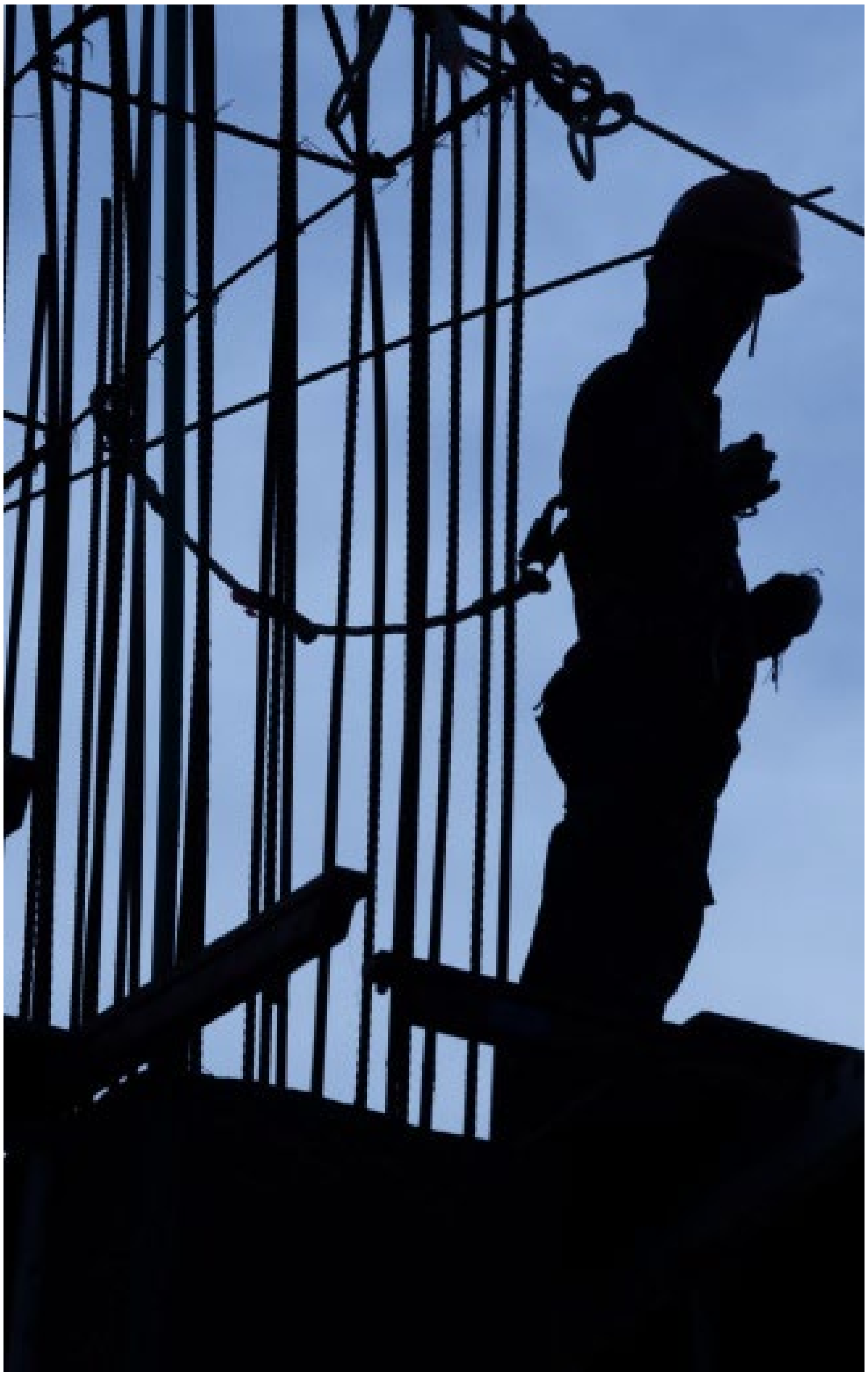
Environmental Product Declaration

Reinforcing Bar

ASTM A615, A706, A1035



Reinforcing bar is a steel bar used in the reinforcement of concrete. The Rebar surface may be rolled with a deformed pattern for an improved mechnical bond with the concrete.

For over 50 years, Cascade Steel Rolling Mills has been providing the Western U.S. and Canada with high quality steel products produced from recycled scrap metal at our state-of-the-art electric arc furnace steel mill. Our products include reinforcing bar (rebar), coiled reinforcing bar, wire rod, merchant bar and specialty products. As a Schnitzer subsidiary and part of our parent company's vertical integration, we purchase all the processed scrap metal we use through Schnitzer.

