SMART EPD

Environmental Product Declaration

Program Operator: Smart EPD®

www.smartepd.com

IN ACCORDANCE WITH ISO 14025 AND ISO 21930:2017

O'Hare International Terminal Modernization - Photo Credit: Mark Hendel

Hot-Rolled Structural Steel Sections

Date of Issue	Expiration date	Last updated
October 14, 2025	October 14, 2030	October 30, 2025

Refer to the EPD Library at www.smartepd.com for the latest EPD listing information

General Information

American Institute of Steel Construction

130 East Randolph, Suite 2000, Chicago, IL 60601

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solutions@aisc.org www.aisc.org

Product Name:	Hot-Rolled Structural Steel Sections
Declared Unit:	1 metric ton
Declaration Number:	SmartEPD-2025-090-0613-01.2
Date of Issue:	October 14, 2025
Expiration:	October 14, 2030
Last updated:	October 30, 2025
EPD Scope:	Cradle to gate with other options A1 - A3, B1 - B7, C1 - C4
Market(s) of Applicability:	North America

General Organization Information

The American Institute of Steel Construction (AISC), headquartered in Chicago, is a not-for-profit technical institute and trade association established in 1921 to serve the structural steel design community and construction industry in the United States. AISC's mission is to make structural steel the material of choice by being the leader in structural steel related technical and market-building activities, including; specification and code development, research, education, technical assistance, quality certification, standardization, and market development. AISC has a long tradition of service to the steel construction industry providing timely and reliable information.

The National Steel Bridge Alliance, a division of the AISC, is a national non-for-profit organization dedicated to advancing steel bridge design and construction. NSBA is a unified industry organization of businesses and agencies interested in the development, construction and promotion of cost-effective steel bridges. NSBA represents the entire steel bridge community.

Further information can be found at: https://www.aisc.org/

Limitations, Liability, and Ownership

It is recognized that by following the typical ISO 21930:2017 definitions of module A1, A2 and A3 for a specific production facility, inconsistencies will occur in classifying individual processes as either A1 or A3 based on the scope of the operations that take place at a given facility. Care must be taken not to compare A1, A2 or A3 on an individual basis for a given product from various mill producers, but, instead on the aggregated total of A1, A2 and A3. Separate A1, A2 and A3 values are provided for a better understanding of the processes taking place at a given facility and a greater level of transparency.

Construction product environmental impact results provide a sufficient basis for comparison only when considered in the context of the construction works project. In all cases of comparing construction products, the principle that the basis for comparison of the assessment is the construction works level shall be maintained by ensuring that the same functional requirements are met and the criteria in ISO 21930:2017 Section 5.5 Comparability of EPDs for construction products are satisfied.

The reported fabricated product results are based on industry-average fabrication impacts, as reported in the companion Fabrication of Structural Steel Products EPD. As with any downstream scenario, actual impacts will vary depending on the particular project requirements.

EPDs published using this PCR do not include post-fabrication processes, including, but not limited to, epoxy coating, painting, and galvanization.

A manufacturer shall not make claims based on an industry-average EPD which leads the market to believe the industry-average is representative of manufacturer-specific or product-specific results.

Reference Standards

Standard(s):	ISO 14025:2006 and ISO 21930:2017
Core PCR:	Smart EPD® Part A Product Category Rules for Building and Construction Products and Services, 1000, v1.2 Date of issue: March 14, 2025
Sub-category PCR:	Smart EPD® Part B PCR for Designated Steel Construction Products, 1000-008, v3.0 Date of issue: April 03, 2025 Valid until: April 03, 2030
Sub-category PCR review panel:	Contact Smart EPD for more information.
General Program Instructions:	Smart EPD General Program Instructions v.2.0, March 2025

Verification Information

ACLCA PCR Guidance Version:	1.0
ACLCA PCR Conformance Level:	Transparency
LCA Author/Creator:	Brandie Sebastian | John Beath Environmental LLC | jbe@beath.us
EPD Program Operator:	Smart EPD | info@smartepd.com | www.smartepd.com 585 Grove St., Ste. 145, Herndon, VA 20170, USA
Verification:	Independent critical review of the LCA and data, according to ISO 14044 and ISO 14071: External Rifat Karim | Independent Consultant | rifat.chimique@gmail.com Independent external verification of EPD, according to ISO 14025 and reference PCR(s): External Rifat Karim | Independent Consultant | rifat.chimique@gmail.com

Product Information

Declared Unit:	1 metric ton
Mass:	1000 kg
Reference Service Life:	75 Years
Product Specificity:	✓ Product Average ✗ Product Specific
Variation in GWP Result (Facilities):	-30% to +38%

Product Description

Hot-rolled structural steel sections are typically used in construction applications in buildings, bridges, and industrial projects.

