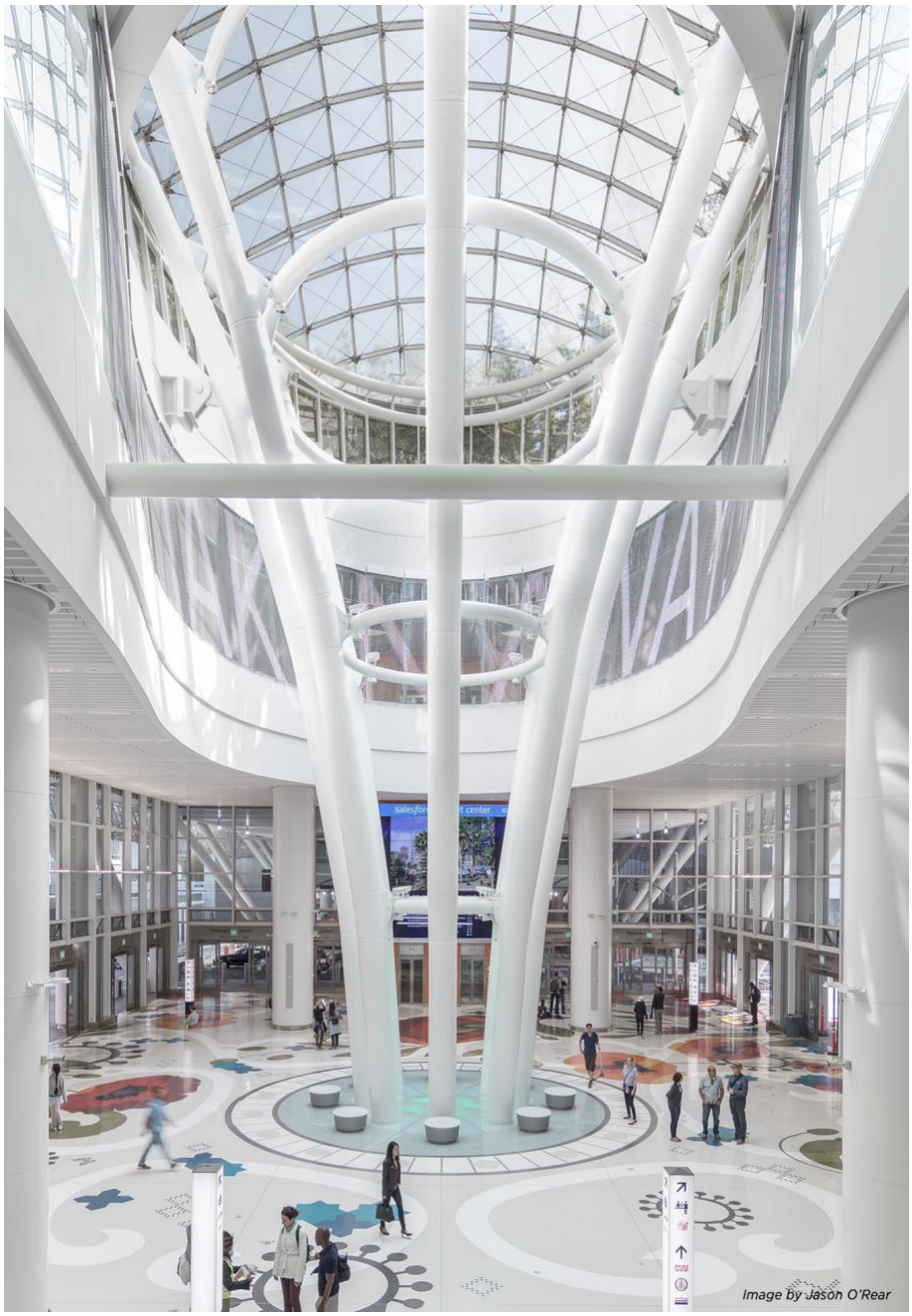
ENVIRONMENTAL PRODUCT DECLARATION

HOLLOW STRUCTURAL SECTIONS

STEEL TUBE INSTITUTE



Hollow Structural Sections produced in North America by the Steel Tube Institute members.

