CANADIAN INSTITUTE OF STEEL CONSTRUCTION
INSTITUT CANADIEN DE LA CONSTRUCTION EN ACIER

Canadian Institute of Steel Construction (CISC) Environmental Product Declaration (EPD)

Fabricated Hollow Structural Steel Sections (Painted)

Environmental Product Declaration

CSA Group Registered Based on ISO 14025 and Other Requirements

For more information visit **csaregistries.ca/epd**

#3002-9840
Dec 2021 - 2026

The development of this industry average environmental product declaration (EPD) for **fabricated hollow structural steel sections (painted) manufactured in Canada** was commissioned by the **Canadian Institute of Steel Construction (CISC)**. This Type III EPD was developed in compliance with CAN/CSA-ISO 14025 and ISO 21930:2017.

This EPD includes life cycle assessment (LCA) results for raw material supply, transport and manufacturing (cradle-to-gate). The LCA was performed by Groupe AGÉCO.

CISC fabricators authorized to use this industry average EPD are listed here: http://www.cisc-icca.ca/sustainability/EPD.

For more information about CISC, please go to www.cisc-icca.ca.

Issue date: December 13, 2021 *Minor amendment: May 6, 2022*

This environmental product declaration (EPD) is in accordance with CAN/CSA-ISO 14025, ISO 21930:2017 and the PCR noted below. EPDs within the same product category but from different programs may not be comparable.

EPD program operator	CSA Group 178 Rexdale Blvd, Toronto, ON, Canada M9W 1R3 www.csagroup.org
General program instructions	CSA-SDP-5-13 CSA Group program operator rules for Type III environmental product declarations (2013)
Manufacturer name and address	Canadian Institute of Steel Construction (CISC) 445 Apple Creek Blvd., Suite 102, Markham ON, Canada L3R 9X7 www.cisc-icca.ca
Declaration number	#3002-9840
Declaration product & declared unit	1 metric ton and 1 short ton of painted fabricated hollow structural steel sections with a density of 7,800 kg/m3 or 487 lb/ft3
Reference PCR and version number	Product Category Rule Guidance for Building-Related Products and Services Part A: Life Cycle Assessment Calculation Rules and Report Requirements (version 3.2) UL Environment Product Category Rule Guidance for Building-Related Products and Services Part B: Designated Steel Construction Product EPD Requirements (version 2.0) UL Environment Valid until August 2025 UN CPC code: 412
Markets of applicability	Canada
Date of issue	December 13, 2021
Period of validity	December 13, 2021 – December 12, 2026
EPD type	Industry-average
Dataset variability	See Table 7, page 16
EPD scope	Cradle-to-gate A1-A3
Year(s) of reported primary data	January 2019-December 2020
LCA software & version number	SimaPro 9
LCI database(s) & version number	Ecoinvent 3.6 Background dataset for North American hot-rolled coil, published by American Iron and Steel Institute (AISI, 2020) LCI of steel scrap from Worldsteel Association (2021)

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LCIA methodology & version number	TRACI 2.1
The sub-category PCR review was conducted by:	Thomas Gloria, Industrial Ecology Consultants (chair) Brandie Sebastian, JBE Consultants James Littlefield, Independent Consultant
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 x **External**
This life cycle assessment was conducted in accordance with ISO 14044 and the reference PCR by:	Groupe AGÉCO 1995, Frank-Carrel Street, suite 219 Quebec (Quebec) G1N 4H9
The life cycle assessment was independently verified in accordance with ISO 14044 and the reference PCR by:	Thomas Gloria, Ph.D. Industrial Ecology Consultants 35 Bracebridge Rd., Newton, MA 02459-1728 t.gloria@industrial-ecology.com www.industrial-ecology.com

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 Section 3.10 for additional EPD comparability guidelines. Environmental declarations from different programs (ISO 14025) may not be comparable.

This is a summary of the industry average environmental product declaration (EPD) describing the environmental performance of fabricated hollow structural steel sections (painted) manufactured in Canada. This EPD is only applicable to structural steel sourced from Canadian and US steel mills. CISC fabricators authorized to use this EPD are listed on the CISC website: www.cisc-icca.ca/sustainability/EPD.

EPD commissioner and owner	Period of validity	Program operator and registration number	Product Category Rule	LCA and EPD consultants
Canadian Institute of Steel Construction (CISC)	December 13, 2021-December 12, 2026	CSA Group #3002-9840	Product Category Rule Guidance for Building-Related Products and Services Part B: Designated Steel Construction Product EPD Requirements v.2	Groupe AGÉCO

Product description

Painted fabricated hollow structural steel sections as specified by CSA G40.21, ASTM A500 and ASTM 1085 standards ASTM A1085 / A1085M, 2015; ASTM A500 / A500M-21, 2015; CSA, 2020.

