Environmental Product Declaration

Program Operator: Smart EPD®

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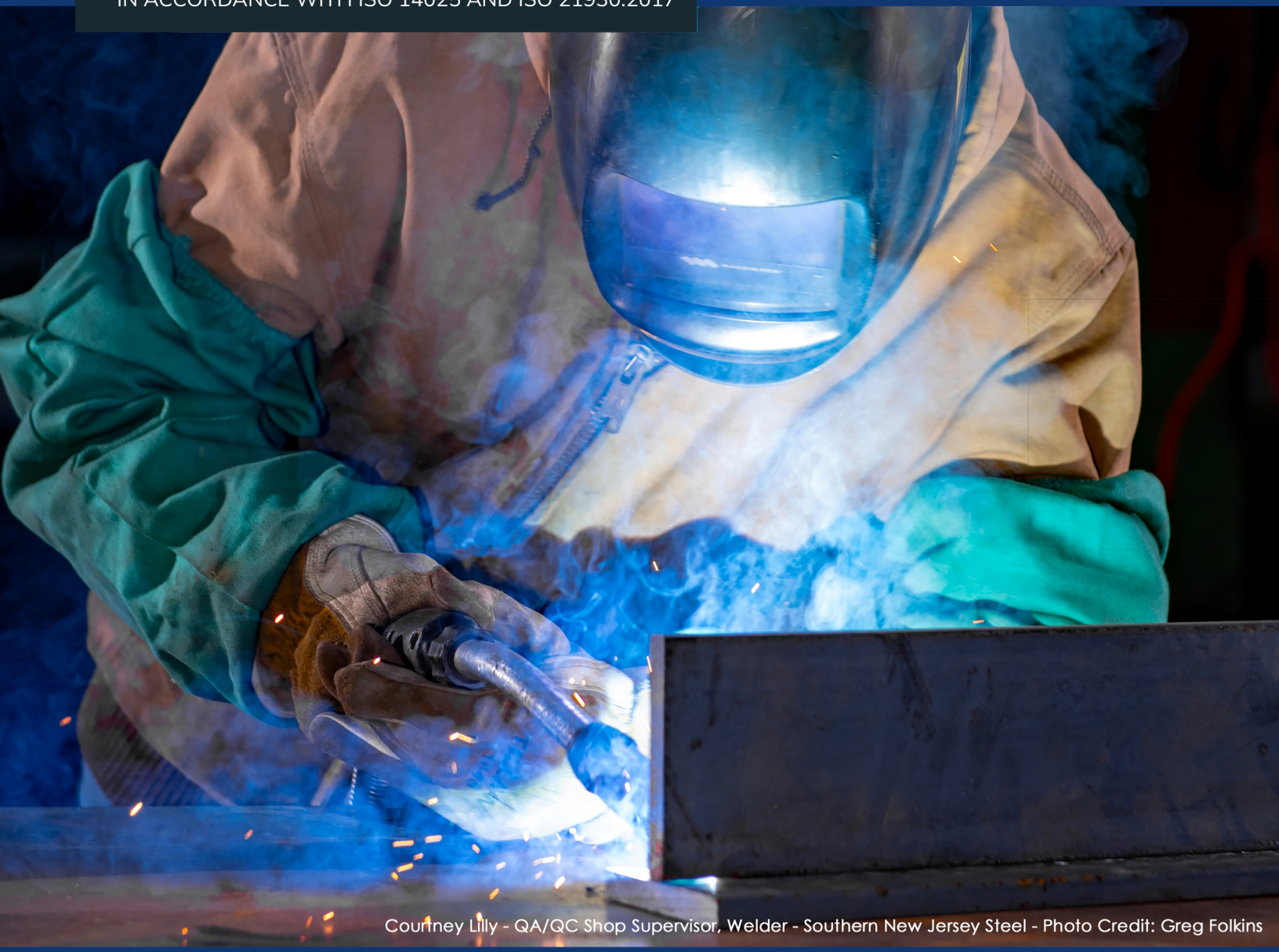
IN ACCORDANCE WITH ISO 14025 AND ISO 21930:2017



Courtney Lilly - QA/QC Shop Supervisor, Welder - Southern New Jersey Steel - Photo Credit: Greg Folkins

Fabrication Process for Structural Steel

Date of Issue	Expiration date	Last updated
October 15, 2025	October 15, 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

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solutions@aisc.org www.aisc.org

Process Name:	Fabrication Process for Structural Steel
Declared Unit:	1 unit of fabrication required for 1 MT of fabricated structural steel
Declaration Number:	SmartEPD-2025-092-0615-01.2
Date of Issue:	October 15, 2025
Expiration:	October 15, 2030
Last updated:	October 30, 2025
EPD Scope:	Cradle to gate A1 - A3
Market(s) of Applicability:	North America
Disclaimer:	This EPD represents the fabrication process for 1 MT of structural steel. It is intended to be additive to structural steel product EPDs and to serve as a data source for modeling of the fabrication process in structural steel product EPDs and whole building LCA tools.