Use of this EPD is limited to STI members. Member names are available online at www.steeltubeinstitute.org/about-us/sti-producers/

STEEL TUBE INSTITUTE

The Steel Tube Institute was formed in 1930 when a group of manufacturers joined forces to promote and market steel tubing. Their goal was to mount a cooperative effort that would improve manufacturing techniques and inform customers about their products' utility and versatility. This remains the basic motivation for the Institute's efforts today. Using that strong history as a foundation, STI is constantly evolving to best meet the needs of a sophisticated and competitive marketplace. The organization is dedicated to the betterment of the steel industry and to the advancement of its member companies.

For more information, please visit: www.steeltubeinstitute.org

UL CERTIFIED ENVIRONMENTAL PRODUCT DECLARATION UL.COM/EPD

ENVIRONMENTAL PRODUCT DECLARATION

STEEL TUBE INSTITUTE

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HOLLOW STRUCTURAL SECTIONS

According to ISO 14025 and ISO 21930:2017

EPD PROGRAM AND PROGRAM OPERATOR NAME, ADDRESS, LOGO, AND WEBSITE	UL PROVIDED
GENERAL PROGRAM INSTRUCTIONS AND VERSION NUMBER	UL Provided
ASSOCIATION NAME AND ADDRESS	Steel Tube Institute | 2516 Waukegan Road, Suite 172, Glenview, IL 60025
DECLARATION NUMBER	UL Provided
DECLARED PRODUCT & DECLARED UNIT	Hollow structural steel sections, 1 metric ton
REFERENCE PCR AND VERSION NUMBER	Part A: Calculation Rules for the LCA and Requirements Project Report, (IBU/UL Environment, V3.2, 12.12.2018) and Part B: Designated Steel Construction Product EPD Requirements (UL Environment, V2.0, 08.26.2020).
DESCRIPTION OF PRODUCT APPLICATION/USE	Hollow structural steel sections used in construction
MARKETS OF APPLICABILITY	North America
DATE OF ISSUE	UL Provided
PERIOD OF VALIDITY	5 years
EPD TYPE	Industry average
EPD SCOPE	Cradle to gate
YEAR(S) OF REPORTED PRIMARY DATA	2019-2020
LCA SOFTWARE & VERSION NUMBER	GaBi v10
LCI DATABASE(S) & VERSION NUMBER	GaBi 2021 (CUP 2021.1)
LCIA METHODOLOGY & VERSION NUMBER	IPCC AR5 + TRACI 2.1

The sub-category PCR review was conducted by:	UL Provided UL Provided UL Provided
This declaration was independently verified in accordance with ISO 14025: 2006. The UL Environment "Part A: Calculation Rules for the Life Cycle Assessment and Requirements on the Project Report,", v3.2 (December 2018), in conformance with ISO 21930:2017, serves as the core PCR, with additional considerations from the USGBC/UL Environment Part A Enhancement (2017) ☐ INTERNAL ☒EXTERNAL	UL Provided
This life cycle assessment was conducted in accordance with ISO 14044 and the reference PCR by:	UL Provided
This life cycle assessment was independently verified in accordance with ISO 14044 and the reference PCR by:	UL Provided

LIMITATIONS

The environmental impact results of steel products in this document are based on a declared unit and therefore do not provide sufficient information to establish comparisons. The results shall not be used for comparisons without knowledge of how the physical properties of the steel product impact the precise function at the construction level. The environmental impact results shall be converted to a functional unit basis before any comparison is attempted. See the results section for additional EPD comparability guidelines.

Environmental declarations from different programs (ISO 14025) may not be comparable.

General Information

Description of Organization

The Steel Tube Institute (STI) is the leading technical resource in North America for all steel tube and pipe products. We proudly represent U.S. manufacturers of carbon steel tubing. Our main goal is to increase utilization of HSS and other steel tubular products in construction and other industries and reveal the wealth of possibilities afforded by designing with HSS. STI's programs include continuing education, technical resources, technical assistance, and safety programs as we promote best practices in manufacturing techniques, industry safety, environmental engagement, and the overall steel industry.

Participating Members

This EPD represents hollow structural sections (HSS) produced by STIs membership. The members that contributed to this EPD are listed below:

- Atlas Tube
- Maruichi American Corporation
- Maruichi Leavitt Pipe and Tube
- Maruichi Oregon Steel Tube
- Nucor Tubular Products
- Searing Industries
- VEST, Inc.
- Wheatland Tube

Product Description

Hollow structural sections covered under this declaration are cold-formed, welded steel tubing produced in round, square, and rectangular shapes in a broad range of dimensions, gauges, and lengths. HSS is used for structural and miscellaneous elements in buildings, bridges and other structures as well as a variety of manufactured products such as agriculture implements and rollover or other protection structures for vehicles.

