ENVIRONMENTAL PRODUCT DECLARATION

as per ISO 14025 and EN 15804

Owner of the Declaration	ArcelorMittal Commercial RPS S.à r.l.
Programme holder	Institut Bauen und Umwelt e.V. (IBU)
Publisher	Institut Bauen und Umwelt e.V. (IBU)
Declaration number	EPD-ARM-20160125-IBD3-EN
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Valid to	22/11/2022

Hot-rolled steel sheet piling

ArcelorMittal

www.ibu-epd.com / https://epd-online.com

1. General Information

ArcelorMittal Commercial RPS S.à r.l.	1 metric ton of steel sheet piling
Programme holder IBU - Institut Bauen und Umwelt e.V. Panoramastr. 1 10178 Berlin Germany	**Owner of the Declaration** ArcelorMittal Commercial RPS S.à r.l. 66, rue de Luxembourg L-4221 Esch-sur-Alzette Luxembourg
Declaration number EPD-ARM-20160125-IBD3-EN	**Declared product / Declared unit** The declared unit is 1 metric ton of steel sheet piling
This Declaration is based on the Product Category Rules: Structural steels, 07.2014 (PCR tested and approved by the SVR)	**Scope:** The declaration applies to 1 metric ton of steel sheet piling. It covers hot rolled steel sheet piling (Z-shaped, U-shaped, straight-web, and H-shaped) produced by ArcelorMittal. This environmental product declaration is valid for steel sheet piling produced by the three ArcelorMittal plants: Dabrowa in Poland, Belval and Differdange in Luxemburg. It is based on 100% of the annual production from 2015.
Issue date 23/11/2016	The owner of the declaration shall be liable for the underlying information and evidence; the IBU shall not be liable with respect to manufacturer information, life cycle assessment data and evidences.
Valid to 22/11/2022	**Verification** The CEN Norm /EN 15804/ serves as the core PCR Independent verification of the declaration according to /ISO 14025/ ☐ internally ☒ externally
Prof. Dr.-Ing. Horst J. Bossenmayer (President of Institut Bauen und Umwelt e.V.)	
Dr. Burkhart Lehmann (Managing Director IBU)	Dr. Frank Werner (Independent verifier appointed by SVR)

2. Product

2.1 Product description

Steel sheet piling are rolled steel profiles with longitudinal clutches at each side. Sheet piles can be connected to each other through these clutches creating a mechanical connection (i.e. interlock) between the profiles allowing continuous wall construction.
This EPD applies to 1 ton of steel sheet piling. The types of steel sheet piling are: Z-shaped, U-shaped, straight-web, and H-shaped.

2.2 Application

Sheet pile walls resist to high pressure and can support massive height of soil with a small quantity of steel compared to the applied loads. Steel piling products are used worldwide in many kinds of permanent or temporary structures: quay walls and breakwaters in harbors and locks, bank reinforcement on rivers and canals, pumping stations, bridge abutments, retaining walls for underpasses or underground car parks, impervious containment walls, temporary cofferdams in land and in water, containment barriers, and load bearing foundations, among others.

2.3 Technical Data

This EPD is valid for steel piling products of varied grades and geometries, as well as different forms of delivery. Specific information on dimension tolerances, constructional data and mechanical and chemical properties can be found in the relevant standards /EN 10248/.

Constructional data

Name	Value	Unit
Density	7850	kg/m^3
Modulus of elasticity	210000	N/mm^2
Coefficient of thermal expansion	12	$10^{-6}K^{-1}$
Thermal conductivity	48	W/(mK)
Melting point	1536	°C

Product standards and national certifications:
- European standard /EN 10248/ “Hot rolled sheet piling of non-alloy steels”
- ASTM international standards /ASTM A328/, /A572/, /A690/
- Canadian standard association (CSA) /Gr 260W/, /Gr 300 W/, /Gr 350W/, /Gr 400W/
- Japanese Industrial Standards (JIS) /JIS SY 295/, /SY 390/

- ArcelorMittal mill specifications: /S460AP/, /AMLoCor Blue/

2.4 Application rules

Standard /EN 1993/ applies to the design of steel structures. Part 5 of /EN 1993/ provides principles and application rules for the structural design of bearing piles and sheet piles made of steel and it includes all performance requirements such as durability, serviceability and ultimate limit states, among others. Standard /EN 12063/ applies to the execution of special geotechnical works – sheet piles walls. It specifies requirement's, recommendation and information concerning the execution of permanent or temporary sheet piles structures in accordance with /EN1991:1/ and the handling of equipment and materials. Installation and extraction have a negligible contribution to the global environmental impact.
In addition, the European standards will work in connection with national amendments, national annexes, guidelines and publications, as well as legal provisions.

