ArcelorMittal Dofasco

XCarb™ Recycled and renewably produced

ArcelorMittal

Environmental Product Declaration (EPD)

Corrugated Steel Pipe

ArcelorMittal Dofasco is pleased to present this environmental product declaration (EPD) for Corrugated Steel Pipe. This EPD was developed in compliance with CAN/CSA-ISO 14025 and ISO 21930 and has been verified under Groupe AGÉCO.

The EPD includes life cycle assessment (LCA) results for a cradle to gate with options scope.

For more information about ArcelorMittal Dofasco and the XCarb product offers, please visit https://dofasco.arcelormittal.com/sustainability/xcarb

CSA Environmental Product Declaration

CSA Group Registered Based on ISO 14025 and Other Requirements
For more information visit csaregistries.ca/epd

3433-8518
November 2023-November 2028

cspi corrugated steel pipe institute

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
Manufacturer name and address	ArcelorMittal Dofasco G.P. 1330 Burlington St. E., Hamilton, ON, L8N 3J5 https://dofasco.arcelormittal.com/
EPD Registration Number	#3433-8518
Declaration product & declared unit	1 metric ton of corrugated steel pipe 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 Valid until December 12, 2023 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 26, 2025 UN CPC code: 412
Markets of applicability	Canada
Date of issue	November 29, 2023
Period of validity	November 29, 2023 – November 27, 2028
EPD type	Product-specific
EPD scope	Cradle-to-gate with options: production (A1-A3), C1-C4 and D
Year(s) of reported primary data	January 2021-December 2021
LCA software & version number	Gabi 10.7
LCI database(s) & version number	Gabi 10.7, Ecoinvent 3.8 LCI of steel scrap from Worldsteel Association (2021)
LCIA methodology & version number	TRACI 2.1

The sub-category PCR review was conducted by:	Thomas Gloria (chair) Industrial Ecology Consultants 35 Bracebridge Rd. Newton MA 02459 info@industrial-ecology.com
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:	Stan Lipkowski ArcelorMittal Global R&D 1330 Burlington St. E Hamilton, ON, L8S 3K2
The life cycle assessment was independently verified in accordance with ISO 14044 and the reference PCR by:	Hugues Imbeault-Tétreault Groupe AGÉCO 1995, Frank-Carrel Street, suite 219 Quebec (Quebec) G1N 4H9

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 product specific environmental product declaration (EPD) describing the environmental performance of corrugated steel pipe manufactured in Canada using XCarb™ RRP hot dip galvanized coils from the ArcelorMittal Dofasco site. This EPD is only applicable to corrugated steel pipe produced in Canada using ArcelorMittal XCarb™ RRP steel.

EPD commissioner and owner	Period of validity	Program operator and registration number	Product Category Rule	LCA and EPD consultants
ArcelorMittal Dofasco	November 29, 2023 – November 27, 2028	CSA Group #3433-8518	Product Category Rule Guidance for Building-Related Products and Services Part B: Designated Steel Construction Product EPD Requirements v.2	ArcelorMittal

Product description

Corrugated steel pipe is specified by CSA G401.

Declared units

1 metric ton of corrugated steel pipe with a density of 7,800 kg/m^3.

Material content (% of total product mass)

Steel substrate: 98%
Metallic coating (zinc or equivalent): 2%

Scope and system boundary

Cradle-to-gate with options: production (A1 to A3), C1 to C4 and D.

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)?

ArcelorMittal Dofasco is seeking to communicate its environmental performances to clients and to position its 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 of corrugated steel pipe (A1-A3, C1-C4 and D[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.

These results are only applicable to corrugated steel pipe produced using ArcelorMittal Dofasco XCarb™ recycled and renewably produced steel.