Declared units

1 metric ton and 1 short ton of painted fabricated hollow structural steel sections with a density of 7,800 kg/m^3 or 487 lb/ft^3.

Material content (% of total product mass)

Steel: 99%
Shop primer: 1%

Scope and system boundary

Cradle-to-gate: production (A1 to A3).

What is a Life Cycle Assessment (LCA)?

LCA is a science-based and internationally recognized tool to evaluate the relative potential environmental and human health impacts of products and services throughout their life cycle, beginning with raw material extraction and including all aspects of transportation, production, use, and end-of-life treatment. The method is defined by the International Organization for Standardization (ISO) 14040 and 14044 standards.

Why an Environmental Product Declaration (EPD)?

CISC fabricator members are seeking to communicate their environmental performances to clients and to position their products through a rigorous and recognized approach, an EPD. By selecting products with an EPD, building projects can earn credits towards the Leadership in Energy and Environmental Design (LEED) rating system certification, among others. In the latest versions of the program (LEED v4 and v4.1), points are awarded in the Materials and Resources category.

This EPD summary provides an overview of the full ISO 14025 compliant EPD registered with CSA Group.

Environmental impacts

The life cycle environmental impacts of 1 metric ton and 1 short ton of painted fabricated hollow structural steel sections (A1-A3 stages[1]) are summarized below for the main environmental indicators (based on life cycle impact assessment method TRACI 2.1). Refer to the LCA report or full EPD for more detailed results. Results on resource use, generated waste and output flows are presented in the full EPD.

Impact categories		A1 Raw material supply	A2 Transport	A3 Manufacturing	A1-A3 Total
Global warming ($kg\ CO_2$ eq.)	1 mt	1.70E+03	2.51E+01	1.42E+02	1.87E+03
	1 ton	1.55E+03	2.27E+01	1.29E+02	1.70E+03
Ozone depletion (kg CFC 11 eq.)	1 mt	6.45E-06	6.10E-06	2.78E-05	4.03E-05
	1 ton	5.85E-06	5.54E-06	2.25E-05	3.66E-05
Acidification of land and water ($kg\ SO_2$ eq.)	1 mt	3.81E+00	6.08E-02	4.57E-01	4.33E+00
	1 ton	3.46E+00	5.52E-02	4.14E-01	3.93E+00
Eutrophication (kg N eq.)	1 mt	2.01E-01	1.08E-02	8.19E-02	2.93E-01
	1 ton	1.82E-01	9.81E-03	7.43E-02	2.66E-01
Smog ($kg\ O_3$ eq.)	1 mt	6.50E+01	9.08E-01	5.66E+00	7.16E+01
	1 ton	5.90E+01	8.24E-01	5.13E+00	6.49E+01
Depletion of abiotic resources (fossil) (MJ)[1]	1 mt	1.82E+04	3.99E+02	1.89E+03	2.05E+04
	1 ton	1.66E+04	3.62E+02	1.72E+03	1.86E+04

These results are representative of the fabricated hollow structural steel sections available in Canada. They are based on data provided by different CISC fabricators. Data was collected for a full year of manufacturing operations occurring between January 2019 and December 2020. CISC members account for over 70% of the steel used in construction in Canada.

[1] *A1 = raw material supply (raw material extraction and processing, production of structural steel, etc.), A2 = transport of raw materials (transportation from suppliers of steel and other manufacturing materials to manufacturing facilities), A3 = manufacturing (forming, edge preparation, bending and welding).*

For more information: www.cisc-icca.ca

1. Description of the industry

CISC is the voice of the Canadian steel construction industry and the members and associates of the CISC account for over 70% of the steel used in construction in Canada. Over 50 CISC fabricators provided data for the development of this EPD, constituting the majority of the volume of steel used in construction in Canada.

Steel used in construction in North America contains a minimum of 90% recycled content and has a recycling rate of 98%, with over 80 million tons of steel recycled every year (AISI, 2021). The steel industry's commitment to sustainable manufacturing and construction has led to a reduction of its carbon footprint by 37% and a reduction of energy intensity per ton by 32% since 1990 (CSSBI, 2021).

This CISC Industry Average Environmental Product Declaration (EPD) for fabricated hollow structural steel sections quantifies its cradle-to-gate life cycle environmental impacts. It will enable authorized CISC fabricators (see authorized list on the CISC website) to meet the requirements of LEED v4 and v4.1 for Material & Resource credits, among other certifications, and respond to requests from consultants for data/information on environmental performance.

