GERDAU
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Environmental Product Declaration
Gerdau Structural Steel, Midlothian Steel Mill

VERIFIED by SCS GLOBAL SERVICES
ENVIRONMENTAL PRODUCT DECLARATION
BASED ON LCA

Declaration Owner

Gerdau Long Steel North America
Midlothian Steel Mill
300 Ward Rd
Midlothian, TX 76065, USA
www.gerdau.com | GLNinfo@gerdau.com

Product:

Fabricated Structural Steel

Declared Unit

The declared unit is one metric ton of fabricated Structural Steel produced at the Midlothian, TX steel mill

EPD Number and Period of Validity

SCS-EPD-07506
EPD Valid December 10, 2021 through December 9, 2026
Version Date: March 11, 2022

Product Category Rule

PCR Guidance for Version 3.2. UL Environment. December 12, 2018.

PCR Guidance for Building-Related Products and Services. Part B: Designated Steel Construction Product EPD Requirements. UL Environment. V.2. August 2020.

Program Operator

SCS Global Services
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SCSglobal SERVICES

Declaration owner:	Gerdau Long Steel North America
Address:	300 Ward Rd. Midlothian, TX 76065, USA
Declaration Number:	SCS-EPD-07506
Declaration Validity Period:	EPD Valid December 10, 2021 through December 9, 2026
Version Date:	March 11, 2022
Program Operator:	SCS Global Services
Declaration URL Link:	https://www.scsglobalservices.com/certified-green-products-guide
LCA Practitioner:	Tess Garvey, Ph.D., SCS Global Services
LCA Software and LCI database:	OpenLCA 1.10 software and the Ecoinvent v3.7.1 database
Product's Intended Application:	Fabricated Structural Steel
Product RSL:	n/a
Markets of Applicability:	Global
EPD Type:	Product-Specific
EPD Scope:	Cradle-to-Gate
LCIA Method and Version:	CML-IA and TRACI 2.1
Independent critical review of the LCA and data, according to ISO 14044 and ISO 14071	☐ internal ☒ external
LCA Reviewer:	Thomas Gloria, Ph.D., Industrial Ecology Consultants
Part A Product Category Rule:	PCR Guidance for Building-Related Products and Services Part A: Life Cycle Assessment Calculation Rules and Report Requirements. Version 3.2. UL Environment. Dec. 2018.
Part A PCR Review conducted by:	Lindita Bushi, PhD (Chair); Hugues Imbeault-Tétreault, ing., M.Sc.A.; Jack Geibig
Part B Product Category Rule:	PCR Guidance for Building-Related Products and Services. Part B: Designated Steel Construction Product EPD Requirements. UL Environment. V.2. August 2020.
Part B PCR Review conducted by:	Thomas Gloria, PhD; Brandie Sebastian, James Littlefield
Independent verification of the declaration and data, according to ISO 14025 and the PCR	☐ internal ☒ external
EPD Verifier:	Thomas Gloria, Ph.D., Industrial Ecology Consultants

Declaration Contents:

Disclaimers: *This EPD conforms to ISO 14025, 14040, 14044, and ISO 21930.*

Scope of Results Reported: *The PCR requirements limit the scope of the LCA metrics such that the results exclude environmental and social performance benchmarks and thresholds, and exclude impacts from the depletion of natural resources, land use ecological impacts, ocean impacts related to greenhouse gas emissions, risks from hazardous wastes and impacts linked to hazardous chemical emissions.*

Accuracy of Results: *Due to PCR constraints, this EPD provides estimations of potential impacts that are inherently limited in terms of accuracy.*

Comparability: *The PCR this EPD was based on was not written to support comparative assertions. EPDs based on different PCRs, or different calculation models, may not be comparable. When attempting to compare EPDs or life cycle impacts of products from different companies, the user should be aware of the uncertainty in the final results, due to and not limited to, the practitioner's assumptions, the source of the data used in the study, and the specifics of the product modeled.*

In accordance with ISO 21930:2017, EPDs are comparable only if they comply with the core PCR, use the same sub-category PCR where applicable, include all relevant information modules and are based on equivalent scenarios with respect to the context of construction works.

1. Gerdau Long Steel North America

Gerdau Company Profile

Gerdau is a leading producer of long steel in the Americas and one of the largest suppliers of special steel in the world. It is the largest recycler in Latin America and one of the largest recyclers in North America, transforming millions of tons of scrap into steel each year and reinforcing its commitment to sustainable development in the regions where it operates.

