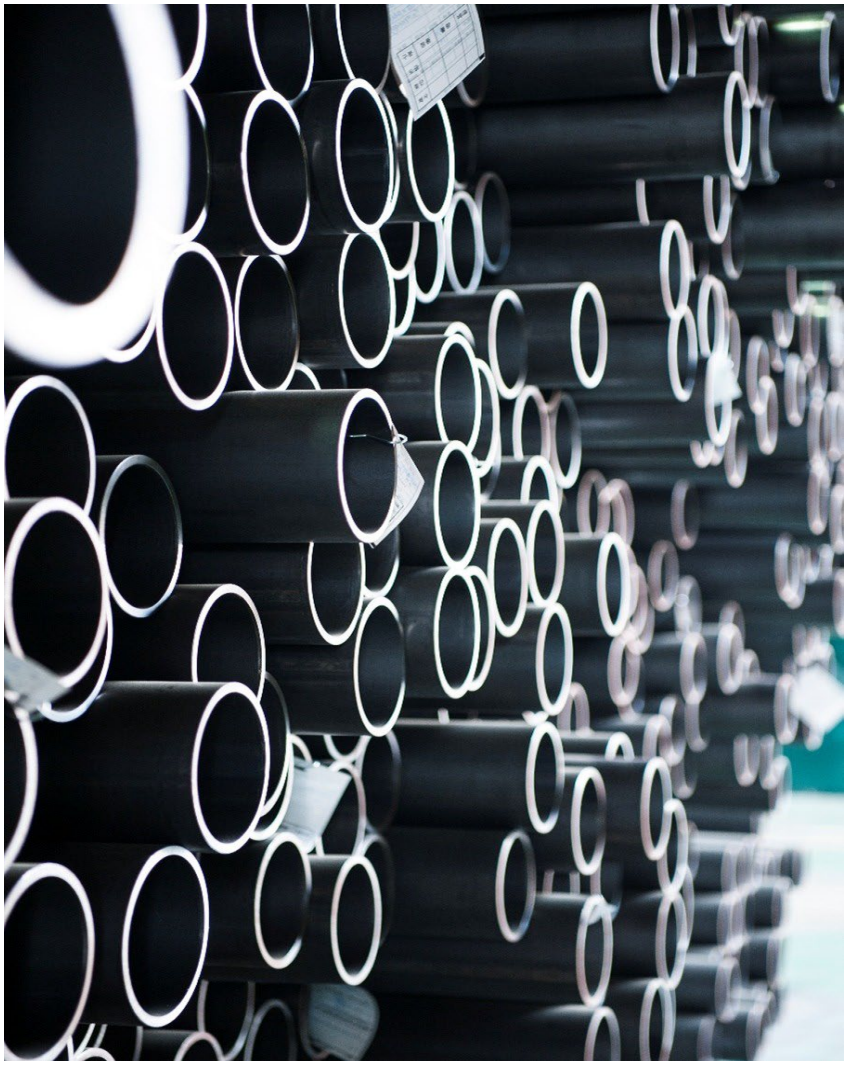
ENVIRONMENTAL PRODUCT DECLARATION

ERW STEEL PIPE

HUSTEEL



Welded carbon steel pipes are manufactured by using high frequency electric resistance welding.

Since founding in 1967, the steel company HUSTEEL has grown for half a century. Now we stand as representatives of steel pipe companies in Korea. We, as a global pipe leader, have been nourishing our resolve to realize even bigger dream. As a result, we have grown into a valuable company that moves the hearts of customers with our production capacity, high-tech equipment for global competitiveness and with the mind which considers its fellow men and environment to be of upmost importance, we continue to exceed expectations.

HUSTEEL has produced a variety of steel pipes used in a variety of industries, including oil and natural gas mining, transportation, and daily life such as API, CSA, ASTM, AS, EN, KS, JIS standards.

We have introduced the equipment for high-strength heavy wall thickness pipe in Korea and supplied high-quality products which have been acknowledged universally.

HUSTEEL has raised the standard of the industry, raising the competitiveness in Korea. HUSTEEL has been faithful in its role as a leader in global steel pipe industry through innovative technologies and high-quality products.

UL CERTIFIED ENVIRONMENTAL PRODUCT DECLARATION UL.COM/EPD

ENVIRONMENTAL PRODUCT DECLARATION

HUSTEEL

Steel Pipe
Designated Steel Construction Production

According to ISO 14025,
and ISO21930:2017

EPD PROGRAM AND PROGRAM OPERATOR NAME, ADDRESS, LOGO, AND WEBSITE	UL Solutions www.ul.com 333 Pfingsten Rd, Northbrook IL, 60062 www.spot.ul.com
GENERAL PROGRAM INSTRUCTIONS AND VERSION NUMBER	Ul Solutions Program Operator Rules v2.7 2022
MANUFACTURER NAME AND ADDRESS	HUSTEEL CO.,LTD. - 131, Bugokgongdan-ro, Songak-eup, Dangjin-si, Chungchengnam-do,31721, Korea - 150, Daebulsandan3-ro, Youngam-gun, Jeollanam-do, 58452, Korea
DECLARATION NUMBER	4791685858.101.2
DECLARED PRODUCT & FUNCTIONAL UNIT OR DECLARED UNIT	1 metric ton
REFERENCE PCR AND VERSION NUMBER	Part A : Calculation Rules for the LCA and Requirements Project Report, (IBU/UL Environment, v4.0) and Part B: Designated Steel Construction Product EPD Requirement (UL Envirnoment, v2.0)
DESCRIPTION OF PRODUCT APPLICATION/USE	ERW pipe for Casing and Tubing, Line pipe, Ordinary piping, Pressure purpose pipe, Structural hollow section, Boiler tube, Mechanical tube and etc
PRODUCT RSL DESCRIPTION (IF APPL.)	N/A
MARKETS OF APPLICABILITY	Global
DATE OF ISSUE	June 10th , 2025
PERIOD OF VALIDITY	5 Years
EPD TYPE	Product-specific
RANGE OF DATASET VARIABILITY	[Industry-average only; mean, median, standard deviation]
YEAR(S) OF REPORTED PRIMARY DATA	2024.03~2025.02
LCA SOFTWARE & VERSION NUMBER	Gabi LCA software (Version 10.6.1.35)
LCI DATABASE(S) & VERSION NUMBER	Professional database 2023 Extension database XVII and full US 2023& Ecoinvent 3.8
LCIA METHODOLOGY & VERSION NUMBER	IPCC AR6 + TRACI 2.1

