Steel Rebar, Merchant Bar Quality and Wire Rods

ARCELORMITTAL LONG PRODUCTS CANADA

ENVIRONMENTAL PRODUCT DECLARATION

ISO 14025:2006 and ISO 21930:2017

ArcelorMittal Long Products Canada is pleased to present this Environmental Product Declaration (EPD) for their Steel Rebar, Merchant Bar Quality and Wire Rods. This EPD was developed in compliance with ISO 14025 and ISO 21930 and has been verified by Lindita Bushi Ph.D., Athena Sustainable Materials Institute.

The LCA and the EPD were prepared by Vertima Inc. The EPD includes cradle-to-gate with options life cycle assessment (LCA) results.

For more information about ArcelorMittal Long Products Canada, visit https://long-canada.arcelormittal.com/en/

For any explanatory material regarding this EPD, please contact the program operator.

Environmental Product Declaration

CSA Group Registered Based on ISO 14025 and Other Requirements
For more information visit csaregistries.ca/epd
5021-0982
September 2024-September 2029

1. GENERAL INFORMATION

PCR GENERAL INFORMATION			
Reference PCR	PCR Part B: Designated Steel Construction Product EPD Requirements (UL 10010-34), v.2.0 and its core PCR Part A: Life Cycle Assessment Calculation Rules and Report Requirements (UL 10010), v.4.0 UL Environment August 2020 to August 2025 (validity period of PCR Part B) March 28, 2022 to March 28, 2027 (validity period of PCR Part A)		
The PCR review was conducted by:	*Thomas Gloria, PhD (chair)* *Industrial Ecology Consultants* *t.gloria@industrial-ecology.com*	*Brandie Sebastian* *JBE Consultants*	*James Littlefield* *Independent Consultant*

EPD GENERAL INFORMATION		
Program Operator	CSA group 178 Rexdale Blvd Toronto (Ontario) Canada M9W 1R3 www.csagroup.org	
Declared Products	**Rebar** **Merchant Bar Quality** **Wire Rods**	
EPD Registration Number 5021-0982	**EPD Date of Issue** September 25, 2024	**EPD Period of Validity** September 25, 2024 - September 24, 2029
EPD Recipient Organization	ArcelorMittal Long Products Canada 3900, route des Aciéries Contrecoeur (Quebec) Canada J0L 1C0 https://long-canada.arcelormittal.com/en/	ArcelorMittal

EPD Type/Scope and Declared Unit Product-specific cradle-to-gate with options EPD with declared unit of 1 metric ton.			**Year of Reported Manufacturer Primary Date** 2023
Geographical Scope North America	**LCA Software** OpenLCA version 2.0.3	**LCI Databases** Ecoinvent 3.9.1 and US LCI	**LCIA Methodology** TRACI 2.1, CML 4.8 (ADP_{fossil}) and CED, LHV, v1.0

This LCA and EPD were prepared by:	Chantal Lavigne Vertima Inc. www.vertima.ca
This EPD and LCA were independently verified in accordance with ISO 14025:2006, ISO 14040:2006 and ISO 14044:2006, as well as the UL Environment PCR "Part B: Designated Steel Construction Product EPD Requirements (UL 10010-34) v.2.0", and PCR "Part A: Life Cycle Assessment Calculation Rules and Report Requirements (UL 10010), v.4.0", which serves as the core PCR. ☐ Internal ☒ External	*Lindita Bushi* ______________ Lindita Bushi, Ph.D. Athena Sustainable Materials Institute

LIMITATIONS

Environmental declarations from different programs based upon differing PCRs may not be comparable.[1]

Comparison of the environmental performance of construction works and construction products using EPD information shall be based on the product's use and impacts at the construction works level. In general, EPDs may not be used for comparability purposes when not considered in a construction works context.[2]

When comparing EPDs created using this PCR, variations and deviations are possible. Example of variations: Different LCA software and background LCI datasets may lead to different results for upstream or downstream of the life cycle stages declared.[2]

Rebar [Photo courtesy of ArcelorMittal Long Products Canada]

2. PRODUCT SYSTEM DESCRIPTION

ArcelorMittal Long Products Canada, a division of ArcelorMittal, is a steel manufacturer.

2.1. PRODUCT DESCRIPTION

Rebar

Rebar, or concrete reinforcing bar, refers to uncoated carbon and low-alloy steel and is the foundation that provides tensile strength to concrete. It is manufactured in conformity with:

- CSA G30.18:21 Carbon Steel Bars for Concrete Reinforcement, grade 400R/400W and 500R/500W [7];
- ASTM A615/A615M-22 Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement, grades 60 and 75 [8];
- ASTM A706 /A706M-24 Standard Specification for Deformed and Plain Low-Alloy Steel Bars for Concrete Reinforcement, grades 60 and 75 [9].

Merchant Bar Quality (MBQ)

Merchant Bar Quality (MBQ) steel refers to uncoated carbon and low-alloy steel. It is manufactured in conformity with:

- CSA G40.20-13/G40.21-13 General requirements for rolled or welded structural quality steel / Structural quality steel, grades 44W, 50W, 55W, and 60W [10];
- ASTM A36/ A36M-14 Standard Specification for Carbon Structural Steel [11];
- ASTM A572/A572M-21e1 Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel, grades 50 type 1 and 2, as well as grade 65 [12];
- ASTM F1554-20 Standard Specification for Anchor Bolts, Steel 36, 55, and 105-ksi Yield Strength, grades 36 and 55 [13].

Rebar [photo courtesy of ArcelorMittal Long Products Canada].

Merchant Bar Quality Steel [photo courtesy of ArcelorMittal Long Products Canada].

Wire Rods

ArcelorMittal Long Products Canada's rod products are manufactured to meet to the most demanding applications in the industry, and are clearly recognized for their high quality and reliability that has been proven over time. One of our main strengths is the solid relationship between our rod mill and steel plants, with the main goal always being to make world-class steel for our customers.

Rod may be made of carbon steel (10xx grades), resulfurized steel (11xx grades), high manganese carbon steel (15xx and 13xx grades), alloy steel (40xx, 41xx, 51xx, 86xx, 92xx grades), boron grades (10Bxx and 15Bxx grades), low tensile (10xxB grades), plating grades (10xxPL) or free cutting steel (1215). The rods comply with ASTM-A510, ASTM-A1040, ASTM-F2282, ASTM -A706 or CSA G30.18-E21.[7], [9], [14]–[16]

Wire Rod [photo courtesy of ArcelorMittal Long Products Canada].

2.2. MATERIAL COMPOSITION

The approximate material content of Rebar, Merchant Bar Quality (MBQ) and Wire Rod steel will vary slightly from batch to batch. In general, the rebar and MBQ steel will contain, by mass, < 94% iron, < 2% Manganese, <1% Copper, <0.5% Carbon, <0.5% Silicon and a total of 2% or less of Nickel, Chromium, Molybdenum, Niobium, Nitrogen, Titanium, Boron, Calcium, Sulfur, Tin, Phosphorus, Vanadium or any other substance or impurities. For more details on rebar and MBQ material content, please refer to the health product declaration (HPD) that can be found at http://www.hpd-collaborative.org/hpd-public-repository/. Wire rods will contain, by mass, < 94% iron, < 2.4% Manganese, <0.2% Copper, <0.9% Carbon, <1.2% Silicon and a total of 1.3% or less of Nickel, Chromium, Molybdenum, Niobium, Nitrogen, Titanium, Boron, Calcium, Sulfur, Tin, Phosphorus, Vanadium or any other substance or impurities.

