ENVIRONMENTAL PRODUCT DECLARATION

as per /ISO 14025/ and /EN 15804/

Owner of the Declaration	ArcelorMittal Brasil
Programme holder	Institut Bauen und Umwelt e.V. (IBU)
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Reinforcing steel in bars
ArcelorMittal Brasil

Institut Bauen und Umwelt e.V.

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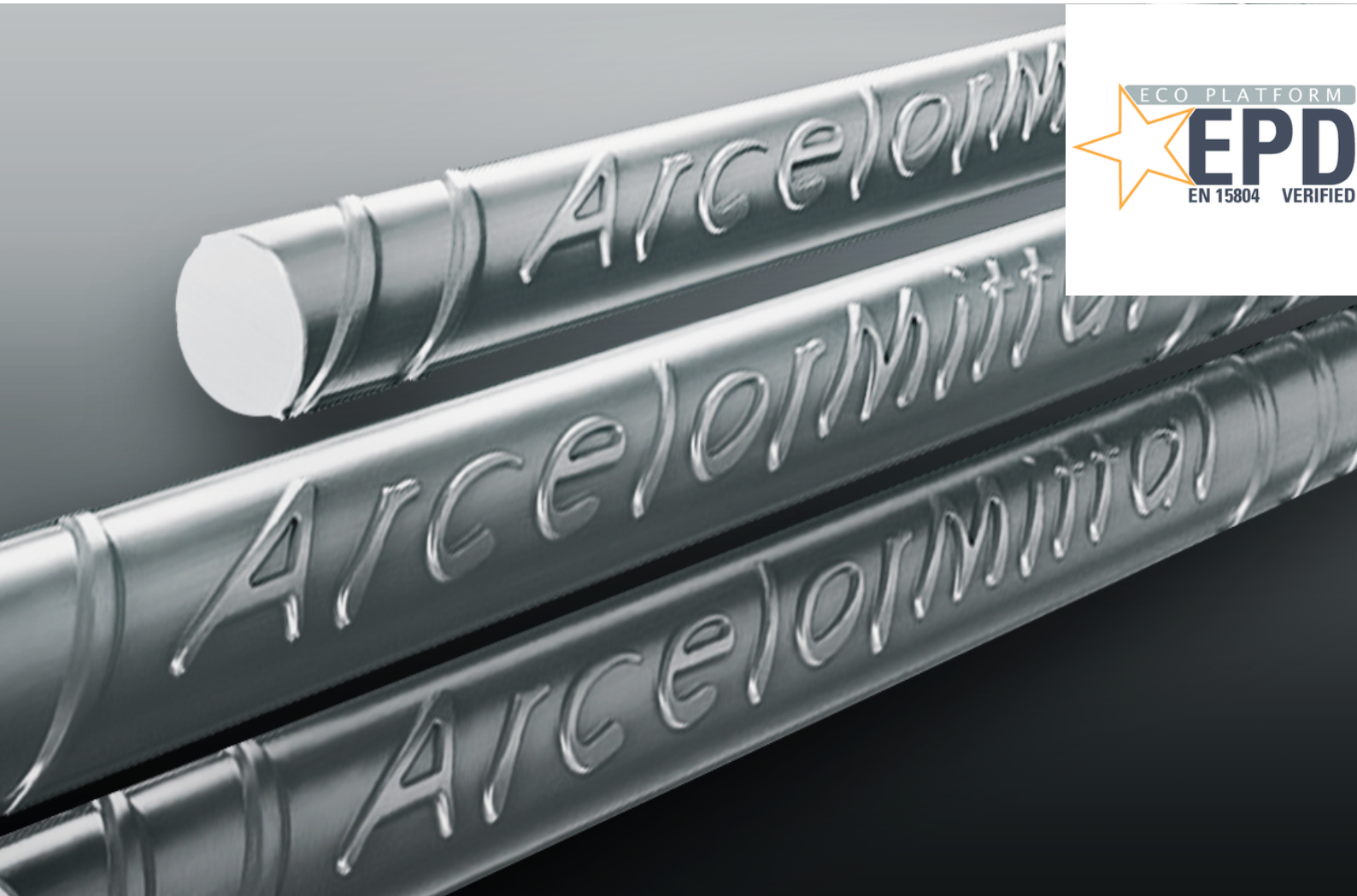

General Information

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Declaration number
EPD-ARC-20170124-CBD2-EN

This Declaration is based on the Product Category Rules:
Reinforcing Steel, 07.2014
(PCR tested and approved by the SVR)

Issue date
23/03/2018

Valid to
22/03/2023

Prof. Dr.-Ing. Horst J. Bossenmayer
(President of Institut Bauen und Umwelt e.V.)