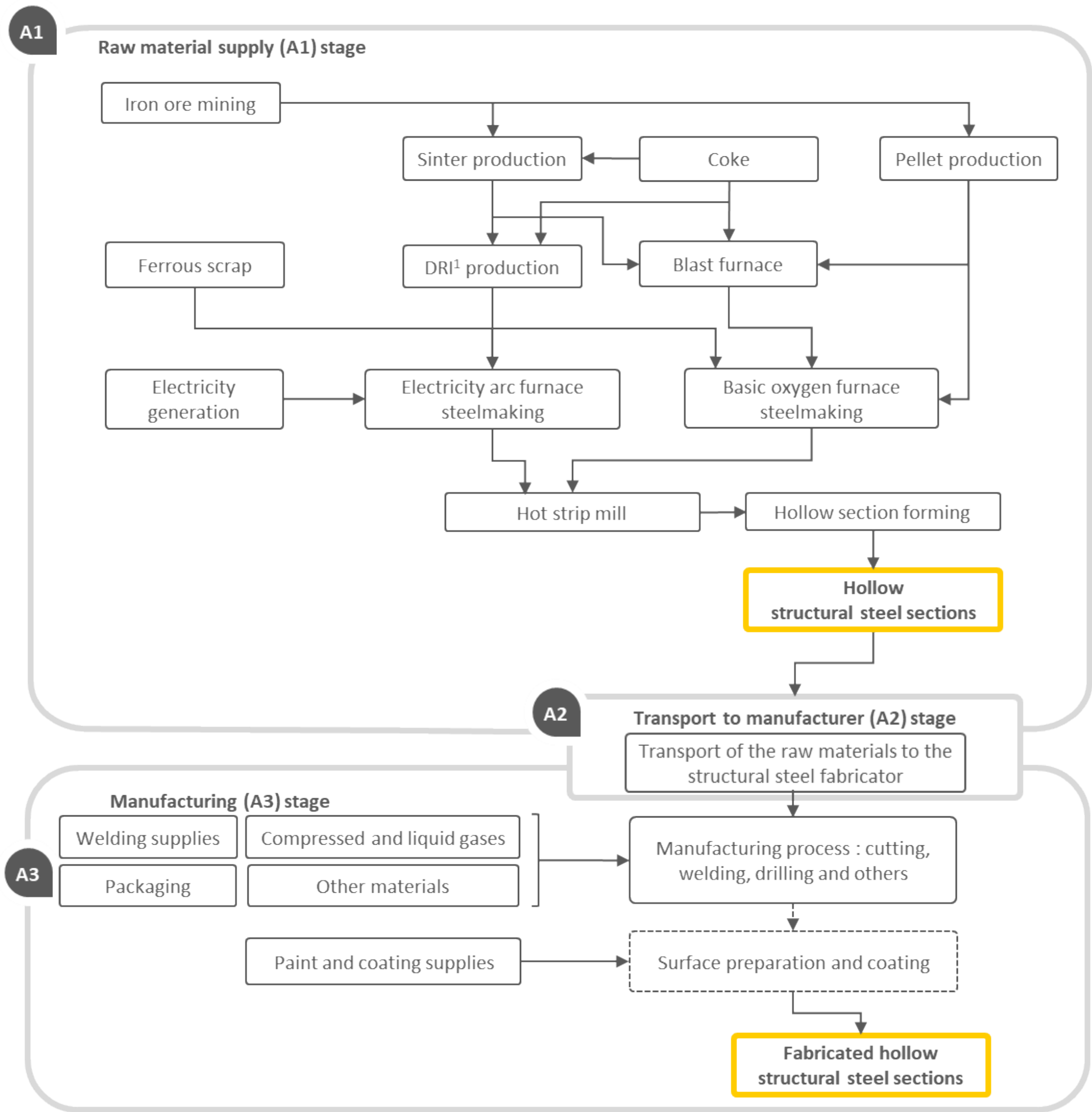
2. Description of product

2.1. Standards

The fabricated hollow structural steel sections included in this EPD are specified by CSA G40.21, ASTM A500 and ASTM 1085 standards ASTM A1085 / A1085M, 2015; ASTM A500 / A500M-21, 2015; CSA, 2020. These products are covered by the Construction Specific Institute and UNSPSC code 05 12 23 Structural Steel for Buildings.

2.2. Production of fabricated hollow structural steel sections

Fabricated hollow structural steel sections are produced through the steps shown in Figure 1. They are steel sections rolled in a hot rolling mill which can be I-beams, H-beams, wide-flange beams, and sheet piling (WSA, 2019). These products are then detailed, cut, drilled, bolted, welded, etc. at the fabricator in order to prepare them for installation. They are used in a wide range of applications in building and infrastructure projects.