While a variety of steel products may be produced via hot-rolling, in the context of structural steel construction, this EPD's scope is limited to the following definition.
Hot-rolled structural steel sections are:

- *W-, S-, C-, and MC- shapes, angles, and*
- *Produced at a mill whose primary output is heavy structural sections intended for subsequent fabrication and installation in buildings, bridges, and other structural applications*

Hot-rolled structural steel sections specifically exclude:

- *Products that do not meet the definition of structural steel per AISC's Code of Standard Practice for Steel Buildings and Bridges (ANSI/AISC 303-2022), such as H-piles, sheet pile, railroad rail, and crane rail*
- *Products originating from a Bar Mill, such as rebar, MBQ, SBQ, rod, and wire*
- *Junior sections, such as those under 8 inches in depth*
- *Miscellaneous M- shapes*

Product Specifications

Product SKU(s):	Hot-rolled structural steel sections fall under CSI and UNSPSC codes: •CSI 05 12 00 Structural Steel Framing •CSI 05 12 13 Architecturally-Exposed Structural Steel Framing •CSI 05 12 23 Structural Steel for Buildings •UNSPSC 30103618 – Steel framework
Product Classification Codes:	EC3 - Steel -> StructuralSteel -> HotRolledSections UNSPSC - 30103618 undefined - undefined
System boundary option:	Mill product (Option 1)
Product Route Representation:	✓ EAF
EAF Percentage of Representation (optional):	100 %
Steel Type:	Carbon/Alloy

Material Composition

Material/Component Category	Origin	% Mass
Virgin iron	North America	6.5
Alloying elements	North America	1.5
Recycled steel scrap	North America	92

Packaging Material	Origin	kg Mass
Dunnage	North America	50.8
Steel Banding	North America	1.21
VCI Bag	North America	5.86E-04

Hazardous Materials
The products do not contain any hazardous substances according to the Resource Conservation and Recovery Act (RCRA), 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. Therefore, no substances required to be reported as hazardous are associated with the production of this product.

EPD Data Specificity

Primary Data Year: 2023

Manufacturing Specificity:

- ✓ Industry Average
- ✗ Manufacturer Average
- ✗ Facility Specific

Averaging:

This industry-average, cradle-to-mill-gate with options LCA study represents the production-weighted average of hot-rolled structural steel sections produced by six mills in the U.S. in 2023. The mill sites included in this study represent 100% of hot-rolled structural steel sections production in the United States during the study year.

Retroactive participation in this study and the resultant industry-average EPD will be determined by AISC and Smart EPD in accordance with Smart EPD Part B Section 5.3.2.2.2.

System Boundary

Production	A1	Raw material supply	✓
	A2	Transport	✓
	A3	Manufacturing	✓
Construction	A4	Transport to site	ND
	A5	Assembly / Install	ND
Use	B1	Use	✓
	B2	Maintenance	✓
	B3	Repair	✓
	B4	Replacement	✓
	B5	Refurbishment	✓
	B6	Operational Energy Use	✓
	B7	Operational Water Use	✓
End of Life	C1	Deconstruction	✓
	C2	Transport	✓
	C3	Waste Processing	✓
	C4	Disposal	✓
Benefits & Loads Beyond System Boundary	D	Recycling, Reuse Recovery Potential	ND

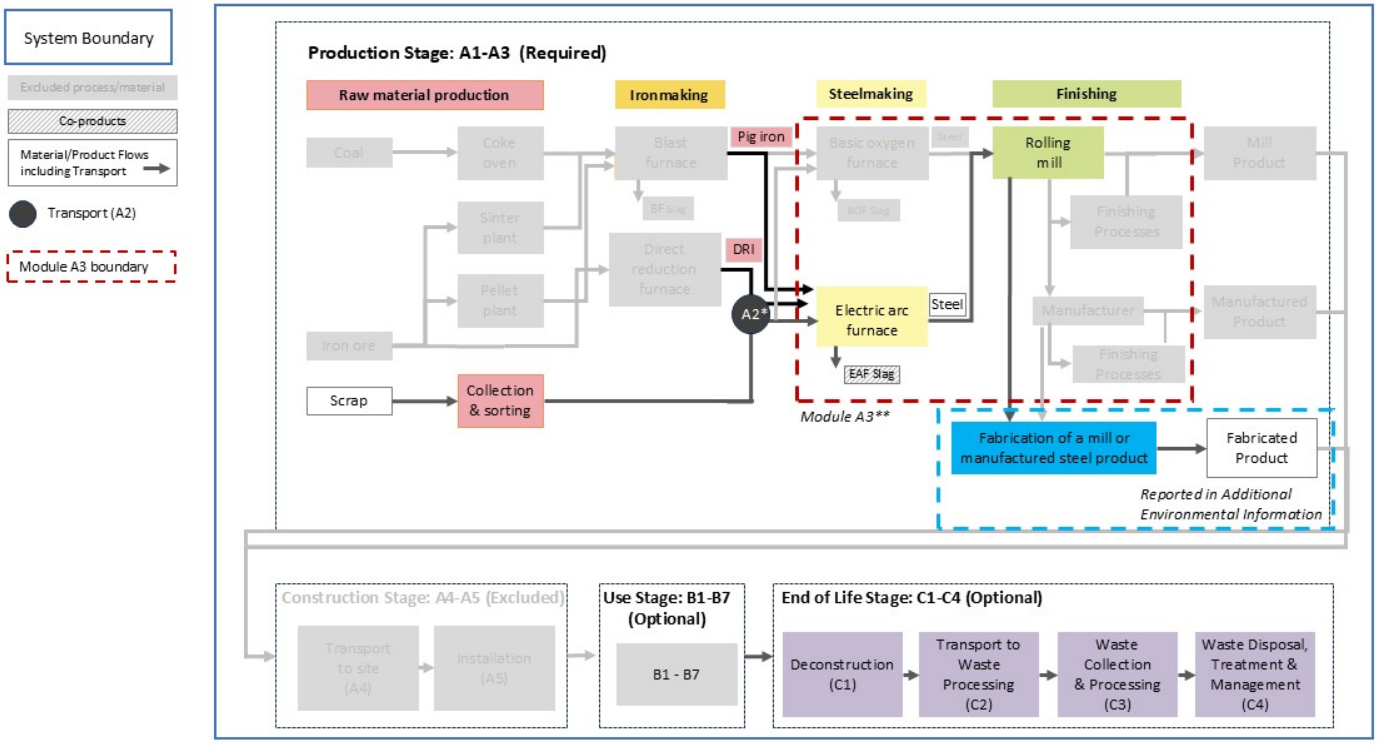
Note:

ND = Module not declared

Participating Manufacturers

- Gerdau Long Steel North America
- Nucor
- Steel Dynamics Inc.