Material composition of ArcelorMittal Long Products Canada steel.

Steel alloying element	CAS Number	Rebar and MBQ (wt.%)	Wire Rods (wt.%)
Iron (Fe)	7439-89-6	> 94%	> 94%
Carbon (C)	7440-44-0	< 0.5%	< 0.9%
Manganese (Mn)	7439-96-5	< 2%	> 0.1% – < 2.4%
Copper	7440-50-8	< 1%	< 0.2%
Silicon (Si)	7440-21-3	<0.5%	<1.2%
Others (such as Ni, Cr,Mo...)	7440-44-0	< 2%	< 1.3%

2.3. PRODUCT APPLICATION

Rebar is an essential part of roads, buildings and infrastructures around the world. Concrete has a high compressive strength but a low tensile strength. To compensate for this imbalance in concrete's behavior, rebar is cast into it to carry the tensile loads.[17]

MBQ steel is generally used in structural-type applications involving bending, forming, punching and welding. Merchant Bars are used by fabricators and manufacturers to produce a wide variety of products including steel frames and structures, brackets, steel floor and roof joists, walkways, ornamental furniture, railings, and more.[17]

Wire Rods are used by four main business segments:

- Low carbon which is mainly catering to the construction industry for mesh product and nails;
- Cold heading which is made of fasteners for the automotive industry and others;
- Welding consumable which is used almost everywhere, from the farmer welding his tractor to a robot welding a precise automotive part on an assembly line;
- Coiled rebar is mainly used in the construction industry.

2.4. PROPERTIES OF DECLARED PRODUCT AS DELIVERED

Technical information for unfabricated Rebar in uncoated carbon and low-alloy steel

Name	Value	Unit
Key Properties	Weldability and Mechanical properties	
Density	7850	kg/m³ (kilograms/cubic meters)
Boiling Point	2850	ºC (degrees Celsius)
Melting Point	1450	ºC (degrees Celsius)
Rebar in Length		
Length	6.0 – 18.5	(m) meters
Diameter	0.01 – 0.055	(m) meters
Rebar in Coils		
Outer diameter	1.24	(m) meters
Inner diameter	0.86	(m) meters
Length	1.02	(m) meters
Standard	CSA G30.18 (grades 400R/400W and 500R/500W, ASTM A615 (grades 60 and 75), ASTM A706 (grades 60 and 75) [7]–[9]	

Technical information for unfabricated Merchant Bar Quality (MBQ) steel in uncoated carbon and low-alloy steel

Name	Value	Unit
Key Properties	Mechanical Properties and Steel Homogeneity	
Density	7850	kg/m^3 (kilograms/cubic meters)
Boiling Point	2850	ºC (degrees Celsius)
Melting Point	1450	ºC (degrees Celsius)
Dimensions – Rounded Shaped		
Diameter	0.02 – 0.1	(m) meters
Length	4.5 – 18.2	(m) meters
Dimensions – Flat Shaped		
Thickness	0.006 – 0.05	(m) meters
Width	0.04 – 0.15	(m) meters
Length	4.5 – 18.2	(m) meters
Standard	CSA G40.21 (grades 44W, 50W, 55W, and 60W) , ASTM A36, ASTM A572 (grades 50 type 1 and 2, grade 65), ASTM F1554 (grades 36 and 55) [10]–[13]	

Technical information for rods

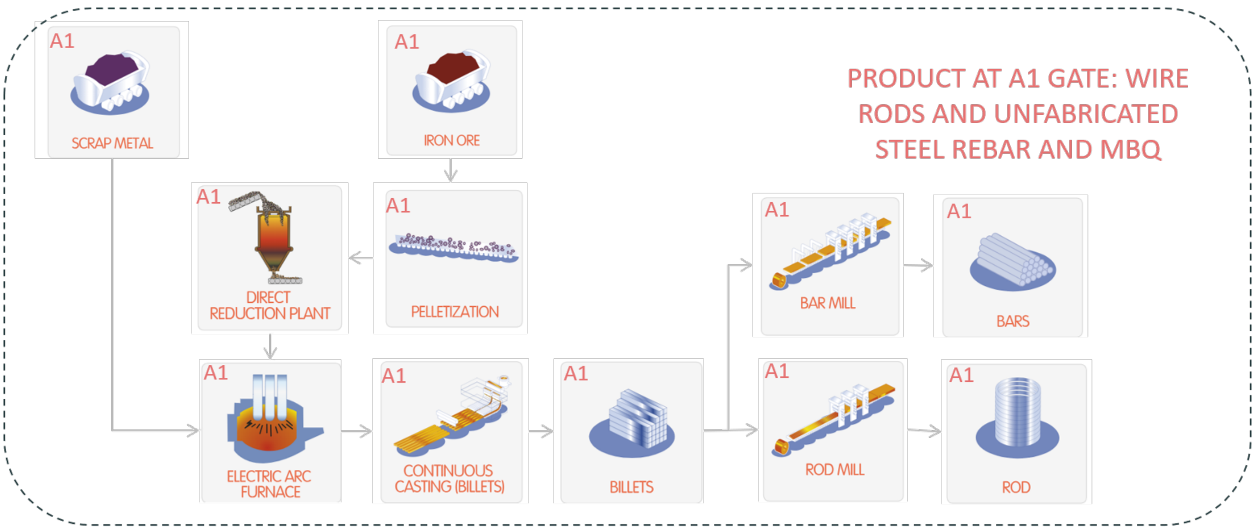
Name	Value	Unit
Density	7850	kg/m^3 (kilograms/cubic meters)
Boiling Point	2850	ºC (degrees Celsius)
Melting Point	1450	ºC (degrees Celsius)
Dimensions		
Diameter	5.5 – 20.6	(mm) millimeters
Outer Diameter (OD	127	(cm) centimeters
Inner Diameter (ID)	83	(cm) centimeters
Length (min)	163	(cm) centimeters
Coil Weight (min)	1928	(kg) kilograms
Standard	ASTM-A510, ASTM-A1040, ASTM-F2282, ASTM -A706 or CSA G30.18-E21.[7], [9], [14]–[16]	

More details can be found on ArcelorMittal Long Products Canada' website: https://long-canada.arcelormittal.com/flipbook/.

2.5. MANUFACTURING

Scrap metal and iron ore are melted with very hot electrodes (about 1,650 degrees Celsius) in the electric arc furnace (EAF). Oxygen blown into the furnace during the process removes impurities from the hot metal. The molten steel is then tapped into a ladle furnace where additives are mixed in to refine the composition of the steel and give it certain properties. In continuous casting, steel billets are produced on a four-strand system (four billets at the same time) or six-strand system (six billets at once), depending on the plant. A billet is a long bar of steel measuring 8 to 12.5 meters long. It can be sold to customers as a base for fabricating other products. However, most of the billets are supplied to ArcelorMittal Long Products Canada's rolling mills before being sent to fabricators. In this study, at the rolling mill gate, products are Wire Rods, unfabricated Rebar and unfabricated MBQ steel.

At the rolling mills, billets pass through a series of rolling stands that stretch and reshape the steel into bars of different lengths and sizes or into rods. Bars formed this way may be reinforcing bars, such as rebar, for use in residential and road construction, bars used to produce the leaf springs used in light and heavy trucks, special bar quality, merchant bar quality, steel angles, etc. Wire rods may be used in a variety of products depend on the steel composition and additional transformation steps. Examples include fasteners, nails, mesh, fencing, and more.