The PCR review was conducted by:	UL Solutions PCR Review Panel epd@ul.com
This declaration was independently verified in accordance with ISO 14025: 2006. ☐ INTERNAL ☒ EXTERNAL	Cooper McCollum, UL Solutions
This life cycle assessment was conducted in accordance with ISO 14044 and the reference PCR by:	SMaRT ECO
This life cycle assessment was independently verified in accordance with ISO 14044 and the reference PCR by:	Sung Mo Yeon, H.I.P Pathway

LIMITATIONS

Exclusions: EPDs do not indicate that any environmental or social performance benchmarks are met, and there may be impacts that they do not encompass. LCAs do not typically address the site-specific environmental impacts of raw material extraction, nor are they meant to assess human health toxicity. EPDs can complement but cannot replace tools and certifications that are designed to address these impacts and/or set performance thresholds – e.g. Type 1 certifications, health assessments and declarations, environmental impact assessments, etc.

Accuracy of Results: EPDs regularly rely on estimations of impacts; the level of accuracy in estimation of effect differs for any particular product line and reported impact.

Comparability: EPDs from different programs may not be comparable. Full conformance with a PCR allows EPD comparability only when all stages of a life cycle have been considered. However, variations and deviations are possible". Example of variations: Different LCA software and background LCI datasets may lead to differences results for upstream or downstream of the life cycle stages declared.

ENVIRONMENTAL PRODUCT DECLARATION

HUSTEEL

Steel Pipe
Designated Steel Construction Production

According to ISO 14025,
and ISO 21930:2017

Product Definition and Information

Description of Company

With the spirit of Quality and Customer satisfaction, Husteel has grown with pride as a company specialized in manufacturing steel pipes In order to meet various needs of our customers, we produced our products with the best technology and the latest facilities to satisfy our customers.

In 1995, we introduced the 24 ERW Mill in Daebul plant to produce large-diameter steel pipes. In 2005, we introduced the FFX-mill, which is the most advanced steel making facility in Korea, to Dangjin plant. In 2012, we introduced high-strength-heavy-wall facility which can produce 18mm wall at 8 ERW mill with excellent weldability and appearance to replace the seamless pipe.

Based on these latest production facilities and the highest level of technical expertise, we have grown into a world-class steel pipe maker with solid financial structure and annual production capacity of 1 million tons of ERW pipes. In 2015, We acquired Daegu plant, which is equipped with STS manufacturing facilities, and expanded our business area to STS steel pipes, thus making a second leap towards higher ideals.In addition, the Gunsan plant, which installed a roll bender and JCO line for the production of large-diameter SAW steel pipes in 2024, was completed.

Husteel, who grew up with the affection of customers, will become the world's leading company through the vision of Global Pipe Leader with U .

Product name

Product name: ERW STEEL PIPE

HUSTEEL

CERTIFIED
ENVIRONMENTAL PRODUCT DECLARATION
UL.COM/EPD

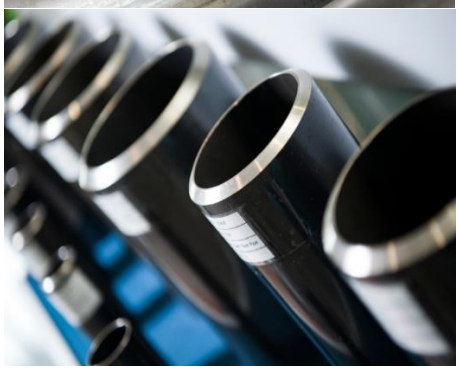
Steel Pipe
Designated Steel Construction Production

According to ISO 14025, and ISO 21930:2017

Product description

The welding method of welded carbon steel pipes is high-frequency electric resistance welding, and is generally called ERW steel pipes.
The production capacity is 1/2 ~ 24” of O.D, up to 0.866” of wall thickness and 60ft of length.
The applications of welded carbon steel pipes are Line pipe, Casing and Tubing, Pressure purpose pipe, Structural hollow section, Ordinary pipe, Pile, Pressure purpose pipe, Mechanical tube, Boiler tube and etc., and they come in the form of circular and square steel pipe.






Application

PRODUCTS	
Oil & Gas Pipes	▪ Tubing & Casing (OCTG) : to extract oil and natural gas ▪ Line Pipe : to transfer oil and natural gas
General Pipes	▪ Standard Pipe: to transfer lower pressured steam, gas, and water ▪ Fuel Pipe : to transfer fuel and gas ▪ Pressure Pipe : to use under 350MPa(52,000PSI)
Structural Pipes	▪ Standard Pipe : for civil engineering, construction, steel tower, pile, pillar and etc. ▪ Square steel Pipe : for civil engineering, construction and etc. ▪ Pipe Pile : for civil engineering, construction and etc.
Etc	▪ Conduit Pipe : used to protect wires ▪ Boiler tube & HRSG Pipe : used for boiler tube, heat exchanger in petrochemical plant