2.5 Delivery status

The dimensions of the declared products are given in /EN10248-1/ and /EN 10248-2/. The quantities may vary according to the intended application.

2.6 Base materials / Ancillary materials

Steel piling products according to /EN 10248/ are non-alloy steel products, except for AMLoCor and ASTM A690 products.
Iron is the main component of steel piling products. Alloying elements are added on the form of ferroalloys or metal, the most common element are manganese, chromium and vanadium. Other elements like nitrogen or copper may be present in the steel. The composition of these elements depends on the steel designation/grade.

2.7 Manufacture

Energy: /ISO 50001/
Quality control: /ISO 9001/.
Two different routes to produce steel are used:

- BF/BOF route: In integrated steel production plants, iron ore is used as raw material to prepare sinter which is later on used in a blast furnace (BF) together with coke to produce pig iron. Different ferro-alloys, metal alloys, steel scraps are added to the liquid pig iron in a basic oxygen furnace (BOF) or in a tandem furnace, with blowing oxygen to lower carbon content in the steel and to obtain liquid steel with the required characteristics.

- EAF route: Different steel scraps are melted in an electric arc furnace to obtain liquid steel. This steel is then refined in a ladle furnace with addition of ferro-alloys and metals to obtain the required steel characteristics.

2.8 Environment and health during manufacturing

Environmental, occupational health, safety and quality management are in accordance with the following norms:

- /ISO 14001/,

- /OHSAS 18001/.

2.9 Product processing/Installation

Processing the material to its final shape and length has to be done depending on the generally recognized rules of engineering (or structural calculation) and the manufacturer's recommendations.
Normal safety measures should be applied during handling and use of the product. Any instructions from the manufacturer concerning special operations (e.g. welding) have to be applied.

2.10 Packaging

Unless otherwise demanded steel piling products are delivered unpacked.

2.11 Condition of use

During use no changes in material composition shall occur. Maintenance requirements will depend on specific design and application.

2.12 Environment and health during use

Under normal conditions of use, sheet piling steel products do not cause any adverse health effects nor release other emissions to indoor air.
No environmental impact to water, air or soil is expected due to the extremely low metal release from steel and the low maintenance requirements.

2.13 Reference service life

A reference service life for steel piling products is not declared. Steel piling products are construction products with many different application purposes. The lifetime therefore will be limited by the service life of the work.

2.14 Extraordinary effects

Fire
The material is class A1, i.e. not flammable per /EN 13501/.
The material does not emit fumes or fire-gases.
The critical temperature for the integrity of the structure substantially depends on component loading and restraining conditions.

Fire protection

Name	Value
Building material class acc. /EN 13501-1/	A1
Burning droplets	-
Smoke gas development	-

Water
No environmental impact to water, air or soil is expected due to the extremely low metal release from steel and the low maintenance requirements.
In case of flooding no impacts are to be expected.

Mechanical destruction
In case of mechanical destruction, no risks are expected to occur in terms of environment and human health.

2.15 Re-use phase

General:
Depending upon the type of installation, it is possible to recover and reuse up to 100% of steel piling products. If not reused, steel piling products are 100% recyclable.
Currently, 99% of the used steel is regained after dismantling thanks to the magnetic properties of steel according to the /European Commission Technical Steel Research/ and the /German Ministry of Environmental Affairs/.

Reuse:
Steel piling products can be reused several times. Part of the production is used for temporary works (lasting up 3 years). Steel piling products can be reused from 3 to 10 times, without loss of their properties. The frequency of reuse varies depending on the use case. For instance, the same steel piling product can be used successively for different parts of a construction site, or stocked by a company between two usages. Currently, approximately 25% of the products are reused, according to internal documentation within ArcelorMittal.

Recycling:
Steel can be recycled to the same (or higher/lower) quality of steel depending upon the metallurgy and processing of the recycling route. Steel piling product can be recycled without any problem after dismantling, and recycling routes are well established.
Currently, around 74% of the products are recycled (calculated as difference between 99% recovery and 25% reuse).