Figure 1. Product Flow Diagram



Notes
Each unit process shall account for resource inputs (fuels, electricity, water, materials, etc) and emissions to air/land/water, wastes and co-products, if relevant
* A2 transportation is represented by any grey arrow that crosses A1 / A3 boundary.
** Processes inside the red dashed line are in module A3 and include specific data.
Processes outside of the dashed red line indicate processes in module A1

Software and Database

LCA Software:	openLCA v. 2.4
LCI Foreground Database(s):	Ecoinvent v. 3.10
LCI Background Database(s):	Ecoinvent v. 3.10 | US LCI v. 1.2024-06.0

A foreground LCI database is the database used to model the primary, site-specific data collected for this EPD. A background LCI database is the database used to model generic or non-specific data.

Data Sources

Input / Unit Process	Origin of Material or Process	LCI data source reference
Coal	RNA, RoW	hard coal mine operation and hard coal preparation | hard coal | Cutoff, U - RNA (ecoinvent v3.10) market for hard coal | hard coal | Cutoff, U - RoW (ecoinvent v3.10)
Lime	RoW, RNA	lime production, milled, loose | lime | Cutoff, U - RoW (ecoinvent v3.10) Quicklime, at plant (US LCI, matched to ecoinvent v3.10 upstreams)
Coke	RoW	coke production | coke | Cutoff, U - RoW (ecoinvent v3.10)
Ferroalloys / other alloying elements	RoW, GLO	All from ecoinvent v3.10, unless indicated otherwise: aluminum, primary ingot, at plant, RNA (US LCI, matched to ecoinvent v3.10 upstreams) copper, anode to generic market for copper-rich materials | copper-rich materials | Cutoff, U - GLO ferrochromium production, high-carbon, 55% Cr | ferrochromium, high-carbon, 55% Cr | Cutoff, U - RoW ferromanganese production, high-coal, 74.5% Mn | ferromanganese, high-coal, 74.5% Mn | Cutoff, U - RoW ferroniobium production, from pyrochlore concentrate, 66% Nb | ferroniobium, 66% Nb | Cutoff, U - RoW ferrosilicon production | ferrosilicon | Cutoff, U - RoW molybdenum production | molybdenum | Cutoff, U - RoW molybdenum trioxide production | molybdenum trioxide | Cutoff, U - GLO silicon carbide production | silicon carbide | Cutoff, U - RoW smelting and refining of nickel concentrate, 16% Ni | nickel, class 1 | Cutoff, U - GLO titanium production | titanium | Cutoff, U - GLO
Pig iron	RoW	pig iron production | pig iron | Cutoff, U - RoW (ecoinvent v3.10)
Sponge iron	Confidential primary data	Confidential primary data
Semi-finished steel products: billets, slabs, blooms, beam blanks, rounds	USA	Primary data
Hot-rolled sections	USA	Primary data
Grid electricity - delivered	USA - Subregion specific (SERC, RF, TERC)	eGRID 2022 subregion power type mixes. Mapped to ecoinvent v3.10 sub-region specific datasets: electricity production, deep geothermal | electricity, high voltage | Cutoff, U - US electricity production, hard coal | electricity, high voltage | Cutoff, U - US electricity production, hydro, run-of-river | electricity, high voltage | Cutoff, U - US electricity production, lignite | electricity, high voltage | Cutoff, U - US electricity production, natural gas, conventional power plant | electricity, high voltage | Cutoff, U - US electricity production, nuclear, boiling water reactor | electricity, high voltage | Cutoff, U - US electricity production, oil | electricity, high voltage | Cutoff, U - US electricity production, photovoltaic, 570kWp open ground installation, multi-Si | electricity, low voltage | Cutoff, U - US electricity production, wind, >3MW turbine, onshore | electricity, high voltage | Cutoff, U - US electricity production, wind, <1MW turbine, onshore | electricity, high voltage | Cutoff, U - US heat and power co-generation, biogas, gas engine | electricity, high voltage | Cutoff, U - US
Grid electricity - Energy Attribute Certificates (EACs) (e.g. RECs, PPAs, GOs)	USA	electricity production, photovoltaic, 3kWp slanted-roof installation, single-Si, panel, mounted | electricity, low voltage | Cutoff, U - US-SERC (ecoinvent v3.10)
Transportation	USA (incl. to/from USA)	Transport, barge, average fuel mix (US LCI, mapped to ecoinvent v3.10: transport, freight, inland waterways, barge tanker | transport, freight, inland waterways, barge tanker | Cutoff, U - RoW) Transport, combination truck, short-haul, diesel powered- US (US LCI, mapped to ecoinvent v3.10: diesel production, petroleum refinery operation | diesel | Cutoff, U - RoW) Transport, combination truck, long-haul, diesel powered- US (US LCI, mapped to ecoinvent v3.10: diesel production, petroleum refinery operation | diesel | Cutoff, U - RoW) Transport, ocean freighter, average fuel mix (US LCI, mapped to ecoinvent v3.10: transport, freight, sea, container ship | transport, freight, sea, container ship | Cutoff, U - GLO) Transport, train, diesel powered (US LCI, mapped to ecoinvent v3.10: diesel production, petroleum refinery operation | diesel | Cutoff, U - RoW)
Fabrication (including fabrication scrap rate that determines the quantity of inputted unfabricated steel product in A1; transport to fabricator impacts (A2); and fabrication operations impacts (A3))	Hot-rolled sections, plate, HSS	Primary data