Product Specification

Complies with the Korean Industrial Standard (KS D 3507, KS D 3562, KS D 3565, KS D 3566, KS D 3568, KS D 3517, KS D 3777, KS D 3631, KS D 3632, KS D 3864, KS D 3563, KS F 4602)
Complies with the Japan Industrial Standard (JIS G 3452, JIS G 3454, JIS G 3444, JIS G 3445, JIS G 3466, JIS G 3461, JIS A 5525)
Complies with the American Petroleum Institute (API 5L, API 5CT)
Complies with the American Society for Testing Materials (ASTM A53, ASTM A178, ASTM A214, ASTM A252, ASTM A500, ASTM A513)
Complies with the Canadian Standards Association (CSA Z245.1)
Complies with the Australian Standard & New Zealand Standard (AS/NZS 1163)
Complies with the European Standard (EN 10217-1, EN 10219-1, EN 10255)

Material Composition

Table 1. API/CSA Material

Unit : Max, %

STANDARD	GRADE	C	SI	MN	P	S	V	NB	TI	OTHER
API 5L	B PSL1	0.26	-	1.20	0.030	0.030	V+Nb ≤ 0.06 V+Nb+Ti ≤ 0.15			-
	X42 PSL1	0.26	-	1.30	0.030	0.030	V+Nb+Ti ≤ 0.15			-
	X52 PSL2	0.22	0.45	1.40	0.025	0.015	V+Nb+Ti ≤ 0.15			a
	X56 PSL2	0.22	0.45	1.40	0.025	0.015	V+Nb+Ti ≤ 0.15			a
	X60 PSL2	0.12	0.45	1.60	0.025	0.015	V+Nb+Ti ≤ 0.15			b
	X65 PSL2	0.12	0.45	1.60	0.025	0.015	V+Nb+Ti ≤ 0.15			b

STANDARD	GRADE	C	SI	MN	P	S	V	NB	TI	OTHER
API 5CT	X70 PSL2	0.12	0.45	1.70	0.025	0.015	V+Nb+Ti ≤ 0.15			b
	J55 PSL1	-	-	-	0.030	0.030	-	-	-	-
	K55 PSL1	-	-	-	0.030	0.030	-	-	-	-
CSAZ245.1	All grade	0.26	0.50	2.00	0.030	0.035	0.11	0.11	0.11	c

a. Cu ≤ 0.50%; Ni ≤ 0.30%; Cr ≤ 0.30%; Mo ≤ 0.15%; B ≤ 0.001%
b. Cu ≤ 0.50%; Ni ≤ 0.50%; Cr ≤ 0.50%; Mo ≤ 0.50%; B ≤ 0.001%
c. B ≤ 0.001%

Table 2. ASTM Material

Unit : Max, %

STANDARD	GRADE	C	SI	MN	P	S	V	OTHER
ASTM A53	B	0.30	-	1.20	0.050	0.045	0.08	a
ASTM A252	All Grade	-	-	-	0.050	-	-	-
ASTM A500	B	0.30	-	1.40	0.045	0.045	-	-
	C	0.27	-	1.40	0.045	0.045	-	-

a. Cu ≤ 0.40%; Ni ≤ 0.40%; Cr ≤ 0.40%; Mo ≤ 0.15%

Table 3. AS/EN Material

STANDARD	GRADE	C	SI	MN	P	S	V	OTHER
AS/NZS 1163	C350L0	0.20	0.25	1.60	0.030	0.030	0.10	a
EN10217-1	P235TR1	0.16	0.35	1.20	0.025	0.020	0.02	b
EN10217-1	P265TR1	0.20	0.40	1.40	0.025	0.020	0.02	b
EN10219-1	S355J2H	0.22	0.55	1.60	0.030	0.030	-	-

a. Cu ≤ 0.25%; Ni ≤ 0.25%; Cr ≤ 0.15%; Mo ≤ 0.10%, Al ≤ 0.10%, Ti ≤ 0.04%
b. Cu ≤ 0.30%; Ni ≤ 0.30%; Cr ≤ 0.30%; Mo ≤ 0.08%, Nb ≤ 0.10%, Ti ≤ 0.04%

Usage areas and conditions, Application Rules

Represent Ordinary piping, Mechanical tube, Structural hollow section, Pile, Boiler tube, Pressure purpose pipe, (Threaded) Casing and Tubing, Line pipe and etc

Production process

No.	Step	Descripton
1	Slitting	Process to shearing hot rolled coil into skelp according to the pipe size using slitter.
2	Uncoiling	The process of unwinding a coil or skelp and feeding it into the forming process.
3	Edge Miling	Process of machining the edge surfaces on both sides of the coil(or skelp) to ensure weldability and to match the desired material width
4	Forming	Process of transforming a flat coil or skelp into a circular pipe shape by passing it sequentially through a roll stand.
5	Welding(ERW)	Process of joining both edges of a coil or skelp formed into a pipe shape using high-frequency electric resistance welding.
6	Heat treatment	Process of partially heat treating only the welded area using inductors.
7	Cooling	Process to cool down heat-treated welds with air and water.
8	Sizing	Process of adjusting pipe outside diameter and roundness according to specification requirements.
9	Cutting	Process to cut the pipe length as per customer requirements.
10	End Facing	Process of machining both ends of pipe cut to customer or specification requirements.
11	Hydrostatic Test	Process of applying hydraulic pressure to the inside of a pipe to check for leaks.
12	Non-destructive Test	Process of detecting defects in the welds and base material of a pipe using ultrasonic, eddy current, etc. non-destructively.
13	Marking	Process of displaying information on the surface of a pipe according to customer or specification requirements
14	Final Inspection	Process of inspecting the dimensions and appearance of the final product to determine whether it passes or fails.
15	Varnish Coating	Process of applying varnish to the surface of a product to prevent corrosion temporarily.