2.16 Disposal

Due to its high value as a resource, steel scrap is not disposed of, but instead fed to reuse or recycling in a well-established cycle. However, in case of dumping due to collection loss, no environmental impacts are expected.
Waste code according to the list of waste pursuant to Directive 2008/98/EC of the European Parliament and of the Council is: 17 04 05 - iron and steel.

2.17 Further information

Additional information on steel piling product can be found at http://sheetpiling.arcelormittal.com/.

3. LCA: Calculation rules

3.1 Declared Unit

The declaration refers to the functional unit of 1 metric ton of steel sheet piling as specified in Part B requirements on the EPD for structural steels.

Declared unit

Name	Value	Unit
Declared unit	1	t
Density	7850	kg/m³
Conversion factor to 1 kg	0.001	-

3.2 System boundary

Type of the EPD: cradle-to-gate - with options. Module A1-A3, Module C3 and module D were considered.

Modules A1-A3 of the structural steel production include the following:

- The provision of resources, additives, and energy
- Transport of resources and additives to the production site
- Production processes on-site including energy, production of additives, disposal of production residues, and consideration of related emissions
- Recycling of production/manufacturing scrap. Steel scrap is assumed to reach the end-of-waste status once is shredded and sorted, thus becomes input to the product system in the inventory.

Module C3 takes into account the sorting and shredding of after-use steel, as well as the non-recovered scrap due to sorting efficiency which is landfilled. A conservative value of 1% landfill is considered.

Module D refers to the End-of-Life of the sheet pile, including reuse and recycling.

3.3 Estimates and assumptions

For all input- and output material the actual transport distances were applied or assumptions were taken.

3.4 Cut-off criteria

All information from the data collection process has been considered, covering all used and registered materials, thermal energy, electrical energy and diesel consumption. Measurement of onsite emissions took place and those emissions were considered. The specific emissions that are linked to the provision of thermal and electrical energy were considered in the specific processes.
Data is collected through recommended templates developed by worldsteel association and its experts for LCI purpose. [Worldsteel LCA 2011 methodology report]. Data for different sites were cross-checked with one another and with the previous years' data to identify potential data gaps. No processes, materials or emissions that are known to make a significant contribution to the environmental impact of the products studied have been omitted. On this basis, there is no evidence to suggest that input or outputs contributing more than 1% to the overall mass or energy of the system or that are environmentally significant have been omitted. It can be assumed, that all neglected processes contribute less than 5% to the impact assessment categories.

Note: The required machines for manufacturing and other infrastructure are not considered in the LCA.

3.5 Background data

For life cycle modeling of the considered products, the GaBi 6 Software System for Life Cycle Engineering, developed by thinkstep AG, is used /GaBi 6 2015/. The GaBi-database contains consistent and documented datasets which can viewed in the online GaBi-documentation /GaBi 6 2013D/.
To ensure comparability of results in the LCA, the basic data of GaBi database were used for energy, transportation and auxiliary materials.

3.6 Data quality

´All relevant background datasets are taken from the /GaBi 6/ software database.

Regarding foreground data, this study is based on high quality of primary data, collected by ArcelorMittal for the period of 2014. Data were delivered in form of excel tables and manually integrated in the GaBi model with 2 iterations of data quality check:

- First iteration is for raw manufacturing data
- Second iteration is for the cradle-to-gate data and including End-of-Life recycling potential.

3.7 Period under review

The considered primary data for the input and output of energy and materials where collected in the year 2014.

3.8 Allocation

The allocation method used here was developed by the World Steel Association and EUROFER to be in line with /EN 15804/. The methodology is based on physical allocation and takes account of the manner in which changes in inputs and outputs affect the production of co-products. The method also takes account of material flows that carry specific inherent properties. This method is deemed to provide the most representative partitioning of the processes involved. Economic allocation was not considered, as slag is considered a low-value co-product under /EN 15804/, however, as neither hot metal nor slag are tradable products upon leaving the BF/BOF route, economic allocation would most likely be based on estimates. Similarly, blast furnace slag must undergo processing before being used as a clinker or cement substitute. Worldsteel and EUROFER also highlight that companies purchasing and processing slag work on long-term contracts which do not follow regular market dynamics of supply and demand.
In some plants system expansion has been used to allocate electricity and process steam produced by the power plants as it is not possible to allocate using the economic basis., This approach deviates from the standard procedure in EN 15804. Nevertheless this is a conservative approach as, e.g., the GWP impact of the electricity generated by the power plant is 10% to 100% higher per kWh compared to the national electricity grid mix GWP impact.