Dr. Burkhart Lehmann
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Reinforcing steel in bars

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Declared product / Declared unit
1 metric ton reinforcing steel bars produced by ArcelorMittal in Brazil

Scope:
The declaration applies to 1 metric ton of reinforcing steel bar produced by ArcelorMittal in Brazil, representing 95% of the annual production of 2014.

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.

Verification

The CEN Norm /EN 15804/ serves as the core PCR
Independent verification of the declaration according to /ISO 14025/
☐ internally ☒ externally

Dr.-Ing. Wolfram Trinius
(Independent verifier appointed by SVR)

Product

Product description / Product definition
Rebar is short for reinforcing (steel) bar, used for the reinforcement of concrete according to /EN10080/ standard (as weldable reinforcing steel in bars and coils).

For the use and application of the product the respective national provisions at the place of use apply, being /ABNT NBR 6118/, /ABNT NBR 8965/, /ABNT NBR 6215/, /ABNT NBR 7477/, /ABNT NBR 7478/, /ABNT NBR 7480/, /ABNT NBR ISO 6892/, /ISO 15630-1/.

Application
Reinforcing steel bars (rebar) are steel rods that are used as a tension device in concrete. Typical applications are in the construction of buildings, bridges, roads and other civil works (infrastructure, superstructures, etc.).

Technical Data

Constructional data

Name	Value	Unit
Tensile strength (CA25)	30	kgf/mm²
Tensile strength (CA50)	54	kgf/mm²
Type of steel (Bar, coil, welded fabric, lattice grinders)	Bundle and roll	-
Production route	BF and EAF	-
Weldability (Ceq)	0,55 (max)	%
Yield strength (CA25)	25	kgf/mm²
Yield strength (CA50)	50	kgf/mm²
Surface geometry (fR or PRA) (CA25)	Plain	-
Surface geometry (fR or PRA)(CA50)	Rib	
Elongation (after break in 10xØ) (CA25)	18	%
Elongation (after break in 10xØ) (CA50)	8	%
Recycled content	76	%

Delivery status
Reinforcing steel bars (rebar) are supplied in rolls or in bundles using a wire rod with low carbon levels (7 mm), which can be recycled after collection and sorting as steel scrap. The rebars also have a plastic tag with information needed for product identification and tracking.

Base materials / Ancillary materials

The base material for the rebar is iron. Other elements like nitrogen or copper may be present in steel. The composition of these elements depends on the steel designation/grade. Substances listed on the "Candidate list of substances of very high concern for authorization" from the European Chemicals Agency are not contained in the steel in declarable quantities.

The *Associação Brasileira de Normas Técnicas* – ABNT (Brazilian National Standards Organization) established in standard ABNT NBR 8965 the maximum content of the following elements:

- % Carbon: 0,35 maximum
- % Manganese: 1,50 maximum
- % Phosphorus: 0,050 maximum
- % Sulphur: 0,050 maximum
- % Silicon: 0,50 maximum

The standard /ABNT NBR 8965/, also allows for ferroalloy content of elements like niobium, vanadium, but with a Carbon Equivalent Value (CEV) not exceeding 0,55% analysis in the ladle furnace, according the following equation.

For reinforcing steel, typical material compositions are given in the table below (Piracicaba template).