Sustainability starts with our business model. Recycling metal instead of using virgin ore to create new steel products saves energy and natural resources. However, sustainability doesn't end with our business model. Like our parent company and its other subsidiaries, we are constantly working on reducing our environmental footprint. For over 50 years, we've shown that it is possible to operate profitably while maintaining a focus on sustainability and being responsible stewards of our environment.

Environmental Product Declaration

ASTM A615, A706 AND A1035
REINFORCING BAR

According to ISO 14025, EN 15804, and ISO21930:2017

EPD Program and Program Operator Name, Address, Logo, and Website	UL Environment 333 Pfingsten Road Northbrook, IL 60611	https://www.ul.com https://spot.ul.com
General Program Instructions and Version Number	General Program Instructions v.2.5 March 2020	
Manufacturer Name and Address	Cascade Steel Rolling Mills, Inc 3200 NE Highway 99W McMinnville, OR 97128	
Declaration Number	4790066131.101.1	
Declared Product & Functional Unit or Declared Unit	Reinforcing bar (ASTM A615, A706, A1035) The declared unit is one metric ton of reinforcing bar.	
Reference PCR and Version Number	Part A: Product Category Rules for Building Related Products and Services (UL Environment, 2018) Part B: Designated Steel Construction Product EPD Requirements (UL Environment, 2020)	
Description of Product Application/Use	Reinforcing bar is used to increase the tensile strength of poured concrete	
Product RSL Description (if Appl.)	Not applicable	
Markets of Applicability	Construction industry	
Date of Issue	January 1, 2022	
Period of Validity	5 Years	
EPD Type	Product-specific	
Range of Dataset Variability	Not applicable	
EPD Scope	Cradle to gate without options	
Year(s) of Reported Primary Data	2020 Calendar Year	
LCA Software & Version Number	GaBi Software System (v10.6)	
LCI Database(s) & Version Number	GaBi Databases (CUP 2021.2)	
LCIA Methodology & Version Number	IPCC AR5 + TRACI 2.1	

The PCR review was conducted by:	UL Environment PCR Review Panel epd@ulenvironment.com
This declaration was independently verified in accordance with ISO 14025: 2006. ☐ INTERNAL ☐ EXTERNAL	Cooper McCollum, UL Environment
This life cycle assessment was conducted in accordance with ISO 14044 and the reference PCR by:	Sphera
This life cycle assessment was independently verified in accordance with ISO 14044 and the reference PCR by:	Thomas P. Gloria, Industrial Ecology Consultants

LIMITATIONS

Exclusions: EPDs do not indicate that any environmental or social performance benchmarks are met, and there may be impacts that they do not encompass. LCAs do not typically address the site-specific environmental impacts of raw material extraction, nor are they meant to assess human health toxicity. EPDs can complement but cannot replace tools and certifications that are designed to address these impacts and/or set performance thresholds – e.g. Type 1 certifications, health assessments and declarations, environmental impact assessments, etc.

Accuracy of Results: EPDs regularly rely on estimations of impacts; the level of accuracy in estimation of effect differs for any particular product line and reported impact.

Comparability: EPDs from different programs may not be comparable. Full conformance with a PCR allows EPD comparability only when all stages of a life cycle have been considered. However, variations and deviations are possible”. Example of variations: Different LCA software and background LCI datasets may lead to differences results for upstream or downstream of the life cycle stages declared.

Product Definition and Information

Description of Company/Organization

For over 50 years, Cascade Steel Rolling Mills has been providing the Western U.S. and Canada with high quality steel products produced from recycled scrap metal at our state-of-the-art electric arc furnace steel mill. Their products include reinforcing bar (rebar), coiled reinforcing bar, wire rod, merchant bar and specialty products.

As a Schnitzer subsidiary and part of the parent company's vertical integration, they purchase all of the processed scrap metal used through Schnitzer. Being part of a Fortune 1000 company has enabled Cascade Steel Rolling Mills to grow stronger and introduce cost efficiencies and state-of-the art environmental controls into their operations.

Recycling metal instead of using virgin ore to create new steel products saves energy and natural resources. However, sustainability doesn't end with their business model. Like their parent company and its other subsidiaries, they are constantly working on reducing their environmental footprint.