[1] Direct reduced iron

Figure 1: Process flow diagram of life cycle stages for painted fabricated hollow structural steel sections

2.3. Product average

In order to calculate the weighted average LCI data for one ton of fabricated structural steel products, two data types were considered for missing data or data equal to zero:

- Required data: In instances where data from a particular plant were missing for a particular parameter of interest (data such as energy consumption, steel sold, etc.), the data from that plant was removed from the horizontal averaging for that parameter.
- Supplementary data: If data were missing or equal to zero for a given parameter (data such as shop primer, gases or welding supplies, etc.), data remained in the horizontal averaging for that parameter.

2.4. Material content

A description of the material components of painted fabricated hollow structural steel sections is presented in Table 1.

Table 1: Materials for fabricated hollow structural steel sections

Materials	Weight %	Availability			Origin of raw materials	Transportation mode
		Renewable	Non-renewable	Recycled		
Steel	99			x	Canada and United States	Truck
Shop primer	1		x		Canada	Truck

3. Scope of EPD

3.1. Declared unit

As stated in the PCR, and as fabricated hollow structural steel sections can be use in a large number of building applications (different sizes, designs and location), a single functional unit cannot be clearly defined. Therefore, a declared unit is used in lieu of a functional unit (see Table 2).

Table 2: Declared unit for fabricated hollow structural steel sections and its density

Parameter	Value (SI units)	Value (imperial units)
Declared Unit	1 metric ton	1 short ton
Density	7,800 kg/m^3	487 lb/ft^3

3.2. System boundaries

The product stage is included in the **cradle-to-gate** system boundary as shown in Table 3. Note that the reference service life is not specified as the study is cradle-to-gate and does not cover life cycle stages for product use.

Table 3: Life cycle stages considered according to the PCR

[**x**: included in the scope, NIS: not in the scope]

Product Stage		**Included within scope**
A1	Raw material supply	**x**
A2	Transport	**x**
A3	Manufacturing	**x**
Construction Process Stage		
A4	Transport to site	MND
A5	Assembly/Install	MND
Use Stage		
B1	Use	MND
B2	Maintenance	MND
B3	Repair	MND
B4	Replacement	MND
B5	Refurbishment	MND
Use Stage, related to the operation of the building		
B6	Operational energy use	MND
B7	Operational water use	MND
End of Life stage		
C1	Deconstruction	MND
C2	Transport	MND
C3	Waste processing	MND
C4	Disposal	MND
Benefits and loads beyond the system boundary		
D	Reuse, recovery, and/or recycling potentials	MND

More precisely, the life cycle stages include the following processes:

- **A1 – Raw material supply:** Raw material extraction and processing, including all activities necessary for the production of steel including but not limited to the recovery or extraction and processing of feedstock materials, furnace and related process operation at the melt shop, creation of the billet, and the rolling of the final product at either the primary or secondary processor, including transportation from a primary producer to a secondary producer and within the facilities. Fabricated hollow structural steel sections are manufactured entirely from structural steel. This EPD is only applicable to structural steel sourced from Canadian and US steel mills.

- **A2 – Transport of raw materials:** Transportation from suppliers of steel and other manufacturing materials (e.g., welding supplies, compressed and liquid gases, paint and coating supplies) to fabrication facility.
- **A3 – Manufacturing:** The main input to the fabrication process is the structural steel (stage A1). Other inputs are required at this stage such as welding supplies, compressed and liquid gases, paint and coating supplies, and other materials (mainly packaging supplies). Also, fuel energy, electricity consumption, natural gas combustion and water use for all the steps involved in the production of the fabricated structural steel products. Waste management of scraps generated during the production, including transportation, is also considered in this stage. Environmental impacts associated with surface preparation and the application of coating materials are included in this study but reported separately. Note also that galvanization is not included as it generally takes place at a different facility.

The geographical boundaries are set to represent the manufacturing processes of fabricated hollow structural steel sections in facilities located in Canada.

The temporal boundaries are set for a full year of manufacturing operations occurring between January 2019 and December 2020.

4. Environmental impacts

This cradle-to-gate life cycle assessment is compliant with ISO 14040 and 14044 and the Product Category Rule (PCR) Guidance for Building-Related Products and Services Part B: Designated Steel Construction Product EPD Requirements v.2. Environmental impacts were calculated using the TRACI 2.1 impact assessment methods, thus yielding six environmental impact categories. A description of these impact categories is provided in the glossary (section 5). These six impact categories are globally deemed mature enough to be included in Type III environmental declarations. Other categories are being developed and defined and LCA should continue making advances in their development. However, the EPD users shall not use additional measures for comparative purposes.

4.1. Assumptions

The main assumptions included in this LCA were related to the production of welding electrodes, welding gas emissions, halon emissions during crude oil, natural gas and uranium extraction, and the heating value of shop primer.