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.

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

Process Information

Declared Unit:	1 unit of fabrication required for 1 MT of fabricated structural steel
Mass:	N/A
Process Specificity:	✓ Process Average
	✗ Process Specific

Process Description

Important Note: This EPD represents the fabrication process for 1 MT of structural steel. It is intended to be additive to structural steel product EPDs and to serve as a data source for the modeling of the fabrication process in structural steel product EPDs and whole building LCA tools.

Prior to installation, structural steel commonly undergoes a scenario-specific fabrication process. This process entails inspection, material handling, cutting, drilling, fit-up, welding, and bolting; all according to the AISC Code of Standard Practice for Steel Buildings and Bridges (ANSI/AISC 303-22). In addition to the steel itself, inputs to fabrication include relatively small amounts of process materials, such as lubricants, gases, electrodes, and welding fluxes. Some facilities also conduct surface preparation using mechanical processes or compressed air blasting in order to clean the surface and prepare it for coating. Surface preparation for the application of coatings, the coatings themselves, and galvanization are not included in the scope of this study. Scrap generated during the fabrication processes is considered manufacturing scrap and is returned to steel mills as a pre-consumer external scrap input.

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

Process Specifications

Process Classification Codes:	EC3 - Steel -> StructuralSteel UNSPSC - 30103618 undefined - undefined
System boundary option:	Fabrication: Process (Option 3A)
Options:	
Steel Type:	Not applicable
Other:	Represents fabrication of structural steel

Material Composition

Material/Component Category	Origin	% Mass
N/A	N/A	N/A

Packaging Material	Origin	kg Mass
None	None	None

Hazardous Materials
No regulated hazardous or dangerous substances are included in this process.

EPD Data Specificity

Primary Data Year:	2019-2020
Manufacturing Specificity:	✓ Industry Average
	✗ Manufacturer Average
	✗ Facility Specific

Averaging:

The fabrication process data was collected from 80 fabricator sites out of AISC's approximately 1,000 fabricator members. The participating companies represent approximately 19% of the total steel tonnage fabricated by AISC's membership, which makes up approximately 75% of the total fabrication tonnage in the U.S. These facilities provided data for the AISC 2021 EPD background report (Sphera, 2021), representing 2019-2020 production. The primary data aggregated for that study was updated with background data representative for 2023 in this study.

System Boundary

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

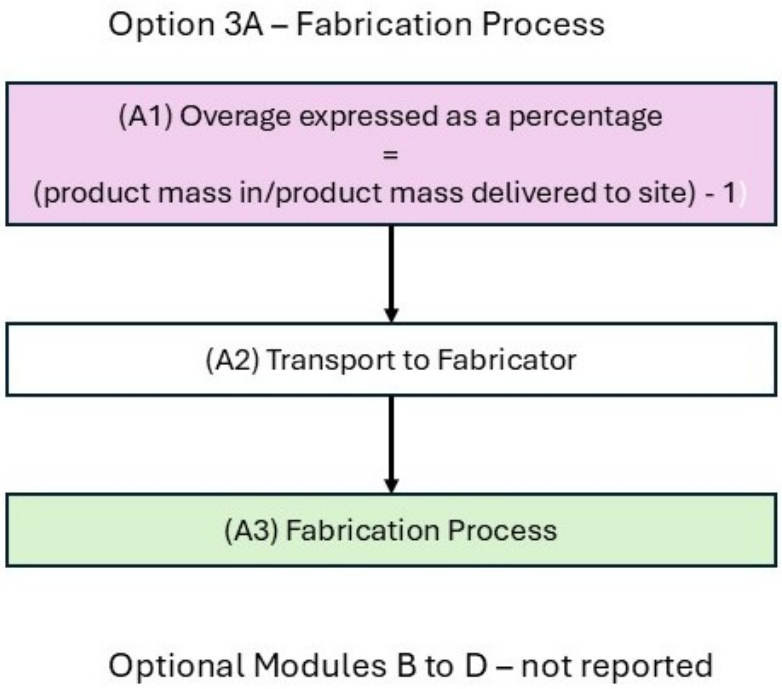
Note:

ND = Module not declared

Participating Manufacturers

Industry-average representing AISC's fabricator members: https://www.aisc.org/aisc-membership/member-directory/. 80 of approximately 1000 fabricator facilities contributed data deemed representative of the industry average.