Chemical Element (%)	CA50	CA25
C	0,24 / 0,33	0,08 / 0,12
Si	0,14 / 0,35	0,16 / 0,26
Mn	0,55 / 0,90	0,65 / 0,80
P	0,05 Max.	0,05 Max.
S	0,045 Max.	0,05 Max.
Cr	0,23 Max.	0,30 Max.
Ni	0,23 Max.	0,30 Max.
Mo	0,10 Max.	0,50 Max.
Sn	0,10 Max.	0,07 Max.
Cu	0,63 Max.	0,45 Max.
V	0,015 Max.	0,015 Max.
Nb	0,008 Max.	0,004 Max.
Zn	0,058 Max.	0,058 Max.
Ceq	0,523 Max.	-
Proportion Mn/Si	2,5 Min	2,5 Min
Proportion Mn/S	22 Min.	22 Min.

Manufacture
In ArcelorMittal Brasil rebars are produced following either of the following routes:

- iron ore and charcoal are fed to a blast furnace to produce liquid iron, steel scrap is added and the energy of liquid iron is used to melt the scrap, which is then converted into steel in an electric arc furnace.
- Different steel scraps are melted in an electric arc furnace to obtain liquid steel.

In both cases the steel is then casted and rolled to obtain rebars.

Environment and health during manufacturing
Environmental, occupational health, safety and quality management at the different plants of ArcelorMittal in Brazil are in accordance with the following norms:

- ISO 14001;
- ISO 9001;
- OHSAS 18001;
- Environmental labeling Type I, provided by the Associação Brasileira de Normas Técnicas; ABNT (Brazilian National Standards Organization), developed according to the standards ISO 14020 and ISO 14024.

Re-use phase
Rebars are not reused at the end of life but can be easily separated from the concrete and recycled into similar steel products to the same (or higher/lower) quality of steel depending upon the metallurgy and processing of the recycling route.

Disposal
Reinforcing steel bars (rebar) is a valuable resource and therefore should not be disposed of. In this perspective, ArcelorMittal has implemented a network all over Brazil to enable scrap collection and to provide logistic support.

The small fraction of steel scraps which cannot be recovered (due to collection loss) is sent to landfill without any preventative measures.
The Brazilian Waste Index code for iron and steel products is 17 04 05.

Reference service life
Rebar is used in concrete structures to give additional mechanical resistance. The lifetime of rebar therefore will be limited by the service life of the building. Under these circumstances, no RSL according to the relevant ISO standards and /EN 15804/ can be declared.

Additional information
Additional information on reinforcing steel bars (rebar) can be found at:

- http://longos.arcelormittal.com.br/produtos/construcao-civil/fundacoes-contencoes/arcelormittal-50-soldavel
- http://longos.arcelormittal.com.br/pdf/produtos/construcao-civil/outros/manual-fabricacao-ca-50-ca-60.pdf

LCA: Calculation rules

Declared Unit
The declaration refers to the functional unit of 1 metric ton of reinforcing steel bar as specified in Part B requirements on the EPD for Reinforcing Steel.

Declared unit

Name	Value	Unit
Declared unit	1	t
Density	7850	kg/m^3
Conversion factor to 1 kg	1.00E-3	-

Reinforcing steel bars are produced by five ArcelorMittal plants in Brazil: Cariacica, Itaúna, João Monlevade, Juiz de Fora and Piracicaba. The data for the life cycle inventory are based on data covering 95% of the production volume of rebar in Brazil in 2014.

All reported data are calculated as total value per site averaged across all production sites based on production volume per site.

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 reinforcing 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
This module takes into account the sorting and shredding of after-use steel and as well the non-recovered scrap due to sorting efficiency which ends up in landfilling. Recycling should be understood as the preferred way to treat the product after use.

Module D refers to the net benefits and loads of the net flow leaving the product system.

Estimates and assumptions
As far as the raw material production is concerned, the Norwegian mix is used instead the Brazilian one for those datasets available only for EU context, namely for the production of nitrogen, oxygen, dolomite and limestone, in light of the similar electricity mix of the two countries (dominated by hydropower).

For raw materials supply an average Euro4 truck, with an utilisation ratio of 70%, was considered.

With regard to the process water used in the facilities, tap water was used as proxy of water coming from river.

Cut-off criteria
A cut-off in mass has been applied on the packaging used for delivering the finished products.

Background data
Background data from thinkstep professional database were used for modules A1, A2, C3 and D.