4.2. Criteria for the exclusion of inputs and outputs

No known flows are deliberately excluded from this EPD. In cases where there is no data readily available on specific inputs and outputs, it is possible to exclude them based on the exclusion criteria set in the PCR. Input and output flows of the studied system may be excluded if they do not exceed a total of 5% of primary energy usage (including both renewable and non-renewable energy) and mass across all modules assessed.

The following processes are excluded either from the study due to the lack of readily available data and their expected low contribution to the life cycle unit process to which they pertain based on Groupe AGÉCO's past experience, or according to the PCR:

- Capital equipment production and maintenance
- Employee commute
- Office energy consumption and office-related purchases
- Maintenance of equipment or other related services

4.3. Data quality

Data sources

Primary data were provided by 55 fabricators for transport and manufacturing processes for a full year of operations occurring between January 2019 and December 2020 and were considered reliable overall. Secondary data collected for raw material supply processes were representative of the North American context and technologies used. Table 4 presents the main sources of data used for the LCA. The LCA model was developed with the SimaPro 9 software using ecoinvent 3.6 database which was released in 2019. Since most of the data within ecoinvent is of European origin and produced to represent European industrial conditions and processes, several data were adapted to enhance their representativeness of the products and contexts being examined. Table 5 summarizes the data quality assessment for each module included in the LCA based on the parameters listed in the PCR.

Table 4: Data sources for the LCA of fabricated hollow structural steel sections

Module	Main processes	Data source	Region	Year
A1	Raw material extraction and processing for the production of hollow structural steel sections	Background dataset for North American hot-rolled coil, published by American Iron and Steel Institute (AISI, 2020) and for HSS production stage surveys were received from 5 Atlas Tube production facilities via CISC	North America (Canada and U.S.)	2020
A2	Transportation to fabricators	Survey answers from 55 CISC fabricators	Canada	12 consecutive months from January 2019 - December 2020
A3	Fabricated hollow structural steel sections manufacturing	Survey answers from 55 CISC fabricators	Canada	12 consecutive months from January 2019 - December 2020

Table 5: Data quality assessment

Data quality parameters	Data quality assessment for each module
Time-related coverage	All data are from within the last 10 years with most primary data collected between 2019-2020. Time-related coverage is therefore considered good.
Geographical coverage	All primary data collected for the fabricators (A2 and A3 stages) were specific to the manufacturing location in Canada. For steel mills (A1 stages), data for hot-rolled coils (inputs for HSS) of the North American production. Overall, geographical coverage is good.
Technology coverage	Very recent annual data covering a large number of fabricator sizes and types were used to be reflective of typical or average technologies employed in Canada for the production of structural steel for building projects. Technological representativeness is therefore good.
Reliability	The majority of the relevant foreground data are measured data or calculated based on primary information provided by steel mills (A1 stage) or fabricators (A2 and A3 stages). Therefore, reliability is considered to be high for A1-A3 after the exclusion of outliers. Secondary data for end-of-life stages are considered good.
Completeness	For the data collected from fabricators (A2 and A3 stages), each parameter was checked in comparison of the weighted average. Fabricators' data represented annual operations inclusive of seasonal and other normal annual fluctuations in operations. All relevant and specific processes were considered and modeled to represent the specified products. The completeness of the data used for A1-A3 is considered high.
Representativeness	The representativeness is good overall. See time-related, geography and technology coverages parameters above.
Consistency	All primary data were collected with the same level of detail (i.e., using consistent data collection templates), while all background data were sourced from the ecoinvent v3.6 database. Allocation and other methodological choices were made consistently throughout the model.
Reproducibility	Reproducibility is supported as much as possible through the disclosure of the weighted average inventory, datasets choices, and modeling approaches in this report.
Sources of the data	Data for Module A1 were sourced from the American Iron and Steel Institute and Atlas Tube while data for Modules A2 and A3 were mainly collected through a survey filled by 55 fabricators.
Uncertainty of the information	A sensitivity analysis on the methodological choice for data exclusion showed that it does not significantly affect the results when all modules are considered. The methodology used in the baseline scenario may increase the risk of considering potential outliers and/or errors in the datasets, but this modelling choice constitutes a more conservative approach.

4.4. Allocation

The following allocation approaches were used in the different life cycle stages.

Steel mill co-products allocation (A1)

Using the AISI (2020) data as stated in the PCR, the Worldsteel methodology (WSA, 2017) is followed for the allocation. It means that the recovery and use of co-products, including process gases and slag, outside of the steel mill were accounted using the system expansion approach specifically by giving credit to the avoided production of the material that is replaced by the recovered material.