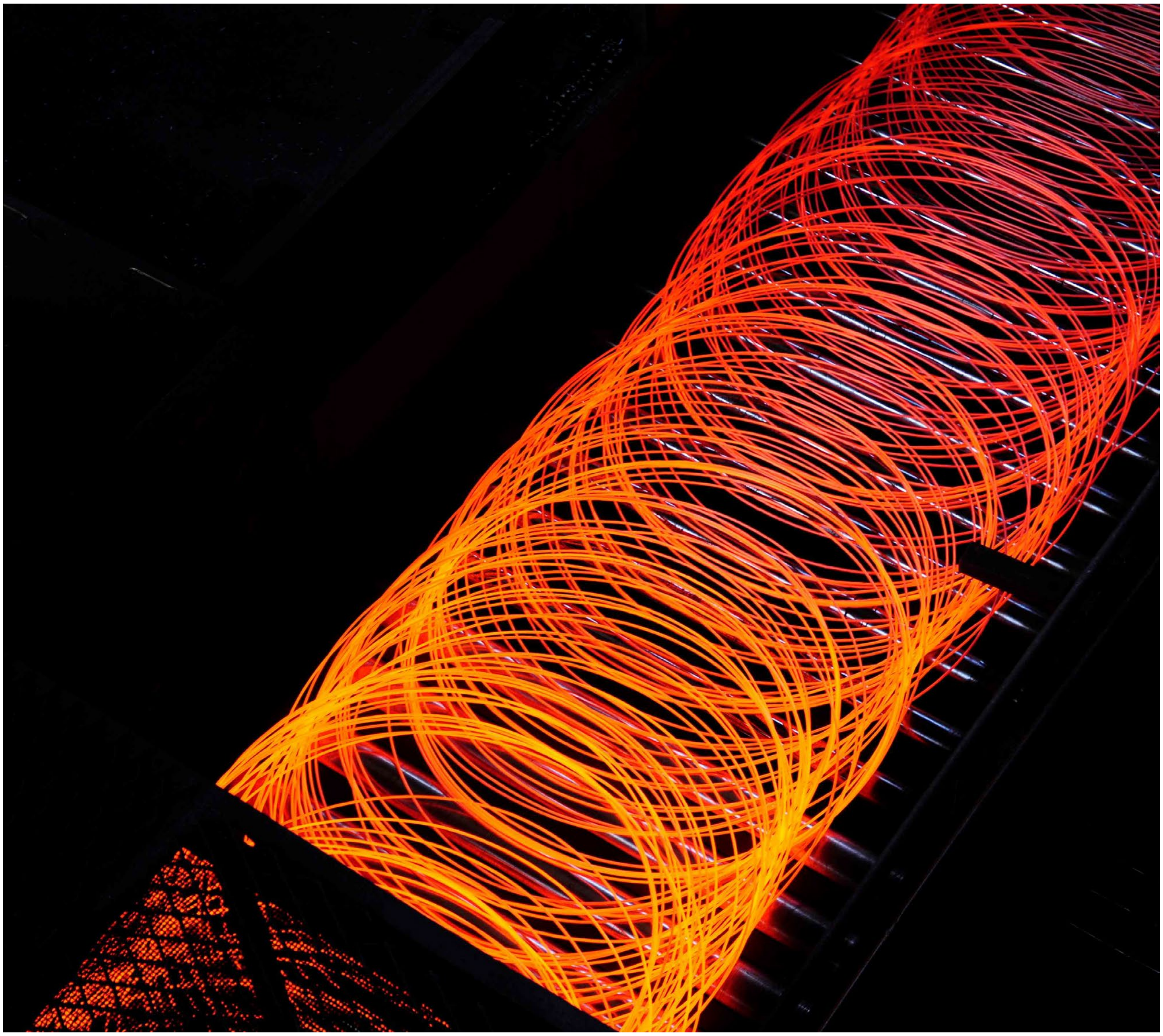
2.6. DISPOSAL

At its end of life, steel may be reused or recycled.

2.7. BENEFITS AND LOADS BEYOND THE SYSTEM BOUNDARY (MODULE D)

Module D is included in this study and was calculated using the World Steel Association methodology and their 2020 LCI value for scrap steel. ArcelorMittal billets contain 0% - 4.9% pre-consumer recycled content and 17.9% – 19.6% post-consumer recycled content for a total of 19.6% - 22.8%% recycled content. Furthermore, the 2019 steel recycling rate, according to American Iron and Steel Institute & Steel Manufacturers Association technical report of the United States steel recycling rate, is 59% for rebar and 68% for other construction steel (excluding structural sections).[18]

In this study, 1 metric ton (MT) of fabricated Rebar used 0.298 MT of pre- and post-consumer scrap, while 1 MT of fabricated MBQ used 0.308 MT of pre- and post-consumer scrap. Pre-consumer iron is material diverted from the waste stream during the fabrication process of fabricated rebar or fabricated MBQ steel and put back in the EAF process, while post-consumer iron includes materials generated by households or by commercial, industrial and institutional facilities in their role as end-user of the product which can no longer be used for its intended purpose.



Wire Rod [photo courtesy of ArcelorMittal Long Products Canada]

3. LCA CALCULATION RULES

3.1. DECLARED UNIT

The selected declared unit (DU) for this study is **one (1) metric ton of fabricated products**. ArcelorMittal Long Products Canada reports a steel density of 7850 kg/m^3.

3.2. PRODUCTION AVERAGE

The weighted average profile of Rebar, Merchant Bar Quality (MBQ) Steel and Wire Rods are calculated based on 2023 annual production data (on mass basis) from the two steel mills and three rolling mills. The steel mills are located in Contrecoeur (Quebec) and the rolling mills are located in Contrecoeur (Quebec) and Longueuil (Quebec).