Allocation
The facility level data were allocated to the rebar using the annual production volume of the rebar (physical relationship).

As far as co-products allocation is concerned, the partitioning method was applied in accordance with Worldsteel recommendations (Worldsteel 2014).

Data quality
The life cycle inventory data used in this study complies with the quality requirements set out in ISO 14044 (ISO, 2006).

All relevant background datasets are taken from the GaBi 6 software database, using – as far as possible – the most updated processes.
Regarding foreground data, high quality primary data was collected by ArcerlorMittal Brasil and they subsequently underwent a verification process by Worldsteel.

Period under review
The reference year for the present EPD is 2014.

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.

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LCA: Scenarios and additional technical information

End of life (C1 - C4)
The waste processing of the rebar was modelled considering the /OVAM 2013/ MMG scenario for dismantling (C1), scenario based on the ecoinvent 2.0 record “Disposal, building, reinforced concrete, to recycling/CH U”. This scenario was adapted to the Brazilian situation with country-specific electricity mix. The end of life scenario (C4) for concrete reinforcement steel bars applied considers that after use 15% is landfilled.

Name	Value	Unit
Landfilling	150	kg

Reuse, recovery and/or recycling potentials (D), relevant scenario information
In module D, the benefit brought the 85% of the steel that goes to recycling after use, which becomes avoided production of virgin material, was applied to the net output of scraps leaving the product system.

Name	Value	Unit
Recycling	850	kg

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 ton reinforcing steel bars

Parameter	Unit	A1-A3	C3	D
Global warming potential	[kg CO_2-Eq.]	7.86E+2	3.66E+0	-2.56E+2
Depletion potential of the stratospheric ozone layer	[kg CFC11-Eq.]	1.22E-7	8.82E-11	-1.17E-9
Acidification potential of land and water	[kg SO_2-Eq.]	2.74E+0	2.20E-2	-9.82E-1
Eutrophication potential	[kg $(PO_4)^{3-}$-Eq.]	2.18E-1	2.59E-3	-7.48E-2
Formation potential of tropospheric ozone photochemical oxidants	[kg ethene-Eq.]	1.21E-1	1.65E-3	-1.41E-1
Abiotic depletion potential for non-fossil resources	[kg Sb-Eq.]	1.87E-4	6.72E-7	4.85E-6
Abiotic depletion potential for fossil resources	[MJ]	5.50E+3	4.12E+1	-2.40E+3

RESULTS OF THE LCA - RESOURCE USE: 1 metric ton reinforcing steel bars

Parameter	Unit	A1-A3	C3	D
Renewable primary energy as energy carrier	[MJ]	2.42E+3	2.00E+1	1.45E+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]	2.42E+3	2.01E+1	1.45E+2
Non-renewable primary energy as energy carrier	[MJ]	5.71E+3	4.35E+1	-2.30E+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]	5.71E+3	4.35E+1	-2.30E+3
Use of secondary material	[kg]	7.00E+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]	1.47E+1	1.09E-1	-1.91E+1

RESULTS OF THE LCA – OUTPUT FLOWS AND WASTE CATEGORIES: 1 metric ton reinforcing steel bars

Parameter	Unit	A1-A3	C3	D
Hazardous waste disposed	[kg]	3.14E-4	5.24E-7	-1.73E-6
Non-hazardous waste disposed	[kg]	4.80E+0	1.50E+2	-3.56E+0
Radioactive waste disposed	[kg]	8.08E-2	8.78E-4	3.97E-2
Components for re-use	[kg]	0.00E+0	0.00E+0	0.00E+0
Materials for recycling	[kg]	0.00E+0	8.50E+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

LCA interpretation

Rebar is produced by ArcelorMittal Brasil using both Electric Arc Furnace route (EAF route) and Blast Furnace route (BF route). Per metric ton of rebar produced, 700 kg scrap is used.

A potential environmental benefit is calculated for the end-of-life stage (module D) for all the considered impact categories. The net amount of scrap (net output of scrap) is 150 kg, which carries a potential credit, shown as environmental benefit in module D.

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/EN 15804/
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