Data Quality

The key requirement for data quality is that data be as accurate and representative as possible. Data quality requirements are based on the ISO 14040:2006 and ISO 14044:2006 standards and include time-related, geographical, technological, precision, completeness, representativeness, consistency, reproducibility, sources of data, and uncertainty criteria. To fulfill these requirements and to ensure reliable results, primary data in combination with representative secondary literature, and consistent background LCI data from ecoinvent v3.10 (Wernet, et al., 2016) and other sources were used.

The reported impact assessment values in this EPD may not be a precise representation of potential environmental burdens.

Life Cycle Module Descriptions

A1 Extraction and processing of feedstock materials, i.e., this category includes the upstream production of iron and steel inputs, as well as alloy materials.
A2 Transportation of the feedstock to the mill facility, i.e., this category includes the inbound transportation of feedstock materials to the EAF process.
A3 Mill operations, i.e., this category includes production of ancillary materials (e.g., refractory, lubricants, electrodes, etc.), energy requirements (e.g., electricity, natural gas, mobile fuels), water use, packaging (after section rolling), transport of non-A1 materials to the mill, waste and waste transport, and emissions.
B1-B7 Product use, i.e., this category includes impacts associated with the use stage of the product in a building setting. There are no associated emissions or impacts from the use of the product, in accordance with PCR Part B Section 7.1.7.4, since the RSL of the product exceeds the estimated 75-year service life of the project.
C1 Deconstruction/Demolition, i.e., this module includes all deconstruction and demolition activities taking place at the existing project site including sorting.
C2 Transport, i.e., this module includes the transportation of the steel product to be recovered or landfilled from the existing project site to a recycling center or landfill.
C3 Waste Processing, i.e., this module includes the processing of material for disposal not intended for recycling or reuse.
C4 Disposal, i.e., this module includes disposal impacts associated with landfill or incineration processes.

LCA Discussion

Allocation Procedure

Facility-level Allocation
Data from the mills was requested for two distinct unit processes: 1) EAF steelmaking (cradle-to-crude steel), and 2) section rolling (crude steel to hot-rolled sections). Where data was provided on a facility-wide basis, including some on-site transportation fuels, non-CO2 air emissions, and wastes, allocation was performed to assign each item into the unit processes at a ratio of 50:50 before accounting for the share of in-scope production.
Additionally, data was requested from each mill on the production of products that were deemed out-of-scope. For facilities where out-of-scope products were also produced, impacts were scaled to the share of in-scope products based on production masses.

Co-product Allocation
During the EAF process at the mills, slag is produced via a joint co-production process per ISO 21930:2017 along with steel blooms/billets. EAF slag is sold directly from the mills for beneficial use as an aggregate among other applications. In accordance with the governing PCR, physical partitioning was used to allocate a share of each of the inputs and outputs at the EAF to the steel and the slag based on the energy demand required to form each co-product and other physical relationships. The ratios applied to each flow were sourced from the World Steel Association and EUROFER's 2014 slag LCI methodology report, These values were entered as causal allocation factors in openLCA.

Steel Scrap Allocation
The largest raw material input for hot-rolled structural steel sections production is external steel scrap. Relatively small amounts of internal scrap, which is generated at the EAF process and fed back into the EAF, and home scrap, which is scrap generated downstream of the castor within a steelmaking facility, are also consumed as inputs. In accordance with the governing PCR and ISO 21930's polluter pays principle, external steel scrap was assigned no upstream burden from its production. Both internal and home scrap were modeled as secondary materials receiving no burden as they stay within the facility's bounds and impacts associated with their production and processing were captured in the site-wide inventories.

End-of-life Allocation
Hot-rolled structural steel sections are typically recycled at the end-of-life. This study assumes 97% of the structural steel is recycled for Module C. Recycling flows were modeled with a cut-off approach as Module D is not declared. Background data for the study used a cut-off approach for end-of-life allocation.

Cut-off Procedure

No cut-off criteria were defined for this analysis. All known energy and material flow data were included in accordance with the system boundary. Proxy data were used as needed in the model to capture all considered life cycle impacts.

Renewable Electricity

Energy Attribute Certificates (EACs) such as Renewable Energy Certificates (RECs) or Power Purchase Agreements (PPAs) are included in the baseline reported results:	✓ Yes
Electricity Source:	Offsite
Renewable type(s):	Wind and Solar
Percent of EPD Owner's product-related electricity covered:	2 %
Grid type used to model remaining electricity:	98
Commitment pledged for entire EPD validity period:	✓ Yes
Electricity accounting methodology:	Market-based

Scenarios

Use (B1)
B1 Module

Declared Product Properties:

Hot-rolled structural steel sections have strength, performance, physical, metallurgical, and chemical characteristics meeting the requirements of the Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes and Sheet Piling (ASTM A6-19) and grade specific standards referenced therein. Structural Steel, as defined in The Code of Standard Practice for Steel Buildings and Bridges (ANSI/AISC 303-2022).

