# Environmental Product Declaration

According to ISO 14025

## Fabricated Steel Reinforcing Bar (Rebar)

Issue Date: September 27, 2022

Valid Until: September 27, 2027



Declaration Number: 367

# Declaration Information

## Declaration

| | | |
|---|---|---|
| **Program Operator:** ASTM International | www.astm.org | www.steeldynamics.com |
| **Company:** Steel Dynamics, Inc. (SDI) | | |

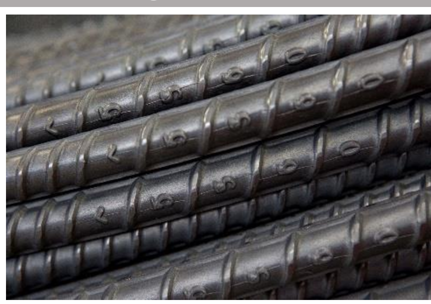
## Product Information / Validity / Applicability

| Product Information | Validity / Applicability |
|---|---|
| **Product Name:** Steel reinforcing bar (rebar)<br>**Product Definition:** Reinforcing bar or rebar is used to strengthen concrete or other masonry structures | **Period of Validity:** This declaration is valid for a period of 5 years from the date of publication |
| **Declaration Type:** Business to business<br>**PCR Reference:** UL Part B: Designated Steel Construction Products | **Geographic Scope:** This declaration is valid for steel reinforcement milled by SDI in Columbia City, Indiana, sold and fabricated in North America |

## Product Application and / or Characteristics

This declaration covers steel reinforcing bar (rebar) for use in concrete and masonry structures.

## Technical Drawing or Product Visual



## Content of the Declaration

- Rebar milled at single steel mill owned and operated by SDI and fabricated in North America
- Steel made from greater than 90% recycled steel scrap via electric arc furnace (EAF) technology
- Cradle-to-gate assessment results

## Product Information / Validity / Applicability

**This declaration and the rules on which this EPD is based have been examined by an independent verifier in accordance with ISO 14025.**

| | | | |
|---|---|---|---|
| **Name: Timothy S. Brooke** | **Date: Sept 27, 2022** | **Name: Thomas P. Gloria** | **Date: Sept 27, 2022** |

# EPD Summary

This document is a Type III environmental product declaration by Steel Dynamics, Inc. (SDI) that is certified by ASTM International (ASTM) as conforming to the requirements of ISO 14025. ASTM has assessed that the Life Cycle Assessment (LCA) information fulfills the requirements of ISO 14040 and ISO 14044 in accordance with the instructions listed in the referenced product category rules. The intent of this document is to further the development of environmentally compatible and sustainable construction methods by providing comprehensive environmental information related to potential impacts in accordance with international standards.

This EPD was not written to support any comparative assertions. Even for similar products, differences in declared unit, use and end-of-life assumptions, and data quality may produce incomparable results. It is not recommended to compare EPDs with another organization as there may be differences in assumptions, methodology, allocation methods, and data quality such as variability in datasets and results of variability in assessment software tools.

## Scope and Boundaries of the Life Cycle Assessment

The Life Cycle Assessment (LCA) was performed according to ISO 14040 (ISO, 2006) and ISO 14044 (ISO, 2006) following the requirements of the ASTM EPD Program Instructions and referenced PCR.

**System Boundary:** Cradle-to-gate
**Allocation Method:** Substitution for co-products
**Declared Unit:** One metric ton (1,000 kg) of steel reinforcing bar

| EVALUATION VARIABLE | UNIT PER METRIC TON | TOTAL | UNIT PER SHORT TON | TOTAL |
|---|---|---|---|---|
| Primary Energy, non-renewable | MJ | 10,100 | BTU | 8.68E+06 |
| Primary Energy, renewable | MJ | 777 | BTU | 6.68E+05 |
| Global Warming Potential | metric ton $CO_2$ eq. | 0.86 | short ton $CO_2$ eq. | 0.86 |
| Ozone Depletion Potential | metric ton R11 eq. | 2.66E-13 | short ton R11 eq. | 2.66E-13 |
| Acidification Potential | metric ton $SO_2$ eq. | 4.66E-03 | short ton $SO_2$ eq. | 4.66E-03 |
| Eutrophication Potential | metric ton N eq. | 1.14E-04 | short ton N eq. | 1.14E-04 |
| Smog Formation Potential | metric ton $O_3$ eq. | 3.82E-02 | short ton $O_3$ eq. | 3.82E-02 |

## Additional Information

The vast majority of reinforcing steel (ASTM A615 and A706) has recycled material content typically greater than 98%. Specialty reinforcing steel products have a recycled material content typically greater than 75%.