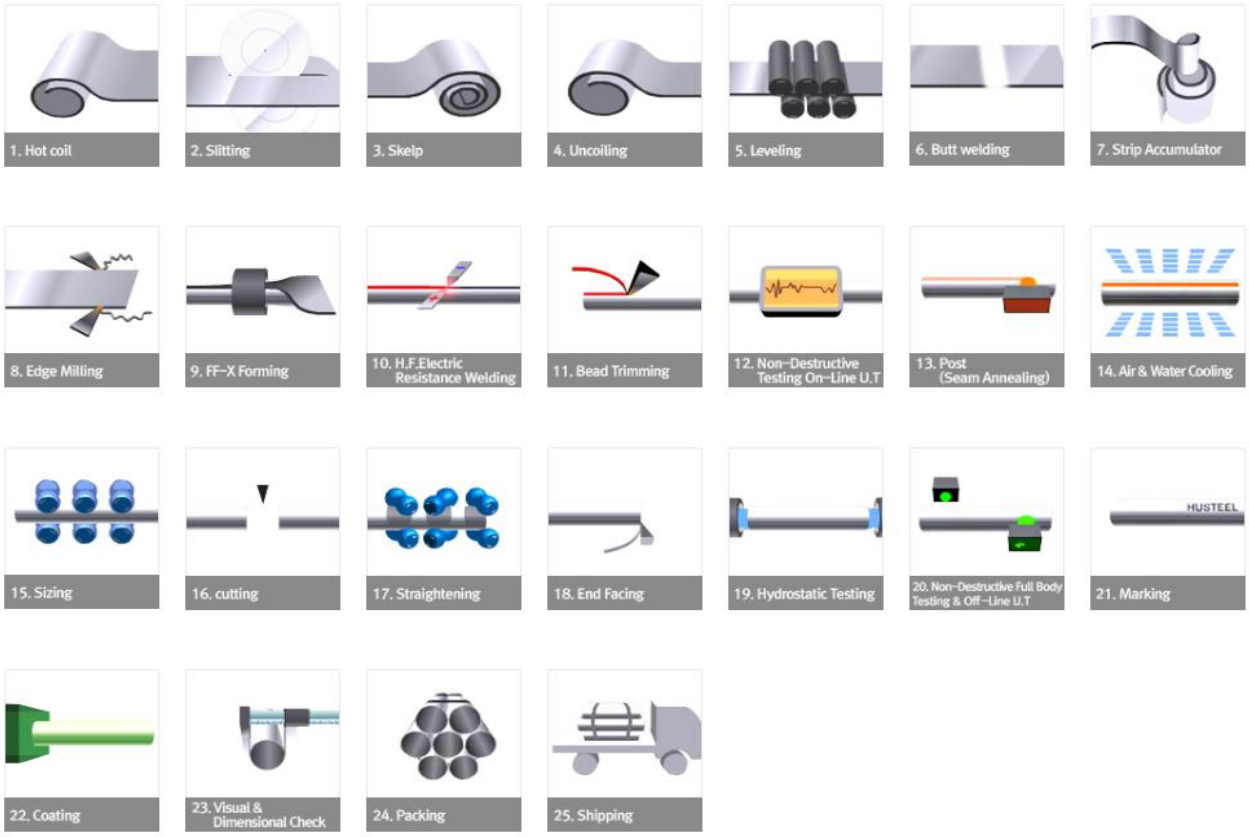


Figure 1 Manufacturing Process

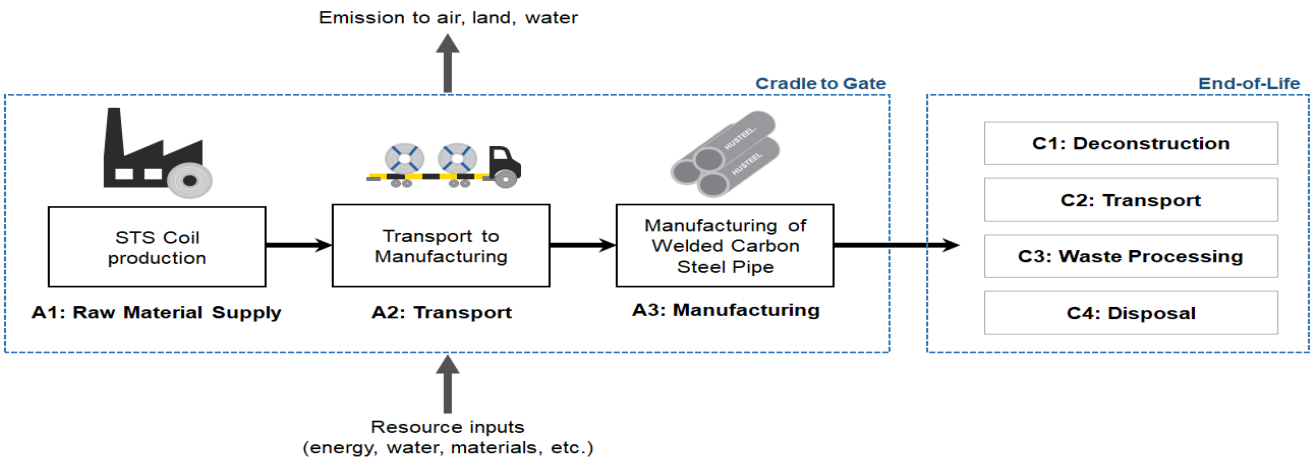


Figure 2 Process Flow Diagram

Methodological Framework

Goal of the study

This study aims to assess the environmental impact of Electric Resistance Welding(ERW) pipes. The results of the life cycle assessment (LCA) study were verified by a third party because they will disclose to the product purchaser. The product purchaser includes both Business-to-Business (B2B) and Business-to-Consumer (B2C) customers.