Design Application Parameters:

Prior to installation, hot-rolled structural steel sections commonly undergo a scenario-specific fabrication process. Based on the engineering required for use in load-bearing applications, they are then cut, drilled, bolted, welded, and otherwise processed by a fabricator to prepare them for installation at a construction site, in accordance with industry standards including The Code of Standard Practice for Steel Buildings and Bridges (ANSI/AISC 303-22).

Maintenance (B2)
B2 Module

Net Fresh Water Consumption Specified by Water Source and Fate:	0 m3
Ancillary Materials Specified by Type:	0 kg
Other Resources:	0 kg
Energy Input:	0 kWh
Other Energy Carriers:	0 kWh
Power Output of Equipment:	0 kWh
Waste Materials from Maintenance:	0 kg
Direct Emissions to Ambient Air, Soil and Water:	0 kg
VOC Emissions:	0 ug/m3

Repair (B3)

B3 Module

Net Fresh Water Consumption Specified by Water Source and Fate:	0 m3
Ancillary Materials Specified by Type:	0 kg
Energy Input:	0 kWh
Waste Materials From Repair:	0 kg
Direct Emissions to Ambient Air, Soil and Water:	0 kg
Repair Process Information:	Since the RSL of hot-rolled structural steel sections is expected to be at least equivalent to the building service life, there are no associated emissions or impacts from the use of the product, in accordance with PCR Part B, Section 7.1.7.4. The product is not expected to require repair over its lifetime.

Replacement (B4)

B4 Module

Reference Service Life:	>75 Years
Energy Input:	0 kWh
Net Fresh Water Consumption Specified by Water Source and Fate:	0 m3
Ancillary Materials Specified by Type:	0 kg
Replacement of Worn Parts:	0 kg
Direct Emissions to Ambient Air, Soil and Water:	0 kg
Further assumptions for scenario development:	Hot-rolled structural steel sections are typically installed when a building is constructed and not replaced until the building reaches its end-of-life.

Refurbishment (B5)

B5 Module

Energy Input:	0 kWh
Net Fresh Water Consumption Specified by Water Source and Fate:	0 m3
Material Input for Refurbishment:	0 kg
Waste Materials From Repair:	0 kg
Direct Emissions to Ambient Air, Soil and Water:	0 kg
Refurbishment Process Description:	The product is not expected to require refurbishment over its lifetime.

Operational Energy Use (B6) & Operational Water Use (B7)

B6 & B7 Modules

Net Fresh Water Consumption Specified by Water Source and Fate:	0 m3
Ancillary Materials Specified by Type:	0 kg
Energy Input:	0 kWh
Equipment Power Output:	0 kWh
Direct Emissions to Ambient Air, Soil and Water:	0 kg

Further assumptions for scenario development:

There is no operational water and electricity use associated with the use of the product.

End of Life (C1 - C4)

C1 - C4 Modules

Collection Process

Collected Separately:	1000 kg

Recovery

Recycling:	970 kg
Landfill:	30 kg

Results

Environmental Impact Assessment Results

IPCC AR6 GWP 100, TRACI 2.2, CML 2016 v4.8
per 1 metric ton of hot-rolled structural steel sections.
LCIA results are relative expressions and do not predict impacts on category endpoints, the exceeding of thresholds, safety margins or risks.

Impact Category	Method	Unit	A1	A2	A3	A1A2A3	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4
GWP-total	IPCC AR6 GWP 100	kg CO2 eq	1.79e+2	2.78e+1	6.91e+2	8.98e+2	0	0	0	0	0	0	0	2.34e+1	4.25e+0	0	1.88e-1
GWP-fossil	IPCC AR6 GWP 100	kg CO2 eq	1.79e+2	2.78e+1	6.91e+2	8.97e+2	0	0	0	0	0	0	0	2.34e+1	4.25e+0	0	1.88e-1
GWP-biogenic	IPCC AR6 GWP 100	kg CO2 eq	9.87e-2	2.10e-3	3.48e-1	4.49e-1	0	0	0	0	0	0	0	2.03e-3	2.00e-4	0	4.60e-5
GWP-luluc	IPCC AR6 GWP 100	kg CO2 eq	7.27e-2	4.77e-3	1.62e-1	2.39e-1	0	0	0	0	0	0	0	2.24e-3	1.80e-4	0	9.66e-5
ODP	TRACI 2.2	kg CFC 11 eq	1.01e-6	4.52e-7	5.64e-6	7.10e-6	0	0	0	0	0	0	0	3.72e-7	5.76e-8	0	5.72e-9
AP	TRACI 2.2	kg SO2 eq	1.15e+0	2.15e-1	1.43e+0	2.80e+0	0	0	0	0	0	0	0	1.92e-1	8.10e-3	0	1.20e-3
EP	TRACI 2.2	kg N eq	5.04e-1	1.84e-1	9.51e-1	1.64e+0	0	0	0	0	0	0	0	2.49e-1	8.37e-3	0	1.31e-3
SFP	TRACI 2.2	kg O3 eq	1.67e+1	4.50e+0	2.31e+1	4.44e+1	0	0	0	0	0	0	0	6.10e+0	2.02e-1	0	3.20e-2
ADP-fossil	CML 2016 v4.8	MJ	2.02e+3	4.10e+2	8.98e+3	1.14e+4	0	0	0	0	0	0	0	3.03e+2	5.38e+1	0	4.55e+0

Note:

Not all abbreviated indicators listed below may be present in the results above. The inclusion of indicators varies based on PCR requirements.