# Steel Reinforcement Bar (Rebar) | EPD - 367

## Product Description

Steel rebar is used as reinforcement in concrete or masonry structures. We produce coiled rebar as well as cut-to-length rebar in several grades that vary in yield and tensile strength – ASTM A615 certified from GR60-GR100, as well as A706. Available lengths include our standard 20', 30', 40' and 60' pieces.

## Delivered Product Configurations

Our compact spooled coils provide a change-out downtime reduction, thus increasing production rates and improving material yield and safety. Unlike loose coils, our twist-free spooled coils create a more efficient bar, fewer rejects, and fewer returns on your fabricated product. Safety is optimized with compact spooled coils, offering more stability and tighter stacking. This allows for easier storage, staging, loading and transportation. Our coils give an advantage to fabricators through tangle-free de-coiling and decreased downtime, increasing your production rates compared to loose coils.

## Product Applicability and Technical Characteristics

Steel rebar is defined by the following standards:

- ASTM A615/A615M-20 Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
- ASTM A706/A706M-16 Standard Specification for Deformed and Plain Low-Alloy Steel Bars for Concrete Reinforcement
- AASHTO M31-21 Deformed and Plain Carbon and Low-Alloy Steel Bars for Concrete Reinforcement

Additional information can be found on SDI's website at www.stld-cci.com.

# Life Cycle Stages

The life cycle stages for rebar are summarized in the flow diagram shown in the figure below. Only the cradle-to-gate performance is considered in the analysis.


*Figure 1: Life cycle modules included in analysis*

## Steel production (A1)

The study represents steel produced at SDI's steel mill in Columbia City, IN. Primary data include the amounts of steel scrap into the facility, alloys and process materials, electricity and fuel consumption, steel output, as well as emissions and wastes from their furnaces. A1 also includes inbound truck transportation for steel scrap and internal transport was included via reported fuel consumption, based on SDI data.

The declared product does not contain any materials or substances for which there exists a route to exposure that leads to humans or flora/fauna in the environment being exposed at levels exceeding safe health thresholds.

## Transportation to fabrication (A2)

A2 is represented burden of transportation to fabrication from the industry average EPD for "Fabricated Steel Reinforcement" which is a work in progress at the time of publication (expected to be finalized in 2022) by CRSI (Concrete Reinforcing Steel Institute, 2022).

## Fabrication (A3)

A3 is represented using the data from fabrication process of rebar from the industry average EPD for "Fabricated Steel Reinforcement" which is a work in progress at the time of publication (expected to be finalized in 2022) by CRSI (Concrete Reinforcing Steel Institute, 2022).

# Underlying Life Cycle Assessment

## Declared Unit

The declared unit for this EPD is one metric ton of steel reinforcing bar. Note that comparison of EPD results on a mass basis, alone, is insufficient and should consider the technical performance of the product.

**Declared Unit**

| Name | Required unit | Optional unit |
|---|---|---|
| Declared unit | 1 metric ton | 1 short ton |
| Density | 7,800 kg / $m^3$ | 487 lbs. / $ft^3$ |

## System Boundaries

The “cradle-to-gate” life cycle stages represent the product stage (information modules A1-A3) and include:

- A1: steel production;
- A2: transport to fabrication;*
- A3: steel fabrication.*

* As calculated by CRSI in the work-in-progress industry-average EPD for “Fabricated Steel Reinforcement” (Concrete Reinforcing Steel Institute, 2022).

**Declared Unit (MND = Module Not Declared)**

| Product Stage | | | Construction Stage | | Use Stage | | | | | | | End-of-Life Stage | | | | Benefits & Loads |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A1 | A2 | A3 | A4 | A5 | B1 | B2 | B3 | B4 | B5 | B6 | B7 | C1 | C2 | C3 | C4 | D |
| | | | EXCLUDED FROM THIS STUDY | | | | | | | | | | | | | |
| Steel production | Transport to fabrication | Fabrication | Transport | Installation | Use | Maintenance | Repair | Replacement | Refurbishment | Operational energy use | Operational water use | De-construction | Transport | Waste processing | Disposal | Reuse, recovery, recycling potential |
| x | x | x | MND | MND | MND | MND | MND | MND | MND | MND | MND | MND | MND | MND | MND | MND |

This EPD represents average SDI rebar production during the 2020 reference year.