Over the years, they've improved their processes and controls, invested capital to increase efficiency and decrease energy use, and fostered a culture of resourcefulness and accountability. For over 50 years, they have shown that it is possible to operate profitably while maintaining a focus on sustainability and being responsible stewards of our environment.

Product Description

Product Identification

This EPD is for reinforcing bar produced by Cascade Steel mill located in McMinnville, Oregon. Reinforcing bar is a steel bar used in the reinforcement of concrete. The rebar surface may be rolled with a deformed pattern in order to form an improved mechanical bond with the concrete.

Mechanical properties, sizes, and deformation dimensions are specified by ASTM standards A615, A706, and A1035. Rebar sizes produced range from #3 through #18. In accordance with the PCR, the declared unit and product density is shown in Table 1.

PARAMETER	VALUE
Declared unit	1 metric ton
Density	7,850 kg/m^3

Table 1: Declared unit for reinforcing bar and the approximate density

Product Specification

Reinforcing bar (also known as "rebar") is used to increase the tensile strength of poured concrete.

ChromX, also known as MMFX, is a high strength, corrosion resistant concrete reinforcing steel. It is produced to the ASTM A1035 standard which is available in two grades (strength levels) and three chromium levels. Typical grade names are ChromX9100, ChromX4100, and ChromX2100.

Product Average

The 2020 production data used in this EPD considers all concrete reinforcing steel produced by Cascade Steel during this year. The products are manufactured at one facility located in McMinnville, Oregon, United States. Results are weighted according to the production total at the above location.

Flow Diagram

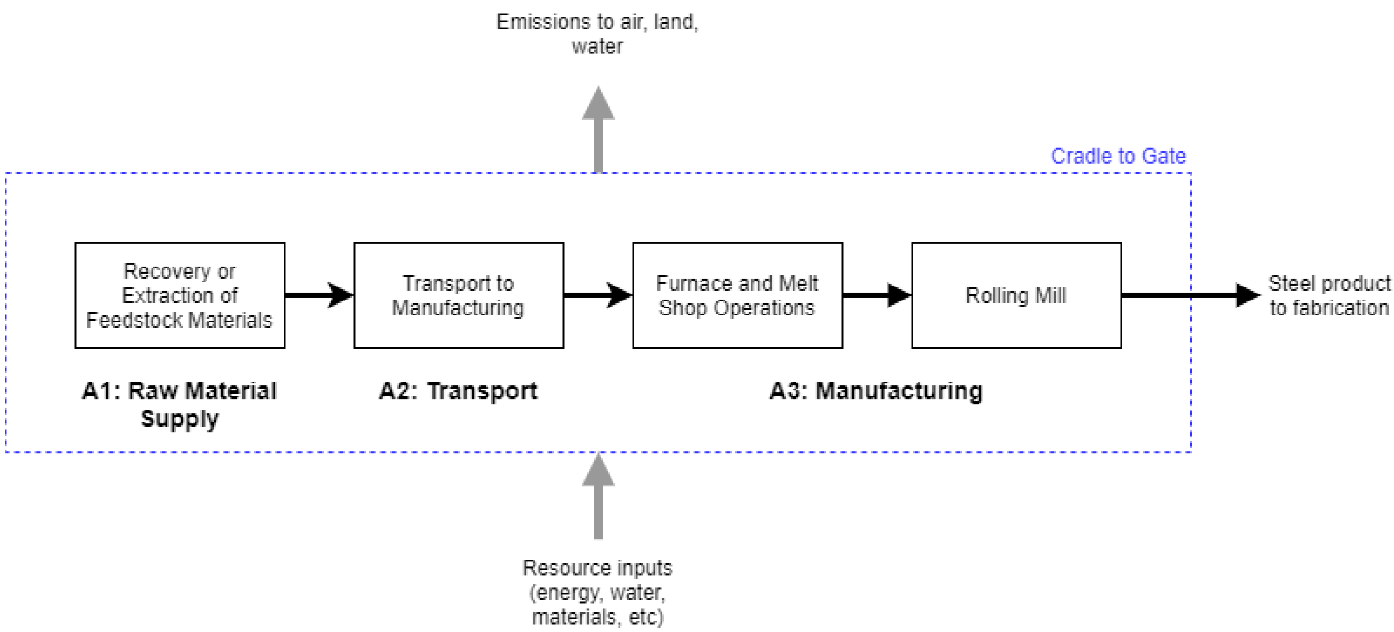


Figure 1: Production Flow Diagram

Application

Carbon steel rebar is used as reinforcement in concreate or masonry, including concrete roads, bridges, foundations, columns and pillars. It may be installed as-is, or fabricated to specific lengths and shapes as per project specifications.