Product Specification

Hollow structural sections products are defined by the following ASTM standards.

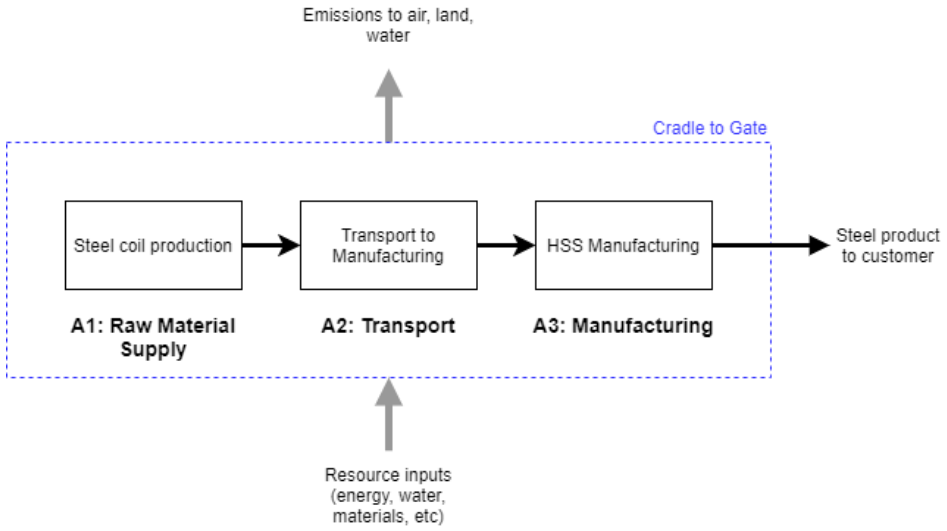
- ASTM A500: Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
- ASTM A513: Standard Specification for Electric-Resistance-Welded Carbon and Alloy Steel Mechanical Tubing
- ASTM A847: Standard Specification for Cold-Formed Welded and Seamless High-Strength, Low-Alloy Structural Tubing with Improved Atmospheric Corrosion Resistance
- ASTM A1085: Standard Specification for Cold-Formed Welded Carbon Steel Hollow Structural Sections (HSS)

Steel pipe piles and steel pipe are also included in the declaration as the same materials and processes are used to manufacture these products Steel pipe piles and steel pipe products are defined by the following ASTM standards:

- ASTM A135: Standard Specification for Electric-Resistance-Welded Steel Pipe
- ASTM A252: Standard Specification for Welded and Seamless Steel Pipe Piles
- ASTM A53: Standard Specification for Pipe

- ASTM A795: Standard Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection
- CSA G40.21: General requirements for rolled or welded structural quality steel

Flow Diagram



Product Average

The data collected represents HSS production in 2019 and 2020 by participating STI members located throughout North America. Results are weighted according to production totals at participating facilities.

Application

HSS are typically used in buildings, bridges, and industrial applications.

Material Composition

Steel HSS products are made of carbon steel with a small percentage of alloy elements and paints included. 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.

Methodological Framework

Declared unit

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

Table 1. Declared unit

NAME	VALUE	UNIT
Declared unit	1	metric ton
Density (typical)	7,850	kg/m^3

System Boundary

This EPD is “cradle-to-gate” in scope. The life cycle stages included in the assessment represent the product stage (modules A1-A3) and include:

PRODUCT STAGE			CONSTRUCT-ION PROCESS STAGE		USE STAGE							END OF LIFE STAGE				BENEFITS AND LOADS BEYOND THE SYSTEM BOUNDARY
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
A1	**A2**	**A3**	**A4**	**A5**	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**C1**	**C2**	**C3**	**C4**	**D**
X	X	X	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND

* X = module included, MND = module not declared

Allocation

No multi-output allocation was required in the foreground system of the study.

Allocation of background data (energy and materials) taken from the GaBi 2021 databases is documented online at https://sphera.com/wp-content/uploads/2020/04/Modeling-Principles-GaBi-Databases-2021.pdf. Background data for steelmaking from AISI and worldsteel use the system expansion allocation method for co-products from the steelmaking process.