Fabricated steel products allocation (A3)

Allocation between fabricated structural steel for building projects and fabricated non-structural steel or structural steel used in other projects than building construction was based on shop hours.

ecoinvent processes with allocation

Many of the processes in the ecoinvent database also provide multiple functions, and allocation is required to provide inventory data per function (or per process). This study follows the allocation method used by ecoinvent for those processes. It should be noted that the background allocation methods used in ecoinvent, such as mass or economic allocation, may be inconsistent with the approach used to model the foreground system. While this allocation is appropriate for foreground processes, continuation of this methodology into the background datasets would add complexity without substantially improving the quality of the study.

4.5. Life cycle impact assessment – Results

Results for 1 metric ton (mt) and 1 short ton (1 ton) of painted fabricated hollow structural steel sections are presented in Table 6 to Table 9. LCIA results are relative expressions and do not predict impacts on category endpoints, the exceeding of thresholds, safety margins or risks.

Table 6: Results for the environmental impacts for 1 metric ton and 1 short ton of painted fabricated hollow structural steel sections

Impact categories		A1 Raw material supply	A2 Transport	A3 Manufacturing	A1-A3 Total
Global warming ($kg\ CO_2$ eq.)	1 mt	1.70E+03	2.51E+01	1.42E+02	1.87E+03
	1 ton	1.55E+03	2.27E+01	1.29E+02	1.70E+03
Ozone depletion (kg CFC 11 eq.)	1 mt	6.45E-06	6.10E-06	2.78E-05	4.03E-05
	1 ton	5.85E-06	5.54E-06	2.52E-05	3.66E-05
Acidification of land and water ($kg\ SO_2$ eq.)	1 mt	3.81E+00	6.08E-02	4.57E-01	4.33E+00
	1 ton	3.46E+00	5.52E-02	4.14E-01	3.93E+00
Eutrophication (kg N eq.)	1 mt	2.01E-01	1.08E-02	8.19E-02	2.93E-01
	1 ton	1.82E-01	9.81E-03	7.43E-02	2.66E-01
Smog ($kg\ O_3$ eq.)	1 mt	6.50E+01	9.08E-01	5.66E+00	7.16E+01
	1 ton	5.90E+01	8.24E-01	5.13E+00	6.49E+01
Depletion of abiotic resources (fossil) (MJ)[1]	1 mt	1.82E+04	3.99E+02	1.89E+03	2.05E+04
	1 ton	1.66E+04	3.62E+02	1.72E+03	1.86E+04

[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.*

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.

A statistical distribution of all fabrication stage (A3) data is shown below in Table 7.

Table 7: Statistical distribution of fabricant stage (A3), per metric ton of hollow structural sections

Impact categories	Results for 1 metric ton Mean	Median	Std dev	Range	Min	Max
Global warming (kg CO_2 eq.)	1.23E+02	7.07E+01	1.82E+02	9.08E+02	1.88E+00	9.10E+02
Ozone depletion (kg CFC 11 eq.)	2.62E-05	1.78E-05	3.04E-05	1.42E-04	5.11E-07	1.43E-04
Acidification of land and water (kg SO_2 eq.)	3.60E-01	1.88E-01	6.37E-01	3.13E+00	3.29E-03	3.14E+00
Eutrophication (kg N eq.)	6.09E-02	1.30E-02	1.28E-01	6.87E-01	1.87E-04	6.87E-01
Smog (kg O_3 eq.)	4.65E+00	2.49E+00	7.03E+00	3.49E+01	7.03E-02	3.50E+01
Depletion of abiotic resources (fossil) (MJ)	1.68E+03	1.01E+03	2.30E+03	1.12E+04	2.82E+01	1.12E+04

Table 8: Results for the resource use for 1 metric ton (1 mt) and 1 short ton (1 ton) of painted fabricated hollow structural steel sections

Impact categories		A1 Raw material supply	A2 Transport	A3 Manufacturing
Renewable primary resources used as energy carrier (fuel) (MJ)	1 mt	9.21E+02	5.48E+00	4.79E+02
	1 ton	8.36E+02	4.97E+00	4.35E+02
Renewable primary resources with energy content used as material (MJ)	1 mt	0.00E+00	0.00E+00	0.00E+00
	1 ton	0.00E+00	0.00E+00	0.00E+00
Non-renewable primary resources used as an energy carrier (fuel) (MJ)	1 mt	2.15E+04	4.06E+02	2.28E+03
	1 ton	1.95E+04	3.69E+02	2.07E+03
Non-renewable primary resources with energy content used as material (MJ)	1 mt	0.00E+00	0.00E+00	2.81E+01
	1 ton	0.00E+00	0.00E+00	2.55E+01
Secondary materials (metric ton)	1 mt	4.69E+02	0.00E+00	0.00E+00
	1 ton	4.25E+02	0.00E+00	0.00E+00
Renewable secondary fuels (MJ)	1 mt	0.00E+00	0.00E+00	0.00E+00
	1 ton	0.00E+00	0.00E+00	0.00E+00
Non-renewable secondary fuels (MJ)	1 mt	0.00E+00	0.00E+00	0.00E+00
	1 ton	0.00E+00	0.00E+00	0.00E+00
Recovered energy (MJ)	1 mt	0.00E+00	0.00E+00	0.00E+00
	1 ton	0.00E+00	0.00E+00	0.00E+00
Use of net fresh water resources (m^3)	1 mt	7.06E+00	4.69E-02	2.88E+00
	1 ton	6.40E+00	4.25E-02	2.61E+00