## Assumptions

This study describes an annual average rebar product manufactured by SDI at Roanoke VA, which were modeled with the energy grid associated with their Columbia City, IN site. Module A1 represents primary data from the steel mill, from scrap intake, through steel making and rolling to output of packaged product. A1 product output includes material which becomes scrap in production (adopting 3% scrap rate from CRSI EPD study). Modules A2 and A3 represent results from the work-in-progress industry-average EPD for "Fabricated Steel Reinforcement" by the CRSI (Concrete Reinforcing Steel Institute, 2022).

## Cut-off Criteria

All available energy and material flow data were included in the model for the processes identified within the system boundary of this study. The PCR's cut-off criteria were applied only in the case of packaging. Based on a check of packaging data, packaging was shown to represent less than 1% of steel output mass and is, therefore, excluded under the cut-off criteria provided by the PCR. In cases where life cycle inventory data were not available to represent a flow, proxy data were applied based on conservative assumptions regarding environmental impacts.

## Data Quality

A variety of tests and checks were performed throughout the project to ensure high quality of the completed LCA. Checks included an extensive review of the LCA model as well as the background data used.

### Temporal Representativeness

Primary data represent twelve months of continuous operation in the 2020 calendar year. All secondary data came from the GaBi 2022 databases and are representative of the years 2016 to 2021. Rebar A2 (transport to fabrication) and A3 (fabrication) results are adopted from CRSI industry average EPD representing the 2019-2020 calendar years, with secondary data from the GaBi 2022 databases. As the study is intended to represent rebar produced in 2020, temporal representativeness is considered to be very good.

### Geographical Representativeness

All primary and secondary data were collected specific to the countries or regions under study. Whenever country-specific background data were not readily available, U.S., European, or global data were used as proxies. Geographical representativeness is considered to be good.

### Technological Representativeness

The majority of primary data and all secondary data were modeled to be specific to the technologies or technology mixes under study. Rebar production data represent manufacturing via electric arc furnace at SDI's Roanoke, VA site, with the Columbia City, IN energy grid attached. Overall, technological representativeness is considered to be good.

### Precision

As the majority of the relevant foreground data are measured data or calculated based on primary information sources of the owner of the technology, precision is considered to be high. All background data are sourced from GaBi databases with the documented precision (www.gabi-software.com).

### Completeness

Each unit process was checked for mass balance and completeness of the emission inventory. No foreground data were omitted in this study, except for packaging which was sufficiently small and not anticipated to significantly impact results. This approach is in line with the cut-off criteria in the PCR.

### Consistency

To ensure consistency, all primary data were collected with the same level of detail (i.e., using consistent data collection templates), while background data were sourced from the GaBi 2022 databases. Allocation and other methodological choices were made consistently throughout the model.

### Reproducibility

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

### Sources of Data

Primary data for rebar manufacturing were provided by SDI. Secondary data were obtained from GaBi 2022.1 databases.

### Uncertainty

SDI provided complete facility data.

## Allocation

Regarding co-products from rebar production—system expansion is used to address these co-products from the steel mill. As such, zinc content in the baghouse dust (on average, 18% by weight) is credited with the production of primary zinc; slag is repurposed as embankment and credited with gravel production; and mill scale is credited with primary iron. Where manufacturing inputs, such as electricity use, were not sub-metered, they were allocated by mass.

Allocation of background data (energy and materials) taken from the GaBi 2022 databases is documented online at http://www.gabi-software.com/international/databases/gabi-databases/.

# LCA: Results

## Results

Life cycle assessment results are presented per metric ton of steel product (required reporting unit) and per short ton of steel product (optional reporting unit). Results are also presented in the 'Additional Environmental Information' chapter per metric ton of mill product at SDI before being scaled up to account for losses during fabrication.

The product stage (modules A1-A3) includes A1 (manufacturing of mill product at SDI), followed by module A2 and A3 results from the work-in-progress industry-average EPD for "Fabricated Steel Reinforcement" from CRSI (Concrete Reinforcing Steel Institute, 2022).

Primary energy use represents lower heating value.