Gerdau's North American business division focus on long steel and special steel products including beams and piling, merchant bar quality, rebar, and special bar quality products. The company serves the construction, automotive, agricultural, service center and energy markets through its vertically integrated network of steel mills and metals recycling facilities.

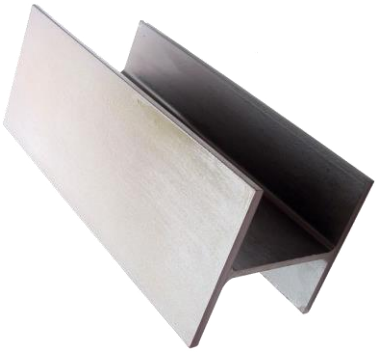
2. Products

2.1 PRODUCT DESCRIPTION

Gerdau is a global leader in the production of hot-rolled structural products. Gerdau Structural steel is manufactured from recycled steel – both pre-consumer and post-consumer scrap, demonstrating the company's commitment to environmentally-responsible steel production. From hospitals in Montreal to schools in Texas, from data halls to fulfillment centers across North America, and from the Panama Canal to the bays of Alaska, Gerdau beams and piling products have proven the company's commitment to consistently high production standards.

Gerdau produces four distinct beam shapes in North America, providing a range of geometries to suit applications from construction to manufacturing. Gerdau also produces three primary categories of piling, typically used in deep foundation and geo-technical construction projects, such as foundations, marine, environmental and transportation. The Midlothian Steel Mill in Texas produces Wide Flange Beams, Miscellaneous Beams, Standard I-Beams, H-Piling, PS Flat Sheet Piling, and other structural size shapes.

This Environmental Product Declaration is for 1 metric ton of fabricated structural steel produced by Gerdau in the Midlothian Steel Mill. Structural steel is manufactured from steel scrap, melted in an Electric Arc Furnace (EAF) followed by hot rolling, and by transport to external fabrication shops for fabrication of the final product.



2.2 PRODUCT FLOW DIAGRAM

A flow diagram illustrating the production processes and life cycle phases included in the scope of the EPD is provided below.

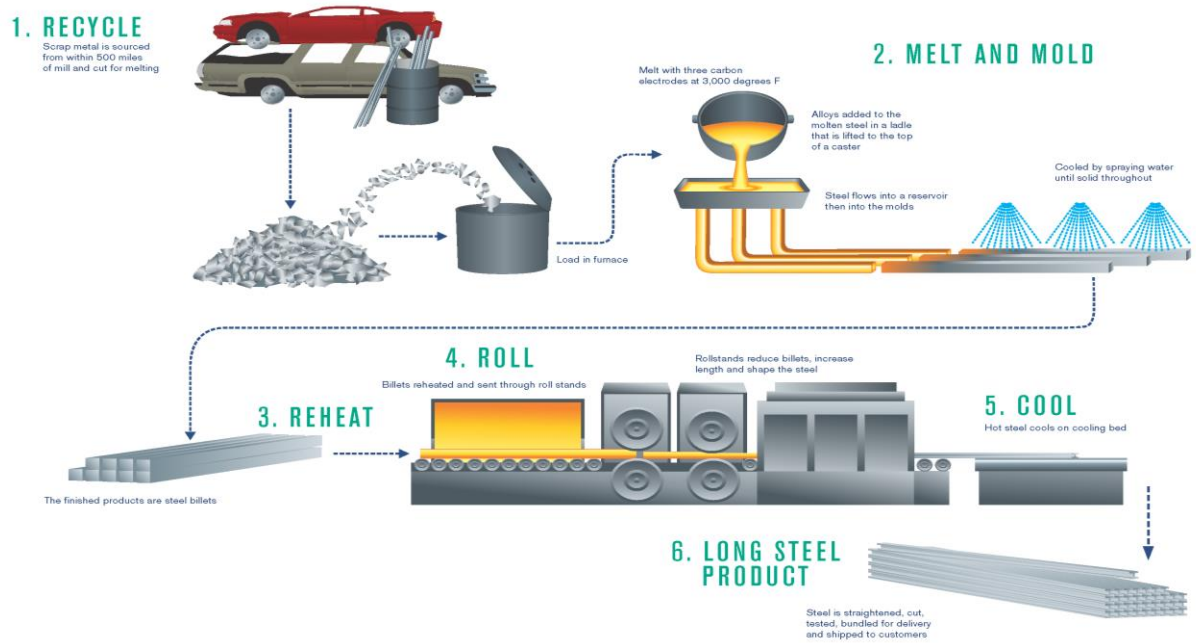


Figure 1. *Flow Diagram for the life cycle of the Gerdau structural steel.*

2.4 DECLARATION OF METHODOLOGICAL FRAMEWORK

The scope of the EPD is cradle-to-gate, including raw material extraction and processing, transportation, steel manufacture and rolling and structural steel fabrication. The life cycle phases included in the product system boundary are shown below.