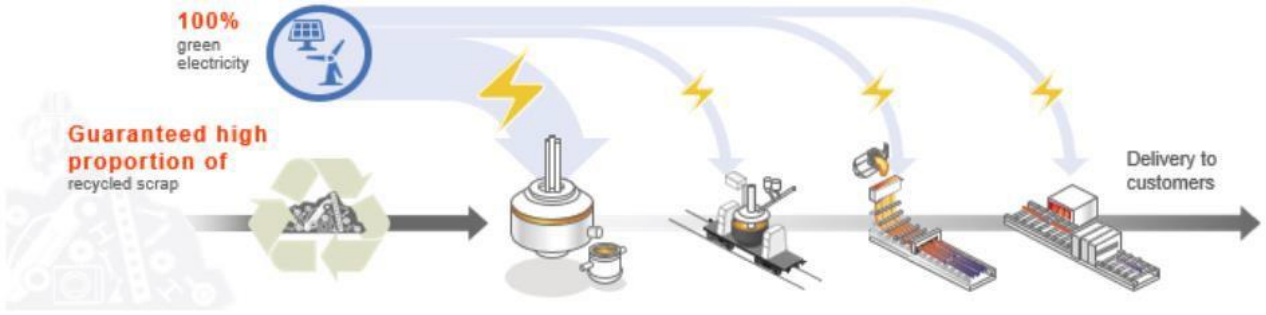
Per metric ton of corrugated steel pipe								
Environmental Impact indicators (IPCC 2013 (AR5))	**A1**	**A2**	**A3**	**C1**	**C2**	**C3**	**C4**	**D**
GWP 100- [kg CO_2 eq.]	1.21E+03	1.15E+01	2.29E+01	6.66E-01	2.23E+01	6.68E-01	1.30E+00	-2.41E+02
Environmental Impact Indicators (TRACI 2.1)	**A1**	**A2**	**A3**	**C1**	**C2**	**C3**	**C4**	**D**
AP [kg SO_2 eq.]	2.48E+00	3.27E-02	9.17E-02	2.77E-03	4.60E-02	2.29E-03	8.53E-03	-3.71E-01
EP [kg N eq.]	1.10E-01	3.42E-03	1.25E-02	2.46E-04	5.52E-03	1.58E-04	7.40E-04	-2.36E-02
ODP [kg CFC 11 eq.]	2.35E-11	2.16E-14	7.72E-10	1.21E-15	4.17E-14	5.57E-14	2.36E-11	-7.82E-13
SFP [kg O_3 eq.]	4.71E+01	7.44E-01	1.04E+00	9.27E-02	1.04E+00	2.78E-02	1.64E-01	-5.15E+00
ADP_{fossil} [MJ]	1.32E+03	2.12E+01	5.09E+01	1.19E+00	4.11E+01	7.66E-01	2.11E+00	-1.61E+01

[1] *A1 = raw material supply (raw material extraction and processing, production of galvanized coils, etc.), A2 = transport of raw materials (transportation from suppliers of steel to manufacturing facilities), A3 = manufacturing (roll forming) C1 = System deconstruction, C2 = transportation to scrap processing, C3 = scrap processing, C4 = waste disposal, D = end of life recycling credit.*

1. Description of ArcelorMittal and XCarb™

ArcelorMittal is the world's leading steel and mining company with 154,000 employees, a manufacturing presence across 16 countries and 59 million metric tons of crude steel production in 2022. In Canada, ArcelorMittal Dofasco is Hamilton's largest private sector employer with more than 4,500 employees and shipping 4.5 million tons of high-quality flat carbon steel annually.

XCarb™ is the new brand name for ArcelorMittal's ongoing global program of steelmaking innovation targeted at carbon-neutral steel by 2050. The initiatives that are part of XCarb® aim to reduce the carbon footprint of ArcelorMittal and of its customers.



The XCarb™ recycled and renewably produced applies to products made via the Electric Arc Furnace route using scrap steel and 100% renewable energy.

By using above average scrap content and renewable energy, XCarb™ recycled and renewably produced products have a CO_2 footprint per tonne of finished steel that is significantly lower than the industry average.

The electricity used in the steelmaking process is independently verified, with a 'Guarantee of Origin' given that it is from renewable sources. This is ensured by the purchasing of Renewable Energy Certificates (RECs), a market-based offering that certifies the bearer owns a specific amount (in megawatt-hours) of electricity generated from a renewable energy resource. However, to conform with the UL Part A PCR requirements, the environmental benefit associated with the use of RECs is not captured in this EPD.