*Table 1: Product stage energy results per 1 metric ton of fabricated rebar*

| Primary energy | Units | A1 | A2 | A3 | Total |
|---|---|---|---|---|---|
| **Renewable primary energy excluding resources used as raw materials** | MJ LHV | 7.29E+02 | 2.44E+01 | 2.40E+01 | **7.77E+02** |
| **Renewable primary energy resources used as raw materials** | MJ LHV | - | - | - | **-** |
| ***Renewable primary energy, total*** | MJ LHV | 7.29E+02 | 2.44E+01 | 2.40E+01 | **7.77E+02** |
| **Non-renewable primary energy excluding resources used as raw materials** | MJ LHV | 8.29E+03 | 6.83E+02 | 1.08E+03 | **1.01E+04** |
| **Non-renewable primary energy resources used as raw materials** | MJ LHV | - | - | - | **-** |
| ***Non-renewable primary energy demand, total*** | MJ LHV | 8.29E+03 | 6.83E+02 | 1.08E+03 | **1.01E+04** |
| ***Total primary energy demand*** | MJ LHV | 9.02E+03 | 7.08E+02 | 1.10E+03 | **1.08E+04** |

*Table 2: Product stage material resource results per 1 metric ton of fabricated rebar*

| Material resource use | Units | A1 | A2 | A3 | Total |
|---|---|---|---|---|---|
| **Use of secondary material** | tonne | 1.33 | 0.00 | 0.04 | **1.36** |
| **Use of secondary fuel (renewable)** | MJ LHV | - | - | - | **-** |
| **Use of secondary fuel (fossil)** | MJ LHV | - | - | - | **-** |
| **Blue water consumption** | $m^3$ | 2.12E+00 | 1.02E-01 | 6.60E-02 | **2.29E+00** |

*Table 3: Product stage waste and other environmental output results per 1 metric ton of fabricated rebar*

| Waste or environmental output | Units | A1 | A2 | A3 | Total |
|---|---|---|---|---|---|
| Hazardous waste disposed | tonne | 2.38E-10 | 2.77E-12 | 3.22E-09 | **3.46E-09** |

| Waste or environmental output | Units | A1 | A2 | A3 | Total |
|---|---|---|---|---|---|
| Non-hazardous waste disposed | tonne | 2.36E-02 | 5.80E-05 | 1.73E-03 | **2.54E-02** |
| Radioactive waste disposed | tonne | 7.92E-04 | 1.64E-06 | 6.12E-06 | **7.99E-04** |
| Components for re-use | tonne | - | - | - | **-** |
| Materials for recycling | tonne | - | - | 0.03 | **0.03** |
| Materials for energy recovery | tonne | - | - | - | **-** |
| Exported energy | MJ LCV | - | - | - | **-** |

*Table 4: Product stage life cycle impact assessment results per 1 metric ton of fabricated rebar*

| Impact category | | A1 | A2 | A3 | Total |
|---|---|---|---|---|---|
| Impact Assessment Method: TRACI 2.1 | | | | | |
| **Global warming potential (GWP)** | tonne $CO_2$ eq. | 0.79 | 0.05 | 0.02 | **0.86** |
| **Ozone depletion potential (ODP)** | tonne R11 eq. | 8.79E-15 | 7.81E-17 | 2.57E-13 | **2.66E-13** |
| **Acidification potential (AP)** | tonne $SO_2$ eq. | 4.10E-03 | 5.03E-04 | 5.57E-05 | **4.66E-03** |
| **Eutrophication potential (EP)** | tonne N eq. | 7.69E-05 | 3.06E-05 | 6.62E-06 | **1.14E-04** |
| **Smog formation (SFP)** | tonne $O_3$ eq. | 2.45E-02 | 1.25E-02 | 1.24E-03 | **3.82E-02** |
| Impact Assessment Method: CML 2001 (version April 2013) | | | | | |
| **Abiotic depletion potential, elements (ADPe)[1]** | tonne Sb eq. | 2.02E-07 | 1.62E-08 | 6.53E-09 | **2.24E-07** |
| **Abiotic depletion potential, fossil (ADPf)** | MJ LCV | 6268.08 | 679.25 | 1059.36 | **8006.69** |

[1] This indicator is based on assumptions regarding current reserves estimates. Users should use caution when interpreting results because there is insufficient information on which indicator is best for assessing the depletion of abiotic resources.