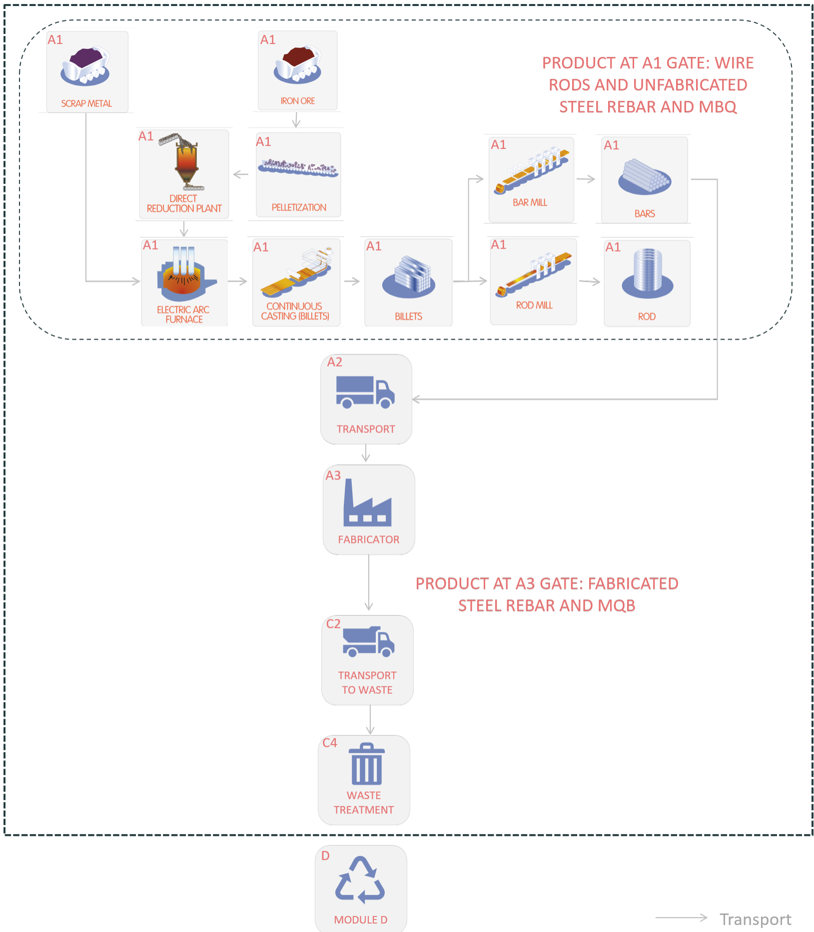
3.3. SYSTEM BOUNDARIES

The system boundaries are **cradle-to-gate with options**, i.e., cover the production and end-of-life life cycle stages as well as the benefits and loads beyond the system boundary (see table below). Within the production life cycle stage, three (3) modules are considered, namely A-1) Extraction and Upstream Production, A-2) Transport to Factory and A-3) Manufacturing. Construction (A-4; A-5) and Use (B-1 to B-7) stages are not included in the present study. Within the End-of-Life stage, four (4) modules are considered, namely C-1) Deconstruction / Demolition, C-2) Transport to Waste Processing or Disposal, C-3) Waste Processing and C-4) Disposal of Waste. The figure below presents the process flow diagram. Neither green power nor CO_2 credits are used in the framework of this project.

Description of the system boundary life cycle stages and related information modules

PRODUCTION STAGE			CONSTRUC-TION STAGE		USE STAGE							END-OF-LIFE STAGE				BENEFITS AND LOADS BEYOND THE SYSTEM BOUNDARY
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
Extraction and Upstream Production	Transport to Factory	Manufacturing	Transport to site	Installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational Energy Use	Operational Water Use	Deconstruction / Demolition	Transport to Waste Processing or Disposal	Waste Processing	Disposal of Waste	Reuse, Recovery, Recycling Potential
X	X	X	MND	MND	MND	MND	MND	MND	MND	MND	MND	X	X	X	X	X

Key: X = included; MND = module not declared (excluded)



System boundaries of cradle-to-gate with options LCA of fabricated Rebar and MBQ steel.

Extraction and upstream production (A1): This module includes the extraction and transformation of raw materials needed to produce steel, transport of the raw materials to the steel mill, the steel production process, and the bar mill process, including transportation from the primary producer to the secondary producer. Wire rods as well as unfabricated rebar and unfabricated MBQ steel packaging is negligeable and not considered.

Iron ore used at ArcelorMittal originates from Northern Quebec mines, run by ArcelorMittal Mining Canada. Before being shipped from Port-Cartier to Contrecoeur, the iron ore is enriched and converted into pellets that are cooked at high temperatures in a pelletization process. Prior to being used in Contrecoeur's steelworks, the iron pellets go through the direct reduction process to remove most of the oxygen and increase purity.

Scrap metal, i.e. pre- and post-consumer steel, can be used with or without iron ore to make steel. Scrap metal (from cars, home appliances, steel waste, household recycling, etc.) is collected at recycling centres and processed by external suppliers.

Scrap metal and iron ore are melted in the electric arc furnace (EAF) and steel billets are produced. The billets are sent to the rolling mills **where unfabricated Rebar**, **unfabricated Merchant Bar Quality steel**, and **Wire Rods** are produced.

Transport to factory (A2): This module includes the transportation of the unfabricated steel to the fabricator.

Manufacturing (A3): This stage includes the fabricator operations taken from the industry-wide Concrete Reinforcing Steel Institute (CRSI) EPD for fabricated steel reinforcement.[19] At the gate of this module, **fabricated Rebar** and **fabricated MBQ steel** are available for distribution.

Deconstruction / Demolition (C1): This module includes deconstruction and demolition. The contribution of this module is assumed negligeable and has been excluded.

Transport to Waste Processing or Disposal (C2): This module includes the transport of rebar and MBQ steel to either the landfill or the recycling center.

Waste Processing (C3): This module includes waste processing of material flows resulting in, for example, secondary materials. As a cut-off approach has been used to consider recycling at end-of-life, sorting and pressing of scrap steel is considered in A1 and it is assumed that no other processing takes place prior to this process step; hence, no impacts are related to this module.

Disposal of Waste (C4): This module includes landfilling of fabricated Rebar and fabricated MBQ steel that is not recycled.

Reuse, Recovery, Recycling Potential (D): The results values of Module D include a recognition of the benefits or impacts related to steel recycling which occur at the end of the product's service life. The rate of steel recycling (RR) and related processes will evolve over time. The results included in Module D attempt to capture future benefits, or impacts, but are based on a methodology that uses current industry-average data reflecting current processes.

3.4. CUT-OFF CRITERIA

According to the UL Environment PCR – Part B,[2] all known mass and energy flows shall be reported. No known flows should be deliberately excluded.

No known flows are deliberately excluded from this EPD.

For this study, no data on the construction, maintenance or dismantling of the capital assets, daily transport of the employees, office work, business trips and other activities from ArcelorMittal Long Products Canada's employees was included in the model. The model only takes into account the processes associated with infrastructure that are already included in the *ecoinvent* unit processes.

3.5. ALLOCATION

According to the UL Environment PCR – Part B,[2] mass should be used as the primary basis for co-product allocation. Allocation methods deemed more appropriate than on the basis of mass may be used but only when justified.

Slag and mill scale are co-products of wire rod and unfabricated rebars. **Mass allocation was used** to partition the inputs and outputs of the production process.

Waste processing of the material flows undergoing recycling processes are included up to the system boundary of the end-of-waste state.[6] In other words, a cut-off approach was used as further processing of the recycled material is part of raw material preparation of another product system (open-loop recycling).

3.6. DATA SOURCES AND QUALITY REQUIREMENTS

Data Quality Parameter	Data Quality Discussion
Source of manufacturing data	Manufacturing data was collected from ArcelorMittal Long Product Canada manufacturing plants located in Contrecoeur (Quebec) and Longueuil (Quebec) for the 2023 production year. This data included: total annual mass of products produced at the different manufacturing plants; raw materials and fuels entering the product production process; transport distance of materials and fuels, electricity consumption, water consumption, and emissions to the environment at the manufacturing plants.
Source of secondary data	In priority, background data was taken from ecoinvent 3.9.1 “cut-off” datasets representative of Quebec, Canada, the United States or North America. Otherwise, ecoinvent data representative of the global market or the “rest-of-the-world” was selected as proxies. Train and truck transport data were taken from the US LCI Database, which is specific to a North American context.
Geographical representativeness	The ArcelorMittal Long Products Canada manufacturing facilities are based in the province of Quebec; hence electricity consumption is based on the Quebec grid mix. Geographical correlation of the material supply and the selected datasets are largely representative of the same area. When appropriate, the grid mix was changed for the grid mix of the province or country where production takes place.
Temporal representativeness	Primary data was collected as to be representative of the 2023 full production year. Selected ecoinvent and US LCI datasets were not always published within the last ten years. Nevertheless, ecoinvent and US LCI remain the reference LCI databases.
Technological representativeness	Primary data, obtained from the manufacturer, is representative of the current technologies and materials used by this company.
Completeness	All relevant process steps were considered and modelled to satisfy the goal and scope. No known flows were cut off.