Figure 1. Process Flow Diagram



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
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
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.

The data from fabrication facilities represents primary data collected for the 2019 and 2020 calendar years and used in AISC's 2021 industry-average EPD. The 80 fabrication facilities included in the study utilize a representative mix of current fabrication techniques for the U.S. The production-weighted fabrication life cycle inventory (LCI) data was updated for this study in two ways to improve temporal and geographical representativeness. First, the fabrication tonnage for each state was provided by AISC for the 2023 calendar year, which was used to update the mix of region-specific electricity datasets paired with the inventory. Second, all background datasets were updated to the ecoinvent database v3.10, representing the 2023 calendar year.

Life Cycle Module Descriptions

A1 Extraction and processing of feedstock materials; this category includes the overage in upstream production of mill or manufactured product input necessary to account for fabrication scrap expressed as a percentage.
A2 Transportation of the mill or manufactured product to the fabrication facility; this category includes the inbound transportation of structural steel products to the fabrication facility.
A3 Fabrication operations; this category includes fabrication processes, such as inspection, material handling, cutting, drilling, fit-up, welding, bolting, and fabrication waste disposal.

LCA Discussion

Allocation Procedure

No co-product allocation was required for the fabrication process, as no co-products are produced. Fabrication scrap generated in A3 was modeled using the cut-off (or recycled content) approach.

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:	✕ No

Results

Environmental Impact Assessment Results

IPCC AR6 GWP 100, TRACI 2.2, CML 2016 v4.8

per 1 unit of fabrication required for 1 MT of fabricated structural steel

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
GWP-total	IPCC AR6 GWP 100	kg CO2 eq	7.71%	2.62e+1	8.24e+1
GWP-fossil	IPCC AR6 GWP 100	kg CO2 eq	7.71%	2.62e+1	8.23e+1
GWP-biogenic	IPCC AR6 GWP 100	kg CO2 eq	7.71%	1.85e-3	4.27e-2
GWP-luluc	IPCC AR6 GWP 100	kg CO2 eq	7.71%	1.71e-3	5.48e-2
ODP	TRACI 2.2	kg CFC 11 eq	7.71%	5.41e-7	7.72e-7
AP	TRACI 2.2	kg SO2 eq	7.71%	9.89e-2	2.15e-1
EP	TRACI 2.2	kg N eq	7.71%	1.13e-1	1.08e-1
POCP	TRACI 2.2	kg O3 eq	7.71%	2.77e+0	2.70e+0
ADP-fossil	CML 2016 v4.8	MJ	7.71%	5.06e+2	1.13e+3

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.

Structural steel often undergoes 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 column in Table 1 shows a multiplier of 7.71% which is the additional structural steel that must be produced by the mills to account for overage.

The A2 module modeled applies only to shipments from domestic mills to domestic fabricators and is not valid for mill shipments originating outside the U.S.

Comparisons cannot be made between process-specific or industry average EPDs at the design stage of a project, before a building has been specified. Comparisons may be made between process-specific or industry average EPDs at the time of process purchase when process 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 process category rules or are missing relevant environmental impacts. Such comparison can be inaccurate, and could lead to erroneous selection of materials or processs which are higher-impact, at least in some impact categories.

Resource Use Indicators

per 1 unit of fabrication required for 1 MT of fabricated structural steel

Indicator	Unit	A1	A2	A3
RPRE	MJ	7.71%	1.11e+0	1.50e+2
RPRM	MJ	7.71%	0	0
NRPRE	MJ	7.71%	5.03e+2	1.46e+3
NRPRM	MJ	7.71%	0	0
SM	kg	7.71%	0	0
RSF	MJ	7.71%	0	0
NRSF	MJ	7.71%	0	0
FW	m3	7.71%	5.51e-3	3.72e-1
RE	MJ	7.71%	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 unit of fabrication required for 1 MT of fabricated structural steel

Indicator	Unit	A1	A2	A3
HWD	kg	7.71%	3.53e-3	4.08e-3
NHWD	kg	7.71%	7.05e-2	1.23e+1
RWD	kg	0	0	0
HLRW	kg	N/A	N/A	N/A
ILLRW	kg	N/A	N/A	N/A
CRU	kg	0	0	0
MFR	kg	7.71%	0	7.71e+1
MER	kg	7.71%	0	0
EEE	MJ	7.71%	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:

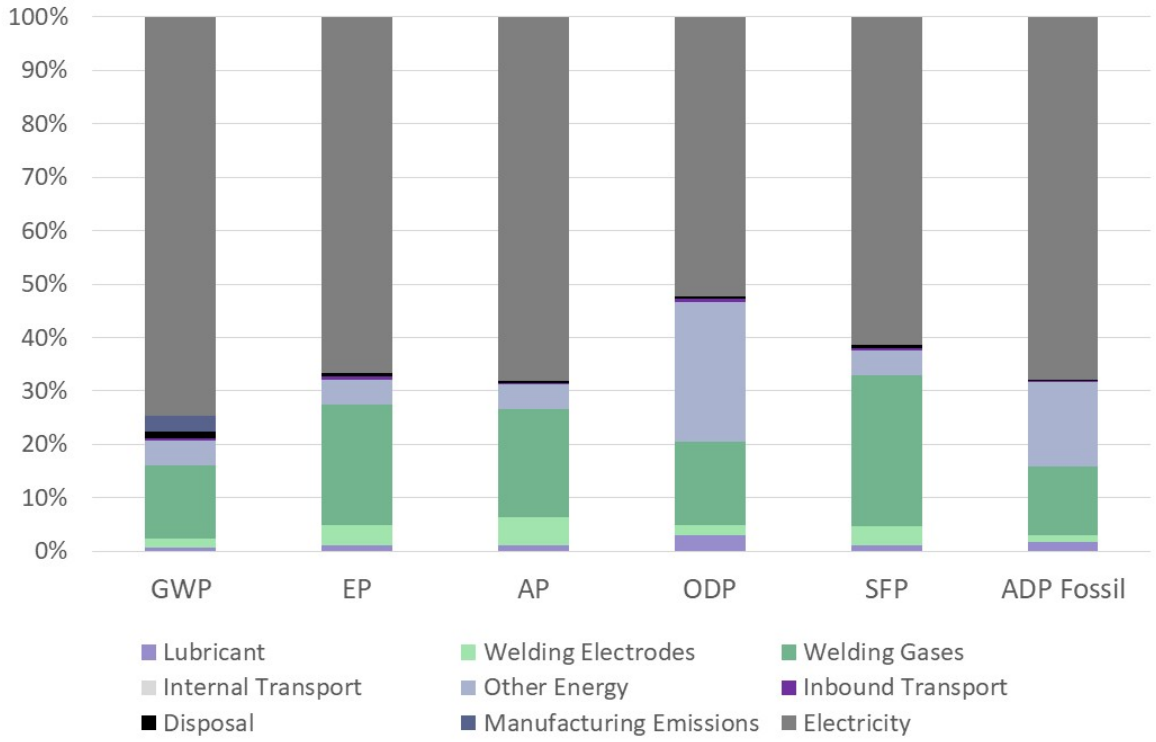
HWD = Hazardous waste disposed, NHWD = Non-hazardous waste disposed, RWD = Radioactive waste disposed, HLRW = High-level radioactive waste, ILLRW = Intermediate- and low-level radioactive waste, CRU = Components for re-use, MFR or MR = Materials for recycling, MER = Materials for energy recovery, MNER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

Interpretation

The contribution analysis for the fabrication stage (A3), based on a gate-to-gate assessment of the fabrication process, found that electricity consumption is the largest contributor across all impact categories, representing between 52 and 75 percent of the total. Welding gases are also significant contributors to all impacts (up to 28%) and other energy consumed at the sites is significant for ODP and ADPf.

For the fabrication process needed for 1 metric ton of fabricated structural steel, the average, 10th percentile, and 90th percentile GWP values were calculated from the 80 fabrication facilities that provided primary data for modules A2 (transportation to fabrication) and A3 (fabrication). For A2, the 10th percentile, average, and 90th percentile GWP results were 26, 26, and 28, kg CO2eq/MT, respectively. For A3, the 10th percentile, average, and 90th percentile impacts were 29, 82, and 256 kg CO2eq/MT, respectively.

Figure 2. Contribution analysis results for the U.S. average fabrication process



Additional Environmental Information

The fabrication process does 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 fabrication of structural steel products.

As electricity is the largest contributor to fabrication impacts, and the amount and type of fabrication required to produce a unit of fabricated structural steel can vary widely based upon the unique requirements of any structural steel project, the value and meaning of fabricator-specific impacts is highly questionable. Alternatively, AISC administers the only sustainability program in the U.S. specifically designed to elevate and acknowledge the sustainable practices of structural steel fabricators. Those participating in the program are listed dynamically online at aisc.org/partnerprogram.

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