Abbreviations:

GWP = Global Warming Potential, 100 years (may also be denoted as GWP-total, GWP-fossil (fossil fuels), GWP-biogenic (biogenic sources), GWP-luluc (land use and land use change)), ODP = Ozone Depletion Potential, AP = Acidification Potential, EP = Eutrophication Potential, SFP = Smog Formation Potential, POCP = Photochemical oxidant creation potential, ADP-Fossil = Abiotic depletion potential for fossil resources, ADP-Minerals&Metals = Abiotic depletion potential for non-fossil resources, WDP = Water deprivation potential, PM = Particular Matter Emissions, IRP = Ionizing radiation, human health, ETP-fw = Eco-toxicity (freshwater), HTP-c = Human toxicity (cancer), HTP-nc = Human toxicity (non-cancer), SQP = Soil quality index.

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 or EN 15804. 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 comparison can be inaccurate, and could lead to erroneous selection of materials or products which are higher-impact, at least in some impact categories.

Resource Use Indicators

per 1 metric ton of hot-rolled structural steel sections.

Indicator	Unit	A1	A2	A3	A1A2A3	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4
RPRE	MJ	0	0	1.73e+3	1.73e+3	0	0	0	0	0	0	0	2.88e+0	1.18e-1	0	4.27e-2
RPRM	MJ	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NRPRE	MJ	2.27e+3	4.61e+2	1.01e+4	1.28e+4	0	0	0	0	0	0	0	3.06e+2	5.36e+1	0	4.57e+0
NRPRM	MJ	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SM	kg	9.90e+2	0	0	9.90e+2	0	0	0	0	0	0	0	0	0	0	0
RSF	MJ	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NRSF	MJ	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FW	m3	3.09e-1	3.43e-2	3.09e+0	3.43e+0	0	0	0	0	0	0	0	1.12e-2	5.90e-4	0	2.20e-4
RE	MJ	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Note:

Not all abbreviated indicators listed below may be present in the results above. The inclusion of indicators varies based on PCR requirements.

Abbreviations:

RPRE or PERE = Renewable primary resources used as energy carrier (fuel), RPRM or PERM = Renewable primary resources with energy content used as material, RPRT or PERT = Total use of renewable primary resources with energy content, NRPRE or PENRE = Non-renewable primary resources used as an energy carrier (fuel), NRPRM or PENRM = Non-renewable primary resources with energy content used as material, NRPRT or PENRT = Total non-renewable primary resources with energy content, SM = Secondary materials, RSF = Renewable secondary fuels, NRSF = Non-renewable secondary fuels, RE = Recovered energy, ADPF = Abiotic depletion potential, FW = Use of net freshwater resources, VOCs = Volatile Organic Compounds.

Waste and Output Flow Indicators

per 1 metric ton of hot-rolled structural steel sections.

Indicator	Unit	A1	A2	A3	A1A2A3	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4
HWD	kg	2.96e-2	3.29e-3	2.96e-1	3.29e-1	0	0	0	0	0	0	0	2.09e-3	3.80e-4	0	2.91e-5
NHWD	kg	5.59e+0	6.21e-1	5.59e+1	6.21e+1	0	0	0	0	0	0	0	1.96e-1	7.50e-3	0	3.00e+1
RWD	kg	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
HLRW	kg	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
ILLRW	kg	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
CRU	kg	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
MFR	kg	0	0	5.61e+1	5.61e+1	0	0	0	0	0	0	0	0	0	0	0
MER	kg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EEE	MJ	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Note:

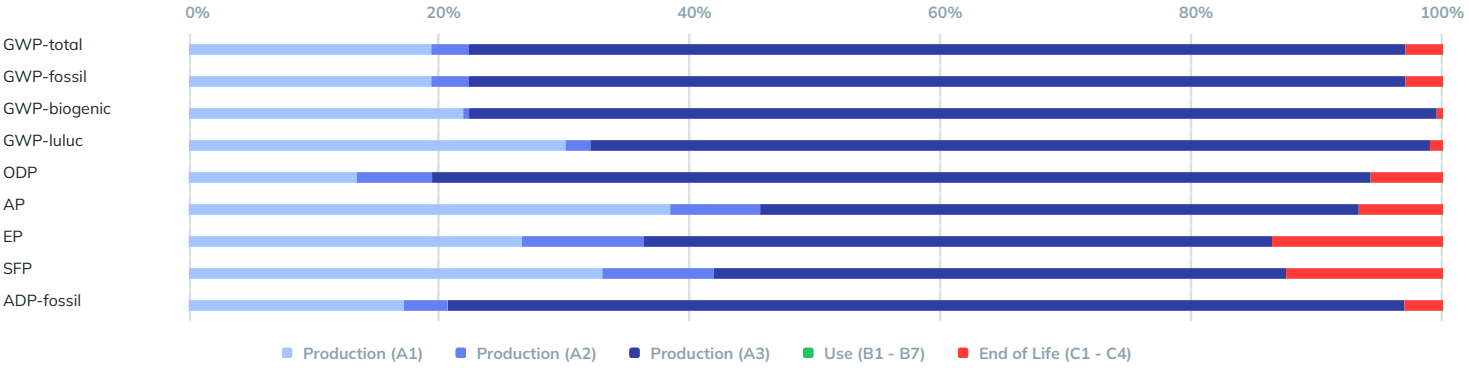
Not all abbreviated indicators listed below may be present in the results above. The inclusion of indicators varies based on PCR requirements.