Table 1. *Life cycle phases included in the Gerdau structural steel product system boundary.*

Product			Construction Process		Use							End-of-life				Benefits and loads beyond the system boundary
A1	A2	A3	A4	A5	B1	B1	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
Raw material extraction and processing	Transport to manufacturer	Manufacturing	Transport	Construction - installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	Deconstruction demolition	Transport	Waste processing	Disposal	Reuse, recovery and/or recycling potential
X	X	X	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND

X = Module Included | MND = Module Not Declared

Cut-off and allocation procedures are described below and conform to the PCR and ISO standards.

2.5 TECHNICAL DATA

Technical specifications for the structural steel in this study include structural steel meeting customer and industry standards such as ASTM A992.

2.6 INTENDED APPLICATION

The intended application of the structural steel is for use in providing structural support to buildings, foundations and other structures, and the products consists of a range of beam and piling products

2.7 MATERIAL COMPOSITION

The approximate material content of carbon steel structural steel will vary slightly from batch to batch. In general, the steel will contain < 97% recycled iron, < 2% Manganese, <1.5% Copper, <0.9% Carbon, and a total of 1.5% or less of Nickel, Silicon, Sulfur, Tin, Phosphorus, and Vanadium. Steel products used inside the building envelope (e.g., used in load-bearing applications present inside wall structures) do not include materials or substances which have any potential route of exposure to humans or flora/fauna in the environment.

2.8 PROPERTIES OF DECLARED PRODUCT AS DELIVERED

The structural steel is fabricated into a final shape by a fabricator, prior to shipment to a job site.

2.9 MANUFACTURING

The structural steel in this study is manufactured at the Midlothian, TX facility.

2.10 PACKAGING

Structural steel does not require packaging, and none is modeled in the present study.

2.11 FURTHER INFORMATION

Further information on the product can be found on the manufacturers' website at www.gerdau.com

3. LCA: Calculation Rules

3.1 DECLARED UNIT

The declared unit used in the study is defined as one (1) metric ton of fabricated structural steel, consistent with the PCR.

Table 2. *The modules and unit processes included in the scope for the Gerdau structural steel.*

Module	Module Description	Unit Processes Included in Scope
A1	Extraction and processing of raw materials; any reuse of products or materials from previous product systems; processing of secondary materials; generation of electricity from primary energy resources; energy, or other, recovery processes from secondary fuels	Raw material extraction and processing, including all activities necessary for the reprocessing steel scrap, including but not limited to the recovery or extraction and processing of feedstock materials. Transportation from primary production to Gerdau facilities; EAF steelmaking and manufacture of structural steel, including furnace and related process operation at the melt shop, creation of the billet, and the rolling of the final product
A2	Transport (to the fabricator)	Transportation from primary production facility in Midlothian, TX to offsite fabricator
A3	Structural Steel fabrication	Structural steel fabrication including cutting, drilling, fit up, bolting, and welding per customers' request
A4	Transport (to the building site)	Module Not Declared
A5	Construction-installation process	Module Not Declared
B1	Product use	Module Not Declared
B2	Product maintenance	Module Not Declared
B3	Product repair	Module Not Declared
B4	Product replacement	Module Not Declared
B5	Product refurbishment	Module Not Declared
B6	Operational energy use by technical building systems	Module Not Declared
B7	Operational water uses by technical building systems	Module Not Declared
C1	Deconstruction, demolition	Module Not Declared
C2	Transport (to waste processing)	Module Not Declared
C3	Waste processing for reuse, recovery and/or recycling	Module Not Declared
C4	Disposal	Module Not Declared
D	Reuse-recovery-recycling potential	Module Not Declared

3.4 UNITS

All data and results are presented using SI units.