2. Description of product

2.1. Standards

The corrugated steel pipe in this EPD is specified by CSA G401 standards.

2.2. Production of corrugated steel pipe using XCarb™ RRP coils

XCarb Recycled and Renewably Produced (RRP) coils are produced through the Electric Arc Furnace (EAF) steelmaking route at ArcelorMittal Dofasco (AMD). The process begins with raw materials extraction (mainly iron ore, hard coal, and limestone) which are prepared in the coke making and pelletizing plants, and which are then fed into the Blast Furnace (BF). Pig iron, the BF product is then fed into the EAF with steel scrap which typically accounts for 75% of the load weight. The EAF process melts the scrap, removes impurities, and reduces the carbon level in the liquid steel. Then the outgoing liquid steel is refined in a ladle metallurgy operation with added elements in order to give a targeted chemical composition

Liquid steel is then continuously cast through a mold to produce slabs which are subsequently hot rolled into coils. This product is known as hot rolled steel and is of a significantly heavier gauge than the finished product gauge, the subject products of this study.

The hot rolled coils pass through a pickling operation where hydrochloric acid removes scale from the strip surface before passing through a cold rolling mill where the strip is reduced to the final thickness. The cold roll coils are then transported to a hot dip galvanizing line where a zinc coating is applied.

Roll forming is a continuous bending operation where the steel strip is passed through consecutive sets of rolls, each performing only an incremental part of the bend until the desired profile of corrugated steel pipe is obtained. The steel coils are roll formed into a variety of profiles and fabricated into the ordered CSP's conduit dimensions for different applications such as water drainage systems and culvert.