4. LIFE CYCLE ASSESSMENT SCENARIOS

4.1. END-OF-LIFE STAGE

Demolition and deconstruction (C1) energy use is not known and has been considered negligeable. Transport to the waste facility (C2) is assumed to be 100 km travelled by truck. Further processing of steel at the steel recycling facility (C3) is considered in A1 for the scrap steel input and is null in C3 as a cut-off recycling approach was used. Finally, unrecycled steel is considered sent to inert landfill (C4). Wire Rods are not fabricated products; hence, are not included here.

End-of-Life (C1 to C4) scenario assumptions

Name		Rebar	MBQ	Unit
Collection process (specified by type)*	Collected separately	0.59	0.68	kg/MT
	Collected with mixed construction waste	0.41	0.32	kg/MT
Recovery (specified by type	Reuse	0	0	kg/MT
	Recycling	0.59	0.68	kg/MT
	Landfill	0.41	0.32	kg/MT
	Incineration	0	0	kg/MT
	Incineration with energy recovery	0	0	kg/MT
	Energy conversion (specify efficiency rate)	0	0	kg/MT
Disposal (specific by type)	Product or material for final deposition	0.41	0.32	kg/MT
Removal of biogenic carbon (excluding packaging)		0	0	kg/MT

* Distance travelled estimated at 100 km by truck

4.2. MODULE D

As stated in the UL Environment PCR, "*Module D reports the potential benefit or burden from the displacement of primary materials and/or fuels associated with recycling and recovery at end-of-life.*" For this study, the World Steel Association methodology, section 3.6.2, was followed [20], i.e., a closed-loop recycling methodology. In a closed-loop system, the inherent properties of the primary and secondary products are equivalent. Note, however, that in this study, the definition of pre-consumer and post-consumer steel differs slightly from the World Steel Association methodology, while the definition of internal scrap, home scrap, fabrication scrap and end-of-life scrap are used as defined by World Steel Association methodology. Internal scrap is steel scrap from the EAF steelmaking processes up to casting (billet) that is put back into the same EAF process. Home scrap is steel scrap from a downstream steelworks process, such as from the hot rolling process, that is put back into the EAF process. In this study, pre-consumer scrap is material diverted from the waste stream during a manufacturing process, such as fabrication scrap, and excludes internal and home scrap, whereas post-consumer scrap includes end-of-life scrap.

The life cycle equation for this "closed-loop recycling methodology" is applied as shown by the equations below:

$$LCI\ including\ recycling = X - (RR - S)Y(X_{pr} - X_{re})$$

$$LCI_{credit/burden} = (RR - S)Y(X_{pr} - X_{re})$$

If (RR-S) > 1: credit; if (RR-S) < 1: burden

$$ScrapLCI = (X_{pr} - X_{re})Y$$

$$Amount\ of\ scrap\ producted\ by\ the\ system = (RR - S)$$

Where:

- X: LCI of the steel product under study.
- RR (Recycling rate): the end-of-life recycling rate of the steel product. It represents the fraction of steel recovered as scrap during the lifetime of a steel product and includes any scrap that is generated after manufacturing the steel product under analysis.
- S (Scrap input to the steelmaking process): This is the net scrap consumed in the steelmaking process to make a specific product and does not include internally generated scrap (in this case "internal scrap" and "home scrap"). In other words, the quantity of pre- and post-consumer scrap used in the process is considered.
- Y (Metallic yield): the process yield (or efficiency) of the EAF process. It is the ratio of steel output to scrap input (i.e. >1kg scrap is required to produce 1kg steel).
- X_{pr} (LCI for primary steel production): the theoretical LCI for 100% primary metal production, from the BOF route, assuming 0% scrap input.
- X_{re} (LCI for secondary steel production): the theoretical LCI for 100% secondary metal production, from the EAF route, assuming 100% scrap input.

When the system has an LCI credit (RR-S >1), it means it has generated primary metal to feed the closed-loop system in post-consumer steel, and gets credit for avoiding impacts, such as iron ore extraction, in secondary metal production. On the other hand, when the system has an LCI burden (RR – S <1), it means the system under study uses more post-consumer steel that can be produced by the whole steel system, and has to include part of the impacts encountered in the production of primary metal needed to supply the basin of post-consumer steel.

The World Steel Association provided values for the *ScrapLCI*. The data was published in 2020 and represents steel production from 2014 to 2019, with the majority being from 2014. The data represents global production as scrap is traded globally. The World Steel Association data was gathered according to ISO 14040 and 14044.

Benefits and Loads Beyond the System Boundary (D), Relevant Scenario Information

Name	Rebar	MBQ	Unit
Recycling rate of product (RR)	59.0	68.0	%
Recycled content of product	22.8	22.1	%

In this study, the recycling rate (RR) at end-of-life for steel is assumed to be 59% for unfabricated rebar and 68% for unfabricated MBQ. This is based on the 2021 sector-specific recycling rate published by the American Iron and Steel Institute and the Steel Manufacturers Association.[18]

Rebar [Photo courtesy of ArcelorMittal Long Products Canada]

5. LIFE CYCLE ASSESSMENT RESULTS

5.1. RESULTS TABLES

LCIA results are relative expressions and do not predict impacts on category endpoints, the exceeding of thresholds, safety margins or risks. These six impact categories are globally deemed mature enough to be included in Type III environmental declarations. Other categories are being developed and defined and LCA should continue making advances in their development. However, the EPD users shall not use additional measures for comparative purposes.

The tables below present the LCIA results for one metric ton (MT) of fabricated steel product using TRACI methodologies, as well as primary energy consumption, consumption of renewable and non-renewable materials, water consumption, and waste generation. Results are presented for the production of Rebar and Merchant Bar Quality (MBQ) steel. It should be noted that fabrication requires 1.08 metric tons of unfabricated product to produce 1 metric ton of fabricated products; hence, module A1 represents 1.08 MT of unfabricated rebar or MBQ steel.

Results are presented for the following indicators:

TRACI 2.1 potential impact indicators
GWP: Global Warming Potential; **AP**: Acidification Potential: **EP**: Eutrophication Potential: **ODP**: Ozone Layer Depletion Potential; **SFP**: Smog Formation Potential; **ADP_{fossil}**: Abiotic Resource Depletion Potential of Non-Renewable (Fossil) Energy Resources.
Resource use
RPR_E: Renewable Primary Resources Used as Energy Carrier (Fuel); **RPR_M**: Renewable Primary Resources with Energy Content Used as Material; **RPR_T**: Renewable Primary Resources Total; **$NRPR_E$**: Non-Renewable Primary Resources Used as Energy Carrier (Fuel); **$NRPR_M$**: Non-Renewable Primary Resources with Energy Content Used as Material; **$NRPR_T$**: Non-Renewable Primary Resources Total; **SM**: Secondary Materials; **RSF**: Renewable Secondary Fuels; **NRSF**: Non-Renewable Secondary Fuels; **RE**: Recovered Energy; **FW**: Use of Net Fresh Water Resources.
Output flows and waste categories
HWD: Hazardous Waste Disposed; **NHWD**: Non-Hazardous Waste Disposed; **RWD**: Radioactive Waste Disposed; **HLRW**: High-Level Radioactive Waste, Conditioned, to Final Repository; **ILLRW**: Intermediate and Low-Level Radioactive Waste, Conditioned, to Final Repository; **CRU**: Components for Re-Use; **MFR**: Materials for Recycling; **MER**: Materials for Energy Recovery; **EE**: Exported Energy.