3.5 ESTIMATES AND ASSUMPTIONS

- Representative inventory data were used to reflect the energy mix for electricity use. Supply mixes were modeled based on U.S. EPA eGRID 2019 subregion ERCT, in which the steel mill is located.
- Where necessary, the production of steel was modeled with unit process data taken from Ecoinvent 3.7.1. The datasets utilized for steel production are provided in Section 4.4
- Impacts for recycling EAF baghouse dust are modeled using the energy required to recycle zinc from the melting of steel scrap, based on Narita et al. 1999.
- Primary data for resource use (e.g., electricity, natural gas, water), waste/co-products, and emissions released, are allocated on a mass-basis to structural steel and co-products (e.g. EAF dust, slag, baghouse dust and millscale).
- Representative inventory data for raw materials and ancillary materials were modeled with unit process data taken from Ecoinvent.
- Disposal of manufacturing waste where unknown is modeled based for solid and hazardous waste generation and disposal in the United States, as specified in the PCR. Specifically, 80% of non-hazardous wastes are disposed in landfill and 20% incinerated. Transportation for end-of-life scenarios was modeled using the EPA WARM model assumption of 20 miles (~32 km), from the point of product use to a landfill, material recovery center, or waste incinerator. Ecoinvent datasets are used to model the impacts associated with incineration and landfilling, which does not include energy recovery from landfill gas.
- Primary data of material components (e.g., alloys, refractory materials) could not be modeled with actual process information, and representative data from the ecoinvent database were used to represent the alloy materials. Additionally, A2 and A3 were modeled with representative secondary data, but may vary considerably for a specific product.

The PCR requires the results for several inventory flows related to construction products to be reported including energy and resource use and waste and outflows. These are aggregated inventory flows, and do not characterize any potential impact; results should be interpreted considering this limitation.

3.6 CUT-OFF RULES

According to the PCR, processes contributing greater than 1% of the total environmental impact indicator for each impact are included in the inventory. No data gaps were allowed which were expected to significantly affect the outcome of the indicator results. No known flows are deliberately excluded from this EPD.

3.7 DATA SOURCES

Primary data were provided by Gerdau for their manufacturing facility. The sources of secondary LCI data are the Ecoinvent database, as well as the US LCI database.

Table 3. *Data sources for the Gerdau structural steel.*

Flow	Dataset	Data Source	Public-ation Date
Raw Materials and Consumables			
Ferro chrome	ferrochromium production, high carbon, 55% Cr | ferrochromium, high carbon, 55% Cr | Cutoff, U - RoW	Ecoinvent 3.7.1	2020
Ferromanganese,	ferromanganese production, high-coal, 74.5% Mn | ferromanganese, high-coal, 74.5% Mn | Cutoff, U – RoW	Ecoinvent 3.7.1	2020
Ferronickel	ferronickel production | ferronickel | Cutoff, U - GLO	Ecoinvent 3.7.1	2020
Ferro silicon	market for ferrosilicon | ferrosilicon | Cutoff, U – GLO,	Ecoinvent 3.7.1	2020
Silicomanganese	market for ferrosilicon | ferrosilicon | Cutoff, U – GLO, ferromanganese production, high-coal, 74.5% Mn | ferromanganese, high-coal, 74.5% Mn | Cutoff, U - RoW	Ecoinvent 3.7.1	2020
Calcium carbide	calcium carbide production, technical grade | calcium carbide, technical grade | Cutoff, U - RoW	Ecoinvent 3.7.1	2020
Fluorspar	fluorspar production, 97% purity | fluorspar, 97% purity | Cutoff, U - GLO	Ecoinvent 3.7.1	2020
Refractory	refractory production, basic, packed | refractory, basic, packed | Cutoff, U - RoW	Ecoinvent 3.7.1	2020
Electrodes	market for graphite | graphite | Cutoff, U - GLO	Ecoinvent 3.7.1	2020
Hard coal	market for hard coal | hard coal | Cutoff, U - RoW	Ecoinvent 3.7.1	2020
Coke products	market for petroleum coke | petroleum coke | Cutoff, U - GLO	Ecoinvent 3.7.1	2020
Lime products	market for quicklime, milled, loose | quicklime, milled, loose | Cutoff, U – RoW, lime production, milled, loose | lime | Cutoff, U - RoW	Ecoinvent 3.7.1	2020
Sand	market for sand | sand | Cutoff, U - RoW	Ecoinvent 3.7.1	2020
MgO	magnesium oxide production | magnesium oxide | Cutoff, U - RoW	Ecoinvent 3.7.1	2020
Silicon Carbide	silicon carbide production | silicon carbide | Cutoff, U - RoW	Ecoinvent 3.7.1	2020
FeAl, AlO2, Aluminum products	market for aluminium scrap, post-consumer, prepared for melting | aluminium scrap, post-consumer, prepared for melting | Cutoff, U – GLO, market for aluminium, cast alloy | aluminium, cast alloy | Cutoff, U – GLO, aluminium oxide production | aluminium oxide, metallurgical | Cutoff, U - RNA,	Ecoinvent 3.7.1	2020
FeCu	copper, anode to generic market for copper-rich materials | copper-rich materials | Cutoff, U - GLO	Ecoinvent 3.7.1	2020
Dolomite	dolomite production | dolomite | Cutoff, U - RoW	Ecoinvent 3.7.1	2020
FeB	boric oxide production | boric oxide | Cutoff, U - GLO	Ecoinvent 3.7.1	2020
Casi	cast iron production | cast iron | Cutoff, U - RoW	Ecoinvent 3.7.1	2020
Iron Pyrite	iron sulfate production | iron sulfate | Cutoff, U - RoW	Ecoinvent 3.7.1	2020
FeMolybdenum	molybdenum production | molybdenum | Cutoff, U - RoW	Ecoinvent 3.7.1	2020
FeTi	titanium production, primary | titanium, primary | Cutoff, U - GLO	Ecoinvent 3.7.1	2020
Oxygen, nitrogen and argon	air separation, cryogenic | oxygen, liquid | Cutoff, U - RoW Oxygen, liquid, at plant - RNA	Ecoinventv3.71 US LCI	2020 2012
Electricity/Heat			
Electricity	electricity voltage transformation from high to medium voltage | electricity, medium voltage | Cutoff, U modified for egrid 2019 subregion ERCT	Ecoinventv3.7.1 egrid 2019	2020 2021
Natural gas	heat and power co-generation, natural gas, conventional power plant, 100MW electrical | heat, district or industrial, natural gas | Cutoff, U (various locations)	Ecoinvent 3.7.1	2020
Diesel	market for diesel | diesel | Cutoff, U - RoW	Ecoinvent 3.7.1	2020
Light fuel oil	market for light fuel oil | light fuel oil | Cutoff, U - RoW	Ecoinvent 3.7.1	2020
Propane	market for propane | propane | Cutoff, U - GLO	Ecoinvent 3.7.1	2020
Transportation			
Rail	transport, freight train, diesel | transport, freight train | Cutoff, U - US	Ecoinvent 3.7.1	2020
Truck	transport, freight, lorry 16-32 metric ton, EURO4 | transport, freight, lorry 16-32 metric ton, EURO4 | Cutoff, U - RoW	Ecoinvent 3.7.1	2020
Ocean shipping	transport, freight, sea, container ship | transport, freight, sea, container ship | Cutoff, U - GLO	Ecoinvent 3.71	2020