Performance Standards

ASTM A615 – Standard specification for deformed and plain carbon-steel bars for concrete reinforcement

ASTM A706 – Standard specification for deformed and plain low-alloy steel bars for concrete reinforcement

ASTM A1035 – Standard specification for deformed and plain, low-carbon, chromium, steel bars for concrete reinforcement

Technical Requirements

The reinforcing steel conforms to ASTM A615-20 Grade 40, 60, 75, 80 or 100 or ASTM A706-16 Grade 60 or 80.

The steel shipped is in fact composed of the heats indicated on the mill test report and is represented by results obtained on heat samples tested in accordance with ASTM A615-18 or ASTM A706-16 specifications for sampling, chemical analysis, physical testing and measuring.

The average spacing and height of deformations have been measured and found to be in accordance with the requirements of ASTM A615-18 or ASTM A706-16 as indicated on the mill test report (Cascade Steel Rolling Mills Inc., 2021).

Properties of Declared Product as Delivered

Concrete reinforcing steel produced by Cascade Steel Rolling Mills are defined by the following ASTM standards:

- ASTM A615 – Standard specification for deformed and plain carbon-steel bars for concrete reinforcement
- ASTM A706 – Standard specification for deformed and plain low-alloy steel bars for concrete reinforcement
- ASTM A1035 – Standard specification for deformed and plain, low-carbon, chromium, steel bars for concrete reinforcement

Material Composition

Cascade Steel's products contain approximately 95.4% recycled scrap steel content with 4.5% alloys and additives.

The average A615/706 steel rebar contains 1.7% of alloying elements and 98.3% of recycled scrap steel.

The ChromX rebar contains 88.5% of recycled scrap steel and 11.5% of alloying elements.

	STEEL	MANGANESE	CARBON	CHROMIUM	SILICON	OTHERS (NI, S, V, MO, P…ETC)
ASTM A615/A706	98.3%	< 2%	< 1%	< 1%	< 1%	< 1.5%
ASTM A1035	88.5%	< 2%	< 1%	< 11%	< 1%	< 4%

Table 2 - Typical material composition of ASTM A615, A706 and A1035

The products do not contain any hazardous substances according to the Resource Conservation and Recovery Act, Subtitle 3. The products do not release dangerous substances to the environment, including indoor air emissions, gamma or ionizing radiation, or chemicals released to air or leached to water and soil.

Manufacturing

Steelmaking involves two major processes: the melt shop and rolling mill. Cascade Steel's melt shop operations all utilize EAF technology and take steel scrap as an input to the steel billet production process. The rolling mill then hot-rolls the steel billet from Cascade Steel's melt shop into steel products. Fabrication occurs beyond the rolling mill gate and is excluded from this study. Product packaging, including raw materials for packaging and end-of-life, is also excluded from this study.

Cascade Steel operates a single steel mill in the United States, located in McMinnville, Oregon which produces the rebar products described in Table 2.

Melt shop

In the melt shop, steel scrap materials, including shredded and cut steel scrap, are loaded into a refractory-lined EAF and melted via electricity supplied through graphite electrodes. In the EAF, carbon is introduced by injection and sometimes as charge carbon to improve electrical efficiency and contribute chemical energy, and quick lime and dolomitic lime are introduced to remove impurities by forming slag. The furnace is then tapped, the molten steel is transferred to the ladle metallurgical station, where the chemistry of the steel is refined by adding a range of alloy elements. The ladle of liquid steel is carried from the ladle metallurgy station to the continuous caster where the molten steel is solidified into strands which are cut into billets for use in the rolling mill.

Melt shop operations account for a large fraction of direct emissions from the steelmaking process as well as a large fraction of steelmaking's potential environmental impacts. Carbon dioxide emissions result from fossil fuel combustion as well as from consumption of the graphite electrodes and carbon used in the EAF.

The EAF steelmaking process produces slag as a co-product, which is sold for use as a cement or gravel substitute. Dust collected at the melt shop baghouse is sold for recovery of zinc, iron, and other elements. Baghouse dust at the facility typically contains around 0.205 metric ton of zinc per metric ton of dust.