3.9 Comparability

Basically, a comparison or an evaluation of EPD data is only possible if all the data sets to be compared were created according to /EN 15804/ and the building context, respectively the product-specific characteristics of performance, are taken into account. The used background database has to be mentioned.

4. LCA: Scenarios and additional technical information

Depending upon the type of installation, it is possible to recover and reuse up to 100% of steel piling products. If not reused, steel piling products are 100% recyclable. End of life practices can vary between these values.
Current practice for the average sheet piling product consist of 25% reuse, 74% recycling and 1% landfill according to the /European Commission Technical Steel Research/, the /German Ministry of Environmental Affairs/, and internal documentation within ArcelorMittal.

For specific case studies, dedicated scenarios can be calculated by contacting ArcelorMittal or using the data provided in this document.
Thus, based on current practice:

End of life (C3)

Name	Value	Unit
Landfilling	1	%

Reuse, recovery and/or recycling potentials (D), relevant scenario information

Name	Value	Unit
Recycling	74	%
Reuse	25	%

5. LCA: Results

DESCRIPTION OF THE SYSTEM BOUNDARY (X = INCLUDED IN LCA; MND = MODULE NOT DECLARED)

PRODUCT STAGE			CONSTRUCTION PROCESS STAGE		USE STAGE							END OF LIFE STAGE				BENEFITS AND LOADS BEYOND THE SYSTEM BOUNDARIES
Raw material supply	Transport	Manufacturing	Transport from the gate to the site	Assembly	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	De-construction demolition	Transport	Waste processing	Disposal	Reuse-Recovery-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	MNR	MNR	MNR	MND	MND	MND	MND	X	MND	X

RESULTS OF THE LCA - ENVIRONMENTAL IMPACT: 1 metric to Hot-rolled steel sheet piling

Parameter	Unit	A1-A3	C3	D
Global warming potential	[kg CO_2-Eq.]	9.37E+2	2.03E+0	-3.34E+2
Depletion potential of the stratospheric ozone layer	[kg CFC11-Eq.]	5.21E-7	1.22E-9	-1.30E-7
Acidification potential of land and water	[kg SO_2-Eq.]	2.44E+0	6.30E-3	-9.92E-1
Eutrophication potential	[kg $(PO_4)^{3-}$-Eq.]	2.15E-1	6.96E-4	-8.37E-2
Formation potential of tropospheric ozone photochemical oxidants	[kg ethene-Eq.]	3.22E-1	4.89E-4	-1.36E-1
Abiotic depletion potential for non-fossil resources	[kg Sb-Eq.]	2.62E-4	6.22E-7	-5.73E-5
Abiotic depletion potential for fossil resources	[MJ]	8.55E+3	2.27E+1	-3.07E+3

RESULTS OF THE LCA - RESOURCE USE: 1 metric to Hot-rolled steel sheet piling

Parameter	Unit	A1-A3	C3	D
Renewable primary energy as energy carrier	[MJ]	7.87E+2	8.76E+0	-1.48E+2
Renewable primary energy resources as material utilization	[MJ]	0.00E+0	0.00E+0	0.00E+0
Total use of renewable primary energy resources	[MJ]	7.87E+2	8.76E+0	-1.48E+2
Non-renewable primary energy as energy carrier	[MJ]	1.15E+4	3.41E+1	-3.76E+3
Non-renewable primary energy as material utilization	[MJ]	0.00E+0	0.00E+0	0.00E+0
Total use of non-renewable primary energy resources	[MJ]	1.15E+4	3.41E+1	-3.76E+3
Use of secondary material	[kg]	9.09E+2	0.00E+0	0.00E+0
Use of renewable secondary fuels	[MJ]	0.00E+0	0.00E+0	0.00E+0
Use of non-renewable secondary fuels	[MJ]	0.00E+0	0.00E+0	0.00E+0
Use of net fresh water	[m^3]	3.51E+0	1.36E-2	-9.44E-1