Reference PCR

This LCA study was conducted according to Part A: Life Cycle Assessment Calculation Rules and Report Requirements, (UL Environment, V4. 28.03.2022) and Part B: Designated Steel Construction Product EPD Requirements (UL Environment, V2.0, 26.08.2020).

Declared unit

The declared unit is 1 metric ton of steel pipe product.

Table 5. Declared Unit

NAME	AMOUNT	UNIT
ERW Steel Pipe	1	Metric Ton
Conversion Faction(density)	7.847	g/cm3

Reference service life

Not applicable

System Boundary

Per the PCR, this cradle-to-gate with options(End of life) analysis provides information of the Product Stage of the ERW steel pipe product life cycle, Including modules product stage(A1~A3), end of life stage (C1~C4) and benefits and recycling potential (D) boundary.

The system boundary was defined in accordance with the PCR and ISO 14044. In this LCA, capital goods (e.g., machinery, buildings) and infrastructure flows (e.g., roads, utilities) were excluded from the system boundary in accordance with the general rules of the PCR.

PRODUCT STAGE			CONSTRUCT-ION PROCESS STAGE		USE STAGE							END OF LIFE STAGE				BENEFITS AND LOADS BEYOND THE SYSTEM BOUNDARY
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
Raw material supply	Transport	Manufacturing	Transport from gate to site	Assembly/Install	Use	Maintenance	Repair	Replacement	Refurbishment	Building Operational Energy Use During Product Use	Building Operational Water Use During Product Use	Deconstruction	Transport	Waste processing	Disposal	Reuse, Recovery, Recycling Potential
X	X	X	MND	MND	MND	MND	MND	MND	MND	MND	MND	X	X	X	X	X

*X = module included, MND = module not declared

■ **Module A1:** Raw material extraction and processing

- Extraction and production of raw materials and auxiliary materials

- Supply of process utilities, including electricity and process gases

■ **Module A2**: Transport to manufacturer

- Land transportation of steel plate and auxiliary materials

■ **Module A3**: Manufacturing of ERW steel pipes

- Supply of process utilities, including process water

- Manufacturing ERW steel pipes at high-frequency electric resistance welding process

- Waste treatment of process wastes and emissions

■ **Module C1-4, D:** End-of-Life and Resource recovery

- Deconstruction & Demolition

-Transport to waste processing unit

-Disposal

-Recycling of the end of life of the products

■ **Module A4,5, B1~B7**: System boundary exclusions

- Modules (A4,5, B1 through B7) that correspond to configuration and use according to PCR are excluded from the system boundary.

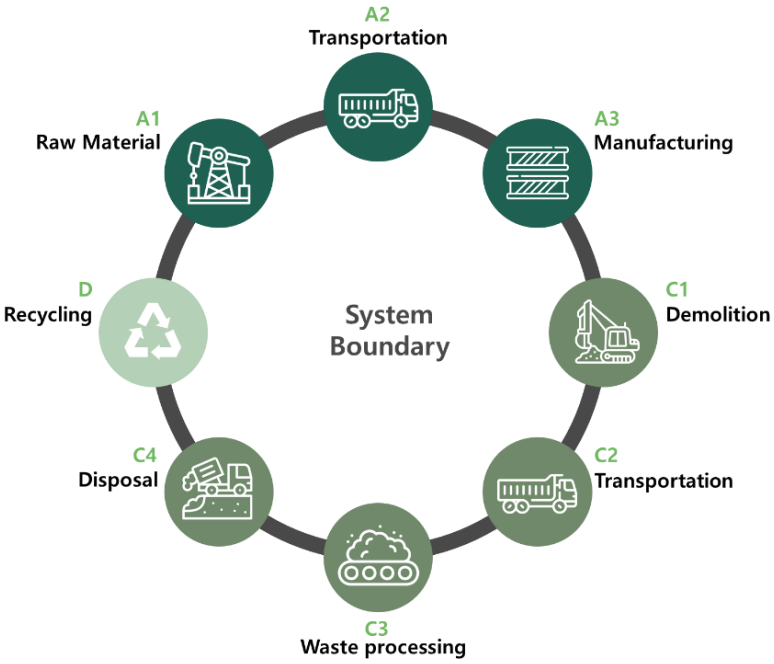


Figure 3 System boundary

Cut-off rules

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

Allocation rules

During the product manufacturing process, co-products such as steel scrap are generated. According to the PCR (Part A), due to significant revenue disparities between the product and co-products, economic allocation was applied in the assessment.

Table 5. Difference in revenue between product and the co-product

NAME	FACTORY	VALUE	UNIT
Difference in revenue*	Dangjin	74	%
	Daebul	72	%

* Percentage Difference in revenue = (ERW PIPE price - Scrap price)/ERW PIPE price *100

Data Quality Assessment

For the data quality assessment, the following requirements are considered.

- Time related coverage: Primary data from on-site was collected during the March 2024 to February 2025
- Geographical coverage: Primary data was collected from Dangjin and Daebul HUSTEEL manufacturer. For the End of life stage, we assumed environmental impacts per disposal stage and linked secondary data from the US, EU, etc.
- Technology coverage: Primary data current was collected from current manufacturing ERW steel pipes
- Source of the data: The data used for this Life cycle assessment is ERW steel pipe production data for March 2024 to February 2025. Products are produced at the Dangjin and Daebul HUSTEEL Factory. All input and output data were collected in the Manufacturing Execution Systems (MES) and enterprise resources planning (ERP) system where the data is sorted by product and process unit. The collected data are the primary data such as measurement, engineering calculations and purchasing records.
- Precision: Measure of the variability of the data value for each data expressed.
- Completeness: Percentage of flow that is measure or estimated.
- Consistency: Quality assessment of the degree to which the data set reflects the true population of interest.
- Reproducibility: Quality 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 of the information: Minimize any uncertainly about the data, models, etc

Technical Information and Scenarios

Data calculation

Information regarding raw materials, raw material transportation, energy use, resource consumption, and emissions was compiled based on an annual per site.
Manufacturing of ERW steel pipe (Module A3)
Source of the data
-The data used for this Life cycle assessment is ERW steel pipe production data for March 2024 to February 2025. Products are produced at the Dangjin and Daebul HUSTEEL manufacturer. Since the product is produced at both the Dangjin and Daebul factories, a weighted average was calculated based on the production weight from each factory. All input and output data were collected in the Manufacturing Execution Systems (MES) and enterprise resources planning (ERP) system where the data is sorted by product and process unit. The collected data are the primary data such as measurement, engineering calculations and purchasing records.