Scrap originated from the A615/A706 stream at the melt shop is fed back into the EAF (home scrap) while the scrap originated from the A1035 stream is sold externally to other steel producers (external scrap).

Internal scrap feedstocks to the melt shop are not reported as it is assumed that the mills internally recycle all scrap that is generated. This approach is in line with worldsteel's modeling approach for its steel product LCIs (worldsteel association, 2017).

Rolling Mill

At the rolling mill, the billets from the melt shop are reheated in a natural gas furnace and passed through several mill stands which reduce the billet size and shape down to meet the final bar product specifications. The products are then cut to length and distributed to fabricators for further processing. Environmental impacts from the rolling mill are attributed to energy use and production of dusts and waste.

Scrap from the rolling mill is fed back into the EAF (home scrap) except for that originating from the ChromX processing which is sold externally to other steel producers (external scrap).

Packaging

Packaging materials have not been reported hence are been excluded in the scope of this study.

Transportation

Primary data for inbound transportation of raw materials were collected for steel scrap, alloy elements, and process materials. Where insufficient data were available, this study assumed an inbound transportation distance of 100 miles by truck.

Reference Service Life and Estimated Building Service Life

The Reference Service Life (RSL) of the products is not specified. Because the use stage is not included in the system scope, no reference sevice life is necessary for the analysis.

Disposal

The disposal of the final product is not specified. Because the end-of-life stage is not included in the system scope, no disposal information is necessary for the analysis.

Life Cycle Assessment Background Information

Declared Unit

The declared unit of the underlying life cycle assessment study was one metric tonne of reinforcement bar meeting the performance standards presented in Table 3. The reference flow is the same as the declared unit. The total production volume at Cascade Steel Rolling Mills was used to derive the declared unit.

PARAMETER	VALUE
Declared Unit	1 metric ton
Density	7,850 kg/m^3

Table 3 - Declared unit for reinforcing bar and the approximate density

System Boundary

The system boundary for the declaration is cradle-to-gate per the guiding PCR. The product life cycle stages included within this boundary are illustrated in Figure 1.

Raw Material Supply (A1): Includes all activities necessary for the processing of raw materials. This includes the acquisition, recovery and processing of scrap blend, and extraction and processing of alloys, fluxes, EAF consumables, and refractory consumables.

Transport to Manufacturing (A2): Includes the inbound transportation of all materials from suppliers to the McMinnville facility.

Manufacturing (A3): Includes all the activities necessary for the production of steel reinforcing bar. This stage includes furnace and related process operation at the melt shop, creation of the billet, and the rolling of the product into unfabricated reinforcing bar. The energy, consumables required and the processing of waste during manufacturing are also included in this life cycle stage. Fabrication of the steel reinforcing rebar takes place outside of this system boundary.

Estimates and Assumptions

One of the drivers of impacts associated with alloying elements is silicomanganese, for which no LCI data is available. Ferromanganese was used as a proxy, which is typically a precursor to silicomanganese production. As such, the impacts of silicomanganese use are likely underestimated. Cascade Steel's rolling mill only uses steel billets produced at Cascade Steel's facility from purchased and internal steel scrap.

Where insufficient data were available for inbound transportation of steel scrap, alloy elements and process materials, this study assumed an inbound transportation distance of 100 miles by truck.

Cut-off Criteria

The cut-off rules, as specified in the PCR, did not have to be applied as non of the reported data was excluded.

Data Sources

To cover these requirements and to ensure reliable results, all primary data were collected by Cascade Steel for annual production during the 2020 calendar year. All secondary data were obtained from the 2021 GaBi database CUP 2021.2. Where appropriate LCI data was not available proxy datasets were used, as documented in the background report.

Data Quality

Temporal

All primary data were collected for the year 2020. All secondary data come from the GaBi 2021 databases and are representative of the years 2013-2021. As the study intended to represent the product systems for the reference year 2020, temporal representativeness is considered to be high.

Geographical

All primary and secondary data were collected specific to the regions under study. Where country- or region-specific data were unavailable, proxy data were used. Geographical representativeness is considered to be high.

Technological

All primary and secondary data were modeled to be specific to the technologies under study. Where technology-specific data were unavailable, proxy data were used. Technological representativeness is considered to be high.

Consistency

To ensure data consistence, all primary data were collected with the same level of detail, while all background data were sourced from the GaBi databases.