# LCA: Interpretation

## Visualization of Life Cycle Impact Assessment

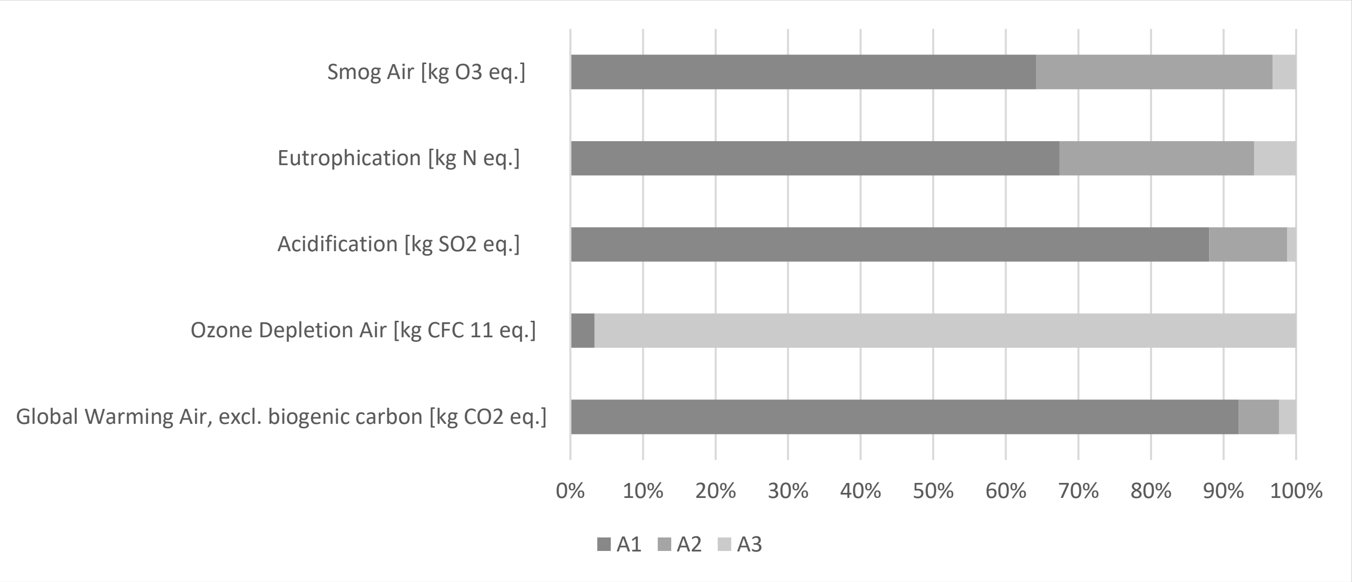



*Figure 2: Relative contribution to life cycle modules to product stage impact assessment results*

Note: ODP is dominated by the A3 stage, likely due to older data used to calculate results for CRSI's work-in-progress EPD (Concrete Reinforcing Steel Institute, 2022).

## Disclaimer

This Environmental Product Declaration (EPD) conforms to ISO 14025, ISO 14040, ISO 14044, and ISO 21930 (ISO, 2007).

**Scope of Results Reported:** The PCR requires the reporting of a limited set of LCA metrics; therefore, there may be relevant environmental impacts beyond those disclosed by this EPD. The EPD does not indicate that any environmental or social performance benchmarks are met nor are thresholds exceeded.

**Accuracy of Results:** This EPD has been developed in accordance with the PCR applicable for the identified product following the principles, requirements and guidelines of the ISO 14040, ISO 14044, ISO 14025 and ISO 21930 standards. The results in this EPD are estimations of potential impacts. The accuracy of results in different EPDs may vary as a result of value choices, background data assumptions and quality of data collected.

**Comparability:** EPDs are not comparative assertions and are either not comparable or have limited comparability when they cover different life cycle stages, are based on different product category rules or are missing relevant environmental impacts. Such comparisons can be inaccurate and could lead to the erroneous selection of materials or products which are higher impact, at least in some impact categories. Any comparison of EPDs shall be subject to the requirements of ISO 21930. For comparison of EPDs which report different module scopes, such that one EPD includes Module D and the other does not, the comparison shall only be made on the basis of Modules A1, A2 and A3. Additionally, when Module D is included in the EPDs being compared, all EPDs must use the same methodology for calculation of Module D values.

# Additional Environmental Information

## Results

Life cycle assessment results above are presented per metric ton (required reporting unit) and per short ton (optional reporting unit) of fabricated structural sections. Here are results reported per metric ton of mill product leaving SDI. These results represent the unfabricated impacts of rebar and they don't include a scaling factor which is applied above to account for 3% cutting waste which happens during fabrication.