Since the EPD does not cover the end-of-life of the products, end-of-life allocation is outside the scope of the study. Metal scrap from manufacturing (module A3) was balanced with the scrap demand of the raw materials module (A1) in order to calculate the net scrap input to module A1.

Under a cradle-to-gate system boundary, scrap inputs to the system are not associated with any upstream burden, and scrap produced during manufacturing is assumed to be at least the same quality as scrap inputs into steelmaking. Remelting of scrap to produce structural steel and other raw materials is accounted for within module A1 using upstream datasets.

Cut-off Rules

In lieu of arbitrary cut-off criteria, all available energy and material flow data were included in the model for processes within the system boundary.

In cases where no matching life cycle inventories were available to represent a flow, proxy data were applied based on conservative assumptions regarding environmental impacts.

Data Sources

The LCA model was created using the GaBi 10 software system for life cycle engineering, developed by Sphera (Sphera, 2021). Background life cycle inventory data for raw materials and processes were obtained from the GaBi 2021 database (CUP 2021.1). Primary manufacturing data were provided by participating STI member companies.

Data Quality

A variery of tests and checks were performed by the LCA practitioner throughout the project to ensure high quality of the completed LCA. Checks in cluded an extensive internal review of the project-specific LCA models developed as well as the background data used. A full data quality assessment is documented in the background report.

Period Under Review

Primary data were collected for HSS production during the years 2019 and 2020. Background data for steel coil production was taken from the AISI and worldsteel and represents steel production during 2017 and 2019 respectively. This analysis is intended to represent HSS manufacturing in 2020.

Estimates and Assumptions

The HSS inventory data was collected by participating STI member companies to represent HSS manufacturing in North America. Where inbound transportation data was incomplete, a distance of 500 miles by truck was used.

Proxy data were applied to some materials where no matching life cycle inventories were available as documented in the background report.

Technical Information and Scenarios

Manufacturing

Hollow structural sections are manufactured by cold-forming steel coil into tubes. Hot-rolled coil is first slit into sections of appropriate width. The narrower coils are then uncoiled and passed through a series of rollers that form the continuious sheet into tubes. Tube cross-sections can be rectangular, round, or elliptical, depending upon the intended

application. The two edges of the coil are welded together via an electric resistance welding process and the product is then cut to length. Once manufactured, HSS can be powder coated or primed—or left uncoated. The tubes are subsequently packaged for shipment.

The primary input to HSS production is the steel itself, although small amounts of process and coating materials are needed. Electricity is used for manufacturing and to move the materials. Manufacturing produces some metal scrap. The scrap generated during manufacturing is assumed to be produced at the same quality as used by the upstream metal production processes. Therefore, the scrap from manufacturing is treated assuming open-loop recycling.

Inbound Transportation

Inbound transportation distances and modes for steel and process materials were collected from each participating HSS manufacturer.

Transportation

Transportation to the customer or construction site is outside the scope of this EPD.

Product Installation

Installation is outside the scope of this EPD.

Use

Product use is outside the scope of this EPD.

Reuse, Recycling, and Energy Recovery

Product reuse, recycling, and incineration for energy recovery is outside the scope of this EPD.

Disposal

Product disposal is outside the scope of this EPD.

Environmental Indicators Derived from LCA

North American life cycle impact assessment (LCIA) results are declared using TRACI 2.1 (Bare, 2012; EPA, 2012) methodology, with the exception of GWP which is reported using the IPCC AR5 (IPCC, 2013) methodology, excluding biogenic carbon. Primary energy use represents the lower heating value (LHV) a.k.a. net calorific value (NCV).

LCIA results are relative expressions and do not predict actual impacts, the exceeding of thresholds, safety margins or risks.

Table 2. LCIA results, per 1 metric ton

PARAMETER	UNIT	TOTAL	A1	A2	A3
GWP 100	kg CO_2 eq.	**1.71E+03**	1.64E+03	1.51E+01	6.23E+01

PARAMETER	UNIT	TOTAL	A1	A2	A3
ODP*	kg CFC 11 eq.	**-2.17E-12**	-2.39E-12	3.04E-15	2.18E-13
AP	kg SO_2 eq.	**3.71E+00**	3.52E+00	1.01E-01	9.14E-02
EP	kg N eq.	**1.91E-01**	1.72E-01	8.47E-03	1.02E-02
SFP	kg O_3 eq.	**6.38E+01**	5.86E+01	3.24E+00	1.98E+00
ADP_{fossil}	MJ surplus	**1.49E+03**	1.35E+03	2.87E+01	1.07E+02

* ODP has limited relevance due to the absence of ozone-depleting emissions in the LCI, in both the background and foreground data. ODP for A1 is negative due to crediting in the background data for steel coil from AISI.