	Environmental Indicator	Unit	Fabricated Rebar					
			A1*	A2	A3	C2	C4	D
TRACI 2.1	GWP_{100}-AR5(1)	kg CO_2 eq./MT	1.10E+03	1.07E+02	2.70E+01	1.24E+01	4.84E+00	-4.79E+02
	GWP_{100}-AR4(2)	kg CO_2 eq./MT	1.08E+03	1.07E+02	2.70E+01	1.23E+01	4.73E+00	-4.73E+02
	AP	kg SO2 eq./MT	2.74E+00	9.89E-01	6.10E-02	1.51E-01	3.08E-01	-7.14E-01
	EP	kg N eq./MT	1.16E+00	7.00E-02	6.11E-03	1.08E-02	1.27E-02	-1.78E-02
	ODP	kg CFC-11 eq./MT	1.15E-05	2.47E-07	2.57E-10	4.25E-08	1.25E-07	0.00E+00
	SFP	kg O_3 eq./MT	5.03E+01	2.91E+01	1.48E+00	4.12E+00	7.92E-01	-1.04E+01
	ADP_{fossil}(3)	MJ, LHV/MT	1.36E+04	1.02E+03	1.16E+03	1.76E+02	1.02E+02	-4.89E+03
Resource use	RPR_E(4)	MJ, LHV/MT	4.59E+03	1.80E+00	2.42E+01	3.23E-01	1.77E+00	3.06E+02
	RPR_M(5)	MJ, LHV/MT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	RPR_T	MJ, LHV/MT	4.59E+03	1.80E+00	2.42E+01	3.23E-01	1.77E+00	3.06E+02
	$NRPR_E$(6)	MJ, LHV/MT	1.43E+04	1.02E+03	1.16E+03	1.75E+02	1.04E+02	-5.02E+03
	$NRPR_M$(7)	MJ, LHV/MT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	$NRPR_T$	MJ, LHV/MT	1.43E+04	1.02E+03	1.16E+03	1.75E+02	1.04E+02	-5.02E+03
	SM	Kg/MT	2.48E+02	0.00E+00	3.54E+01	0.00E+00	0.00E+00	-
	RSF	MJ, LHV/MT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-
	NRSF	MJ, LHV/MT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-
	RE	MJ, LHV/MT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-
	FW(8)	m^3/MT	2.62E+01	1.15E-02	6.72E-02	2.06E-03	1.06E-01	-
Output flows and waste	HWD(9)	Kg/MT	7.81E+02	6.08E-01	6.94E-01	1.09E-01	3.09E+00	-
	NHWD(10)	Kg/MT	7.30E+01	9.32E-01	9.71E-01	1.62E-01	4.11E+02	-
	HLRW(11)	m^3/MT	1.30E-06	7.05E-11	1.92E-08	1.25E-11	1.68E-09	-
	ILLRW(12)	m^3/MT	2.65E-06	4.17E-10	9.57E-07	7.41E-11	9.14E-09	-
	CRU	Kg/MT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-
	MFR	Kg/MT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-
	MER	Kg/MT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-
	EE	MJ, LHV/MT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-

Environmental Indicator		Unit	Fabricated MBQ					
			A1*	A2	A3	C2	C4	D
TRACI 2.1	GWP_{100}-AR5[1]	kg CO_2 eq./MT	1.17E+03	1.07E+02	2.70E+01	1.24E+01	3.78E+00	-6.10E+02
	GWP_{100}-AR4[2]	kg CO_2 eq./MT	1.16E+03	1.07E+02	2.70E+01	1.23E+01	3.69E+00	-6.03E+02
	AP	kg SO2 eq./MT	3.01E+00	9.89E-01	6.10E-02	1.51E-01	2.41E-01	-9.10E-01
	EP	kg N eq./MT	1.21E+00	7.00E-02	6.11E-03	1.08E-02	9.87E-03	-2.27E-02
	ODP	kg CFC-11 eq./MT	1.21E-05	2.47E-07	2.57E-10	4.25E-08	9.75E-08	0.00E+00
	SFP	kg O_3 eq./MT	5.61E+01	2.91E+01	1.48E+00	4.12E+00	6.18E-01	-1.32E+01
	ADP_{fossil}[3]	MJ, LHV/MT	1.46E+04	1.02E+03	1.16E+03	1.76E+02	7.99E+01	-6.23E+03
Resource use	RPR_E[4]	MJ, LHV/MT	4.70E+03	1.80E+00	2.42E+01	3.23E-01	1.38E+00	3.90E+02
	RPR_M[5]	MJ, LHV/MT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	RPR_T	MJ, LHV/MT	4.70E+03	1.80E+00	2.42E+01	3.23E-01	1.38E+00	3.90E+02
	$NRPR_E$[6]	MJ, LHV/MT	1.52E+04	1.02E+03	1.16E+03	1.75E+02	8.11E+01	-6.40E+03
	$NRPR_M$[7]	MJ, LHV/MT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	$NRPR_T$	MJ, LHV/MT	1.52E+04	1.02E+03	1.16E+03	1.75E+02	8.11E+01	-6.40E+03
	SM	Kg/MT	2.57E+02	0.00E+00	3.54E+01	0.00E+00	0.00E+00	-
	RSF	MJ, LHV/MT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-
	NRSF	MJ, LHV/MT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-
	RE	MJ, LHV/MT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-
	FW[8]	m^3/MT	2.81E+01	1.15E-02	6.72E-02	2.06E-03	8.25E-02	-
Output flows and waste	HWD[9]	Kg/MT	8.11E+02	6.08E-01	6.94E-01	1.09E-01	2.41E+00	-
	NHWD[10]	Kg/MT	7.67E+01	9.32E-01	9.71E-01	1.62E-01	3.21E+02	-
	HLRW[11]	m^3/MT	1.35E-06	7.05E-11	1.92E-08	1.25E-11	1.31E-09	-
	ILLRW[12]	m^3/MT	2.61E-06	4.17E-10	9.57E-07	7.41E-11	7.13E-09	-
	CRU	Kg/MT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-
	MFR	Kg/MT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-
	MER	Kg/MT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-
	EE	MJ, LHV/MT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-

Environmental Indicator		Unit	Wire Rods (A1)
TRACI 2.1	GWP_{100}-AR5(1)	kg CO_2 eq./MT	1.07E+03
	GWP_{100}-AR4(2)	kg CO_2 eq./MT	1.05E+03
	AP	kg SO2 eq./MT	2.73E+00
	EP	kg N eq./MT	1.08E+00
	ODP	kg CFC-11 eq./MT	1.09E-05
	SFP	kg O_3 eq./MT	5.06E+01
	ADP_{fossil}(3)	MJ, LHV/MT	1.33E+04
Resource use	RPR_E(4)	MJ, LHV/MT	4.79E+03
	RPR_M(5)	MJ, LHV/MT	0.00E+00
	RPR_T	MJ, LHV/MT	4.79E+03
	$NRPR_E$(6)	MJ, LHV/MT	0.00E+00
	$NRPR_M$(7)	MJ, LHV/MT	0.00E+00
	$NRPR_T$	MJ, LHV/MT	1.39E+04
	SM	Kg/MT	2.26E+02
	RSF	MJ, LHV/MT	0.00E+00
	NRSF	MJ, LHV/MT	0.00E+00
	RE	MJ, LHV/MT	0.00E+00
	FW(8)	m^3/MT	2.86E+01
Output flows and waste	HWD(9)	Kg/MT	7.21E+02
	NHWD(10)	Kg/MT	7.71E+01
	HLRW(11)	m^3/MT	1.31E-06
	ILLRW(12)	m^3/MT	2.34E-06
	CRU	Kg/MT	0.00E+00
	MFR	Kg/MT	0.00E+00
	MER	Kg/MT	0.00E+00
	EE	MJ, LHV/MT	0.00E+00