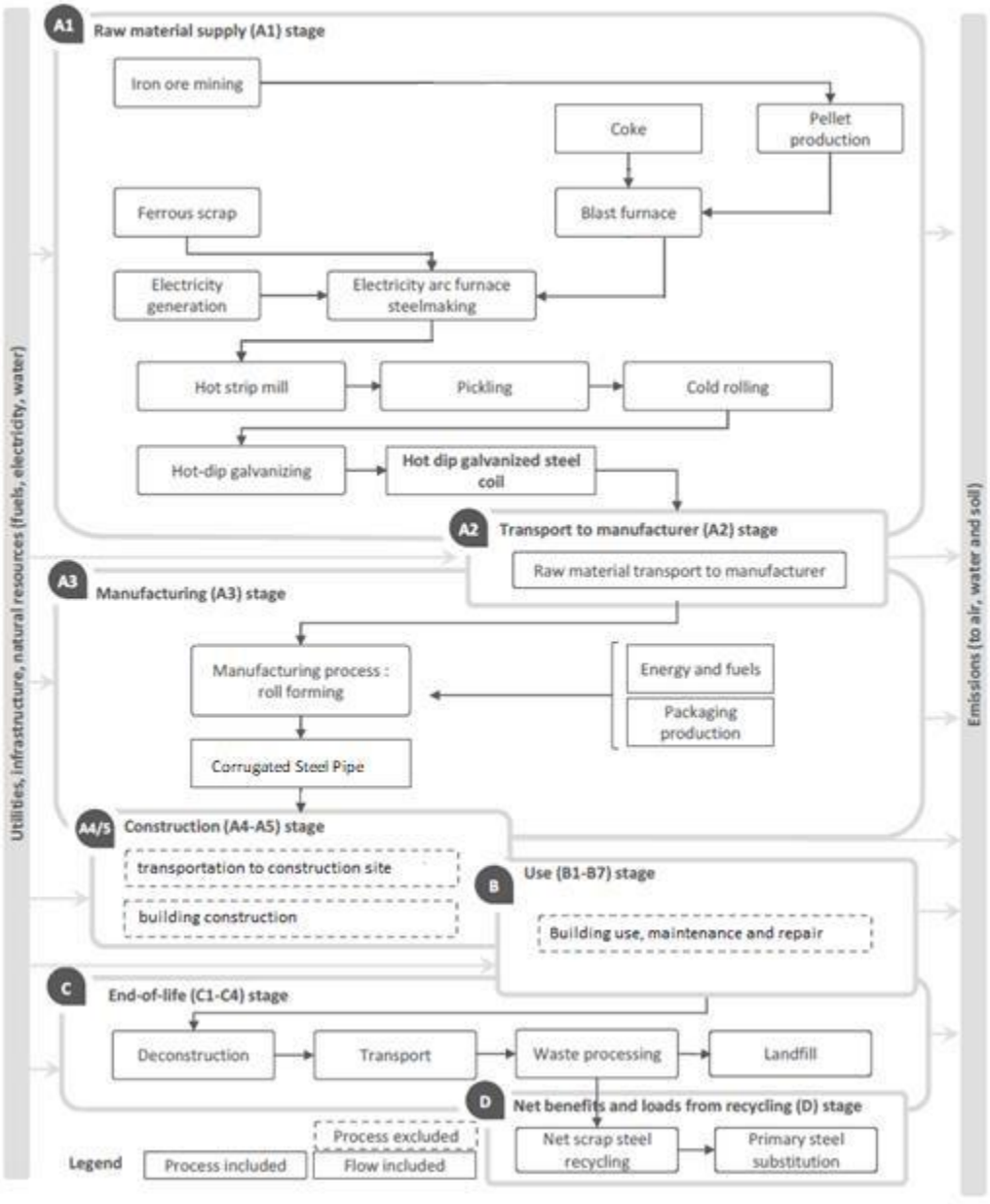


Figure 1: Process flow diagram for corrugated steel pipe

2.3. Material content

Table 1 shows typical material content for corrugated steel pipe.

Table 1: Material content for corrugated steel pipe

Materials	Typical Material Specifications	Weight %
Steel	95 mm (20 gauge)	98
Metallic coating	180 g/m² (G60)	2

3. Scope of EPD

3.1. Declared Unit

The declared unit for this EPD is one metric ton of corrugated steel pipe.

Table 2: Declared unit for corrugated steel pipe

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

3.2. System boundaries

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

The primary data collected in this study for module A1 represents the cradle to mill gate production of hot dip galvanized coil through the ArcelorMittal Dofasco EAF stream. The secondary dataset that was used for module A3 is based on a weighted average from the production volume from Corrugated Steel Pipe Institute (CSPI) member manufacturers across Canada.

Table 3: Life cycle stages considered according to the PCR

[**x**: included in the scope, MND: module not declared]

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	**x**
C2	Transport	**x**
C3	Waste processing	**x**
C4	Disposal	**x**
Benefits and loads beyond the system boundary		
D	Reuse, recovery, and/or recycling potentials	**x**

4. Environmental impacts

This cradle-to-gate with options 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.

4.1. Criteria for the exclusion of inputs and outputs

This study complies with the rules defined by worldsteel's procedure of data inventory.

1. All energetic inputs to the process stages were recorded, including heating fuels, electricity, steam and compressed air.
2. The sum of the excluded material flows must not exceed 5% of mass, energy or environmental relevance. However, in reality at least 99.9% of material inputs to each process stage were included, which is in line with the ISO 21930 requirement (<1%)
3. Input scrap does not carry a burden in module A1.

4.2. Data quality

Data sources

Primary data was collected from the Arcelormittal Dofasco site for a full year of operations occurring between January 2021 and December 2021. Secondary data for CSPI manufacturing and raw material supply processes were representative of the context and technologies used. Table 4 presents the main sources of data used for the LCA. The LCA model was developed with Gabi 10.7 software and database. 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 corrugated steel pipe