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

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

Table 3. Resource use results, per 1 metric ton

PARAMETER	UNIT	TOTAL	A1	A2	A3
RPR_E	MJ LHV	**9.09E+02**	7.97E+02	8.68E+00	1.03E+02
RPR_M	MJ LHV	**-**	-	-	-
$NRPR_E$	MJ LHV	**2.19E+04**	2.06E+04	2.16E+02	1.07E+03
$NRPR_M$	MJ LHV	**1.82E-01**	-	-	1.82E-01
SM	kg	**4.84E+02**	4.84E+02	-	2.44E-02
RSF	MJ LHV	**-**	-	-	-
NRSF	MJ LHV	**-**	-	-	-
RE	MJ LHV	**-**	-	-	-
FW	m^3	**9.46E+00**	9.29E+00	3.70E-02	1.30E-01

Table 4. Output flows and waste categories results, per 1 metric ton

PARAMETER	UNIT	TOTAL	A1	A2	A3
HWD	kg	**1.54E-01**	-	-	1.54E-01
NHWD	kg	**5.87E+00**	-	-	5.87E+00
HLRW	kg	**7.94E-04**	7.28E-04	7.27E-07	6.52E-05
ILLRW	kg	**6.63E-01**	6.08E-01	6.12E-04	5.45E-02
CRU	kg	**-**	-	-	-
MR	kg	**7.05E+01**			7.05E+01
MER	kg	**-**	-	-	-
EE	MJ LHV	**-**	-	-	-

Per the PCR, "industry average EPDs shall report information on the statistical distribution of results for all TRACI indicators". The min and max results presented in Table 5 represent the facilities with the lowest (best) and highest (worst) impacts, respectively. Min and max facilities are determined for each impact category separately. The mean and median do not take production volumes across facilities into account (i.e., it is a calculation based on each individual facility as a data point), while the weighted average presented in Table 2 through Table 4 is calculated via production volume weightings reported by each participating facility.

Table 5. Statistical distribution of LCIA results, per 1 metric ton

PARAMETER	UNIT	MIN (A1-A3)	MAX (A1-A3)	MAX/MIN RATIO (A1-A3)	MEAN (A1-A3)	MEDIAN (A1-A3)
GWP 100	kg CO_2 eq.	1.55E+03	2.76E+03	1.79E+00	1.77E+03	1.71E+03
ODP	kg CFC 11 eq.	-2.54E-12	1.04E-13	-4.07E-02	-1.99E-12	-2.27E-12
AP	kg SO_2 eq.	3.29E+00	5.11E+00	1.55E+00	3.84E+00	3.76E+00
EP	kg N eq.	1.65E-01	3.98E-01	2.41E+00	2.02E-01	1.89E-01
SFP	kg O_3 eq.	5.53E+01	9.59E+01	1.73E+00	6.62E+01	6.35E+01
ADP_{fossil}	MJ surplus	1.29E+03	3.64E+03	2.82E+00	1.56E+03	1.41E+03

Visualization of Life Cycle Impact Assessment

The relative contribution of each life cycle stage to the overall cradle-to-gate impact are presented in Figure 1, while the contribution of HSS manufacturing process components to A3 impacts are presented in Figure 2.