Factory production ratio

NAME	FACTORY	VALUE	UNIT
Production volume	Dangjin	64	%
	Daebul	36	%

* The results for the Dangjin and Daebul factories were calculated by reflecting their respective production volume ratios.

Utility
-The electricity and water consumption data were collected using utility bills representing the overall usage for the entire factory. The data corresponding to each process were distributed based on the production quantity for each process.

Waste
- The types of generated waste include forming oil, waste oil generated from the use of thinner and varnish, and scrap residues from the process.

Waste water
- Although forming oil may be generated as wastewater, it is treated as waste oil and consigned to a waste disposal company; therefore, no wastewater treatment process is involved.

Assumptions and limitations

Transport to manufacturer (Module A2)
- The transportation distance for raw materials was optimized by applying the shortest distance between the manufacturing plant and HUSTEEL factory.

Manufacturing of ERW steel pipe (Module A3)
Co-product
- The product of HUSTEEL is ERW steel pipes and Scrap. The ERW steel pipes are considered as the target product of LCA. All scraps from HUSTEEL are sold. The scrap cannot be treated as waste but co-product which need allocation.

Process water
- Process water is utilized as cooling water by mixing with rust preventive oil. Part of the process water is treated as waste rather than being discharged as wastewater. The difference between the input water volume and the output associated with water-containing waste is considered as evaporative loss.

Utility
- Electricity is not separately allocated, but is used directly in the ERW steel pipe manufacturing process. At the Dangjin plant, only waste organic solvents are subject to allocation, as they are managed on a whole-facility basis.
- CO2 used is purchased in a liquid state and is used as the welding gas. It is assumed that the amount of CO2 gas used is emitted during the process.

Waste
-The transportation distance for waste materials was optimized by applying the shortest distance between the HUSTEEL factory and the waste disposal facility.

End-of-Life and Resource recovery (Module C1-C4, D)
De-construction demolition (C1)
- The energy consumption during the demolition process averages 10 kWh/m2 (Bozdag, Ö & Seçer, M. 2007). A reinforced concrete building has an average mass of about 1000 kg/m2. Consequently, the energy consumption during demolition is 10 kWh per declared unit, which is equivalent to 1 metric ton. A conservative assumption has been made that the energy consumed during the demolition of a steel building is the same as that of a concrete building. The source of energy is derived from diesel fuel used by industrial equipment. We assessed this energy consumption by converting it through diesel fuel production and combustion.

Transport to the waste processing site (C2)
- We assume that all waste is collected and transported to the waste treatment center. The transportation distance to the waste treatment center is set at 300 km, and we assume that lorries, Euro 0-6 mix, are the chosen transportation method.

Waste processing (C3)
- In PCR part A, it is stated that 97% of the Structural steel is assumed to be recycled, while 0% is assumed to undergo incineration. Please consult Table 7 for disposal assumptions specific to different regions.

Disposal (C4)
- According to PCR part A, it is assumed that 3% of the Structural steel is sent to landfills. Please refer to Table 7 for regional product disposal assumptions.

Reuse-Recovery-Recycling-potential (D)
- During the recycling process, 97% of the end-of-life product is converted into recycled steel.

Scenarios (C1~C4, D Module)

Table 7. End of Life & Benefits and loads beyond the system boundary (C1-C4 & D)

NAME		VALUE	UNIT
Assumptions for scenario	Energy consumption during the demolition	10	kWh
Collection process specified by type	Collected separately	-	kg
	Collected with mixed construction waste	1.00 E+03	kg
Recovery system specified by type Deposition	Re-use	-	kg
	Recycling	9.70 E+02	kg
	Incineration	0.00 E+00	kg
	Landfill	3.00 E+01	kg
Assumptions	For waste transport	300	km

Table 8. Benefits and loads beyond the system Boundary (D)

NAME	VALUE	UNIT
Recycling rate of product	97	%

LCA Software

Gabi LCA software (Version 10.7.0.183) was used to measure the lifecycle inventory profile and lifecycle impact results.All the background data relevant for modelling were taken from the Ecoinvent Database 3.8, Professional database 2023 Extension database XVII and full US 2023

Life Cycle Impact Assessment (LCIA) methodology

The following methodologies were used for LCA.
- TRACI 2.1
- IPCC AR6

Units and Quantities

The International System of Units (SI units) shall be used for both LCA and EPD. The quantities shall be represented with a maximum of three significant figures.

Environmental Parameters Derived from LCA

life cycle impact assessment (LCIA) results are declared using TRACI 2.1 methodology, except for GWP which is reported using the IPCC AR6.

LCIA results are relative expressions and do not predict actual impacts, the exceeding of thresholds, safety margins or risks. Life cycle assessment results of manufacturing ERW pipes process are presented per the declared unit. And no substances required to be reported as hazardous are associated with the production of this product.