Module	Main processes	Data source	Region	Year
A1	Raw material extraction and processing to produce corrugated steel pipe	Primary data collection	Hamilton, Ontario	2021
A2	Transportation to fabricators	Primary data collection	Canada	12 consecutive months from January 2021 - December 2021
A3	corrugated steel pipe manufacturing	CSPI	Canada	2017
C1	Deconstruction	GaBi 10.7	Global	2021
C2	Transportation to waste processing	GaBi 10.7	US	2021
C3	Waste Processing	Ecoinvent 3.8	Global	2021
C4	Disposal of waste	GaBi 10.7	Europe	2021
D	Credit for end-of-life recycling	worldsteel	Global	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 in 2021. Time-related coverage is therefore considered good.
Geographical coverage	The CSPI dataset for the manufacturers (A2 and A3 stages) were specific to the manufacturing location in Canada. Primary data collection from the ArcelorMittal Dofasco site (A1 stage).
Technology coverage	Very recent primary data collection covering Electric Arc Furnace steel making, the predominant steelmaking technology route in North America.
Reliability	The majority of the relevant foreground data are measured data or calculated based on primary information collected from the ArcelorMittal Dofasco site (A1 stage) or manufacturers (A2 and A3 stages). Therefore, reliability is considered to be high for A1-A3. Secondary data for end-of-life stages are considered good.
Completeness	For the data collected from the manufacturers (A2 and A3 stages), each parameter was checked in comparison of the weighted average. Manufacturer's 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 GaBi and Ecoinvent databases. 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.

4.3. Allocation

Steel production generates a number of co-products from coke ovens, the blast furnace, basic oxygen furnace and Electric Arc Furnace (EAF) that are sold to and used by other industries. These include slags, process gases and organic products from coke making. The processes that produce these co-products cannot be further sub-divided into sub-processes related to each co-product, so allocation is required.

The allocation method used in this study was developed by the worldsteel association and EUROFER to be in line with EN 15804 and ISO 21930:2017 standards.

The methodology is based on physical allocation and takes account of the manner in which changes in inputs and outputs affect the production of co-products and material flows that

carry specific inherent properties. The method is deemed to provide the most representative partitioning of the processes involved.

4.4. Life cycle impact assessment – Results

Results for production of 1 metric ton (mt) of corrugated steel pipe are presented in Table 6 to Table 8.

These results are only applicable to corrugated steel pipe produced using ArcelorMittal Dofasco XCarb™ recycled and renewably produced steel.

Table 6: Results for the environmental impacts for 1 metric ton of corrugated steel pipe

Per metric ton of corrugated steel pipe								
Environmental Impact indicators (IPCC 2013 (AR5))	**A1**	**A2**	**A3**	**C1**	**C2**	**C3**	**C4**	**D**
GWP 100- [kg CO_2 eq.]	1.21E+03	1.15E+01	2.29E+01	6.66E-01	2.23E+01	6.68E-01	1.30E+00	-2.41E+02
Environmental Impact Indicators (TRACI 2.1)	**A1**	**A2**	**A3**	**C1**	**C2**	**C3**	**C4**	**D**
AP [kg SO_2 eq.]	2.48E+00	3.27E-02	9.17E-02	2.77E-03	4.60E-02	2.29E-03	8.53E-03	-3.71E-01
EP [kg N eq.]	1.10E-01	3.42E-03	1.25E-02	2.46E-04	5.52E-03	1.58E-04	7.40E-04	-2.36E-02
ODP [kg CFC 11 eq.]	2.35E-11	2.16E-14	7.72E-10	1.21E-15	4.17E-14	5.57E-14	2.36E-11	-7.82E-13
SFP [kg O_3 eq.]	4.71E+01	7.44E-01	1.04E+00	9.27E-02	1.04E+00	2.78E-02	1.64E-01	-5.15E+00
ADP_{fossil} [MJ]	1.32E+03	2.12E+01	5.09E+01	1.19E+00	4.11E+01	7.66E-01	2.11E+00	-1.61E+01

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.

Module D Considerations: The values in Module D include a recognition of the benefits or impacts related to steel recycling which occur at the end of the product's service life. The rate of steel recycling and related processes will evolve over time. The results

included in Module D attempt to capture future benefits, or impacts, but are based on a methodology that uses current industry-average data reflecting current processes.