In these tables, A1 represents the raw material inputs to steelmaking, A2 is the inbound transportation of those inputs, and A3 represents the energy and emissions associated with the steelmaking and rolling mill within SDI.

*Table 5: Primary energy demand by usage for 1 metric ton of unfabricated rebar mill product*

| | Units | A1 | A2 | A3 | Total |
|---|---|---|---|---|---|
| Renewable primary energy excluding resources used as raw materials | MJ LHV | 8.20E+01 | 4.96E+00 | 6.21E+02 | **7.08E+02** |
| Renewable primary energy resources used as raw materials | MJ LHV | - | - | - | **-** |
| Renewable primary energy, total | MJ LHV | 8.20E+01 | 4.96E+00 | 6.21E+02 | **7.08E+02** |
| Non-renewable primary energy excluding resources used as raw materials | MJ LHV | 1.08E+03 | 1.28E+02 | 6.85E+03 | **8.05E+03** |
| Non-renewable primary energy resources used as raw materials | MJ LHV | - | - | - | **-** |
| Non-renewable primary energy demand, total | MJ LHV | 1.08E+03 | 1.28E+02 | 6.85E+03 | **8.05E+03** |
| *Total primary energy demand* | MJ LHV | 1.16E+03 | 1.32E+02 | 7.47E+03 | **8.76E+03** |

*Table 6: Other resources for 1 metric ton of unfabricated rebar mill product*

| | Units | A1 | A2 | A3 | Total |
|---|---|---|---|---|---|
| Use of secondary material | tonne | 1.29 | 0.00 | 2.14E-04 | **1.29** |
| Use of secondary fuel (renewable) | MJ LHV | - | - | - | **-** |
| Use of secondary fuel (fossil) | MJ LHV | - | - | - | **-** |
| Blue water consumption | $m^3$ | 4.00E-01 | 1.78E-02 | 1.64E+00 | **2.06E+00** |

*Table 7: Wastes for 1 metric ton of unfabricated rebar mill product*

| | Units | A1 | A2 | A3 | Total |
|---|---|---|---|---|---|
| Hazardous waste | tonne | 2.36E-11 | 5.30E-13 | 2.07E-10 | **2.31E-10** |
| Non-hazardous waste | tonne | 3.98E-04 | 1.10E-05 | 2.25E-02 | **2.29E-02** |
| Radioactive waste | tonne | 1.42E-05 | 3.53E-07 | 7.54E-04 | **7.68E-04** |

*Table 8: TRACI 2.1 and ADP impact assessment results for 1 metric ton of unfabricated rebar mill product*

| | Units | A1 | A2 | A3 | Total |
|---|---|---|---|---|---|
| Global warming potential (GWP) | tonne $CO_2$ eq. | 0.10 | 0.01 | 0.66 | **0.768** |
| Ozone depletion potential (ODP) | tonne R11 eq. | 1.98E-15 | 1.71E-17 | 6.53E-15 | **8.53E-15** |
| Acidification potential (AP) | tonne $SO_2$ eq. | 6.58E-04 | 7.81E-05 | 3.24E-03 | **3.98E-03** |
| Eutrophication potential (EP) | tonne N eq. | 1.33E-05 | 6.00E-06 | 5.53E-05 | **7.47E-05** |
| Smog formation (SFP) | tonne $O_3$ eq. | 6.71E-03 | 2.72E-03 | 1.44E-02 | **2.38E-02** |
| Abiotic depletion potential, elements (ADPe)[2] | tonne Sb eq. | 1.30E-07 | 2.98E-09 | 6.31E-08 | **1.96E-07** |
| Abiotic depletion potential, fossil (ADPf) | MJ LCV | 1039.59 | 126.60 | 4919.32 | **6085.52** |

*Table 9: IPCC AR5 GWP100 results, per 1 metric ton of unfabricated rebar mill product*

| | Units | A1 | A2 | A3 | Total |
|---|---|---|---|---|---|
| Global warming potential (GWP) | tonne $CO_2$ eq. | 0.10 | 0.01 | 0.67 | **0.78** |

[2] This indicator is based on assumptions regarding current reserves estimates. Users should use caution when interpreting results because there is insufficient information on which indicator is best for assessing the depletion of abiotic resources.

# References

American Institute of Steel Construction. (2021). *AISC.* Retrieved from aisc.org: https://www.aisc.org/globalassets/why-steel/epd-aisc-hr-sections-2021.pdf

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