A declared unit shall be applied if the precise function of the product is not stated or not known. The declared unit shall be one (1) metric ton and optionally one (1) short ton for steel construction products. Conversion factors (e.g. density, thickness, surface area, etc.) shall be provided in order to allow the users to conduct further calculations (e.g. transport impacts).

Environmental Impact results based on a declared unit of a steel product 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 5.1 for additional EPD comparability guidelines

Table 9. LCA resluts, per 1 metric ton

PARAMETER	UNIT	A1	A2	A3	C1	C2	C3	C4	D
GWP 100	kg CO_2 eq	2.57E+03	4.09E+01	5.32E+00	6.37E-01	3.03E+00	8.22E+01	1.76E+01	-1.68E+03
ODP	kg CFC-11 eq	2.46E-05	8.12E-07	1.92E-08	1.75E-10	1.23E-10	1.07E-13	3.87E-07	4.55E-11
AP	kg SO2 eq	9.11E+00	1.34E-01	4.63E-03	8.34E-03	4.18E-02	5.41E-01	8.75E-02	-3.32E+00
EP	kg N eq	1.08E+01	3.42E-02	6.93E-03	3.64E-04	2.49E-03	3.97E-02	2.41E-02	-1.98E-01
SFP	kg O3 eq	1.41E+02	2.67E+00	1.28E-01	1.02E-01	1.33E+00	1.22E+01	2.41E+00	-3.58E+01
ADP fossil	MJ, LHV	1.56E+03	7.47E+01	7.97E-01	8.20E+00	5.75E+00	1.63E+02	4.11E+01	-2.12E+00

Table 10. Resource use indicators, per 1 metric ton

PARAMETER	UNIT	A1	A2	A3	C1	C2	C3	C4	D
RPR_E	MJ, LHV	2.27E+03	9.50E+00	2.83E-01	0.00E+00	0.00E+00	6.45E+01	4.04E+00	6.61E+02
RPR_M	MJ, LHV	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00
RPR_T	MJ, LHV	2.27E+03	9.50E+00	2.83E-01	0.00E+00	0.00E+00	6.45E+01	4.04E+00	6.61E+02
$NRPR_E$	MJ, LHV	3.47E+04	5.74E+02	7.85E+00	5.96E+01	4.19E+01	1.14E+03	3.18E+02	-1.68E+04

PARAMETER	UNIT	A1	A2	A3	C1	C2	C3	C4	D
$NRPR_M$	MJ, LHV	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00
$NRPR_T$	MJ, LHV	3.47E+04	5.74E+02	7.85E+00	5.96E+01	4.19E+01	1.14E+03	3.18E+02	-1.68E+04
SM	kg	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00
RSF	MJ, LHV	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00
NRSF	MJ, LHV	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00
RE	MJ, LHV	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00
FW	m3	2.49E+01	7.59E-02	4.40E-03	0.00E+00	0.00E+00	7.30E-02	1.85E-01	-1.70E+02

Table 11. Output flows and waste category indicators, per 1 metric ton

PARAMETER	UNIT	A1	A2	A3	C1	C2	C3	C4	D
HWD	kg	7.84E+02	5.39E-01	1.48E+00	0.00E+00	0.00E+00	5.45E-09	3.23E-01	-1.25E-04
NHWD	kg	6.72E-03	2.47E-03	0.00E+00	0.00E+00	0.00E+00	1.63E-01	0.00E+00	2.03E+02
RWD	kg	1.15E-06	2.74E-05	0.00E+00	0.00E+00	0.00E+00	1.40E-03	0.00E+00	1.84E-03
CRU	kg	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00
MR	kg	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00	9.70 E+02	0.00 E+00	0.00 E+00
MER	kg	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00
EE	MJ, LHV	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00

Table 12. Carbon emissions and removals, per 1 metric ton

PARAMETER	UNIT	A1	A2	A3	C1	C2	C3	C4	D
BCRP	kg CO_2	0.00 E+0.0	0.00 E+0.0	0.00 E+0.0	0.00 E+0.0	0.00 E+0.0	0.00 E+0.0	0.00 E+0.0	0.00 E+0.0
BCEP	kg CO_2	0.00 E+0.0	0.00 E+0.0	0.00 E+0.0	0.00 E+0.0	0.00 E+0.0	0.00 E+0.0	0.00 E+0.0	0.00 E+0.0
BCRK	kg CO_2	0.00 E+0.0	0.00 E+0.0	0.00 E+0.0	0.00 E+0.0	0.00 E+0.0	0.00 E+0.0	0.00 E+0.0	0.00 E+0.0
BCEK	kg CO_2	0.00 E+0.0	0.00 E+0.0	0.00 E+0.0	0.00 E+0.0	0.00 E+0.0	0.00 E+0.0	0.00 E+0.0	0.00 E+0.0
BCEW	kg CO_2	0.00 E+0.0	0.00 E+0.0	0.00 E+0.0	0.00 E+0.0	0.00 E+0.0	0.00 E+0.0	0.00 E+0.0	0.00 E+0.0
CCE	kg CO_2	0.00 E+0.0	0.00 E+0.0	0.00 E+0.0	0.00 E+0.0	0.00 E+0.0	0.00 E+0.0	0.00 E+0.0	0.00 E+0.0
CCR	kg CO_2	0.00 E+0.0	0.00 E+0.0	0.00 E+0.0	0.00 E+0.0	0.00 E+0.0	0.00 E+0.0	0.00 E+0.0	0.00 E+0.0
CWNR	kg CO_2	0.00 E+0.0	0.00 E+0.0	0.00 E+0.0	0.00 E+0.0	0.00 E+0.0	0.00 E+0.0	0.00 E+0.0	0.00 E+0.0

Life Cycle Interpretation

According to the impact assessment results (excluding the D module), Module A1, which raw material supply, including input of materials for product production and purchased electricity generation, was found to have the most significant contribution to the potential environmental impacts of the OF Structure across all impact categories. Module A2, involving transportation to the manufacturing facility, have a little contribution to ODP compared with Module A1. Additionally, Module A3 within the manufacturing sector was found not to have a significant contribution to any environmental impact category.