For the North American context, hazardous waste is defined by the United States Resource Conservation and Recovery Act legislation (40 CFR 261.33) (Resource Conservation and Recovery Act, 2014), except in module A3 where the classification of the manufacturer was used. All output flows and waste generated during the manufacturing processes are presented in Table 9).

Table 9: Results for the output flows and waste generated for 1 metric ton (1 mt) and 1 short ton (1 ton) of painted fabricated hollow structural steel sections

Impact categories		A1 Raw material supply	A2 Transport	A3 Manufacturing
Hazardous waste disposed (kg)	1 mt	2.06E-02	0.00E+00	3.38E-01
	1 ton	1.87E-02	0.00E+00	3.07E-01
Non-hazardous waste disposed (kg)	1 mt	1.43E-02	0.00E+00	2.53E+00
	1 ton	1.29E-02	0.00E+00	2.29E+00
High-level radioactive waste, conditioned, to final repository (kg)	1 mt	7.28E-05	0.00E+00	0.00E+00
	1 ton	6.61E-05	0.00E+00	0.00E+00
Intermediate- and low-level radioactive waste, conditioned, to final repository (kg)	1 mt	0.00E+00	0.00E+00	0.00E+00
	1 ton	0.00E+00	0.00E+00	0.00E+00
Components for reuse (kg)	1 mt	0.00E+00	0.00E+00	0.00E+00
	1 ton	0.00E+00	0.00E+00	0.00E+00
Materials for recycling (kg)	1 mt	0.00E+00	0.00E+00	6.30E-02
	1 ton	0.00E+00	0.00E+00	5.71E-02
Materials for energy recovery (kg)	1 mt	0.00E+00	0.00E+00	0.00E+00
	1 ton	0.00E+00	0.00E+00	0.00E+00
Exported energy (MJ)	1 mt	0.00E+00	0.00E+00	0.00E+00
	1 ton	0.00E+00	0.00E+00	0.00E+00

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

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 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.

4.6. Life cycle impact assessment – Interpretation

Figure 2 presents the relative contributions of each life cycle stage for each environmental impact category, for hollow structural steel sections.

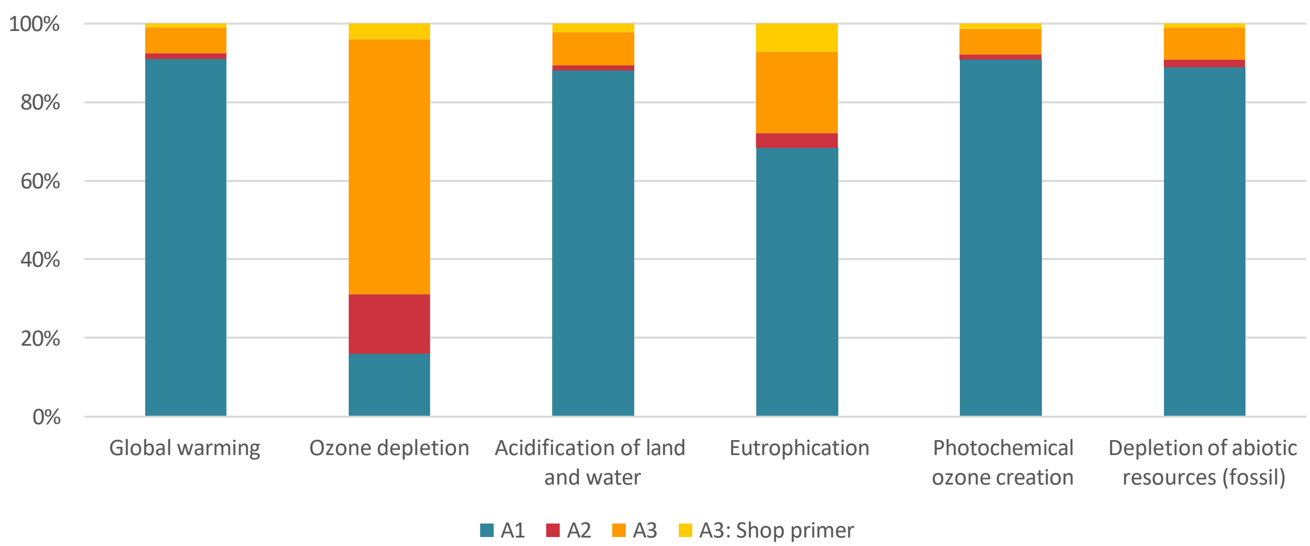


Figure 2: Relative contributions of the life cycle stages of the painted fabricated hollow structural steel sections