3.8 DATA QUALITY

The data quality assessment addressed the following parameters: time-related coverage, geographical coverage, technological coverage, precision, completeness, representativeness, consistency, reproducibility, sources of data, and uncertainty.

Table 4. *Data quality assessment for the Gerdau structural steel product system.*

Data Quality Parameter	Data Quality Discussion
Time-Related Coverage: Age of data and the minimum length of time over which data is collected	For the most part, data are representative of the actual technologies used for processing, transportation, and manufacturing operations.
Geographical Coverage: Geographical area from which data for unit processes is collected to satisfy the goal of the study	Precision of results are not quantified due to a lack of data. Data collected for operations were typically averaged for one or more years and over multiple operations, which is expected to reduce the variability of results.
Technology Coverage: Specific technology or technology mix	The LCA model included all known mass and energy flows for production of structural steel. In some instances, surrogate data used to represent upstream and downstream operations may be missing some data which is propagated in the model. No known processes or activities contributing to more than 1% of the total environmental impact for each indicator are excluded.
Precision: Measure of the variability of the data values for each data expressed	Data used in the assessment represent typical or average processes as currently reported from multiple data sources and are therefore generally representative of the range of actual processes and technologies for production of these materials. Considerable deviation may exist among actual processes on a site-specific basis; however, such a determination would require detailed data collection throughout the supply chain back to resource extraction.
Completeness: Percentage of flow that is measured or estimated	The consistency of the assessment is considered to be high. Data sources of similar quality and age are used with a bias towards Ecoinvent v3.7.1 data where available. Different portions of the product life cycle are equally considered; however, it must be noted that final disposition of the product is based on assumptions of current average practices in Europe and the United States.
Representativeness: Qualitative assessment of the degree to which the data set reflects the true population of interest	Based on the description of data and assumptions used, this assessment would be reproducible by other practitioners. All assumptions, models, and data sources are documented.
Consistency: Qualitative assessment of whether the study methodology is applied uniformly to the various components of the analysis	Data from the Gerdau manufacturing facilities represent an annual average and are considered of high quality due to the length of time over which these data are collected, as compared to a snapshot that may not accurately reflect fluctuations in production. The Ecoinvent database is used for secondary LCI datasets.
Reproducibility: Qualitative assessment of the extent to which information about the methodology and data values would allow an independent practitioner to reproduce the results reported in the study	Uncertainty related to materials in the structural steel is moderate. Specifically, some alloys were not available in the secondary datasets are were modeled with proxy datasets. Actual supplier data for upstream operations was not available for steel suppliers or fabrication, and the study relied upon the use of existing representative datasets. These datasets contained relatively recent data (<10 years) but lacked geographical representativeness. Uncertainty related to the impact assessment methods used in the study are high. The impact assessment method required by the PCR includes impact potentials, which lack characterization of providing and receiving environments or tipping points.
Sources of the Data: Description of all primary and secondary data sources	For the most part, data are representative of the actual technologies used for processing, transportation, and manufacturing operations.
Uncertainty of the Information: Uncertainty related to data, models, and assumptions	Precision of results are not quantified due to a lack of data. Data collected for operations were typically averaged for one or more years and over multiple operations, which is expected to reduce the variability of results.