Abbreviations:

HWD = Hazardous waste disposed, NHWD = Non-hazardous waste disposed, RWD = Radioactive waste disposed, HLRW = High-level radioactive waste, ILLRW = Intermediate- and low-level radioactive waste, CRU = Components for re-use, MFR or MR = Materials for recycling, MER = Materials for energy recovery, MNER = Materials for incineration, no energy recovery, EE or EEE = Recovered energy exported from the product system, EET = Exported thermal energy.

Interpretation

For industry average results, A3 (steelmaking) was the largest contributor to impact, amounting to 77% of the total GWP and 51-79% for all other impact categories. Transportation of feedstock materials to the mills was a minor contributor. Within the mill sites, the EAF steelmaking process is the largest contributor, representing 75% of the overall GWP results. It is also the most significant contributor to all other impacts (69% - 86%). Electricity usage at the mills represents the highest contribution to each LCIA impact category, ranging from 18% - 41% of the overall A1-A3 impacts and contributing 38% of the GWP impact.



Additional Environmental Information

Hot-rolled structural steel sections often undergo the downstream scenario of custom fabrication. There is steel scrap, referred to as overage created during product fabrication; therefore, 1.0771 MT of structural steel produced at the mill sites are required to produce 1 MT of fabricated product output, per Part B PCR Annex F. Therefore, the A1 results in the tables below show a multiplier of 7.71% which is the structural steel that must be generated by the mills to account for overage. When industry-average transportation and fabrication impacts are added, including the industry-average fabrication waste rate of 7.71%, Table 5 below displays the cradle-to-fabricator-gate Impact Assessment Results for 1 metric ton of Fabricated Hot-rolled Structural Sections.

The baseline results reflect a dedicated on-site solar facility at one mill, which began operation in June 2023. One other facility purchased a small share of solar and wind RECs during the study's production year. The renewable energy associated with these RECs was confirmed by the supplier as retired from the system and is therefore included in the baseline results, in accordance with Smart EPD Part A requirements. The results presented in Table 6 show the baseline results without the purchased RECs included, which only slightly increased all impact categories assessed.

Table 5. One (1) metric ton of Fabricated Hot-rolled Structural Sections.

Indicator	Unit	A1	A2	A3	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4
GWP-total	kg CO2 eq	9.67E+02	2.62E+01	8.24E+01	0.00e+0	0.00e+0	0.00e+0	0.00e+0	0.00e+0	0.00e+0	0.00e+0	2.34E+01	4.25e+0	0.00e+0	1.88e-1
GWP-fossil	kg CO2 eq	9.67E+02	2.62E+01	8.23E+01	0.00e+0	0.00e+0	0.00e+0	0.00e+0	0.00e+0	0.00e+0	0.00e+0	2.34E+01	4.25e+0	0.00e+0	1.88e-1
GWP-biogenic	kg CO2 eq	4.83E-01	1.85E-03	4.27E-02	0.00e+0	0.00e+0	0.00e+0	0.00e+0	0.00e+0	0.00e+0	0.00e+0	2.03e-3	2.00e-4	0.00e+0	4.60e-5
GWP-luluc	kg CO2 eq	2.57E-01	1.71E-03	5.48E-02	0.00e+0	0.00e+0	0.00e+0	0.00e+0	0.00e+0	0.00e+0	0.00e+0	2.24e-3	1.80e-4	0.00e+0	9.66e-5
ODP	kg CFC 11 eq	7.65E-06	5.41E-07	7.72E-07	0.00e+0	0.00e+0	0.00e+0	0.00e+0	0.00e+0	0.00e+0	0.00e+0	3.72e-7	5.76e-8	0.00e+0	5.72e-9
AP	kg SO2 eq	3.02E+00	9.89E-02	2.15E-01	0.00e+0	0.00e+0	0.00e+0	0.00e+0	0.00e+0	0.00e+0	0.00e+0	1.92e-1	8.10e-3	0.00e+0	1.20e-3
EP	kg N eq	1.77E+00	1.08E-01	9.51e-1	0.00e+0	0.00e+0	0.00e+0	0.00e+0	0.00e+0	0.00e+0	0.00e+0	2.49e-1	8.37e-3	0.00e+0	1.31e-3
SFP	kg O3 eq	4.78E+01	2.77E+00	2.70E+00	0.00e+0	0.00e+0	0.00e+0	0.00e+0	0.00e+0	0.00e+0	0.00e+0	6.10e+0	2.02e-1	0.00e+0	3.20e-2
ADP-fossil	MJ	1.23E+04	5.06E+02	1.13E+03	0.00e+0	0.00e+0	0.00e+0	0.00e+0	0.00e+0	0.00e+0	0.00e+0	3.03e+2	5.38e+1	0.00e+0	4.44e+0

Modified Impact Results: Renewable Electricity

per 1 metric ton of hot-rolled structural steel sections.

Impact Category	Unit	Method	A1	A2	A3	A1A2A3	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4
GWP-total	kg CO2 eq	IPCC AR6 GWP 100	ND	ND	ND	9.06e+2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
GWP-fossil	kg CO2 eq	IPCC AR6 GWP 100	ND	ND	ND	9.05e+2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
GWP-biogenic	kg CO2 eq	IPCC AR6 GWP 100	ND	ND	ND	4.50e-1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
GWP-luluc	kg CO2 eq	IPCC AR6 GWP 100	ND	ND	ND	2.38e-1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ODP	kg CFC 11 eq	TRACI 2.2	ND	ND	ND	7.12e-6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
POCP	kg O3 eq	TRACI 2.2	ND	ND	ND	4.45e+1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
AP	kg SO2 eq	TRACI 2.2	ND	ND	ND	2.82e+0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
EP-freshwater	kg P eq	TRACI 2.2	0	0	0	0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
EP-marine	kg N eq	TRACI 2.2	ND	ND	ND	1.65e+0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Note:

Not all abbreviated indicators listed below may be present in the results above. The inclusion of indicators varies based on PCR requirements.