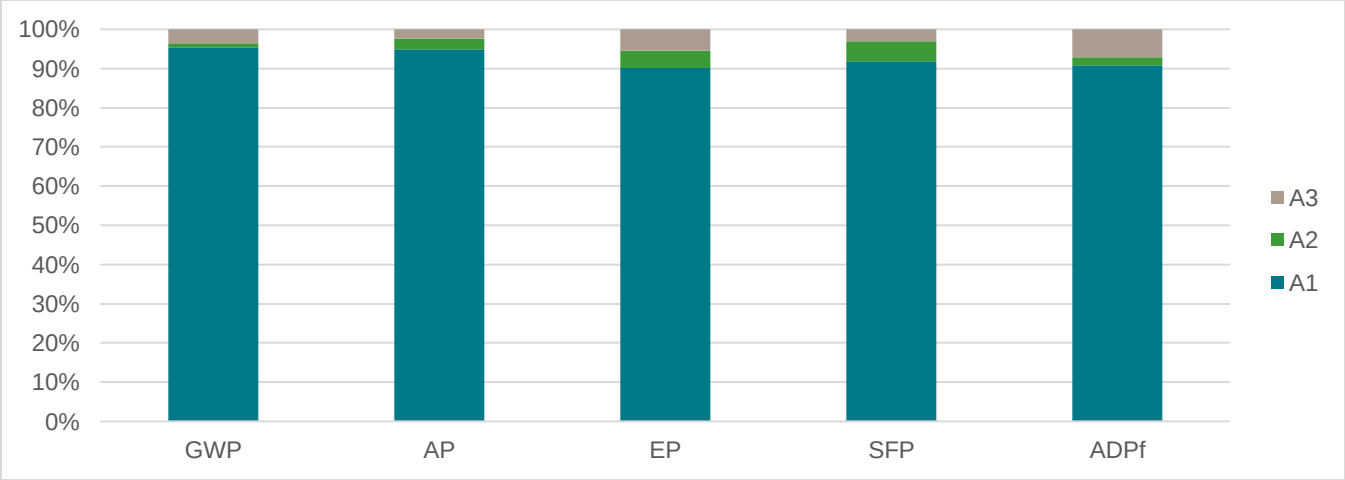


Figure 1: Relative contribution by life cycle stage for 1 metric ton of hollow structural sections

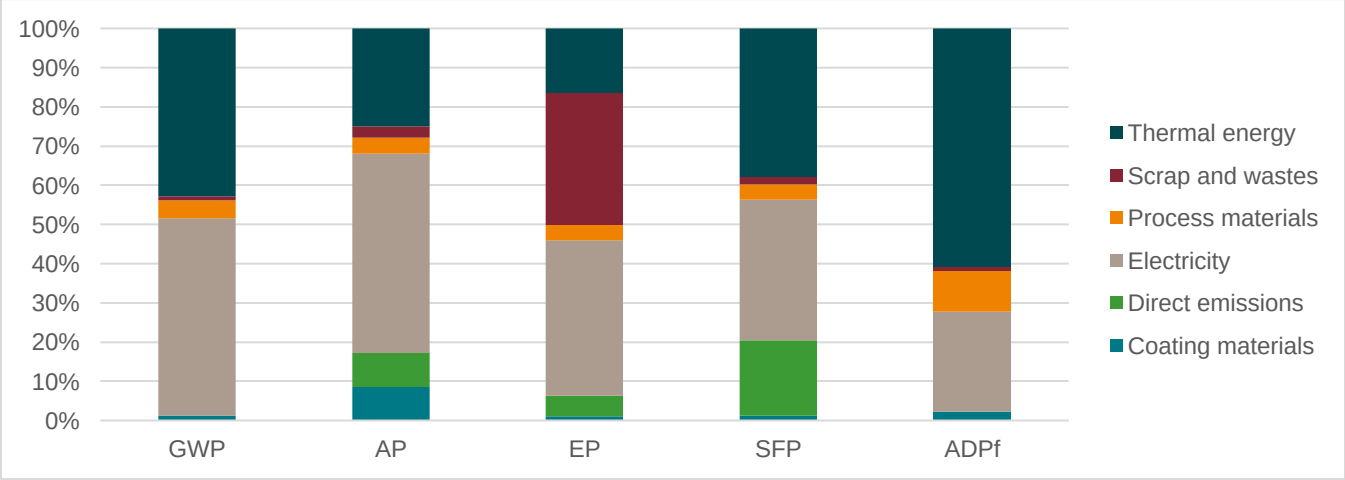


Figure 2: Relative contribution of manufacturing components for 1 metric ton of hollow structural sections

Interpretation

The cradle-to-gate potential environmental impacts of HSS products are driven by steel coil production (A1). Inbound transport to manufacturing (A2) and HSS manufacturing (A3) contribute to potential environmental impacts on a smaller order of magnitude.

Additional Environmental Information

Environment and Health During Manufacturing

Environmental, occupational health and safety practices are in accordance with OSHA and individual state requirements. Hollow structural sections are manufactured entirely from steel. They do 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 to said materials or substances at levels exceeding safe health thresholds.

Further Information

Further information can be found at www.steeltubeinstitute.org or by emailing hssinfo@steeltubeinstitute.org.

References

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