone Layer Depletion Potential (ODP, steady state)	The Cradle to Gate ODP is 2.29E-06 kg CFC11-equiv. with EoL credit of 4.11E-05 kg CFC11-equiv. In Cradle to Gate impacts, BOF contributes the highest with 89.08% to ODP
Photochemical Ozone Creation Potential (POCP)	The Cradle to Gate POCP is 1.01 kg Ethene-equiv. with EoL credit of -0.66 kg Ethene-equiv. In Cradle to Gate impacts, coke oven contributes the highest with 51.68% to POCP.
Human Toxicity Potential (HTP inf.)	The Cradle to Gate HTP is 893.29 kg DCB-equiv. with EoL credit of -85.01 kg DCB-equiv. In Cradle to Gate impacts, coke oven contributes highest to HTP with 53.47%.
Abiotic depletion potential (ADP) - Fossil	The Cradle to Gate ADP fossil is 29374 MJ with EoL credit of -13469 MJ. In Cradle to Gate impacts, coke oven contributes the highest with 42.63%, followed by BF with 22.92%.
Primary Energy Demand (Net Cal. Value)	The total Primary Energy Demand is 29768 MJ with EoL credit of -11297 MJ. The highest PED is contributed by coke oven (42.29%) followed by BF (22.71%) and corex (10.19%)

Concluding, the study provides fair understanding of environmental impacts during the various life cycle stages of the product. 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, transportation, steel production as well as the end of life stage considerations. Major focus areas should align to optimise the coke consumption in blast furnaces, coal consumption in CO plants, corex gas consumption in DRI plant, improve electricity consumption at various plants and improve iron ore consumption in sinter plant.

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. Glossary of Terms

Impact Category	Units	Description	Characterisation Method
Global Warming (Climate Change) Potential	kg CO_2 equiv	Contribution to the greenhouse effect, referred to as carbon dioxide equivalent)	CML
Stratospheric Ozone Depletion Potential	kg CFC-11 equiv	Impact on the ozone layer	CML
Acidification Potential of Land and Water	kg SO_2 equiv	Emissions which increase the acidity of the environment	CML
Eutrophication Potential	kg PO_4^{3-} equiv	Addition of nutrients to a water system resulting in reduction of the oxygen available to support aquatic life	CML
Photochemical Ozone Creation Potential	kg C_2H_2 equiv	Contribution to air pollution in the form of smog	CML
Depletion of Abiotic Resources (Elements/Minerals)	kg Sb equiv	Impact of consuming non- renewable metal resources	CML
Depletion of Abiotic Resources (Fossil)	MJ net calorific value	Impact of consuming non- renewable fossil fuel resources	CML
Human Toxicity Potential	kg DCB equiv	Human health impact of chemical emissions	CML

7. 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.

8. References

- EN 15804: 2012, Sustainability of construction works - Environmental product declarations - Core rules for the product category of construction products
- GaBi 8 2018: Dokumentation der GaBi-Datensätze der Datenbank zur Ganzheitlichen Bilanzierung. LBP, Universität Stuttgart und PE International, 2012
- GaBi 8 2018: 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.