End of life stage(C1 to C3), especially transportation to the waste processing site(C2) has a significant contribution to the potential environmental impacts across AP and SFP.

Module D

The results from Module D signify the benefits or impacts associated with recycling and recovery at the end-of-life stage of the product. Particularly, the pace of processes related to steel recycling may undergo changes over time. The current findings are estimated based on the methodology utilizing current industry-average data, aiming to project future benefits or impacts.

These outcomes should be considered in light of potential technological advancements, shifts in environmental policies , or updates within the industry that may occur in the future. Additionally, these results rely on presently available infor mation, warranting consideration of uncertainty and comparability. Continuous monitoring and updates may be necess ary for a better understanding of changes in the future.

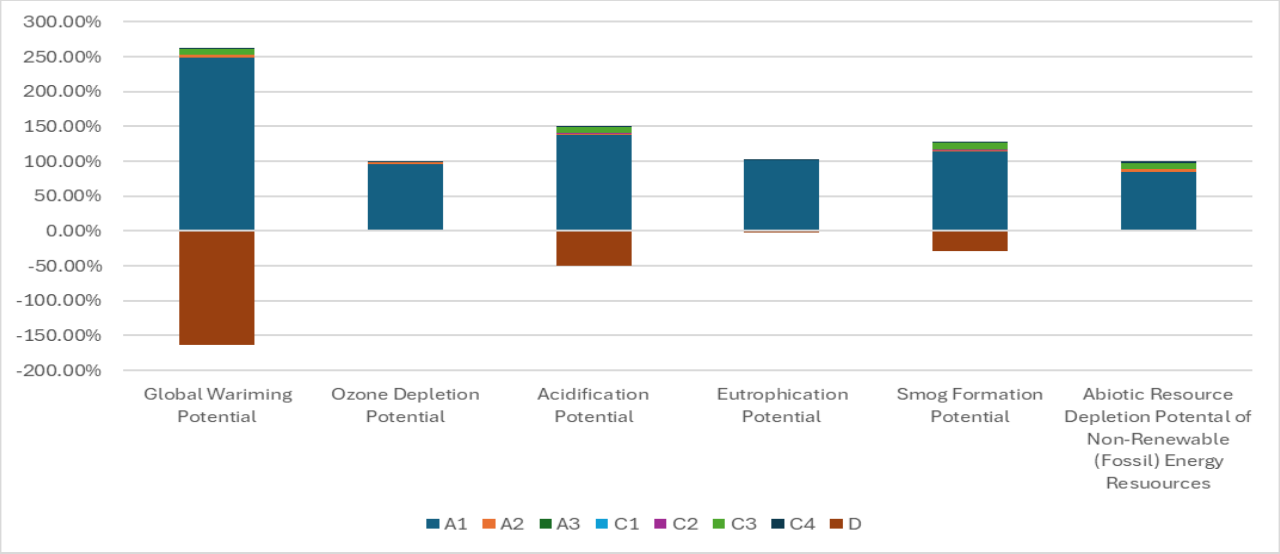


Figure 4 Impact Assessment results

Sensitivity Analysis

Sensitivity analysis (SA) is a crucial tool for assessing the robustness of results and their sensitivity to uncertain factors in life cycle assessment (LCA).

We conducted a sensitivity analysis based on the change in the database geography for the electricity used as utility of all process. The database used for this sensitivity analysis is shown in Table 13. Result 1 applied the Korea geography electricity, high-voltage database, while Result 2 utilized the GLO (Global) geography electricity, high-voltage database. These results are presented in Table 14. Sensitivity percentages indicate the difference between the two LCA results. Result 1 and Result 2 exhibit a variance of 0.15% at the production stage(A1~A3).

Table 13. Electricity, high voltage DB in the module A1

PARAMETER	GEOGRAPHY COVERAGE	INDICATOR	FACTOR	UNIT
Result 1	KR	KR: market for electricity, high voltage ecoinvent 3.10	6.92E-01	kg CO2 eq
Result 2	GLO	GLO: market group for electricity, high voltage ecoinvent 3.10	7.10E-01	kg CO2 eq

Table 14. Sensitivity Analysis

PARAMETER	UNIT	A1-A3	C1	C2	C3	C4	D
Result 1 (GWP)	kg CO_2 eq	2.62E+03	6.37E-01	3.03E+00	8.22E+01	1.76E+01	-1.68E+03
Result 2 (GWP)	kg CO_2 eq	2.65E+03	6.37E-01	3.03E+00	8.22E+01	1.76E+01	-1.68E+03
Sensitivity		1.28%	0.00%	0.00%	0.00%	0.00%	0.00%

Limitation

The assumptions, the data sources, the system boundaries and other methodological choices can differ between studies, possibly resulting in contradicting results between LCA studies. Consequently, LCA should not be regarded as a single method but as a complement to other tools and frameworks

Recommendations

According to the impact assessment results, it can be observed that the impact from the input of raw materials during the product manufacturing is the most significant. In the production of ERW steel pipes, environmental impact can be reduced through the use of recycled materials and efficient process management.

Additional Information

Environmental, safety and health management system during the manufacturing process are in accordance with the following standards and certificates; ISO 14001, ISO 45001.
Husteel fulfills its social responsibility for the environment in all aspects of its corporate management activities and has established an environmental management system that complies with ISO 14001 requirements to minimize the impact of all organizational activities, products, and services on the environment.
In addition, Husteel places “safety and health” as the top priority in management and establishes an effective “safety and health system” to create a safe workplace.

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