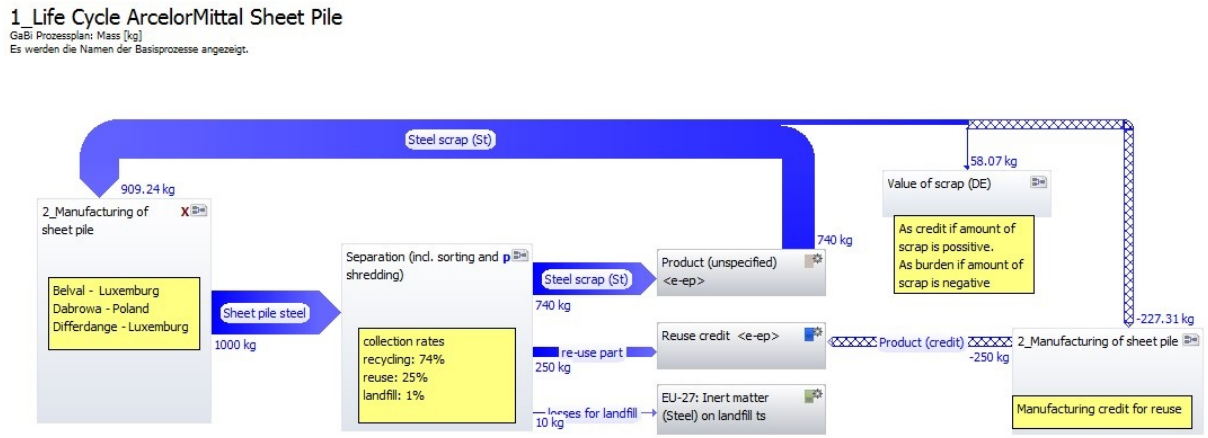
RESULTS OF THE LCA – OUTPUT FLOWS AND WASTE CATEGORIES: 1 metric to Hot-rolled steel sheet piling

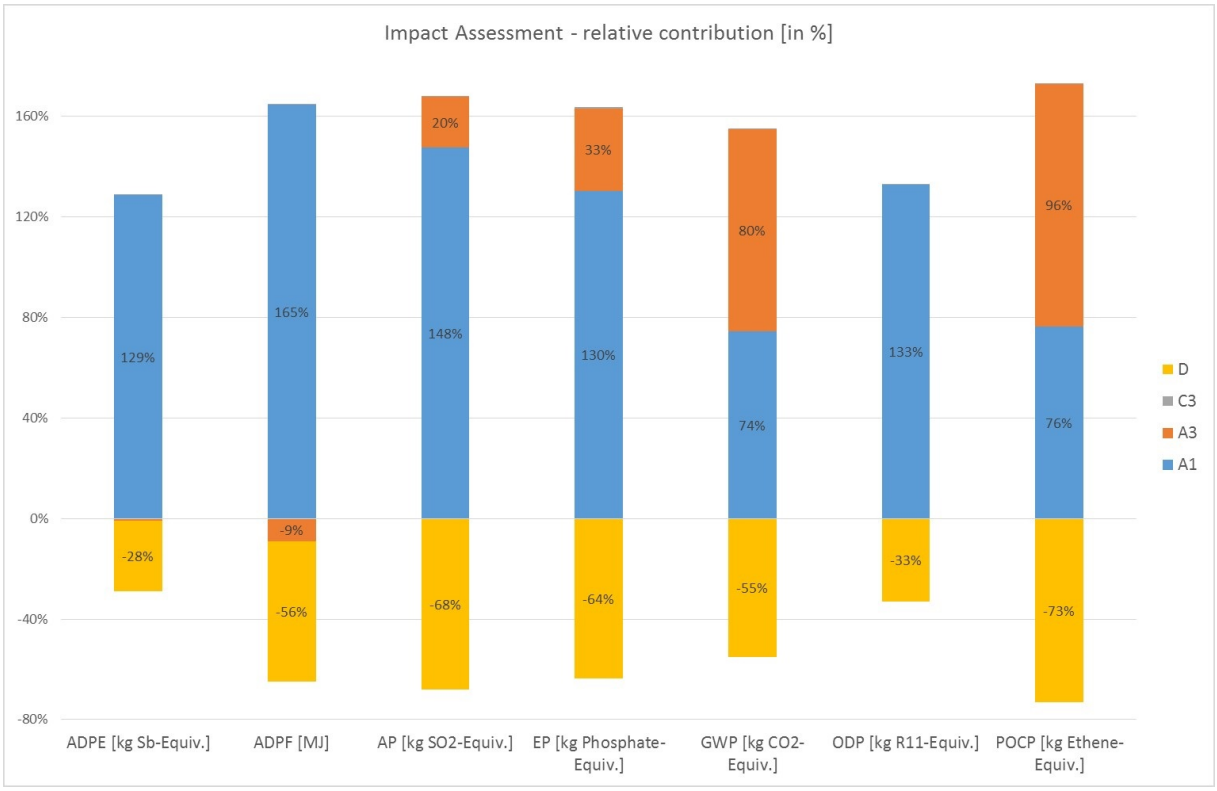
Parameter	Unit	A1-A3	C3	D
Hazardous waste disposed	[kg]	9.38E-6	3.34E-7	-3.61E-6
Non-hazardous waste disposed	[kg]	6.47E+0	1.00E+1	-3.03E+0
Radioactive waste disposed	[kg]	1.16E+0	4.54E-3	-2.74E-1
Components for re-use	[kg]	0.00E+0	2.50E+2	0.00E+0
Materials for recycling	[kg]	0.00E+0	7.40E+2	0.00E+0
Materials for energy recovery	[kg]	0.00E+0	0.00E+0	0.00E+0
Exported electrical energy	[MJ]	0.00E+0	0.00E+0	0.00E+0
Exported thermal energy	[MJ]	0.00E+0	0.00E+0	0.00E+0