Raw material supply (A1 stage) is the main contributor for 4 of the 6 indicators (except ozone depletion and eutrophication). In the case of HSS, A1 has a non-zero ozone depletion potential, as a supplementary inventory (as described in section 2.3) was used addition to background steel inventory. The fabrication stage (A3) is the main contributor for eutrophication indicator (86% fabrication and 14% shop primer application). The transport of raw materials by truck (A2 stage) between suppliers and the fabricator facilities scores low for all the indicators, though it has a higher contribution for ozone depletion due to A1 having a lower relative score.

5. GLOSSARY

5.1. Acronyms

CISC - Canadian Institute of Steel Construction

CSA - Canadian Standard Association

EPD - Environmental Product Declaration

ISO - International Organization for Standardization

LCA - Life cycle assessment

LCI – Life cycle inventory

PCR - Product Category Rule

5.2. Environmental impact categories and parameters assessed

Acidification potential (kg SO_2 equivalent): This impact category is expressed in sulphur dioxide equivalents and refers to the change in acidity in soil or water due to the addition of certain substances (e.g., nitric acid, sulfuric acid and ammonia) which can build or release hydrogen ions (H+) through interactions with the local environment (US EPA, 2012).

Abiotic resource depletion potential of non-renewable (fossil) energy resources (MJ, net calorific value): This indicator measures the reduction of raw natural resources (e.g., minerals) due to their extraction. It is expressed in units of kg of antimony equivalents according to concentration reserves and rate of de-accumulation. This indicator also refers to the reduction of fossil fuels due to their extraction for consumption and is expressed in megajoules (PRé, 2021).

Eutrophication (kg N equivalent): This impact category measures the enrichment of an ecosystem (i.e., aquatic or terrestrial) due to the release of nutrients (e.g., nitrates, phosphates) which increases biological activity. In an aquatic environment, this activity results in the growth of algae which consume dissolved oxygen present in water when they degrade and thus affect species sensitive to the concentration of dissolved oxygen. This category is expressed in nitrogen equivalents (US EPA, 2012).

Global warming (kg CO_2 equivalent): This indicator refers to the impact of a temperature increase on the global climate patterns due to the release of greenhouse gases (GHG) (e.g., carbon dioxide and methane). GHG emissions contribute to the increase in the absorption of radiation from the sun at the earth's surface. Global warming impact is expressed in units of kg of carbon dioxide equivalents (US EPA, 2012).

Ozone depletion (kg CFC 11 equivalent): This indicator measures the potential of stratospheric ozone level reduction and thus the increase in ultraviolet (UV) radiation causing higher risks to human health (e.g., skin cancers and cataracts). Pollutants that are responsible for this impact are often released by cooling systems (e.g., refrigerants such as chlorofluorocarbons). It is expressed in kg of trichlorofluoromethane equivalents (US EPA, 2012).

Smog (kg O_3 equivalent): This impact category covers the emissions of pollutants such as nitrogen oxides and volatile organic compounds (VOCs) at the ground level ozone. When reacting with the sunlight, these pollutants create smog. It is expressed in kg of ozone equivalents (US EPA, 2012).

Recovered energy (MJ, net calorific value): Energy recovered from disposal of waste in previous systems, such as energy recovery from combustion of landfill gas or energy recovered from other systems using energy sources.

Renewable/non-renewable primary energy (MJ, net calorific value): This parameter refers to the use of energy from renewable resources (e.g., wind, solar, hydro) and non-renewable resources (e.g., natural gas, coal, petroleum).

Renewable/non-renewable secondary fuels (MJ, net calorific value): Inventory of renewable or non-renewable secondary fuels.

Secondary material (kg): Recycled material used to produce a product (ISO, 2020b)

Use of net fresh water resources (m^3): This parameter includes water that is consumed by a system. However, it does not refer to water that is used but returned to the original source (e.g., water for hydroelectric turbines, for cooling or river transportation), or to water lost from a natural system (e.g., due to evaporation of rainwater) (EPD International, 2015).

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