3.9 PERIOD UNDER REVIEW

The period of review is January 01, 2020 through December 31, 2020.

3.10 ALLOCATION

With respect to the steel scrap, the 100-0 recycled content approach is used in which the recycled material bears only the burden of any processing from waste material.

Mass allocation was deemed the most accurate and reproducible way of calculating the energy and material requirements for the manufacture of structural steel and co-products. Primary data for resource use (e.g., electricity, natural gas, water), waste/co-products, and emissions released, are allocated on a mass-basis as a fraction of total annual production of structural steel and the co-products, including EAF slag, millscale and baghouse dust.

The transportation from primary producer of material components (e.g., alloys, fluxes) to steel mill is based on primary data provided by Gerdau, including modes, distances, and amount of steel transported from each supplier to the Gerdau. Transportation was allocated on the basis of the mass and distance the material was transported.

3.11 COMPARABILITY

The PCR this EPD was based on was not written to support comparative assertions. EPDs based on different PCRs, or different calculation models, may not be comparable. When attempting to compare EPDs or life cycle impacts of products from different companies, the user should be aware of the uncertainty in the final results, due to and not limited to, the practitioner's assumptions, the source of the data used in the study, and the specifics of the product modeled.

When comparing EPDs created using this PCR, variations and deviations are possible. Example of variations: Different LCA software and background LCI datasets may lead to different results for upstream or downstream of the life cycle stages declared.

4. LCA: Scenarios and Additional Technical Information

Manufacturing

Electric arc furnace (EAF) steelmaking and rolling occurs at the Midlothian, TX facility. Electricity is modeled using ecoinvent v3.7.1 and modified to meet the grid mix for the ERCT eGRID 2019 subregion, the subregion in which the facility is located.

Transportation of waste materials at manufacturing assumes a 20 mile (~32 km) average distance to disposal, where unknown, consistent with assumptions used in the US EPA WARM model. Assumed disposal rates for nonhazardous wastes are based on US EPA MSW statistics rate of 20% incineration and 80% landfilled. The overall majority of hazardous waste at Gerdau facilities are recycled with only a small amount going to landfills. Recycling of EAF dust is discussed in section 3.5 and based on actual modes of transport and distances, provided by the manufacturer.

5. LCA: Results

Results of the Life Cycle Assessment are calculated using Life Cycle Impact Assessment (LCIA) methods. Two LCIA methods are reported in this EPD:

1) TRACI (Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts), developed by the U.S. EPA with a primarily North American focus; and

2) CML-IA, developed at Leiden University in The Netherlands.

The following environmental impact category indicators are reported using characterization factors based on the TRACI 2.1 and CML-IA impact assessment methods. It is noted that LCA results are relative expressions and do not predict impacts on category endpoints, the exceeding of thresholds, safety margins or risks.

CMLI-A Impact Category	Unit	TRACI 2.1 Impact Category	Unit
Global Warming Potential **(GWP)**	kg CO_2 eq	Global Warming Potential **(GWP)**	kg CO_2 eq
Depletion potential of the stratospheric ozone layer **(ODP)**	kg CFC 11 eq	Ozone Depletion Potential **(ODP)**	kg CFC 11 eq
Acidification Potential of soil and water **(AP)**	kg SO_2 eq	Acidification Potential **(AP)**	kg SO_2 eq
Eutrophication Potential **(EP)**	kg PO_4^{3-} eq	Eutrophication Potential **(EP)**	kg N eq
Photochemical Oxidant Creation Potential **(POCP)**	kg C_2H_4 eq	Smog Formation Potential **(SFP)**	kg O_3 eq
Abiotic depletion potential **(ADP-elements)** for non-fossil resources	kg Sb eq	Fossil Fuel Depletion Potential **(FFD)**	MJ Surplus, LHV
Abiotic depletion potential **(ADP-fossil fuels)** for fossil resources	MJ, LHV	-	-

These 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.