Abbreviations:

GWP = Global Warming Potential, 100 years (may also be denoted as GWP-total, GWP-fossil (fossil fuels), GWP-biogenic (biogenic sources), GWP-luluc (land use and land use change)), ODP = Ozone Depletion Potential, AP = Acidification Potential, EP = Eutrophication Potential, SFP = Smog Formation Potential, POCP = Photochemical oxidant creation potential, ADP-Fossil = Abiotic depletion potential for fossil resources, ADP-Minerals&Metals = Abiotic depletion potential for non-fossil resources, WDP = Water deprivation potential, PM = Particular Matter Emissions, IRP = Ionizing radiation, human health, ETP-fw = Eco-toxicity (freshwater), HTP-c = Human toxicity (cancer), HTP-nc = Human toxicity (non-cancer), SQP = Soil quality index.

References

ACLCA. (2018). *ACLCA Guidance to Calculating Non-LCIA Inventory Metrics in Accordance with ISO 21930: 2017.*
American Iron and Steel Institute. (2020). *Life Cycle Inventories of North American Steel Products.*
ANSI/AISC 303-22. (2022). *Code of Standard Practice for Steel Buildings and Bridges.* Retrieved from https://www.aisc.org/globalassets/aisc/publications/standards/a303-22w.pdf
Aufhauser. (n.d). *Safety Data Sheet*. Retrieved from https://www.brazing.com/Pdf/MSDS/New-SDS-MildSteelFluxCore.pdf
Bare, J. (2011). TRACI - The Tool for the Reduction and Assessment of Chemical and other Environmental Impacts. *CLEAN TECHNOLOGIES AND ENVIRONMENTAL POLICY*.
EPA. (2023). *Documentation for Greenhouse Gas Emission and Energy Factors Used in the Waste Reduction Model (WARM), Background Chapters (EPA-530-R-23-017).* Washington, DC: U.S. Government Printing Office. Retrieved from https://www.epa.gov/system/files/documents/2023-12/warm-background_v16_dec.pdf
European Commission. (2022). *Environmental Footprint (EF) reference package 3.1*. Retrieved from https://eplca.jrc.ec.europa.eu/LCDN/developerEF.html
Federal LCA Commons. (2024). *National Renewable Energy Laboratory/US LCI*. Retrieved from https://www.lcacommons.gov/lca-collaboration/National_Renewable_Energy_Laboratory/USLCI_Database_Public/datasets/Processes/48-49:%20Transportation%20and%20Warehousing
Guine, J.B. et al. (2002). *Handbook on life cycle assessment. Operational guide to the ISO standards. I: LCA in perspective. IIa: Guide. IIb: Operational annex. III: Scientific background.* Dordrecht: Kluwer Academic Publishers.
IPCC. (2021). *Climate Change 2021: The Physical Science Basis.* IPCC.
ISO. (2006a). *14040:2006/Amd.1:2020 Environmental management Life cycle assessment Principles and framework.* Geneva: International Organization of Standardization.
ISO. (2006b). *14044:2006/Amd.1:2017/Amd.2:2020 Environmental management Life cycle assessment Requirements and guidelines.* Geneva: International Organization for Standardization.
ISO. (2017). *ISO 21930:2017, Sustainability in buildings and civil engineering works -- Core rules for environmental product declarations of construction products and sevices.*
Pinnacle Alloys. (2022). *Safety Data Sheet*. Retrieved from https://www.pinnaclealloys.com/wp/wp-content/uploads/2015/11/A5.28.pdf
Pinnacle Alloys. (2022). *Safety Data Sheet (SDS)*. Retrieved from https://www.pinnaclealloys.com/wp/wp-content/uploads/2015/11/A5.17-A5.23-11.4.19.pdf
Siebers, R. W. (2020). *Recording sustainability indicators for the value chain - construction and demolition in steel construction [Ph.D. Thesis]*. University of Wuppertal.
SmartEPD. (2025a, March). *Smart EPD Part A Product Category Rules for Building and Construction Products and Services, Standard 1000. Version 1.2.* Retrieved from www.smartepd.com
SmartEPD. (2025b, April 3). *Smart EPD Part B Product Category Rules for Designated Steel Construction Products. Version 3.0. Standard 1000-008.* Retrieved from www.smartepd.com
Sphera. (2021). *EPD Background Report: Fabricated hot-rolled sections and plates.*
United States Environment Protection Agency. (2025). *Detailed Data: eGRID with 2023 Data*. Retrieved from https://www.epa.gov/egrid/detailed-data
Washington Alloy. (2023). *Carbon Steel Electrodes*. Retrieved from https://www.washingtonalloy.com/wp-content/uploads/2023/07/CARBON-STEELELECTRODES-2023.pdf
Wernet, G., Bauer, C., Steubing, B., Reinhard, J., Moreno-Ruiz, E., & Weidema, B. (2016). The ecoinvent database version 3 (part I): overview and methodology. *The International Journal of Life Cycle Assessment*, 1218-1230.
World Steel Association. (2014). *A methodology to determine the LCI of steel industry co-products.* World Steel Association.
World Steel Association. (2025). *LCI Data for Steel Prodcuts.*