Reproducibility

Reproducibility is supported as much as possible through the disclosure of input-output data, dataset choices, and modeling approaches in this report. Based on this information, any third party should be able to approximate the results of this study using the same data and modeling approaches.

Uncertainty

Given the consistency within the data and the representativeness of the data, uncertainty associated with the model and results is low. Data quality meets the requirements set forth in the PCR.

Period under Review

Primary data have been collected on production within the calendar year 2020.

Allocation

Steel scrap

Steel scrap from the melt shop, rolling and other operations is internally recycled by steel mills. While whether a product is associated with a net consumption or generation of internal scrap is calculated by the model, this particular flow is not reported as part of the final LCIs as, from a mill-level perspective, all internal scrap is fed back into the melt shop.

Multi-product output

Where multiple finished products are produced, allocation sometimes had to be applied. While the melt shop knows exact formulations and energy requirements for each billet produced, the data for the rolling mill had to be allocated by total production time. In cases where melt shop and rolling mill water, waste and emissions could not be separated, impacts were allocated by product mass.

Co-products

Co-products during steel mill operations are allocated using a method used developed by the World Steel Association and EUROFER (worldsteel and EUROFER, 2014) to be in line with CEN EN 15804 (CEN, 2019). The methodology takes into the account the way 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 approach is conformant with the PCR and ISO 21930. ISO 21930 takes precedence over EN15804, per the PCR Part A and Part B (UL Environment, 2020; UL Environment, 2018).

FLOW	% TO STEEL	% TO SLAG
Steel inputs	100	0
Slag	0	100
Steel scrap outputs	86.4	13.6

Oxygen	100	0
Carbon dioxide	100	0
All other inputs/outputs	86.4	13.6

Table 4: Co-product allocation, mass basis

Life Cycle Assessment Results

The system boundary is defined as per the following Table 5.

	PRODUCT STAGE			CONSTRUCT-ION PROCESS 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
	Raw material supply	Transport	Manufacturing	Transport from gate to site	Assembly/Install	Use	Maintenance	Repair	Replacement	Refurbishment	Building Operational Energy Use During Product Use	Building Operational Water Use During Product Use	Deconstruction	Transport	Waste processing	Disposal	Reuse, Recovery, Recycling Potential
EPD Type	x	x	x	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND

Table 5: Description of the system boundary modules

Life Cycle Impact Assessment Results

IPCC AR5	**A1-A3**	**A1**	**A2**	**A3**
GWP 100 [kg CO_2 eq]	4.35E+02	1.21E+02	1.40E+01	3.00E+02
TRACI v2.1	**A1-A3**	**A1**	**A2**	**A3**
ODP [kg CFC-11 eq]	4.32E-13	2.58E-13	2.88E-15	1.71E-13
AP [kg SO_2 eq]	1.21E+00	8.62E-01	7.09E-02	2.79E-01
EP [kg N eq]	4.06E-02	1.67E-02	6.62E-03	1.73E-02
SFP [kg O_3 eq]	1.80E+01	8.49E+00	2.03E+00	7.47E+00
ADP_{fossil} [MJ, LHV]	4.77E+02	3.25E+01	2.70E+01	4.17E+02

Table 6: Impact results for 1 metric ton of standard A615/706 rebar

IPCC AR5	A1-A3	A1	A2	A3
GWP 100 [kg CO_2 eq]	1.76E+03	1.37E+03	1.22E+01	3.71E+02
TRACI v2.1	**A1-A3**	**A1**	**A2**	**A3**
ODP [kg CFC-11 eq]	3.26E-12	3.05E-12	2.51E-15	2.09E-13
AP [kg SO_2 eq]	8.79E+00	8.24E+00	6.14E-02	4.90E-01
EP [kg N eq]	2.26E-01	1.87E-01	5.74E-03	3.31E-02
SFP [kg O_3 eq]	1.13E+02	9.66E+01	1.85E+00	1.45E+01
ADP_{fossil} [MJ, LHV]	1.20E+03	3.44E+02	2.36E+01	8.33E+02