The following inventory parameters, specified by the PCR, are also reported.

Resources	Unit	Waste and Outflows	Unit
RPR_E: Renewable primary resources used as energy carrier (fuel)	MJ, LHV	**HWD:** Hazardous waste disposed	kg
RPR_M: Renewable primary resources with energy content used as material	MJ, LHV	**NHWD:** Non-hazardous waste disposed	kg
$NRPR_E$: Non-renewable primary resources used as an energy carrier (fuel)	MJ, LHV	**HLRW:** High-level radioactive waste, conditioned, to final repository	kg
$NRPR_M$: Non-renewable primary resources with energy content used as material	MJ, LHV	**ILLRW:** Intermediate- and low-level radioactive waste, conditioned, to final repository	kg
SM: Secondary materials	MJ, LHV	**CRU:** Components for re-use	kg
RSF: Renewable secondary fuels	MJ, LHV	**MR:** Materials for recycling	kg
NRSF: Non-renewable secondary fuels	MJ, LHV	**MER:** Materials for energy recovery	kg
RE: Recovered energy	MJ, LHV	**EE:** Recovered energy exported from the product system	MJ, LHV
FW: Use of net freshwater resources	m^3	-	-

Table 5. *Life Cycle Impact Assessment (LCIA) results for 1 metric ton of Gerdau fabricated structural steel. Results reported in MJ are calculated using lower heating values. All values are rounded to three significant digits.*

Impact Category	Life cycle stage			
	A1	A2	A3	Total (A1-A3)
CML-IA				
GWP (kg CO_2 eq)	779	37.6	83.0	900
	86.6%	4.2%	9.2%	100%
AP (kg SO_2 eq)	1.46	0.143	0.234	1.83
	79.4%	7.8%	12.8%	100%
EP (kg $(PO_4)^{3-}$ eq)	1.48	0.0333	0.244	1.75
	84.2%	1.9%	13.9%	100%
POCP (kg C_2H_4 eq)	0.123	0.00476	0.0137	0.142
	87.0%	3.4%	9.7%	100%
ODP (kg CFC-11 eq)	$7.45x10^{-5}$	$6.86x10^{-6}$	$6.40x10^{-6}$	$8.77x10^{-5}$
	84.9%	7.8%	7.3%	100%
ADPE (kg Sb eq)	$5.42x10^{-6}$	$3.42x10^{-7}$	$1.30x10^{-6}$	$7.06x10^{-6}$
	76.8%	4.8%	18.4%	100%
ADPF (MJ)	10,600	564	1,330	12,500
	84.9%	4.5%	10.6%	100%
TRACI 2.1				
GWP (kg CO_2 eq)	769	37.5	81.9	888
	86.6%	4.2%	9.2%	100%
AP (kg SO_2 eq)	1.66	0.168	0.225	2.06
	80.9%	8.2%	11.0%	100%
EP (kg N eq)	3.28	0.0393	0.559	3.88
	84.6%	1.0%	14.4%	100%
SFP (kg O_3 eq)	22.2	4.17	2.35	28.7
	77.3%	14.5%	8.2%	100%
ODP (kg CFC-11 eq)	$9.12x10^{-5}$	$9.13x10^{-6}$	$8.34x10^{-6}$	$1.09x10^{-4}$
	83.9%	8.4%	7.7%	100%
FFD (MJ eq)	1,480	82.6	166	1,730
	85.6%	4.8%	9.6%	100%

Neg = negligible

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 6. *Resource use and waste flows for one metric ton of Gerdau fabricated structural steel. Results reported in MJ are calculated using lower heating values. All values are rounded to three significant digits.*