6. LCA: Interpretation

Per ton of sheet pile produced, 909 kg scrap is used. After use, 740 kg sheet pile is recycled, 250 kg sheet pile is reused, and 10 kg is landfilled.

A potential environmental benefit is calculated for the end-of-life stage (module D) for all the considered impact categories. As shown in screenshot below, the net amount of scrap is 740 - 909 + 227= 58 kg. This means that the system has a net output of 58 kg scrap (which carries a potential credit).Also reuse of 250kg causes a potential benefit, thus all in all module D shows an environmental benefit.





The graph above shows the relative contribution of the production stages (Module A1-A3), waste sorting and treatment (Module C3) and the benefits and loads beyond the product system boundary (Module D).
For all the selected categories, the results for product stage (A1-3) provide the largest contribution to the results. Module D results in a potential benefit across all categories. Overall, C3 has a negligible contribution.

The most relevant and significant emissions from steel production (A1-3):

- for **GWP** are CO2 and CH4
- for **AP** are SO2 and NOx
- for **EP** are NOx
- for **POCP** are CO, SO2, NOx, and NMVOC.

Global Warming Potential (GWP) is caused both by provision of materials and energy needed in the steelmaking (module A1) and onsite emission (A3).

Acidification Potential (AP) is strongly dominated by the extraction and processing of raw materials and the generation of electricity, steam and heat from primary energy resources, including extraction, refining and transport (A1).

Similarly, Eutrophication Potential (EP) is also strongly dominated by the extraction and processing of raw materials and the generation of electricity, steam and heat from primary energy resources, including extraction, refining and transport (A1).

Photochemical Ozone Creation Potential (POCP) is caused both by onsite emission (A3) and by the production of ancillary materials/pre-products upstream materials (A1).

Abiotic Depletion (elements) is dominated by the use of non-renewable elements in the production of ancillary materials/pre-products e.g. copper and molybdenum (A1).

Abiotic Depletion Potential (fossil) is strongly dominated by the extraction and processing of raw materials and the generation of electricity, steam and heat from primary energy resources, including extraction, refining and transport (A1).

Total use of renewable primary energy carrier (PERT) and total use of non-renewable primary energy (PENRT) are dominated by the extraction and processing of raw materials and the generation of electricity, steam and heat from primary energy resources, including extraction, refining and transport (A1).

In general, the main contribution to primary energy in the BF/BOF route comes from the use of coal/coke as an energy and carbon source. For the EAF route, the provision of electrical energy is the main contributor.

7. Requisite evidence

This EPD covers finished structural steel of hot-rolled construction products. Further processing and fabrication depends on the intended application. Therefore further documentation is not applicable.

7.1 Weathering performance

The rusting rate of unalloyed steel depends on the position of the component and the conditions of the surrounding atmosphere (corrosively categories according to /EN ISO 12944-2/.
If required, the surfaces of fabricated structural components are usually protected with anticorrosion material in order to prevent any direct contact with the atmosphere. The weathering of this protection depends on the used protection system.

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