Table 7. Impact results for 1 metric ton of ChromX (A1035) rebar

Life Cycle Inventory Results – A615/706

PARAMETER	A1-A3	A1	A2	A3
RPR_E [MJ, LHV]	2.16E+03	6.61E+01	8.41E+00	2.08E+03
RPR_M [MJ, LHV]	-	-	-	-
RPR_T [MJ, LHV]	2.16E+03	6.61E+01	8.41E+00	2.08E+03
$NRPR_E$ [MJ, LHV]	5.38E+03	1.18E+03	2.04E+02	3.99E+03
$NRPR_M$ [MJ, LHV]	-	-	-	-
$NRPR_T$ [MJ, LHV]	5.38E+03	1.18E+03	2.04E+02	3.99E+03
SM [kg]	1.10E+03	1.10E+03	-	1.27E-01
RSF [MJ, LHV]	-	-	-	-
NRSF [MJ, LHV]	-	-	-	-
RE [MJ, LHV]	-	-	-	-
FW [m^3]	1.39E+01	1.49E+00	3.59E-02	1.24E+01

Table 8. Resource Use

PARAMETER	A1-A3	A1	A2	A3
HWD [kg]	1.76E-06	2.77E-08	1.70E-08	1.72E-06
NHWD [kg]	9.89E+00	9.00E-01	1.88E-02	8.97E+00
HLRW [kg] or [m^3]	3.04E-04	1.89E-05	6.87E-07	2.85E-04
ILLRW [kg] or [m^3]	-	-	-	-
CRU [kg]	-	-	-	-
MR [kg]	1.85E+01	-	-	1.85E+01
MER [kg]	-	-	-	-
EE [MJ, LHV]	-	-	-	-

Table 9. Output Flows and Waste Categories

Life Cycle Inventory Results – A1035

PARAMETER	A1-A3	A1	A2	A3
RPR_E [MJ, LHV]	3.43E+03	7.71E+02	7.33E+00	2.65E+03
RPR_M [MJ, LHV]	-	-	-	-
RPR_T [MJ, LHV]	3.43E+03	7.71E+02	7.33E+00	2.65E+03
$NRPR_E$ [MJ, LHV]	2.04E+04	1.31E+04	1.78E+02	7.13E+03
$NRPR_M$ [MJ, LHV]	-	-	-	-
$NRPR_T$ [MJ, LHV]	2.04E+04	1.31E+04	1.78E+02	7.13E+03
SM [kg]	1.21E+03	1.21E+03	-	1.31E-01
RSF [MJ, LHV]	-	-	-	-
NRSF [MJ, LHV]	-	-	-	-
RE [MJ, LHV]	-	-	-	-
FW [m^3]	1.82E+01	4.37E+00	3.13E-02	1.38E+01

Table 10. Resource Use

PARAMETER	A1-A3	A1	A2	A3
HWD [kg]	2.41E-06	3.62E-07	1.49E-08	2.04E-06
NHWD [kg]	2.48E+02	2.39E+02	1.64E-02	9.13E+00
HLRW [kg] or [m^3]	5.59E-04	1.97E-04	5.99E-07	3.61E-04
ILLRW [kg] or [m^3]	-	-	-	-
CRU [kg]	-	-	-	-
MR [kg]	1.97E+02	-	-	1.97E+02
MER [kg]	-	-	-	-
EE [MJ, LHV]	-	-	-	-

Table 11. Output Flows and Waste Categories

LCA Interpretation

Across the steel products produced by Cascade Steel, potential environmental impacts are driven by alloying elements, electricity use, direct emissions from the EAF, and process materials. Direct emissions and alloying elements are the largest contributors to GWP100, while energy use is the dominant contributor to ADPfossil. ODP is driven by the alloying elements used in the melt shop operation, mostly silico manganese for the standard A615/706 rebar or ferro chrome in the case of the ChromX rebar.

One of the drivers of impacts associated with alloying elements is silicomanganese, for which no LCI data is available. Ferromanganese was used as a proxy, which is typically a precursor to silicomanganese production. As such, the impacts of silicomanganese use are likely underestimated. Cascade Steel's rolling mill only uses steel billets produced at Cascade Steel's facilities from purchased and internal steel scrap.

Overall, direct emissions from the EAF process and electricity use was found to be the largest drivers of the total environmental impacts, while alloying elements are also significant contributors.

A scenario analysis performed on the allocation approach for the slag by-product of steelmaking shows that the choice of allocation method does not have a significant impact on the results of the study.

A scenario analysis performed on the electricity grid mix used shows that the selection of the subregion grid mix has a significant impact on the results of the study, with both approaches to spatial resolution being equally relevant.

References

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