Table notes

(1) GWP 100, excludes biogenic CO_2 removals and emissions associated with biobased products and packaging; 100-year time horizon GWP factors are provided by the IPCC 2013 Fifth Assessment Report (AR5).
(2): GWP 100, excludes biogenic CO_2 removals and emissions associated with biobased products and packaging; 100-year time horizon GWP factors are provided by the IPCC 2007 Fourth Assessment Report (AR4).
(3) Calculated according to CML-baseline, v.4.8, August 2016.[21]
(4): RPR_E = RPR_T - RPR_M, where RPR_T is equal to the value for renewable energy obtained using the CED methodology (LHV).
(5) Calculated as per ACLCA ISO 21930 Guidance, 6.2 Renewable primary resources with energy content used as a material, RPR_M.
(6): $NRPR_E$ = $NRPR_T$ - $NRPR_M$, where $NRPR_T$ is equal to the value for non-renewable energy obtained using the CED methodology (LHV).
(7): Calculated as per ACLCA ISO 21930 Guidance, 6.4 Non-renewable primary resources with energy content used as a material, $NRPR_M$.
(8): Represents the use of net fresh water calculated from life cycle inventory results, i.e., water consumption.
(9): Calculated from life cycle inventory results, based on datasets classified under "treatment and disposal of hazardous waste." The manufacturer does not generate hazardous waste.
(10): Calculated from life cycle inventory results, based on waste that is neither "hazardous" nor "radioactive" and EPD values.
(11): Calculated from life cycle inventory results, based on ecoinvent waste flow "high-level radioactive waste for final repository." The manufacturer does not generate radioactive waste.
(12): Calculated from life cycle inventory results, based on ecoinvent waste flow "low-level radioactive waste for final repository." The manufacturer does not generate radioactive waste.
* Module A1 represents 1.08 MT of unfabricated rebar or unfabricated MBQ steel.

Comparability: *Comparisons cannot be made between product-specific or industry average EPDs at the design stage of a project, before a building has been specified. Comparisons may be made between product-specific or industry average EPDs at the time of product purchase when product performance and specifications have been established and serve as a functional unit for comparison. Environmental impact results shall be converted to a functional unit basis before any comparison is attempted.*

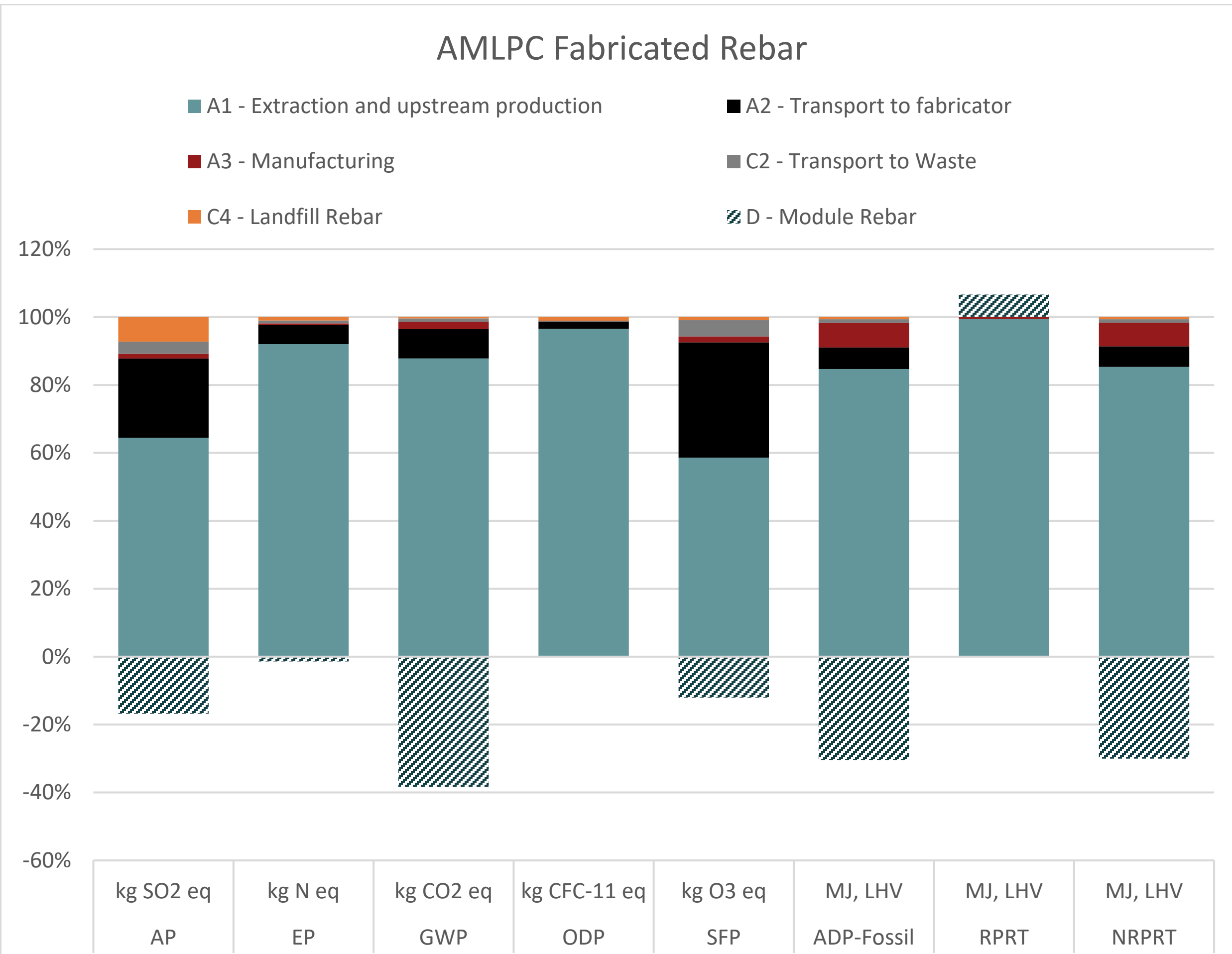
Any comparison of EPDs shall be subject to the requirements of ISO 21930. EPDs are not comparative assertions and are either not comparable or have limited comparability when they have different system boundaries, are based on different product category rules or are missing relevant environmental impacts. Such comparisons can be inaccurate, and could lead to an erroneous selection of materials or products which are higher-impact, at least in some impact categories.