Table 7: Results for the resource use of corrugated steel pipe production

Per metric ton of corrugated steel pipe								
Resource use flows	**A1**	**A2**	**A3**	**C1**	**C2**	**C3**	**C4**	**D**
NRPRe [MJ]	1.79E+04	1.60E+02	5.97E+02	8.99E+00	3.11E+02	1.40E+01	1.75E+01	-2.41E+03
RPRe [MJ]	1.99E+03	6.24E+00	3.64E+02	3.50E-01	1.21E+01	1.30E+01	1.72E+00	1.52E+02
NRPRm [MJ]	6.88E-03	5.96E-08	1.96E-07	3.34E-09	1.15E-07	7.81E-09		-5.53E-04
RPRm [MJ]								
NRSF [MJ]							6.54E-02	
RSF [MJ]							3.21E-02	
RE [MJ]								
FW [m3]	6.10E+00	1.51E-06	4.04E-03	8.46E-08	2.93E-06	1.11E-06		-1.63E+01
SM [kg]	7.89E+02		4.12E-03					1.45E+02

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 8).

Table 8: Results for waste and output flows generated for corrugated steel pipe production

Per metric ton of corrugated steel pipe								
Waste and output flows	**A1**	**A2**	**A3**	**C1**	**C2**	**C3**	**C4**	**D**
MR [kg]						9.2E+02		
HWD [kg]			7.31E-04					
NHWD [kg]			2.79E-04			8.0E+01		
CRU [kg]								
MER [kg]								
EE [MJ]								
HLRW [kg]	2.07E-03	5.27E-07	8.03E-05	2.95E-08	1.02E-06	2.86E-06	3.64E-07	2.70E-07
ILLRW [kg]	3.49E-02	9.63E-06	1.34E-03	5.39E-07	1.86E-05	4.77E-05	5.62E-06	4.96E-06

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 based on 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.

Statistical distribution of results was not provided in this study because the primary data was collected from one site only.

4.5. End of Life Recycling

End of life recycling is one of the most important sustainability attributes for the steel industry and it is essential that the benefits associated with recycling at the end of life be recognized. As a result of a global scrap shortage in the industry, all scrap that is recovered at the end life will offset primary BOF steel production which has significantly larger environmental footprint than secondary EAF steel production route.

Table 9 below shows the assumptions used for end-of-life modeling in this study.

Table 9: End of life assumptions for corrugated steel pipe

Assumption	Value
End of life recycling rate	92%
Recycled content	77.57%
Reuse at end of life	0%

4.6. Life cycle impact assessment – Interpretation

Global Warming Potential:

The global warming potential indicator is dominated by emissions of CO_2 (~90%) at the Blast Furnace and by energy production and use all along the production steps. Methane also contributes to a lower extent (6%) to GWP from coal mining and coke making operations.

Acidification Potential:

Sulphur dioxide and nitrogen oxides together contribute most to the acidification potential indicator (90%). They arise primarily from electricity production and transportation.

Eutrophication Potential:

The EP for steel products is dominated by emissions to air, which contribute 94% to this impact. The main contributor is nitrogen oxides (90%). Emissions to water that contribute to this impact are from nitrogen containing substances, e.g. nitrate, ammonia.

Ozone Depletion Potential:

Ozone layer depletion indicator value is mainly determined by electricity production for high grade zinc refining.

Smog Formation Potential:

The smog formation potential for steel products is dominated by carbon monoxide coming from the iron ore preparation process which accounts for over 60% of the contribution to this impact. All other major substances contributing to this impact are sulphur dioxide and nitrogen oxides.

ADP fossil:

This indicator is dominated by the use of natural gas and the use of hard coal at the Blast Furnace. The balance is accounted by the use of crude oil and lignite.

5. GLOSSARY

5.1. Acronyms

AISI – American Iron and Steel Institute

BF – Blast Furnace

BOF – Blast Oxygen Furnace

CSPI – Corrugated Steel Pipe Institute

CSA - Canadian Standard Association

EAF – Electric Arc Furnace

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 freshwater 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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