Parameter	Life cycle stage			
	A1	A2	A3	Total (A1-A3)
Resources				
RPR_E (MJ)	650	7.63	115	773
	84.1%	0.986%	14.9%	100%
RPR_M (MJ)	Neg.	Neg.	Neg.	Neg.
	n/a	n/a	n/a	n/a
$NRPR_E$ (MJ)	5,210	542	906	6,660
$NRPR_M$ (MJ)	0.00	0.00	0.00	0.00
SM (MT)	1.00	0.00	0.00	1.00
	100%	0.00%	0.00%	100%
RSF/NRSF (MJ)	Neg	Neg	Neg	Neg
RE (MJ)	Neg	Neg	Neg	Neg
FW (m^3)	1.72	0.356	0.590	2.67
	64.6%	13.3%	22.1%	100%
Wastes				
HWD (kg)	0.00824	0.00250	0.00102	0.0108
	76.5%	14.0%	9.49%	100%
NHWD (kg)	208	27.6	14.5	250
	83.2%	11.0%	5.78%	100%
HLRW (kg)	0.00333	$4.38x10^{-5}$	$5.82x10^{-4}$	0.00396
	84.2%	1.11%	14.7%	100%
ILLRW (kg)	0.0171	0.00391	0.00371	0.0247
	69.1%	15.8%	15.0%	100%
CRU (kg)	0.00	0.00	0.00	0.00
MR (kg)	71.3	0.00	77.1	148
	48.1%	0.00%	51.9%	100.0%
MER (kg)	Neg	Neg	Neg	Neg
EE (MJ)	Neg	Neg	Neg	Neg

Neg = negligible

The PCR requires the calculation of carbon emissions and removals, all of which are negligible due to the fact that no biogenic carbon is included in the product and any packaging is negligible.

Unfabricated Structural Steel

The values shown in Tables 5 and 6 account for losses of steel scrap during the fabrication process. To account for this scrap, the value in A1 represents 1.077 metric tons of steel produced. Table 7 below provides the TRACI 2.1 100 year GWP for one metric ton of structural steel, prior to downstream transport or fabrication into a final shape.

Table 7. *100-year Global Warming Potential, based on TRACI 2.1, for one metric ton of unfabricated structural steel.*

Cradle-to-Gate Mill Product (MT CO2e per 1 metric ton unfabricated steel)
0.713

6. LCA: Interpretation

The contributions to total impact indicator results are dominated by the product manufacturing phase (A1), followed by the fabrication stage (A3) for most indicators, except smog formation potential in which the second greatest life cycle stage is transportation.

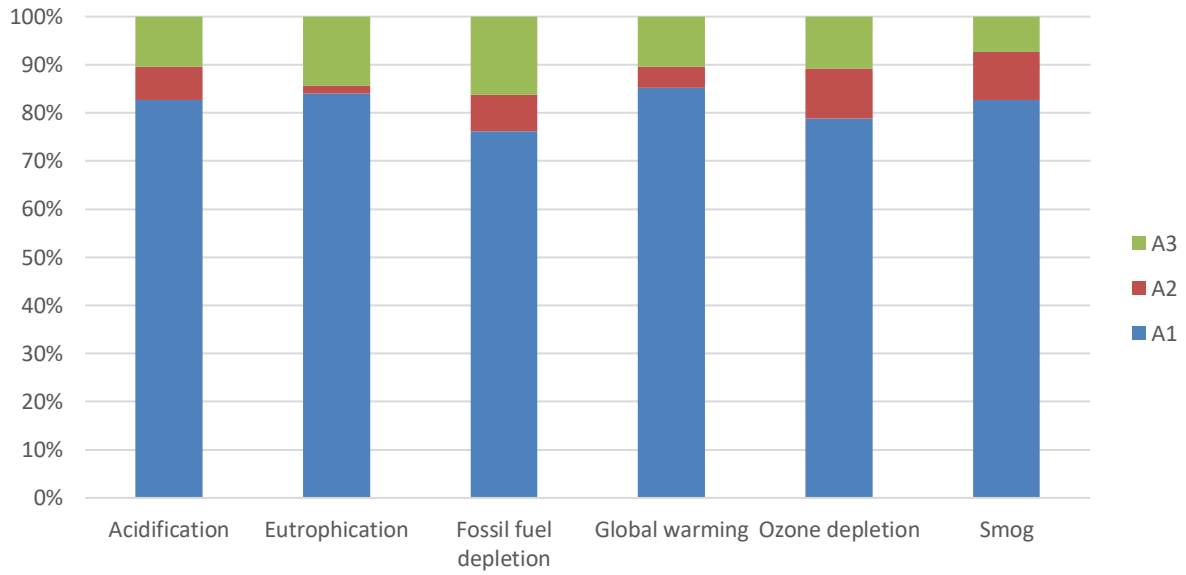


Figure 2. *Contribution analysis for the Gerdau fabricated structural steel.*

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