5.2. CONTRIBUTION ANALYSIS

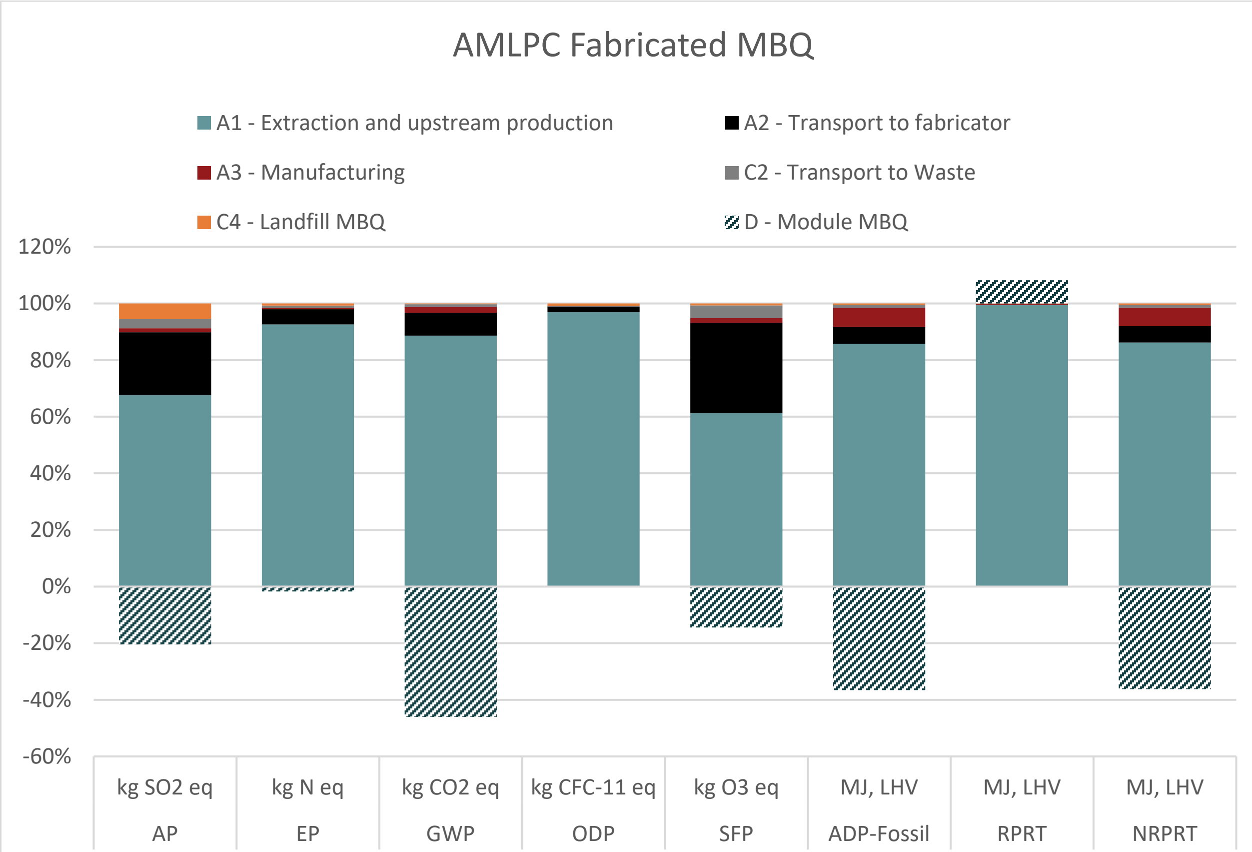
The two figures below present the contribution of the different information modules to the life cycle of fabricated Rebar and fabricated Merchant Bar Quality (MBQ) steel, respectively. Module A1, Extraction and upstream production, is the main contributor to all impact categories and energy use. This module includes the steel production process and rolling process as well as all the upstream material and energy production process and their transport to the AMLPC facilities.

It should be noted that transport of unfabricated steel to the fabricator is a large contributor to acidification potential (AP) and smog formation potential (SFP).

Module D, which represents the benefits and loads beyond the system boundary, indicates a benefit for all impact categories and non-renewable primary resource use as the recycling rate (RR) is greater than the product recycled content; hence AMLPC has generated primary metal to feed the closed-loop system and obtain a credit. Module D represents a load for the renewable primary resource use. The load comes from the negative Scrap LCI ((X_{pr}-X_{re})Y) value for renewable primary resource use, i.e., the theoretical LCI for 100% primary metal production, from the BOF route, assuming 0% scrap input (X_{pr}), uses less renewable energy than the theoretical LCI for 100% secondary metal production, from the EAF route, assuming 100% scrap input (X_{re}).



GWP: Global Warming Potential; **AP**: Acidification Potential: **EP**: Eutrophication Potential: **ODP**: Ozone Layer Depletion Potential; **SFP**: Smog Formation Potential; **ADP$_{fossil}$**: Abiotic Resource Depletion Potential of Non-Renewable (Fossil) Energy Resources; **RPRT**: Renewable Primary Resources – Total; **NRPRT**: Non-Renewable Primary Resources – Total.



GWP: Global Warming Potential; **AP**: Acidification Potential: **EP**: Eutrophication Potential: **ODP**: Ozone Layer Depletion Potential; **SFP**: Smog Formation Potential; **ADP$_{fossil}$**: Abiotic Resource Depletion Potential of Non-Renewable (Fossil) Energy Resources; **RPRT**: Renewable Primary Resources – Total; **NRPRT**: Non-Renewable Primary Resources – Total.

6. ADDITIONAL ENVIRONMENTAL INFORMATION

6.1. ENVIRONMENT AND HEALTH DURING MANUFACTURING

ArcelorMittal is committed to becoming the safest steel and mining company in the world. At ArcelorMittal Long Products Canada, the health and safety of their employees and their subcontractors is of the utmost importance, and allows them to achieve this vision. ArcelorMittal believes that all workplace accidents can be avoided, and are actively pursuing the corporate-wide Journey to Zero program with an objective of zero incidents and zero fatalities. At ArcelorMittal Long Products Canada, accident prevention is their primary concern in their business processes and industrial operations.

Aware of its responsibilities as a member of the community and in line with its strategic planning which puts forward, among other things, the reduction of its environmental footprint, ArcelorMittal Long Products Canada makes the following environmental compliance and evaluation and management reporting commitments to its stakeholders: implement measures and controls to comply with applicable laws, regulations and other requirements and take appropriate actions to continuously improve its environmental performance; conduct environmental compliance audits of its activities and facilities and report to its management on the status and evolution of the company's environmental performance as well as the improvement/risk management actions to be carried out.

6.2. ENVIRONMENT AND HEALTH DURING INSTALLATION

Steel is not classified as hazardous by the OSHA Hazard Communication Standard (29 CFR 1910.1200). However, certain processes such as welding, burning or grinding of metal may generate metal fume or proper protection equipment shall be worn when needed.

6.3. ENVIRONMENTAL ACTIVITIES AND CERTIFICATIONS

ArcelorMittal Long Products Canada is part of a third-party verification process with Vertima Inc. where ArcelorMittal Long Product Canada's products and its entire supply chain are assessed. At the end of the process, they have received a Validated Eco-Declaration® summarizing verified environmental claims, as well as Vertima's Environmental Data Sheet.

ArcelorMittal Long Products Canada has also published a Health Product Declaration® for their Rebar and Merchant Bar Quality steel. More details are available on the HPDC public repository: https://www.hpd-collaborative.org/hpd-public-repository/.

ArcelorMittal Long Products Canada environmental management system is certified ISO 14001:2015 (Certificate Number: 60807-1-05).

6.4. FURTHER INFORMATION

To learn more about ArcelorMittal Long Products Canada and its products, visit https://long-canada.arcelormittal.com/en/.

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